Cisco ONS 15454 DWDM Reference Manual

Cisco ONS 15454, Cisco ONS 15454-M2, and Cisco ONS 15454-M6
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Preface

Note The terms "Unidirectional Path Switched Ring" and "UPSR" may appear in Cisco literature. These terms do not refer to using Cisco ONS 15xxx products in a unidirectional path switched ring configuration. Rather, these terms, as well as "Path Protected Mesh Network" and "PPMN," refer generally to Cisco's path protection feature, which may be used in any topological network configuration. Cisco does not recommend using its path protection feature in any particular topological network configuration.

This section explains the objectives, intended audience, and organization of this publication and describes the conventions that convey instructions and other information.

This section provides the following information:

- Revision History
- Document Objectives
- Audience
- Document Organization
- Related Documentation
- Document Conventions
- Obtaining Optical Networking Information
- Obtaining Documentation and Submitting a Service Request

Revision History

Date	Notes
May 2010	• Added the section “Flexible Protection Mechanism” in the chapter “Transponder and Muxponder Cards”. • Updated the table “Single-Mode Fiber XFP Port Cabling Specifications” in the appendix “Hardware Specifications”.
June 2010	• Updated the table “ONS 15454 Security Levels—Node View” in the chapter “Security Reference”.

Date	Notes
July 2010	• Updated the table “SFP/XFP Card Compatibility” in the chapter “Transponder and Muxponder Cards”. • Updated the section “40G-MXP-C Card Specifications” in the appendix “Hardware Specifications”. • Updated the sub-section “Key Features” under the section “40G-MXP-C Card” in the chapter “Transponder and Muxponder Cards”. • Updated the following sections: – Updated the key features for the MXP_MR_10DME card in the chapter, Transponder and Muxponder Cards. – Updated the section, Y-cable protection in the chapter, Transponder and Muxponder Cards.
August 2010	• Updated the table “Node View (Single-Shelf Mode) or Shelf View (Multishelf Mode) Tabs and Subtab” in the chapter, “Cisco Transport Controller Operation”. • Updated the tables “SFP Specifications” and “Single-Mode Fiber SFP Port Cabling Specifications” in the appendix “Hardware Specifications”.
September 2010	• Updated the table “SFP/XFP Card Compatibility” in the chapter “Transponder and Muxponder Cards”. • Updated the “OTU2_XP Card” section in the Chapter “Transponder and Muxponder Cards”. • Added the FAPS switching criteria in the section, “Layer 2 Over DWDM Protection” in the chapter, “Transponder and Muxponder Cards”.
October 2010	• Updated the "Class 1M Laser Product Statement" section in the chapters “Optical Amplifier Cards”, “Multiplexer and Demultiplexer Cards”, “Optical Add/Drop Cards”, “Reconfigurable Optical Add/Drop Cards”, and “Transponder and Muxponder Cards”. • Updated the table “Internal Patchcord Ports” in the chapter “Optical Channel Circuits and Virtual Patchcords Reference”.
November 2010	• Updated the “SFP/XFP Card Compatibility” table in the “Transponder and Muxponder Cards” chapter with a new footnote. • Updated the section, “SNMP in Multishelf Management” in the chapter, SNMP. • Updated the width of the single slot cards for Control cards and Transponder and Muxponder Cards in the appendix, "Hardware Specifications". • Updated the table “SFP/XFP Card Compatibility” in the chapter “Transponder and Muxponder Cards”. • Updated the tables “SFP Specifications” and “Single-Mode Fiber SFP Port Cabling Specifications” in the appendix, “Hardware Specifications”.
December 2010	• Updated the table "ONS 15454 Security Levels—Node View" in the chapter "Security Reference".
January 2011	• Updated the width of all the cards in the appendix, "Hardware Specifications". • Updated the section “40G-MXP-C Card” and the table “40G-MXP-C Card Port-Level Indicators” i nthe chapter “Transponder and Muxponder Cards”.
March 2011	• Removed the table “8G Fibre Channel (FC) Payload PMs for the 40G-MXP-C Card” in the chapter, “Performance Monitoring”.

Date	Notes
April 2011	• Updated the section “Interllink Interfaces” and the table “SFP/XFP Card Compatibility” in the chapter “Transponder and Muxponder Cards”. • Updated the table, “XFP Specifications” in the chapter, “Hardware Specifications”. • Updated the section “Safety Labels” in the following chapters: – Common Control Cards – Optical Service Channel Cards – Optical Amplifier Cards – Multiplexer and Demultiplexer Cards – Tunable Dispersion Compensating Units – Optical Add/Drop Cards – Reconfigurable Optical Add/Drop Cards – Transponder and Muxponder Cards • Updated the section “Node View (Multishelf Mode), Node View (Single-Shelf Mode), and Shelf View (Multishelf Mode)” in the chapter “Cisco Transport Controller Operation”. • Updated the section “SFP and XFP Modules” in the chapter “Transponder and Muxponder Cards”. • Updated the power values in the “Individual Card Power Requirements” table in the appendix, “Hardware Specifications”.
May 2011	• Updated the section “SFP and XFP Modules” in the chapter “Transponder and Muxponder Cards”. • Removed the sections “SFP Specifications” and “XFP Specifications” and added the section “SFP and XFP Specifications” in the appendix “Hardware Specifications”. • Updated the minimum output power value for the MXP_MR_10DMEX_C card in the appendix “Hardware Specifications”.
June 2011	• Updated the section “Y-Cable Protection” in the chapter “Transponder and Muxponder Cards”. • Updated the sections “MXP_2.5G_10EX_C Card Specifications” and “TXP_MR_10EX_C Card Specifications” in the chapter “Hardware Specifications”. • Updated the TNC and TSC card power consumption values in Table A-1 in the chapter “Hardware Specifications”.
July 2011	• Added a note in the “PC and UNIX Workstation Requirements” section of Chapter, “Cisco Transport Controller Operation”.
August 2011	• Updated the sub-section “Configuration Management” under the section “OTU2_XP Card” in the chapter “Transponder and Muxponder Cards”. • Updated the section “40G-MXP-C Card” in the chapter “Transponder and Muxponder Cards”.

Date	Notes
September 2011	• Updated the key features section of TXP_MR_10G, TXP_MR_10E, TXP_MR_10E_C, TXP_MR_10E_L, TXP_MR_10EX_C, and OTU2_XP cards in the chapter “Transponder and Muxponder Cards”. • Added a note to SONET PM Parameters table in “SONET PM Parameter Definitions” section. • Replaced G.975.1 with G.975.1 I.7 and added a note in the "Enhanced FEC (E-FEC) Feature" section in the chapter, "Transponder and Muxponder Cards". • Created a “Summary Pane” section in the chapter, “Cisco Transport Controller Operation”.
October 2011	• Removed the Temperature table and updated the Temperature section with standard operating temperature values, removed the Environmental section from all the 15454 card specifications, and added "Environmental Exception" to “40G-MXP-C Card Specifications” section in the appendix "Hardware Specifications."
December 2011	• Updated the power values in the table “Individual Card Power Requirements” in the appendix “Hardware Specifications”. • Updated the section “Termination Modes” in the chapter “Transponder and Muxponder Cards”.
January 2012	• Updated the section “GE_XP, 10GE_XP, GE_XPE, and 10GE_XPE Cards” with pluggable limitations in the chapter Transponder and Muxponder Cards”.
February 2012	• Removed the autonegotiation support statement for ADM-10G card from the “Key Features” section in the chapter “Transponder and Muxponder Cards”.
March 2012	• Updated the section, “Multishelf Node” in the chapter, “ Node Reference”.
April 2012	• Updated the “Functional View for an Eight-Sided Node” diagram in the chapter “Node Reference”. • Added a note in the “Displaying Optical Power” section of chapter, “Node Reference”. • Updated the "Faceplate and Block Diagram" section of "GE_XP, 10GE_XP, GE_XPE, and 10GE_XPE Cards" in the chapter, “Transponder and Muxponder Cards”. • Upadted the section “SNMP in Multishelf Management” in the chapter “SNMP”.
May 2012	Updated the section “Optical Channel Circuits” in the chapter “Optical Channel Circuits and Virtual Patchcords Reference”.
June 2012	Updated the section “Generic Threshold and Performance Monitoring MIBs” in the chapter “SNMP”.
July 2012	Document Part Number revisioned to 78-19285-02 and a full length book-PDF was generated.

Document Objectives

This document provides background and reference material for Cisco ONS 15454 dense wavelength division (DWDM) systems.

Audience

To use this publication, you should be familiar with Cisco or equivalent optical transmission hardware and cabling, telecommunications hardware and cabling, electronic circuitry and wiring practices, and preferably have experience as a telecommunications technician.

Document Organization

Table 1 Cisco ONS 15454 Reference Manual Chapters

Title	Summary
Chapter 1, "Cisco ONS 15454 (ANSI and ETSI), ONS 15454 M2, and ONS 15454 M6 Shelf Assembly"	Provides a description of Cisco ONS 15454 (ANSI and ETSI),Cisco ONS 15454 M2, and Cisco ONS 15454 M6 shelf assemblies.
Chapter 2, "Common Control Cards"	Includes descriptions of the TCC2, TCC3, TCC2P, AIC-I, and MS-ISC-100T cards.
Chapter 3, "Optical Service Channel Cards"	Includes descriptions of OSCM and OSC-CSM cards.
Chapter 4, "Optical Amplifier Cards"	Includes descriptions of the OPT-PRE, OPT-BST, OPT-BST-E, OP-BST-L, OPT-AMP-L, OPT-AMP-C, and OPT-AMP-17-C cards, as well as card temperature ranges and card compatibility.
Chapter 5, "Multiplexer and Demultiplexer Cards"	Includes descriptions of the Protection Switching Module (PSM) card used in Cisco ONS 15454 dense wavelength division multiplexing (DWDM) networks.
Chapter 6, "Tunable Dispersion Compensating Units"	Explains the Tunable Dispersion Compensating Units (T-DCU) used in Cisco ONS 15454 dense wavelength division multiplexing (DWDM) networks.
Chapter 7, "Protection Switching Module"	Includes descriptions of the 32-MUX-O, 32DMX-O, and 4MD-xx.x cards.
Chapter 8, "Optical Add/Drop Cards"	Includes descriptions of the AD-1C-xx.x, AD-2C-xx.x, AD-4C-xx.x, AD-1B-xx.x, and AD-4B-xx.x cards, card temperature ranges, compatibility, and applications.

Table 1 Cisco ONS 15454 Reference Manual Chapters (continued)

Title	Summary
Chapter 9, "Reconfigurable Optical Add/Drop Cards"	Includes descriptions of the 32WSS, 32WSS-L, 32DMX, 32DMX-L, 40-DMX-C, 40-DMX-CE, 40-MUX-C, 40-WSS-C, 40-WSS-CE, 40-WXC-C, and MMUC cards, card temperature ranges, compatibility, and applications.
Chapter 10, "Transponder and Muxponder Cards"	Includes information about ransponder (TXP), muxponder (MXP), GE_XP, 10GE_XP, and ADM-10G cards, as well as their associated plug-in modules (Small Form-factor Pluggables [SFPs or XFPs]).
Chapter 11, "Node Reference"	Explains the DWDM node types t available for the ONS 15454. The DWDM node type is determined by the type of amplifier and filter cards that are installed in an ONS 15454. Also explains the DWDM automatic power control (APC), reconfigurable optical add/drop multiplexing (ROADM) power equalization, span loss verification, and automatic node setup (ANS) functions.
Chapter 12, "Network Reference"	Explains the DWDM network applications and topologies. Also provides network-level optical performance references.
Chapter 13, "Optical Channel Circuits and Virtual Patchcords Reference"	Explains the DWDM optical channel (OCH) circuit types and virtual patchcords that can be provisioned. Circuit types include the OCH client connection (OCHCC), the OCH trail, and the OCH network connection (OCHNC).
Chapter 14, "Cisco Transport Controller Operation"	Describes Cisco Transport Controller (CTC), the software interface for the Cisco ONS 15454.
Chapter 15, "Security Reference"	Provides information about Cisco ONS 15454 users and security.
Chapter 16, "Timing Reference"	Provides information about Cisco ONS 15454 users and node timing.
Chapter 17, "Management Network Connectivity"	Provides an overview of ONS 15454 data communications network (DCN) connectivity. Cisco Optical Networking System (ONS) network communication is based on IP, including communication between Cisco Transport Controller (CTC) computers and ONS 15454 nodes, and communication among networked ONS 15454 nodes. The chapter shows common Cisco ONS 15454 IP network configurations and includes detailed data communications network (DCN) case studies.

Table 1 Cisco ONS 15454 Reference Manual Chapters (continued)

Title	Summary
Chapter 18, "Alarm and TCA Monitoring and Management"	Describes Cisco Transport Controller (CTC) alarm and threshold crossing alert (TCA) monitoring and management.
Chapter 19, "Performance Monitoring"	Performance monitoring (PM) parameters are used by service providers to gather, store, set thresholds for, and report performance data for early detection of problems. In this chapter, PM parameters and concepts are defined for transponder, muxponder, and dense wavelength division multiplexing (DWDM) cards in the Cisco ONS 15454 including optical amplifier, multiplexer, demutiplexer, optical add/drop multiplexer (OADM), and optical service channel (OSC) cards.
Chapter 20, "SNMP"	Explains Simple Network Management Protocol (SNMP) as implemented by the Cisco ONS 15454.
Appendix A, "Hardware Specifications"	Contains hardware and software specifications for the ONS 15454 ANSI and ETSI shelf assemblies and cards.
Appendix B, "Administrative and Service States"	Describes the administrative and service states for Cisco ONS 15454 dense wavelength division multiplexing (DWDM) cards, optical payload ports, out-of-band optical service channel (OSC) ports, optical channel network connections (OCHNCs), and transponder/muxponder cards and ports.
Appendix C, "Pseudo Command Line Interface Reference"	Describes Pseudo-IOS command line interface (PCLI) for GE_XP, 10GE_XP, GE_XPE, and 10GE_XPE cards.
Appendix D, "Fiber and Connector Losses in Raman Link Configuration"	Describes guidelines to be followed when configuring a Raman link.

Related Documentation

Use the *Cisco ONS 15454 DWDM Reference Manual* in conjunction with the following referenced Release 9.2 publications:

- *Cisco ONS 15454 DWDM Procedure Guide*
- *Cisco ONS 15454 DWDM Troubleshooting Guide*
- *Cisco ONS SONET TL1 Command Guide*
- *Cisco ONS SONET TL1 Reference Guide*
- Cisco *ONS SONET TL1 Command Quick Reference Guide*
- *Cisco ONS 15454 SDH TL1 Command Guide*
- *Cisco ONS 15454 SDH TL1 Reference Guide*

- Cisco *ONS 15454 SDH TL1 Command Quick Reference Guide*
- *Release Notes for Cisco ONS 15454 Release 9.2*
- *Release Notes for Cisco ONS 15454 SDH Release 9.2*
- *Cisco TransportPlanner DWDM Operations Guide*
- *Cisco ONS 15454 Hardware Installation Guide*

For an update on End-of-Life and End-of-Sale notices, refer to

http://www.cisco.com/en/US/products/hw/optical/ps2006/prod_eol_notices_list.html

Document Conventions

This publication uses the following conventions:

Convention	Application
boldface	Commands and keywords in body text.
italic	Command input that is supplied by the user.
[ ]	Keywords or arguments that appear within square brackets are optional.
{ x | x | x }	A choice of keywords (represented by x) appears in braces separated by vertical bars. The user must select one.
Ctrl	The control key. For example, where Ctrl + D is written, hold down the Control key while pressing the D key.
`screen font`	Examples of information displayed on the screen.
`boldface screen font`	Examples of information that the user must enter.
< >	Command parameters that must be replaced by module-specific codes.

Note Means *reader take note*. Notes contain helpful suggestions or references to material not covered in the document.

Caution Means *reader be careful*. In this situation, the user might do something that could result in equipment damage or loss of data.

Warning **IMPORTANT SAFETY INSTRUCTIONS**

This warning symbol means danger. You are in a situation that could cause bodily injury. Before you work on any equipment, be aware of the hazards involved with electrical circuitry and be familiar with standard practices for preventing accidents. Use the statement number provided at the end of each warning to locate its translation in the translated safety warnings that accompanied this device. Statement 1071

SAVE THESE INSTRUCTIONS

Waarschuwing **BELANGRIJKE VEILIGHEIDSINSTRUCTIES**

Dit waarschuwingssymbool betekent gevaar. U verkeert in een situatie die lichamelijk letsel kan veroorzaken. Voordat u aan enige apparatuur gaat werken, dient u zich bewust te zijn van de bij elektrische schakelingen betrokken risico's en dient u op de hoogte te zijn van de standaard praktijken om ongelukken te voorkomen. Gebruik het nummer van de verklaring onderaan de waarschuwing als u een vertaling van de waarschuwing die bij het apparaat wordt geleverd, wilt raadplegen.

BEWAAR DEZE INSTRUCTIES

Varoitus **TÄRKEITÄ TURVALLISUUSOHJEITA**

Tämä varoitusmerkki merkitsee vaaraa. Tilanne voi aiheuttaa ruumiillisia vammoja. Ennen kuin käsittelet laitteistoa, huomioi sähköpiirien käsittelemiseen liittyvät riskit ja tutustu onnettomuuksien yleisiin ehkäisytapoihin. Turvallisuusvaroitusten käännökset löytyvät laitteen mukana toimitettujen käännettyjen turvallisuusvaroitusten joukosta varoitusten lopussa näkyvien lausuntonumeroiden avulla.

SÄILYTÄ NÄMÄ OHJEET

Attention **IMPORTANTES INFORMATIONS DE SÉCURITÉ**

Ce symbole d'avertissement indique un danger. Vous vous trouvez dans une situation pouvant entraîner des blessures ou des dommages corporels. Avant de travailler sur un équipement, soyez conscient des dangers liés aux circuits électriques et familiarisez-vous avec les procédures couramment utilisées pour éviter les accidents. Pour prendre connaissance des traductions des avertissements figurant dans les consignes de sécurité traduites qui accompagnent cet appareil, référez-vous au numéro de l'instruction situé à la fin de chaque avertissement.

CONSERVEZ CES INFORMATIONS

Warnung **WICHTIGE SICHERHEITSHINWEISE**

Dieses Warnsymbol bedeutet Gefahr. Sie befinden sich in einer Situation, die zu Verletzungen führen kann. Machen Sie sich vor der Arbeit mit Geräten mit den Gefahren elektrischer Schaltungen und den üblichen Verfahren zur Vorbeugung vor Unfällen vertraut. Suchen Sie mit der am Ende jeder Warnung angegebenen Anweisungsnummer nach der jeweiligen Übersetzung in den übersetzten Sicherheitshinweisen, die zusammen mit diesem Gerät ausgeliefert wurden.

BEWAHREN SIE DIESE HINWEISE GUT AUF.

Avvertenza **IMPORTANTI ISTRUZIONI SULLA SICUREZZA**

Questo simbolo di avvertenza indica un pericolo. La situazione potrebbe causare infortuni alle persone. Prima di intervenire su qualsiasi apparecchiatura, occorre essere al corrente dei pericoli relativi ai circuiti elettrici e conoscere le procedure standard per la prevenzione di incidenti. Utilizzare il numero di istruzione presente alla fine di ciascuna avvertenza per individuare le traduzioni delle avvertenze riportate in questo documento.

CONSERVARE QUESTE ISTRUZIONI

Advarsel **VIKTIGE SIKKERHETSINSTRUKSJONER**

Dette advarselssymbolet betyr fare. Du er i en situasjon som kan føre til skade på person. Før du begynner å arbeide med noe av utstyret, må du være oppmerksom på farene forbundet med elektriske kretser, og kjenne til standardprosedyrer for å forhindre ulykker. Bruk nummeret i slutten av hver advarsel for å finne oversettelsen i de oversatte sikkerhetsadvarslene som fulgte med denne enheten.

TA VARE PÅ DISSE INSTRUKSJONENE

Aviso **INSTRUÇÕES IMPORTANTES DE SEGURANÇA**

Este símbolo de aviso significa perigo. Você está em uma situação que poderá ser causadora de lesões corporais. Antes de iniciar a utilização de qualquer equipamento, tenha conhecimento dos perigos envolvidos no manuseio de circuitos elétricos e familiarize-se com as práticas habituais de prevenção de acidentes. Utilize o número da instrução fornecido ao final de cada aviso para localizar sua tradução nos avisos de segurança traduzidos que acompanham este dispositivo.

GUARDE ESTAS INSTRUÇÕES

¡Advertencia! **INSTRUCCIONES IMPORTANTES DE SEGURIDAD**

Este símbolo de aviso indica peligro. Existe riesgo para su integridad física. Antes de manipular cualquier equipo, considere los riesgos de la corriente eléctrica y familiarícese con los procedimientos estándar de prevención de accidentes. Al final de cada advertencia encontrará el número que le ayudará a encontrar el texto traducido en el apartado de traducciones que acompaña a este dispositivo.

GUARDE ESTAS INSTRUCCIONES

Varning! **VIKTIGA SÄKERHETSANVISNINGAR**

Denna varningssignal signalerar fara. Du befinner dig i en situation som kan leda till personskada. Innan du utför arbete på någon utrustning måste du vara medveten om farorna med elkretsar och känna till vanliga förfaranden för att förebygga olyckor. Använd det nummer som finns i slutet av varje varning för att hitta dess översättning i de översatta säkerhetsvarningar som medföljer denna anordning.

SPARA DESSA ANVISNINGAR

FONTOS BIZTONSÁGI ELOÍRÁSOK

Ez a figyelmezeto jel veszélyre utal. Sérülésveszélyt rejto helyzetben van. Mielott bármely berendezésen munkát végezte, legyen figyelemmel az elektromos áramkörök okozta kockázatokra, és ismerkedjen meg a szokásos balesetvédelmi eljárásokkal. A kiadványban szereplo figyelmeztetések fordítása a készülékhez mellékelt biztonsági figyelmeztetések között található; a fordítás az egyes figyelmeztetések végén látható szám alapján keresheto meg.

ORIZZE MEG EZEKET AZ UTASÍTÁSOKAT!

Предупреждение **ВАЖНЫЕ ИНСТРУКЦИИ ПО СОБЛЮДЕНИЮ ТЕХНИКИ БЕЗОПАСНОСТИ**

Этот символ предупреждения обозначает опасность. То есть имеет место ситуация, в которой следует опасаться телесных повреждений. Перед эксплуатацией оборудования выясните, каким опасностям может подвергаться пользователь при использовании электрических цепей, и ознакомьтесь с правилами техники безопасности для предотвращения возможных несчастных случаев. Воспользуйтесь номером заявления, приведенным в конце каждого предупреждения, чтобы найти его переведенный вариант в переводе предупреждений по безопасности, прилагаемом к данному устройству.

СОХРАНИТЕ ЭТИ ИНСТРУКЦИИ

警告 重要的安全性说明

此警告符号代表危险。您正处于可能受到严重伤害的工作环境中。在您使用设备开始工作之前，必须充分意识到触电的危险，并熟练掌握防止事故发生的标准工作程序。请根据每项警告结尾提供的声明号码来找到此设备的安全性警告说明的翻译文本。

请保存这些安全性说明

警告 安全上の重要な注意事項

「危険」の意味です。人身事故を予防するための注意事項が記述されています。装置の取り扱い作業を行うときは、電気回路の危険性に注意し、一般的な事故防止策に留意してください。警告の各国語版は、各注意事項の番号を基に、装置に付属の「Translated Safety Warnings」を参照してください。

これらの注意事項を保管しておいてください。

주의 중요 안전 지침

이 경고 기호는 위험을 나타냅니다. 작업자가 신체 부상을 일으킬 수 있는 위험한 환경에 있습니다. 장비에 작업을 수행하기 전에 전기 회로와 관련된 위험을 숙지하고 표준 작업 관례를 숙지하여 사고를 방지하십시오. 각 경고의 마지막 부분에 있는 경고문 번호를 참조하여 이 장치와 함께 제공되는 번역된 안전 경고문에서 해당 번역문을 찾으십시오.

이 지시 사항을 보관하십시오.

Aviso **INSTRUÇÕES IMPORTANTES DE SEGURANÇA**

Este símbolo de aviso significa perigo. Você se encontra em uma situação em que há risco de lesões corporais. Antes de trabalhar com qualquer equipamento, esteja ciente dos riscos que envolvem os circuitos elétricos e familiarize-se com as práticas padrão de prevenção de acidentes. Use o número da declaração fornecido ao final de cada aviso para localizar sua tradução nos avisos de segurança traduzidos que acompanham o dispositivo.

GUARDE ESTAS INSTRUÇÕES

Advarsel **VIGTIGE SIKKERHEDSANVISNINGER**

Dette advarselssymbol betyder fare. Du befinder dig i en situation med risiko for legemesbeskadigelse. Før du begynder arbejde på udstyr, skal du være opmærksom på de involverede risici, der er ved elektriske kredsløb, og du skal sætte dig ind i standardprocedurer til undgåelse af ulykker. Brug erklæringsnummeret efter hver advarsel for at finde oversættelsen i de oversatte advarsler, der fulgte med denne enhed.

GEM DISSE ANVISNINGER

تحذير **إرشادات الأمان الهامة**

يوضح رمز التحذير هذا وجود خطر. وهذا يعني أنك متواجد في مكان قد ينتج عنه التعرض لإصابات. قبل بدء العمل، احذر مخاطر التعرض للصدمات الكهربائية وكن على علم بالإجراءات القياسية للحيلولة دون وقوع أي حوادث. استخدم رقم البيان الموجود في أخر كل تحذير لتحديد مكان ترجمته داخل تحذيرات الأمان المترجمة التي تأتي مع الجهاز.

قم بحفظ هذه الإرشادات

Upozorenje **VAŽNE SIGURNOSNE NAPOMENE**

Ovaj simbol upozorenja predstavlja opasnost. Nalazite se u situaciji koja može prouzročiti tjelesne ozljede. Prije rada s bilo kojim uređajem, morate razumjeti opasnosti vezane uz električne sklopove, te biti upoznati sa standardnim načinima izbjegavanja nesreća. U prevedenim sigurnosnim upozorenjima, priloženima uz uređaj, možete prema broju koji se nalazi uz pojedino upozorenje pronaći i njegov prijevod.

SAČUVAJTE OVE UPUTE

Upozornění **DŮLEŽITÉ BEZPEČNOSTNÍ POKYNY**

Tento upozorňující symbol označuje nebezpečí. Jste v situaci, která by mohla způsobit nebezpečí úrazu. Před prací na jakémkoliv vybavení si uvědomte nebezpečí související s elektrickými obvody a seznamte se se standardními opatřeními pro předcházení úrazům. Podle čísla na konci každého upozornění vyhledejte jeho překlad v přeložených bezpečnostních upozorněních, která jsou přiložena k zařízení.

USCHOVEJTE TYTO POKYNY

Προειδοποίηση

ΣΗΜΑΝΤΙΚΕΣ ΟΔΗΓΙΕΣ ΑΣΦΑΛΕΙΑΣ

Αυτό το προειδοποιητικό σύμβολο σημαίνει κίνδυνο. Βρίσκεστε σε κατάσταση που μπορεί να προκαλέσει τραυματισμό. Πριν εργαστείτε σε οποιοδήποτε εξοπλισμό, να έχετε υπόψη σας τους κινδύνους που σχετίζονται με τα ηλεκτρικά κυκλώματα και να έχετε εξοικειωθεί με τις συνήθεις πρακτικές για την αποφυγή ατυχημάτων. Χρησιμοποιήστε τον αριθμό δήλωσης που παρέχεται στο τέλος κάθε προειδοποίησης, για να εντοπίσετε τη μετάφρασή της στις μεταφρασμένες προειδοποιήσεις ασφαλείας που συνοδεύουν τη συσκευή.

ΦΥΛΑΞΤΕ ΑΥΤΕΣ ΤΙΣ ΟΔΗΓΙΕΣ

אזהרה

הוראות בטיחות חשובות

סימן אזהרה זה מסמל סכנה. אתה נמצא במצב העלול לגרום לפציעה. לפני שתעבוד עם ציוד כלשהו, עליך להיות מודע לסכנות הכרוכות במעגלים חשמליים ולהכיר את הנהלים המקובלים למניעת תאונות. השתמש במספר ההוראה המסופק בסופה של כל אזהרה כד לאתר את התרגום באזהרות הבטיחות המתורגמות שמצורפות להתקן.

שמור הוראות אלה

Opomena

ВАЖНИ БЕЗБЕДНОСНИ НАПАТСТВИЈА

Симболот за предупредување значи опасност. Се наоѓате во ситуација што може да предизвика телесни повреди. Пред да работите со опремата, бидете свесни за ризикот што постои кај електричните кола и треба да ги познавате стандардните постапки за спречување на несреќни случаи. Искористете го бројот на изјавата што се наоѓа на крајот на секое предупредување за да го најдете неговиот период во преведените безбедносни предупредувања што се испорачани со уредот.

ЧУВАЈТЕ ГИ ОВИЕ НАПАТСТВИЈА

Ostrzeżenie

WAŻNE INSTRUKCJE DOTYCZĄCE BEZPIECZEŃSTWA

Ten symbol ostrzeżenia oznacza niebezpieczeństwo. Zachodzi sytuacja, która może powodować obrażenia ciała. Przed przystąpieniem do prac przy urządzeniach należy zapoznać się z zagrożeniami związanymi z układami elektrycznymi oraz ze standardowymi środkami zapobiegania wypadkom. Na końcu każdego ostrzeżenia podano numer, na podstawie którego można odszukać tłumaczenie tego ostrzeżenia w dołączonym do urządzenia dokumencie z tłumaczeniami ostrzeżeń.

NINIEJSZE INSTRUKCJE NALEŻY ZACHOWAĆ

Upozornenie

DÔLEŽITÉ BEZPEČNOSTNÉ POKYNY

Tento varovný symbol označuje nebezpečenstvo. Nachádzate sa v situácii s nebezpečenstvom úrazu. Pred prácou na akomkoľvek vybavení si uvedomte nebezpečenstvo súvisiace s elektrickými obvodmi a oboznámte sa so štandardnými opatreniami na predchádzanie úrazom. Podľa čísla na konci každého upozornenia vyhľadajte jeho preklad v preložených bezpečnostných upozorneniach, ktoré sú priložené k zariadeniu.

USCHOVAJTE SI TENTO NÁVOD

Obtaining Optical Networking Information

This section contains information that is specific to optical networking products. For information that pertains to all of Cisco, refer to the Obtaining Documentation and Submitting a Service Request section.

Where to Find Safety and Warning Information

For safety and warning information, refer to the *Cisco Optical Transport Products Safety and Compliance Information* document that accompanied the product. This publication describes the international agency compliance and safety information for the Cisco ONS 15454 system. It also includes translations of the safety warnings that appear in the ONS 15454 system documentation.

Cisco Optical Networking Product Documentation CD-ROM

Optical networking-related documentation, including Cisco ONS 15xxx product documentation, is available in a CD-ROM package that ships with your product. The Optical Networking Product Documentation CD-ROM is updated periodically and may be more current than printed documentation.

Obtaining Documentation and Submitting a Service Request

For information on obtaining documentation, submitting a service request, and gathering additional information, see the monthly *What's New in Cisco Product Documentation*, which also lists all new and revised Cisco technical documentation, at:

http://www.cisco.com/en/US/docs/general/whatsnew/whatsnew.html

Subscribe to the *What's New in Cisco Product Documentation* as a Really Simple Syndication (RSS) feed and set content to be delivered directly to your desktop using a reader application. The RSS feeds are a free service and Cisco currently supports RSS Version 2.0.

CHAPTER 1

Cisco ONS 15454 (ANSI and ETSI), ONS 15454 M2, and ONS 15454 M6 Shelf Assembly

For information on the Cisco ONS 15454 (ANSI and ETSI), ONS 15454 M2, and ONS 15454 M6 shelf assemblies, see the Cisco ONS 15454 Hardware Installation Guide.

CHAPTER 2

Common Control Cards

Note The terms "Unidirectional Path Switched Ring" and "UPSR" may appear in Cisco literature. These terms do not refer to using Cisco ONS 15xxx products in a unidirectional path switched ring configuration. Rather, these terms, as well as "Path Protected Mesh Network" and "PPMN," refer generally to Cisco's path protection feature, which may be used in any topological network configuration. Cisco does not recommend using its path protection feature in any particular topological network configuration.

This chapter describes the Cisco ONS 15454 common-control cards. For installation and card turn-up procedures, refer to the *Cisco ONS 15454 DWDM Procedure Guide*. For card safety and compliance information, refer to the *Cisco Optical Transport Products Safety and Compliance Information* document.

Note Unless otherwise specified, “ONS 15454” refers to both ANSI and ETSI shelf assemblies.

Note The cards described in this chapter are supported on the Cisco ONS 15454, Cisco ONS 15454 M6, Cisco ONS 15454 M2 platforms, unless noted otherwise.

Chapter topics include:

- 2.1 Card Overview, page 2-2
- 2.3 TCC2 Card, page 2-3
- 2.4 TCC2P Card, page 2-8
- 2.5 TCC3 Card, page 2-12
- 2.6 TNC Card, page 2-16
- 2.7 TSC Card, page 2-25
- 2.8 Digital Image Signing, page 2-33
- 2.9 AIC-I Card, page 2-34
- 2.10 MS-ISC-100T Card, page 2-39
- 2.11 Front Mount Electrical Connections, page 2-42

2.1 Card Overview

The card overview section lists the cards described in this chapter.

Each card is marked with a symbol that corresponds to a slot (or slots) on the ONS 15454 shelf assembly. The cards are then installed into slots displaying the same symbols. For a list of slots and symbols, see the "Card Slot Requirements" section in the *Cisco ONS 15454 Hardware Installation Guide*.

2.1.1 Common Control Cards

The following common control cards are needed to support the functions of the DWDM, transponder, and muxponder cards on ONS 15454 shelf:

- TCC2 or TCC2P or TCC3
- AIC-I (optional)
- MS-ISC-100T (multishelf configurations only)

The TNC and TSC cards are used to support the functions of DWDM, transponder, and muxponder cards on the Cisco ONS 15454 M2 and Cisco ONS 15454 M6 shelves.

2.1.2 Card Compatibility

Table 2-1 lists the platform and software release compatibility for the control cards.

Table 2-1 Platform and Software Release Compatibility for Control Cards

Card Name	R4.5	R4.6	R4.7	R5.0	R6.0	R7.0	R7.2	R8.0	R8.5	R9.0	R9.1	R9.2
TCC2	15454-DWDM	15454-DWDM	15454-DWDM	15454-DWDM	15454-DWDM	15454-DWDM	15454-DWDM	15454-DWDM	15454-DWDM	15454-DWDM	15454-DWDM	15454-DWDM
TCC2P	15454-DWDM	15454-DWDM	15454-DWDM	15454-DWDM	15454-DWDM	15454-DWDM	15454-DWDM	15454-DWDM	15454-DWDM	15454-DWDM	15454-DWDM	15454-DWDM
AIC-I	15454-DWDM	15454-DWDM	15454-DWDM	15454-DWDM	15454-DWDM	15454-DWDM	15454-DWDM	15454-DWDM	15454-DWDM	15454-DWDM	15454-DWDM	15454-DWDM
MS-ISC-100T	15454-DWDM	15454-DWDM	15454-DWDM	15454-DWDM	15454-DWDM	15454-DWDM	15454-DWDM	15454-DWDM	15454-DWDM	15454-DWDM	15454-DWDM	15454-DWDM
TCC3	No	No	No	No	No	No	No	No	No	No	No	15454-DWDM
TNC	No	No	No	No	No	No	No	No	No	No	No	15454-M2 and 15454-M6
TSC	No	No	No	No	No	No	No	No	No	No	No	15454-M2 and 15454-M6

2.1.3 Front Mount Electrical Connections (ETSI only)

The following Front Mount Electrical Connections (FMECs) are needed to support the functions of the DWDM, transponder, and muxponder cards:

- MIC-A/P
- MIC-C/T/P

2.2 Safety Labels

This section explains the significance of the safety labels attached to some of the cards. The faceplates of the cards are clearly labeled with warnings about the laser radiation levels. You must understand all warning labels before working on these cards.

2.2.1 Hazard Level 1 Label

The Hazard Level 1 label is shown in Figure 2-1.

Figure 2-1 Hazard Level Label

The Hazard Level label warns users against exposure to laser radiation of Class 1 limits calculated in accordance with IEC60825-1 Ed.1.2. This label is displayed on the faceplate of the cards.

Warning **Class 1 laser product.** Statement 1008

2.3 TCC2 Card

(Cisco ONS 15454 only)

Note For TCC2 card specifications, see the "A.3.1 TCC2 Card Specifications" section on page A-4.

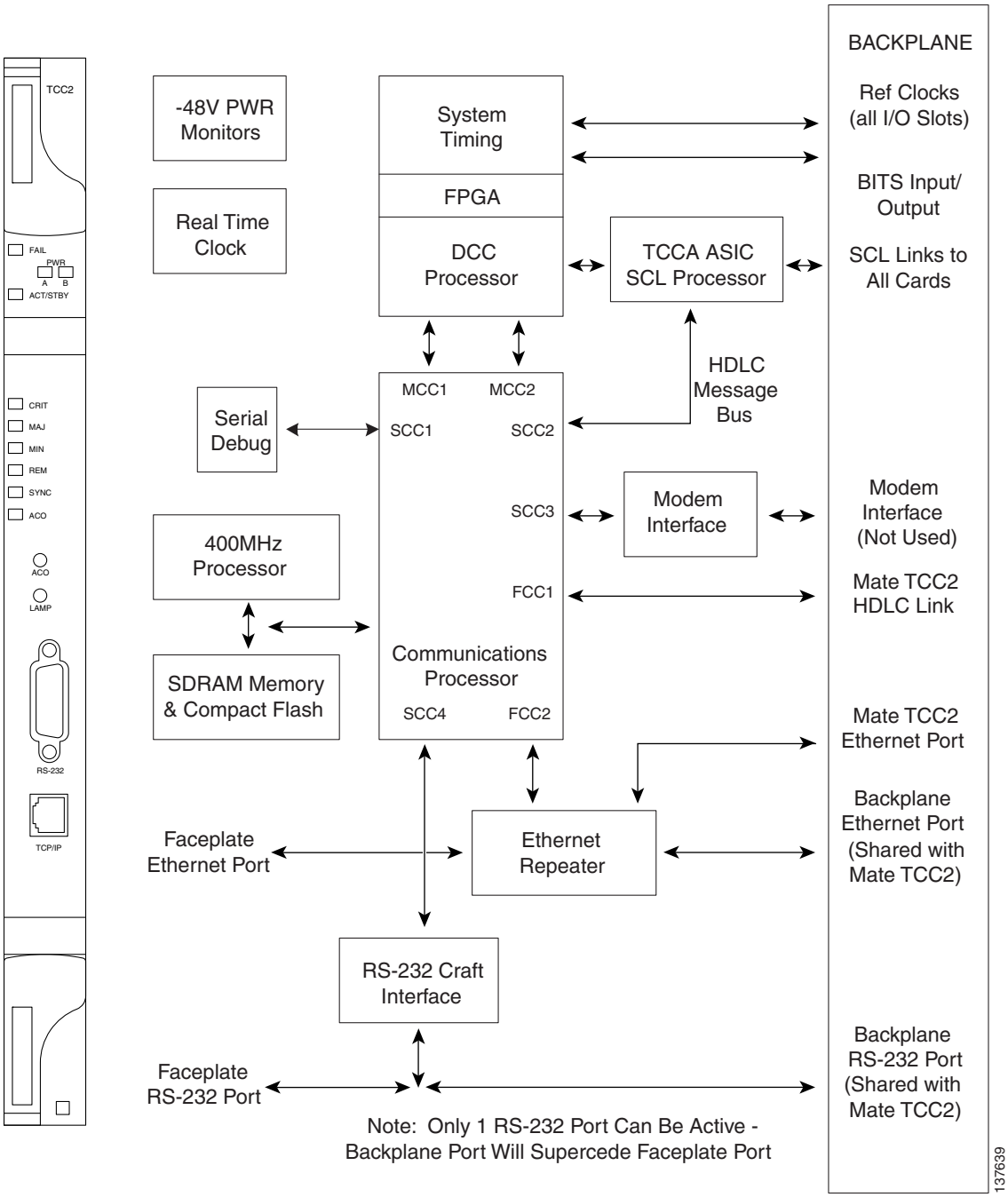
The Advanced Timing, Communications, and Control (TCC2) card performs system initialization, provisioning, alarm reporting, maintenance, diagnostics, IP address detection/resolution, SONET section overhead (SOH) data communications channel/generic communications channel (DCC/GCC)

termination, optical service channel (OSC) DWDM data communications network (DCN) termination, and system fault detection for the ONS 15454. The TCC2 also ensures that the system maintains Stratum 3 (Telcordia GR-253-CORE) timing requirements. It monitors the supply voltage of the system.

Note The LAN interface of the TCC2 card meets the standard Ethernet specifications by supporting a cable length of 328 ft (100 m) at temperatures from 32 to 149 degrees Fahrenheit (0 to 65 degrees Celsius).

Figure 2-2 shows the faceplate and block diagram for the TCC2.

Figure 2-2 TCC2 Faceplate and Block Diagram



2.3.1 TCC2 Functionality

The TCC2 card terminates up to 32 DCCs. The TCC2 hardware is prepared for up to 84 DCCs, which will be available in a future software release.

The node database, IP address, and system software are stored in TCC2 nonvolatile memory, which allows quick recovery in the event of a power or card failure.

The TCC2 performs all system-timing functions for each ONS 15454. The TCC2 monitors the recovered clocks from each traffic card and two building integrated timing supply (BITS) ports for frequency accuracy. The TCC2 selects a recovered clock, a BITS, or an internal Stratum 3 reference as the system-timing reference. You can provision any of the clock inputs as primary or secondary timing sources. A slow-reference tracking loop allows the TCC2 to synchronize with the recovered clock, which provides holdover if the reference is lost.

The TCC2 monitors both supply voltage inputs on the shelf. An alarm is generated if one of the supply voltage inputs has a voltage out of the specified range.

Install TCC2 cards in Slots 7 and 11 for redundancy. If the active TCC2 fails, traffic switches to the protect TCC2.

The TCC2 card has two built-in interface ports for accessing the system: an RJ-45 10BaseT LAN interface and an EIA/TIA-232 ASCII interface for local craft access. It also has a 10BaseT LAN port for user interfaces via the backplane.

2.3.2 Redundant TCC2 Card Installation

Cisco does not support operation of the ONS 15454 with only one TCC2 card. For full functionality and to safeguard your system, always operate with two TCC2 cards.

When a second TCC2 card is inserted into a node, it synchronizes its software, its backup software, and its database with the active TCC2. If the software version of the new TCC2 does not match the version on the active TCC2, the newly inserted TCC2 copies from the active TCC2, taking about 15 to 20 minutes to complete. If the backup software version on the new TCC2 does not match the version on the active TCC2, the newly inserted TCC2 copies the backup software from the active TCC2 again, taking about 15 to 20 minutes. Copying the database from the active TCC2 takes about 3 minutes. Depending on the software version and backup version the new TCC2 started with, the entire process can take between 3 and 40 minutes.

2.3.3 TCC2 Card-Level Indicators

The TCC2 faceplate has ten LEDs. Table 2-2 describes the two card-level LEDs on the TCC2 faceplate.

Table 2-2 TCC2 Card-Level Indicators

Card-Level LEDs	Definition
Red FAIL LED	This LED is on during reset. The FAIL LED flashes during the boot and write process. Replace the card if the FAIL LED persists.
ACT/STBY LED Green (Active) Yellow (Standby)	Indicates the TCC2 is active (green) or in standby (yellow) mode. The ACT/STBY LED also provides the timing reference and shelf control. When the active TCC2 is writing to its database or to the standby TCC2 database, the card LEDs blink. To avoid memory corruption, do not remove the TCC2 when the active or standby LED is blinking.

2.3.4 Network-Level Indicators

Table 2-3 describes the six network-level LEDs on the TCC2 faceplate.

Table 2-3 TCC2 Network-Level Indicators

System-Level LEDs	Definition
Red CRIT LED	Indicates critical alarms in the network at the local terminal.
Red MAJ LED	Indicates major alarms in the network at the local terminal.
Yellow MIN LED	Indicates minor alarms in the network at the local terminal.
Red REM LED	Provides first-level alarm isolation. The remote (REM) LED turns red when an alarm is present in one or more of the remote terminals.
Green SYNC LED	Indicates that node timing is synchronized to an external reference.
Green ACO LED	After pressing the alarm cutoff (ACO) button, the ACO LED turns green. The ACO button opens the audible alarm closure on the backplane. ACO is stopped if a new alarm occurs. After the originating alarm is cleared, the ACO LED and audible alarm control are reset.

2.3.5 Power-Level Indicators

Table 2-4 describes the two power-level LEDs on the TCC2 faceplate.

Table 2-4 TCC2 Power-Level Indicators

Power-Level LEDs	Definition
Green/Amber/Red PWR A LED	The PWR A LED is green when the voltage on supply input A is between the low battery voltage (LWBATVG) and high battery voltage (HIBATVG) thresholds. The LED is amber when the voltage on supply input A is between the high battery voltage and extremely high battery voltage (EHIBATVG) thresholds or between the low battery voltage and extremely low battery voltage (ELWBATVG) thresholds. The LED is red when the voltage on supply input A is above extremely high battery voltage or below extremely low battery voltage thresholds.
Green/Amber/Red PWR B LED	The PWR B LED is green when the voltage on supply input B is between the low battery voltage and high battery voltage thresholds. The LED is amber when the voltage on supply input B is between the high battery voltage and extremely high battery voltage thresholds or between the low battery voltage and extremely low battery voltage thresholds. The LED is red when the voltage on supply input B is above extremely high battery voltage or below extremely low battery voltage thresholds.

Note For ONS 15454 ETSI shelf, the power-level LEDs are either green or red. The LED is green when the voltage on supply inputs is between the extremely low battery voltage and extremely high battery voltage thresholds. The LED is red when the voltage on supply inputs is above extremely high battery voltage or below extremely low battery voltage thresholds.

2.4 TCC2P Card

(Cisco ONS 15454 only)

Note For TCC2P card specifications, see the "A.3.2 TCC2P Card Specifications" section on page A-5.

The Advanced Timing, Communications, and Control Plus (TCC2P) card is an enhanced version of the TCC2 card. The primary enhancements are Ethernet security features and 64K composite clock BITS timing.

The TCC2P card performs system initialization, provisioning, alarm reporting, maintenance, diagnostics, IP address detection/resolution, SONET SOH DCC/GCC termination, and system fault detection for the ONS 15454. The TCC2P also ensures that the system maintains Stratum 3 (Telcordia GR-253-CORE) timing requirements. It monitors the supply voltage of the system.

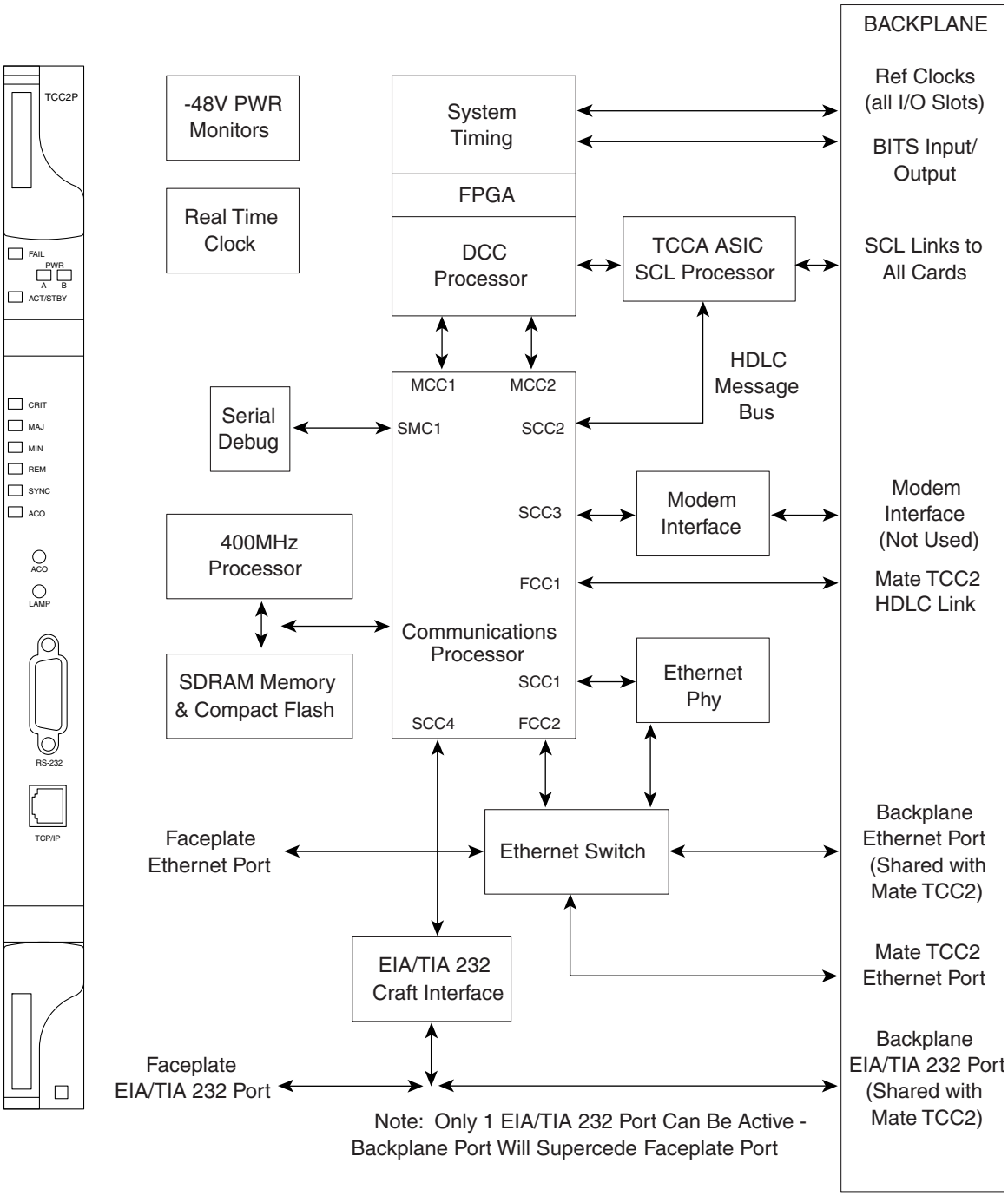
The TCC2P card supports multi-shelf management. The TCC2P card acts as a shelf controller and node controller for the ONS 15454. The TCC2P card supports up to 12 subtended shelves through the MSM-ISC card or external switch. In a multi-shelf configuration, the TCC2P card allows the ONS 15454 node to be a node controller if an M6 shelf is subtended to it.

The TCC2P card is compliant to the following standards:

- The LAN interface of the TCC2P card meets the standard Ethernet specifications by supporting a cable length of 328 ft (100 m) at temperatures from 32 to 149 degrees Fahrenheit (0 to 65 degrees Celsius). The interfaces can operate with a cable length of 32.8 ft (10 m) maximum at temperatures from –40 to 32 degrees Fahrenheit (–40 to 0 degrees Celsius).
- The TCC2P card is Restriction of Use of Hazardous Substances (RoHS) complaint. The RoHS regulations limit or ban the specific substances such as lead, cadmium, polybrominated biphenyl (PBB), mercury, hexavalent chromium, and polybrominated diphenyl ether (PBDE) flame retardants in a new electronic and electric equipment.

Figure 2-3 shows the faceplate and block diagram for the TCC2P card.

Figure 2-3 TCC2P Faceplate and Block Diagram



2.4.1 TCC2P Functionality

The TCC2P card supports multichannel, high-level data link control (HDLC) processing for the DCC. Up to 84 DCCs can be routed over the TCC2P card and up to 84 section DCCs can be terminated at the TCC2P card (subject to the available optical digital communication channels). The TCC2P selects and processes 84 DCCs to facilitate remote system management interfaces.

The TCC2P card also originates and terminates a cell bus carried over the module. The cell bus supports links between any two cards in the node, which is essential for peer-to-peer communication. Peer-to-peer communication accelerates protection switching for redundant cards.

The node database, IP address, and system software are stored in TCC2P card nonvolatile memory, which allows quick recovery in the event of a power or card failure.

The TCC2P card performs all system-timing functions for each ONS 15454. The TCC2P card monitors the recovered clocks from each traffic card and two BITS ports for frequency accuracy. The TCC2P card selects a recovered clock, a BITS, or an internal Stratum 3 reference as the system-timing reference. You can provision any of the clock inputs as primary or secondary timing sources. A slow-reference tracking loop allows the TCC2P card to synchronize with the recovered clock, which provides holdover if the reference is lost.

The TCC2P card supports 64/8K composite clock and 6.312 MHz timing output.

The TCC2P card monitors both supply voltage inputs on the shelf. An alarm is generated if one of the supply voltage inputs has a voltage out of the specified range.

Install TCC2P cards in Slots 7 and 11 for redundancy. If the active TCC2P card fails, traffic switches to the protect TCC2P card. All TCC2P card protection switches conform to protection switching standards when the bit error rate (BER) counts are not in excess of 1 * 10 exp – 3 and completion time is less than 50 ms.

The TCC2P card has two built-in Ethernet interface ports for accessing the system: one built-in RJ-45 port on the front faceplate for on-site craft access and a second port on the backplane. The rear Ethernet interface is for permanent LAN access and all remote access via TCP/IP as well as for Operations Support System (OSS) access. The front and rear Ethernet interfaces can be provisioned with different IP addresses using CTC.

Two EIA/TIA-232 serial ports, one on the faceplate and a second on the backplane, allow for craft interface in TL1 mode.

Note To use the serial port craft interface wire-wrap pins on the backplane, the DTR signal line on the backplane port wire-wrap pin must be connected and active.

2.4.2 Redundant TCC2P Card Installation

Cisco does not support operation of the ONS 15454 with only one TCC2P card. For full functionality and to safeguard your system, always operate with two TCC2P cards.

When a second TCC2P card is inserted into a node, it synchronizes its software, its backup software, and its database with the active TCC2P card. If the software version of the new TCC2P card does not match the version on the active TCC2P card, the newly inserted TCC2P card copies from the active TCC2P card, taking about 15 to 20 minutes to complete. If the backup software version on the new TCC2P card does not match the version on the active TCC2P card, the newly inserted TCC2P card copies the backup

software from the active TCC2P card again, taking about 15 to 20 minutes. Copying the database from the active TCC2P card takes about 3 minutes. Depending on the software version and backup version the new TCC2P card started with, the entire process can take between 3 and 40 minutes.

2.4.3 TCC2P Card-Level Indicators

The TCC2P faceplate has ten LEDs. Table 2-5 describes the two card-level LEDs on the TCC2P faceplate.

Table 2-5 TCC2P Card-Level Indicators

Card-Level LEDs	Definition
Red FAIL LED	This LED is on during reset. The FAIL LED flashes during the boot and write process. Replace the card if the FAIL LED persists.
ACT/STBY LED Green (Active) Amber (Standby)	Indicates the TCC2P is active (green) or in standby (amber) mode. The ACT/STBY LED also provides the timing reference and shelf control. When the active TCC2P is writing to its database or to the standby TCC2P database, the card LEDs blink. To avoid memory corruption, do not remove the TCC2P when the active or standby LED is blinking.

2.4.4 Network-Level Indicators

Table 2-6 describes the six network-level LEDs on the TCC2P faceplate.

Table 2-6 TCC2P Network-Level Indicators

System-Level LEDs	Definition
Red CRIT LED	Indicates critical alarms in the network at the local terminal.
Red MAJ LED	Indicates major alarms in the network at the local terminal.
Amber MIN LED	Indicates minor alarms in the network at the local terminal.
Red REM LED	Provides first-level alarm isolation. The remote (REM) LED turns red when an alarm is present in one or more of the remote terminals.
Green SYNC LED	Indicates that node timing is synchronized to an external reference.
Green ACO LED	After pressing the ACO button, the ACO LED turns green. The ACO button opens the audible alarm closure on the backplane. ACO is stopped if a new alarm occurs. After the originating alarm is cleared, the ACO LED and audible alarm control are reset.

2.4.5 Power-Level Indicators

Table 2-7 describes the two power-level LEDs on the TCC2P faceplate.

Table 2-7 TCC2P Power-Level Indicators

Power-Level LEDs	Definition
Green/Amber/Red PWR A LED	The PWR A LED is green when the voltage on supply input A is between the low battery voltage (LWBATVG) and high battery voltage (HIBATVG) thresholds. The LED is amber when the voltage on supply input A is between the high battery voltage and extremely high battery voltage (EHIBATVG) thresholds or between the low battery voltage and extremely low battery voltage (ELWBATVG) thresholds. The LED is red when the voltage on supply input A is above extremely high battery voltage or below extremely low battery voltage thresholds.
Green/Amber/Red PWR B LED	The PWR B LED is green when the voltage on supply input B is between the low battery voltage and high battery voltage thresholds. The LED is amber when the voltage on supply input B is between the high battery voltage and extremely high battery voltage thresholds or between the low battery voltage and extremely low battery voltage thresholds. The LED is red when the voltage on supply input B is above extremely high battery voltage or below extremely low battery voltage thresholds.

Note For ONS 15454 ETSI shelf, the power-level LEDs are either green or red. The LED is green when the voltage on supply inputs is between the extremely low battery voltage and extremely high battery voltage thresholds. The LED is red when the voltage on supply inputs is above extremely high battery voltage or below extremely low battery voltage thresholds.

2.5 TCC3 Card

(Cisco ONS 15454 only)

Note For TCC3 card specifications, see the "A.3.3 TCC3 Card Specifications" section on page A-6.

The Timing Communications Control Three (TCC3) card is an enhanced version of the TCC2P card. The primary enhancements include the increase in memory size and compact flash space. The TCC3 card boots up as TCC2P card in older releases and as TCC3 card from Release 9.2 onwards.

The TCC3 card performs system initialization, provisioning, alarm reporting, maintenance, diagnostics, IP address detection/resolution, SONET SOH DCC/GCC termination, and system fault detection for the ONS 15454. The TCC3 also ensures that the system maintains Stratum 3 (Telcordia GR-253-CORE) timing requirements. It monitors the supply voltage of the system.

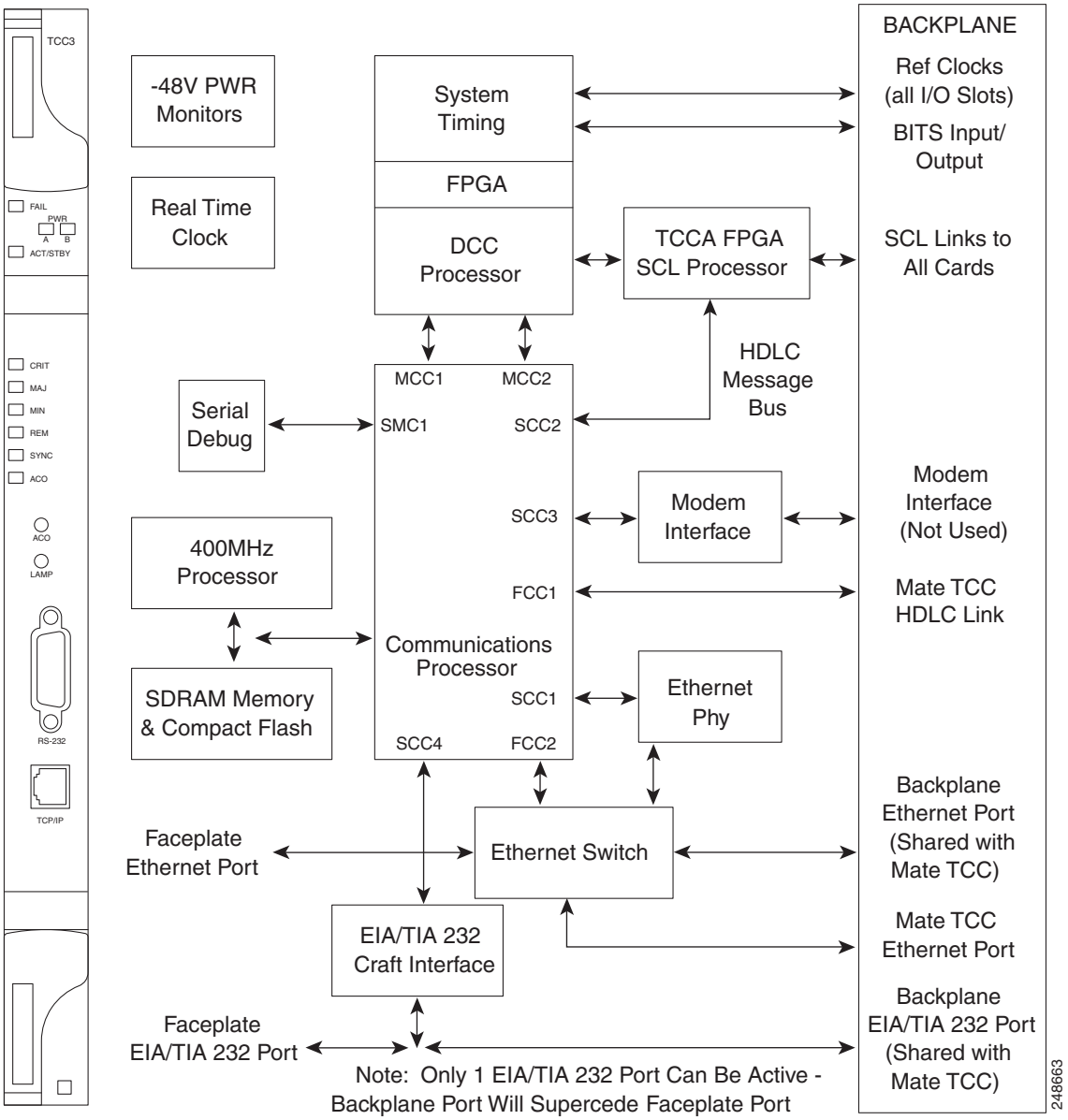
The TCC3 card supports multi-shelf management. The TCC3 card acts as a shelf controller and node controller for the ONS 15454. The TCC3 card supports up to 30 subtended shelves through the MSM-ISC card or external switch. In a multi-shelf configuration, the TCC3 card allows the ONS 15454 node to be a node controller if an M6 shelf is subtended to it. We recommend the use the TCC3 card as a node controller when the number of subtended shelves exceeds 12.

The TCC3 card is compliant with the following standards:

- The LAN interface of the TCC3 card meets the standard Ethernet specifications by supporting a cable length of 328 ft (100 m) at temperatures ranging from 32 to 149 degrees Fahrenheit (0 to 65 degrees Celsius). The interfaces can operate with a cable length of 32.8 ft (10 m) maximum at temperatures from –40 to 32 degrees Fahrenheit (–40 to 0 degrees Celsius).
- The TCC3 card is Restriction of Use of Hazardous Substances (RoHS) compliant. The RoHS regulations limit or ban the specific substances such as lead, cadmium, polybrominated biphenyl (PBB), mercury, hexavalent chromium, and polybrominated diphenyl ether (PBDE) flame retardants in a new electronic and electric equipment.

Figure 2-3 shows the faceplate and block diagram for the TCC3 card.

Figure 2-4 TCC3 Faceplate and Block Diagram



2.5.1 TCC3 Functionality

The TCC3 card supports multichannel, high-level data link control (HDLC) processing for the DCC. Up to 84 DCCs can be routed over the TCC3 card and up to 84 section DCCs can be terminated at the TCC3 card (subject to the available optical digital communication channels). The TCC3 selects and processes 84 DCCs to facilitate remote system management interfaces.

The TCC3 card also originates and terminates a cell bus carried over the module. The cell bus supports links between any two cards in the node, which is essential for peer-to-peer communication. Peer-to-peer communication accelerates protection switching for redundant cards.

The node database, IP address, and system software are stored in the TCC3 card's nonvolatile memory, which allows quick recovery of data in the event of a power or card failure.

The TCC3 card performs all system-timing functions for the ONS 15454. The TCC3 card monitors the recovered clocks from each traffic card and two BITS ports for frequency accuracy. The TCC3 card selects a recovered clock, a BITS, or an internal Stratum 3 reference as the system-timing reference. You can provision any of the clock inputs as primary or secondary timing sources. A slow-reference tracking loop allows the TCC3 card to synchronize with the recovered clock, which provides holdover if the reference is lost.

The TCC3 card supports 64/8K composite clock and 6.312 MHz timing output.

The TCC3 card monitors both the supply voltage inputs on the shelf. An alarm is generated if one of the supply voltage inputs has a voltage level above the specified range.

The TCC3 card has two built-in Ethernet interface ports for accessing the system: one built-in RJ-45 port on the front faceplate for on-site craft access and a second port on the backplane. The rear Ethernet interface is for permanent LAN access and all remote access via TCP/IP as well as for Operations Support System (OSS) access. The front and rear Ethernet interfaces can be provisioned with different IP addresses using CTC.

Two EIA/TIA-232 serial ports, one on the faceplate and a second on the backplane, allow for craft interface in TL1 mode.

Note To use the serial port craft interface wire-wrap pins on the backplane, the DTR signal line on the backplane port wire-wrap pin must be connected and active.

2.5.2 Redundant TCC3 Card Installation

We do not recommend the operation of the ONS 15454 with only one TCC3 card. For full functionality and to safeguard your system, always operate with two TCC3 cards.

Install TCC3 cards in Slots 7 and 11 for redundancy. If the active TCC3 card fails, traffic switches to the protect TCC3 card. All TCC3 card protection switches conform to protection switching standards when the bit error rate (BER) counts are not in excess of 1 * 10 exp – 3 and completion time is less than 50 ms.

When a second TCC3 card is inserted into a node, it synchronizes its software, backup software, and database with those of the active TCC3 card. If the software version of the new TCC3 card does not match the version on the active TCC3 card, the newly inserted TCC3 card copies from the active TCC3 card, taking about 15 to 20 minutes to complete. Copying the database from the active TCC3 card takes about 3 minutes. Depending on the software version and backup version the new TCC3 card started with, the entire process can take between 3 and 40 minutes.

2.5.3 TCC3 Card-Level Indicators

The TCC3 faceplate has ten LEDs. Table 2-5 describes the two card-level LEDs on the TCC3 faceplate.

Table 2-8 TCC3 Card-Level Indicators

Card-Level LEDs	Definition
Red FAIL LED	Indicates the TCC3 card is being reset. The FAIL LED flashes during the boot and write process. Replace the card if the FAIL LED persists.
ACT/STBY LED Green (Active) Amber (Standby)	Indicates the TCC3 is active (green) or in standby (amber) mode. The ACT/STBY LED also provides the timing reference and shelf control. When the active TCC3 is writing to its database or to the standby TCC3 database, the card LEDs blink. To avoid memory corruption, do not remove the TCC3 when the active or standby LED is blinking.

2.5.4 Network-Level Indicators

Table 2-6 describes the six network-level LEDs on the TCC3 faceplate.

Table 2-9 TCC3 Network-Level Indicators

System-Level LEDs	Definition
Red CRIT LED	Indicates critical alarms in the network at the local terminal.
Red MAJ LED	Indicates major alarms in the network at the local terminal.
Amber MIN LED	Indicates minor alarms in the network at the local terminal.
Red REM LED	Indicates first-level alarm isolation. The remote (REM) LED turns red when an alarm is present in one or more of the remote terminals.
Green SYNC LED	Indicates that node timing is synchronized to an external reference.
Green ACO LED	Indicates teh audible alarms. After pressing the ACO button, the ACO LED turns green. The ACO button opens the audible alarm closure on the backplane. ACO is stopped if a new alarm occurs. After the originating alarm is cleared, the ACO LED and audible alarm control are reset.

2.5.5 Power-Level Indicators

Table 2-7 describes the two power-level LEDs on the TCC3 faceplate.

Table 2-10 TCC3 Power-Level Indicators

Power-Level LEDs	Definition
Green/Amber/Red PWR A LED	Indicates the voltage on supply input A. The PWR A LED is green when the voltage on supply input A is between the low battery voltage (LWBATVG) and high battery voltage (HIBATVG) thresholds. The LED is amber when the voltage on supply input A is between the high battery voltage and extremely high battery voltage (EHIBATVG) thresholds or between the low battery voltage and extremely low battery voltage (ELWBATVG) thresholds. The LED is red when the voltage on supply input A is above extremely high battery voltage or below extremely low battery voltage thresholds.
Green/Amber/Red PWR B LED	Indicates the voltage on supply input B.The PWR B LED is green when the voltage on supply input B is between the low battery voltage and high battery voltage thresholds. The LED is amber when the voltage on supply input B is between the high battery voltage and extremely high battery voltage thresholds or between the low battery voltage and extremely low battery voltage thresholds. The LED is red when the voltage on supply input B is above extremely high battery voltage or below extremely low battery voltage thresholds.

Note For the ONS 15454 ETSI shelf, the power-level LEDs are either green or red. The LED is green when the voltage on supply inputs is between the extremely low battery voltage and extremely high battery voltage thresholds. The LED is red when the voltage on supply inputs is above extremely high battery voltage or below extremely low battery voltage thresholds.

2.6 TNC Card

(Cisco ONS 15454 M2 and ONS 15454 M6 only)

The TNC card combines the functions of multiple cards such as TCC2P, OSCM, ISC, and AIC-I cards. The card has a similar look and feel to TCC2/TCC2P/TCC3 cards.

Note For TNC card specifications, see the A.3.4 TNC Card Specifications (Cisco ONS 15454 M2 and Cisco ONS 15454 M6), page A-6 section.

The TNC card is provisioned as master and slave in the 15454-M6 shelf, and as a stand-alone card in the 15454-M2 shelf. The TNC card serves as the processor card for the node.

On the 15454-M6 shelf, install redundant TNC cards in slots 1 and 8. If the active TNC card fails, system traffic switches to the redundant TNC card. The card supports line cards from slots 2 to 7.

On the 15454-M2 shelf, install the stand-alone TNC card in slot 1. The TNC card supports line cards in slots 2 and 3.

The TNC card monitors both the supply voltage inputs on the 15454-M6 shelf. The TNC card raises an alarm if one of the supply voltage inputs has a voltage out of the specified range. The 15454-M2 shelf has dual power supply.

You can insert and remove the TNC card even when the system is online, without impacting the system traffic.

You can upgrade the TSC card to a TNC card. During the upgrade, the TNC card does not support OSC functions such as UDC, VoIP, DCC, and timing function. However, you can still provision the SFP ports on the TNC card during the upgrade. The TNC and TSC cards cannot be inserted in the same shelf.

Note Downgrade procedures from TNC cards to TSC cards are not supported. For information on upgrading TSC card to a TNC card, refer chapter, "*Upgrade, Add, and Remove Cards and Nodes*" in the *Cisco ONS 15454 DWDM Procedure Guide*.

The TNC card supports all the alarms supported by the TCC2P and AIC-I cards. The card adjusts the fan speed according to the temperature and reports a fan failure alarm.

Note The LAN interface of the TNC card meets the standard Ethernet specifications by supporting a cable length of 328 ft (100 m) at temperatures from 32 to 149 degrees Fahrenheit (0 to 65 degrees Celsius). The interfaces can operate with a cable length of 32.8 ft (10 m) maximum at temperatures from -40 to 32 degrees Fahrenheit (-40 to 0 degrees Celsius).

2.6.1 Functions of TNC

The functions of the TNC card are explained in the following sections:

2.6.1.1 Communication and Control

The TNC card acts as node controller and shelf controller. The control tasks include system initialization, provisioning, alarm reporting, maintenance, diagnostics, IP address detection, and resolution. The control tasks also include SONET and SDH data communications channel (DCC) termination, 84 section SDCC and multiplex section MSDCC terminations, 28 SDCC tunnels or SDCC-to-line LDCC terminations, and system fault detection for the 15454-M2 and 15454-M6 shelves.

The system initialization tasks include assigning the network parameters to the system and loading the system with the provisioning data stored in the database. The line cards in the system do not boot without the TNC card.

The TNC card supports and provides the following:

- OSC communication to implement the Optical DCN, User Data Channels and Voice over IP interface.
- Supervisory data channel (SDC) for communication between the nodes.
- Two point-to-point Ethernet channels at 10 Mbps to carry Voice over IP traffic.
- Two point-to-point Ethernet channels at 10/100 Mbps to carry UDC traffic.
- Passive inventory of external devices on the 15454-M2 and 15454-M6 shelves.
- Supports OSC, UDC, and VoIP traffic. Two UDC/VoIP ports are present on the external connection unit that can be configured to carry UDC/VoIP traffic.

Note The TNC card supports UDC and VoIP configuration only when OSC is configured on the ports. To delete the OSC channel on a port, delete the UDC and VoIP configuration on that port. For more information, refer chapter, "*Install the Cisco ONS 15454 Shelf Assembly*" in the *Cisco ONS 15454 DWDM Procedure Guide*.

On the 15454-M2 and 15454-M6 shelves, the TNC card must adhere to the following rules for SDCC/LDCC allocation:

- SDCC + SDCC Tunnels <= 68
- LDCC <= 28
- IP Tunnels <= 10
- SDCC + SDCC tunnels + (LDCC * 3) <= 84

2.6.1.2 Optical Service Channel

The TNC card supports two optical service channels (OSC) through two small-form factor pluggable (SFP) ports. The two SFP ports are named SFP1 and SFP2. The supported SFPs on TNC ports are ONS-SC-OSC-ULH, ONS-SE-155-1510, and ONS-SC-Z3-1510.

Note When you replace SFPs on the TNC card, provisioning for the current SFP has to be deleted before the new SFP is plugged in.

SFP1 supports the following payloads:

- OC-3/STM-1
- Fast Ethernet (FE)
- Gigabit Ethernet (GE)

SFP2 supports the following payloads:

- Fast Ethernet (FE)
- Gigabit Ethernet (GE)

2.6.1.3 Timing and Synchronization

The TNC card performs all the system-timing functions for the 15454-M2 and 15454-M6 shelves. This includes short-term clock recovery, reducing the need to reset the calendar and time-of-day settings after a power failure.

The TNC card ensures that the system maintains Stratum 3 (Telcordia GR-253-CORE) timing and synchronization requirements. The TNC card supports external, line, and internal timing inputs.

The TNC card supports 64KHz+8KHz composite clock and 6.312 MHz timing output.

Note The TNC card supports the BITS-1 and BITS-2 external timing interfaces on the ONS 15454 M6 shelf. The card supports the BITS-1 interface on the ONS 15454 M2 shelf.

The TNC card monitors the recovered clocks from each traffic card and two building integrated timing supply (BITS-1 and BITS-2) ports for accurate frequencies. The card selects a recovered clock, a BITS, OC-N/STM-N, or an internal Stratum 3 reference as the system-timing reference. You can provision any of the clock inputs as primary or secondary timing sources. A slow-reference tracking loop allows the TNC card to synchronize with the recovered clock, which provides holdover if the reference is lost.

The card supports SNTP operation that allows the nodes to synchronize the system clock automatically with a reference SNTP server following system reboots, card resets, and software upgrades.

For more information on the timing function, see the Timing Reference chapter.

2.6.1.4 MultiShelf Management

The TNC card supports multishelf management of up to 30 shelves including the node controller. The card supports up to 29 subtending shelves. The subtending shelves can be the ONS 15454 M6 or ONS 15454 shelves. This allows network administrators to isolate faults and provision new services across the DWDM network.

In the ONS 15454 M6 shelf, there are six FE RJ45 ports on the ECU and each TNC card supports three FE RJ45 connections to connect subtending shelves.

2.6.1.5 Database Storage

The TNC card provides 4 GB of non-volatile database storage (IDE Compact Flash Module) for communication, provisioning, and system control. This allows full database recovery during power failure.

The TNC card supports writing and reading to and from an external non-volatile memory device. The card also communicates with the non-volatile memory device through a USB 2.0 standard interface.

The USB-WRITE-FAIL alarm may be raised on the TNC card when synchronization occurs between Compact Flash and USB Flash. If this alarm does not clear even after 20 minutes duration, it is recommended to contact TAC.

For information on USB-WRITE-FAIL alarm, see the *Cisco ONS 15454 DWDM Troubleshooting Guide*.

Note The configuration details are stored in the database of the TNC card. The database restore from a TNC card to a TSC card or vice versa is not supported.

2.6.1.6 Interface Ports

The TNC card has three built-in interface ports:

- RJ-45 LAN port
- RJ-45 console port
- RS-232 port (serial port)

The RJ-45 LAN port and RS-232 port are located on the faceplate of the TNC card. The RJ-45 console port is behind the faceplate of the TNC card.

The front access RJ-45 LAN port provides 10/100 BASE-T Ethernet connectivity to the system. The RJ-45 LAN port has LEDs to provide link and activity status. The RJ-45 LAN port provides local and remote access to the Cisco Transport Controller through a common Web interface.

The RJ-45 console port is used to launch a debug session on the TNC card.

The RS-232 port is used to connect to the Transaction Language 1 (TL1) management interface. In TL1 mode, the RS-232 port runs at 9.6 Kbps without any flow control.

The front access LAN port and RJ-45 EMS LAN port can be provisioned with different IP addresses by configuring the TNC card in secure mode using CTC. On 15454 M2, the EMS port is on the power module. On 15454 M6, the EMS port is on the ECU.

The two SFP ports (SFP1 and SFP2) are used for primary OSC and secondary OSC connections. SFP1 supports OC-3/STM-1, FE, or GE payloads; SFP2 supports FE or GE payloads.

The two SFP ports on the TNC card are in IS,AINS administrative state during payload creation. In this state, only the following alarms are raised:

- AS-MT alarm on PPM
- AS-CMD alarm on PPM and facility
- Prov-Mismatch alarm on PPM

The TX power is -40 and RX power is -50 for Ultra long-haul SFPs. The TX power is -40 and RX power is -40 for other SFPs. When the OSC is created, the two SFP ports move to IS state. In this state, all the supported alarms are raised.

Note VLAN tagged traffic is not supported on UDC or VoIP ports that are present on the external connection unit.

2.6.1.7 External Alarms and Controls

The TNC card provides customer-defined (environmental) alarms and external controls on the ONS 15454 M6 shelf. The card provides input/output alarm contact closures. The TNC card operates in two modes:

- External alarms mode - This is the default mode and up to 14 alarm input ports can be configured. External alarms (input contacts) are typically used for external sensors such as open doors, temperature sensors, flood sensors, and other environmental conditions.
- External control mode - Up to 10 alarm input ports and four alarm output ports can be configured. External controls (output contacts) are typically used to drive visual or audible devices such as bells and lights, but they can control other devices such as generators, heaters, and fans.

To configure the external alarms and external controls, go to Provisioning -> Alarm Extenders tab in the CTC node view. To view the external alarms and external controls, go to Maintenance -> Alarm Extenders tab in the CTC node view. For information on how to configure and view the external alarms and external controls, refer chapter "*Manage Alarms*" in the *Cisco ONS 15454 DWDM Procedure Guide*.

Note The LCD module must be present in the ONS 15454 M6 shelf assembly to provision alarms from the ECU, fan-tray assembly, or power modules.

For information on pinouts of external alarms and external controls, see the "ONS 15454 ANSI Alarm, Timing, LAN, and Craft Pin Connections" section in the *Cisco ONS 15454 Hardware Installtion Guide*.

2.6.1.8 Digital Image Signing (DIS)

The TNC card provides services that authenticate the origin of the software running on the Cisco ONS 15454 M2 and Cisco ONS 15454 M6 platforms, see the 2.8 Digital Image Signing, page 2-33 section.

2.6.2 Faceplate and Block Diagram

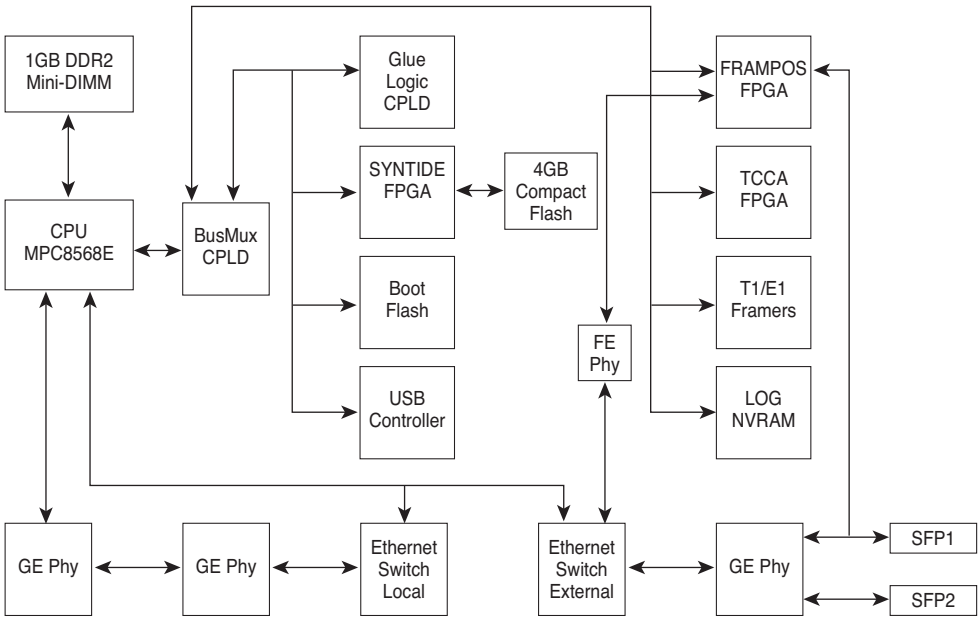
The faceplate design of the TNC card allows sufficient space to insert or remove cables while accessing the Ethernet and SFP ports.

The TNC card can be installed only in slots 1 or 8 of the ONS 15454 M6 shelf and in slot 1 of the ONS 15454 M2 shelf. The TNC card has an identifier on the faceplate that matches with an identifier in the shelf. A key is also provided on the backplane interface connectors as identifier in the shelf.

The TNC card supports field-programmable gate array (FPGA) for the backplane interface. The TNC card has three FPGA: TCCA, SYNTIDE, and FRAMPOS.

Figure 2-5 illustrates the faceplate and block diagram for the TNC card.

Figure 2-5 TNC Faceplate and Block Diagram



2.6.3 Lamp Test

The TNC card supports a lamp test function that is activated by pressing the Lamp Test button on the faceplate or from CTC. The lamp test function allows the user to test the working state of LEDs and ensures that all LEDs are functional. When you activate the lamp test function, all the port LEDs illuminate simultaneously for several seconds.

2.6.4 TNC Card Installation (ONS 15454 M6)

On the ONS 15454 M6 shelf, the TNC card operates in either simplex or duplex (redundant) control mode. In redundant control mode, high availability is achieved.

When a redundant TNC card is inserted into a node, it synchronizes its software, backup software, and database with the active TNC card. If the software versions do not match, the redundant TNC card copies from the active TNC card, taking about 15 to 20 minutes to complete. If the software versions match, the redundant TNC card copies the backup software from the active TNC card, taking about 15 to 20 minutes. Copying the database from the active TNC card takes about 3 minutes. Depending on the software version and backup version the redundant TNC card started with, the entire process can take between 3 and 40 minutes.

2.6.5 Card-Level Indicators

The TNC faceplate has twelve LEDs. Table 2-11 describes the two card-level LEDs on the TNC faceplate.

Table 2-11 TNC Card-Level Indicators

Card-Level LEDs	Definition
Red FAIL LED	Indicates the TNC card is in fail mode. This LED is on during reset. This LED flashes during the boot and write process. Replace the card if the FAIL LED persists.
ACT/STBY LED Green (Active) Amber (Standby)	Indicates the TNC card is active (green) or in standby (amber) mode. The ACT/STBY LED also provides the timing reference and shelf control. When the active TNC is writing to its database or to the standby TNC database, the card LEDs blink. To avoid memory corruption, do not remove the TNC card when the active or standby LED is blinking.

2.6.6 Network-Level Indicators

Table 2-12 describes the six network-level LEDs on the TNC faceplate.

Table 2-12 TNC Network-Level Indicators

System-Level LEDs	Definition
Red CRIT LED	Indicates critical alarms in the network at the local terminal.
Red MAJ LED	Indicates major alarms in the network at the local terminal.
Yellow MIN LED	Indicates minor alarms in the network at the local terminal.
Red REM LED	Provides first-level alarm isolation. The remote (REM) LED turns red when a critical, major, or minor alarm is present in one or more of the remote terminals.
Green SYNC LED	Indicates the synchronization status; Indicates that node timing is synchronized to an external reference.
Green ACO LED	Indicates the Alarm Cut-Off status. After pressing the ACO button, the ACO LED turns green. The ACO button opens the audible alarm closure on the backplane. ACO is stopped if a new alarm occurs. After the originating alarm is cleared, the ACO LED and audible alarm control are reset.

2.6.7 Power-Level Indicators

Table 2-13 describes the two power-level LEDs on the TNC faceplate.

Table 2-13 TNC Power-Level Indicators

Power-Level LEDs	Definition
Green/Red PWR A LED	Indicates the status of power to the card. The PWR A LED is green when the voltage on supply input A is between the low battery voltage (LWBATVG) and high battery voltage (HIBATVG) thresholds. The LED is red when the voltage on supply input A is above high battery voltage/extremely high battery voltage (EHIBATVG) or below low battery voltage/extremely low battery voltage (ELWBATVG) thresholds. The LED is red when the voltage on supply input A is 0.
Green/Red PWR B LED	Indicates the status of power to the card. The PWR B LED is green when the voltage on supply input B is between the low battery voltage and high battery voltage thresholds. The LED is red when the voltage on supply input B is above high battery voltage/extremely high battery (EHIBATVG) voltage or below low battery voltage/extremely low battery voltage (ELWBATVG) thresholds. The LED is red when the voltage on supply input B is 0.

2.6.8 Ethernet Port Indicators

Table 2-14 describes the two port-level LEDs on the TNC faceplate.

Table 2-14 TNC Port-Level Indicators

Port-Level LEDs	Definition
Green LINK LED	Indicates the connectivity status.
Amber ACT LED	Indicates data reception.

2.6.9 SFP Indicators

Table 2-15 describes the SFP LED indicators.

Table 2-15 TNC SFP Indicators

Port Type	Link LED	Activity LED
OC3	• RED - No link • GREEN - Link	—
FE	• RED - No link • GREEN - Link	Blinks on packet flow
GE	• RED - No link • GREEN - Link	Blinks on packet flow

2.6.10 Protection Schemes

The TNC card supports active and redundant architecture. The ONS 15454 M6 shelf supports 1:1 equipment protection with one TNC card acting as active and the other TNC card as redundant.

The ONS 15454 M2 shelf supports simplex control mode. In this mode, the active TNC card operates without a redundant TNC card.

The ONS 15454 M6 shelf supports both simplex and redundant control mode. In redundant control mode, the active TNC card operates with a redundant TNC card as the backup. If the active TNC card is removed, system traffic switches to the redundant TNC card. If the redundant TNC card is not present or not in the standby state, removing the active TNC card results in loss of system traffic and management connectivity.

In redundant control mode, a TNC card can protect another TNC card. However, a TNC card cannot protect a TSC card or vice versa.

2.6.11 Cards Supported by TNC

The TNC card supports 15454 MSTP line cards except the following cards:

- OSCM
- ISC
- AIC
- AIC-I

The TNC card is not interoperable with TCC2 /TCC2P/TCC3 cards. The TNC and TCC cards cannot be inserted in the same shelf.

The line cards such as Transponder and Muxponder cards can be inserted in the ONS 15454 M2 and ONS 15454 M6 shelves along with the TNC card.

2.7 TSC Card

(Cisco ONS 15454 M2 and ONS 15454 M6 only)

The TSC card combines the functions of multiple cards such as TCC2P, ISC, and AIC-I cards. The card has a similar look and feel to TCC2/TCC2P/TCC3 cards.

Note For TSC card specifications, see the A.3.5 TSC Card Specifications (ONS 15454 M2 and ONS 15454 M6), page A-7 section.

The TSC card is provisioned as master and slave in the ONS 15454 M6 shelf, and as a stand-alone card in the ONS 15454 M2 shelf. The TSC card serves as the processor card for the node.

On the ONS 15454 M6 shelf, install redundant TSC cards in slots 1 and 8. If the active TSC card fails, system traffic switches to the redundant TSC card. The TSC card supports line cards from slots 2 to 7.

On the ONS 15454 M2 shelf, install the stand-alone TSC card in slot 1. The TSC card supports line cards in slots 2 and 3.

The TSC card monitors both the supply voltage inputs on the 15454-M6 shelf. The TSC card raises an alarm if one of the supply voltage inputs has a voltage out of the specified range. The 15454-M2 shelf has dual power supply.

You can insert and remove the TSC card even when the system is online, without impacting the system traffic.

The TSC card does not support optical service channel (OSC) and SFP ports.

You can upgrade the TSC card to a TNC card. During the upgrade, the TNC card does not support OSC functions such as UDC, VoIP, DCC, and timing function. However, you can still provision SFP ports on the TNC card during the upgrade. The TNC and TSC cards cannot be inserted in the same shelf.

The TSC card supports all the alarms supported by the TCC2P and AIC-I cards. The card adjusts the fan speed according to the temperature and reports a fan failure alarm.

Note The LAN interface of the TSC card meets the standard Ethernet specifications by supporting a cable length of 328 ft (100 m) at temperatures from 32 to 149 degrees Fahrenheit (0 to 65 degrees Celsius). The interfaces can operate with a cable length of 32.8 ft (10 m) maximum at temperatures from -40 to 32 degrees Fahrenheit (-40 to 0 degrees Celsius).

2.7.1 Functions of TSC

The functions of the TSC card are explained in the following sections:

2.7.1.1 Communication and Control

The TSC card acts as a shelf controller. The control tasks include system initialization, provisioning, alarm reporting, maintenance, diagnostics, IP address detection, and resolution. The control tasks also include SONET and SDH data communications channel (DCC) termination, 84 section SDCC and multiplex section MSDCC terminations, 28 SDCC tunnels or SDCC-to-line LDCC terminations, and system fault detection for the ONS 15454 M2 and ONS 15454 M6 shelves.

The system initialization tasks include assigning the network parameters to the system and loading the system with the provisioning data stored in the database. The line cards in the system do not boot without the TSC card.

The TSC card supports and provides the following:

- Passive inventory of external devices on the 15454-M2 and 15454-M6 shelves.
- 100 Mbps UDC on the 15454-M6 shelf.

On the 15454-M2 and 15454-M6 shelves, the TSC card must adhere to the following rules for SDCC/LDCC allocation.

- SDCC + SDCC Tunnels <= 68
- LDCC <= 28
- IP Tunnels <= 10
- SDCC + SDCC tunnels + (LDCC * 3) <= 84

2.7.1.2 Timing and Synchronization

The TSC card performs all the system-timing functions for the 15454-M2 and 15454-M6 shelves. This includes short-term clock recovery, reducing the need to reset the calendar and time-of-day settings after a power failure.

The TSC card ensures that the system maintains Stratum 3 (Telcordia GR-253-CORE) timing and synchronization requirements. The TSC card supports external, line, and internal timing inputs.

The TSC card supports 64KHz+8KHz composite clock and 6.312 MHz timing output.

Note The TSC card supports the BITS-1 and BITS-2 external timing interfaces on the 15454-M6 shelf. The card supports the BITS-1 interface on the 15454-M2 shelf.

The TSC card monitors the recovered clocks from each traffic card and two building integrated timing supply (BITS-1 and BITS-2) ports for accurate frequencies. The card selects a recovered clock, a BITS, OC-N/STM-N, or an internal Stratum 3 reference as the system-timing reference. You can provision any of the clock inputs as primary or secondary timing sources. A slow-reference tracking loop allows the TSC card to synchronize with the recovered clock, which provides holdover if the reference is lost.

The card supports SNTP operation that allows the nodes to synchronize the system clock automatically with a reference SNTP server following system reboots, card resets, and software upgrades.

For more information on the timing function, see the Timing Reference chapter.

2.7.1.3 MultiShelf Management

The TSC card supports multishelf management with support for up to 30 shelves including the node controller. The card supports up to 29 subtending shelves. The subtending shelves can be the 15454-M6 or 15454-DWDM shelves. This allows network administrators to isolate faults and provision new services across the DWDM network.

In the 15454-M6 shelf, there are six FE RJ45 ports on the ECU. Each TSC card supports three FE RJ45 connections to connect subtending shelves.

2.7.1.4 Database Storage

The TSC card provides 4 GB of non-volatile database storage (IDE Compact Flash Module) for communication, provisioning, and system control. This allows full database recovery during power failure.

The TSC card supports writing and reading to and from an external non-volatile memory device. The card also communicates with the non-volatile memory device through a USB 2.0 standard interface.

Note The configuration details are stored in the database of the TSC card. The database restore from a TSC card to a TNC card or vice versa is not supported.

2.7.1.5 Interface Ports

The TSC card has three built-in interface ports:

- RJ-45 LAN port
- RJ-45 console port
- RS-232 port (serial port)

The RJ-45 LAN port and RS-232 port are located on the faceplate of the TSC card. The RJ-45 console port is behind the faceplate of the TSC card.

The front access RJ-45 LAN port provides 10/100 BASE-T Ethernet connectivity to the system. The RJ-45 LAN port has LEDs to provide link and activity status. The RJ-45 LAN port provides local and remote access to the Cisco Transport Controller through a common Web interface.

The RJ-45 console port is used to launch a debug session on the TSC card.

The RS-232 port is used to connect to the TL1 management interface. In TL1 mode, the RS-232 port runs at 9.6 Kbps without any flow control.

The front access LAN port and RJ-45 EMS LAN port can be provisioned with different IP addresses by configuring the TSC card in secure mode using CTC. On 15454 M2, the EMS port is on the power module. On 15454 M6, the EMS port is on the ECU.

2.7.1.6 External Alarms and Controls

The TSC card provides customer-defined (environmental) alarms and external controls on the ONS 15454 M6 shelf. The card provides input/output alarm contact closures. The TSC card operates in two modes:

- External alarms mode - This is the default mode and up to 14 alarm input ports can be configured. External alarms (input contacts) are typically used for external sensors such as open doors, temperature sensors, flood sensors, and other environmental conditions.
- External control mode - Up to 10 alarm input ports and four alarm output ports can be configured. External controls (output contacts) are typically used to drive visual or audible devices such as bells and lights, but they can control other devices such as generators, heaters, and fans.

To configure the external alarms and external controls, go to Provisioning -> Alarm Extenders tab in the CTC node view. To view the external alarms and external controls, go to Maintenance -> Alarm Extenders tab in the CTC node view. For information on how to configure and view the external alarms and external controls, refer chapter "*Manage Alarms*" in the *Cisco ONS 15454 DWDM Procedure Guide*.

Note The LCD module must be present in the ONS 15454 M6 shelf assembly to provision alarms from the ECU, fan-tray assembly, or power modules.

For information on pinouts of external alarms and external controls, see the "ONS 15454 ANSI Alarm, Timing, LAN, and Craft Pin Connections" section in the *Cisco ONS 15454 Hardware Installation Guide*.

2.7.1.7 Digital Image Signing (DIS)

The TSC card provides services that authenticate the origin of the software running on the Cisco ONS 15454 M2 and Cisco ONS 15454 M6 platforms. For more information, see the 2.8 Digital Image Signing, page 2-33 section.

2.7.2 Faceplate and Block Diagram

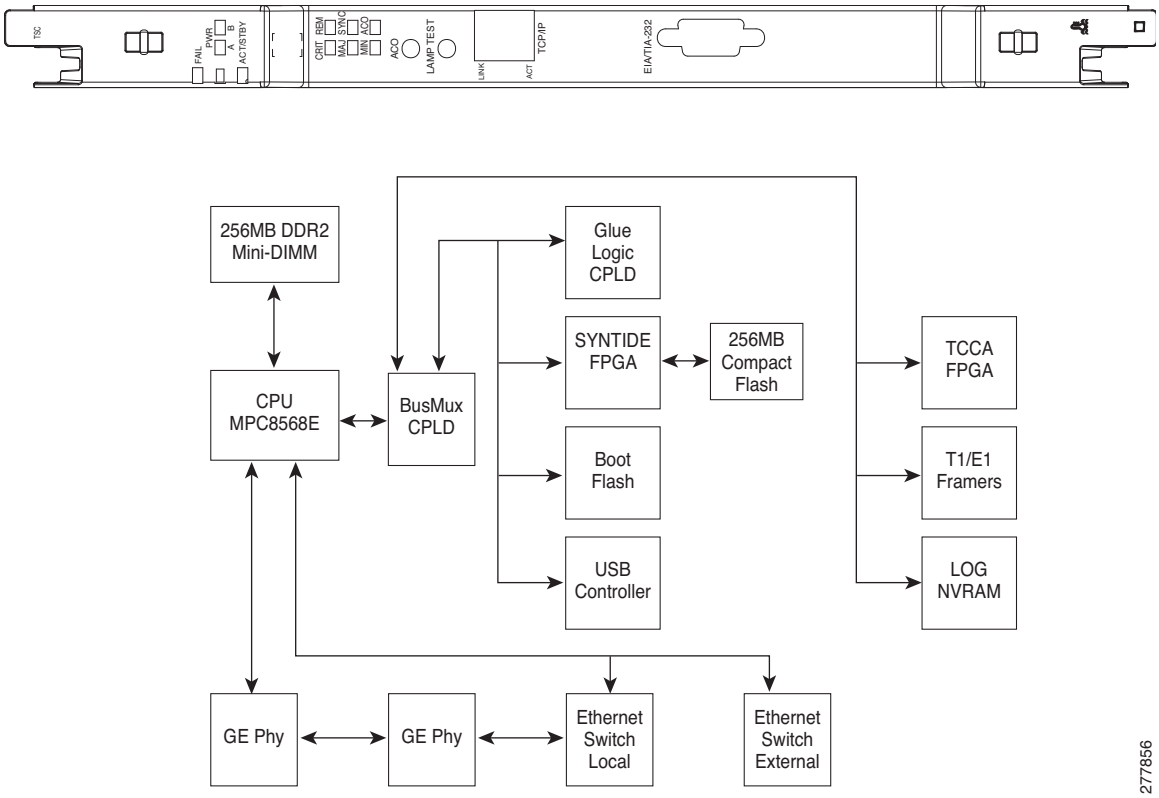
The faceplate design of the TSC card allows sufficient space to insert or remove cables while accessing the Ethernet ports.

The TSC card can be installed only in slots 1 or 8 of the 15454-M6 shelf and in slot 1 of the 15454-M2 shelf. The TSC card has an identifier on the faceplate that matches with an identifier in the shelf. A key is also provided on the backplane interface connectors as identifier in the shelf.

The TSC card supports field-programmable gate array (FPGA) for the backplane interface. The TSC card has two FPGA: TCCA and SYNTIDE.

Figure 2-6 illustrates the faceplate and block diagram for the TSC card.

Figure 2-6 TSC Faceplate and Block Diagram



2.7.3 Lamp Test

The TSC card supports a lamp test function that is activated by pressing the Lamp Test button on the faceplate or from CTC. The lamp test function allows the user to test the working state of LEDs and ensures that all LEDs are functional. When you activate the lamp test function, all the port LEDs illuminate simultaneously for several seconds.

2.7.4 TSC Card Installation (ONS 15454 M6)

On the ONS 15454 M6 shelf, the TSC card operates in either simplex or duplex (redundant) control mode. In redundant control mode, high availability is achieved.

When a redundant TSC card is inserted into a node, it synchronizes its software, backup software, and database with the active TSC card. If the software versions do not match, the redundant TSC card copies from the active TSC card, taking about 15 to 20 minutes to complete. If the software versions match, the redundant TSC card copies the backup software from the active TSC card, taking about 15 to 20 minutes. Copying the database from the active TSC card takes about 3 minutes. Depending on the software version and backup version the redundant TSC card started with, the entire process can take between 3 and 40 minutes.

2.7.5 Card-Level Indicators

The TSC faceplate has twelve LEDs. Table 2-11 describes the two card-level LEDs on the TSC faceplate.

Table 2-16 TSC Card-Level Indicators

Card-Level LEDs	Definition
Red FAIL LED	Indicates the TSC card is in fail mode. The FAIL LED flashes during the boot and write process. Replace the card if the FAIL LED persists.
ACT/STBY LED Green (Active) Amber (Standby)	Indicates the TSC card is active (green) or in standby (amber) mode. The ACT/STBY LED also provides the timing reference and shelf control. When the active TSC is writing to its database or to the standby TSC database, the card LEDs blink. To avoid memory corruption, do not remove the TSC card when the active or standby LED is blinking.

2.7.6 Network-Level Indicators

Table 2-12 describes the six network-level LEDs on the TSC faceplate.

Table 2-17 TSC Network-Level Indicators

System-Level LEDs	Definition
Red CRIT LED	Indicates critical alarms in the network at the local terminal.
Red MAJ LED	Indicates major alarms in the network at the local terminal.
Yellow MIN LED	Indicates minor alarms in the network at the local terminal.
Red REM LED	Provides first-level alarm isolation. The remote (REM) LED turns red when a critical, major, or minor alarm is present in one or more of the remote terminals.
Green SYNC LED	Indicates the synchronization status; Indicates that node timing is synchronized to an external reference.
Green ACO LED	Indicates the Alarm Cut-Off status. After pressing the ACO button, the ACO LED turns green. The ACO button opens the audible alarm closure on the backplane. ACO is stopped if a new alarm occurs. After the originating alarm is cleared, the ACO LED and audible alarm control are reset.

2.7.7 Power-Level Indicators

Table 2-13 describes the two power-level LEDs on the TSC faceplate.

Table 2-18 TSC Power-Level Indicators

Power-Level LEDs	Definition
Green/Red PWR A LED	Indicates the status of power to the card. The PWR A LED is green when the voltage on supply input A is between the low battery voltage (LWBATVG) and high battery voltage (HIBATVG) thresholds. The LED is red when the voltage on supply input A is above high battery voltage/extremely high battery voltage (EHIBATVG) or below low battery voltage/extremely low battery voltage (ELWBATVG) thresholds. The LED is red when the voltage on supply input A is 0.
Green/Red PWR B LED	Indicates the status of power to the card. The PWR B LED is green when the voltage on supply input B is between the low battery voltage and high battery voltage thresholds. The LED is red when the voltage on supply input B is above high battery voltage/extremely high battery (EHIBATVG) voltage or below low battery voltage/extremely low battery voltage (ELWBATVG) thresholds. The LED is red when the voltage on supply input B is 0.

2.7.8 Ethernet Port Indicators

Table 2-14 describes the two port-level LEDs on the TSC faceplate.

Table 2-19 TSC Port-Level Indicators

Port-Level LEDs	Definition
Green LINK LED	Indicates the connectivity status.
Amber ACT LED	Indicates the data reception.

2.7.9 Protection Schemes

The TSC card supports active and redundant architecture. The ONS 15454 M6 shelf supports 1:1 equipment protection with one TSC card acting as active and the other TSC card as redundant.

The 15454-M2 shelf supports simplex control mode. In this mode, the active TSC card operates without a redundant TSC card.

The 15454-M6 shelf supports both simplex and redundant control mode. In redundant control mode, the active TSC card operates with a redundant TSC card as the backup. If the active TSC card is removed, system traffic switches to the redundant TSC card. If the redundant TSC card is not present or not in the standby state, removing the active TSC card results in loss of system traffic and management connectivity.

In redundant control mode, a TSC card can protect another TSC card. However, a TSC card cannot protect a TNC card or vice versa.

2.7.10 Cards Supported by TSC

The TSC card supports 15454 MSTP line cards except the following cards:

- OSCM
- ISC
- AIC
- AIC-I

The TSC card is not interoperable with TCC2 /TCC2P/TCC3 cards. The TSC and TCC cards cannot be inserted in the same shelf.

The line cards such as Transponder and Muxponder cards can be inserted in the 15454-M2 and 15454-M6 shelves along with the TSC card.

2.8 Digital Image Signing

(Cisco ONS 15454 M2 and ONS 15454 M6 only)

The DIS feature complies with the new U.S. Government Federal Information

Processing Standard (FIPS) 140-3 to provide security for all software provided on the Cisco ONS 15454 M6 and ONS 15454 M2 platforms. This standard requires software to be digitally signed and verified for authenticity and integrity prior to load and execution.

DIS feature automatically provides increased protection. DIS focuses on software security and provides increased protection from attacks and threats to Cisco ONS 15454 M2 and ONS 15454 M6 products. DIS verifies software integrity and provides assurance that the software has not been tampered with or modified. Digitally signed Cisco software provides counterfeit protection.

New controller cards, such as TNC/TSC, provide services that authenticate the origin of the software running on the Cisco ONS 15454 M2 and Cisco ONS 15454 M6 platforms. The signage and verification process is transparent until verification fails.

2.8.1 DIS Identification

Digitally signed software can be identified by the last three characters appended to the working version and protected version field in CTC. The DIS conventions can be viewed under the working version displayed in the **Maintenance > Software** tab in CTC. For example, 9.2.0 (09.20-X10C-29.09-SDA) and 9.2.0 (09.20-010C-18.18-SPA).

The significance of the three characters appended to the software version is explained in Table:

Table 2-20 DIS Conventions in the Software Version

Character	Meaning
S (first character)	Indicates that the package is signed.
P or D (second character)	Production (P) or Development (D) image. Production image—Software approved for general release. Development image—development software provided under special conditions for limited use.
A (third character)	This third character indicates the version of the key used for signature generation. The version changes when a key is revoked and a new key is used. The values of the version key varies from A to Z.

For information on how to retrieve and view DIS information in CTC please refer to the "Turn Up a Node" Chapter in the *Cisco ONS 15454 DWDM Procedure Guide, 9.2*.

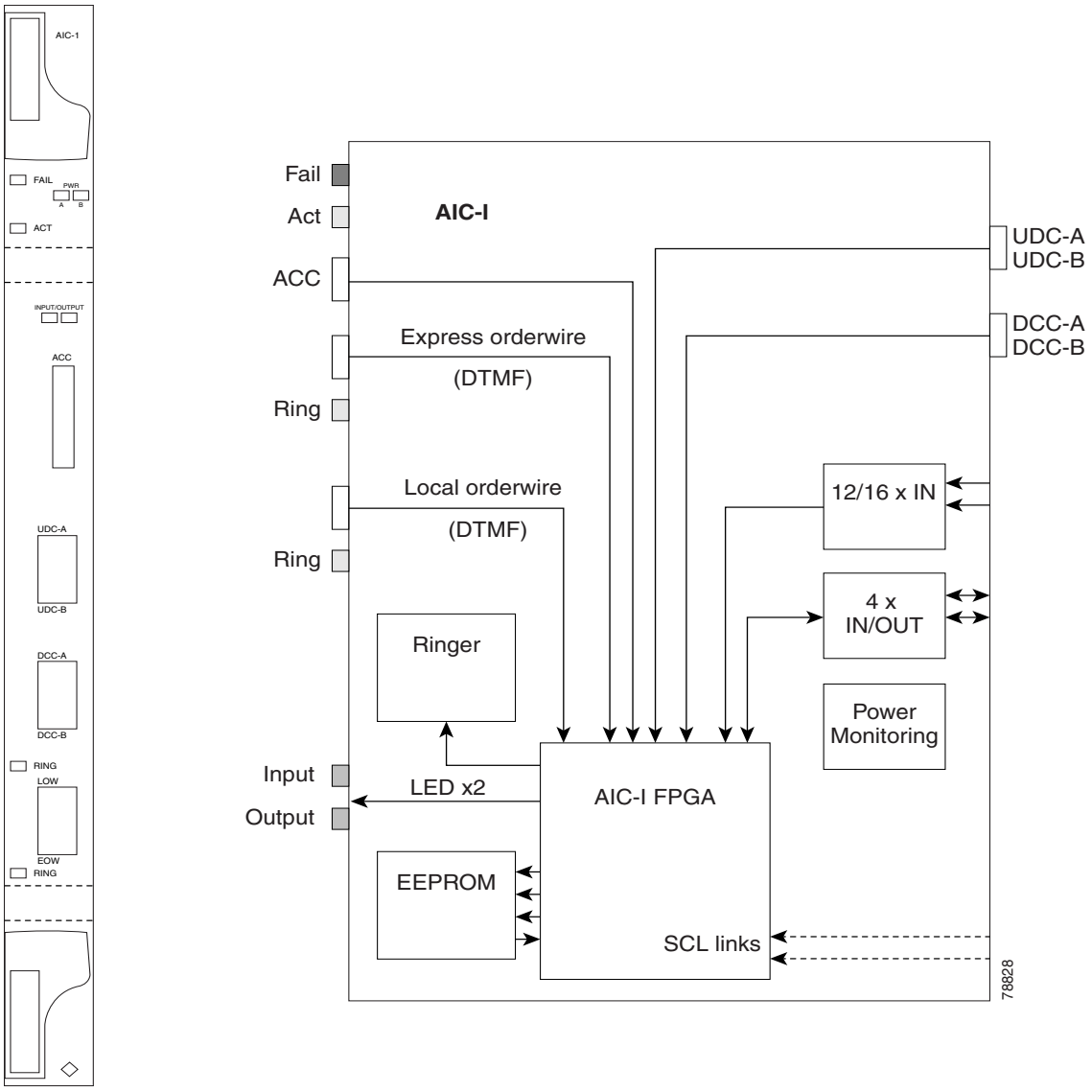
2.9 AIC-I Card

(Cisco ONS 15454 only)

Note For hardware specifications, see the "A.3.6 AIC-I Card Specifications" section on page A-8.

The optional Alarm Interface Controller–International (AIC-I) card provides customer-defined (environmental) alarms and controls and supports local and express orderwire. It provides 12 customer-defined input and 4 customer-defined input/output contacts. The physical connections are via the backplane wire-wrap pin terminals. If you use the additional alarm expansion panel (AEP), the AIC-I card can support up to 32 inputs and 16 outputs, which are connected on the AEP connectors. The AEP is compatible with ANSI shelves only. A power monitoring function monitors the supply voltage (–48 VDC). Figure 2-7 shows the AIC-I faceplate and a block diagram of the card.

Figure 2-7 AIC-I Faceplate and Block Diagram



2.9.1 AIC-I Card-Level Indicators

Table 2-21 describes the eight card-level LEDs on the AIC-I card faceplate.

Table 2-21 AIC-I Card-Level Indicators

Card-Level LEDs	Description
Red FAIL LED	Indicates that the card's processor is not ready. The FAIL LED is on during reset and flashes during the boot process. Replace the card if the red FAIL LED persists.
Green ACT LED	Indicates the AIC-I card is provisioned for operation.

Table 2-21 AIC-I Card-Level Indicators (continued)

Card-Level LEDs	Description
Green/Red PWR A LED	The PWR A LED is green when a supply voltage within a specified range has been sensed on supply input A. It is red when the input voltage on supply input A is out of range.
Green/Red PWR B LED	The PWR B LED is green when a supply voltage within a specified range has been sensed on supply input B. It is red when the input voltage on supply input B is out of range.
Yellow INPUT LED	The INPUT LED is yellow when there is an alarm condition on at least one of the alarm inputs.
Yellow OUTPUT LED	The OUTPUT LED is yellow when there is an alarm condition on at least one of the alarm outputs.
Green RING LED	The RING LED on the local orderwire (LOW) side is flashing green when a call is received on the LOW.
Green RING LED	The RING LED on the express orderwire (EOW) side is flashing green when a call is received on the EOW.

2.9.2 External Alarms and Controls

The AIC-I card provides input/output alarm contact closures. You can define up to 12 external alarm inputs and 4 external alarm inputs/outputs (user configurable). The physical connections are made using the backplane wire-wrap pins or FMEC connections. For information about increasing the number of input/output contacts, see the "ONS 15454 ANSI Alarm Expansion Panel" section in the *Cisco ONS 15454 Hardware Installation Guide*.

LEDs on the front panel of the AIC-I indicate the status of the alarm lines, one LED representing all of the inputs and one LED representing all of the outputs. External alarms (input contacts) are typically used for external sensors such as open doors, temperature sensors, flood sensors, and other environmental conditions. External controls (output contacts) are typically used to drive visual or audible devices such as bells and lights, but they can control other devices such as generators, heaters, and fans.

You can program each of the twelve input alarm contacts separately. You can program each of the sixteen input alarm contacts separately. Choices include:

- Alarm on Closure or Alarm on Open
- Alarm severity of any level (Critical, Major, Minor, Not Alarmed, Not Reported)
- Service Affecting or Non-Service Affecting alarm-service level
- 63-character alarm description for CTC display in the alarm log

You cannot assign the fan-tray abbreviation for the alarm; the abbreviation reflects the generic name of the input contacts. The alarm condition remains raised until the external input stops driving the contact or you provision the alarm input.

The output contacts can be provisioned to close on a trigger or to close manually. The trigger can be a local alarm severity threshold, a remote alarm severity, or a virtual wire:

- Local NE alarm severity: A hierarchy of Not Reported, Not Alarmed, Minor, Major, or Critical alarm severities that you set to cause output closure. For example, if the trigger is set to Minor, a Minor alarm or above is the trigger.

- Remote NE alarm severity: Same as the local NE alarm severity but applies to remote alarms only.
- Virtual wire entities: You can provision any environmental alarm input to raise a signal on any virtual wire on external outputs 1 through 4 when the alarm input is an event. You can provision a signal on any virtual wire as a trigger for an external control output.

You can also program the output alarm contacts (external controls) separately. In addition to provisionable triggers, you can manually force each external output contact to open or close. Manual operation takes precedence over any provisioned triggers that might be present.

Note For ANSI shelves, the number of inputs and outputs can be increased using the AEP. The AEP is connected to the shelf backplane and requires an external wire-wrap panel.

2.9.3 Orderwire

Orderwire allows a craftsperson to plug a phoneset into an ONS 15454 and communicate with craftspeople working at other ONS 15454s or other facility equipment. The orderwire is a pulse code modulation (PCM) encoded voice channel that uses E1 or E2 bytes in section/line overhead.

The AIC-I allows simultaneous use of both local (section overhead signal) and express (line overhead channel) orderwire channels on a SONET/SDH ring or particular optics facility. Express orderwire also allows communication via regeneration sites when the regenerator is not a Cisco device.

You can provision orderwire functions with CTC similar to the current provisioning model for DCC/GCC channels. In CTC, you provision the orderwire communications network during ring turn-up so that all NEs on the ring can reach one another. Orderwire terminations (that is, the optics facilities that receive and process the orderwire channels) are provisionable. Both express and local orderwire can be configured as on or off on a particular SONET/SDH facility. The ONS 15454 supports up to four orderwire channel terminations per shelf. This allows linear, single ring, dual ring, and small hub-and-spoke configurations. Orderwire is not protected in ring topologies such as bidirectional line switched ring (BLSR), multiplex section-shared protection ring (MS-SPRing), path protection, or subnetwork connection protection (SNCP) ring.

Caution Do not configure orderwire loops. Orderwire loops cause feedback that disables the orderwire channel.

The ONS 15454 implementation of both local and express orderwire is broadcast in nature. The line acts as a party line. Anyone who picks up the orderwire channel can communicate with all other participants on the connected orderwire subnetwork. The local orderwire party line is separate from the express orderwire party line. Up to four OC-N/STM-N facilities for each local and express orderwire are provisionable as orderwire paths.

The AIC-I supports selective dual tone multifrequency (DTMF) dialing for telephony connectivity, which causes one AIC-I card or all ONS 15454 AIC-I cards on the orderwire subnetwork to “ring.” The ringer/buzzer resides on the AIC-I. There is also a “ring” LED that mimics the AIC-I ringer. It flashes when a call is received on the orderwire subnetwork. A party line call is initiated by pressing ***0000** on the DTMF pad. Individual dialing is initiated by pressing * and the individual four-digit number on the DTMF pad.

Table 2-22 shows the pins on the orderwire connector that correspond to the tip and ring orderwire assignments.

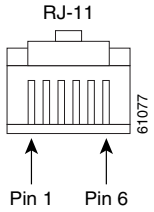
Table 2-22 Orderwire Pin Assignments

RJ-11 Pin Number	Description
1	Four-wire receive ring
2	Four-wire transmit tip
3	Two-wire ring
4	Two-wire tip
5	Four-wire transmit ring
6	Four-wire receive tip

When provisioning the orderwire subnetwork, make sure that an orderwire loop does not exist. Loops cause oscillation and an unusable orderwire channel.

Figure 2-8 shows the standard RJ-11 connectors used for orderwire ports.

Figure 2-8 RJ-11 Connector



2.9.4 Power Monitoring

The AIC-I card provides a power monitoring circuit that monitors the supply voltage of –48 VDC for presence, undervoltage, and overvoltage.

2.9.5 User Data Channel

The user data channel (UDC) features a dedicated data channel of 64 kbps (F1 byte) between two nodes in an ONS 15454 network. Each AIC-I card provides two user data channels, UDC-A and UDC-B, through separate RJ-11 connectors on the front of the AIC-I card. Each UDC can be routed to an individual optical interface in the ONS 15454. For instructions, see the *Cisco ONS 15454 DWDM Procedure Guide*.

The UDC ports are standard RJ-11 receptacles. Table 2-23 lists the UDC pin assignments.

Table 2-23 UDC Pin Assignments

RJ-11 Pin Number	Description
1	For future use
2	TXN
3	RXN

Table 2-23 UDC Pin Assignments (continued)

RJ-11 Pin Number	Description
4	RXP
5	TXP
6	For future use

2.9.6 Data Communications Channel

The DCC features a dedicated data channel of 576 kbps (D4 to D12 bytes) between two nodes in an ONS 15454 network. Each AIC-I card provides two data communications channels, DCC-A and DCC-B, through separate RJ-45 connectors on the front of the AIC-I card. Each DCC can be routed to an individual optical interface in the ONS 15454. For instructions, see the *Cisco ONS 15454 DWDM Procedure Guide*.

The DCC ports are synchronous serial interfaces. The DCC ports are standard RJ-45 receptacles. Table 2-24 lists the DCC pin assignments.

Table 2-24 DCC Pin Assignments

RJ-45 Pin Number	Description
1	TCLKP
2	TCLKN
3	TXP
4	TXN
5	RCLKP
6	RCLKN
7	RXP
8	RXN

2.10 MS-ISC-100T Card

(Cisco ONS 15454 only)

Note For hardware specifications, see the "A.3.10 MS-ISC-100T Card Specifications" section on page A-11.

The Multishelf Internal Switch Card (MS-ISC-100T) is an Ethernet switch used to implement the multishelf LAN. It connects the node controller shelf to the network and to subtending shelves. The MS-ISC-100T must always be equipped on the node controller shelf; it cannot be provisioned on a subtending controller shelf.

The recommended configuration is to implement LAN redundancy using two MS-ISC-100T cards: one switch is connected to the Ethernet front panel port of the TCC2/TCC2P card in Slot 7, and the other switch is connected to the Ethernet front panel port of the TCC2/TCC2P card in Slot 11. The Ethernet

configuration of the MS-ISC-100T card is part of the software package and is automatically loaded. The MS-ISC-100T card operates in Slots 1 to 6 and 12 to 17 on the node controller shelf; the recommended slots are Slot 6 and Slot 12.

Table 2-25 lists the MS-ISC-100T port assignments.

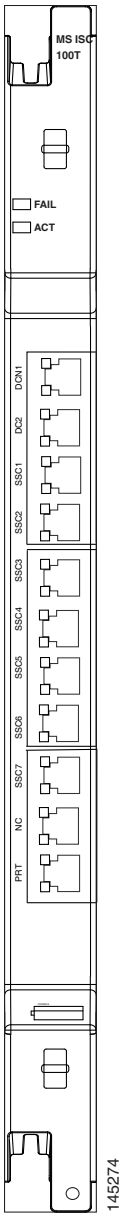
Table 2-25 MS-ISC-100T Card Port Assignments

Port	Description
DCN 1and DCN 2	Connection to the network
SSC1 to SSC7	Connection to subtending shelves
NC	Connection to TCC2/TCC2P using a cross-over cable
PRT	Connection to the PRT port of the redundant MS-ISC-100T

Figure 2-9 shows the card faceplate.

Caution Shielded twisted-pair cabling should be used for interbuilding applications.

Figure 2-9 MS-ISC-100T Faceplate



2.10.1 MS-ISC-100T Card-Level Indicators

The MS-ISC-100T card supports two card-level LED indicators. The card-level indicators are described in Table 2-26.

Table 2-26 MS-ISC-100T Card-Level Indicators

Card-Level LEDs	Description
FAIL LED (Red)	The red FAIL LED indicates that the card processor is not ready or that a catastrophic software failure occurred on the card. As part of the boot sequence, the FAIL LED is turned on until the software deems the card operational.
ACT LED (Green)	The green ACT LED provides the operational status of the card. If the ACT LED is green, it indicates that the card is active and the software is operational.

2.11 Front Mount Electrical Connections

This section describes the MIC-A/P and MIC-C/T/P FMECs, which provide power, external alarm, and timing connections for the ONS 15454 ETSI shelf.

2.11.1 MIC-A/P FMEC

Note For hardware specifications, see the "A.3.8 MIC-A/P FMEC Specifications (ETSI only)" section on page A-10.

The MIC-A/P FMEC provides connection for the BATTERY B input, one of the two possible redundant power supply inputs. It also provides connection for eight alarm outputs (coming from the TCC2/TCC2P card), sixteen alarm inputs, and four configurable alarm inputs/outputs. Its position is in Slot 23 in the center of the subrack Electrical Facility Connection Assembly (EFCA) area.

The MIC-A/P FMEC has the following features:

- Connection for one of the two possible redundant power supply inputs
- Connection for eight alarm outputs (coming from the TCC2/TCC2P card)
- Connection for four configurable alarm inputs/outputs
- Connection for sixteen alarm inputs
- Storage of manufacturing and inventory data

For proper system operation, both the MIC-A/P and MIC-C/T/P FMECs must be installed in the ONS 15454 ETSI shelf. Figure 2-10 shows the MIC-A/P faceplate.

Figure 2-10 MIC-A/P Faceplate

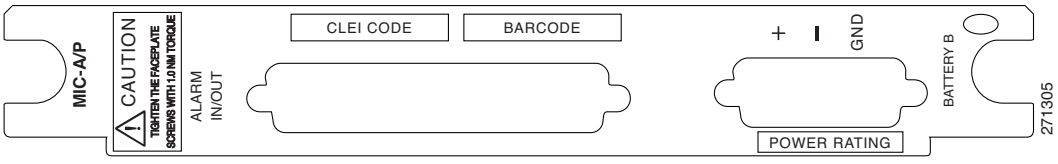


Figure 2-11 shows a block diagram of the MIC-A/P.

Figure 2-11 MIC-A/P Block Diagram

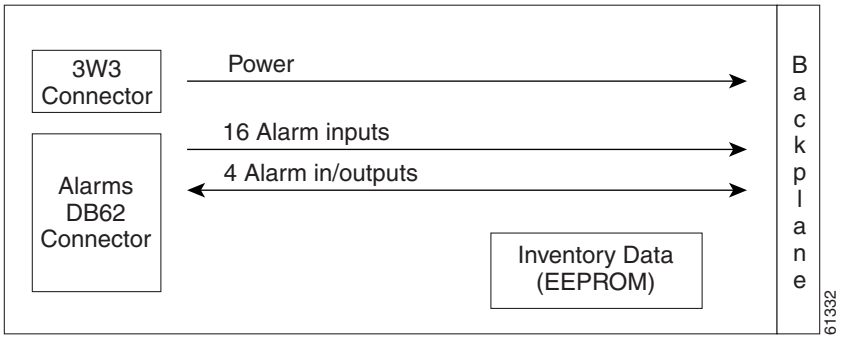


Table 2-27 shows the alarm interface pinouts on the MIC-A/P DB-62 connector.

Table 2-27 Alarm Interface Pinouts on the MIC-A/P DB-62 Connector

Pin No.	Signal Name	Signal Description
1	ALMCUTOFF N	Alarm cutoff, normally open ACO pair
2	ALMCUTOFF P	Alarm cutoff, normally open ACO pair
3	ALMINP0 N	Alarm input pair 1, reports closure on connected wires
4	ALMINP0 P	Alarm input pair 1, reports closure on connected wires
5	ALMINP1 N	Alarm input pair 2, reports closure on connected wires
6	ALMINP1 P	Alarm input pair 2, reports closure on connected wires
7	ALMINP2 N	Alarm input pair 3, reports closure on connected wires
8	ALMINP2 P	Alarm input pair 3, reports closure on connected wires
9	ALMINP3 N	Alarm input pair 4, reports closure on connected wires
10	ALMINP3 P	Alarm input pair 4, reports closure on connected wires
11	EXALM0 N	External customer alarm 1
12	EXALM0 P	External customer alarm 1
13	GND	Ground
14	EXALM1 N	External customer alarm 2
15	EXALM1 P	External customer alarm 2
16	EXALM2 N	External customer alarm 3
17	EXALM2 P	External customer alarm 3
18	EXALM3 N	External customer alarm 4
19	EXALM3 P	External customer alarm 4
20	EXALM4 N	External customer alarm 5
21	EXALM4 P	External customer alarm 5
22	EXALM5 N	External customer alarm 6
23	EXALM5 P	External customer alarm 6
24	EXALM6 N	External customer alarm 7
25	EXALM6 P	External customer alarm 7

Table 2-27 Alarm Interface Pinouts on the MIC-A/P DB-62 Connector (continued)

Pin No.	Signal Name	Signal Description
26	GND	Ground
27	EXALM7 N	External customer alarm 8
28	EXALM7 P	External customer alarm 8
29	EXALM8 N	External customer alarm 9
30	EXALM8 P	External customer alarm 9
31	EXALM9 N	External customer alarm 10
32	EXALM9 P	External customer alarm 10
33	EXALM10 N	External customer alarm 11
34	EXALM10 P	External customer alarm 11
35	EXALM11 N	External customer alarm 12
36	EXALM11 P	External customer alarm 12
37	ALMOUP0 N	Normally open output pair 1
38	ALMOUP0 P	Normally open output pair 1
39	GND	Ground
40	ALMOUP1 N	Normally open output pair 2
41	ALMOUP1 P	Normally open output pair 2
42	ALMOUP2 N	Normally open output pair 3
43	ALMOUP2 P	Normally open output pair 3
44	ALMOUP3 N	Normally open output pair 4
45	ALMOUP3 P	Normally open output pair 4
46	AUDALM0 N	Normally open Minor audible alarm
47	AUDALM0 P	Normally open Minor audible alarm
48	AUDALM1 N	Normally open Major audible alarm
49	AUDALM1 P	Normally open Major audible alarm
50	AUDALM2 N	Normally open Critical audible alarm
51	AUDALM2 P	Normally open Critical audible alarm
52	GND	Ground
53	AUDALM3 N	Normally open Remote audible alarm
54	AUDALM3 P	Normally open Remote audible alarm
55	VISALM0 N	Normally open Minor visual alarm
56	VISALM0 P	Normally open Minor visual alarm
57	VISALM1 N	Normally open Major visual alarm
58	VISALM1 P	Normally open Major visual alarm
59	VISALM2 N	Normally open Critical visual alarm
60	VISALM2 P	Normally open Critical visual alarm

Table 2-27 Alarm Interface Pinouts on the MIC-A/P DB-62 Connector (continued)

Pin No.	Signal Name	Signal Description
61	VISALM3 N	Normally open Remote visual alarm
62	VISALM3 P	Normally open Remote visual alarm

2.11.2 MIC-C/T/P FMEC

Note For hardware specifications, see the "A.3.9 MIC-C/T/P FMEC Specifications (ETSI only)" section on page A-10.

The MIC-C/T/P FMEC provides connection for the BATTERY A input, one of the two possible redundant power supply inputs. It also provides connection for system management serial port, system management LAN port, modem port (for future use), and system timing inputs and outputs. Install the MIC-C/T/P in Slot 24.

The MIC-C/T/P FMEC has the following features:

- Connection for one of the two possible redundant power supply inputs
- Connection for two serial ports for local craft/modem (for future use)
- Connection for one LAN port
- Connection for two system timing inputs
- Connection for two system timing outputs
- Storage of manufacturing and inventory data

For proper system operation, both the MIC-A/P and MIC-C/T/P FMECs must be installed in the shelf.

Figure 2-12 shows the MIC-C/T/P FMEC faceplate.

Figure 2-12 MIC-C/T/P Faceplate

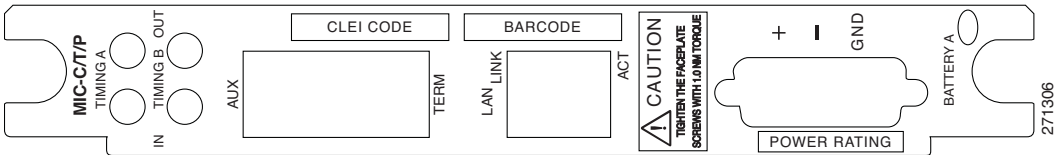
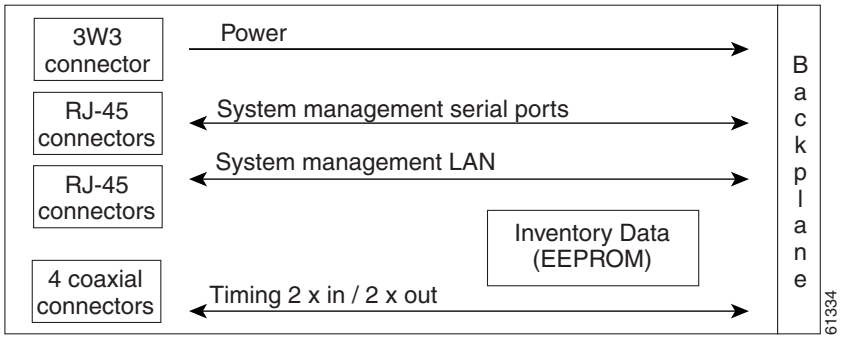


Figure 2-13 shows a block diagram of the MIC-C/T/P.

Figure 2-13 MIC-C/T/P Block Diagram



The MIC-C/T/P FMEC has one pair of LEDs located on the RJ45 LAN connector. The green LED is on when a link is present, and the amber LED is on when data is being transferred.

CHAPTER 3

Optical Service Channel Cards

This chapter describes the optical service channel (OSC) cards for Cisco ONS 15454 dense wavelength division multiplexing (DWDM) networks. For installation and card turn-up procedures, refer to the *Cisco ONS 15454 DWDM Procedure Guide*. For card safety and compliance information, refer to the *Cisco Optical Transport Products Safety and Compliance Information* document.

Note Unless noted otherwise, the cards described in this chapter are supported on the Cisco ONS 15454, Cisco ONS 15454 M6, Cisco ONS 15454 M2 platforms.

Note Unless otherwise specified, "ONS 15454" refers to both ANSI and ETSI shelf assemblies.

Chapter topics include:

- 3.1 Card Overview, page 3-1
- 3.2 Class 1 Laser Safety Labels, page 3-3
- 3.3 OSCM Card, page 3-5
- 3.4 OSC-CSM Card, page 3-9

3.1 Card Overview

This section provides card summary and compatibility information.

Note Each card is marked with a symbol that corresponds to a slot (or slots) on the ONS 15454 shelf assembly. The cards are then installed into slots displaying the same symbols. For a list of slots and symbols, see the "Card Slot Requirements" section in the *Cisco ONS 15454 Hardware Installation Guide*.

An optical service channel (OSC) is a bidirectional channel connecting two adjacent nodes in a DWDM ring. For every DWDM node (except terminal nodes), two different OSC terminations are present, one for the west side and another for the east side. The channel transports OSC overhead that is used to manage ONS 15454 DWDM networks. An OSC signal uses the 1510-nm wavelength and does not affect client traffic. The primary purpose of this channel is to carry clock synchronization and orderwire channel communications for the DWDM network. It also provides transparent links between each node in the network. The OSC is an OC-3/STM-1 formatted signal.

There are two versions of the OSC modules: the OSCM, and the OSC-CSM, which contains the OSC wavelength combiner and separator component in addition to the OSC module.

The Mesh/Multiring Upgrade (MMU) card is used to optically bypass a given wavelength from one section of the network or ring to another one without requiring 3R regeneration.

Note On 15454-M2 and 15454-M6 shelves, the TNC card includes the functions of the OSCM card. OSC can be created on the OC3 port (SFP-0) of the TNC card.

The TNC card supports two optical service channels (OSC): primary OSC and secondary OSC.

The primary optical service channel (SFP-0) supports the following interfaces:

- OC-3/STM-1
- Fast Ethernet (FE)
- Gigabit Ethernet (GE).

The secondary optical service channel (SFP-1) supports the following interfaces:

- Fast Ethernet (FE)
- Gigabit Ethernet (GE).

3.1.1 Card Summary

Table 3-1 lists and summarizes the functions of each card.

Table 3-1 OSCM, OSC-CSM, and MMU Card Summary

Card	Port Description	For Additional Information
OSCM	The OSCM has one set of optical ports and one Ethernet port located on the faceplate. It operates in Slots 8 and 10.	See the "3.3 OSCM Card" section on page 3-5.
OSC-CSM	The OSC-CSM has three sets of optical ports and one Ethernet port located on the faceplate. It operates in Slots 1 to 6 and 12 to 17.	See the "3.4 OSC-CSM Card" section on page 3-9.

3.1.2 Card Compatibility

Table 3-2 lists the CTC software compatibility for the OSC and OSCM cards.

Table 3-2 Software Release Compatibility for Optical Service Channel Cards

Card Name	R4.5	R4.6	R4.7	R5.0	R6.0	R7.0	R7.2	R8.0	R8.5	R9.0	R9.1	R9.2
OSCM	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
OSC-CSM	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

3.2 Class 1 Laser Safety Labels

This section explains the significance of the safety labels attached to the OSCM and OSC-CSM cards. The faceplates of the cards are clearly labeled with warnings about the laser radiation levels. You must understand all warning labels before working on these cards.

3.2.1 Class 1 Laser Product Label

The Class 1 Laser Product label is shown in Figure 3-1.

Figure 3-1 Class 1 Laser Product Label

Class 1 lasers are products whose irradiance does not exceed the Maximum Permissible Exposure (MPE) value. Therefore, for Class 1 laser products the output power is below the level at which it is believed eye damage will occur. Exposure to the beam of a Class 1 laser will not result in eye injury and may therefore be considered safe. However, some Class 1 laser products may contain laser systems of a higher Class but there are adequate engineering control measures to ensure that access to the beam is not reasonably likely. Anyone who dismantles a Class 1 laser product that contains a higher Class laser system is potentially at risk of exposure to a hazardous laser beam

3.2.2 Hazard Level 1 Label

The Hazard Level 1 label is shown in Figure 3-2.

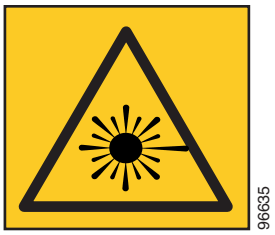
Figure 3-2 Hazard Level Label

The Hazard Level label warns users against exposure to laser radiation of Class 1 limits calculated in accordance with IEC60825-1 Ed.1.2. This label is displayed on the faceplate of the cards.

3.2.3 Laser Source Connector Label

The Laser Source Connector label is shown in Figure 3-3.

Figure 3-3 Laser Source Connector Label



This label indicates that a laser source is present at the optical connector where the label has been placed.

3.2.4 FDA Statement Label

The FDA Statement labels are shown in Figure 3-4 and Figure 3-5. These labels show compliance to FDA standards and that the hazard level classification is in accordance with IEC60825-1 Am.2 or Ed.1.2.

Figure 3-4 FDA Statement Label

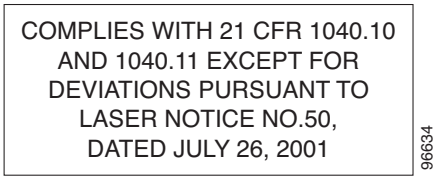
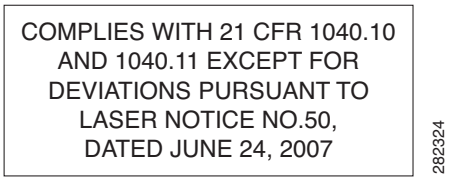


Figure 3-5 FDA Statement Label



3.2.5 Shock Hazard Label

The Shock Hazard label is shown in Figure 3-6.

Figure 3-6 Shock Hazard Label

This label alerts personnel to electrical hazard within the card. The potential of shock hazard exists when removing adjacent cards during maintenance, and touching exposed electrical circuitry on the card itself.

This section describes the optical service channel cards. An optical service channel (OSC) is a bidirectional channel connecting two adjacent nodes in a DWDM ring. For every DWDM node (except terminal nodes), two different OSC terminations are present, one for the west side and another for the east side. The channel transports OSC overhead that is used to manage ONS 15454 DWDM networks. An OSC signal uses the 1510-nm wavelength and does not affect client traffic. The primary purpose of this channel is to carry clock synchronization and orderwire channel communications for the DWDM network. It also provides transparent links between each node in the network. The OSC is an OC-3/STM-1 formatted signal.

There are two versions of the OSC modules: the OSCM, and the OSC-CSM, which contains the OSC wavelength combiner and separator component in addition to the OSC module.

3.3 OSCM Card

(Cisco ONS 15454 only)

Note For OSCM card specifications, see the "A.4.1 OSCM Card Specifications" section on page A-11.

Note On 15454-M2 and 15454-M6 shelves, the TNC card includes the functions of the OSCM card.

The OSCM card is used in amplified nodes that include the OPT-BST, OPT-BST-E, or OPT-BST-L booster amplifier. The OPT-BST, OPT-BST-E, and OPT-BST-L cards include the required OSC wavelength combiner and separator component. The OSCM cannot be used in nodes where you use OC-N/STM-N cards, electrical cards, or cross-connect cards. The OSCM uses Slots 8 and 10, which are also cross-connect card slots.

The OSCM supports the following features:

- OC-3/STM-1 formatted OSC
- Supervisory data channel (SDC) forwarded to the TCC2/TCC2P/TCC3 cards for processing
- Distribution of the synchronous clock to all nodes in the ring
- 100BaseT far-end (FE) User Channel (UC)
- Monitoring functions such as orderwire support and optical safety

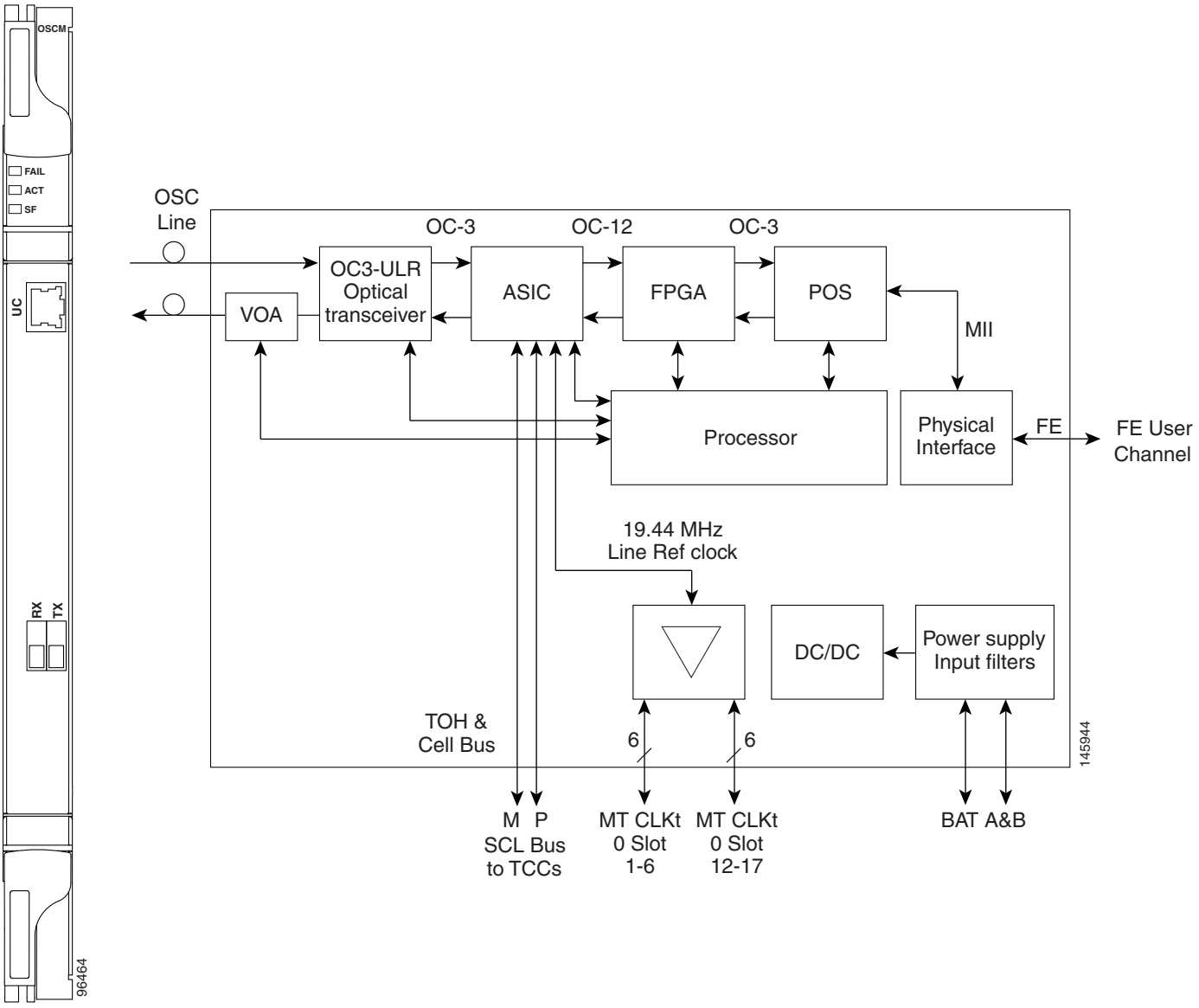
The OC-3/STM-1 section data communications channel (SDCC or RS-DCC) overhead bytes are used for network communications. An optical transceiver terminates the OC-3/STM-1, then it is regenerated and converted into an electrical signal. The SDCC or RS-DCC bytes are forwarded to the active and standby TCC2/TCC2P/TCC3 cards for processing through the system communication link (SCL) bus on the backplane. Orderwire bytes (E1, E2, F1) are also forwarded via the SCL bus to the TCC2/TCC2P/TCC3 for forwarding to the AIC-I card.

The payload portion of the OC-3/STM-1 is used to carry the fast Ethernet UC. The frame is sent to a packet-over-SONET/SDH (POS) processing block that extracts the Ethernet packets and makes them available at the RJ-45 connector.

The OSCM distributes the reference clock information by removing it from the incoming OC-3/STM-1 signal and then sending it to the DWDM cards. The DWDM cards then forward the clock information to the active and standby TCC2/TCC2P/TCC3 cards.

Figure 3-7 shows the OSCM card faceplate and block diagram.

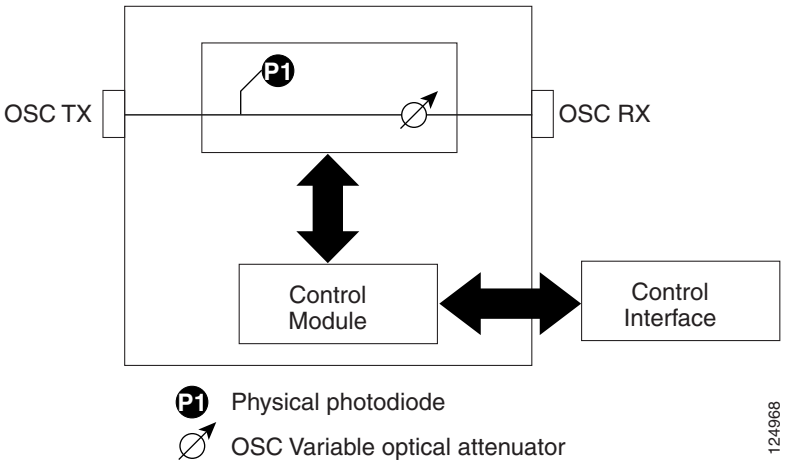
Figure 3-7 OSCM Card Faceplate



For information on safety labels for the card, see the "3.2 Class 1 Laser Safety Labels" section on page 3-3.

Figure 3-8 shows the block diagram of the variable optical attenuator (VOA) within the OSCM.

Figure 3-8 OSCM VOA Optical Module Functional Block Diagram



3.3.1 Power Monitoring

Physical photodiode P1 monitors the power for the OSCM card. The returned power level value is calibrated to the OSC TX port (Table 3-3).

Table 3-3 OSCM VOA Port Calibration

Photodiode	CTC Type Name	Calibrated to Port
P1	Output OSC	OSC TX

For information on the associated TL1 AIDs for the optical power monitoring points, refer the "CTC Port Numbers and TL1 Aids" section in *Cisco ONS SONET TL1 Command Guide, Release 9.2*.

3.3.2 OSCM Card-Level Indicators

The OSCM card has three card-level LED indicators, described in Table 3-4.

Table 3-4 OSCM Card-Level Indicators

Card-Level Indicators	Description
Red FAIL LED	The red FAIL LED indicates that the card's processor is not ready or that there is an internal hardware failure. Replace the card if the red FAIL LED persists.

Table 3-4 OSCM Card-Level Indicators (continued)

Card-Level Indicators	Description
Green ACT LED	The green ACT LED indicates that the OSCM is carrying traffic or is traffic-ready.
Amber SF LED	The amber SF LED indicates a signal failure or condition such as loss of signal (LOS), loss of frame alignment (LOF), line alarm indication signal (AIS-L), or high BER on one or more of the card's ports. The amber signal fail (SF) LED also illuminates when the transmit and receive fibers are incorrectly connected. When the fibers are properly connected, the light turns off.

3.3.3 OSCM Port-Level Indicators

You can find the status of the card ports using the LCD screen on the ONS 15454 fan-tray assembly. Use the LCD to view the status of any port or card slot; the screen displays the number and severity of alarms for a given port or slot. The OSCM has one OC-3/STM-1 optical port located on the faceplate. One long-reach OSC transmits and receives the OSC to and from another DWDM node. Both DCN data and FE payload are carried on this link.

3.4 OSC-CSM Card

Note For OSC-CSM card specifications, see the "A.4.2 OSC-CSM Card Specifications" section on page A-12.

The OSC-CSM card is used in unamplified nodes. This means that the booster amplifier with the OSC wavelength combiner and separator is not required for OSC-CSM operation. The OSC-CSM can be installed in Slots 1 to 6 and 12 to 17. To operate in hybrid mode, the OSC-CSM cards must be accompanied by cross-connect cards. The cross-connect cards enable functionality on the OC-N/STM-N cards and electrical cards.

The OSC-CSM supports the following features:

- Optical combiner and separator module for multiplexing and demultiplexing the optical service channel to or from the wavelength division multiplexing (WDM) signal
- OC-3/STM-1 formatted OSC
- SDC forwarded to the TCC2/TCC2P/TCC3 cards for processing
- Distribution of the synchronous clock to all nodes in the ring
- 100BaseT FE UC
- Monitoring functions such as orderwire support
- Optical safety: Signal loss detection and alarming, fast transmitted power shut down by means of an optical 1x1 switch
- Optical safety remote interlock (OSRI), a feature capable of shutting down the optical output power

- Automatic laser shutdown (ALS), a safety mechanism used in the event of a fiber cut. For details on ALS provisioning for the card, see the *Cisco ONS 15454 DWDM Procedure Guide*. For information on using the card to implement ALS in a network, see the "12.11 Network Optical Safety" section on page 12-27.

The WDM signal coming from the line is passed through the OSC combiner and separator, where the OSC signal is extracted from the WDM signal. The WDM signal is sent along with the remaining channels to the COM port (label on the front panel) for routing to the OADM or amplifier units, while the OSC signal is sent to an optical transceiver.

The OSC is an OC-3/STM-1 formatted signal. The OC-3/STM-1 SDCC or RS-DCC overhead bytes are used for network communications. An optical transceiver terminates the OC-3/STM-1, and then it is regenerated and converted into an electrical signal. The SDCC or RS-DCC bytes are forwarded to the active and standby TCC2/TCC2P/TCC3 cards for processing via the SCL bus on the backplane. Orderwire bytes (E1, E2, F1) are also forwarded via the SCL bus to the TCC2/TCC2P/TCC3 for forwarding to the AIC-I card.

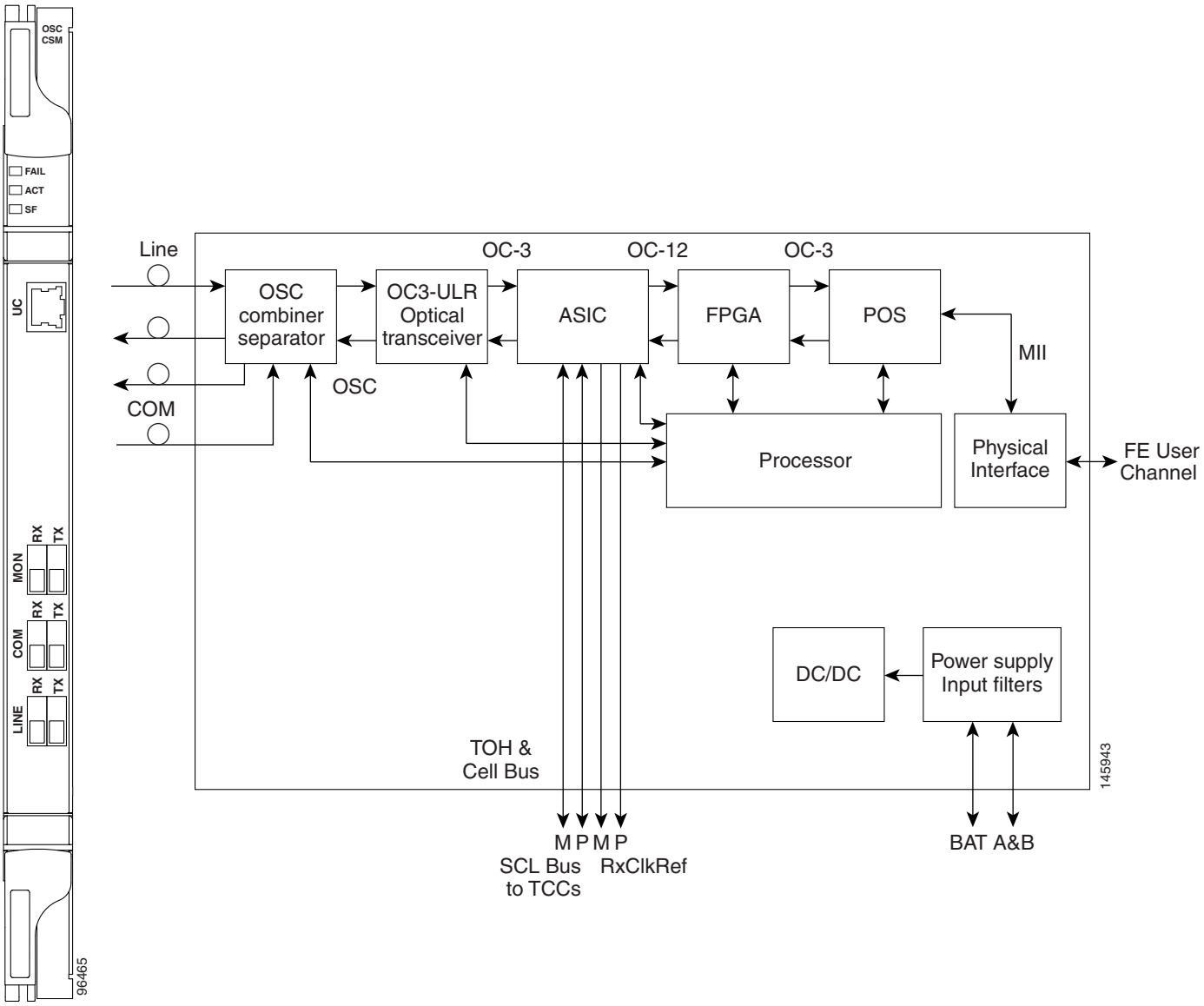
The payload portion of the OC-3/STM-1 is used to carry the fast Ethernet UC. The frame is sent to a POS processing block that extracts the Ethernet packets and makes them available at the RJ-45 front panel connector.

The OSC-CSM distributes the reference clock information by removing it from the incoming OC-3/STM-1 signal and then sending it to the active and standby TCC2/TCC2P/TCC3 cards. The clock distribution is different from the OSCM card because the OSC-CSM does not use Slot 8 or 10 (cross-connect card slots).

Note S1 and S2 (Figure 3-11 on page 3-13) are optical splitters with a splitter ratio of 2:98. The result is that the power at the MON TX port is about 17 dB lower than the relevant power at the COM RX port, and the power at the MON RX port is about 20 dB lower than the power at the COM TX port. The difference is due to the presence of a tap coupler for the P1 photodiode.

Figure 3-9 shows the OSC-CSM faceplate.

Figure 3-9 OSC-CSM Faceplate



For information on safety labels for the card, see the "3.2 Class 1 Laser Safety Labels" section on page 3-3.

Figure 3-10 shows a block diagram of the OSC-CSM card.

Figure 3-10 OSC-CSM Block Diagram

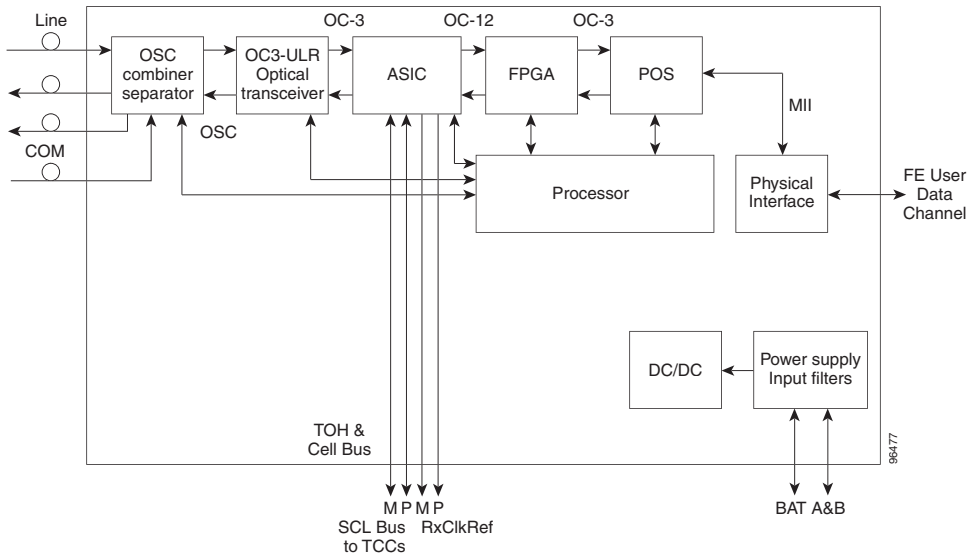
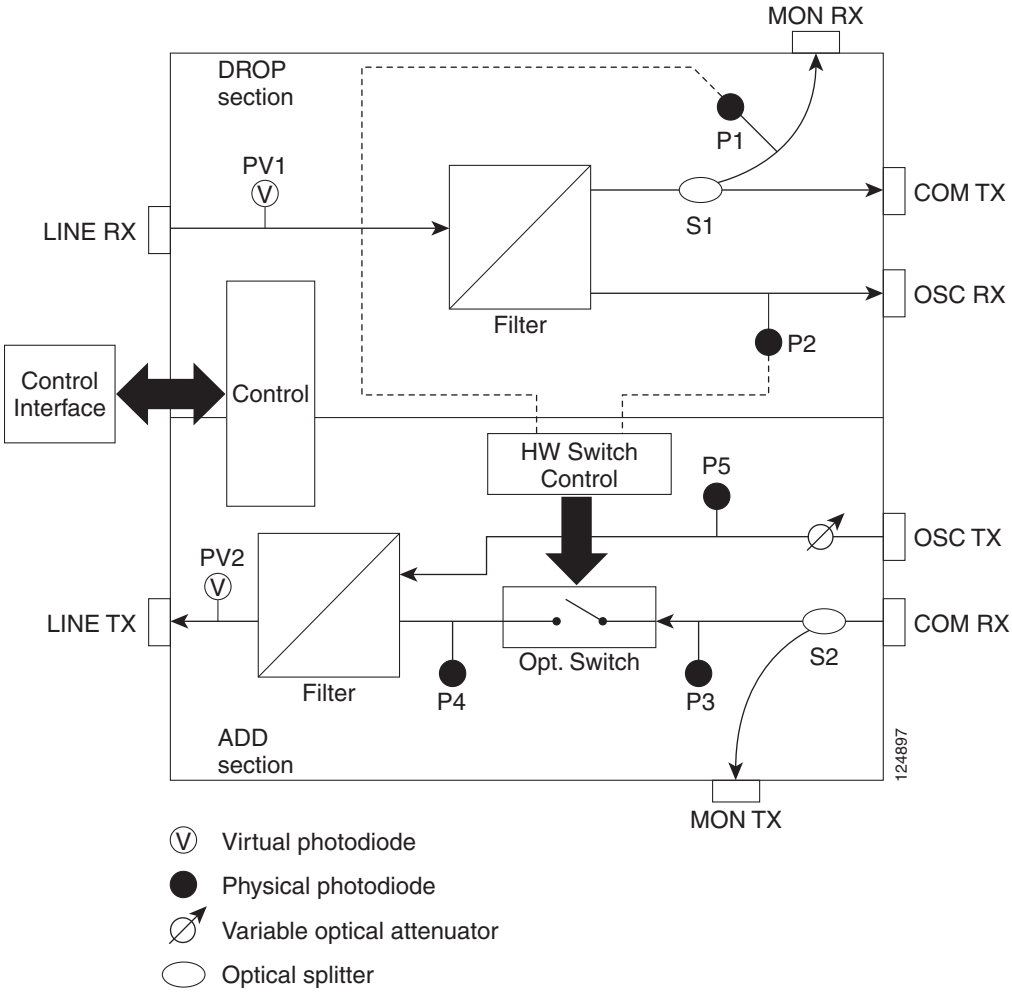


Figure 3-11 shows the OSC-CSM optical module functional block diagram.

Figure 3-11 OSC-CSM Optical Module Functional Block Diagram



3.4.1 Power Monitoring

Physical photodiodes P1, P2, P3, and P5 monitor the power for the OSC-CSM card. Their function is as follows:

- P1: The returned power value is calibrated to the LINE RX port, including the insertion loss of the previous filter (the reading of this power dynamic range has been brought backward towards the LINE RX output).
- P2: The returned value is calibrated to the LINE RX port.
- P3: The returned value is calibrated to the COM RX port.
- P5: The returned value is calibrated to the OSC TX port, including the insertion loss of the subsequent filter.

The returned power level values are calibrated to the ports as shown in Table 3-5.

Table 3-5 OSC-CSM Port Calibration

Photodiode	CTC Type Name	Calibrated to Port	Power	PM Parameters
P1	Input Line	LINE RX	Channel Power	Supported
			OSC Power	
P2	Input Line	LINE RX	OSC Power	Supported
P3	Input Com	COM RX	Channel Power	Supported
P5	Output OSC	OSC TX	OSC Power	Supported

The OSC power on the LINE TX is the same as the power reported from P5.

The PM parameters for the power values are listed in Table 19-31.

For information on the associated TL1 AIDs for the optical power monitoring points, refer the "CTC Port Numbers and TL1 Aids" section in *Cisco ONS SONET TL1 Command Guide, Release 9.2.*

3.4.2 Alarms and Thresholds

Table 3-6 lists the alarms and its related thresholds for the OSC-CSM card.

Table 3-6 Alarms and Thresholds

Port	Alarms	Thresholds
LINE RX	LOS	None
	LOS-P	LOS-P Fail Low
	LOS-O	LOS-O Fail Low
LINE TX	None	None
OSC TX	OPWR-DEG-HIGH	OPWR-DEG-HIGH Th
	OPWR-DEG-LOW	OPWR-DEG-LOW Th
	OPWR-FAIL-LOW	OPWR-FAIL-LOW Th
OSC RX	None	None
COM TX	None	None
COM RX	LOS-P	LOS-P Fail Low

3.4.3 OSC-CSM Card-Level Indicators

The OSC-CSM card has three card-level LED indicators, described in Table 3-7.

Table 3-7 OSC-CSM Card-Level Indicators

Card-Level Indicators	Description
Red FAIL LED	The red FAIL LED indicates that the card's processor is not ready or that there is an internal hardware failure. Replace the card if the red FAIL LED persists.
Green ACT LED	The green ACT LED indicates that the OSC-CSM is carrying traffic or is traffic-ready.
Amber SF LED	The amber SF LED indicates a signal failure or condition such as LOS, LOF, AIS-L, or high BER on one or more of the card's ports. The amber SF LED also illuminates when the transmit and receive fibers are incorrectly connected. When the fibers are properly connected, the light turns off.

3.4.4 OSC-CSM Port-Level Indicators

You can find the status of the card ports using the LCD screen on the ONS 15454 fan-tray assembly. Use the LCD to view the status of any port or card slot; the screen displays the number and severity of alarms for a given port or slot. The OSC-CSM has a OC3 port and three other sets of ports located on the faceplate.

CHAPTER 4

Optical Amplifier Cards

This chapter describes the optical amplifier cards used in Cisco ONS 15454 dense wavelength division multiplexing (DWDM) networks. For installation and card turn-up procedures, refer to the *Cisco ONS 15454 DWDM Procedure Guide*. For card safety and compliance information, refer to the *Cisco Optical Transport Products Safety and Compliance Information* document.

Note The cards described in this chapter are supported on the Cisco ONS 15454, Cisco ONS 15454 M6, Cisco ONS 15454 M2 platforms, unless noted otherwise.

Note Unless otherwise specified, “ONS 15454” refers to both ANSI and ETSI shelf assemblies.

Chapter topics include:

- 4.1 Card Overview, page 4-1
- 4.2 Class 1M Laser Safety Labels, page 4-5
- 4.3 OPT-PRE Amplifier Card, page 4-7
- 4.4 OPT-BST Amplifier Card, page 4-11
- 4.5 OPT-BST-E Amplifier Card, page 4-16
- 4.6 OPT-BST-L Amplifier Card, page 4-19
- 4.7 OPT-AMP-L Card, page 4-24
- 4.8 OPT-AMP-17-C Card, page 4-29
- 4.9 OPT-AMP-C Card, page 4-33
- 4.10 OPT-RAMP-C and OPT-RAMP-CE Cards, page 4-38

4.1 Card Overview

This section provides summary and compatibility information for the optical amplifier cards.

Note Each card is marked with a symbol that corresponds to a slot (or slots) on the ONS 15454 shelf assembly. Cards should be installed in slots that have the same symbols. For a list of slots and symbols, see the "Card Slot Requirements" section in the *Cisco ONS 15454 Hardware Installation Guide*.

Optical amplifiers are used in amplified nodes (such as hub nodes), amplified OADM nodes, and line amplifier nodes. The nine types of ONS 15454 DWDM amplifiers are:

- Optical Preamplifier (OPT-PRE)
- Optical Booster amplifier (OPT-BST)
- Optical Booster Enhanced amplifier (OPT-BST-E)
- Optical Booster L-band amplifier (OPT-BST-L)
- Optical L-band preamplifier (OPT-AMP-L)
- Optical C-band amplifier (OPT-AMP-17-C).
- Optical C-band high-gain high-power amplifier (OPT-AMP-C)
- Optical C-band Raman amplifier (OPT-RAMP-C)
- Optical C-band enhanced Raman amplifier (OPT-RAMP-CE)

Optical amplifier card architecture includes an optical plug-in module with a controller that manages optical power, laser current, and temperature control loops. An amplifier also manages communication with the TCC2/TCC2P/TCC3/TNC/TSC card and operation, administration, maintenance, and provisioning (OAM&P) functions such as provisioning, controls, and alarms.

4.1.1 Applications

Using CTC (CTC > Card > Provisioning), the following amplifiers can be configured as booster or preamplifiers:

- OPT-AMP-C
- OPT-AMP-17C
- OPT-AMP-L
- OPT-BST-E
- OPT-BST

The amplifier functions as a booster amplifier by default. The amplifier role is automatically configured when the CTP NE update configuration file is loaded in CTC. The amplifier role can also be manually modified.

Note The OPT-BST and OPT-BST-E amplifiers are supported as preamplifiers in sites that are equipped with the OPT-RAMP-C card. In any other configuration, the OPT-BST and OPT-BST-E cards must be configured as a booster amplifier.

For more information about the supported configurations and network topologies, see Chapter 11, “Node Reference” and Chapter 12, “Network Reference.”

4.1.2 Card Summary

Table 4-1 lists and summarizes the functions of each optical amplifier card.

Table 4-1 Optical Amplifier Cards for the ONS 15454

Card	Port Description	For Additional Information
OPT-PRE	The OPT-PRE amplifier has five optical ports (three sets) located on the faceplate. It operates in Slots 1 to 6 and 12 to 17.	See the "4.3 OPT-PRE Amplifier Card" section on page 4-7.
OPT-BST	The OPT-BST amplifier has four sets of optical ports located on the faceplate. It operates in Slots 1 to 6 and 12 to 17.	See the "4.4 OPT-BST Amplifier Card" section on page 4-11.
OPT-BST-E	The OPT-BST-E amplifier has four sets of optical ports located on the faceplate. It operates in Slots 1 to 6 and 12 to 17.	See the "4.5 OPT-BST-E Amplifier Card" section on page 4-16.
OPT-BST-L	The OPT-BST-L L-band amplifier has four sets of optical ports located on the faceplate. It operates in Slots 1 to 6 and 12 to 17.	See the "4.6 OPT-BST-L Amplifier Card" section on page 4-19.
OPT-AMP-L	The OPT-AMP-L L-band preamplifier has five sets of optical ports located on the faceplate. It is a two-slot card that operates in Slots 1 to 6 and 12 to 17.	See the "4.7 OPT-AMP-L Card" section on page 4-24.
OPT-AMP-17-C	The OPT-AMP-17-C C-band low-gain preamplifier/booster amplifier has four sets of optical ports located on the faceplate. It operates in Slots 1 to 6 and 12 to 17.	See the "4.8 OPT-AMP-17-C Card" section on page 4-29.
OPT-AMP-C	The OPT-AMP-C C-band high-gain, high-power preamplifier/booster amplifier has five sets of optical ports located on the faceplate. It operates as a preamplifier when equipped and provisioned in Slots 2 to 6 and 11 to 16 or as a booster amplifier when equipped and provisioned in Slot 1 and 17.	See the "4.9 OPT-AMP-C Card" section on page 4-33.
OPT-RAMP-C	The OPT-RAMP-C C-band amplifier has five sets of optical ports located on the faceplate and operates in Slots 1 to 5 and 12 to 16.	See the "4.10 OPT-RAMP-C and OPT-RAMP-CE Cards" section on page 4-38.
OPT-RAMP-CE	The OPT-RAMP-CE C-band amplifier has five sets of optical ports located on the faceplate and operates in Slots 1 to 5 and 12 to 16.	See the "4.10 OPT-RAMP-C and OPT-RAMP-CE Cards" section on page 4-38.

4.1.3 Card Compatibility

Table 4-2 lists the Cisco Transport Controller (CTC) software compatibility for each optical amplifier card.

Table 4-2 Software Release Compatibility for Optical Amplifier Cards

Card Type	R4.5	R4.6	R4.7	R5.0	R6.0	R7.0	R7.2	R8.0	R8.5	R9.0	R9.1	R 9.2
OPT-PRE	15454-DWDM	15454-DWDM	15454-DWDM	15454-DWDM	15454-DWDM	15454-DWDM	15454-DWDM	15454-DWDM	15454-DWDM	15454-DWDM	15454-DWDM	ONS 15454, 15454-M2, 15454-M6
OPT-BST	15454-DWDM	15454-DWDM	15454-DWDM	15454-DWDM	15454-DWDM	15454-DWDM	15454-DWDM	15454-DWDM	15454-DWDM	15454-DWDM	15454-DWDM	ONS 15454, 15454-M2, 15454-M6
OPT-BST-E	No	No	15454-DWDM	15454-DWDM	15454-DWDM	15454-DWDM	15454-DWDM	15454-DWDM	15454-DWDM	15454-DWDM	15454-DWDM	ONS 15454, 15454-M2, 15454-M6
OPT-BST-L	No	No	No	No	No	15454-DWDM	15454-DWDM	15454-DWDM	15454-DWDM	15454-DWDM	15454-DWDM	15454-DWDM
OPT-AMP-L	No	No	No	No	No	15454-DWDM	15454-DWDM	15454-DWDM	15454-DWDM	15454-DWDM	15454-DWDM	15454-DWDM
OPT-AMP-17-C	No	No	No	No	No	No	No	15454-DWDM	15454-DWDM	15454-DWDM	15454-DWDM	ONS 15454, 15454-M2, 15454-M6
OPT-AMP-C	No	No	No	No	No	No	No	No	15454-DWDM	15454-DWDM	15454-DWDM	ONS 15454, 15454-M2, 15454-M6
OPT-RAMP-C	No	No	No	No	No	No	No	No	No	15454-DWDM	15454-DWDM	ONS 15454, 15454-M6
OPT-RAMP-CE	No	No	No	No	No	No	No	No	No	No	15454-DWDM	ONS 15454, 15454-M6

4.1.4 Optical Power Alarms and Thresholds

Table 4-3 lists the alarms and related thresholds for the OPT-BST, OPT-BST-E, OPT-BST-L, OPT-AMP-L, OPT-AMP-17-C, and OPT-AMP-C cards.

Table 4-3 Alarms and Thresholds

Port	Alarms	Thresholds
LINE RX	LOS	None
	LOS-P	LOS-P Fail Low
	LOS-O	LOS-O Fail Low
LINE TX	OPWR-FAIL	OPWR Fail Low
OSC TX	None	None
OSC RX	None	None
COM TX	None	None
COM RX	LOS-P	LOS-P Fail Low

4.2 Class 1M Laser Safety Labels

This section explains the significance of the safety labels attached to the optical amplifier cards. The faceplates of the cards are clearly labeled with warnings about the laser radiation levels. You must understand all warning labels before working on these cards.

4.2.1 Class 1M Laser Product Statement

Figure 4-1 shows the Class 1M Laser Product statement. Class 1M lasers are products that produce either a highly divergent beam or a large diameter beam. Therefore, only a small part of the whole laser beam can enter the eye. However, these laser products can be harmful to the eye if the beam is viewed using magnifying optical instruments.

Figure 4-1 Class 1M Laser Product Statement

4.2.2 Hazard Level 1M Label

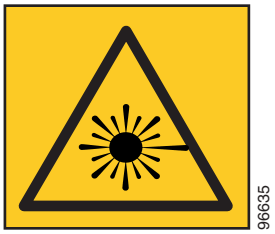
Figure 4-2 shows the Hazard Level 1M label. The Hazard Level label warns users against exposure to laser radiation calculated in accordance with IEC60825-1 Ed.1.2. This label is displayed on the faceplate of the cards.

Figure 4-2 Hazard Level Label

4.2.3 Laser Source Connector Label

Figure 4-3 shows the Laser Source Connector label. This label indicates that a laser source is present at the optical connector where the label appears.

Figure 4-3 Laser Source Connector Label



4.2.4 FDA Statement Label

The FDA Statement labels are shown in Figure 4-4 and Figure 4-5.

Figure 4-4 FDA Statement Label

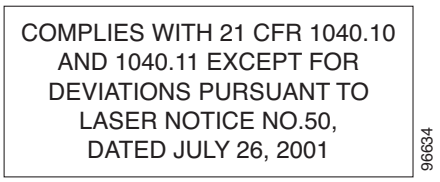
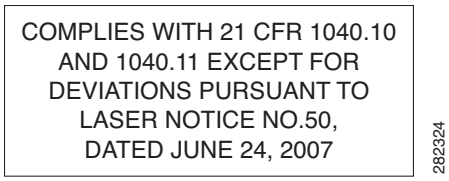


Figure 4-5 FDA Statement Label

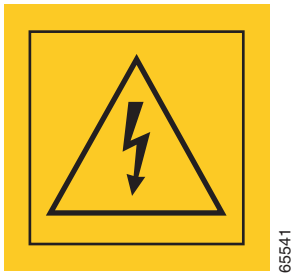


These labels show compliance to FDA standards and that the hazard level classification is in accordance with IEC60825-1 Am.2 or Ed.1.2.

4.2.5 Shock Hazard Label

Figure 4-6 shows the Shock Hazard label. This label alerts you to an electrical hazard within the card. The potential for shock exists when you remove adjacent cards during maintenance or touch exposed electrical circuity on the card.

Figure 4-6 Shock Hazard Label



4.3 OPT-PRE Amplifier Card

Note For hardware specifications, see the "A.5.1 OPT-PRE Amplifier Card Specifications" section on page A-13.

Note For OPT-PRE card safety labels, see the "4.2 Class 1M Laser Safety Labels" section on page 4-5.

The OPT-PRE is a C-band, DWDM, two-stage erbium-doped fiber amplifier (EDFA) with midamplifier loss (MAL) that can be connected to a dispersion compensating unit (DCU). The OPT-PRE is equipped with a built-in variable optical attenuator (VOA) that controls the gain tilt and can also be used to pad the DCU to a reference value. You can install the OPT-PRE in Slots 1 to 6 and 12 to 17. The card is designed to support up to 80 channels at 50-GHz channel spacing. The OPT-PRE features include:

- Fixed gain mode with programmable tilt
- True variable gain

- Fast transient suppression
- Nondistorting low-frequency transfer function
- Settable maximum output power
- Fixed output power mode (mode used during provisioning)
- MAL for fiber-based DCU
- Amplified spontaneous emissions (ASE) compensation in fixed gain mode
- Full monitoring and alarm handling with settable thresholds
- Four signal photodiodes to monitor the input and output optical power of the two amplifier stages through CTC
- An optical output port for external monitoring

Note The optical splitter has a ratio of 1:99, resulting in about 20 dB-lower power at the MON port than at the COM TX port.

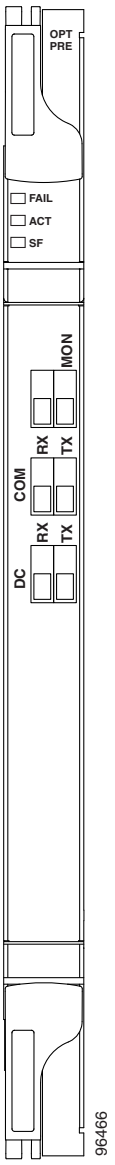
4.3.1 OPT-PRE Faceplate Ports

The OPT-PRE amplifier has five optical ports located on the faceplate:

- MON is the output monitor port
- COM RX (receive) is the input signal port
- COM TX (transmit) is the output signal port
- DC RX is the MAL input signal port
- DC TX is the MAL output signal port

Figure 4-7 shows the OPT-PRE amplifier card faceplate.

Figure 4-7 OPT-PRE Faceplate



4.3.2 OPT-PRE Block Diagrams

Figure 4-8 shows a simplified block diagram of the OPT-PRE card's features.

Figure 4-8 OPT-PRE Block Diagram

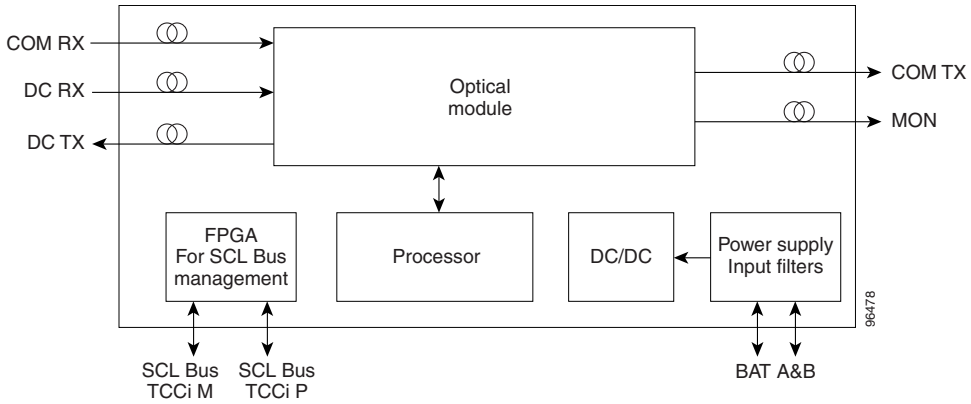
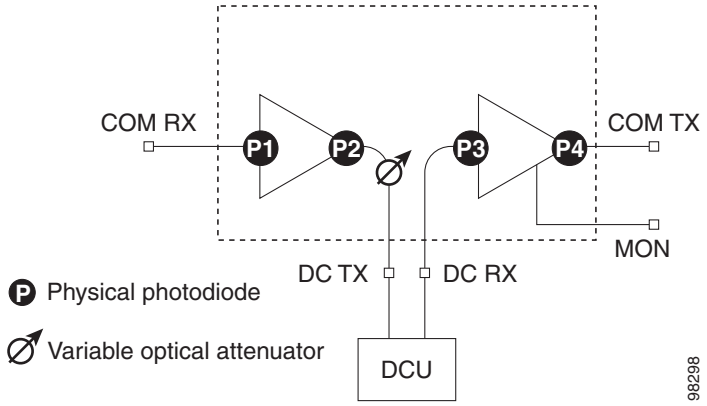


Figure 4-9 shows the a block diagram of how the OPT-PRE optical module functions.

Figure 4-9 OPT-PRE Optical Module Functional Block Diagram



4.3.3 OPT-PRE Power Monitoring

Physical photodiodes P1, P2, P3, and P4 monitor the power for the OPT-PRE card. Table 4-4 shows the returned power level values calibrated to each port.

Table 4-4 OPT-PRE Port Calibration

Photodiode	CTC Type Name	Calibrated to Port
P1	Input Com	COM RX
P2	Output DC	DC TX
P3	Input DC	DC RX
P4	Output COM (Total Output)	COM TX
	Output COM (Signal Output)	

For information on the associated TL1 AIDs for the optical power monitoring points, refer the "CTC Port Numbers and TL1 Aids" section in *Cisco ONS SONET TL1 Command Guide, Release 9.2*.

4.3.4 OPT-PRE Amplifier Card-Level Indicators

Table 4-5 shows the three card-level LED indicators on the OPT-PRE amplifier card.

Table 4-5 OPT-PRE Amplifier Card-Level Indicators

Card-Level Indicators	Description
Red FAIL LED	The red FAIL LED indicates that the card's processor is not ready or that an internal hardware failure occurred. Replace the card if the red FAIL LED persists.
Green ACT LED	The green ACT LED indicates that the OPT-PRE is carrying traffic or is traffic-ready.
Amber SF LED	The amber SF LED indicates a signal failure or condition such as LOS on one or more of the card's ports. The amber SF LED also turns on when the transmit and receive fibers are incorrectly connected. When the fibers are properly connected, the light turns off.

4.3.5 OPT-PRE Amplifier Port-Level Indicators

You can determine the status of the card ports using the LCD screen on the ONS 15454 fan-tray assembly. Use the LCD to view the status of any port or card slot; the screen displays the number and severity of alarms for a given port or slot.

4.4 OPT-BST Amplifier Card

Note For hardware specifications, see the "A.5.2 OPT-BST Amplifier Card Specifications" section on page A-13.

Note For OPT-BST card safety labels, see the "4.2 Class 1M Laser Safety Labels" section on page 4-5.

The OPT-BST is designed to ultimately support up to 80 channels at 50-GHz channel spacing. The OPT-BST is a C-band, DWDM EDFA with optical service channel (OSC) add-and-drop capability. When an OPT-BST installed in the an ONS 15454, an OSCM card is also needed to process the OSC. You can install the OPT-BST in Slots 1 to 6 and 12 to 17. The card's features include:

- Fixed gain mode (with programmable tilt)
- Gain range of 5 to 20 dB in constant gain mode and output power mode
- True variable gain
- Built-in VOA to control gain tilt
- Fast transient suppression

- Nondistorting low-frequency transfer function
- Settable maximum output power
- Fixed output power mode (mode used during provisioning)
- ASE compensation in fixed gain mode
- Full monitoring and alarm handling with settable thresholds
- Optical Safety Remote Interlock (OSRI), a CTC software feature capable of shutting down optical output power or reducing the power to a safe level (automatic power reduction)
- Automatic laser shutdown (ALS), a safety mechanism used in the event of a fiber cut. For details on ALS provisioning for the card, refer to the *Cisco ONS 15454 DWDM Procedure Guide*. For information about using the card to implement ALS in a network, see the "12.11 Network Optical Safety" section on page 12-27.

Note The optical splitters each have a ratio of 1:99. The result is that MON TX and MON RX port power is about 20 dB lower than COM TX and COM RX port power.

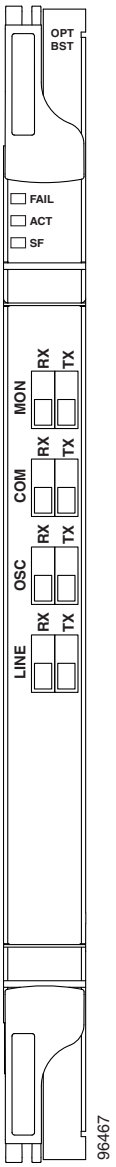
4.4.1 OPT-BST Faceplate Ports

The OPT-BST amplifier has eight optical ports located on the faceplate:

- MON RX is the output monitor port (receive section).
- MON TX is the output monitor port.
- COM RX is the input signal port.
- LINE TX is the output signal port.
- LINE RX is the input signal port (receive section).
- COM TX is the output signal port (receive section).
- OSC RX is the OSC add input port.
- OSC TX is the OSC drop output port.

Figure 4-10 shows the OPT-BST amplifier card faceplate.

Figure 4-10 OPT-BST Faceplate



4.4.2 OPT-BST Block Diagrams

Figure 4-11 shows a simplified block diagram of the OPT-BST card's features.

Figure 4-11 OPT-BST Block Diagram

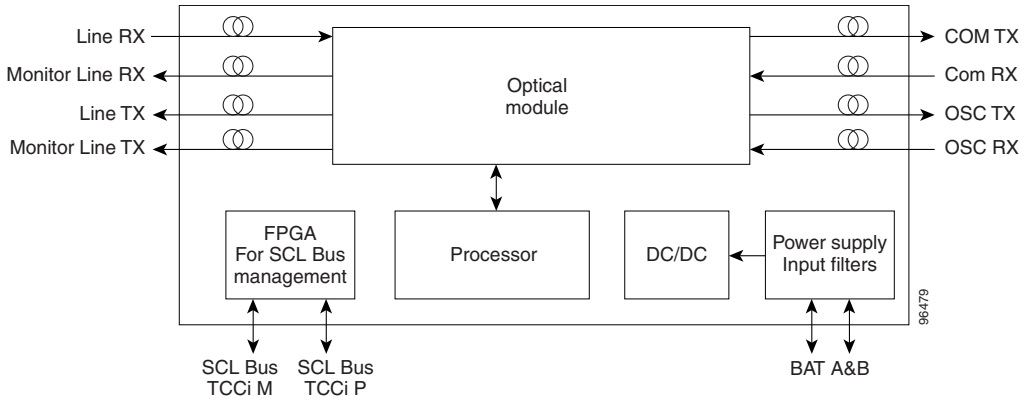
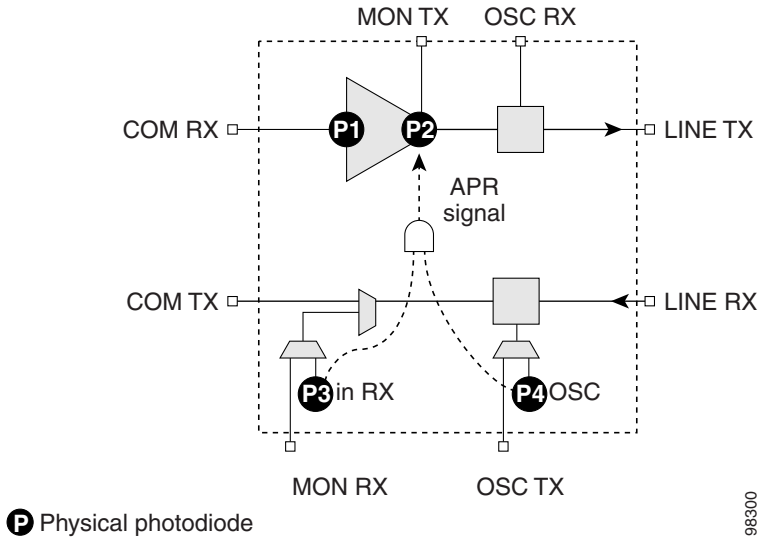


Figure 4-12 shows a block diagram of how the OPT-BST optical module functions.

Figure 4-12 OPT-BST Optical Module Functional Block Diagram



4.4.3 OPT-BST Power Monitoring

Physical photodiodes P1, P2, P3, and P4 monitor the power for the OPT-BST card. Table 4-6 shows the returned power level values calibrated to each port.

Table 4-6 OPT-BST Port Calibration

Photodiode	CTC Type Name	Calibrated to Port	Power	PM Parameter
P1	Input Com	COM RX	Channel Power	Supported

Table 4-6 OPT-BST Port Calibration (continued)

Photodiode	CTC Type Name	Calibrated to Port	Power	PM Parameter
P2	Output Line (Total Output)	LINE TX	Channel Power	Supported
	Output Line (Signal Output)			
P3	Input Line	LINE RX	Channel Power	Supported
P4	Input Line	LINE RX	OSC Power	Supported

The power on the OSC TX and COM TX ports are calculated by adding the insertion loss (IL) to the power reported from P3 and P4.

The PM parameters for the power values are listed in Table 19-31.

For information on the associated TL1 AIDs for the optical power monitoring points, refer the "CTC Port Numbers and TL1 Aids" section in *Cisco ONS SONET TL1 Command Guide, Release 9.2*.

4.4.4 OPT-BST Card-Level Indicators

Table 4-7 describes the three card-level LED indicators on the OPT-BST card.

Table 4-7 OPT-BST Card-Level Indicators

Card-Level Indicators	Description
Red FAIL LED	The red FAIL LED indicates that the card's processor is not ready or that an internal hardware failure occurred. Replace the card if the red FAIL LED persists.
Green ACT LED	The green ACT LED indicates that the OPT-BST is carrying traffic or is traffic-ready.
Amber SF LED	The amber SF LED indicates a signal failure or condition such as LOS on one or more of the card's ports. The amber SF LED also turns on when the transmit and receive fibers are incorrectly connected. When the fibers are properly connected, the light turns off.

4.4.5 OPT-BST Port-Level Indicators

You can determine the status of the card ports using the LCD screen on the ONS 15454 fan-tray assembly. Use the LCD to view the status of any port or card slot; the screen displays the number and severity of alarms for a given port or slot.

4.5 OPT-BST-E Amplifier Card

Note For hardware specifications, see the "A.5.3 OPT-BST-E Amplifier Card Specifications" section on page A-14.

Note For OPT-BST-E safety labels, see the "4.2 Class 1M Laser Safety Labels" section on page 4-5.

The OPT-BST-E amplifier card is a gain-enhanced version of the OPT-BST card. It is designed to support up to 80 channels at 50-GHz channel spacing. The OPT-BST-E is a C-band, DWDM EDFA with OSC add-and-drop capability. When an OPT-BST-E installed, an OSCM card is needed to process the OSC. You can install the OPT-BST-E in Slots 1 to 6 and 12 to 17. The card's features include:

- Fixed gain mode (with programmable tilt)
- True variable gain
- Gain range of 8 to 23 dBm with the tilt managed at 0 dBm in constant gain mode and output power mode
- Enhanced gain range of 23 to 26 dBm with unmanaged tilt
- Built-in VOA to control the gain tilt
- Fast transient suppression
- Nondistorting low-frequency transfer function
- Settable maximum output power
- Fixed output power mode (mode used during provisioning)
- ASE compensation in fixed gain mode
- Full monitoring and alarm handling with settable thresholds
- OSRI
- ALS

Note The optical splitters each have a ratio of 1:99. The result is that MON TX and MON RX port power is about 20 dB lower than COM TX and COM RX port power.

4.5.1 OPT-BST-E Faceplate Ports

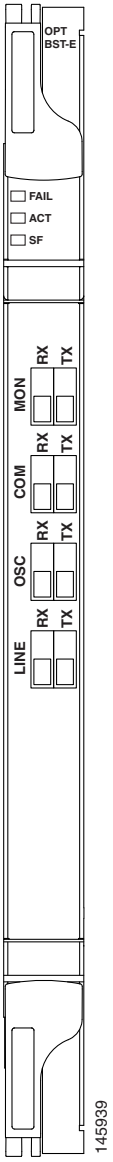
The OPT-BST-E amplifier card has eight optical ports located on the faceplate:

- MON RX is the output monitor port (receive section).
- MON TX is the output monitor port.
- COM RX is the input signal port.
- LINE TX is the output signal port.
- LINE RX is the input signal port (receive section).
- COM TX is the output signal port (receive section).

- OSC RX is the OSC add input port.
- OSC TX is the OSC drop output port.

Figure 4-13 shows the OPT-BST-E amplifier card faceplate.

Figure 4-13 OPT-BST-E Faceplate



4.5.2 OPT-BST-E Block Diagrams

Figure 4-14 shows a simplified block diagram of the OPT-BST-E card's features.

Figure 4-14 OPT-BST-E Block Diagram

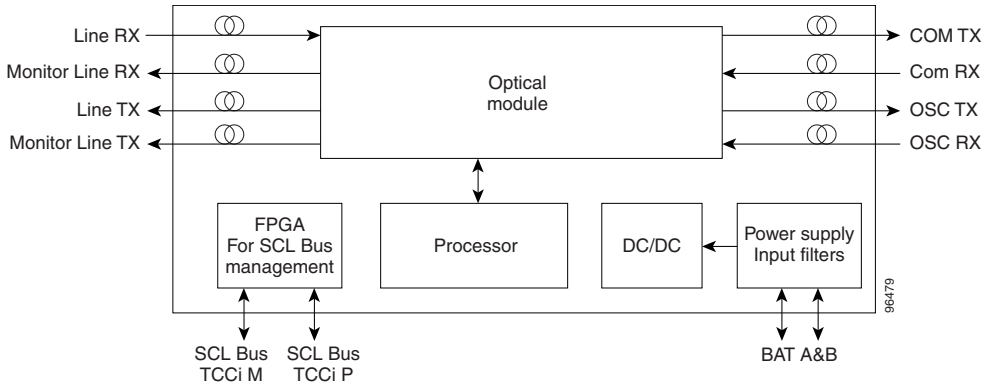
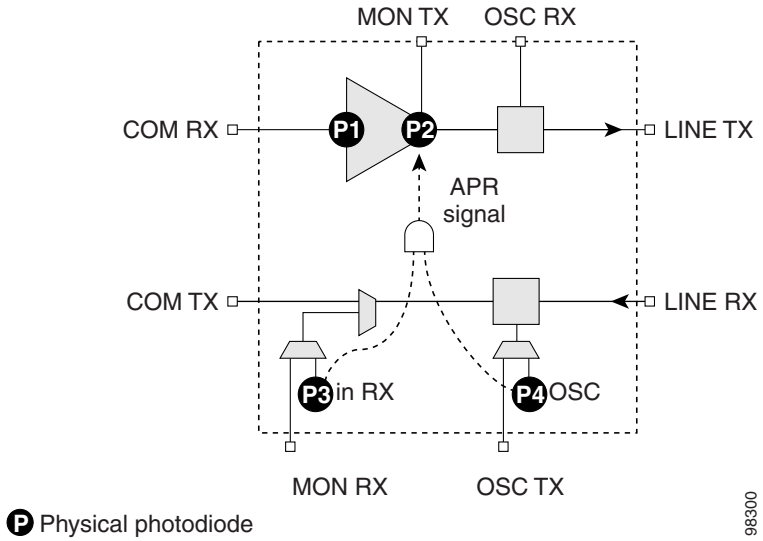


Figure 4-15 shows a block diagram of how the OPT-BST-E optical module functions.

Figure 4-15 OPT-BST-E Optical Module Functional Block Diagram



4.5.3 OPT-BST-E Power Monitoring

Physical photodiodes P1, P2, P3, and P4 monitor the power for the OPT-BST-E card. Table 4-8 shows the returned power level values calibrated to each port.

Table 4-8 OPT-BST-E Port Calibration

Photodiode	CTC Type Name	Calibrated to Port	Power	PM Parameter
P1	Input Com	COM RX	Channel Power	Supported

Table 4-8 OPT-BST-E Port Calibration (continued)

Photodiode	CTC Type Name	Calibrated to Port	Power	PM Parameter
P2	Output Line (Total Output)	LINE TX	Channel Power	Supported
	Output Line (Signal Output)			
P3	Input Line	LINE RX	Channel Power	Supported
P4	Input Line	LINE RX	OSC Power	Supported

The power on the OSC-TX and COM-TX ports are calculated by adding the insertion loss (IL) to the power reported from P3 and P4.

The PM parameters for the power values are listed in Table 19-31.

For information on the associated TL1 AIDs for the optical power monitoring points, refer the "CTC Port Numbers and TL1 Aids" section in *Cisco ONS SONET TL1 Command Guide, Release 9.2*.

4.5.4 OPT-BST-E Card-Level Indicators

Table 4-9 describes the three card-level LED indicators on the OPT-BST-E amplifier card.

Table 4-9 OPT-BST-E Card-Level Indicators

Card-Level Indicators	Description
Red FAIL LED	The red FAIL LED indicates that the card's processor is not ready or that an internal hardware failure occurred. Replace the card if the red FAIL LED persists.
Green ACT LED	The green ACT LED indicates that the OPT-BST-E is carrying traffic or is traffic-ready.
Amber SF LED	The amber SF LED indicates a signal failure or condition such as LOS on one or more of the card's ports. The amber SF LED also turns on when the transmit and receive fibers are incorrectly connected. When the fibers are properly connected, the light turns off.

4.5.5 OPT-BST-E Port-Level Indicators

You can determine the status of the card ports using the LCD screen on the ONS 15454 fan-tray assembly. Use the LCD to view the status of any port or card slot; the screen displays the number and severity of alarms for a given port or slot.

4.6 OPT-BST-L Amplifier Card

(Cisco ONS 15454 only)

Note For hardware specifications, see the "A.5.4 OPT-BST-L Amplifier Card Specifications" section on page A-15.

Note For OPT-BST-L safety labels, see the "4.2 Class 1M Laser Safety Labels" section on page 4-5.

The OPT-BST-L is an L-band, DWDM EDFA with OSC add-and-drop capability. The card is well suited for use in networks that employ dispersion shifted (DS) fiber or SMF-28 single-mode fiber. The OPT-BST-L is designed to ultimately support 64 channels at 50-GHz channel spacing, but in Software R9.0 and earlier it is limited to 32 channels at 100-GHz spacing.When an ONS 15454 has an OPT-BST-L installed, an OSCM card is needed to process the OSC. You can install the OPT-BST-L in Slots 1 to 6 and 12 to 17. The card's features include:

- Fixed gain mode (with programmable tilt)
- Standard gain range of 8 to 20 dB in the programmable gain tilt mode
- True variable gain
- 20 to 27 dB gain range in the uncontrolled gain tilt mode
- Built-in VOA to control gain tilt
- Fast transient suppression
- Nondistorting low-frequency transfer function
- Settable maximum output power
- Fixed output power mode (mode used during provisioning)
- ASE compensation in fixed gain mode
- Full monitoring and alarm handling with settable thresholds
- OSRI
- ALS

Note The optical splitters each have a ratio of 1:99. The result is that MON TX and MON RX port power is about 20 dB lower than COM TX and COM RX port power.

4.6.1 OPT-BST-L Faceplate Ports

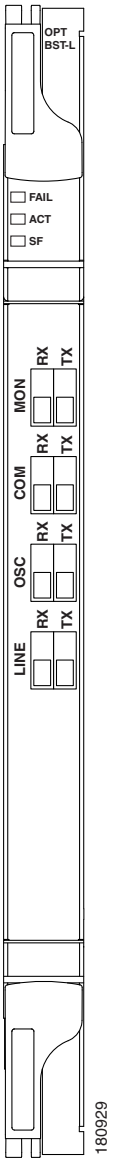
The OPT-BST-L amplifier has eight optical ports located on the faceplate:

- MON RX is the output monitor port (receive section).
- MON TX is the output monitor port.
- COM RX is the input signal port.
- LINE TX is the output signal port.
- LINE RX is the input signal port (receive section).
- COM TX is the output signal port (receive section).
- OSC RX is the OSC add input port.

- OSC TX is the OSC drop output port.

Figure 4-16 shows the OPT-BST-L card faceplate.

Figure 4-16 OPT-BST-L Faceplate



4.6.2 OPT-BST-L Block Diagrams

Figure 4-17 shows a simplified block diagram of the OPT-BST-L card's features.

Figure 4-17 OPT-BST-L Block Diagram

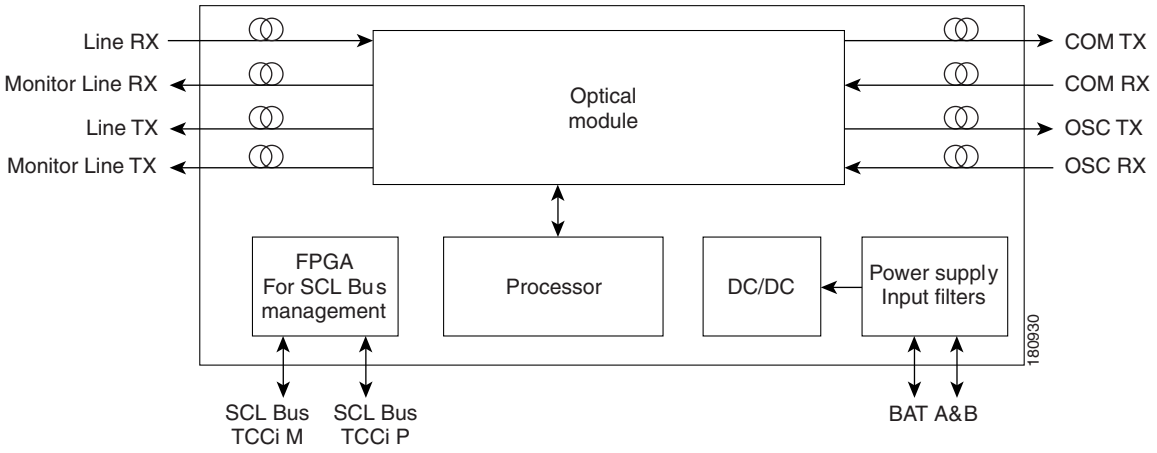
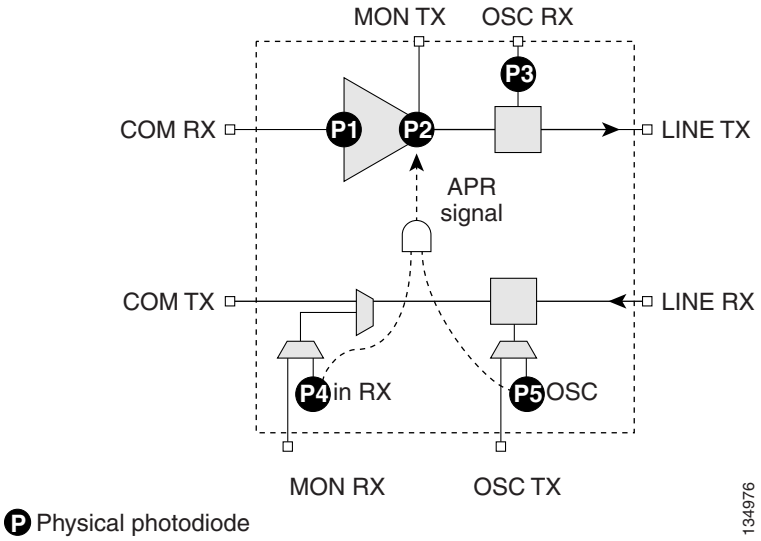


Figure 4-18 shows a block diagram of how the OPT-BST-L optical module functions.

Figure 4-18 OPT-BST-L Optical Module Functional Block Diagram



4.6.3 OPT-BST-L Power Monitoring

Physical photodiodes P1, P2, P3, P4, and P5 monitor the power for the OPT-BST-L card. Table 4-10 shows the returned power level values calibrated to each port.

Table 4-10 OPT-BST-L Port Calibration

Photodiode	CTC Type Name	Calibrated to Port	Power	PM Parameter
P1	Input COM	COM RX	Channel Power	Supported

Table 4-10 OPT-BST-L Port Calibration (continued)

Photodiode	CTC Type Name	Calibrated to Port	Power	PM Parameter
P2	Output Line (Total Output)	LINE TX	Channel Power	Supported
	Output Line (Signal Output)			
P3	Input OSC	OSC RX	OSC Power	Supported
P4	Input Line	LINE RX	Channel Power	Supported
P5	Input Line	LINE RX	OSC Power	Supported

The power values on the OSC-TX and COM-TX ports are calculated by adding the insertion loss (IL) to the power values reported from P4 and P5.

The OSC power on the LINE TX is calculated by adding the IL to the power reported from P3.

The PM parameters for the power values are listed in Table 19-31.

For information on the associated TL1 AIDs for the optical power monitoring points, refer the "CTC Port Numbers and TL1 Aids" section in *Cisco ONS SONET TL1 Command Guide, Release 9.2*.

4.6.4 OPT-BST-L Card-Level Indicators

Table 4-11 shows the three card-level LEDs on the OPT-BST-L card.

Table 4-11 OPT-BST-L Card-Level Indicators

Card-Level Indicators	Description
Red FAIL LED	The red FAIL LED indicates that the card's processor is not ready or that an internal hardware failure occurred. Replace the card if the red FAIL LED persists.
Green ACT LED	The green ACT LED indicates that the OPT-BST-L is carrying traffic or is traffic-ready.
Amber SF LED	The amber SF LED indicates a signal failure or condition such as LOS on one or more of the card's ports. The amber SF LED also turns on when the transmit and receive fibers are incorrectly connected. When the fibers are properly connected, the light turns off.

4.6.5 OPT-BST-L Port-Level Indicators

You can determine the status of the card ports using the LCD screen on the ONS 15454 fan-tray assembly. Use the LCD to view the status of any port or card slot; the screen displays the number and severity of alarms for a given port or slot.

4.7 OPT-AMP-L Card

(Cisco ONS 15454 only)

Note For hardware specifications, see the "A.5.5 OPT-AMP-L Preamplifier Card Specifications" section on page A-15.

Note For OPT-AMP-L card safety labels, see the "4.2 Class 1M Laser Safety Labels" section on page 4-5.

The OPT-AMP-L is an L-band, DWDM optical amplifier card consisting of a two-stage EDFA with midstage access loss (MSL) for an external DCU and OSC add-and-drop capability. Using CTC, the card is provisionable as a preamplifier (OPT-PRE) or booster amplifier (OPT-BST), and is well suited for use in networks that employ DS or SMF-28 fiber. The amplifier can operate up to 64 optical transmission channels at 50-GHz channel spacing in the 1570 nm to 1605 nm wavelength range.

When an OPT-AMP-L installed, an OSCM card is needed to process the OSC. You can install the two-slot OPT-AMP-L in Slots 1 to 6 and 12 to 17.

The card has the following features:

- Maximum power output of 20 dBm
- True variable gain amplifier with settable range from 12 to 24 dBm in the standard gain range and 24 dBm to 35 dbM with uncontrolled gain tilt
- Built-in VOA to control gain tilt
- Up to 12 dBm MSL for an external DCU
- Fast transient suppression; able to adjust power levels in hundreds of microseconds to avoid bit errors in failure or capacity growth situations
- Nondistorting low frequency transfer function
- Midstage access loss for dispersion compensation unit
- Constant pump current mode (test mode)
- Constant output power mode (used during optical node setup)
- Constant gain mode
- Internal ASE compensation in constant gain mode and in constant output power mode
- Full monitoring and alarm handling capability
- Optical safety support through signal loss detection and alarm at any input port, fast power down control (less than one second), and reduced maximum output power in safe power mode. For details on ALS provisioning for the card, refer to the *Cisco ONS 15454 DWDM Procedure Guide*. For information on using the card to implement ALS in a network, see the "12.11 Network Optical Safety" section on page 12-27.

Note Before disconnecting any OPT AMP-L fiber for troubleshooting, first make sure the OPT AMP-L card is unplugged.

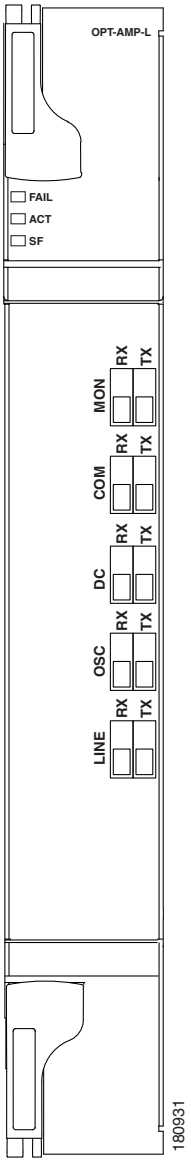
4.7.1 OPT-AMP-L Faceplate Ports

The OPT-AMP-L amplifier card has ten optical ports located on the faceplate:

- MON RX is the output monitor port (receive section).
- MON TX is the output monitor port.
- COM RX is the input signal port.
- LINE TX is the output signal port.
- LINE RX is the input signal port (receive section).
- COM TX is the output signal port (receive section).
- OSC RX is the OSC add input port.
- OSC TX is the OSC drop output port.
- DC TX is the output signal to the DCU.
- DC RX is the input signal from the DCU.

Figure 4-19 shows the OPT-AMP-L card faceplate.

Figure 4-19 OPT-AMP-L Faceplate



4.7.2 OPT-AMP-L Block Diagrams

Figure 4-20 shows a simplified block diagram of the OPT-AMP-L card's features.

Figure 4-20 OPT-AMP-L Block Diagram

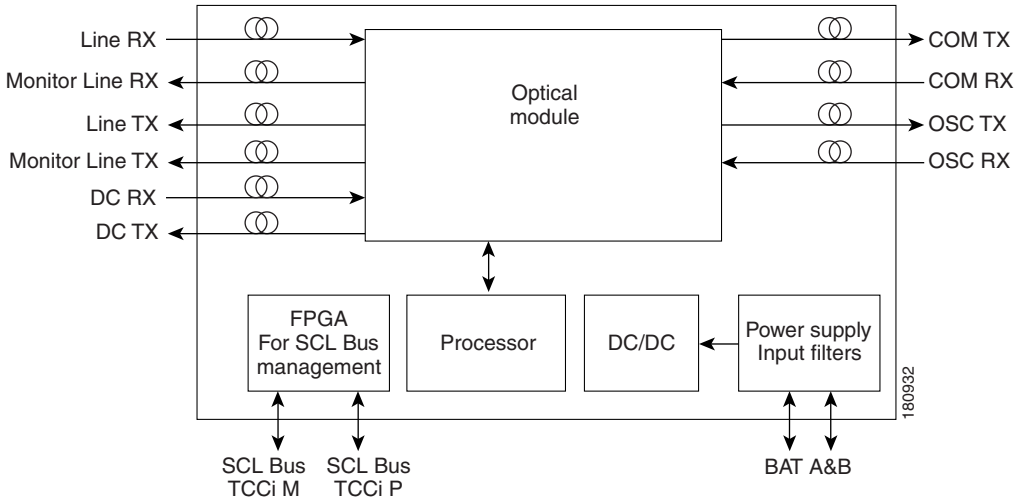
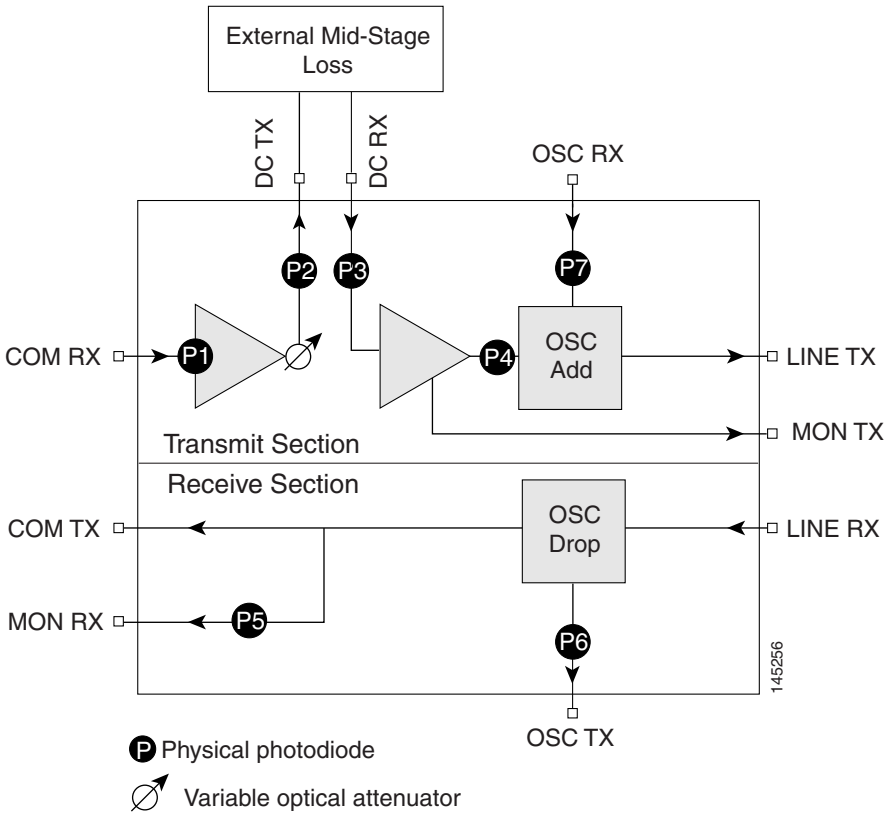


Figure 4-21 shows a block diagram of how the OPT-AMP-L optical module functions.

Figure 4-21 OPT-AMP-L Optical Module Functional Block Diagram



4.7.3 OPT-AMP-L Power Monitoring

Physical photodiodes P1 through P7 monitor the power for the OPT-AMP-L card. Table 4-12 shows the returned power level values calibrated to each port.

Table 4-12 OPT-AMP-L Port Calibration

Photodiode	CTC Type Name	Calibrated to Port	Power	PM Parameter
P1	Input COM	COM RX	Channel Power	Supported
P2	Output DC (total power)	DC TX	Channel Power	Supported
	Output DC (signal power)			
P3	Input DC (input power)	DC RX	Channel Power	Supported
P4	Output Line (total power)	LINE TX	Channel Power	Supported
	Output Line (signal power)			
P5	Input Line	LINE RX	Channel Power	Supported
P6	Input Line	LINE RX	OSC Power	Supported
P7	Input OSC	OSC RX	OSC Power	Supported

The power values on the OSC-TX and COM-TX ports are calculated by adding the insertion loss (IL) to the power values reported from P5 and P6.

The power values on the LINE TX port is calculated by adding the IL to the power value reported from P7.

The PM parameters for the power values are listed in Table 19-31.

For information on the associated TL1 AIDs for the optical power monitoring points, refer the "CTC Port Numbers and TL1 Aids" section in *Cisco ONS SONET TL1 Command Guide, Release 9.2*.

4.7.4 OPT-AMP-L Card-Level Indicators

Table 4-13 shows the three card-level LEDs on the OPT-AMP-L card.

Table 4-13 OPT-AMP-L Card-Level Indicators

Card-Level Indicators	Description
Red FAIL LED	The red FAIL LED indicates that the card's processor is not ready or that an internal hardware failure occurred. Replace the card if the red FAIL LED persists.
Green ACT LED	The green ACT LED indicates that the OPT-AMP-L is carrying traffic or is traffic-ready.
Amber SF LED	The amber SF LED indicates a signal failure or condition such as LOS on one or more of the card's ports. The amber SF LED also turns on when the transmit and receive fibers are incorrectly connected. When the fibers are properly connected, the light turns off.

4.7.5 OPT-AMP-L Port-Level Indicators

You can determine the status of the card ports using the LCD screen on the ONS 15454 fan-tray assembly. Use the LCD to view the status of any port or card slot; the screen displays the number and severity of alarms for a given port or slot.

4.8 OPT-AMP-17-C Card

Note For hardware specifications, see the "A.5.6 OPT-AMP-17-C Amplifier Card Specifications" section on page A-16.

Note For OPT-AMP-17-C safety labels, see the "4.2 Class 1M Laser Safety Labels" section on page 4-5.

The OPT-AMP-17-C is a 17-dB gain, C-band, DWDM EDFA amplifier/preamplifier with OSC add-and-drop capability. It supports 80 channels at 50-GHz channel spacing in the C-band (that is, the 1529 nm to 1562.5 nm wavelength range). When an ONS 15454 has an OPT-AMP-17-C installed, an OSCM card is needed to process the OSC. You can install the OPT-AMP-17-C in Slots 1 to 6 and 12 to 17.

The card's features include:

- Fixed gain mode (no programmable tilt)
- Standard gain range of 14 to 20 dB at startup when configured as a preamplifier
- Standard gain range of 20 to 23 dB in the transient mode when configured as a preamplifier
- Gain range of 14 to 23 dB (with no transient gain range) when configured as a booster amplifier
- True variable gain
- Fast transient suppression
- Nondistorting low-frequency transfer function
- Settable maximum output power
- Fixed output power mode (mode used during provisioning)
- ASE compensation in fixed gain mode
- Full monitoring and alarm handling with settable thresholds
- OSRI
- ALS

4.8.1 OPT-AMP-17-C Faceplate Ports

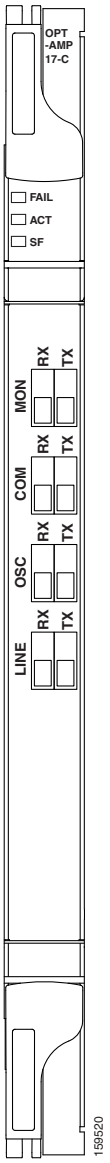
The OPT-AMP-17-C amplifier card has eight optical ports located on the faceplate:

- MON RX is the output monitor port (receive section).
- MON TX is the output monitor port.
- COM RX is the input signal port.

- LINE TX is the output signal port.
- LINE RX is the input signal port (receive section).
- COM TX is the output signal port (receive section).
- OSC RX is the OSC add input port.
- OSC TX is the OSC drop output port.

Figure 4-22 shows the OPT-AMP-17-C amplifier card faceplate.

Figure 4-22 OPT-AMP-17-C Faceplate



4.8.2 OPT-AMP-17-C Block Diagrams

Figure 4-23 shows a simplified block diagram of the OPT-AMP-17C card's features.

Figure 4-23 OPT-AMP17-C Block Diagram

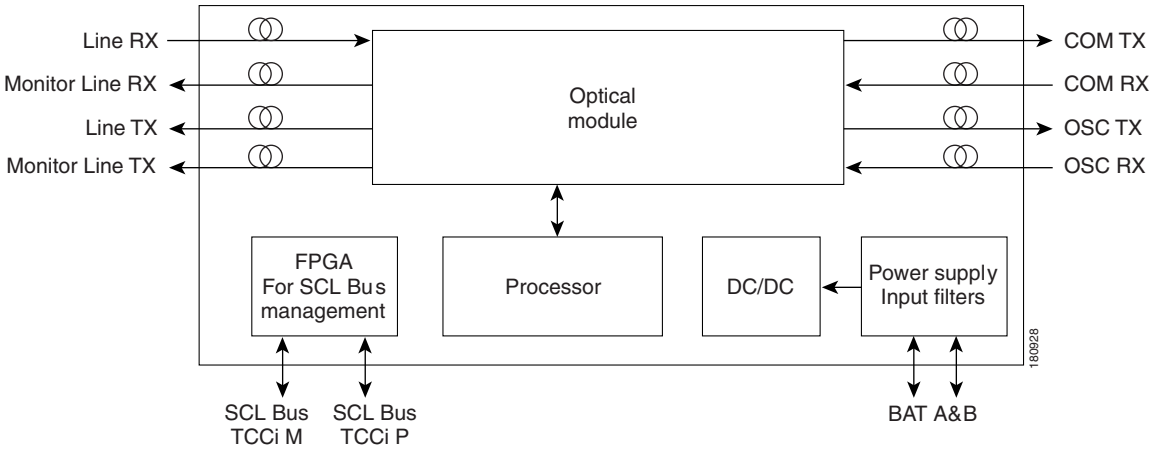
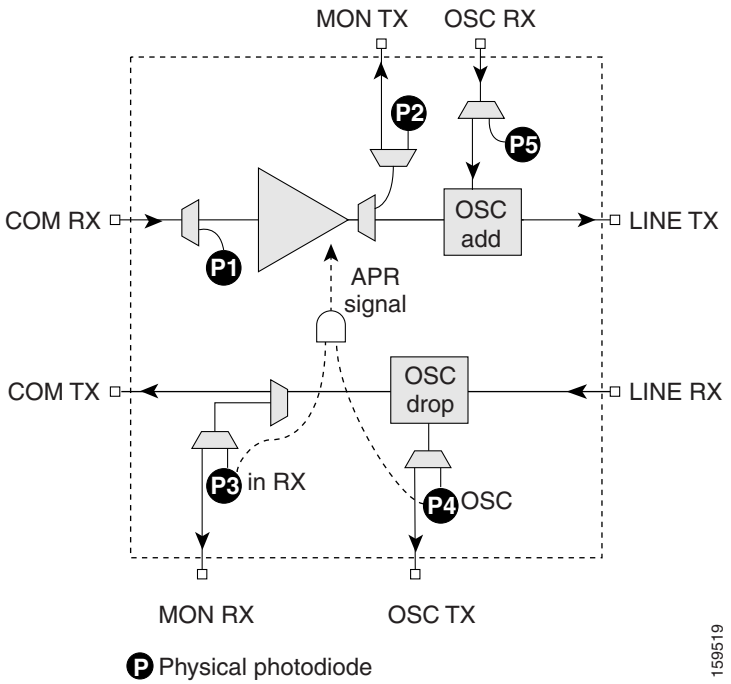


Figure 4-24 shows how the OPT-AMP-17-C optical module functions.

Figure 4-24 OPT-AMP-17-C Optical Module Functional Block Diagram



4.8.3 OPT-AMP-17-C Automatic Power Control

A transient gain range of 20 to 23 dB is available to APC in order to permit other amplifiers to reach their expected set points. However, operation in this range is not continuous. At startup, the OPT-AMP-17-C card caps the gain at a maximum of 20 dB.

Note When the OPT-AMP-17-C operates as a booster amplifier, APC does not control its gain.

4.8.4 OPT-AMP-17-C Power Monitoring

Physical photodiodes P1, P2, P3, P4, and P5 monitor power for the OPT-AMP-17-C card. Table 4-14 shows the returned power level values calibrated to each port.

Table 4-14 OPT-AMP-17-C Port Calibration

Photodiode	CTC Type Name	Calibrated to Port	Power	PM Parameter
P1	Input COM	COM RX	Channel Power	Supported
P2	Output Line (Total Output)	LINE TX	Channel Power	Supported
	Output Line (Signal Output)			
P3	Input Line	LINE RX	Channel Power	Supported
P4	Input Line	LINE RX	OSC Power	Supported
P5	Input OSC	OSC RX	OSC Power	Supported

The power on the OSC-TX and COM-TX ports are calculated by adding the insertion loss (IL) to the power reported from P3 and P4.

The OSC power on the LINE TX is calculated by adding the IL to the power reported from P5.

The PM parameters for the power values are listed in Table 19-31.

For information on the associated TL1 AIDs for the optical power monitoring points, refer the “CTC Port Numbers and TL1 Aids” section in *Cisco ONS SONET TL1 Command Guide, Release 9.2*.

4.8.5 OPT-AMP-17-C Card-Level Indicators

Table 4-15 shows the three card-level LEDs on the OPT-AMP-17-C card.

Table 4-15 OPT-AMP-17-C Card-Level Indicators

Card-Level Indicators	Description
Red FAIL LED	The red FAIL LED indicates that the card’s processor is not ready or that an internal hardware failure occurred. Replace the card if the red FAIL LED persists.

Table 4-15 OPT-AMP-17-C Card-Level Indicators (continued)

Card-Level Indicators	Description
Green ACT LED	The green ACT LED indicates that the OPT-AMP-17-C is carrying traffic or is traffic-ready.
Amber SF LED	The amber SF LED indicates a signal failure or condition such as LOS on one or more of the card's ports. The amber SF LED also turns on when the transmit and receive fibers are incorrectly connected. When the fibers are properly connected, the light turns off.

4.8.6 OPT-AMP-17-C Port-Level Indicators

You can determine the status of the card ports using the LCD screen on the ONS 15454 fan-tray assembly. Use the LCD to view the status of any port or card slot; the screen displays the number and severity of alarms for a given port or slot.

4.9 OPT-AMP-C Card

Note For hardware specifications, see the "A.5.7 OPT-AMP-C Amplifier Card Specifications" section on page A-17.

Note For OPT-AMP-C card safety labels, see the "4.2 Class 1M Laser Safety Labels" section on page 4-5.

The OPT-AMP-C card is a 20-dB output power, C-band, DWDM EDFA amplifier/preamplifier. It contains mid-stage access loss for a Dispersion Compensation Unit (DCU). To control gain tilt, a VOA is used. The VOA can also be used to attenuate the signal to the DCU to a reference value. The amplifier module also includes the OSC add (TX direction) and drop (RX direction) optical filters.

The OPT-AMP-C card supports 80 channels at 50-GHz channel spacing in the C-band (that is, the 1529 nm to 1562.5 nm wavelength range). When an ONS 15454 has an OPT-AMP-C card installed, an OSCM card is needed to process the OSC. You can install the OPT-AMP-C card in Slots 1 to 6 and 12 to 17. Slots 2 to 6 and Slots 12 to 16 are the default slots for provisioning the OPT-AMP-C card as a preamplifier, and slots 1 and 17 are the default slots for provisioning the OPT-AMP-C card as a booster amplifier.

The card's features include:

- Fast transient suppression
- Nondistorting low-frequency transfer function
- Mid-stage access for DCU
- Constant pump current mode (test mode)
- Fixed output power mode (mode used during provisioning)
- Constant gain mode
- ASE compensation in Constant Gain and Constant Output Power modes
- Programmable tilt

- Full monitoring and alarm handling capability
- Gain range with gain tilt control of 12 to 24 dB
- Extended gain range (with uncontrolled tilt) of 24 to 35 dB
- Full monitoring and alarm handling with settable thresholds
- OSRI
- ALS

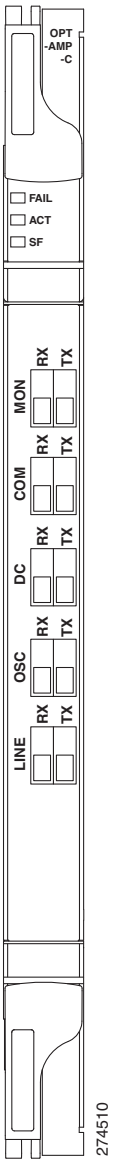
4.9.1 OPT-AMP-C Card Faceplate Ports

The OPT-AMP-C amplifier card has 10 optical ports located on the faceplate:

- MON RX is the output monitor port (receive section).
- MON TX is the output monitor port.
- COM RX is the input signal port.
- COM TX is the output signal port (receive section).
- DC RX is the input DCU port.
- DC TX is the output DCU port.
- OSC RX is the OSC add input port.
- OSC TX is the OSC drop output port.
- LINE RX is the input signal port (receive section).
- LINE TX is the output signal port.

Figure 4-25 shows the OPT-AMP-C amplifier card faceplate.

Figure 4-25 OPT-AMP-C Card Faceplate



4.9.2 OPT-AMP-C Card Block Diagrams

Figure 4-26 shows a simplified block diagram of the OPT-AMP-C card features.

Figure 4-26 OPT-AMP-C Block Diagram

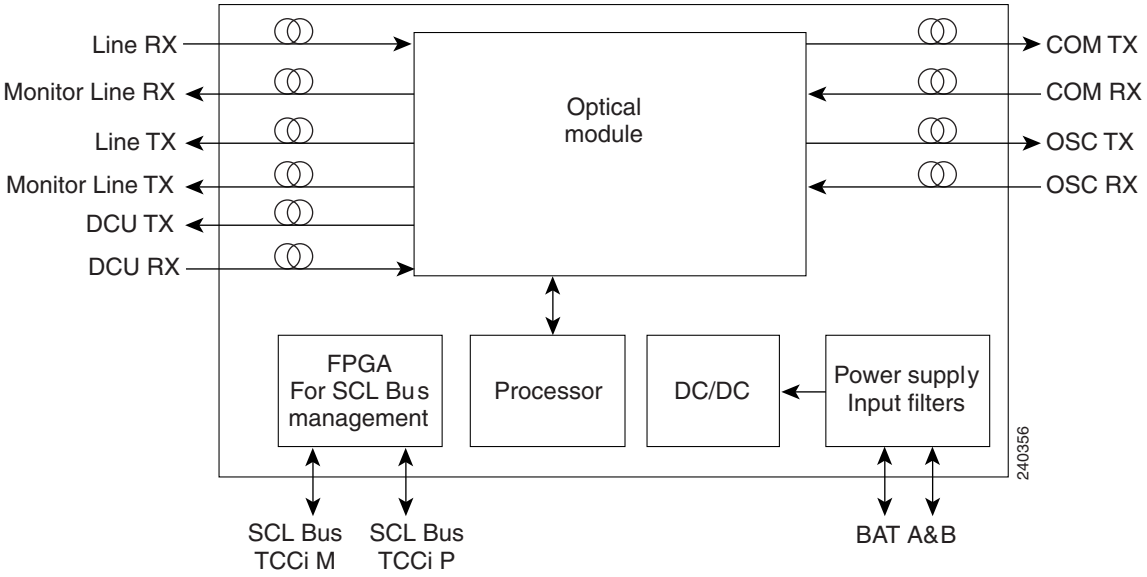
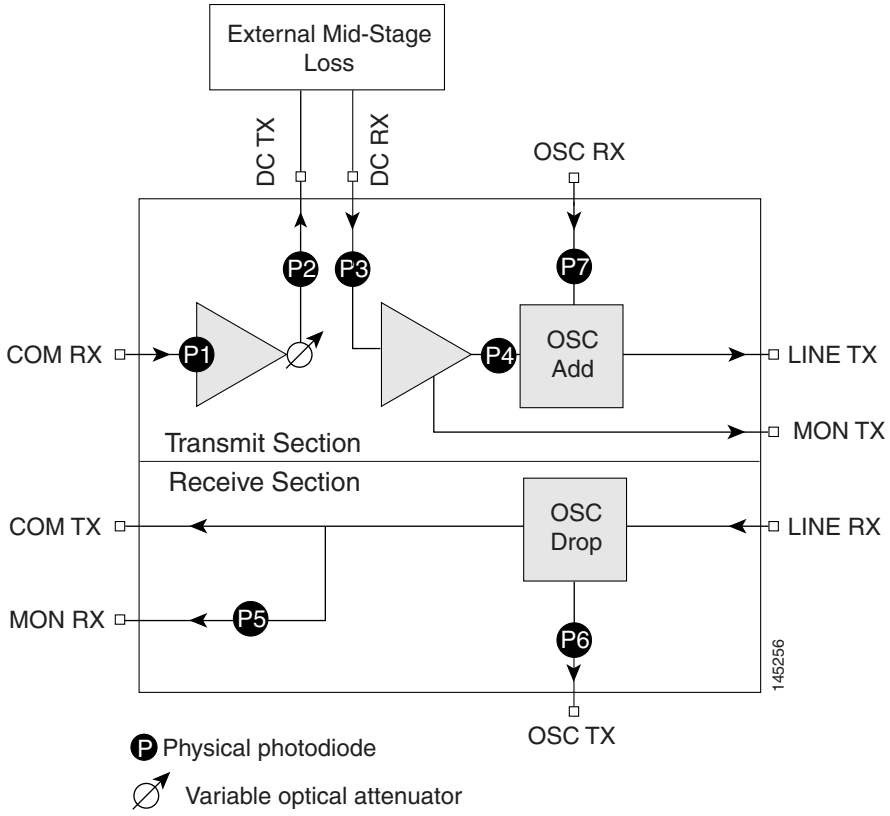


Figure 4-27 shows how the OPT-AMP-C optical module functions.

Figure 4-27 OPT-AMP-C Optical Module Functional Block Diagram



4.9.3 OPT-AMP-C Card Power Monitoring

Physical photodiodes P1 through P7 monitor the power for the OPT-AMP-C card (see Table 4-16).

Table 4-16 OPT-AMP-C Port Calibration

Photodiode	CTC Type Name	Calibrated to Port	Power	PM Parameters
P1	Input COM	COM RX	Channel Power	Supported
P2	Output DC (total power)	DC TX	Channel Power	Supported
	Output DC (signal power)			
P3	Input DC (input power)	DC RX	Channel Power	Supported
P4	Output Line (total power)	LINE TX	Channel Power	Supported
	Output Line (signal power)			
P5	Input Line	LINE RX	Channel Power	Supported
P6	Input Line	LINE RX	OSC Power	Supported
P7	Input OSC	OSC RX	OSC Power	Supported

The power on the OSC-TX and COM-TX ports are calculated by adding the insertion loss (IL) to the power reported from P5 and P6.

The OSC power on the LINE TX is calculated by adding the IL to the power reported from P7.

The PM parameters for the power values are listed in Table 19-31.

For information on the associated TL1 AIDs for the optical power monitoring points, refer the "CTC Port Numbers and TL1 Aids" section in *Cisco ONS SONET TL1 Command Guide, Release 9.2*.

4.9.4 OPT-AMP-C Card-Level Indicators

Table 4-17 shows the three card-level LEDs on the OPT-AMP-C card.

Table 4-17 OPT-AMP-C Card-Level Indicators

Card-Level Indicators	Description
Red FAIL LED	The red FAIL LED indicates that the card's processor is not ready or that an internal hardware failure occurred. Replace the card if the red FAIL LED persists.
Green ACT LED	The green ACT LED indicates that the OPT-AMP-C card is carrying traffic or is traffic-ready.
Amber SF LED	The amber SF LED indicates a signal failure or condition such as LOS on one or more of the card's ports. The amber SF LED also turns on when the transmit and receive fibers are incorrectly connected. When the fibers are properly connected, the light turns off.

4.9.5 OPT-AMP-C Card Port-Level Indicators

You can determine the status of the card ports using the LCD screen on the ONS 15454 fan-tray assembly. Use the LCD to view the status of any port or card slot; the screen displays the number and severity of alarms for a given port or slot.

4.10 OPT-RAMP-C and OPT-RAMP-CE Cards

(Cisco ONS 15454 and ONS 15454 M6 only)

Note For hardware specifications, see the "A.5.8 OPT-RAMP-C Amplifier Card Specifications" section on page A-17 and "A.5.9 OPT-RAMP-CE Amplifier Card Specifications" section on page A-18.

Note For OPT-RAMP-C or OPT-RAMP-CE card safety labels, see the "4.2 Class 1M Laser Safety Labels" section on page 4-5.

The OPT-RAMP-C card is a double-slot card that improves unregenerated sections in long spans using the span fiber to amplify the optical signal. Different wavelengths in C-band receive different gain values. To achieve Raman amplification, two Raman signals (that do not carry any payload or overhead) are required to be transmitted on the optical fiber because the gain generated by one signal is not flat. The energy of these Raman signals transfer to the higher region of the spectrum thereby amplifying the signals transmitted at higher wavelengths. The Raman effect reduces span loss but does not compensate it completely.

When the Raman optical powers are set correctly, a gain profile with limited ripple is achieved. The wavelengths of the Raman signals are not in the C-band of the spectrum (used by MSTP for payload signals). The two Raman wavelengths are fixed and always the same. Due to a limited Raman gain, an EDFA amplifier is embedded into the card to generate a higher total gain. An embedded EDFA gain block provides a first amplification stage, while the mid stage access (MSA) is used for DCU loss compensation.

The OPT-RAMP-CE card is a 20 dBm output power, gain-enhanced version of the OPT-RAMP-C card and is optimized for short spans. The OPT-RAMP-C and OPT-RAMP-CE cards can support up to 80 optical transmission channels at 50-GHz channel spacing over the C-band of the optical spectrum (wavelengths from 1529 nm to 1562.5 nm). To provide a counter-propagating Raman pump into the transmission fiber, the Raman amplifier provides up to 500 mW at the LINE-RX connector. The OPT-RAMP-C or OPT-RAMP-CE card can be installed in Slots 1 to 5 and 12 to 16, and supports all network configurations. However, the OPT-RAMP-C or OPT-RAMP-CE card must be equipped on both endpoints of a span.

The Raman total power and Raman ratio can be configured using CTC. For information on how to configure the Raman parameters, refer the *Cisco ONS 15454 DWDM Procedure Guide*. The Raman configuration can be viewed on the Maintenance > Installation tab.

The features of the OPT-RAMP-C and OPT-RAMP-CE card include:

- Raman pump with embedded EDFA gain block
- Raman section: 500 mW total pump power for two pump wavelengths
- EDFA section:
  - OPT-RAMP-C: 16 dB gain and 17 dB output power

  - OPT-RAMP-CE: 11 dB gain and 20 dB output power
- Gain Flattening Filter (GFF) for Raman plus EDFA ripple compensation
- MSA for DC units
- VOA for DC input power control
- Full monitoring of pump, OSC, and signal power
- Fast gain control for transient suppression
- Low-FIT (hardware-managed) optical laser safety
- Hardware output signals for LOS monitoring at input photodiodes
- Optical service channel add and drop filters
- Raman pump back-reflection detector

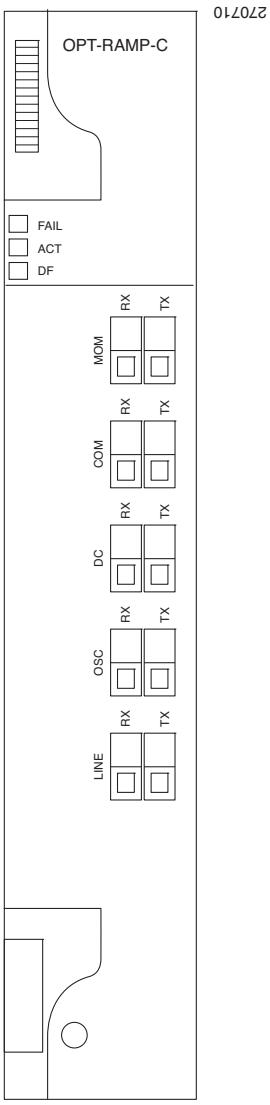
4.10.1 Card Faceplate Ports

The OPT-RAMP-C and OPT-RAMP-CE cards have ten optical ports located on the faceplate:

- MON RX is the output monitor port (receive section).
- MON TX is the output monitor port.
- COM RX is the input signal port (receive section).
- COM TX is the output signal port.
- DC RX is the input DCU port.
- DC TX is the output DCU port.
- OSC RX is the OSC add input port.
- OSC TX is the OSC drop output port.
- LINE RX is the input signal port (receive section).
- LINE TX is the output signal port.

Figure 4-28 shows the OPT-RAMP-C card faceplate.

Figure 4-28 OPT-RAMP-C Faceplate



The OPT-RAMP-CE card faceplate is the same as that of the OPT-RAMP-C card.

4.10.2 Card Block Diagram

Figure 4-29 shows a simplified block diagram of the OPT-RAMP-C and OPT-RAMP-CE card features.

Figure 4-29 OPT-RAMP-C and OPT-RAMP-CE Block Diagram

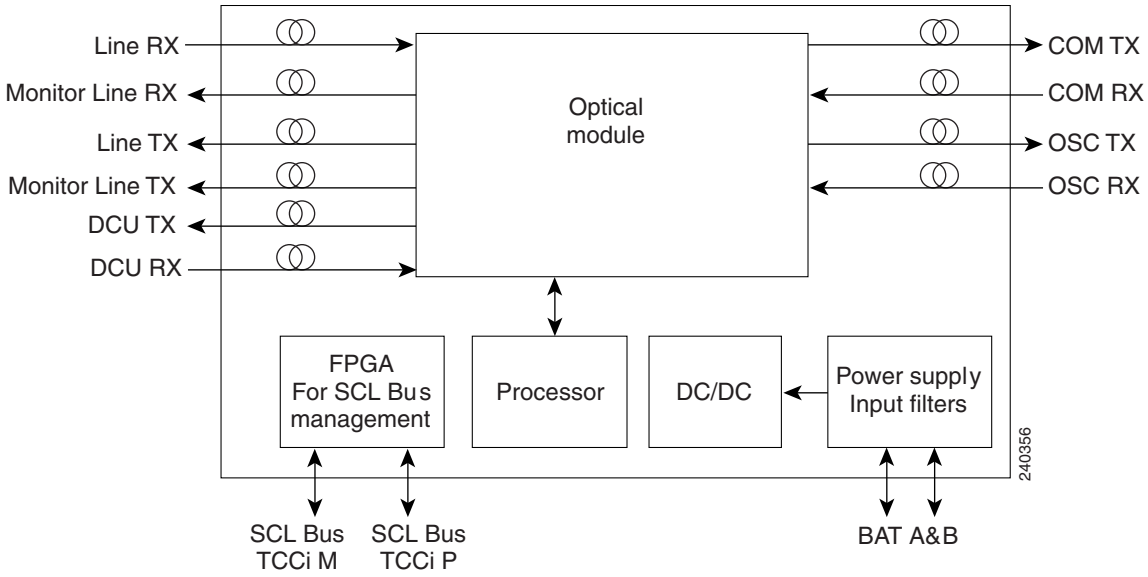
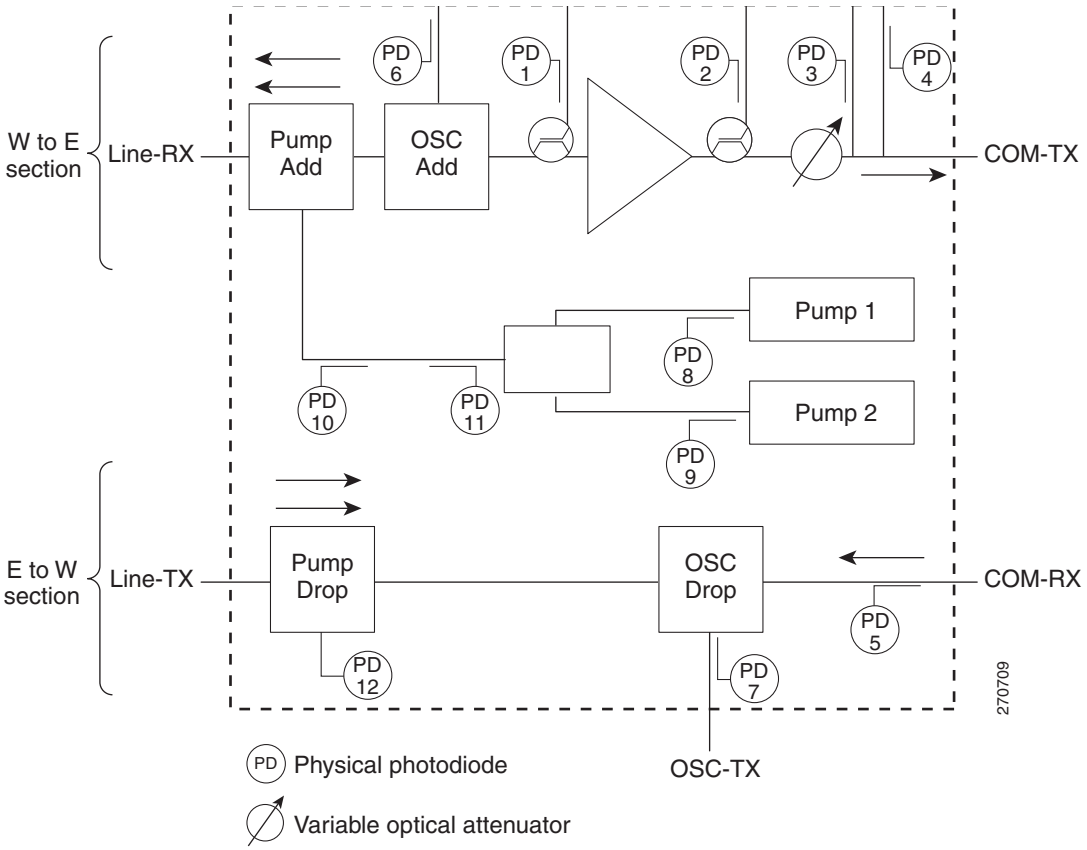


Figure 4-30 shows a block diagram of how the OPT-RAMP-C and OPT-RAMP-CE card functions.

Figure 4-30 OPT-RAMP-C and OPT-RAMP-CE Card Functional Block Diagram



Two Raman pump lasers are combined internally and launched in-fiber at the LINE-RX port, thereby counter-propagating with the DWDM signal. An EDFA gain block provides further amplification of the DWDM signal, which allows regulated output power entry in the mid stage access and acts upon the VOA attenuation. While the optical filters are present for the OSC add and drop functions, the OSC signal counter-propagates with the DWDM signal. Two monitor ports, MON-RX and MON-TX, are provided at the EDFA input and output stages and are used to evaluate the total gain ripple. A total of 12 photodiodes (PDs) are provided, allowing full monitoring of RP power, DWDM power, and OSC power in each section of the device. In particular, PD12 allows the detection of the remnant Raman pump power at the end of the counter-pumped span, while PD11 detects the amount of Raman pump power backscattered by the LINE-RX connector and transmission fiber.

The EDFA section calculates the signal power, considering the expected ASE power contribution to the total output power. The signal output power or the signal gain can be used as feedback signals for the EDFA pump power control loop. The ASE power is derived according to the working EDFA gain. PD2, PD3, and PD4 provide the total power measured by the photodiode and the signal power is derived by calculating the total power value. The insertion loss of the main optical path and the relative optical attenuation of the two monitor ports are stored into the card's not-volatile memory.

4.10.3 OPT-RAMP-C and OPT-RAMP-CE Card Power Monitoring

Physical photodiodes PD1 through PD12 monitor the power for the OPT-RAMP-C and OPT-RAMP-CE cards (see Table 4-18).

Table 4-18 OPT-RAMP-C and OPT-RAMP-CE Port Calibration

Photodiode	CTC Type Name	Calibrated to Port
PD1	EDFA DWDM Input Power	LINE-RX
PD2	EDFA Output Power (pre-VOA attenuation)	DC-TX (port with 0 dB VOA attenuation)
PD3	DCU Input Power	DC-TX
PD4	DCU Output Power	DC-RX
PD5	DWDM Input Power	COM-RX
PD6	OSC ADD Input Power	OSC-RX
PD7	OSC DROP Output Power	OSC-TX
PD8	Pump 1 in-fiber Output Power	LINE-RX
PD9	Pump 2 in-fiber Output Power	LINE-RX
PD10	Total Pump in-fiber Output Power	LINE-RX
PD11	Back-Reflected Pump Power	LINE-RX
PD12	Remnant Pump Power	LINE-TX

For information on the associated TL1 AIDs for the optical power monitoring points, refer the "CTC Port Numbers and TL1 Aids" section in *Cisco ONS SONET TL1 Command Guide, Release 9.2*.

4.10.4 OPT-RAMP-C and OPT-RAMP-CE Card Level Indicators

Table 4-19 shows the three card-level LEDs on the OPT-RAMP-C and OPT-RAMP-CE cards.

Table 4-19 OPT-RAMP-C and OPT-RAMP-CE Card-Level Indicators

Card-Level Indicators	Description
Red FAIL LED	The red FAIL LED indicates that the card processor is not ready or that an internal hardware failure occurred. Replace the card if the red FAIL LED persists.
Green ACT LED	The green ACT LED indicates that the OPT-RAMP-C or OPT-RAMP-CE card is carrying traffic or is traffic-ready.
Amber SF LED	The amber SF LED indicates a signal failure or condition such as LOS on one or more of the card ports. The amber SF LED also turns on when the transmit and receive fibers are incorrectly connected. When the fibers are properly connected, the light turns off.

4.10.5 OPT-RAMP-C and OPT-RAMP-CE Card Port-Level Indicators

You can determine the status of the card ports using the LCD screen on the ONS 15454 fan-tray assembly. Use the LCD to view the status of any port or card slot; the screen displays the number and severity of alarms for a given port or slot.

CHAPTER 5

Multiplexer and Demultiplexer Cards

This chapter describes legacy multiplexer and demultiplexer cards used in Cisco ONS 15454 dense wavelength division multiplexing (DWDM) networks. For installation and card turn-up procedures, see the *Cisco ONS 15454 DWDM Procedure Guide*. For card safety and compliance information, see the *Cisco Optical Transport Products Safety and Compliance Information* document.

Note Unless otherwise specified, "ONS 15454" refers to both ANSI and ETSI shelf assemblies.

Chapter topics include:

- 5.1 Card Overview, page 5-1
- 5.2 Safety Labels, page 5-8
- 5.3 32MUX-O Card, page 5-13
- 5.4 32DMX-O Card, page 5-17
- 5.5 4MD-xx.x Card, page 5-21

Note For a description of the 32DMX, 32DMX-L, 40-DMX-C, 40-DMX-CE, 40-MUX-C, 40-WSS-C, 40-WSS-CE, and 40-WXC-C cards, see Chapter 9, "Reconfigurable Optical Add/Drop Cards."

5.1 Card Overview

The card overview section contains card summary, compatibility, interface class, and channel allocation plan information for legacy multiplexer and demultiplexer cards.

Note Each card is marked with a symbol that corresponds to a slot (or slots) on the ONS 15454 shelf assembly. The cards are then installed into slots displaying the same symbols. For a list of slots and symbols, see the "Card Slot Requirements" section in the *Cisco ONS 15454 Hardware Installation Guide*.

5.1.1 Card Summary

Table 5-1 lists and summarizes the functions of the 32MUX-O, 32DMX-O, and 4MD-xx.x cards.

Table 5-1 Multiplexer and Demultiplexer Cards

Card	Port Description	For Additional Information
32MUX-O	The 32MUX-O has five sets of ports located on the faceplate. It operates in Slots 1 to 5 and 12 to 16.	See the "5.3 32MUX-O Card" section on page 5-13.
32DMX-O	The 32DMX-O has five sets of ports located on the faceplate. It operates in Slots 1 to 5 and 12 to 16.	"5.4 32DMX-O Card" section on page 5-17
4MD-xx.x	The 4MD-xx.x card has five sets of ports located on the faceplate. It operates in Slots 1 to 6 and 12 to 17.	See the "5.5 4MD-xx.x Card" section on page 5-21.

5.1.2 Card Compatibility

Table 5-2 lists the CTC software compatibility for the legacy cards.

Table 5-2 Software Compatibility for Legacy Multiplexer and Demultiplexer Cards

	Cards		
Release	**32MUX-O**	**32DMX-O**	**4MD-xx.x**
R4.5	Yes	Yes	Yes
R4.6	Yes	Yes	Yes
R4.7	Yes	Yes	Yes
R5.0	Yes	Yes	Yes
R6.0	Yes	Yes	Yes
R7.0	Yes	Yes	Yes
R7.2	Yes	Yes	Yes
R8.0	Yes	Yes	Yes
R8.5	Yes	Yes	Yes
R9.0	Yes	Yes	Yes
R9.1	Yes	Yes	Yes
R9.2	Yes	Yes	Yes

5.1.3 Interface Classes

The 32MUX-O, 32DMX-O, and 4MD-xx.x cards have different input and output optical channel signals depending on the interface card where the input signal originates. The input interface cards have been grouped in classes listed in Table 5-3. The subsequent tables list the optical performance and output power of each interface class.

Table 5-3 ONS 15454 Card Interfaces Assigned to Input Power Classes

Input Power Class	Card
A	10-Gbps multirate transponder cards (TXP_MR_10G, TXP_MR_10E, TXP_MR_10E_C, and TXP_MR_10E_L) with forward error correction (FEC) enabled, 10-Gbps muxponder cards (MXP_2.5G_10G, MXP_2.5G_10E, MXP_MR_10DME_C, MXP_MR_10DME_L, MXP_2.5G_10E_C, and MXP_2.5G_10E_L) with FEC enabled, and 40-Gbps muxponder card (40G-MXP-C)
B	10-Gbps multirate transponder card (TXP_MR_10G) without FEC, 10-Gbps muxponder cards (MXP_2.5G_10G, MXP_MR_10DME_C, MXP_MR_10DME_L), 40-Gbps muxponder card (40G-MXP-C), and ADM-10G cards with FEC disabled
C	OC-192 LR ITU cards (TXP_MR_10E, TXP_MR_10E_C, and TXP_MR_10E_L) without FEC
D	2.5-Gbps multirate transponder card (TXP_MR_2.5G), both protected and unprotected, with FEC enabled
E	OC-48 100-GHz DWDM muxponder card (MXP_MR_2.5G) and 2.5-Gbps multirate transponder card (TXP_MR_2.5G), protected or unprotected, with FEC disabled and retime, reshape, and regenerate (3R) mode enabled
F	2.5-Gbps multirate transponder card (TXP_MR_2.5G), protected or unprotected, in regenerate and reshape (2R) mode
G	OC-48 ELR 100 GHz card
H	2/4 port GbE transponder (GBIC WDM 100GHz)
I	TXP_MR_10E, TXP_MR_10E_C, and TXP_MR_10E_L cards with enhanced FEC (E-FEC) and the MXP_2.5G_10E, MXP_2.5G_10E_C, MXP_2.5G_10E_L, MXP_MR_10DME_C, MXP_MR_10DME_L, and 40G-MXP-C cards with E-FEC enabled

Table 5-5 lists the optical performance parameters for 40-Gbps cards that provide signal input to multiplexer and demultiplexer cards.

Table 5-4 40-Gbps Interface Optical Performance

Parameter	Class A		Class B		Class I	
Type	Power Limited	OSNR[1] Limited	Power Limited	OSNR Limited	Power Limited	OSNR Limited
Maximum bit rate	40 Gbps		40 Gbps		40 Gbps	
Regeneration	3R		3R		3R	
FEC	Yes		No		Yes (E-FEC)	
Threshold	Optimum		Average		Optimum	
Maximum BER[2]	10^{-15}		10^{-12}		10^{-15}	
OSNR[1] sensitivity	23 dB	9 dB	23 dB	19 dB	20 dB	8 dB
Power sensitivity	–24 dBm	–18 dBm	–21 dBm	–20 dBm	–26 dBm	–18 dBm
Power overload	–8 dBm		–8 dBm		–8 dBm	

Table 5-4 40-Gbps Interface Optical Performance (continued)

Parameter	Class A		Class B		Class I	
Type	Power Limited	OSNR[1] Limited	Power Limited	OSNR Limited	Power Limited	OSNR Limited
Transmitted Power Range[3]						
OC-192 LR ITU	—		—		—	
Dispersion compensation tolerance	+/–800 ps/nm		+/–1,000 ps/nm		+/–800 ps/nm	

1. OSNR = optical signal-to-noise ratio
2. BER = bit error rate
3. These values, decreased by patchcord and connector losses, are also the input power values for the OADM cards.

Table 5-5 lists the optical performance parameters that provide signal input for the 40-Gbps multiplexer and demultiplexer cards.

Table 5-5 10-Gbps Interface Optical Performance Parameters

Parameter	Class A		Class B		Class C	Class I	
Type	Power Limited	OSNR[1] Limited	Power Limited	OSNR Limited	OSNR Limited	Power Limited	OSNR Limited
Maximum bit rate	10 Gbps		10 Gbps		10 Gbps	10 Gbps	
Regeneration	3R		3R		3R	3R	
FEC	Yes		No		No	Yes (E-FEC)	
Threshold	Optimum		Average		Average	Optimum	
Maximum BER[2]	10^{-15}		10^{-12}		10^{-12}	10^{-15}	
OSNR[1] sensitivity	23 dB	9 dB	23 dB	19 dB	19 dB	20 dB	8 dB
Power sensitivity	–24 dBm	–18 dBm	–21 dBm	–20 dBm	–22 dBm	–26 dBm	–18 dBm
Power overload	–8 dBm		–8 dBm		–9 dBm	–8 dBm	
Transmitted Power Range[3]							
10-Gbps multirate transponder/10-Gbps FEC transponder (TXP_MR_10G)	+2.5 to 3.5 dBm		+2.5 to 3.5 dBm		—	—	
OC-192 LR ITU	—		—		+3.0 to 6.0 dBm	—	
10-Gbps multirate transponder/10-Gbps FEC transponder (TXP_MR_10E)	+3.0 to 6.0 dBm		+3.0 to 6.0 dBm		—	+3.0 to 6.0 dBm	
Dispersion compensation tolerance	+/–800 ps/nm		+/–1,000 ps/nm		+/–1,000 ps/nm	+/–800 ps/nm	

1. OSNR = optical signal-to-noise ratio
2. BER = bit error rate
3. These values, decreased by patchcord and connector losses, are also the input power values for the OADM cards.

Table 5-6 lists the optical interface performance parameters for 2.5-Gbps cards that provide signal input to multiplexer and demultiplexer cards.

Table 5-6 2.5-Gbps Interface Optical Performance

Parameter	Class D		Class E		Class F	Class G		Class H		Class J
Type	Power Limited	OSNR Limited	Power Limited	OSNR Limited	OSNR Limited	Power Limited	OSNR Limited	Power Limited	OSNR Limited	Power Limited
Maximum bit rate	2.5 Gbps		2.5 Gbps		2.5 Gbps	2.5 Gbps		1.25 Gbps		2.5 Gbps
Regeneration	3R		3R		2R	3R		3R		3R
FEC	Yes		No		No	No		No		No
Threshold	Average		Average		Average	Average		Average		Average
Maximum BER	10^{-15}		10^{-12}		10^{-12}	10^{-12}		10^{-12}		10^{-12}
OSNR sensitivity	14 dB	6 dB	14 dB	10 dB	15 dB	14 dB	11 dB	13 dB	8 dB	12 dB
Power sensitivity	–31 dBm	–25 dBm	–30 dBm	–23 dBm	–24 dBm	–27 dBm	–33 dBm	–28 dBm	–18 dBm	–26 dBm
Power overload	–9 dBm		–9 dBm		–9 dBm	–9 dBm		–7 dBm		–17dBm
Transmitted Power Range[1]										
TXP_MR_2.5G	–1.0 to 1.0 dBm		–1.0 to 1.0 dBm		–1.0 to 1.0 dBm	–2.0 to 0 dBm				
TXPP_MR_2.5G	–4.5 to –2.5 dBm		–4.5 to –2.5 dBm		–4.5 to –2.5 dBm					
MXP_MR_2.5G	—		+2.0 to +4.0 dBm		—					
MXPP_MR_2.5G	—		–1.5 to +0.5 dBm		—					
2/4 port GbE Transponder (GBIC WDM 100GHz)								+2.5 to 3.5 dBm		—
Dispersion compensation tolerance	–1200 to +5400 ps/nm		–1200 to +5400 ps/nm		–1200 to +3300 ps/nm	–1200 to +3300 ps/nm		–1000 to +3600 ps/nm		–1000 to +3200 ps/nm

1. These values, decreased by patchcord and connector losses, are also the input power values for the OADM cards.

5.1.4 Channel Allocation Plan

ONS 15454 DWDM multiplexer and demultiplexer cards are designed for use with specific channels in the C band and L band. In most cases, the channels for these cards are either numbered (for example, 1 to 32 or 1 to 40) or delimited (odd or even). Client interfaces must comply with these channel assignments to be compatible with the ONS 15454 system.

Table 5-7 lists the channel IDs and wavelengths assigned to the C-band DWDM channels.

Note In some cases, a card uses only one of the bands (C band or L band) and some or all of the channels listed in a band. Also, some cards use channels on the 100-GHz ITU grid while others use channels on the 50-GHz ITU grid. See the specific card description or Appendix A, "Hardware Specifications" for more details.

Table 5-7 DWDM Channel Allocation Plan (C Band)

Channel Number	Frequency (THz)	Wavelength (nm)	Channel Number	Frequency (THz)	Wavelength (nm)
1	196.00	1529.55	42	193.95	1545.72
2	195.95	1529.94	43	193.90	1546.119
3	195.90	1530.334	44	193.85	1546.518
4	195.85	1530.725	45	193.80	1546.917
5	195.80	1531.116	46	193.75	1547.316
6	195.75	1531.507	47	193.70	1547.715
7	195.70	1531.898	48	193.65	1548.115
8	195.65	1532.290	49	193.60	1548.515
9	195.60	1532.681	50	193.55	1548.915
10	195.55	1533.073	51	193.50	1549.32
11	195.50	1533.47	52	193.45	1549.71
12	195.45	1533.86	53	193.40	1550.116
13	195.40	1534.250	54	193.35	1550.517
14	195.35	1534.643	55	193.30	1550.918
15	195.30	1535.036	56	193.25	1551.319
16	195.25	1535.429	57	193.20	1551.721
17	195.20	1535.822	58	193.15	1552.122
18	195.15	1536.216	59	193.10	1552.524
19	195.10	1536.609	60	193.05	1552.926
20	195.05	1537.003	61	193.00	1553.33
21	195.00	1537.40	62	192.95	1553.73
22	194.95	1537.79	63	192.90	1554.134
23	194.90	1538.186	64	192.85	1554.537
24	194.85	1538.581	65	192.80	1554.940
25	194.80	1538.976	66	192.75	1555.343
26	194.75	1539.371	67	192.70	1555.747
27	194.70	1539.766	68	192.65	1556.151
28	194.65	1540.162	69	192.60	1556.555
29	194.60	1540.557	70	192.55	1556.959
30	194.55	1540.953	71	192.50	1557.36

Table 5-7 DWDM Channel Allocation Plan (C Band) (continued)

Channel Number	Frequency (THz)	Wavelength (nm)	Channel Number	Frequency (THz)	Wavelength (nm)
31	194.50	1541.35	72	192.45	1557.77
32	194.45	1541.75	73	192.40	1558.173
33	194.40	1542.142	74	192.35	1558.578
34	194.35	1542.539	75	192.30	1558.983
35	194.30	1542.936	76	192.25	1559.389
36	194.25	1543.333	77	192.20	1559.794
37	194.20	1543.730	78	192.15	1560.200
38	194.15	1544.128	79	192.10	1560.606
39	194.10	1544.526	80	192.05	1561.013
40	194.05	1544.924	81	192.00	1561.42
41	194.00	1545.32	82	191.95	1561.83

Table 5-8 lists the channel IDs and wavelengths assigned to the L-band channels.

Table 5-8 DWDM Channel Allocation Plan (L Band)

Channel Number	Frequency (THz)	Wavelength (nm)	Channel Number	Frequency (THz)	Wavelength (nm)
1	190.85	1570.83	41	188.85	1587.46
2	190.8	1571.24	42	188.8	1587.88
3	190.75	1571.65	43	188.75	1588.30
4	190.7	1572.06	44	188.7	1588.73
5	190.65	1572.48	45	188.65	1589.15
6	190.6	1572.89	46	188.6	1589.57
7	190.55	1573.30	47	188.55	1589.99
8	190.5	1573.71	48	188.5	1590.41
9	190.45	1574.13	49	188.45	1590.83
10	190.4	1574.54	50	188.4	1591.26
11	190.35	1574.95	51	188.35	1591.68
12	190.3	1575.37	52	188.3	1592.10
13	190.25	1575.78	53	188.25	1592.52
14	190.2	1576.20	54	188.2	1592.95
15	190.15	1576.61	55	188.15	1593.37
16	190.1	1577.03	56	188.1	1593.79
17	190.05	1577.44	57	188.05	1594.22
18	190	1577.86	58	188	1594.64
19	189.95	1578.27	59	187.95	1595.06

Table 5-8 DWDM Channel Allocation Plan (L Band) (continued)

Channel Number	Frequency (THz)	Wavelength (nm)	Channel Number	Frequency (THz)	Wavelength (nm)
20	189.9	1578.69	60	187.9	1595.49
21	189.85	1579.10	61	187.85	1595.91
22	189.8	1579.52	62	187.8	1596.34
23	189.75	1579.93	63	187.75	1596.76
24	189.7	1580.35	64	187.7	1597.19
25	189.65	1580.77	65	187.65	1597.62
26	189.6	1581.18	66	187.6	1598.04
27	189.55	1581.60	67	187.55	1598.47
28	189.5	1582.02	68	187.5	1598.89
29	189.45	1582.44	69	187.45	1599.32
30	189.4	1582.85	70	187.4	1599.75
31	189.35	1583.27	71	187.35	1600.17
32	189.3	1583.69	72	187.3	1600.60
33	189.25	1584.11	73	187.25	1601.03
34	189.2	1584.53	74	187.2	1601.46
35	189.15	1584.95	75	187.15	1601.88
36	189.1	1585.36	76	187.1	1602.31
37	189.05	1585.78	77	187.05	1602.74
38	189	1586.20	78	187	1603.17
39	188.95	1586.62	79	186.95	1603.60
40	188.9	1587.04	80	186.9	1604.03

5.2 Safety Labels

This section explains the significance of the safety labels attached to some of the cards. The faceplates of the cards are clearly labeled with warnings about the laser radiation levels. You must understand all warning labels before working on these cards.

5.2.1 Class 1 Laser Product Labels

The 32MUX-O card has a Class 1 laser. The labels that appear on the card are described in the following sections.

5.2.1.1 Class 1 Laser Product Label

The Class 1 Laser Product label is shown in Figure 5-1.

Figure 5-1 Class 1 Laser Product Label

Class 1 lasers are products whose irradiance does not exceed the Maximum Permissible Exposure (MPE) value. Therefore, for Class 1 laser products the output power is below the level at which it is believed eye damage will occur. Exposure to the beam of a Class 1 laser will not result in eye injury and may therefore be considered safe. However, some Class 1 laser products may contain laser systems of a higher class but there are adequate engineering control measures to ensure that access to the beam is not reasonably likely. Anyone who dismantles a Class 1 laser product that contains a higher Class laser system is potentially at risk of exposure to a hazardous laser beam

5.2.1.2 Hazard Level 1 Label

The Hazard Level 1 label is shown in Figure 5-2. This label is displayed on the faceplate of the cards.

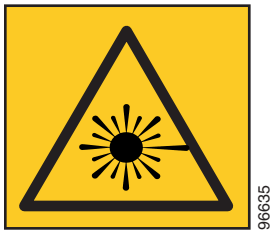
Figure 5-2 Hazard Level Label

The Hazard Level label warns users against exposure to laser radiation of Class 1 limits calculated in accordance with IEC60825-1 Ed.1.2.

5.2.1.3 Laser Source Connector Label

The Laser Source Connector label is shown in Figure 5-3.

Figure 5-3 Laser Source Connector Label



This label indicates that a laser source is present at the optical connector where the label has been placed.

5.2.1.4 FDA Statement Label

The FDA Statement labels are shown in Figure 5-4 and Figure 5-5. These labels show compliance to FDA standards and that the hazard level classification is in accordance with IEC60825-1 Am.2 or Ed.1.2.

Figure 5-4 FDA Statement Label

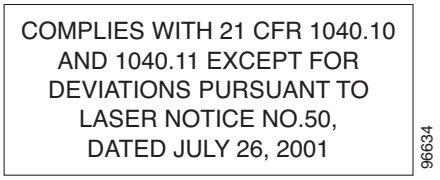
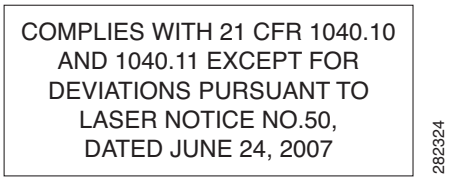


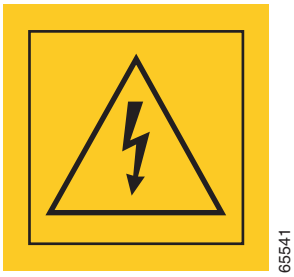
Figure 5-5 FDA Statement Label



5.2.1.5 Shock Hazard Label

The Shock Hazard label is shown in Figure 5-6.

Figure 5-6 Shock Hazard Label



This label alerts personnel to electrical hazard within the card. The potential of shock hazard exists when removing adjacent cards during maintenance, and touching exposed electrical circuitry on the card itself.

5.2.2 Class 1M Laser Product Cards

The 32DMX-O and 4MD-xx.x cards have Class IM lasers. The labels that appear on these cards are described in the following subsections.

5.2.2.1 Class 1M Laser Product Statement

The Class 1M Laser Product statement is shown in Figure 5-7.

Figure 5-7 Class 1M Laser Product Statement

Class 1M lasers are products that produce either a highly divergent beam or a large diameter beam. Therefore, only a small part of the whole laser beam can enter the eye. However, these laser products can be harmful to the eye if the beam is viewed using magnifying optical instruments.

5.2.2.2 Hazard Level 1M Label

The Hazard Level 1M label is shown in Figure 5-8.

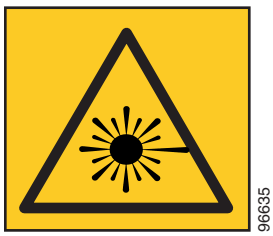
Figure 5-8 Hazard Level Label

The Hazard Level label warns users against exposure to laser radiation of Class 1 limits calculated in accordance with IEC60825-1 Ed.1.2. This label is displayed on the faceplate of the cards.

5.2.2.3 Laser Source Connector Label

The Laser Source Connector label is shown in Figure 5-9.

Figure 5-9 Laser Source Connector Label



This label indicates that a laser source is present at the optical connector where the label has been placed.

5.2.2.4 FDA Statement Label

The FDA Statement labels are shown in Figure 5-10 and Figure 5-11. These labels show compliance to FDA standards and that the hazard level classification is in accordance with IEC60825-1 Am.2 or Ed.1.2.

Figure 5-10 FDA Statement Label

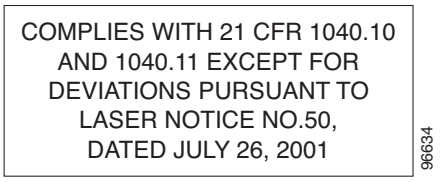
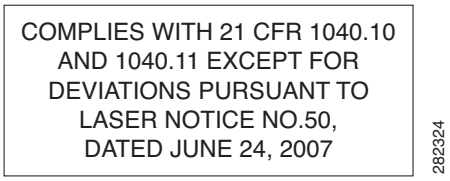


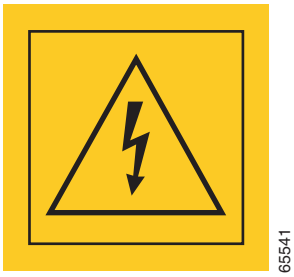
Figure 5-11 FDA Statement Label



5.2.2.5 Shock Hazard Label

The Shock Hazard label is shown in Figure 5-6.

Figure 5-12 Shock Hazard Label



This label alerts personnel to electrical hazard within the card. The potential of shock hazard exists when removing adjacent cards during maintenance, and touching exposed electrical circuitry on the card itself.

5.3 32MUX-O Card

Note See the "A.7.1 32MUX-O Card Specifications" section on page A-20 for hardware specifications.

The 32-Channel Multiplexer (32MUX-O) card multiplexes 32 100-GHz-spaced channels identified in the channel plan. The 32MUX-O card takes up two slots in an ONS 15454 and can be installed in Slots 1 to 5 and 12 to 16.

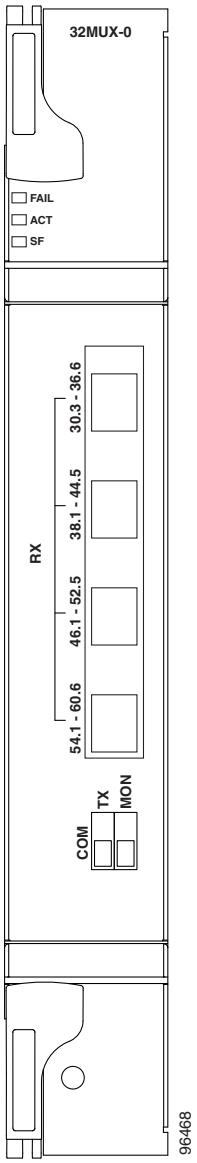
The 32MUX-O features include:

- Arrayed waveguide grating (AWG) device that enables full multiplexing functions for the channels.
- Each single-channel port is equipped with VOAs for automatic optical power regulation prior to multiplexing. In the case of electrical power failure, the VOA is set to its maximum attenuation for safety purposes. A manual VOA setting is also available.
- Each single-channel port is monitored using a photodiode to enable automatic power regulation.

An additional optical monitoring port with 1:99 splitting ratio is available.

Figure 5-13 shows the 32MUX-O faceplate.

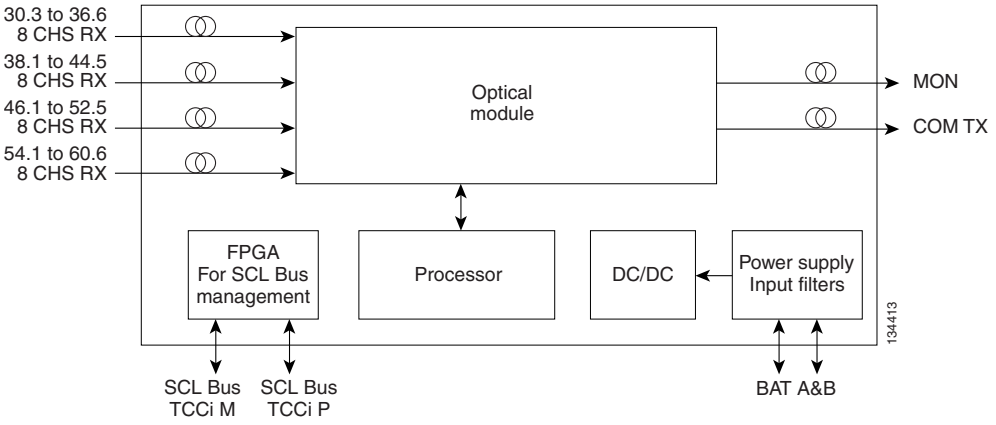
Figure 5-13 32MUX-O Faceplate



For information on safety labels for the card, see the "5.2.1 Class 1 Laser Product Labels" section on page 5-8.

Figure 5-14 shows a block diagram of the 32MUX-O card.

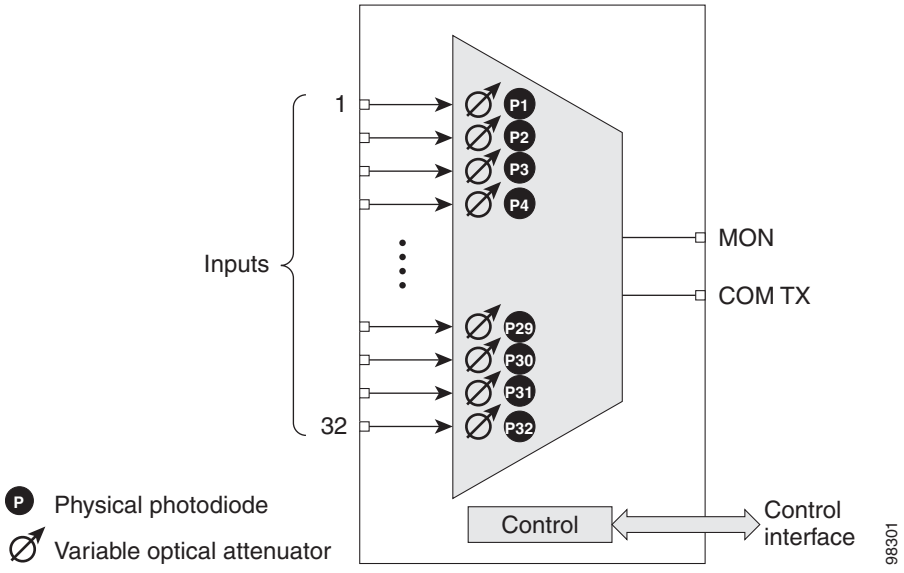
Figure 5-14 32MUX-O Block Diagram



The 32MUX-O card has four receive connectors that accept multifiber push-on (MPO) cables on its front panel for the client input interfaces. MPO cables break out into eight separate cables. The 32MUX-O card also has two LC-PC-II optical connectors, one for the main output and the other for the monitor port.

Figure 5-15 shows the 32MUX-O optical module functional block diagram.

Figure 5-15 32MUX-O Optical Module Functional Block Diagram



5.3.1 Channel Plan

The 32MUX-O is typically used in hub nodes and provides the multiplexing of 32 channels, spaced at 100 GHz, into one fiber before their amplification and transmission along the line. The channel plan is shown in Table 5-9.

Table 5-9 32MUX-O Channel Plan

Channel Number[1]	Channel ID	Frequency (GHz)	Wavelength (nm)
1	30.3	195.9	1530.33
2	31.2	195.8	1531.12
3	31.9	195.7	1531.90
4	32.6	195.6	1532.68
5	34.2	195.4	1534.25
6	35.0	195.3	1535.04
7	35.8	195.2	1535.82
8	36.6	195.1	1536.61
9	38.1	194.9	1538.19
10	38.9	194.8	1538.98
11	39.7	194.7	1539.77
12	40.5	194.6	1540.56
13	42.1	194.4	1542.14
14	42.9	194.3	1542.94
15	43.7	194.2	1543.73
16	44.5	194.1	1544.53
17	46.1	193.9	1546.12
18	46.9	193.8	1546.92
19	47.7	193.7	1547.72
20	48.5	193.6	1548.51
21	50.1	193.4	1550.12
22	50.9	193.3	1550.92
23	51.7	193.2	1551.72
24	52.5	193.1	1552.52
25	54.1	192.9	1554.13
26	54.9	192.8	1554.94
27	55.7	192.7	1555.75
28	56.5	192.6	1556.55
29	58.1	192.4	1558.17
30	58.9	192.3	1558.98
31	59.7	192.2	1559.79
32	60.6	192.1	1560.61

1. The Channel Number column is only for reference purposes. The channel ID is consistent with the ONS 15454 and is used in card identification.

5.3.2 Power Monitoring

Physical photodiodes P1 through P32 monitor the power for the 32MUX-O card. The returned power level values are calibrated to the ports as shown in Table 5-10.

Table 5-10 32MUX-O Port Calibration

Photodiode	CTC Type Name	Calibrated to Port
P1–P32	ADD	COM TX

For information on the associated TL1 AIDs for the optical power monitoring points, refer the "CTC Port Numbers and TL1 Aids" section in *Cisco ONS SONET TL1 Command Guide, Release 9.2*.

5.3.3 32MUX-O Card-Level Indicators

The 32MUX-O card has three card-level LED indicators, described in Table 5-11.

Table 5-11 32MUX-O Card-Level Indicators

Card-Level Indicators	Description
Red FAIL LED	The red FAIL LED indicates that the card's processor is not ready or that there is an internal hardware failure. Replace the card if the red FAIL LED persists.
Green ACT LED	The green ACT LED indicates that the 32MUX-O is carrying traffic or is traffic-ready.
Amber SF LED	The amber SF LED indicates a signal failure on one or more of the card's ports. The amber SF LED also illuminates when the transmit and receive fibers are incorrectly connected. When the fibers are properly connected, the light turns off.

5.3.4 32MUX-O Port-Level Indicators

You can find the status of the card ports using the LCD screen on the ONS 15454 fan-tray assembly. Use the LCD to view the status of any port or card slot; the screen displays the number and severity of alarms for a given port or slot. The 32MUX-O card has five sets of ports located on the faceplate.

COM TX is the line output. COM MON is the optical monitoring port. The xx.x to yy.y RX ports represent the four groups of eight channels ranging from wavelength xx.x to wavelength yy.y, according to the channel plan.

5.4 32DMX-O Card

Note See the "A.7.2 32DMX-O Card Specifications" section on page A-20 for hardware specifications.

The 32-Channel Demultiplexer (32DMX-O) card demultiplexes 32 100-GHz-spaced channels identified in the channel plan. The 32DMX-O takes up two slots in an ONS 15454 and can be installed in Slots 1 to 5 and 12 to 16.

The 32DMX-O features include:

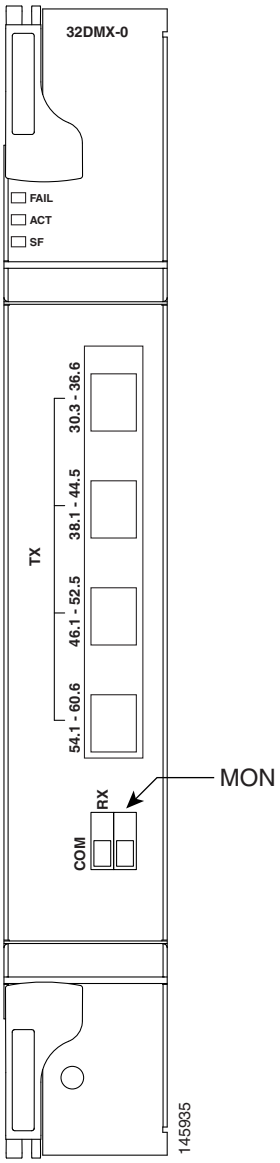
- AWG that enables channel demultiplexing functions.
- Each single-channel port is equipped with VOAs for automatic optical power regulation after demultiplexing. In the case of electrical power failure, the VOA is set to its maximum attenuation for safety purposes. A manual VOA setting is also available.
- The 32DXM-O has four physical receive connectors that accept MPO cables on its front panel for the client input interfaces. MPO cables break out into eight separate cables.

Note In contrast, the single-slot 32DMX card does not have VOAs on each drop port for optical power regulation. The 32DMX optical demultiplexer module is used in conjunction with the 32WSS card in ONS 15454 Multiservice Transport Platform (MSTP) nodes.

- Each single-channel port is monitored using a photodiode to enable automatic power regulation.

Figure 5-16 shows the 32DMX-O card faceplate.

Figure 5-16 32DMX-O Faceplate



For information on safety labels for the card, see the "5.2.2 Class 1M Laser Product Cards" section on page 5-10.

Figure 5-17 shows a block diagram of the 32DMX-O card.

Figure 5-17 32DMX-O Block Diagram

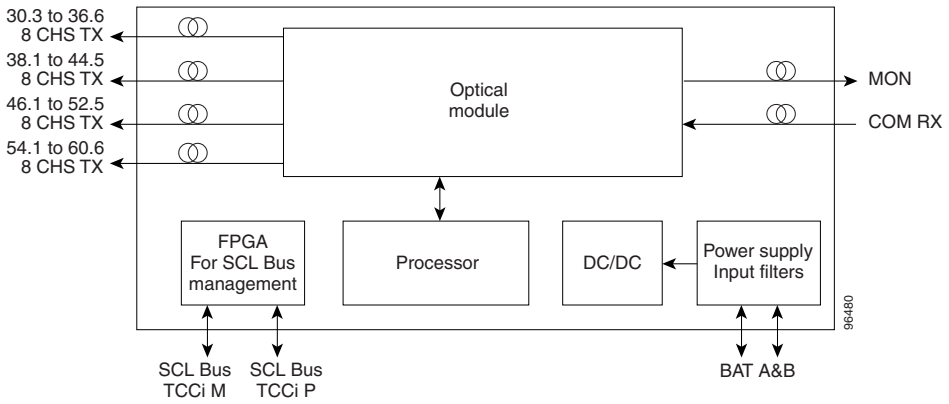
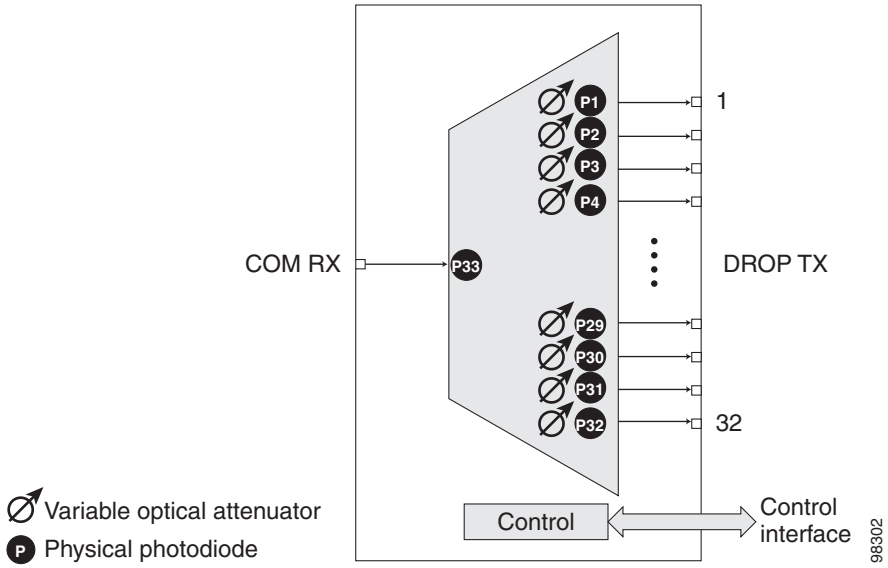


Figure 5-18 shows the 32DMX-O optical module functional block diagram.

Figure 5-18 32DMX-O Optical Module Functional Block Diagram



5.4.1 Power Monitoring

Physical photodiodes P1 through P33 monitor the power for the 32DMX-O card. The returned power level values are calibrated to the ports as shown in Table 5-12.

Table 5-12 32DMX-O Port Calibration

Photodiode	CTC Type Name	Calibrated to Port
P1–P32	DROP	DROP TX
P33	INPUT COM	COM RX

For information on the associated TL1 AIDs for the optical power monitoring points, refer the "CTC Port Numbers and TL1 Aids" section in *Cisco ONS SONET TL1 Command Guide, Release 9.2*.

5.4.2 32DMX-O Card-Level Indicators

The 32DMX-O card has three card-level LED indicators, described in Table 5-13.

Table 5-13 32DMX-O Card-Level Indicators

Card-Level Indicators	Description
Red FAIL LED	The red FAIL LED indicates that the card's processor is not ready or that there is an internal hardware failure. Replace the card if the red FAIL LED persists.
Green ACT LED	The green ACT LED indicates that the 32DMX-O is carrying traffic or is traffic-ready.
Amber SF LED	The amber SF LED indicates a signal failure on one or more of the card's ports. The amber SF LED also illuminates when the transmit and receive fibers are incorrectly connected. When the fibers are properly connected, the light turns off.

5.4.3 32DMX-O Port-Level Indicators

You can find the status of the card ports using the LCD screen on the ONS 15454 fan-tray assembly. Use the LCD to view the status of any port or card slot; the screen displays the number and severity of alarms for a given port or slot. The 32DMX-O card has five sets of ports located on the faceplate. MON is the output monitor port. COM RX is the line input. The xx.x to yy.y TX ports represent the four groups of eight channels ranging from wavelength xx.x to wavelength yy.y according to the channel plan.

5.5 4MD-xx.x Card

Note See the "A.7.3 4MD-xx.x Card Specifications" section on page A-21 for hardware specifications.

The 4-Channel Multiplexer/Demultiplexer (4MD-xx.x) card multiplexes and demultiplexes four 100-GHz-spaced channels identified in the channel plan. The 4MD-xx.x card is designed to be used with band OADMs (both AD-1B-xx.x and AD-4B-xx.x).

The card is bidirectional. The demultiplexer and multiplexer functions are implemented in two different sections of the same card. In this way, the same card can manage signals flowing in opposite directions.

There are eight versions of this card that correspond with the eight sub-bands specified in Table 5-14 on page 5-24. The 4MD-xx.x can be installed in Slots 1 to 6 and 12 to 17.

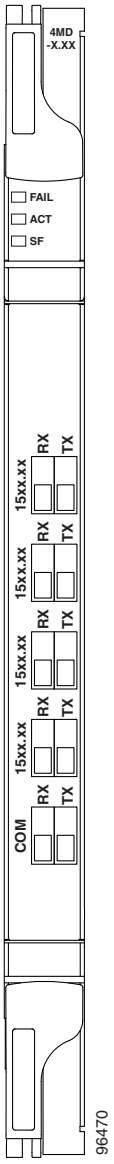
The 4MD-xx.x has the following features implemented inside a plug-in optical module:

- Passive cascade of interferential filters perform the channel multiplex/demultiplex function.
- Software-controlled VOAs at every port of the multiplex section regulate the optical power of each multiplexed channel.

- Software-monitored photodiodes at the input and output multiplexer and demultiplexer ports for power control and safety purposes.
- Software-monitored virtual photodiodes at the common DWDM output and input ports. A virtual photodiode is a firmware calculation of the optical power at that port. This calculation is based on the single channel photodiode reading and insertion losses of the appropriated paths.

Figure 5-19 shows the 4MD-xx.x faceplate.

Figure 5-19 4MD-xx.x Faceplate



For information on safety labels for the card, see the "5.2.2 Class 1M Laser Product Cards" section on page 5-10.

Figure 5-20 shows a block diagram of the 4MD-xx.x card.

Figure 5-20 4MD-xx.x Block Diagram

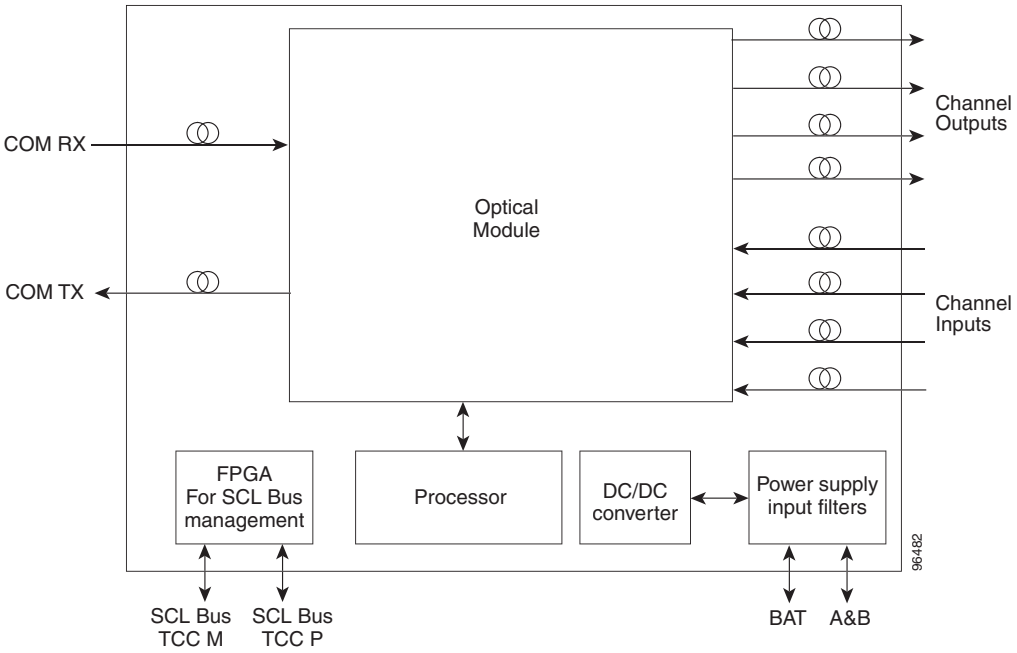
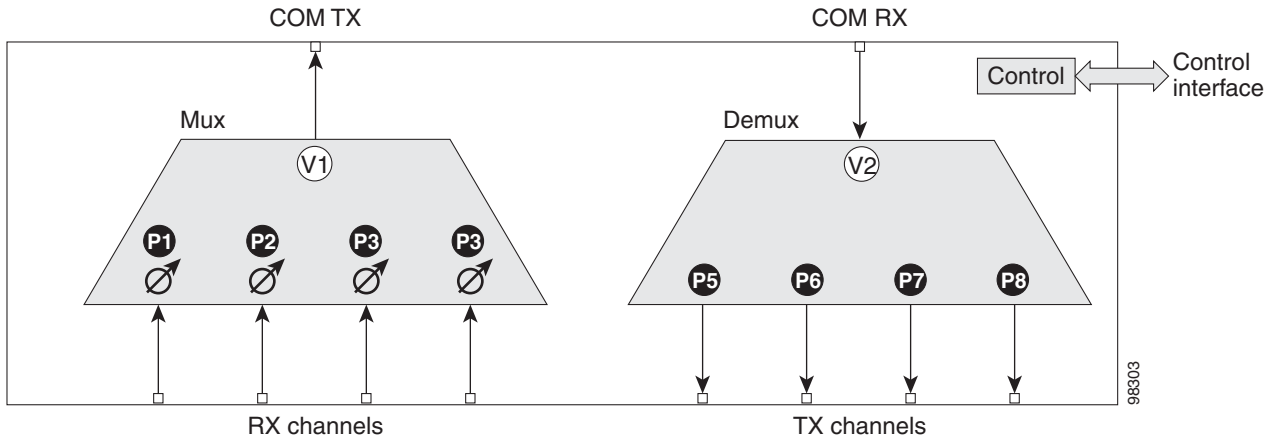


Figure 5-21 shows the 4MD-xx.x optical module functional block diagram.

Figure 5-21 4MD-xx.x Optical Module Functional Block Diagram



The optical module shown in Figure 5-21 is optically passive and consists of a cascade of interferential filters that perform the channel multiplexing and demultiplexing functions.

VOAs are present in every input path of the multiplex section in order to regulate the optical power of each multiplexed channel. Some optical input and output ports are monitored by means of photodiodes implemented both for power control and for safety purposes. An internal control manages VOA settings and functionality as well as photodiode detection and alarm thresholds. The power at the main output

and input ports is monitored through the use of virtual photodiodes. A virtual photodiode is implemented in the firmware of the plug-in module. This firmware calculates the power on a port, summing the measured values from all single channel ports (and applying the proper path insertion loss) and then providing the TCC2/TCC2P/TCC3/TNC/TSC card with the obtained value.

5.5.1 Wavelength Pairs

Table 5-14 shows the band IDs and the add/drop channel IDs for the 4MD-xx.x card.

Table 5-14 4MD-xx.x Channel Sets

Band ID	Add/Drop Channel IDs
Band 30.3 (A)	30.3, 31.2, 31.9, 32.6
Band 34.2 (B)	34.2, 35.0, 35.8, 36.6
Band 38.1 (C)	38.1, 38.9, 39.7, 40.5
Band 42.1 (D)	42.1, 42.9, 43.7, 44.5
Band 46.1 (E)	46.1, 46.9, 47.7, 48.5
Band 50.1 (F)	50.1, 50.9, 51.7, 52.5
Band 54.1 (G)	54.1, 54.9, 55.7, 56.5
Band 58.1 (H)	58.1, 58.9, 59.7, 60.6

5.5.2 Power Monitoring

Physical photodiodes P1 through P8 and virtual photodiodes V1 and V2 monitor the power for the 4MD-xx.x card. The returned power level values are calibrated to the ports as shown in Table 5-15.

Table 5-15 4MD-xx.x Port Calibration

Photodiode	CTC Type Name	Calibrated to Port
P1–P4	ADD	COM TX
P5–P8	DROP	DROP TX
V1	OUT COM	COM TX
V2	IN COM	COM RX

For information on the associated TL1 AIDs for the optical power monitoring points, refer the “CTC Port Numbers and TL1 Aids” section in *Cisco ONS SONET TL1 Command Guide, Release 9.2*.

5.5.3 4MD-xx.x Card-Level Indicators

The 4MD-xx.x card has three card-level LED indicators, described in Table 5-16.

Table 5-16 4MD-xx.x Card-Level Indicators

Card-Level Indicators	Description
Red FAIL LED	The red FAIL LED indicates that the card's processor is not ready or that there is an internal hardware failure. Replace the card if the red FAIL LED persists.
Green ACT LED	The green ACT LED indicates that the 4MD-xx.x card is carrying traffic or is traffic-ready.
Amber SF LED	The amber SF LED indicates a signal failure on one or more of the card's ports. The amber SF LED also illuminates when the transmit and receive fibers are incorrectly connected. When the fibers are properly connected, the light turns off.

5.5.4 4MD-xx.x Port-Level Indicators

You can find the status of the card ports using the LCD screen on the ONS 15454 fan-tray assembly. Use the LCD to view the status of any port or card slot; the screen displays the number and severity of alarms for a given port or slot. The 4MD-xx.x card has five sets of ports located on the faceplate. COM RX is the line input. COM TX is the line output. The 15xx.x TX ports represent demultiplexed channel outputs 1 to 4. The 15xx.x RX ports represent multiplexed channel inputs 1 to 4.

CHAPTER 6

Tunable Dispersion Compensating Units

This chapter explains the Tunable Dispersion Compensating Units (T-DCU) used in Cisco ONS 15454 dense wavelength division multiplexing (DWDM) networks. For installation and card turn-up procedures, refer to the *Cisco ONS 15454 DWDM Procedure Guide*. For card safety and compliance information, refer to the *Cisco Optical Transport Products Safety and Compliance Information* document.

Note Unless otherwise specified, "ONS 15454" refers to both ANSI and ETSI shelf assemblies.

The T-DCU unit compensates for chromatic dispersion (CD) of the transmission fiber. The T-DCU provides two line cards with varied set of tunable wavelengths to compensate for CD.

This chapter includes:

- 6.1 Card Overview, page 6-1
- 6.2 Class 1M Laser Safety Labels, page 6-2
- 6.3 TDC-CC and TDC-FC Cards, page 6-3
- 6.4 Monitoring Optical Performance, page 6-7

6.1 Card Overview

The T-DCU card provides a selectable set of discrete negative chromatic dispersion values to compensate for chromatic dispersion of the transmission line. The card operates over the entire C-band (in the range of 1529.0 nm to 1562.5 nm) and monitors the optical power at the input and the output ports. The two types of T-DCU line cards are:

- TDC-CC (Coarse T-DCU)
- TDC-FC (Fine T-DCU)

Note Each T-DCU card is marked with a symbol that corresponds to a slot (or slots) on the ONS 15454 shelf assembly. Cards should be installed in slots that have the same symbols. See the 1.16.1 Card Slot Requirements section on page 1-59 for a list of slots and symbols.

6.1.1 Card Summary

Table 6-1 lists and summarizes the information about the TDC-CC and TDC-FC cards.

Table 6-1 T-DCU Cards

Card	Port Description	For Additional Information
TDC-CC	The TDC-CC has one set of optical ports located on the faceplate. It operates in slots 1 to 6 and slots 12 to 17.	See the 6.3 TDC-CC and TDC-FC Cards section.
TDC-FC	The TDC-FC has one set of optical ports located on the faceplate. It operates in slots 1 to 6 and slots 12 to 17.	

6.2 Class 1M Laser Safety Labels

This section explains the significance of the safety labels attached to some of the cards. The faceplates of the cards are clearly labeled with warnings about the laser radiation levels. You must understand all warning labels before working on these cards.

6.2.1 Class 1M Laser Product Cards

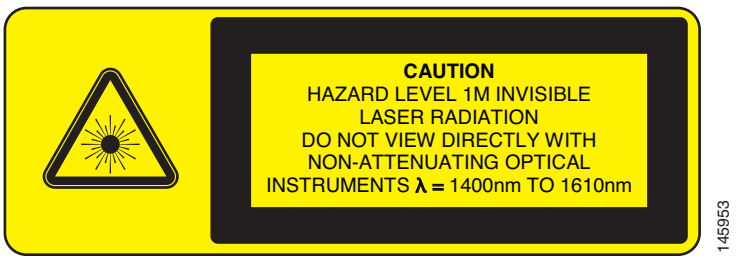
The TDC-CC and TDC-FC cards can be connected to Class 1M lasers. The labels that appear on these cards are described in the following subsections.

Class 1M lasers are products that produce either a highly divergent beam or a large diameter beam. Therefore, only a small part of the whole laser beam can enter the eye. However, these laser products can be harmful to the eye if the beam is viewed using magnifying optical instruments.

6.2.1.1 Hazard Level 1M Label

The Hazard Level 1M label is shown in Figure 6-1.

Figure 6-1 Hazard Level Label

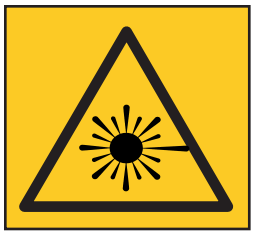


The Hazard Level label warns users against exposure to laser radiation of Class 1 limits calculated in accordance with IEC60825-1 Ed.1.2.

6.2.1.2 Laser Source Connector Label

The Laser Source Connector label is shown in Figure 6-2.

Figure 6-2 Laser Source Connector Label



This label indicates that a laser source is present at the optical connector where the label has been placed.

6.2.1.3 FDA Statement Label

The FDA Statement labels are shown in Figure 6-3 and Figure 6-4. These labels show compliance to FDA standards and that the hazard level classification is in accordance with IEC60825-1 Am.2 or Ed.1.2.

Figure 6-3 FDA Statement Label

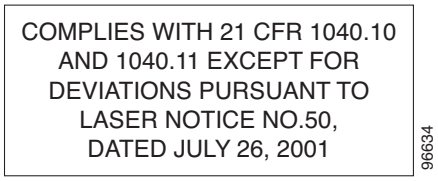
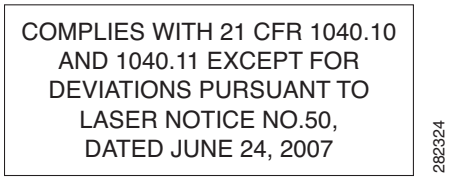


Figure 6-4 FDA Statement Label



6.3 TDC-CC and TDC-FC Cards

The TDC-CC card provides 16 values of CD ranging from 0 to -1650 ps/nm with a granularity of 110 ps/nm in the C-band spectrum.

The TDC-FC card provides 16 values of CD ranging from 0 to -675 ps/nm with a granularity of 45 ps/nm in the C-band spectrum.

You can configure the TDC-CC and TDC-FC cards for the CD value listed in Table 6-2. Refer to the *Cisco ONS 15454 DWDM Procedure Guide* to set the compensating value using CTC.

Table 6-2 TDC-CC and TDC-FC Tunable CD Value

Unit Configuration	TDC-CC [ps/nm]	TDC-FC [ps/nm]
0	0 [1]	0[2]
1	-110	-45
2	-220	-90
3	-330	-135
4	-440	-180
5	-550	-225
6	-660	-270
7	-770	-315
8	-880	-360
9	-990	-405
10	-1100	-450
11	-1210	-495
12	-1320	-540
13	-1430	-585
14	-1540	-630
15	-1650	-675

1. The default value of the TDC-CC CD value for Coarse Unit is 0.
2. The default value of the TDC-FC value for Fine Unit is 0.

6.3.1 Key Features

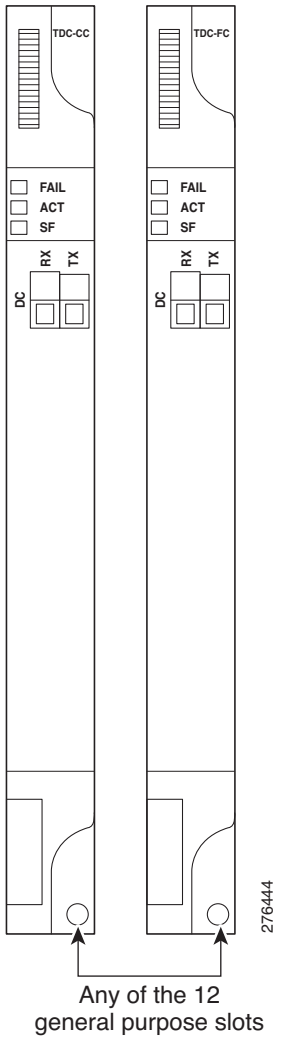
The TDC-CC and TDC-FC cards provide the following features:

- Single slot card with three LEDs on the front panel.
- Two LC-PC-II optical connectors on the front panel.
- Operates in slots from slot 1 to 6 and 12 to 17.
- Operates over the C-band (wavelengths from 1529 nm to 1562.5 nm) of the optical spectrum.
- Allows upto 16 provisionable CD values for chromatic dispersion compensation.
- Connects to OPT-PRE, OPT-AMP-C, OPT-RAMP-C, and OPT-RAMP-CE amplifiers and 40-SMR-1 and 40-SMR-2 cards.
- Supports performance monitoring and alarm handling for selectable thresholds.
- Allows monitoring and provisioning using CTC, SNMP, or TL1.

6.3.2 TDC-CC and TDC-FC Faceplate Diagram

Figure 6-5 shows the TDC-CC and TDC-FC faceplate diagram. The TDC-CC and TDC-FC cards can be installed or pulled out of operation from any user interface slot, without impacting other service cards operating within that shelf. To install the TDC-CC and TDC-FC cards, refer the section NTP-G30 Install the DWDM Cards of the *Cisco ONS 15454 DWDM Procedure Guide*.

Figure 6-5 TDC-CC and TDC-FC Faceplates



Note The coarse T-DCU is identified with the card label as TDC-CC and the fine T-DCU with TDC-FC in the faceplate of the T-DCU card.

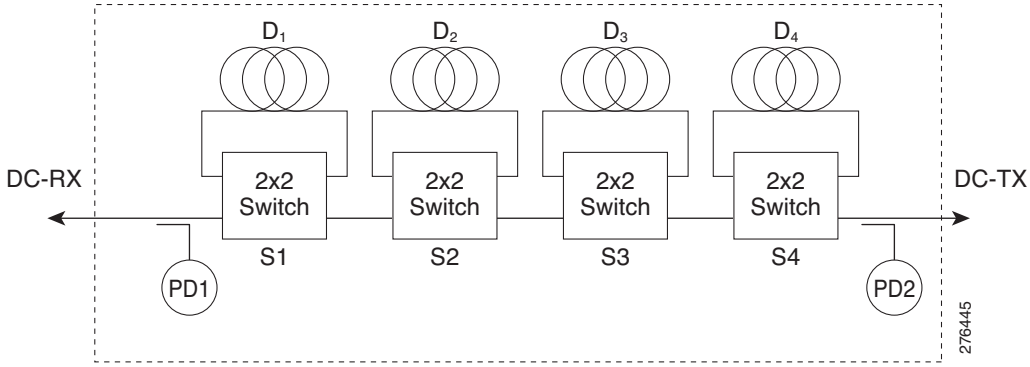
6.3.3 Functioning of Optical Ports

The T-DCU unit contains the DC-RX (input) and DC-TX (output) ports. The optical signal enters the DC-RX port, compensates the chromatic dispersion and then exits from the DC-TX port.

6.3.4 TDC-CC and TDC-FC Block Diagram

The TDC-CC and TDC-FC cards embed an optical module with four spools (D1, D2, D3, and D4) of dispersion compensating fiber that connects through the 2x2 bypass switches (Figure 6-6). Each bypass switch allows the corresponding dispersion compensation fiber spools to connect to the optical path from the DC-RX (input port) to the DC-TX (output port). The switch configuration selects the requested CD value and combines the four spools based on the 16 chromatic dispersion compensation values fetched. The photodiodes PD1 and PD2 are used to monitor the input and output ports respectively.

Figure 6-6 Block Diagram of TDC-CC and TDC-FC



6.3.5 Lamp Test

The TDC-CC and TDC-FC cards support a lamp test function that is activated either from the ONS 15454 front panel or CTC to ensure that all LEDs are functional.

6.3.6 TDC-CC and TDC-FC Card-Level Indicators

Table 6-3 lists the card-level LEDs on the TDC-CC and TDC-FC cards.

Table 6-3 TDC-CC and TDC-FC Card-Level Indicators

Card-Level LED	Description
Red FAIL LED	The red FAIL LED indicates that the card processor is not ready. This LED is ON during reset. The FAIL LED flashes during the boot process. Replace the card if the red FAIL LED persists.
ACT/STBY LED Green (Active) Amber (Standby)	If the ACT/STBY LED is green, the card is operational (one or both ports active) and ready to carry traffic. If the ACT/STBY LED is amber, the card is operational and in standby (protect) mode.
Amber SF LED	The Amber SF LED indicates a signal failure or condition such as LOS and LOF on one or more of the card ports. The amber SF LED is also **ON** if the transmit and receive fibers are incorrectly connected. If the fibers are properly connected and the link is working, the light turns OFF.

6.4 Monitoring Optical Performance

The TDC-CC and TDC-FC cards monitor the optical input power and optical output power of the fiber. It monitors the insertion loss from the input (DC-RX) to the output (DC-TX) port, with the help of the two photodiodes PD1 and PD2. The TDC-CC and TDC-FC cards report the minimum, average, and maximum power statistics of each of the monitored ports or channels in the specific card. To view the optical power statistics of the TDC-CC and TDC-FC cards, refer to the *Cisco ONS 15454 DWDM Procedure Guide.* The performance data is recorded at 15 minutes and 24 hours intervals.

Note You can view the performance monitoring (PM) data of the card using CTC, SNMP, and TL1 interfaces.

Note The PM data is stored on a wrap-around basis at 32 x 15 min and 2 x 24 hour intervals.

CHAPTER 7

Protection Switching Module

This chapter describes the Protection Switching Module (PSM) card used in Cisco ONS 15454 dense wavelength division multiplexing (DWDM) networks. For installation and card turn-up procedures, refer to the *Cisco ONS 15454 DWDM Procedure Guide*. For card safety and compliance information, refer to the *Cisco Optical Transport Products Safety and Compliance Information* document.

Note Unless otherwise specified, "ONS 15454" refers to both ANSI and ETSI shelf assemblies.

Chapter topics include:

- 7.1 PSM Card Overview
- 7.2 Key Features
- 7.3 PSM Block Diagram
- 7.4 PSM Faceplate Ports
- 7.5 PSM Card-Level Indicators
- 7.6 PSM Bidirectional Switching

7.1 PSM Card Overview

The PSM card performs splitter protection functions. In the transmit (TX) section of the PSM card (see Figure 7-1), the signal received on the common receive port is duplicated by a hardware splitter to both the working and protect transmit ports. In the receive (RX) section of the PSM card (Figure 7-1), a switch is provided to select one of the two input signals (on working and protect receive ports) to be transmitted through the common transmit port.

The PSM card supports multiple protection configurations:

- Channel protection—The PSM COM ports are connected to the TXP/MXP trunk ports.
- Line (or path) protection—The PSM working (W) and protect (P) ports are connected directly to the external line.
- Multiplex section protection—The PSM is equipped between the MUX/DMX stage and the amplification stage.
- Standalone—The PSM can be equipped in any slot and supports all node configurations.

The PSM card is a single-slot card that can be installed in any node from Slot 1 to 6 and 12 to 17. The PSM card includes six LC-PC-II optical connectors on the front panel. In channel protection configuration, the PSM card can be installed in a different shelf from its peer TXP/MXP card.

Note It is strongly recommended that you use the default layouts designed by Cisco Transport Planner, which place the PSM card and its peer TXP/MXP card as close as possible to simplify cable management.

For more information on the node configurations supported for the PSM card, see the "11.3 Supported Node Configurations for PSM Card" section on page 11-38.

For more information on the network topologies supported for the PSM card, see the "12.6 Network Topologies for the PSM Card" section on page 12-19.

7.2 Key Features

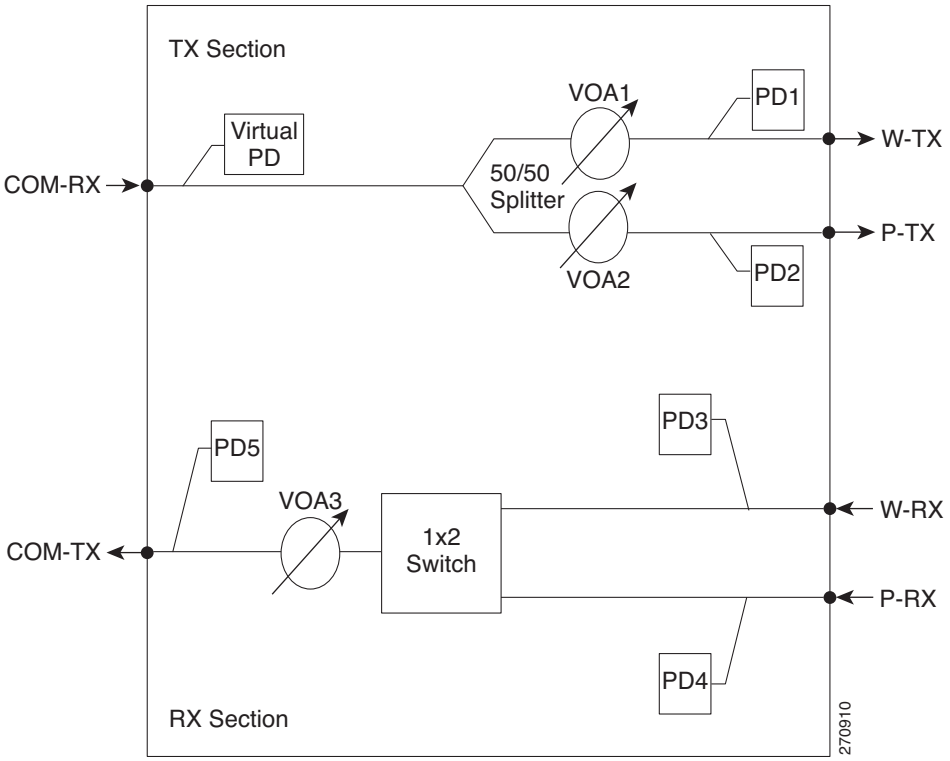
The PSM card provides the following features:

- Operates over the C-band (wavelengths from 1529 nm to 1562.5 nm) and L-band (wavelengths from 1570.5 nm to 1604 nm) of the optical spectrum.
- Implements bidirectional nonrevertive protection scheme. For more details on bidirectional switching, see the "7.6 PSM Bidirectional Switching" section on page 7-5.
- Supports automatic creation of splitter protection group when the PSM card is provisioned.
- Supports switching priorities based on ITU-T G.873.1.
- Supports performance monitoring and alarm handling with settable thresholds.
- Supports automatic laser shutdown (ALS), a safety mechanism used in the event of a fiber cut. ALS is applicable only in line protection configuration. For details on ALS provisioning for the card, refer to the *Cisco ONS 15454 DWDM Procedure Guide*. For information about using the card to implement ALS in a network, see the "12.11 Network Optical Safety" section on page 12-27.

7.3 PSM Block Diagram

Figure 7-1 shows a simplified block diagram of the PSM card.

Figure 7-1 PSM Block Diagram



7.4 PSM Faceplate Ports

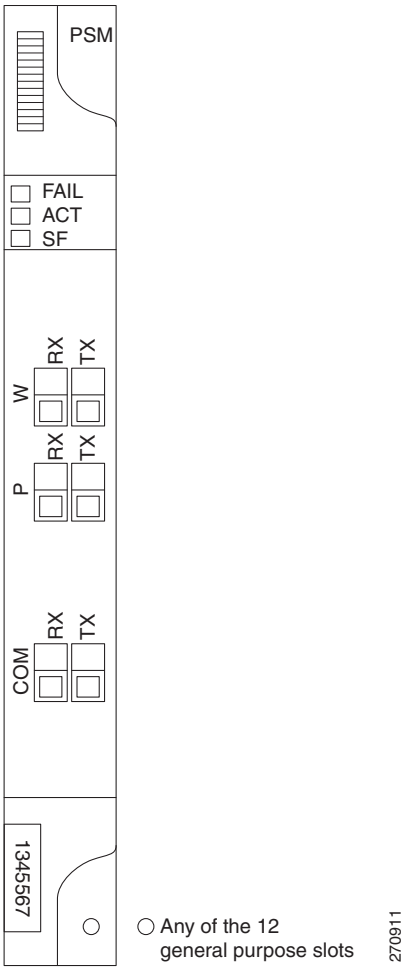
The PSM card has six optical ports located on the faceplate:

- COM-RX (receive) is the input signal port.
- COM-TX (transmit) is the output signal port.
- W-RX is the working input signal port (receive section).
- W-TX is the working output signal port (transmit section).
- P-RX is the protect input signal port (receive section).
- P-TX is the protect output signal port (transmit section).

All ports are equipped with photodiodes to monitor optical power and other related thresholds. The COM-RX port is equipped with a virtual photodiode (firmware calculations of port optical power) to monitor optical power. The W-RX, P-RX, W-TX, and P-TX ports have optical power regulation, which are provided by variable optical attenuators (VOA). All VOAs equipped within the PSM card work in control attenuation mode.

Figure 7-2 shows the PSM card faceplate.

Figure 7-2 PSM Card Faceplate



7.5 PSM Card-Level Indicators

Table 7-1 shows the three card-level indicators on the PSM card.

Table 7-1 PSM Card-Level Indicators

Card-Level Indicators	Description
Red FAIL LED	The red FAIL LED indicates that the card's processor is not ready or that an internal hardware failure occurred. Replace the card if the red FAIL LED persists.

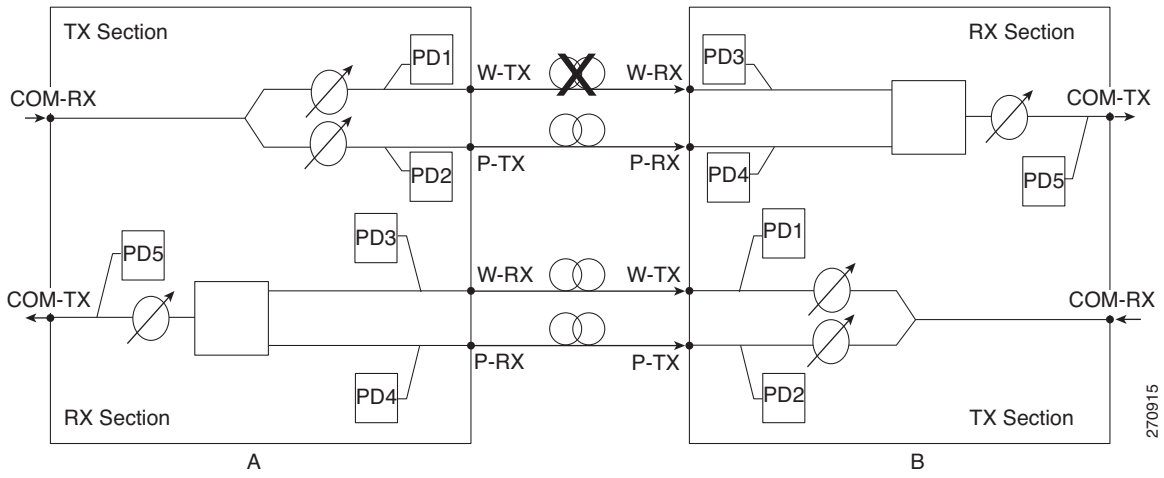
Table 7-1 PSM Card-Level Indicators (continued)

Card-Level Indicators	Description
Green ACT LED	The green ACT LED indicates that the PSM is carrying traffic or is traffic-ready.
Amber SF LED	The amber SF LED indicates a signal failure or condition such as LOS on one or more of the card's ports. The amber SF LED also turns on when the transmit and receive fibers are incorrectly connected. When the fibers are properly connected, the light turns off.

7.6 PSM Bidirectional Switching

A VOA is equipped after the hardware splitter within the PSM card. The VOA implements bidirectional switching when there is a single fiber cut in a protection configuration involving two peer PSM cards. Figure 7-3 shows a sample configuration that explains the bidirectional switching capability of the PSM card.

Figure 7-3 PSM Bidirectional Switching



In this example, there is a fiber cut in the working path from Station A to Station B as shown in Figure 7-3. As a result of the fiber cut, an LOS alarm is raised on the W-RX port of Station B and it immediately switches traffic on to its P-RX port. Station B simultaneously also stops transmission (for approximately 25 milliseconds) on its W-TX port, which raises an LOS alarm on the W-RX port of Station A. This causes Station A to also switch traffic to its P-RX port. In this way, PSM implements bidirectional switching without any data exchange between the two stations.

Since the two stations do not communicate using signaling protocols (overhead bytes), a Manual or Force protection switch on the PSM card is implemented by creating a traffic hit. For example, consider that you perform a Manual or Force protection switch on Station A. The TX VOA on the active path is set to automatic VOA shutdown (AVS) state for 25 milliseconds. This causes Station B to switch traffic to the other path because it cannot differentiate between a maintenance operation and a real fail. After 25 milliseconds, the VOA in Station A is automatically reset. However, Station B will not revert back by itself because of nonrevertive switching protection scheme used in the PSM card.

To effectively implement switching, the Lockout and Force commands must be performed on both the stations. If these commands are not performed on both the stations, the far-end and near-end PSMs can be misaligned. In case of misalignment, when a path recovers, traffic might not recover automatically. You might have to perform a Force protection switch to recover traffic.

Note The order in which you repair the paths is important in the event of a double failure (both the working and protect paths are down due to a fiber cut) on the PSM card in line protection configuration when the active path is the working path. If you repair the working path first, traffic is automatically restored. However, if you repair the protect path first, traffic is not automatically restored. You must perform a Force protection switch to restore traffic on the protect path.

CHAPTER 8

Optical Add/Drop Cards

This chapter describes optical add/drop cards used in Cisco ONS 15454 dense wavelength division multiplexing (DWDM) networks. For installation and card turn-up procedures, refer to the *Cisco ONS 15454 DWDM Procedure Guide*. For card safety and compliance information, refer to the *Cisco Optical Transport Products Safety and Compliance Information* document.

Note The cards described in this chapter are supported on the Cisco ONS 15454, Cisco ONS 15454 M6, Cisco ONS 15454 M2 platforms, unless noted otherwise.

Note Unless otherwise specified, “ONS 15454” refers to both ANSI and ETSI shelf assemblies.

Chapter topics include:

- 8.1 Card Overview, page 8-1
- 8.2 Class 1M Laser Product Safety Lasers, page 8-8
- 8.3 AD-1C-xx.x Card, page 8-11
- 8.4 AD-2C-xx.x Card, page 8-14
- 8.5 AD-4C-xx.x Card, page 8-18
- 8.6 AD-1B-xx.x Card, page 8-22
- 8.7 AD-4B-xx.x Card, page 8-25

8.1 Card Overview

The card overview section contains card overview, software compatibility, interface class, and channel allocation information for optical add/drop cards.

Note Each card is marked with a symbol that corresponds to a slot (or slots) on the ONS 15454 shelf assembly. The cards are then installed into slots displaying the same symbols. For a list of slots and symbols, see the "Card Slot Requirements" section in the *Cisco ONS 15454 Hardware Installation Guide*.

Optical add/drop cards are divided into two groups: band optical add/drop multiplexer (OADM) cards and channel OADM cards. Band OADM cards add and drop one or four bands of adjacent channels. The cards in this chapter, including the 4-Band OADM (AD-4B-xx.x) and the 1-Band OADM (AD-1B-xx.x)

are utilized only in the C band. Channel OADM cards add and drop one, two, or four adjacent channels; they include the 4-Channel OADM (AD-4C-xx.x), the 2-Channel OADM (AD-2C-xx.x), and the 1-Channel OADM (AD-1C-xx.x).

Note For information about L band add and drop capability, see Chapter 9, "Reconfigurable Optical Add/Drop Cards."

8.1.1 Card Summary

Table 8-1 lists and summarizes the functions of the optical add/drop cards.

Table 8-1 Optical Add/Drop Cards

Card	Port Description	For Additional Information
AD-1C-xx.x	The AD-1C-xx.x card has three sets of ports located on the faceplate. It operates in Slots 1 to 6 and 12 to 17.	See the "8.3 AD-1C-xx.x Card" section on page 8-11.
AD-2C-xx.x	The AD-2C-xx.x card has four sets of ports located on the faceplate. It operates in Slots 1 to 6 and 12 to 17.	See the "8.4 AD-2C-xx.x Card" section on page 8-14.
AD-4C-xx.x	The AD-4C-xx.x card has six sets of ports located on the faceplate. It operates in Slots 1 to 6 and 12 to 17.	See the "8.5 AD-4C-xx.x Card" section on page 8-18.
AD-1B-xx.x	The AD-1B-xx.x card has three sets of ports located on the faceplate. It operates in Slots 1 to 6 and 12 to 17.	See the "8.6 AD-1B-xx.x Card" section on page 8-22.
AD-4B-xx.x	The AD-4B-xx.x card has six sets of ports located on the faceplate. It operates in Slots 1 to 6 and 12 to 17.	See the "8.7 AD-4B-xx.x Card" section on page 8-25.

8.1.2 Card Compatibility

Table 8-2 lists the CTC software compatibility for each optical add/drop card.

Table 8-2 Software Release Compatibility for Optical Add/Drop Cards

Card Name	R4.5	R4.6	R4.7	R5.0	R6.0	R7.0	R7.2	R8.0	R8.5	R9.0	R9.1	R9.2
AD-1C-xx.x	15454-DWDM	15454-DWDM	15454-DWDM	15454-DWDM	15454-DWDM	15454-DWDM	15454-DWDM	15454-DWDM	15454-DWDM	15454-DWDM	15454-DWDM	15454-DWDM, 15454-M2, 15454-M6
AD-2C-xx.x	15454-DWDM	15454-DWDM	15454-DWDM	15454-DWDM	15454-DWDM	15454-DWDM	15454-DWDM	15454-DWDM	15454-DWDM	15454-DWDM	15454-DWDM	15454-DWDM, 15454-M2, 15454-M6
AD-4C-xx.x	15454-DWDM	15454-DWDM	15454-DWDM	15454-DWDM	15454-DWDM	15454-DWDM	15454-DWDM	15454-DWDM	15454-DWDM	15454-DWDM	15454-DWDM	15454-DWDM, 15454-M2, 15454-M6
AD-1B-xx.x	15454-DWDM	15454-DWDM	15454-DWDM	15454-DWDM	15454-DWDM	15454-DWDM	15454-DWDM	15454-DWDM	15454-DWDM	15454-DWDM	15454-DWDM	15454-DWDM
AD-4B-xx.x	15454-DWDM	15454-DWDM	15454-DWDM	15454-DWDM	15454-DWDM	15454-DWDM	15454-DWDM	15454-DWDM	15454-DWDM	15454-DWDM	15454-DWDM	15454-DWDM

8.1.3 Interface Classes

The AD-1C-xx.x, AD-2C-xx.x, AD-4C-xx.x, AD-1B-xx.x, and AD-4B-xx.x cards have different input and output optical channel signals depending on the interface card where the input signal originates from. The input interface cards have been grouped in classes listed in Table 8-3. The subsequent tables list the optical performances and output power of each interface class.

Table 8-3 ONS 15454 Card Interfaces Assigned to Input Power Classes

Input Power Class	Card
A	10-Gbps multirate transponder cards (TXP_MR_10G, TXP_MR_10E, TXP_MR_10E_C, and TXP_MR_10E_L) with forward error correction (FEC) enabled, 10-Gbps muxponder cards (MXP_2.5G_10G, MXP_2.5G_10E, MXP_MR_10DME_C, MXP_MR_10DME_L, MXP_2.5G_10E_C, and MXP_2.5G_10E_L) with FEC enabled, and 40-Gbps muxponder card (40G-MXP-C)
B	10-Gbps multirate transponder card (TXP_MR_10G) without FEC and the 10-Gbps muxponder card (MXP_2.5G_10G, MXP_MR_10DME_C, MXP_MR_10DME_L), and 40-Gbps muxponder card (40G-MXP-C), and ADM-10G cards with FEC disabled
C	OC-192 LR ITU cards (TXP_MR_10E, TXP_MR_10E_C, and TXP_MR_10E_L) without FEC
D	2.5-Gbps multirate transponder card (TXP_MR_2.5G), both protected and unprotected, with FEC enabled
E	OC-48 100-GHz DWDM muxponder card (MXP_MR_2.5G) and 2.5-Gbps multirate transponder card (TXP_MR_2.5G), both protected and unprotected, with FEC disabled and retime, reshape, and regenerate (3R) mode enabled
F	2.5-Gbps multirate transponder card (TXP_MR_2.5G), both protected and unprotected, in regenerate and reshape (2R) mode
G	OC-48 ELR 100 GHz card
H	2/4 port GbE transponder (GBIC WDM 100GHz)
I	TXP_MR_10E, TXP_MR_10E_C, and TXP_MR_10E_L cards with enhanced FEC (E-FEC) and the MXP_2.5G_10E, MXP_2.5G_10E_C, MXP_2.5G_10E_L, MXP_MR_10DME_C, MXP_MR_10DME_L, and 40G-MXP-C cards with E-FEC enabled

Table 8-4 lists the optical performance parameters for 40-Gbps cards that provide signal input to the optical add/drop cards.

Table 8-4 40-Gbps Interface Optical Performance

Parameter	Class A		Class B		Class I	
Type	Power Limited	OSNR[1] Limited (if appl.)	Power Limited	OSNR Limited (if appl.)	Power Limited	OSNR Limited (if appl.)
Maximum bit rate	40 Gbps		40 Gbps		40 Gbps	
Regeneration	3R		3R		3R	
FEC	Yes		No		Yes (E-FEC)	
Threshold	Optimum		Average		Optimum	
Maximum BER[2]	10^{-15}		10^{-12}		10^{-15}	
OSNR[1] sensitivity	23 dB	9 dB	23 dB	19 dB	20 dB	8 dB
Power sensitivity	–24 dBm	–18 dBm	–21 dBm	–20 dBm	–26 dBm	–18 dBm

Table 8-4 40-Gbps Interface Optical Performance (continued)

Parameter	Class A		Class B		Class I	
Type	Power Limited	OSNR[1] Limited (if appl.)	Power Limited	OSNR Limited (if appl.)	Power Limited	OSNR Limited (if appl.)
Power overload	–8 dBm		–8 dBm		–8 dBm	
Transmitted Power Range[3]						
OC-192 LR ITU	—		—		—	
Dispersion compensation tolerance	+/–800 ps/nm		+/–1,000 ps/nm		+/–800 ps/nm	

1. OSNR = optical signal-to-noise ratio
2. BER = bit error rate
3. These values, decreased by patchcord and connector losses, are also the input power values for the OADM cards.

Table 8-5 lists the optical performance parameters for 40-Gbps cards that provide signal input to the optical add/drop cards.

Table 8-5 10-Gbps Interface Optical Performance

Parameter	Class A		Class B		Class C	Class I	
Type	Power Limited	OSNR[1] Limited (if appl.)	Power Limited	OSNR Limited (if appl.)	OSNR Limited	Power Limited	OSNR Limited (if appl.)
Maximum bit rate	10 Gbps		10 Gbps		10 Gbps	10 Gbps	
Regeneration	3R		3R		3R	3R	
FEC	Yes		No		No	Yes (E-FEC)	
Threshold	Optimum		Average		Average	Optimum	
Maximum BER[2]	10^{-15}		10^{-12}		10^{-12}	10^{-15}	
OSNR[1] sensitivity	23 dB	9 dB	23 dB	19 dB	19 dB	20 dB	8 dB
Power sensitivity	–24 dBm	–18 dBm	–21 dBm	–20 dBm	–22 dBm	–26 dBm	–18 dBm
Power overload	–8 dBm		–8 dBm		–9 dBm	–8 dBm	
Transmitted Power Range[3]							
10-Gbps multirate transponder/10-Gbps FEC transponder (TXP_MR_10G)	+2.5 to 3.5 dBm		+2.5 to 3.5 dBm		—	—	
OC-192 LR ITU	—		—		+3.0 to 6.0 dBm	—	

Table 8-5 10-Gbps Interface Optical Performance (continued)

Parameter	Class A		Class B		Class C	Class I	
Type	Power Limited	OSNR[1] Limited (if appl.)	Power Limited	OSNR Limited (if appl.)	OSNR Limited	Power Limited	OSNR Limited (if appl.)
10-Gbps multirate transponder/10-Gbps FEC transponder (TXP_MR_10E)	+3.0 to 6.0 dBm		+3.0 to 6.0 dBm		—	+3.0 to 6.0 dBm	
Dispersion compensation tolerance	+/–800 ps/nm		+/–1,000 ps/nm		+/–1,000 ps/nm	+/–800 ps/nm	

1. OSNR = optical signal-to-noise ratio
2. BER = bit error rate
3. These values, decreased by patchcord and connector losses, are also the input power values for the OADM cards.

2.5-Gbps cards that provide signal input to the optical add/drop cards have the interface performance parameters listed in Table 8-6.

Table 8-6 2.5-Gbps Interface Optical Performance

Parameter	Class D		Class E		Class F	Class G		Class H		Class J
Type	Power Limited	OSNR Limited (if appl.)	Power Limited	OSNR Limited (if appl.)	OSNR Limited	Power Limited	OSNR Limited (if appl.)	Power Limited	OSNR Limited (if appl.)	Power Limited
Maximum bit rate	2.5 Gbps		2.5 Gbps		2.5 Gbps	2.5 Gbps		1.25 Gbps		2.5 Gbps
Regeneration	3R		3R		2R	3R		3R		3R
FEC	Yes		No		No	No		No		No
Threshold	Average		Average		Average	Average		Average		Average
Maximum BER	10^{-15}		10^{-12}		10^{-12}	10^{-12}		10^{-12}		10^{-12}
OSNR sensitivity	14 dB	6 dB	14 dB	10 dB	15 dB	14 dB	11 dB	13 dB	8 dB	12 dB
Power sensitivity	–31 dBm	–25 dBm	–30 dBm	–23 dBm	–24 dBm	–27 dBm	–33 dBm	–28 dBm	–18 dBm	–26 dBm
Power overload	–9 dBm		–9 dBm		–9 dBm	–9 dBm		–7 dBm		–17dBm
Transmitted Power Range[1]										
TXP_MR_2.5G	–1.0 to 1.0 dBm		–1.0 to 1.0 dBm		–1.0 to 1.0 dBm	–2.0 to 0 dBm		—		—
TXPP_MR_2.5G	–4.5 to –2.5 dBm		–4.5 to –2.5 dBm		–4.5 to –2.5 dBm					
MXP_MR_2.5G	—		+2.0 to +4.0 dBm		—					
MXPP_MR_2.5G	—		–1.5 to +0.5 dBm		—					

Table 8-6 2.5-Gbps Interface Optical Performance (continued)

Parameter	Class D		Class E		Class F	Class G		Class H		Class J
Type	Power Limited	OSNR Limited (if appl.)	Power Limited	OSNR Limited (if appl.)	OSNR Limited	Power Limited	OSNR Limited (if appl.)	Power Limited	OSNR Limited (if appl.)	Power Limited
2/4 port GbE Transponder (GBIC WDM 100GHz)	—		—		—	—		+2.5 to 3.5 dBm		—
Dispersion compensation tolerance	–1200 to +5400 ps/nm		–1200 to +5400 ps/nm		–1200 to +3300 ps/nm	–1200 to +3300 ps/nm		–1000 to +3600 ps/nm		–1000 to +3200 ps/nm

1. These values, decreased by patchcord and connector losses, are also the input power values for the OADM cards.

8.1.4 DWDM Card Channel Allocation Plan

ONS 15454 DWDM channel OADM and band OADM cards are designed for use with specific channels in the C band. In most cases, the channels for these cards are either numbered (for example, 1 to 32) or delimited (odd or even). Client interfaces must comply with these channel assignments to be compatible with the ONS 15454 system.

Table 8-7 lists the channel IDs and wavelengths assigned to the C-band DWDM channels.

Note In some cases, a card uses only some or all of the channels listed in a band. Also, some cards use channels on the 100-GHz ITU-T grid while others use channels on the 50-GHz ITU-T grid. See specific card descriptions in Appendix A, "Hardware Specifications," for more details.

Table 8-7 DWDM Channel Allocation Plan (C Band)

Channel Number	Frequency (THz)	Wavelength (nm)	Channel Number	Frequency (THz)	Wavelength (nm)
1	196.00	1529.55	42	193.95	1545.72
2	195.95	1529.94	43	193.90	1546.119
3	195.90	1530.334	44	193.85	1546.518
4	195.85	1530.725	45	193.80	1546.917
5	195.80	1531.116	46	193.75	1547.316
6	195.75	1531.507	47	193.70	1547.715
7	195.70	1531.898	48	193.65	1548.115
8	195.65	1532.290	49	193.60	1548.515
9	195.60	1532.681	50	193.55	1548.915
10	195.55	1533.073	51	193.50	1549.32
11	195.50	1533.47	52	193.45	1549.71
12	195.45	1533.86	53	193.40	1550.116

Table 8-7 DWDM Channel Allocation Plan (C Band) (continued)

Channel Number	Frequency (THz)	Wavelength (nm)	Channel Number	Frequency (THz)	Wavelength (nm)
13	195.40	1534.250	54	193.35	1550.517
14	195.35	1534.643	55	193.30	1550.918
15	195.30	1535.036	56	193.25	1551.319
16	195.25	1535.429	57	193.20	1551.721
17	195.20	1535.822	58	193.15	1552.122
18	195.15	1536.216	59	193.10	1552.524
19	195.10	1536.609	60	193.05	1552.926
20	195.05	1537.003	61	193.00	1553.33
21	195.00	1537.40	62	192.95	1553.73
22	194.95	1537.79	63	192.90	1554.134
23	194.90	1538.186	64	192.85	1554.537
24	194.85	1538.581	65	192.80	1554.940
25	194.80	1538.976	66	192.75	1555.343
26	194.75	1539.371	67	192.70	1555.747
27	194.70	1539.766	68	192.65	1556.151
28	194.65	1540.162	69	192.60	1556.555
29	194.60	1540.557	70	192.55	1556.959
30	194.55	1540.953	71	192.50	1557.36
31	194.50	1541.35	72	192.45	1557.77
32	194.45	1541.75	73	192.40	1558.173
33	194.40	1542.142	74	192.35	1558.578
34	194.35	1542.539	75	192.30	1558.983
35	194.30	1542.936	76	192.25	1559.389
36	194.25	1543.333	77	192.20	1559.794
37	194.20	1543.730	78	192.15	1560.200
38	194.15	1544.128	79	192.10	1560.606
39	194.10	1544.526	80	192.05	1561.013
40	194.05	1544.924	81	192.00	1561.42
41	194.00	1545.32	82	191.95	1561.83

8.2 Class 1M Laser Product Safety Lasers

This section lists the safety labels attached to the AD-1C-xx.x, AD-2C-xx.x, AD-4c-xx.x, AD-1B-xx.x, and AD-4B-xx.xx cards.

8.2.1 Class 1M Laser Product Statement

The Class 1M Laser Product statement is shown in Figure 8-1.

Figure 8-1 Class 1M Laser Product Statement

Class 1M lasers are products that produce either a highly divergent beam or a large diameter beam. Therefore, only a small part of the whole laser beam can enter the eye. However, these laser products can be harmful to the eye if the beam is viewed using magnifying optical instruments.

8.2.2 Hazard Level 1M Label

The Hazard Level 1M label is shown in Figure 8-2.

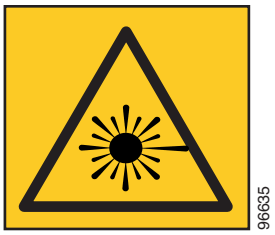
Figure 8-2 Hazard Level Label

The Hazard Level label warns users against exposure to laser radiation of Class 1 limits calculated in accordance with IEC60825-1 Ed.1.2. This label is displayed on the faceplate of the cards.

8.2.3 Laser Source Connector Label

The Laser Source Connector label is shown in Figure 8-3.

Figure 8-3 Laser Source Connector Label



This label indicates that a laser source is present at the optical connector where the label has been placed.

8.2.4 FDA Statement Label

The FDA Statement labels are shown in Figure 8-4 and Figure 8-5. These labels show compliance to FDA standards and that the hazard level classification is in accordance with IEC60825-1 Am.2 or Ed.1.2.

Figure 8-4 FDA Statement Label

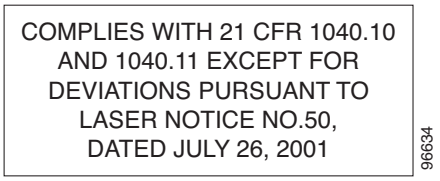
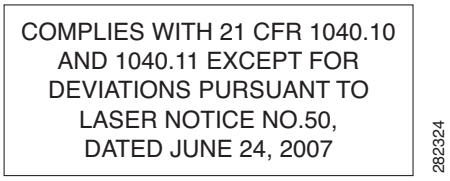


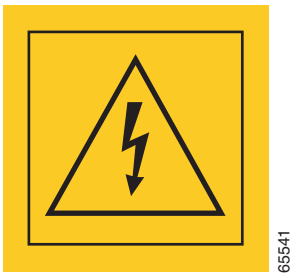
Figure 8-5 FDA Statement Label



8.2.5 Shock Hazard Label

The Shock Hazard label is shown in Figure 8-6.

Figure 8-6 Shock Hazard Label



This label alerts personnel to electrical hazard within the card. The potential of shock hazard exists when removing adjacent cards during maintenance, and touching exposed electrical circuitry on the card itself.

8.3 AD-1C-xx.x Card

Note See the "A.9.1 AD-1C-xx.x Card Specifications" section on page A-44 for hardware specifications.

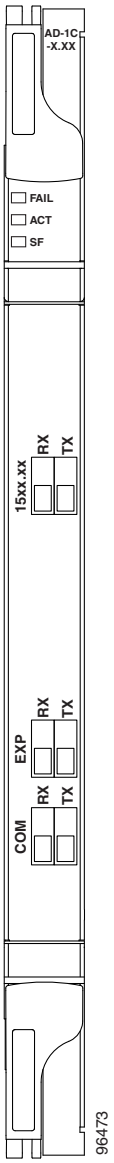
The 1-Channel OADM (AD-1C-xx.x) card passively adds or drops one of the 32 channels utilized within the 100-GHz-spacing of the DWDM card system. Thirty-two versions of this card—each designed only for use with one wavelength—are used in the ONS 15454 DWDM system. Each wavelength version of the card has a different part number. The AD-1C-xx.x can be installed in Slots 1 to 6 and 12 to 17.

The AD-1C-xx.x has the following internal features:

- Two cascaded passive optical interferential filters perform the channel add and drop functions.
- One software-controlled variable optical attenuator (VOA) regulates the optical power of the inserted channel.
- Software-controlled VOA regulates the insertion loss of the express optical path.
- VOA settings and functions, photodiode detection, and alarm thresholds, are internally controlled.
- Virtual photodiodes (firmware calculations of port optical power) at the common DWDM output and input ports are monitored within the software.

Figure 8-7 shows the AD-1C-xx.x faceplate.

Figure 8-7 AD-1C-xx.x Faceplate



For information on safety labels for the card, see the "8.2 Class 1M Laser Product Safety Lasers" section on page 8-8.

Figure 8-8 shows a block diagram of the AD-1C-xx.x card.

Figure 8-8 AD-1C-xx.x Block Diagram

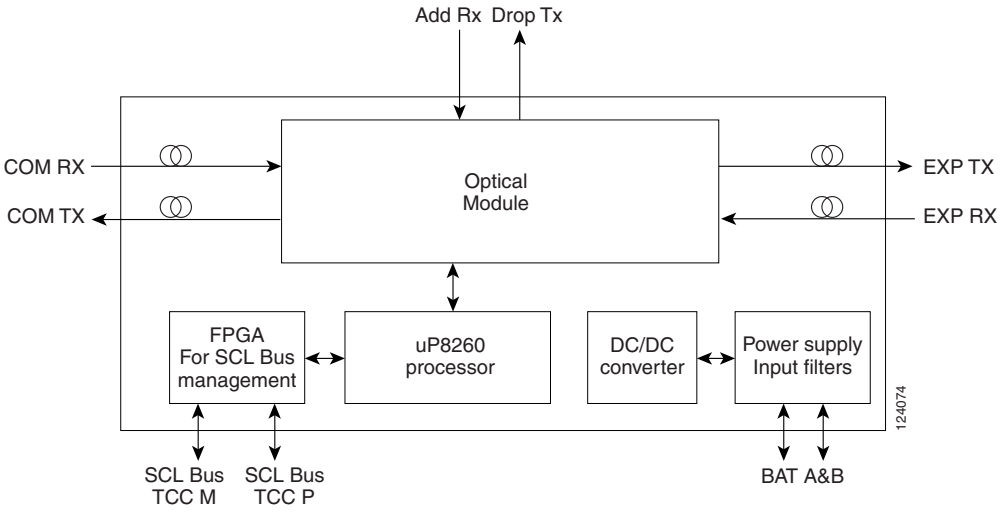
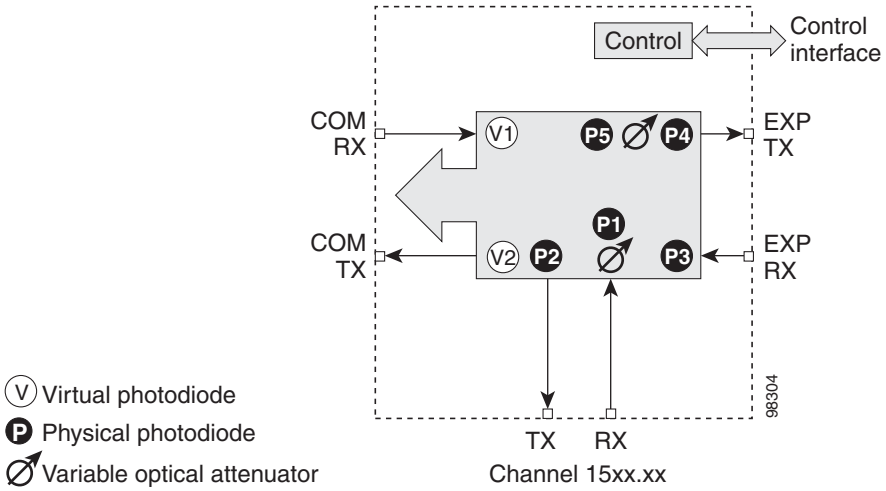


Figure 8-9 shows the AD-1C-xx.x optical module functional block diagram.

Figure 8-9 AD-1C-xx.x Optical Module Functional Block Diagram



8.3.1 Power Monitoring

Physical photodiodes P1 through P4 and virtual photodiodes V1 and V2 monitor the power for the AD-1C-xx.x card. The returned power level values are calibrated to the ports as shown in Table 8-8.

Table 8-8 AD-1C-xx.x Port Calibration

Photodiode	CTC Type Name	Calibrated to Port
P1	ADD	DROP RX
P2	DROP	DROP TX

Table 8-8 AD-1C-xx.x Port Calibration (continued)

Photodiode	CTC Type Name	Calibrated to Port
P3	IN EXP	EXP RX
P4	OUT EXP	EXP TX
V1	IN COM	COM RX
V2	OUT COM	COM TX

For information on the associated TL1 AIDs for the optical power monitoring points, refer the "CTC Port Numbers and TL1 Aids" section in *Cisco ONS SONET TL1 Command Guide, Release 9.2*.

8.3.2 AD-1C-xx.x Card-Level Indicators

The AD-1C-xx.x card has three card-level LED indicators, described in Table 8-9.

Table 8-9 AD-1C-xx.x Card-Level Indicators

Card-Level Indicators	Description
Red FAIL LED	The red FAIL LED indicates that the card's processor is not ready or that there is an internal hardware failure. Replace the card if the red FAIL LED persists.
Green ACT LED	The green ACT LED indicates that the AD-1C-xx.x card is carrying traffic or is traffic-ready.
Amber SF LED	The amber SF LED indicates a signal failure. The SF LED also illuminates when the transmitting and receiving fibers are incorrectly connected. When the fibers are properly connected, the LED turns off.

8.3.3 AD-1C-xx.x Port-Level Indicators

You can find the status of the card port using the LCD screen on the ONS 15454 fan-tray assembly. Use the LCD to view the status of any port or card slot; the screen displays the number and severity of alarms for a given port or slot. The AD-1C-xx.x has six LC-PC-II optical ports: two for add/drop channel client input and output, two for express channel input and output, and two for communication.

8.4 AD-2C-xx.x Card

Note See the "A.9.2 AD-2C-xx.x Card Specifications" section on page A-44 for hardware specifications.

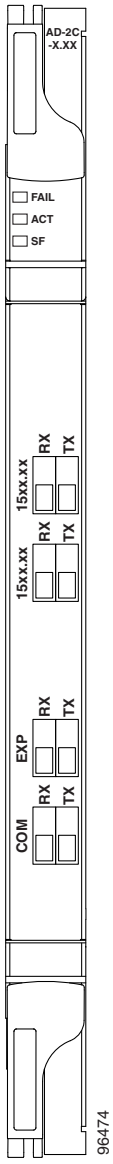
The 2-Channel OADM (AD-2C-xx.x) card passively adds or drops two adjacent 100-GHz channels within the same band. Sixteen versions of this card—each designed for use with one pair of wavelengths—are used in the ONS 15454 DWDM system. The card bidirectionally adds and drops in two different sections on the same card to manage signal flow in both directions. Each version of the card has a different part number.

The AD-2C-xx.x has the following features:

- Passive cascade of interferential filters perform the channel add and drop functions.
- Two software-controlled VOAs in the add section, one for each add port, regulate the optical power of inserted channels.
- Software-controlled VOAs regulate insertion loss on express channels.
- VOA settings and functions, photodiode detection, and alarm thresholds are internally controlled.
- Virtual photodiodes (firmware calculation of port optical power) at the common DWDM output and input ports are monitored within the software.

Figure 8-10 shows the AD-2C-xx.x faceplate.

Figure 8-10 AD-2C-xx.x Faceplate



For information on safety labels for the card, see the "8.2 Class 1M Laser Product Safety Lasers" section on page 8-8.

Figure 8-11 shows a block diagram of the AD-2C-xx.x card.

Figure 8-11 AD-2C-xx.x Block Diagram

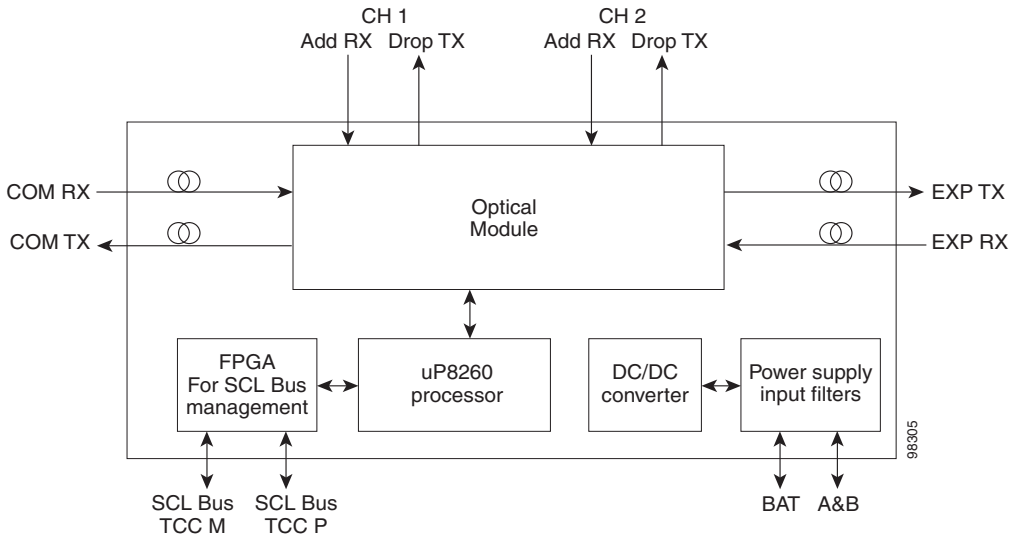
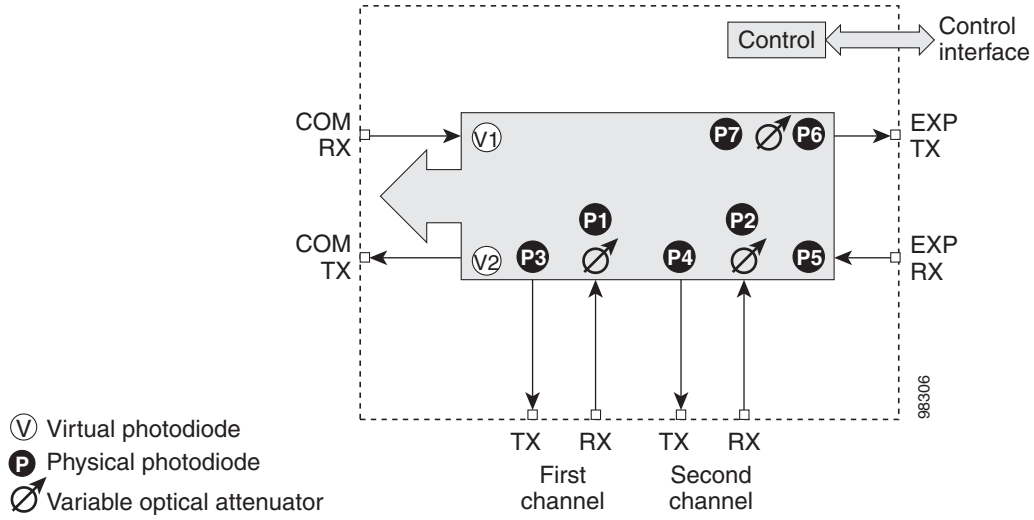


Figure 8-12 shows the AD-2C-xx.x optical module functional block diagram.

Figure 8-12 AD-2C-xx.x Optical Module Functional Block Diagram



8.4.1 Wavelength Pairs

The AD-2C-xx.x cards are provisioned for the wavelength pairs listed in Table 8-10. In this table, channel IDs are given rather than wavelengths. To compare channel IDs with the actual wavelengths they represent, see wavelengths in Table 8-7 on page 8-7.

Table 8-10 AD-2C-xx.x Channel Pairs

Band ID	Add/Drop Channel ID
Band 30.3 (A)	30.3, 31.2
	31.9, 32.6
Band 34.2 (B)	34.2, 35.0
	35.8, 36.6
Band 38.1 (C)	38.1, 38.9
	39.7, 40.5
Band 42.1 (D)	42.1, 42.9
	43.7, 44.5
Band 46.1 (E)	46.1, 46.9
	47.7, 48.5
Band 50.1 (F)	50.1, 50.9
	51.7, 52.5
Band 54.1 (G)	54.1, 54.9
	55.7, 56.5
Band 58.1 (H)	58.1, 58.9
	59.7, 60.6

8.4.2 Power Monitoring

Physical photodiodes P1 through P10 and virtual photodiodes V1 and V2 monitor the power for the AD-2C-xx.x card. The returned power level values are calibrated to the ports as shown in Table 8-11.

Table 8-11 AD-2C-xx.x Port Calibration

Photodiode	CTC Type Name	Calibrated to Port
P1–P2	ADD	COM TX
P3–P4	DROP	DROP TX
P5	IN EXP	EXP RX
P6	OUT EXP	EXP TX
V1	IN COM	COM RX
V2	OUT COM	COM TX

For information on the associated TL1 AIDs for the optical power monitoring points, refer the "CTC Port Numbers and TL1 Aids" section in *Cisco ONS SONET TL1 Command Guide, Release 9.2*.

8.4.3 AD-2C-xx.x Card-Level Indicators

The AD-2C-xx.x card has three card-level LED indicators, described in Table 8-12.

Table 8-12 AD-2C-xx.x Card-Level Indicators

Card-Level Indicators	Description
Red FAIL LED	The red FAIL LED indicates that the card's processor is not ready or that there is an internal hardware failure. Replace the card if the red FAIL LED persists.
Green ACT LED	The green ACT LED indicates that the AD-2C-xx.x card is carrying traffic or is traffic-ready.
Amber SF LED	The amber SF LED indicates a signal failure. The amber SF LED also illuminates when the transmit and receive fibers are incorrectly connected. When the fibers are properly connected, the light turns off.

8.4.4 AD-2C-xx.x Port-Level Indicators

You can find the status of the card port using the LCD screen on the ONS 15454 fan-tray assembly. Use the LCD to view the status of any port or card slot; the screen displays the number and severity of alarms for a given port or slot. The AD-2C-xx.x card has eight LC-PC-II optical ports: four for add/drop channel client input and output, two for express channel input and output, and two for communication.

8.5 AD-4C-xx.x Card

Note See the "A.9.3 AD-4C-xx.x Card Specifications" section on page A-45 for hardware specifications.

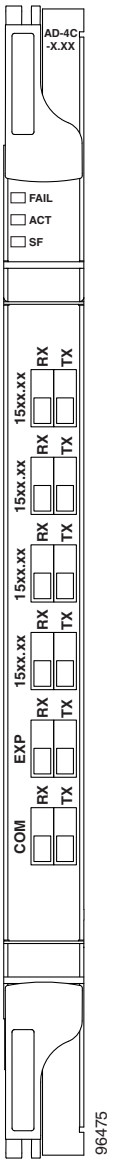
The 4-Channel OADM (AD-4C-xx.x) card passively adds or drops all four 100-GHz-spaced channels within the same band. Eight versions of this card—each designed for use with one band of wavelengths—are used in the ONS 15454 DWDM system. The card bidirectionally adds and drops in two different sections on the same card to manage signal flow in both directions. There are eight versions of this card with eight part numbers.

The AD-4C-xx.x has the following features:

- Passive cascade of interferential filters perform the channel add and drop functions.
- Four software-controlled VOAs in the add section, one for each add port, regulate the optical power of inserted channels.
- Two software-controlled VOAs regulate insertion loss on express and drop path, respectively.
- Internal control of the VOA settings and functions, photodiode detection, and alarm thresholds.
- Software-monitored virtual photodiodes (firmware calculation of port optical power) at the common DWDM output and input ports.

Figure 8-13 shows the AD-4C-xx.x faceplate.

Figure 8-13 AD-4C-xx.x Faceplate



For information on safety labels for the card, see the "8.2 Class 1M Laser Product Safety Lasers" section on page 8-8.

Figure 8-14 shows a block diagram of the AD-4C-xx.x card.

Figure 8-14 AD-4C-xx.x Block Diagram

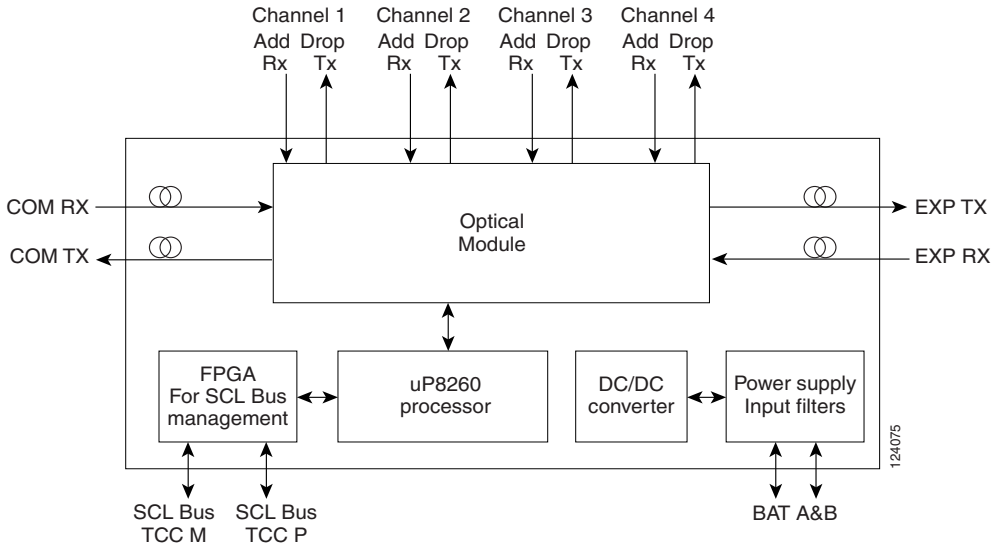
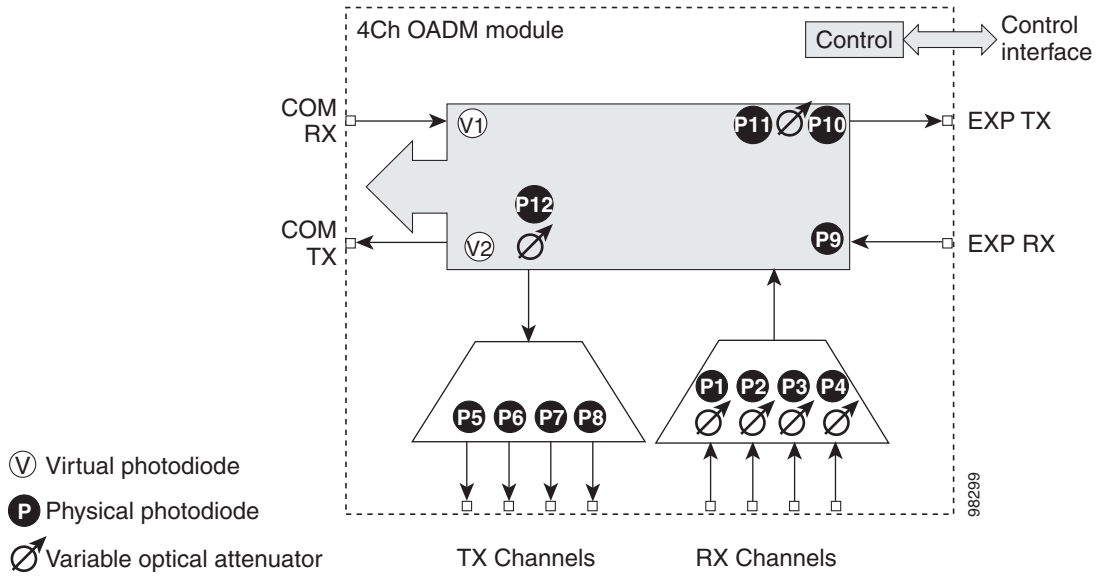


Figure 8-15 shows the AD-4C-xx.x optical module functional block diagram.

Figure 8-15 AD-4C-xx.x Optical Module Functional Block Diagram



8.5.1 Wavelength Sets

The AD-4C-xx.x cards are provisioned for the sets of four 100-GHz-spaced wavelengths shown Table 8-13 on page 8-21.

Table 8-13 AD-4C-xx.x Channel Sets

Band ID	Add/Drop Wavelengths
Band 30.3 (A)	1530.3, 1531.2, 1531.9, 1532.6
Band 34.2 (B)	1534.2, 1535.0, 1535.8, 1536.6
Band 38.1 (C)	1538.1, 1538.9, 1539.7, 1540.5
Band 42.1 (D)	1542.1, 1542.9, 1543.7, 1544.5
Band 46.1 (E)	1546.1, 1546.9, 1547.7, 1548.5
Band 50.1 (F)	1550.1, 1550.9, 1551.7, 1552.5
Band 54.1 (G)	1554.1, 1554.9, 1555.7, 1556.5
Band 58.1 (H)	1558.1, 1558.9, 1559.7, 1560.6

8.5.2 Power Monitoring

Physical photodiodes P1 through P10 and virtual photodiodes V1 and V2 monitor the power for the AD-4C-xx.x card. The returned power level values are calibrated to the ports as shown in Table 8-14.

Table 8-14 AD-4C-xx.x Port Calibration

Photodiode	CTC Type Name	Calibrated to Port
P1–P4	ADD	COM TX
P5–P8	DROP	DROP TX
P9	IN EXP	EXP RX
P10	OUT EXP	EXP TX
V1	IN COM	COM RX
V2	OUT COM	COM TX

For information on the associated TL1 AIDs for the optical power monitoring points, refer the “CTC Port Numbers and TL1 Aids” section in *Cisco ONS SONET TL1 Command Guide, Release 9.2*.

8.5.3 AD-4C-xx.x Card-Level Indicators

The AD-4C-xx.x card has three card-level LED indicators, described in Table 8-15.

Table 8-15 AD-4C-xx.x Card-Level Indicators

Card-Level Indicators	Description
Red FAIL LED	The red FAIL LED indicates that the card’s processor is not ready or that there is an internal hardware failure. Replace the card if the red FAIL LED persists.

Table 8-15 AD-4C-xx.x Card-Level Indicators (continued)

Card-Level Indicators	Description
Green ACT LED	The green ACT LED indicates that the AD-4C-xx.x card is carrying traffic or is traffic-ready.
Amber SF LED	The amber SF LED indicates a signal failure or condition. The amber SF LED also illuminates when the transmit and receive fibers are incorrectly connected. When the fibers are properly connected, the light turns off.

8.5.4 AD-4C-xx.x Port-Level Indicators

You can find the status of the card port using the LCD screen on the ONS 15454 fan-tray assembly. Use the LCD to view the status of any port or card slot; the screen displays the number and severity of alarms for a given port or slot. The AD-4C-xx.x card has 12 LC-PC-II optical ports: eight for add/drop channel client input and output, two for express channel input and output, and two for communication.

8.6 AD-1B-xx.x Card

(Cisco ONS 15454 only)

Note See the "A.9.4 AD-1B-xx.x Card Specifications" section on page A-47 for hardware specifications.

The 1-Band OADM (AD-1B-xx.x) card passively adds or drops a single band of four adjacent 100-GHz-spaced channels. Eight versions of this card with eight different part numbers—each version designed for use with one band of wavelengths—are used in the ONS 15454 DWDM system. The card bidirectionally adds and drops in two different sections on the same card to manage signal flow in both directions. This card can be used when there is asymmetric adding and dropping on each side (east or west) of the node; a band can be added or dropped on one side but not on the other.

The AD-1B xx.x can be installed in Slots 1 to 6 and 12 to17 and has the following features:

- Passive cascaded interferential filters perform the channel add and drop functions.
- Two software-controlled VOAs regulate the optical power flowing in the express and drop OADM paths (drop section).
- Output power of the dropped band is set by changing the attenuation of the VOA drop.
- The VOA express is used to regulate the insertion loss of the express path.
- VOA settings and functions, photodiode detection, and alarm thresholds are internally controlled.
- Virtual photodiode (firmware calculation of port optical power) at the common DWDM output are monitored within the software.

Figure 8-16 shows the AD-1B-xx.x faceplate.

Figure 8-16 AD-1B-xx.x Faceplate

For information on safety labels for the card, see the "8.2 Class 1M Laser Product Safety Lasers" section on page 8-8.

Figure 8-17 shows a block diagram of the AD-1B-xx.x card.

Figure 8-17 AD-1B-xx.x Block Diagram

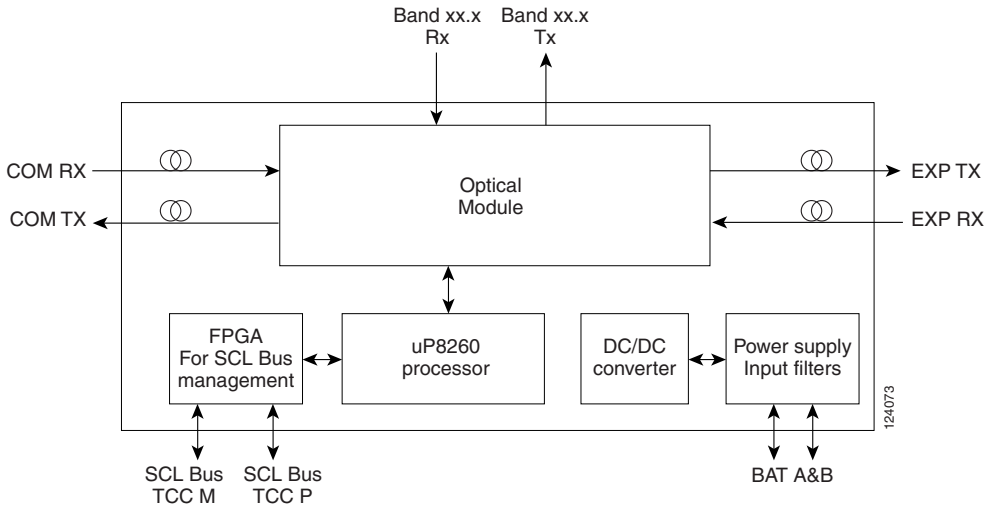
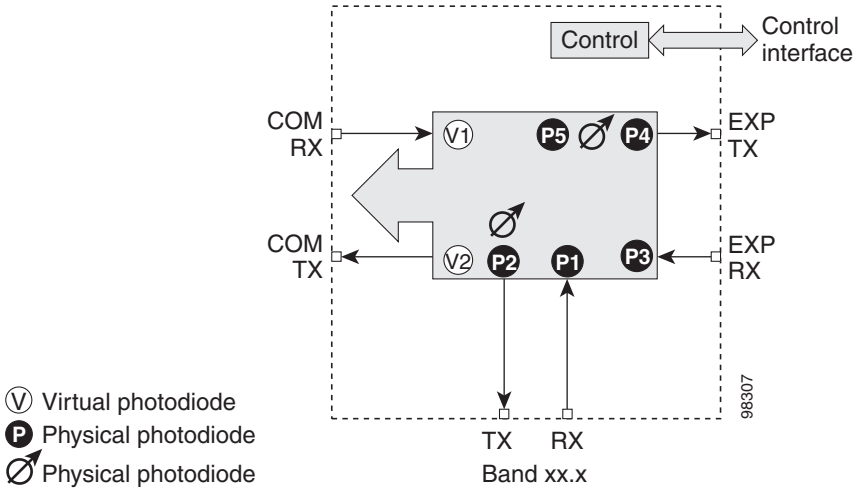


Figure 8-18 shows the AD-1B-xx.x optical module functional block diagram.

Figure 8-18 AD-1B-xx.x Optical Module Functional Block Diagram



8.6.1 Power Monitoring

Physical photodiodes P1 through P4 and virtual photodiodes V1 and V2 monitor the power for the AD-1B-xx.x card. The returned power level values are calibrated to the ports as shown in Table 8-16.

Table 8-16 AD-1B-xx.x Port Calibration

Photodiode	CTC Type Name	Calibrated to Port
P1	ADD	BAND RX
P2	DROP	BAND TX

Table 8-16 AD-1B-xx.x Port Calibration (continued)

Photodiode	CTC Type Name	Calibrated to Port
P3	IN EXP	EXP RX
P4	OUT EXP	EXP TX
V1	IN COM	COM RX
V2	OUT COM	COM TX

For information on the associated TL1 AIDs for the optical power monitoring points, refer the "CTC Port Numbers and TL1 Aids" section in *Cisco ONS SONET TL1 Command Guide, Release 9.2*.

8.6.2 AD-1B-xx.x Card-Level Indicators

The AD-1B-xx.x card has three card-level LED indicators, described in Table 8-17.

Table 8-17 AD-1B-xx.x Card-Level Indicators

Card-Level Indicators	Description
Red FAIL LED	The red FAIL LED indicates that the card's processor is not ready or that there is an internal hardware failure. Replace the card if the red FAIL LED persists.
Green ACT LED	The green ACT LED indicates that the AD-1B-xx.x card is carrying traffic or is traffic-ready.
Amber SF LED	The amber SF LED indicates a signal failure. The amber SF LED also illuminates when the transmit and receive fibers are incorrectly connected. When the fibers are properly connected, the light turns off.

8.6.3 AD-1B-xx.x Port-Level Indicators

You can find the status of the card port using the LCD screen on the ONS 15454 fan-tray assembly. Use the LCD to view the status of any port or card slot; the screen displays the number and severity of alarms for a given port or slot. The AD-1B-xx.x has six LC-PC-II optical ports: two for add/drop channel client input and output, two for express channel input and output, and two for communication.

8.7 AD-4B-xx.x Card

(Cisco ONS 15454 only)

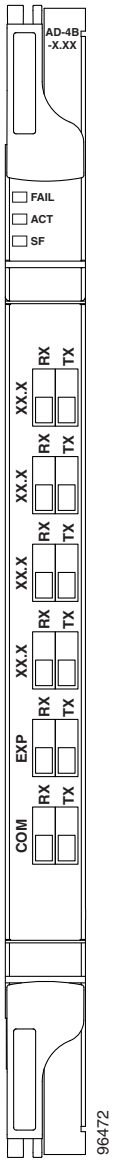
The 4-Band OADM (AD-4B-xx.x) card passively adds or drops four bands of four adjacent 100-GHz-spaced channels. Two versions of this card with different part numbers—each version designed for use with one set of bands—are used in the ONS 15454 DWDM system. The card bidirectionally adds and drops in two different sections on the same card to manage signal flow in both directions. This card can be used when there is asymmetric adding and dropping on each side (east or west) of the node; a band can be added or dropped on one side but not on the other.

The AD1B-xx.x can be installed in Slots 1 to 6 and 12 to 17 and has the following features:

- Five software-controlled VOAs regulate the optical power flowing in the OADM paths.
- Output power of each dropped band is set by changing the attenuation of each VOA drop.
- The VOA express is used to regulate the insertion loss of the express path.
- VOA settings and functions, photodiode detection, and alarm thresholds are internally controlled.
- Virtual photodiode (firmware calculation of port optical power) at the common DWDM output port are monitored within the software.

Figure 8-19 shows the AD-4B-xx.x faceplate.

Figure 8-19 AD-4B-xx.x Faceplate



For information on safety labels for the card, see the "8.2 Class 1M Laser Product Safety Lasers" section on page 8-8.

Figure 8-20 shows a block diagram of the AD-4B-xx.x card.

Figure 8-20 AD-4B-xx.x Block Diagram

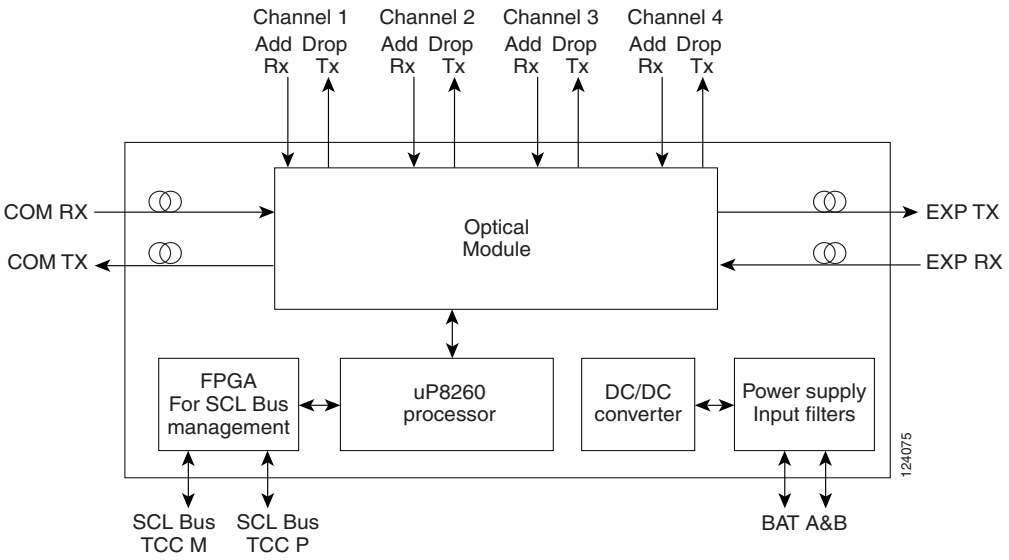
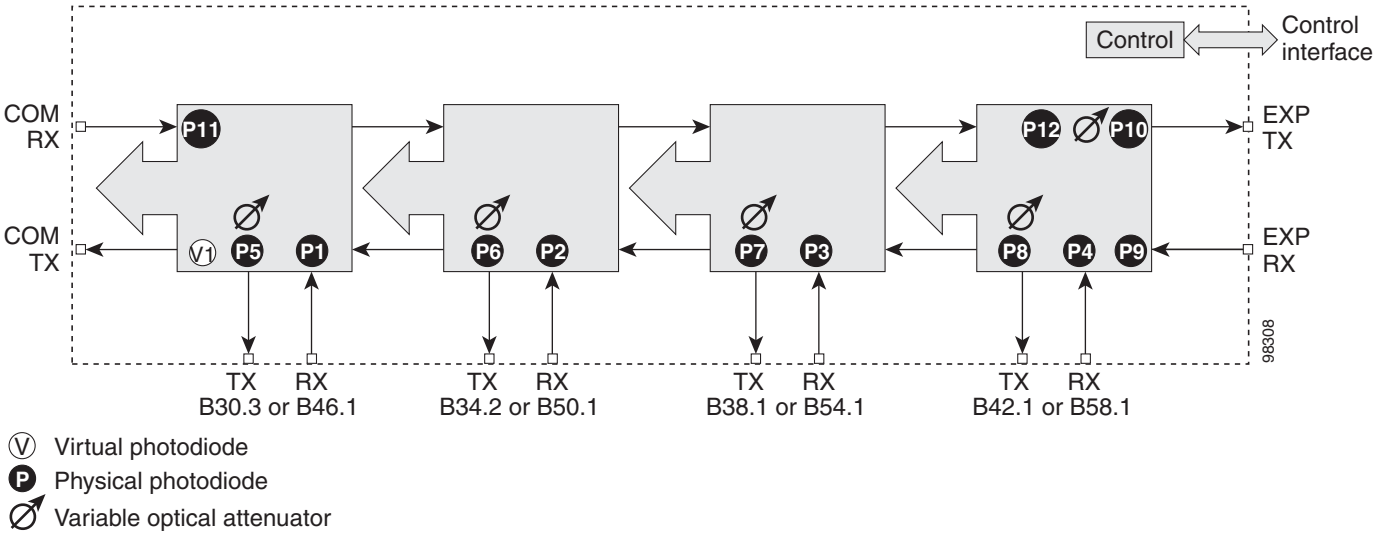


Figure 8-21 shows the AD-4B-xx.x optical module functional block diagram.

Figure 8-21 AD-4B-xx.x Optical Module Functional Block Diagram



8.7.1 Power Monitoring

Physical photodiodes P1 through P11 and virtual photodiode V1 monitor the power for the AD-4B-xx.x card. The returned power level values are calibrated to the ports as shown in Table 8-18.

Table 8-18 AD-4B-xx.x Port Calibration

Photodiode	CTC Type Name	Calibrated to Port
P1–P4	ADD	COM TX
P5–P8	DROP	DROP TX
P9	IN EXP	EXP RX
P10	OUT EXP	EXP TX
P11	IN COM	COM RX
V1	OUT COM	COM TX

For information on the associated TL1 AIDs for the optical power monitoring points, refer the "CTC Port Numbers and TL1 Aids" section in *Cisco ONS SONET TL1 Command Guide, Release 9.2*.

8.7.2 AD-4B-xx.x Card-Level Indicators

The AD-4B-xx.x card has three card-level LED indicators, described in Table 8-19.

Table 8-19 AD-4B-xx.x Card-Level Indicators

Card-Level Indicators	Description
Red FAIL LED	The red FAIL LED indicates that the card's processor is not ready or that there is an internal hardware failure. Replace the card if the red FAIL LED persists.
Green ACT LED	The green ACT LED indicates that the AD-4B-xx.x card is carrying traffic or is traffic-ready.
Amber SF LED	The amber SF LED indicates a signal failure. The amber SF LED also illuminates when the transmit and receive fibers are incorrectly connected. When the fibers are properly connected, the light turns off.

8.7.3 AD-4B-xx.x Port-Level Indicators

You can find the status of the card port using the LCD screen on the ONS 15454 fan-tray assembly. Use the LCD to view the status of any port or card slot; the screen displays the number and severity of alarms for a given port or slot. The AD-4B-xx.x has 12 LC-PC-II optical ports: eight for add/drop band client input and output, two for express channel input and output, and two for communication.

CHAPTER 9

Reconfigurable Optical Add/Drop Cards

This chapter describes the Cisco ONS 15454 cards deployed in reconfigurable optical add/drop (ROADM) networks. For installation and card turn-up procedures, refer to the *Cisco ONS 15454 DWDM Procedure Guide*. For card safety and compliance information, refer to the *Cisco Optical Transport Products Safety and Compliance Information* document.

Note The cards described in this chapter are supported on the Cisco ONS 15454, Cisco ONS 15454 M6, Cisco ONS 15454 M2 platforms, unless noted otherwise.

Note Unless otherwise specified, “ONS 15454” refers to both ANSI and ETSI shelf assemblies.

Chapter topics include:

- 9.1 Card Overview, page 9-2
- 9.2 Safety Labels for Class 1M Laser Product Cards, page 9-14
- 9.3 32WSS Card, page 9-16
- 9.4 32WSS-L Card, page 9-23
- 9.5 32DMX Card, page 9-30
- 9.6 32DMX-L Card, page 9-35
- 9.7 40-DMX-C Card, page 9-40
- 9.8 40-DMX-CE Card, page 9-45
- 9.9 40-MUX-C Card, page 9-50
- 9.10 40-WSS-C Card, page 9-55
- 9.11 40-WSS-CE Card, page 9-61
- 9.12 40-WXC-C Card, page 9-68
- 9.13 80-WXC-C Card, page 9-74
- 9.14 Single Module ROADM (SMR-C) Cards, page 9-81
- 9.15 MMU Card, page 9-92

Note This chapter contains information about cards that perform mesh topology functions. Multiplexer and demultiplexer cards that do not perform these functions are described in Chapter 5, "Multiplexer and Demultiplexer Cards."

9.1 Card Overview

The ROADM cards include six add drop cards utilized in the C-band (32WSS, 32DMX, 32DMX-C, 40-MUX-C, 40-WXC-C, 80-WXC-C, and MMU), two add drop cards utilized for the L-band (32WSS-L, and 32DMX-L), and two single module ROADM (SMR) cards utilized in the C-band (40-SMR1-C and 40-SMR2-C).

This section provides card summary, compatibility, channel allocation, and safety information.

Note Each card is marked with a symbol that corresponds to a slot (or slots) on the ONS 15454 shelf assembly. The cards are then installed into slots that have the same symbols. For a list of slots and symbols, see the "Card Slot Requirements" section in the *Cisco ONS 15454 Hardware Installation Guide*.

9.1.1 Card Summary

Table 9-1 lists and summarizes information about each ROADM card.

Table 9-1 ROADM Card Summary

Card	Port Description	For Additional Information
32WSS	The 32WSS card has seven sets of ports located on the faceplate. It operates in Slots 1 to 5 and 12 to 16.	See the "9.3 32WSS Card" section on page 9-16
32WSS-L	The 32WSS-L card has seven sets of ports located on the faceplate. It operates in Slots 1 to 5 and 12 to 16.	See the "9.4 32WSS-L Card" section on page 9-23
32DMX	The 32DMX has five sets of ports located on the faceplate. It operates in Slots 1 to 6 and 12 to 17.	See the "9.5 32DMX Card" section on page 9-30
32DMX-L	The 32DMX-L has five sets of ports located on the faceplate. It operates in Slots 1 to 6 and 12 to 17.	See the "9.6 32DMX-L Card" section on page 9-35
40-DMX-C	The 40-DMX-C has six sets of ports located on the faceplate. It operates in Slots 1 to 6 and 12 to 17.	See the "9.7 40-DMX-C Card" section on page 9-40
40-DMX-CE	The 40-DMX-CE has six sets of ports located on the faceplate. It operates in Slots 1 to 6 and 12 to 17.	See the "9.8 40-DMX-CE Card" section on page 9-45
40-MUX-C	The 40-MUX-C has six sets of ports located on the faceplate. It operates in Slots 1 to 6 and 12 to 17.	See the "9.9 40-MUX-C Card" section on page 9-50.

Table 9-1 ROADM Card Summary (continued)

Card	Port Description	For Additional Information
40-WSS-C	The 40-WSS-C card has eight sets of ports located on the faceplate. It operates in Slots 1 to 5 and 12 to 16.	See the "9.10 40-WSS-C Card" section on page 9-55
40-WSS-CE	The 40-WSS-CE card has eight sets of ports located on the faceplate. It operates in Slots 1 to 5 and 12 to 16.	See the "9.11 40-WSS-CE Card" section on page 9-61
40-WXC-C	The 40-WXC-C card has five sets of ports located on the faceplate. It operates in Slots 1 to 5 and 12 to 16.	See the "9.12 40-WXC-C Card" section on page 9-68
80-WXC-C	The 80-WXC-C card has 14 ports located on the faceplate. It operates in Slots 1 to 5 and 12 to 16.	See the "9.13 80-WXC-C Card" section on page 9-74.
40-SMR1-C	The 40-SMR1-C card has six sets of ports located on the faceplate. It operates in Slots 1 to 5 and 12 to 16.	See the "9.14 Single Module ROADM (SMR-C) Cards" section on page 9-81
40-SMR2-C	The 40-SMR2-C card has six sets of ports located on the faceplate. It operates in Slots 1 to 5 and 12 to 16.	See the "9.14 Single Module ROADM (SMR-C) Cards" section on page 9-81
MMU	The MMU card has six sets of ports located on the faceplate. It operates in Slots 1 to 6 and 12 to 17.	See the "9.15 MMU Card" section on page 9-92

9.1.2 Card Compatibility

Table 9-2 lists the Cisco Transport Controller (CTC) software compatibility for the ROADM cards.

Table 9-2 Software Release Compatibility for ROADM Cards

Card Name	R4.5	R4.6	R4.7	R5.0	R6.0	R7.0	R7.2	R8.0	R8.5	R9.0	R9.1	R9.2
32WSS	No	No	15454-DWDM	15454-DWDM	15454-DWDM	15454-DWDM	15454-DWDM	15454-DWDM	15454-DWDM	15454-DWDM	15454-DWDM	15454-DWDM
32WSS-L	No	No	No	No	No	15454-DWDM	15454-DWDM	15454-DWDM	15454-DWDM	15454-DWDM	15454-DWDM	15454-DWDM
40-WSS-C	No	No	No	No	No	No	No	15454-DWDM	15454-DWDM	15454-DWDM	15454-DWDM	15454-DWDM, 15454-M6
40-WSS-CE	No	No	No	No	No	No	No	15454-DWDM	15454-DWDM	15454-DWDM	15454-DWDM	15454-DWDM, 15454-M6

Table 9-2 Software Release Compatibility for ROADM Cards

Card Name	R4.5	R4.6	R4.7	R5.0	R6.0	R7.0	R7.2	R8.0	R8.5	R9.0	R9.1	R9.2
32DMX	No	No	15454-DWDM	15454-DWDM	15454-DWDM	15454-DWDM	15454-DWDM	15454-DWDM	15454-DWDM	15454-DWDM	15454-DWDM	15454-DWDM,
32DMX-L	No	No	No	No	No	15454-DWDM	15454-DWDM	15454-DWDM	15454-DWDM	15454-DWDM	15454-DWDM	15454-DWDM
40-DMX-C	No	No	No	No	No	No	No	15454-DWDM	15454-DWDM	15454-DWDM	15454-DWDM	15454-DWDM, 15454-M6
40-DMX-CE	No	No	No	No	No	No	No	15454-DWDM	15454-DWDM	15454-DWDM	15454-DWDM	15454-DWDM, 15454-M6
40-MUX-C	No	No	No	No	No	No	No	15454-DWDM	15454-DWDM	15454-DWDM	15454-DWDM	15454-DWDM, 15454-M6
40-WXC-C	No	No	No	No	No	No	No	15454-DWDM	15454-DWDM	15454-DWDM	15454-DWDM	15454-DWDM, 15454-M6
80-WXC-C	No	No	No	No	No	No	No	No	No	No	No	15454-DWDM, 15454-M6
40-SMR1-C	No	No	No	No	No	No	No	No	No	No	15454-DWDM	15454-DWDM, 15454-M2, 15454-M6
40-SMR2-C	No	No	No	No	No	No	No	No	No	No	15454-DWDM	15454-DWDM, 15454-M2, 15454-M6
MMU	No	No	No	No	No	15454-DWDM	15454-DWDM	15454-DWDM	15454-DWDM	15454-DWDM	15454-DWDM	15454-DWDM

9.1.3 Interface Classes

The input interface cards have been grouped in classes listed in Table 9-3. The subsequent tables list the optical performance and output power of each interface class.

Table 9-3 Cisco ONS 15454 Card Interfaces Assigned to Input Power Classes

Input Power Class	Card
A	10-Gbps multirate transponder cards (TXP_MR_10G, TXP_MR_10E, TXP_MR_10E_C, and TXP_MR_10E_L), 10-Gbps muxponder cards (MXP_2.5G_10G, MXP_2.5G_10E, MXP_MR_10DME_C, MXP_MR_10DME_L, MXP_2.5G_10E_C, and MXP_2.5G_10E_L) with forward error correction (FEC) enabled, and 40-Gbps muxponder card (40G-MXP-C)
B	10-Gbps multirate transponder card (TXP_MR_10G) and muxponder card (MXP_2.5G_10G) without FEC
C	OC-192 LR ITU cards without FEC, 10-Gbps multirate transponder (TXP_MR_10E, TXP_MR_10E_C, and TXP_MR_10E_L) and muxponder (MXP_2.5G_10E, MXP_2.5G_10E_L, and MXP_MR_10DME_L) cards with FEC disabled
D	2.5-Gbps multirate transponder card (TXP_MR_2.5G), both protected and unprotected, with FEC enabled
E	OC-48 100-GHz dense wavelength division multiplexing (DWDM) muxponder card (MXP_MR_2.5G) and 2.5-Gbps multirate transponder card (TXP_MR_2.5G), protected or unprotected; FEC disabled; and retime, reshape, and regenerate (3R) mode enabled
F	2.5-Gbps multirate transponder card (TXP_MR_2.5G), protected or unprotected, in regenerate and reshape (2R) mode
G	OC-48 ELR 100 GHz card
H	2/4 port GbE transponder (GBIC WDM 100GHz)
I	10-Gbps multirate transponder cards (TXP_MR_10E, TXP_MR_10E_C, and TXP_MR_10E_L) and 10-Gbps muxponder cards (MXP_2.5G_10E, MXP_2.5G_10E_L, and MXP_MR_10DME_L) with enhanced FEC (E-FEC) enabled, and 40-Gbps muxponder card (40G-MXP-C)
K	OC-192/STM-64 LR ITU cards without FEC, 100GHz 10Gbps Ethernet Xponder (GE_XP, GE_XPE, 10GE_XP, 10GE_XPE), Sonet/SDH add/drop (ADM_10G), OTU2 Xponder (OTU2_XP), with FEC disabled
L	40Gbps Duobinary CRS-1 DWDM ITU-T line card
M	2.5 Gbps DWDM ITU-T SPF
N	10Gbps enhanced full tunable transponder (TXP_MR_10E_C) and muxponder (MXP_2.5G_10E_C, MXP_MR_10DME_C) with E-FEC enabled
O	10Gbps Ethernet Xponder (GE_XP, GE_XPE, 10GE_XP, 10GE_XPE), 10Gbps Sonet/SDH add/drop (ADM_10G), OTU2 Xponder (OTU2_XP), with FEC enabled
P	10Gbps Ethernet Xponder (GE_XP, GE_XPE, 10GE_XP, 10GE_XPE), 10Gbps Sonet/SDH add/drop (ADM_10G), OTU2 Xponder (OTU2_XP), with E-FEC enabled

Table 9-3 Cisco ONS 15454 Card Interfaces Assigned to Input Power Classes (continued)

Input Power Class	Card
T	40Gbps DPSK CRS-1 DWDM ITU-T line card
V	OC-192/STM-64 LR ITU cards without FEC, full tunable 10Gbps Ethernet Xponder (GE_XP, GE_XPE, 10GE_XP, 10GE_XPE), Sonet/SDH add/drop (ADM_10G), OTU2 Xponder (OTU2_XP), with FEC disabled, full tunable
W	10Gbps Ethernet Xponder (GE_XP, GE_XPE, 10GE_XP, 10GE_XPE), Sonet/SDH add/drop (ADM_10G), OTU2 Xponder (OTU2_XP), with FEC enabled, full tunable
X	10Gbps Ethernet Xponder (GE_XP, GE_XPE, 10GE_XP, 10GE_XPE), Sonet/SDH add/drop (ADM_10G), OTU2 Xponder (OTU2_XP), with E-FEC enabled, full tunable
Y	10Gbps enhanced full tunable transponder (TXP_MR_10EX_C) and muxponder (MXP_2.5G_10EX_C, MXP_MR_10DMEX_C), with FEC enabled and maximum likelihood sequence estimator (MLSE) correction
Z	10Gbps enhanced full tunable transponder (TXP_MR_10EX_C) and muxponder (MXP_2.5G_10EX_C, MXP_MR_10DMEX_C), with E-FEC enabled and MLSE correction

Table 9-4 lists the optical performance parameters for 40-Gbps cards.

Table 9-4 40-Gbps Interface Optical Performance

Parameter	Class A		Class I	
Type	Power Limited	OSNR[1] Limited (if appl.)	Power Limited	OSNR Limited (if appl.)
Maximum bit rate	10 Gbps		10 Gbps	
Regeneration	3R		3R	
FEC	Yes		Yes (E-FEC)	
Threshold	Optimum		Optimum	
Maximum BER[2]	10^{-15}		10^{-15}	
OSNR[1] sensitivity	23 dB	9 dB	20 dB	8 dB
Power sensitivity	–24 dBm	–18 dBm	–26 dBm	–18 dBm
Power overload	–8 dBm		–8 dBm	
Transmitted Power Range[3]				
OC-192 LR ITU	—		—	
Dispersion compensation tolerance	+/–800 ps/nm		+/–800 ps/nm	

1. OSNR = optical signal-to-noise ratio
2. BER = bit error rate
3. These values, decreased by patchcord and connector losses, are also the input power values for the OADM cards.

Table 9-5, Table 9-6, and Table 9-7 lists the optical performance parameters for 10-Gbps cards.

Table 9-5 10-Gbps Interface Optical Performance (Class A, B, C, I, and K)

Parameter	Class A		Class B		Class C		Class I		Class K	
Type	Power Limited	OSNR[1] Limited	Power Limited	OSNR Limited	Power Limited	OSNR Limited	Power Limited	OSNR Limited	Power Limited	OSNR Limited
Maximum bit rate	10 Gbps		10 Gbps		10 Gbps		10 Gbps		10 Gbps	
Regeneration	3R		3R		3R		3R		3R	
FEC	Yes		No		No		Yes (E-FEC)		No	
Threshold	Optimum		Average		Average		Optimum		Average	
Maximum BER[2]	10^{-15}		10^{-12}		10^{-12}		10^{-15}		10^{-12}	
OSNR[1] sensitivity	23 dB	8.5 dB	23 dB	19 dB	19 dB	19 dB	20 dB 6 dB		23 dB[3] 23 dB[4] 23 dB[5]	16 dB[3] 17 dB[4] 17 dB[5]
Power sensitivity	–24 dBm	–18 dBm	–21 dBm	–20 dBm	–22 dBm	–22 dBm	–26 dBm	–18 dBm	–24 dBm[3] –23 dBm[4] –23 dBm[5]	–17 dBm[3] –18 dBm[4] –17 dBm[5]
Power overload	–8 dBm		–8 dBm		–9 dBm		–8 dBm		–7 dBm	
Transmitted Power Range[6]										
10-Gbps multirate transponder/ 10-Gbps FEC transponder	+2.5 to 3.5 dBm (for TXP_MR_10G) +3.0 to 6.0 dBm (for TXP_MR_10E)		+2.5 to 3.5 dBm		+3.0 to 6.0 dBm		+3.0 to 6.0 dBm		—	
OC-192 LR ITU	—		—		+3.0 to 6.0 dBm		—		–1.0 to +3.0 dBm	
10-Gbps Ethernet Xponder, Sonet/SDH Add/Drop, OTU2 Xponder	—		—		—		—		–1.0 to +3.0 dBm	
Dispersion compensation tolerance	+/–800 ps/nm		+/–1,000 ps/nm		+/–1,000 ps/nm		+/–800 ps/nm		–400 to +800 ps/nm	

1. OSNR = optical signal-to-noise ratio
2. BER = bit error rate
3. This value is for Xen Pak XFP used with Catalyst card.
4. This value is for XFP used with Catalyst, Xponder, and ADM-10G cards.
5. This value is for X2 XFP used with Catalyst card.
6. These values, decreased by patchcord and connector losses, are also the input power values for the optical add drop multiplexer (OADM) cards.

Table 9-6 10-Gbps Interface Optical Performance (Class N, O, P, and V)

Parameter	Class N		Class O		Class P		Class V	
Type	Power Limited	OSNR Limited	Power Limited	OSNR[1] Limited	Power Limited	OSNR Limited	Power Limited	OSNR Limited
Maximum bit rate	10 Gbps		10 Gbps		10 Gbps		10 Gbps	
Regeneration	3R		3R		3R		3R	
FEC	Yes (E-FEC)		Yes		Yes (E-FEC)		No	
Threshold	Optimum		Optimum		Optimum		Average	
Maximum BER[2]	10^{-15}		10^{-15}		10^{-15}		10^{-12}	
OSNR[1] sensitivity	19 dB	5 dB	11 dB	11 dB	23 dB	8 dB	23 dB	16 dB
Power sensitivity	–27 dBm	–20 dBm	–18 dBm	–18 dBm	–27 dBm	–18 dBm	–24 dBm	–18 dBm
Power overload	–8 dBm		–7 dBm		–7 dBm		–7 dBm	
Transmitted Power Range[3]								
10-Gbps multirate transponder/10-Gbps FEC transponder	+3.0 to 6.0 dBm		—		—		—	
OC-192 LR ITU	—		—		—		0 to +3.0 dBm	
10-Gbps Ethernet Xponder, Sonet/SDH Add/Drop, OTU2 Xponder	—		–1.0 to +3.0 dBm		–1.0 to +3.0 dBm		0 to +3.0 dBm	
Dispersion compensation tolerance	+/–800 ps/nm		–500 to +1100 ps/nm		–500 to +1100 ps/nm		–500 to +1600 ps/nm	

1. OSNR = optical signal-to-noise ratio
2. BER = bit error rate
3. These values, decreased by patchcord and connector losses, are also the input power values for the optical add drop multiplexer (OADM) cards.

Table 9-7 10-Gbps Interface Optical Performance (Class W, X, Y, and Z)

Parameter	Class W		Class X		Class Y		Class Z	
Type	Power Limited	OSNR Limited	Power Limited	OSNR Limited	Power Limited	OSNR[1] Limited	Power Limited	OSNR Limited
Maximum bit rate	10 Gbps		10 Gbps		10 Gbps		10 Gbps	
Regeneration	3R		3R		3R		3R	
FEC	Yes		Yes (E-FEC)		Yes		Yes (E-FEC)	
Threshold	Optimum		Optimum		Optimum		Optimum	
Maximum BER[2]	10^{-15}		10^{-15}		10^{-15}		10^{-15}	
OSNR[1] sensitivity	8.5 dB	8.5 dB	19 dB	5 dB	23 dB	8 dB	19 dB	5.5 dB
Power sensitivity	–18 dBm	–18 dBm	–27 dBm	–20 dBm	–24 dBm	–20 dBm	–27 dBm	–20 dBm
Power overload	–7 dBm		–7 dBm		–8 dBm		–8 dBm	
Transmitted Power Range[3]								
10-Gbps multirate transponder/10-Gbps FEC transponder	—		—		+3.0 to 6.0 dBm		+3.0 to 6.0 dBm	
OC-192 LR ITU	—		—		—		—	
10-Gbps Ethernet Xponder, Sonet/SDH Add/Drop, OTU2 Xponder	0 to +3.0 dBm		0 to +3.0 dBm		—		—	
Dispersion compensation tolerance	–500 to +1100 ps/nm		–500 to +1300 ps/nm		–800 to +1600 ps/nm		–2200 to +3700 ps/nm	

1. OSNR = optical signal-to-noise ratio
2. BER = bit error rate
3. These values, decreased by patchcord and connector losses, are also the input power values for the optical add drop multiplexer (OADM) cards.

Table 9-8 and Table 9-9 lists the optical interface performance parameters for 2.5-Gbps cards.

Table 9-8 2.5-Gbps Interface Optical Performance (Class D, E, and F)

Parameter	Class D		Class E		Class F	
Type	Power Limited	OSNR Limited	Power Limited	OSNR Limited	Power Limited	OSNR Limited
Maximum bit rate	2.5 Gbps		2.5 Gbps		2.5 Gbps	
Regeneration	3R		3R		2R	
FEC	Yes		No		No	
Threshold	Average		Average		Average	
Maximum BER	10^{-15}		10^{-12}		10^{-12}	
OSNR sensitivity	14 dB	5 dB	14 dB	10 dB	15 dB	15 dB
Power sensitivity	–31 dBm	–25 dBm	–30 dBm	–23 dBm	–24 dBm	–24 dBm
Power overload	–9 dBm		–9 dBm		–9 dBm	

Table 9-8 2.5-Gbps Interface Optical Performance (Class D, E, and F) (continued)

Parameter	Class D		Class E		Class F	
Type	Power Limited	OSNR Limited	Power Limited	OSNR Limited	Power Limited	OSNR Limited
Transmitted Power Range[1]						
TXP_MR_2.5G and TXPP_MR_2.5G	–1.0 to 1.0 dBm		–1.0 to 1.0 dBm		–1.0 to 1.0 dBm	
MXP_MR_2.5G and MXPP_MR_2.5G	—		+2.0 to +4.0 dBm		—	
OC-48 ELR 100 GHz	—		—		—	
2/4 port GbE Transponder (GBIC WDM 100GHz)	—		—		—	
2.5 Gbps DWDM ITU-T SPF	—		—		—	
Dispersion compensation tolerance	–1200 to +5400 ps/nm		–1200 to +5400 ps/nm		–1200 to +3300 ps/nm	

1. These values, decreased by patchcord and connector losses, are also the input power values for the OADM cards.

Table 9-9 2.5-Gbps Interface Optical Performance (Class G, H, and M)

Parameter	Class G		Class H		Class M	
Type	Power Limited	OSNR Limited	Power Limited	OSNR Limited	Power Limited	OSNR Limited
Maximum bit rate	2.5 Gbps		1.25 Gbps		2.5 Gbps	
Regeneration	3R		3R		3R	
FEC	No		No		No	
Threshold	Average		Average		Average	
Maximum BER	10^{-12}		10^{-12}		10^{-12}	
OSNR sensitivity	14 dB	11 dB	13 dB	8 dB	14 dB	9 dB
Power sensitivity	–27 dBm	–23 dBm	–28 dBm	–18 dBm	–28 dBm	–22 dBm
Power overload	–9 dBm		–7 dBm		–9 dBm	
Transmitted Power Range[1]						
TXP_MR_2.5G	—		—		—	
TXPP_MR_2.5G	—					
MXP_MR_2.5G	–2.0 to 0 dBm					
MXPP_MR_2.5G	—					
OC-48 ELR 100 GHz	—		—		—	
2/4 port GbE Transponder (GBIC WDM 100GHz)	–1200 to +3300 ps/nm		0 to +3 dBm		—	

Table 9-9 2.5-Gbps Interface Optical Performance (Class G, H, and M) (continued)

Parameter	Class G		Class H		Class M	
Type	Power Limited	OSNR Limited	Power Limited	OSNR Limited	Power Limited	OSNR Limited
2.5 Gbps DWDM ITU-T SPF			—		0 to +4 dBm	
Dispersion compensation tolerance			–1000 to +3600 ps/nm		–800 to +2400 ps/nm	

1. These values, decreased by patchcord and connector losses, are also the input power values for the OADM cards.

9.1.4 Channel Allocation Plans

ONS 15454 DWDM ROADM cards are designed for use with specific channels in the C band and L band. In most cases, the channels for these cards are either numbered (for example, 1 to 32 or 1 to 40) or delimited (odd or even). Client interfaces must comply with these channel assignments to be compatible with the ONS 15454 system.

. The following cards operate in the C-band:

- 32WSS
- 32DMX
- 32DMX-C
- 40-MUX-C
- 40-WXC-C
- 80-WXC-C
- 40-SMR1-C
- 40-SMR2-C
- MMU

Table 9-10 lists the C-band channel IDs and wavelengths at ITU-T 50-GHz intervals. This is a comprehensive C-band channel table that encompasses present and future card capabilities.

Table 9-10 DWDM C-Band[1] Channel Allocation Plan with 50-GHz Spacing

Channel Number	Frequency (THz)	Wavelength (nm)	Channel Number	Frequency (THz)	Wavelength (nm)
1	196.00	1529.55	42	193.95	1545.72
2	195.95	1529.94	43	193.90	1546.119
3	195.90	1530.334	44	193.85	1546.518
4	195.85	1530.725	45	193.80	1546.917
5	195.80	1531.116	46	193.75	1547.316
6	195.75	1531.507	47	193.70	1547.715
7	195.70	1531.898	48	193.65	1548.115
8	195.65	1532.290	49	193.60	1548.515

Table 9-10 DWDM C-Band[1] Channel Allocation Plan with 50-GHz Spacing (continued)

Channel Number	Frequency (THz)	Wavelength (nm)	Channel Number	Frequency (THz)	Wavelength (nm)
9	195.60	1532.681	50	193.55	1548.915
10	195.55	1533.073	51	193.50	1549.32
11	195.50	1533.47	52	193.45	1549.71
12	195.45	1533.86	53	193.40	1550.116
13	195.40	1534.250	54	193.35	1550.517
14	195.35	1534.643	55	193.30	1550.918
15	195.30	1535.036	56	193.25	1551.319
16	195.25	1535.429	57	193.20	1551.721
17	195.20	1535.822	58	193.15	1552.122
18	195.15	1536.216	59	193.10	1552.524
19	195.10	1536.609	60	193.05	1552.926
20	195.05	1537.003	61	193.00	1553.33
21	195.00	1537.40	62	192.95	1553.73
22	194.95	1537.79	63	192.90	1554.134
23	194.90	1538.186	64	192.85	1554.537
24	194.85	1538.581	65	192.80	1554.940
25	194.80	1538.976	66	192.75	1555.343
26	194.75	1539.371	67	192.70	1555.747
27	194.70	1539.766	68	192.65	1556.151
28	194.65	1540.162	69	192.60	1556.555
29	194.60	1540.557	70	192.55	1556.959
30	194.55	1540.953	71	192.50	1557.36
31	194.50	1541.35	72	192.45	1557.77
32	194.45	1541.75	73	192.40	1558.173
33	194.40	1542.142	74	192.35	1558.578
34	194.35	1542.539	75	192.30	1558.983
35	194.30	1542.936	76	192.25	1559.389
36	194.25	1543.333	77	192.20	1559.794
37	194.20	1543.730	78	192.15	1560.200
38	194.15	1544.128	79	192.10	1560.606
39	194.10	1544.526	80	192.05	1561.013
40	194.05	1544.924	81	192.00	1561.42
41	194.00	1545.32	82	191.95	1561.83

1. Channels on the C-band are 4-skip-1, starting at 1530.33 nm.

The following add drop cards utilize the L-band DWDM channels:

- 32WSS-L
- 32DMX-L

Table 9-11 lists the L-band channel IDs and wavelengths at ITU-T 50-GHz intervals. This is a comprehensive L-band channel table that encompasses present and future card capabilities.

Table 9-11 DWDM L-band[1] Channel Allocation Plan at 50 GHz Spacing

Channel Number	Frequency (THz)	Wavelength (nm)		Channel Number	Frequency (THz)	Wavelength (nm)
1	190.85	1570.83		41	188.85	1587.46
2	190.8	1571.24		42	188.8	1587.88
3	190.75	1571.65		43	188.75	1588.30
4	190.7	1572.06		44	188.7	1588.73
5	190.65	1572.48		45	188.65	1589.15
6	190.6	1572.89		46	188.6	1589.57
7	190.55	1573.30		47	188.55	1589.99
8	190.5	1573.71		48	188.5	1590.41
9	190.45	1574.13		49	188.45	1590.83
10	190.4	1574.54		50	188.4	1591.26
11	190.35	1574.95		51	188.35	1591.68
12	190.3	1575.37		52	188.3	1592.10
13	190.25	1575.78		53	188.25	1592.52
14	190.2	1576.20		54	188.2	1592.95
15	190.15	1576.61		55	188.15	1593.37
16	190.1	1577.03		56	188.1	1593.79
17	190.05	1577.44		57	188.05	1594.22
18	190	1577.86		58	188	1594.64
19	189.95	1578.27		59	187.95	1595.06
20	189.9	1578.69		60	187.9	1595.49
21	189.85	1579.10		61	187.85	1595.91
22	189.8	1579.52		62	187.8	1596.34
23	189.75	1579.93		63	187.75	1596.76
24	189.7	1580.35		64	187.7	1597.19
25	189.65	1580.77		65	187.65	1597.62
26	189.6	1581.18		66	187.6	1598.04
27	189.55	1581.60		67	187.55	1598.47
28	189.5	1582.02		68	187.5	1598.89
29	189.45	1582.44		69	187.45	1599.32
30	189.4	1582.85		70	187.4	1599.75
31	189.35	1583.27		71	187.35	1600.17

Table 9-11 DWDM L-band[1] Channel Allocation Plan at 50 GHz Spacing (continued)

Channel Number	Frequency (THz)	Wavelength (nm)		Channel Number	Frequency (THz)	Wavelength (nm)
32	189.3	1583.69		72	187.3	1600.60
33	189.25	1584.11		73	187.25	1601.03
34	189.2	1584.53		74	187.2	1601.46
35	189.15	1584.95		75	187.15	1601.88
36	189.1	1585.36		76	187.1	1602.31
37	189.05	1585.78		77	187.05	1602.74
38	189	1586.20		78	187	1603.17
39	188.95	1586.62		79	186.95	1603.60
40	188.9	1587.04		80	186.9	1604.03

1. Channels on the L-band are contiguous, starting at 1577.86 nm. The channels listed in this table begin with 1570.83 nm for backward compatibility with other ONS products.

9.2 Safety Labels for Class 1M Laser Product Cards

This section explains the significance of the safety labels attached to some of the cards. The card faceplates are clearly labeled with warnings about the laser radiation levels. You must understand all warning labels before working on these cards.

The 40-SMR1-C and 40-SMR2-C cards have Class IM lasers. The labels that appear on these cards are described in the following subsections.

9.2.1 Class 1M Laser Product Statement

Figure 9-1 shows the Class 1M Laser Product statement.

Figure 9-1 Class 1M Laser Product Statement

Class 1M lasers are products that produce either a highly divergent beam or a large diameter beam. Therefore, only a small part of the whole laser beam can enter the eye. However, these laser products can be harmful to the eye if the beam is viewed using magnifying optical instruments.

9.2.2 Hazard Level 1M Label

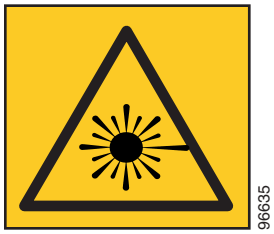
Figure 9-2 shows the Hazard Level 1M label. The Hazard Level label warns users against exposure to laser radiation by Class 1 limits calculated in accordance with IEC60825-1 Ed.1.2. This label is displayed on the faceplate of the cards.

Figure 9-2 Hazard Level Label

9.2.3 Laser Source Connector Label

Figure 9-3 shows the Laser Source Connector label. This label indicates that a laser source is present at the optical connector where the label is located.

Figure 9-3 Laser Source Connector Label



9.2.4 FDA Statement Label

The FDA Statement labels are shown in Figure 9-4 and Figure 9-5. These labels show compliance to FDA standards and that the hazard level classification is in accordance with IEC60825-1 Am.2 or Ed.1.2.

Figure 9-4 FDA Statement Label

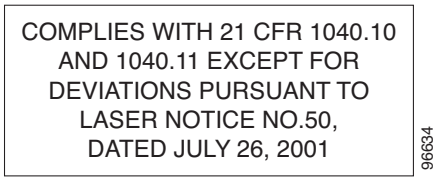
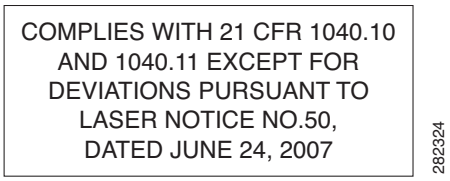


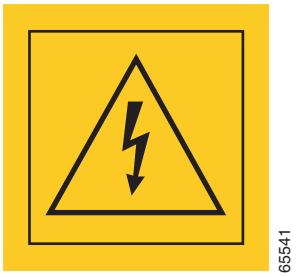
Figure 9-5 FDA Statement Label



9.2.5 Shock Hazard Label

Figure 9-6 shows the Shock Hazard label. This label alerts you to electrical hazards within a card. A shock hazard exists when you remove adjacent cards during maintenance, or when you touch exposed electrical circuitry on the card itself.

Figure 9-6 Shock Hazard Label



9.3 32WSS Card

(Cisco ONS 15454 only)

Note See the "A.8.3 32WSS Card Specifications" section on page A-26 for hardware specifications.

The two-slot 32-Channel Wavelength Selective Switch (32WSS) card performs channel add/drop processing within the ONS 15454 DWDM node. The 32WSS card can be installed in the following pairs of slots:

- Slots 1 and 2
- Slots 3 and 4
- Slots 5 and 6
- Slots 12 and 13
- Slots 14 and 15
- Slots 16 and 17

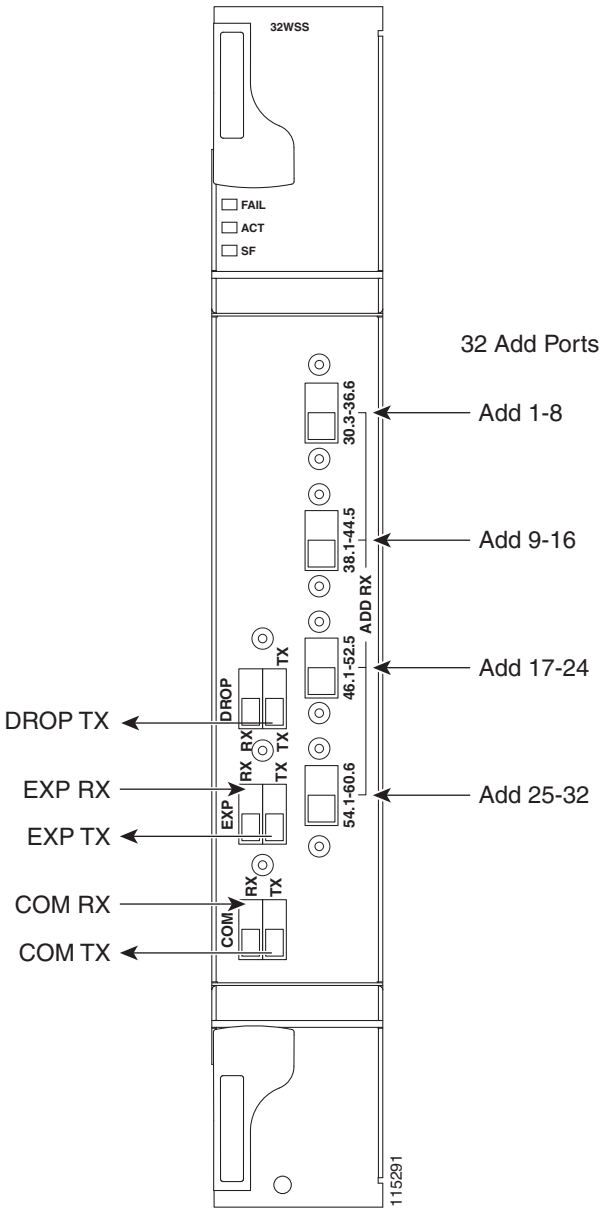
9.3.1 32WSS Faceplate Ports

The 32WSS has six types of ports:

- ADD RX ports (1 to 32): These ports are used for adding channels (listed in Table 9-13 on page 9-22). Each add channel is associated with an individual switch element that selects whether that channel is added. Each add port has optical power regulation provided by a variable optical attenuator (VOA). The 32WSS has four physical receive connectors that accept multifiber push-on (MPO) cables on its front panel for the client input interfaces.Each MPO cable breaks out into eight separate cables.
- EXP RX port: The EXP RX port receives an optical signal from another 32WSS card in the same network element (NE).
- EXP TX port: The EXP TX port sends an optical signal to the other 32WSS card within the NE.
- COM TX port: The COM TX (line input) port sends an aggregate optical signal to a booster amplifier card (for example, OPT-BST) for transmission outside of the NE.
- COM RX port: The COM RX port receives the optical signal from a preamplifier (such as the OPT-PRE) and sends it to the optical splitter.
- DROP TX port: The DROP TX port sends the split-off optical signal containing drop channels to the 32DMX card, where the channels are further processed and dropped.

Figure 9-7 shows the 32WSS card front panel and identifies the traffic flow through the ports.

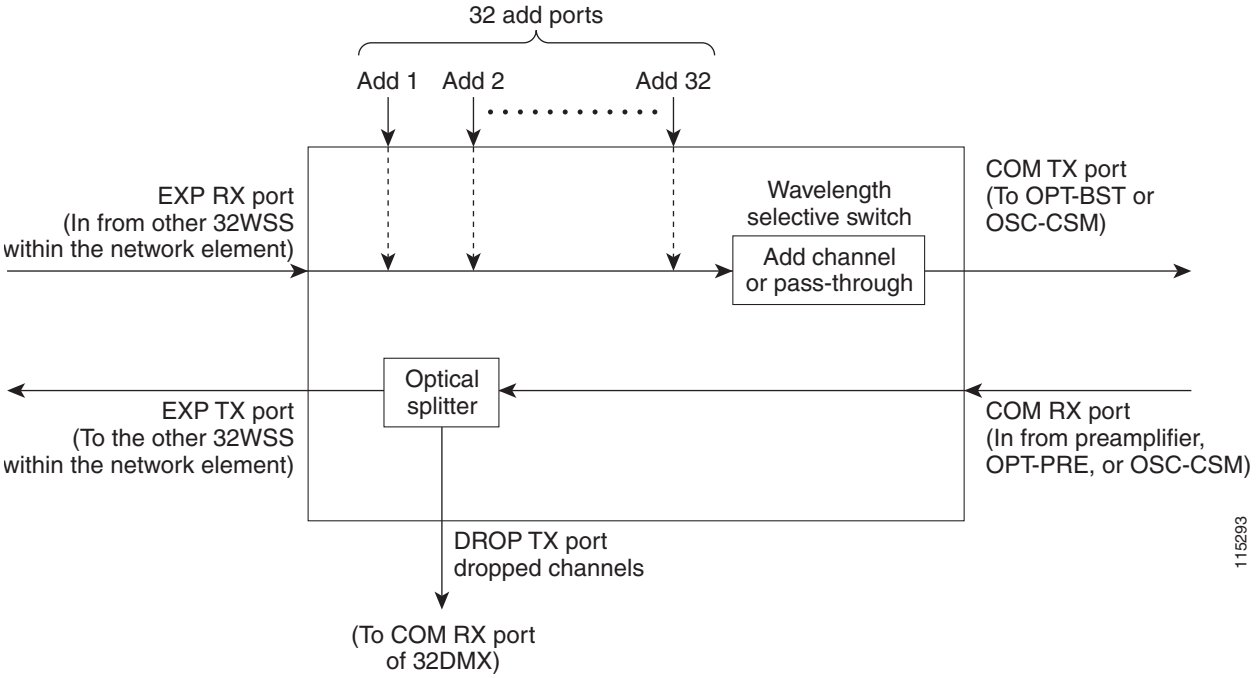
Figure 9-7 32WSS Faceplate and Ports



9.3.2 32WSS Block Diagram

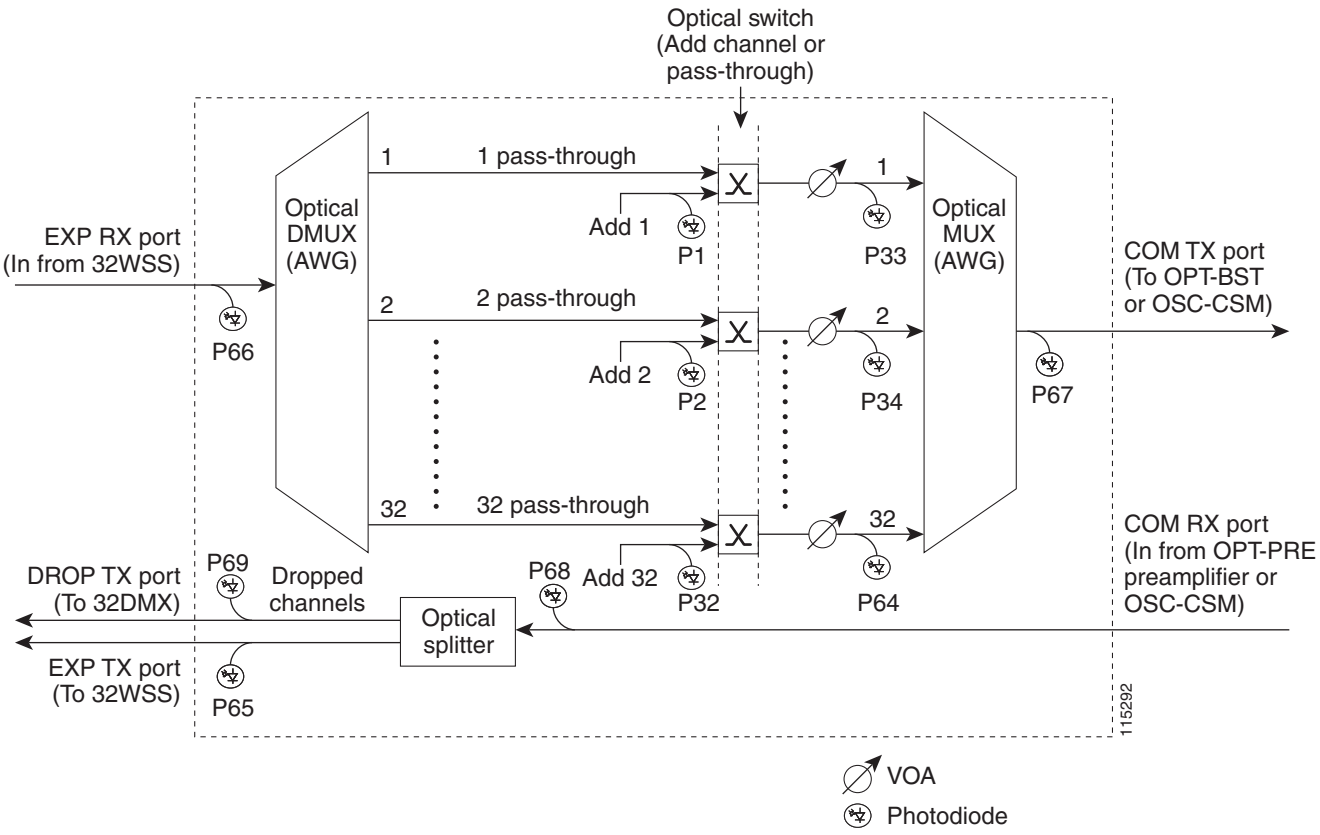
Figure 9-8 provides a high-level functional block diagram of the 32WSS card and Figure 9-9 on page 9-20 shows how optical signals are processed on the EXP RX and COM RX ports.

Figure 9-8 32WSS Block Diagram



Aggregate optical signals that enter the EXP RX and COM RX port are processed in two ways: Add channel/pass-through and optical splitter processing. The optical processing stages are shown in Figure 9-9, which provides a detailed optical functional diagram of the 32WSS card.

Figure 9-9 32WSS Optical Block Diagram



The EXP RX PORT and COM RX PORT operate as follows:

- EXP RX Port Add Channel/Pass-through Processing

  The incoming optical signal is received at the EXP RX port from the other 32WSS card within the NE. The incoming aggregate optical signal is demultiplexed into 32 individual wavelengths, or channels. Each channel is then individually processed by the optical switch, which performs add/pass-through processing. By using software controls, the switch either selects the optical channel coming in from the demultiplexer (that is, the pass-through channel) or it selects the external ADD channel. If the ADD port channel is selected this channel is transmitted and the optical signal coming from the demultiplexer is blocked.

  After the optical switch stage, all of the channels are multiplexed into an aggregate optical signal, which is sent out on the COM TX port. The output is typically connected to an OPT-BST or OPT-BST-E card (in the event a booster amplifier is needed) or to an OSC-CSM card (if no amplification is needed).

- COM RX Port Optical Splitter Processing

  The COM RX port receives the incoming optical signal and directs it to the 32WSS card's optical splitter. The splitter optically diverts channels that are designated to be dropped to the DROP TX port. The DROP TX port is typically connected to the COM RX port of the 32DMX where the drop channels are being dropped. Channels that are not dropped pass-through the optical splitter and flow out of the 32WSS card EXP TX port. Typically, this optical signal is connected to the other 32WSS module within the NE.

- COM TX Port Monitoring

  The COM TX value can be measured by either a physical or a virtual photodiode of the 15454-32WSS card. If the vendor ID of the 15454-32WSS card is between 1024 (0x400) and 2047 (0x800) the COM TX value is measured by physical photodiode. If the vendor ID of the 15454-32WSS card is greater than 2048 (0x800), the COM TX value is measured by the virtual photodiode. For COM TX values measured by virtual photodiode, check the values at the RX port in the downstream of the COM TX port (COM-RX port on OPT-BST or OSC-CSM card).

9.3.3 32WSS ROADM Functionality

The 32WSS card works in combination with the 32DMX card to implement ROADM functionality. As a ROADM node, the ONS 15454 can be configured to add or drop individual optical channels using CTC, Cisco TransportPlanner, and Cisco Transport Manager (CTM). ROADM functionality using the 32WSS card requires two 32DMX single-slot cards and two 32WSS double-slot cards (totalling six slots needed in the ONS 15454 chassis).

For other cards' ROADM functionality, see that card's description in this chapter. For a diagram of a typical ROADM configuration, see the "11.1.3 ROADM Node" section on page 11-10.

Note A terminal site can be configured using only a 32WSS card and a 32DMX card plugged into the east or west side of the shelf.

9.3.4 32WSS Power Monitoring

Physical photodiodes P1 through P69 monitor the power for the 32WSS card. Table 9-12 shows how the returned power level values are calibrated to each port.

Table 9-12 32WSS Port Calibration

Photodiode	CTC Type Name	Calibrated to Port
P1–P32	ADD (Power ADD)	ADD RX
P33–P64[1]	PASS THROUGH	COM TX
	ADD (Power)	COM TX
P65	OUT EXP	EXP TX
P66	IN EXP	EXP RX
P67	OUT COM	COM TX
P68	IN COM	COM RX
P69	DROP	DROP TX

1. P33–P64 monitor either ADD or PASSTHROUGH power, depending on the state of the optical switch

For information on the associated TL1 AIDs for the optical power monitoring points, refer the "CTC Port Numbers and TL1 Aids" section in *Cisco ONS SONET TL1 Command Guide, Release 9.2*.

9.3.5 32WSS Channel Allocation Plan

The 32WSS Card's channel labels, frequencies, and wavelengths are listed in Table 9-13.

Table 9-13 32WSS Channel Allocation Plan

Band ID	Channel Label	Frequency (THz)	Wavelength (nm)
B30.3	30.3	195.9	1530.33
	31.1	195.8	1531.12
	31.9	195.7	1531.90
	32.6	195.6	1532.68
B34.2	34.2	195.4	1534.25
	35.0	195.3	1535.04
	35.8	195.2	1535.82
	36.1	195.1	1536.61
B38.1	38.1	194.9	1538.19
	38.9	194.8	1538.87
	39.7	194.7	1539.77
	40.5	194.6	1540.46
B42.1	42.1	194.4	1542.14
	42.9	194.3	1542.94
	43.7	194.2	1543.73
	44.5	194.1	1544.53
B46.1	46.1	193.9	1546.12
	46.9	193.8	1546.92
	47.7	193.7	1547.72
	48.5	193.6	1548.51
B50.1	50.1	193.4	1550.12
	50.9	193.3	1550.92
	51.7	193.2	1551.72
	52.5	193.1	1552.52
B54.1	54.1	192.9	1554.13
	54.9	192.8	1554.94
	55.7	192.7	1555.75
	56.5	192.6	1556.55
B58.1	58.1	192.4	1558.17
	58.9	192.3	1558.98
	59.7	192.2	1559.79
	60.6	192.1	1560.61

9.3.6 32WSS Card-Level Indicators

Table 9-14 describes the three card-level LED indicators on the 32WSS card.

Table 9-14 32WSS Card-Level Indicators

Card-Level Indicators	Description
Red FAIL LED	The red FAIL LED indicates that the card's processor is not ready or that there is an internal hardware failure. Replace the card if the red FAIL LED persists.
Green ACT LED	The green ACT LED indicates that the 32WSS card is carrying traffic or is traffic-ready.
Amber SF LED	The amber SF LED indicates a signal failure on one or more of the card's ports. The amber SF LED also illuminates when the transmit and receive fibers are incorrectly connected. When the fibers are properly connected, the light turns off.

9.3.7 32WSS Port-Level Indicators

You can find the alarm status of the 32WSS card's ports using the LCD screen on the ONS 15454 fan-tray assembly. The screen displays the number and severity of alarms on a given port or slot. For the procedure to view these counts, refer to "Manage Alarms" in the *Cisco ONS 15454 DWDM Procedure Guide*.

9.4 32WSS-L Card

(Cisco ONS 15454 only)

Note See the "A.8.4 32WSS-L Card Specifications" section on page A-28 for hardware specifications.

The two-slot 32-Channel Wavelength Selective Switch L-Band (32WSS-L) card performs channel add/drop processing within the ONS 15454 DWDM node. The 32WSS-L card is particularly well suited for use in networks that employ DS fiber or SMF-28 single-mode fiber.The 32WSS-L card can be installed in the following pairs of slots:

- Slots 1 and 2
- Slots 3 and 4
- Slots 5 and 6
- Slots 12 and 13
- Slots 14 and 15
- Slots16 and 17

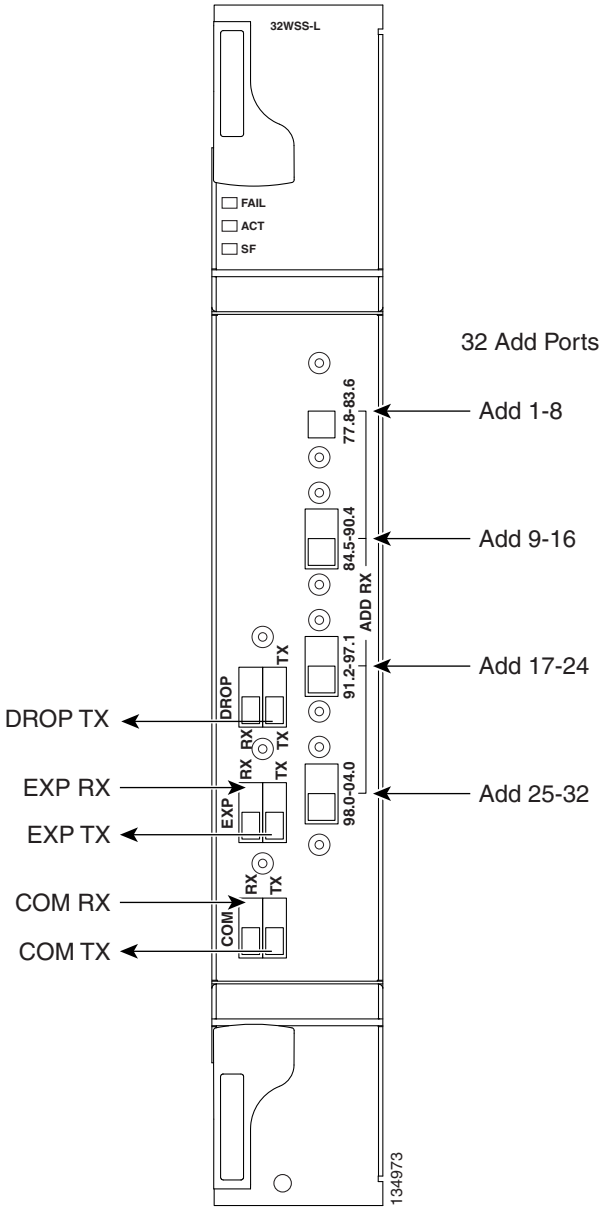
9.4.1 32WSS-L Faceplate Ports

The 32WSS-L card faceplate has six types of ports:

- ADD RX ports (1 to 32): These ports are used for adding channels (which are listed in Table 9-16 on page 9-29). Each add channel is associated with an individual switch element that selects whether the channel is added. Each add port has optical power regulation provided by a VOA.
- EXP RX port: The EXP RX port receives an optical signal from another 32WSS-L card in the same NE.
- EXP TX port: The EXP TX port sends an optical signal to the other 32WSS-L card within the NE.
- COM TX port: The COM TX port sends an aggregate optical signal to a booster amplifier card (for example, the OPT-BST card) for transmission outside of the NE.
- COM RX port: The COM RX port receives the optical signal from a preamplifier (such as the OPT-PRE) and sends it to the optical splitter.
- DROP TX port: The DROP TX port sends the split-off optical signal with drop channels to the 32DMX-L card, where the channels are further processed and dropped.

Figure 9-10 shows the 32WSS-L module front panel and identifies the traffic flow through the ports.

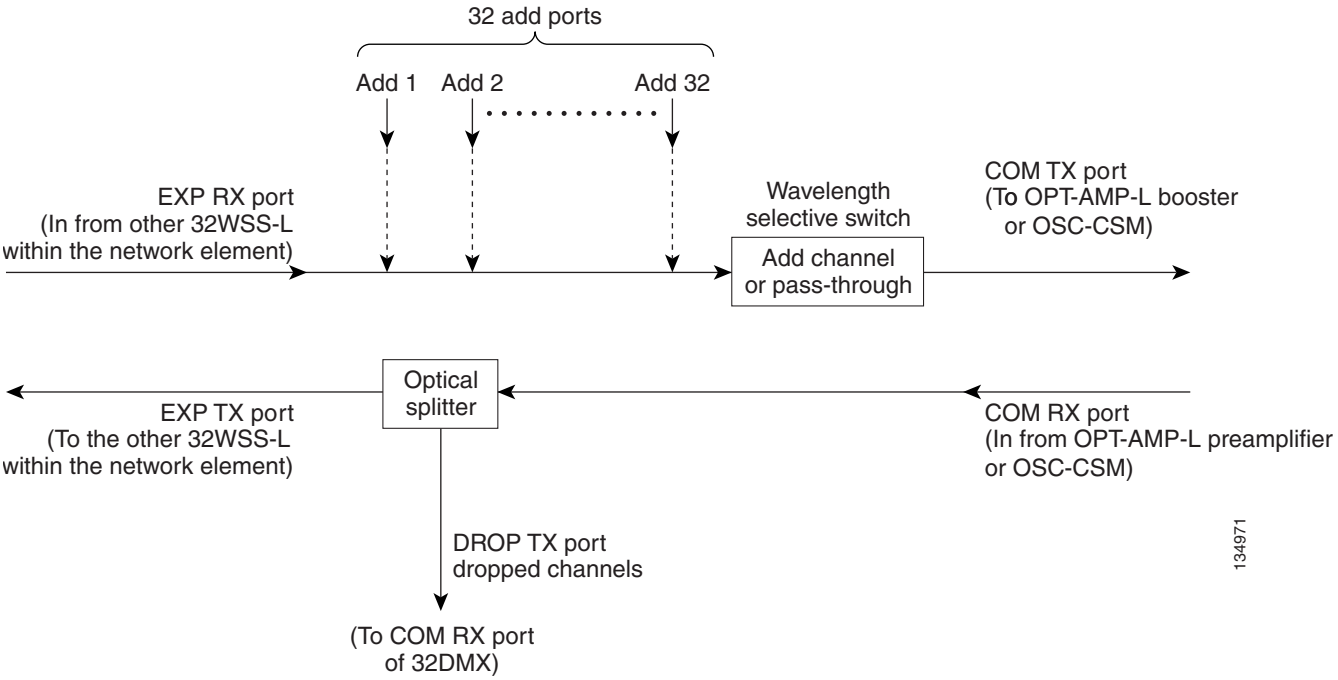
Figure 9-10 32WSS-L Faceplate and Ports



9.4.2 32WSS-L Block Diagram

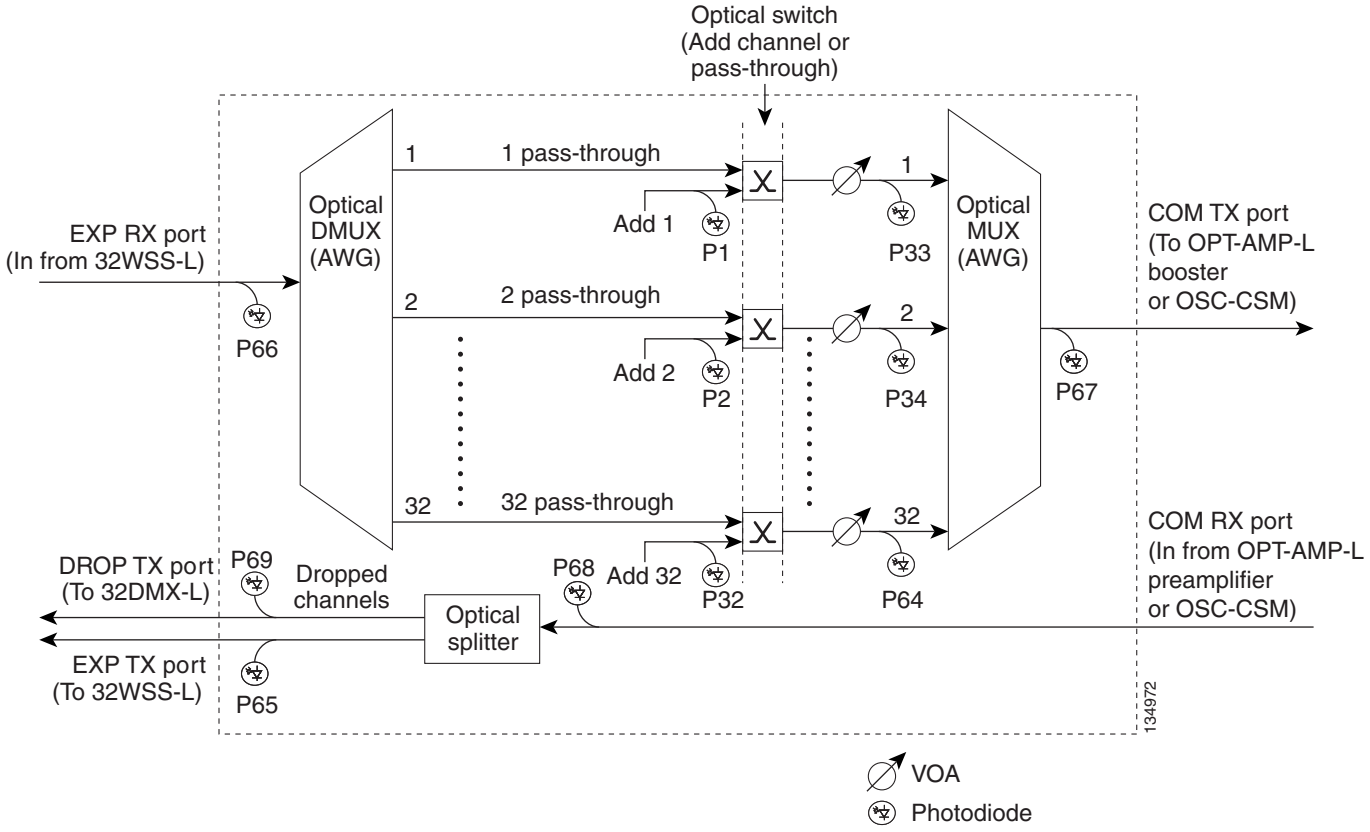
Figure 9-11 provides a high-level functional block diagram of the 32WSS-L card and Figure 9-12 on page 9-27 shows how optical signals are processed on the EXP RX and COM RX ports.

Figure 9-11 32WSS-L Block Diagram



Aggregate optical signals that enter the EXP RX and COM RX ports are processed in two ways: add channel/pass-through and optical splitter processing. The optical processing stages are shown in Figure 9-12, which provides a detailed optical functional diagram of the 32WSS-L card.

Figure 9-12 32WSS-L Optical Block Diagram



The EXP RX PORT and COM RX PORT operate as follows:

- EXP RX Port Add Channel/Pass-through Processing

  The incoming optical signal is received at the EXP RX port from the other 32WSS-L card within the NE. The incoming aggregate optical signal is demultiplexed into 32 individual wavelengths, or channels. Each channel is then individually processed by the optical switch, which performs add/pass-through processing. By using software controls, the switch either selects the optical channel coming in from the demultiplexer (that is, the pass-through channel) or it selects the external ADD channel. If the ADD port channel is selected this channel is transmitted and the optical signal coming from the demultiplexer is blocked.

  After the optical switch stage, all of the channels are multiplexed into an aggregate optical signal, which is sent out on the COM TX port. The output is typically connected to an OPT-AMP-L or OPT-BST-E card (in the event a booster amplifier is needed) or to an OSC-CSM card (if no amplification is needed).

- COM RX Port Optical Splitter Processing

  The COM RX port receives the incoming optical signal and directs it to the 32WSS-L card's optical splitter. The splitter optically diverts channels that are designated to be dropped to the DROP TX port. The DROP TX port is typically connected to the COM RX port of the 32DMX-L where the drop channels are being dropped. Channels that are not dropped pass-through the optical splitter and flow out of the 32WSS-L card EXP TX port. Typically, this optical signal is connected to the other 32WS-L module within the NE.

9.4.3 32WSS-L ROADM Functionality

The 32WSS-L works in combination with the 32DMX-L to implement L-band (1570 to 1620 nm) functionality. As a ROADM node, the ONS 15454 can be configured to add or drop individual optical channels using CTC, Cisco TransportPlanner, and CTM. ROADM functionality using the 32WSS-L card requires two 32DMX-L single-slot cards and two 32WSS-L double-slot cards (totalling six slots needed in the ONS 15454 chassis).

For other cards' ROADM functionality, see that card's description in this chapter. For a diagram of a typical ROADM configuration, see the "11.1.3 ROADM Node" section on page 11-10.

Note A terminal site can be configured using a 32WSS-L card and a 32DMX-L card plugged into the east or west side of the shelf.

9.4.4 32WSS-L Power Monitoring

Physical photodiodes P1 through P69 monitor the power for the 32WSS-L card. Table 9-15 shows the returned power level values calibrated to each port.

Table 9-15 32WSS-L Port Calibration

Photodiode	CTC Type Name	Calibrated to Port
P1–P32	ADD (Power ADD)	ADD RX
P33–P64[1]	PASS THROUGH	COM TX
	ADD (Power)	COM TX
P65	OUT EXP	EXP TX
P66	IN EXP	EXP RX
P67	OUT COM	COM TX
P68	IN COM	COM RX
P69	DROP	DROP TX

1. P33–P64 monitor either ADD or PASSTHROUGH power, depending on the state of the optical switch

For information on the associated TL1 AIDs for the optical power monitoring points, refer the "CTC Port Numbers and TL1 Aids" section in *Cisco ONS SONET TL1 Command Guide, Release 9.2*.

9.4.5 32WSS-L Channel Plan

The 32WSS-L card uses 32 banded channels on the ITU-T 100-GHz grid, as shown in Table 9-16.

Table 9-16 32WSS-L Channel Plan

Band ID	Channel Label	Frequency (THz)	Wavelength (nm)
B77.8	77.8	190	1577.86
	78.6	189.9	1578.69
	79.5	189.8	1579.52
	80.3	189.7	1580.35
B81.1	81.1	189.6	1581.18
	82.0	189.5	1582.02
	82.8	189.4	1582.85
	83.6	189.3	1583.69
B84.5	84.5	189.2	1584.53
	85.3	189.1	1585.36
	86.2	189	1586.20
	87.0	188.9	1587.04
B87.8	87.8	188.8	1587.88
	88.7	188.7	1588.73
	89.5	188.6	1589.57
	90.4	188.5	1590.41
B91.2	91.2	188.4	591.26
	92.1	188.3	1592.10
	92.9	188.2	1592.95
	93.7	188.1	1593.79
B94.6	94.6	188	1594.64
	95.4	187.9	1595.49
	96.3	187.8	1596.34
	97.1	187.7	1597.19
B98.0	98.0	187.6	1598.04
	98.8	187.5	1598.89
	99.7	187.4	1599.75
	00.6	187.3	1600.60
B01.4	01.4	187.2	1601.46
	02.3	187.1	1602.31
	03.1	187	1603.17
	04.0	186.9	1604.03

9.4.6 32WSS-L Card-Level Indicators

Table 9-17 describes the three card-level LED indicators on the 32WSS-L card.

Table 9-17 32WSS-L Card-Level Indicators

Card-Level Indicators	Description
Red FAIL LED	The red FAIL LED indicates that the card's processor is not ready or that an internal hardware failure occurred. Replace the card if the red FAIL LED persists.
Green ACT LED	The green ACT LED indicates that the 32WSS-L card is carrying traffic or is traffic-ready.
Amber SF LED	The amber SF LED indicates a signal failure on one or more of the card's ports. The amber SF LED also turns on when the transmit and receive fibers are incorrectly connected. When the fibers are properly connected, the light turns off.

9.5 32DMX Card

(Cisco ONS 15454 only)

Note See the "A.8.1 32DMX Card Specifications" section on page A-22 for hardware specifications.

The single-slot 32-Channel Demultiplexer (32DMX) card is an optical demultiplexer. The card receives an aggregate optical signal on its COM RX port and demultiplexes it into to (32) ITU-T 100-GHz-spaced channels. The 32DMX card can be installed in Slots 1 to 6 and in Slots 12 to 17.

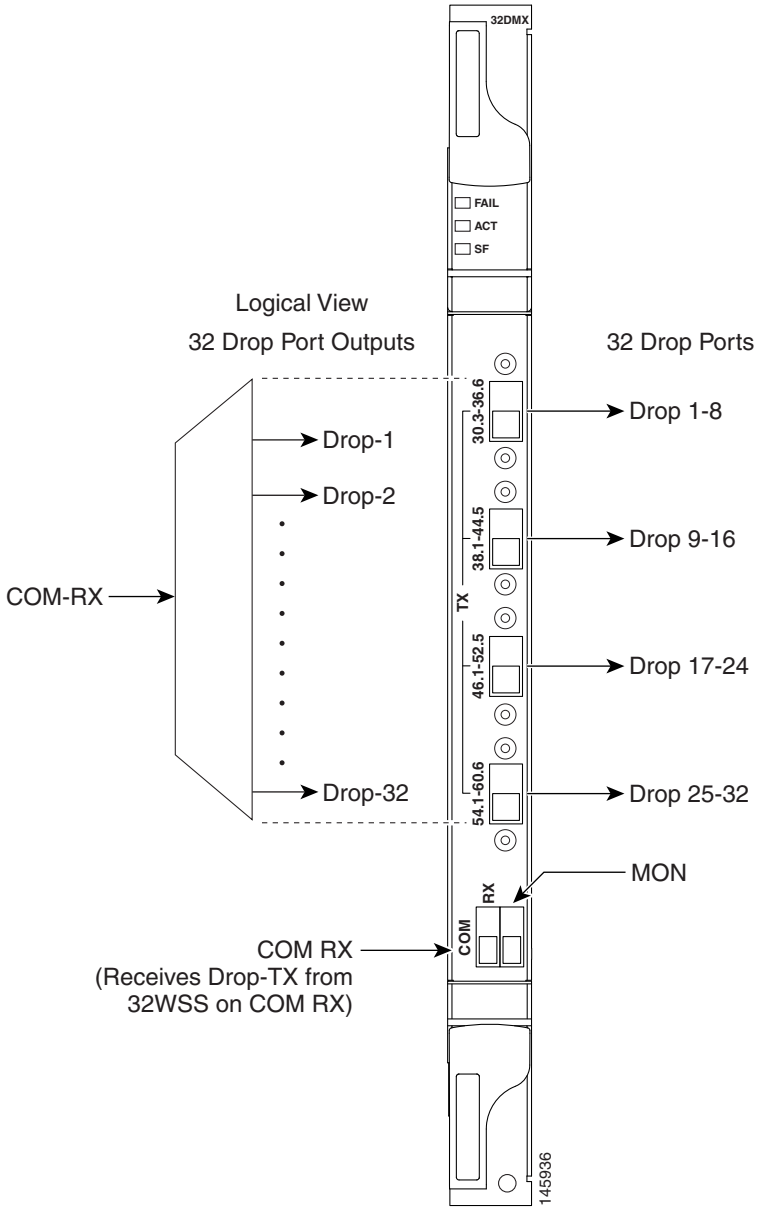
9.5.1 32DMX Faceplate Ports

The 32DMX card has two types of ports:

- COM RX port: COM RX is the input port for the aggregate optical signal being demultiplexed. This port is supported by a VOA for optical power regulation and a photodiode for optical power monitoring.
- DROP TX ports (1 to 32): On its output, the 32DMX provides 32 drop ports (listed in Table 9-19 on page 9-33) that are typically used for dropping channels within the ROADM node. These ports are connected using four 8-fiber MPO ribbon connectors. The incoming optical signal to the demultiplexer comes into the COM RX port. This input port is connected using a single LC duplex optical connector.Each drop port has a photodiode for optical power monitoring. Unlike the two-slot 32DMX-O demultiplexer, the drop ports on the 32DMX do not have a VOA per channel for optical power regulation. For a description of the 32DMX-O card, see the "5.4 32DMX-O Card" section on page 5-17.

Figure 9-13 shows the 32DMX card front panel and the basic traffic flow through the ports.

Figure 9-13 32DMX Faceplate and Ports



9.5.2 32DMX Block Diagram

A block diagram of the 32DMX card is shown in Figure 9-14.

Figure 9-14 32DMX Block Diagram

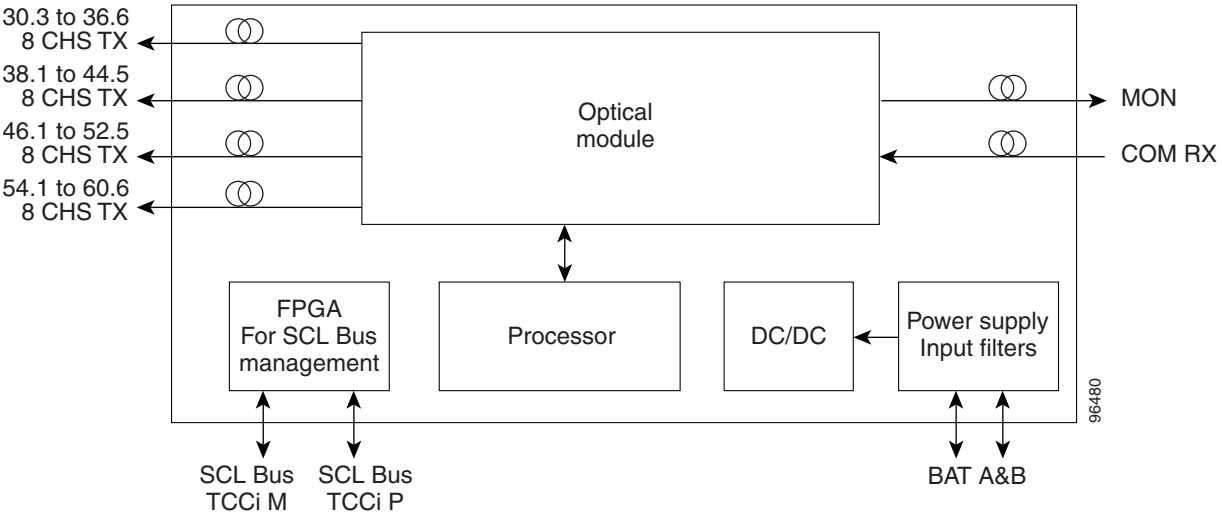
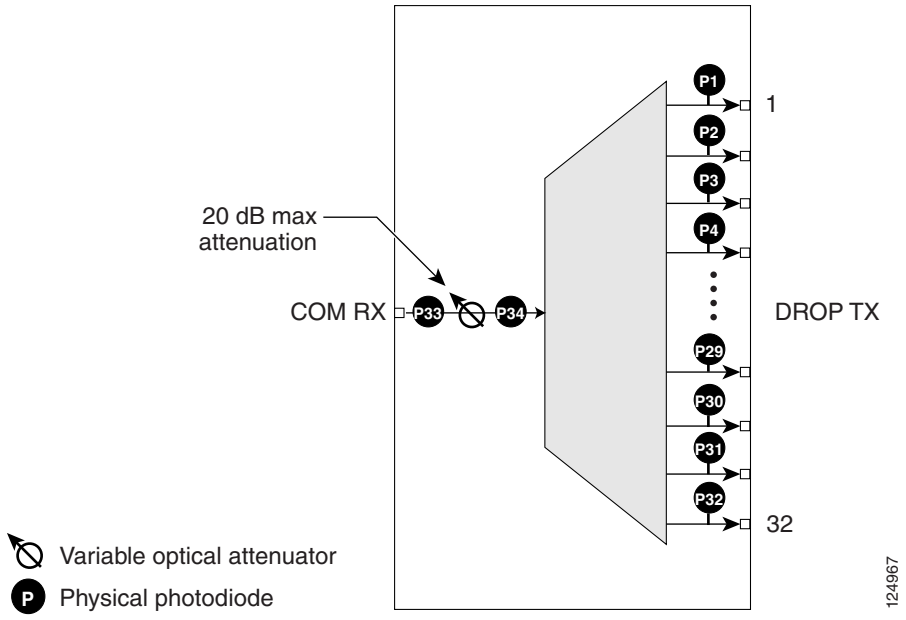


Figure 9-15 shows the 32DMX optical module functional block diagram.

Figure 9-15 32DMX Optical Module Functional Block Diagram



9.5.3 32DMX ROADM Functionality

The 32DMX card works in combination with the 32WSS card to implement ROADM functionality. As a ROADM node, the ONS 15454 can be configured to add or drop individual optical channels using CTC, Cisco TransportPlanner, and CTM. ROADM functionality using the 32DMX card requires two 32DMX single-slot cards and two 32WSS double-slot cards (for six slots total in the ONS 15454 chassis).

For information about the ROADM functionality for other cards, see that card's description in this chapter. For a diagram of a typical ROADM configuration, see the "11.1.3 ROADM Node" section on page 11-10.

Note A terminal site can be configured using only a 32WSS card and a 32DMX card plugged into the east or west side of the shelf.

9.5.4 32DMX Power Monitoring

Physical photodiodes P1 through P33 monitor the power for the 32DMX card. The returned power level values are calibrated to the ports as shown in Table 9-18.

Table 9-18 32DMX Port Calibration

Photodiode	CTC Type Name	Calibrated to Port
P1–P32	DROP	DROP TX
P33	INPUT COM	COM RX

For information on the associated TL1 AIDs for the optical power monitoring points, refer the "CTC Port Numbers and TL1 Aids" section in *Cisco ONS SONET TL1 Command Guide, Release 9.2*.

9.5.5 32DMX Channel Allocation Plan

The 32DMX card's channel labels, frequencies, and wavelengths are listed in Table 9-19.

Table 9-19 32DMX Channel Allocation Plan

Band ID	Channel Label	Frequency (THz)	Wavelength (nm)
B30.3	30.3	195.9	1530.33
	31.1	195.8	1531.12
	31.9	195.7	1531.90
	32.6	195.6	1532.68
B34.2	34.2	195.4	1534.25
	35.0	195.3	1535.04
	35.8	195.2	1535.82
	36.1	195.1	1536.61
B38.1	38.1	194.9	1538.19
	38.9	194.8	1538.87
	39.7	194.7	1539.77
	40.5	194.6	1540.46

Table 9-19 32DMX Channel Allocation Plan (continued)

Band ID	Channel Label	Frequency (THz)	Wavelength (nm)
B42.1	42.1	194.4	1542.14
	42.9	194.3	1542.94
	43.7	194.2	1543.73
	44.5	194.1	1544.53
B46.1	46.1	193.9	1546.12
	46.9	193.8	1546.92
	47.7	193.7	1547.72
	48.5	193.6	1548.51
B50.1	50.1	193.4	1550.12
	50.9	193.3	1550.92
	51.7	193.2	1551.72
	52.5	193.1	1552.52
B54.1	54.1	192.9	1554.13
	54.9	192.8	1554.94
	55.7	192.7	1555.75
	56.5	192.6	1556.55
B58.1	58.1	192.4	1558.17
	58.9	192.3	1558.98
	59.7	192.2	1559.79
	60.6	192.1	1560.61

9.5.6 32DMX Card-Level Indicators

Table 9-20 describes the three card-level LED indicators on the 32DMX card.

Table 9-20 32DMX Card-Level Indicators

Card-Level Indicators	Description
Red FAIL LED	The red FAIL LED indicates that the card's processor is not ready or that an internal hardware failure occurred. Replace the card if the red FAIL LED persists.
Green ACT LED	The green ACT LED indicates that the 32DMX card is carrying traffic or is traffic-ready.
Amber SF LED	The amber SF LED indicates a signal failure on one or more of the card's ports. The amber SF LED also turns on when the transmit and receive fibers are incorrectly connected. When the fibers are properly connected, the light turns off.

9.5.7 32DMX Port-Level Indicators

You can find the alarm status of the 32DMX card's ports using the LCD screen on the ONS 15454 fan-tray assembly. The screen displays the number and severity of alarms on a given port or slot. For the procedure to view these counts, refer to "Manage Alarms" in the *Cisco ONS 15454 DWDM Procedure Guide*.

9.6 32DMX-L Card

(Cisco ONS 15454 only)

Note See the "A.8.2 32DMX-L Card Specifications" section on page A-24 for hardware specifications.

The single-slot 32-Channel Demultiplexer L-Band card (32DMX-L) is an L-band optical demultiplexer. The card receives an aggregate optical signal on its COM RX port and demultiplexes it into to (32) 100-GHz-spaced channels. The 32DMX-L card is particularly well suited for use in networks that employ DS fiber or SMF-28 single-mode fiber. The 32DMX-L card can be installed in Slots 1 to 6 and in Slots 12 to 17.

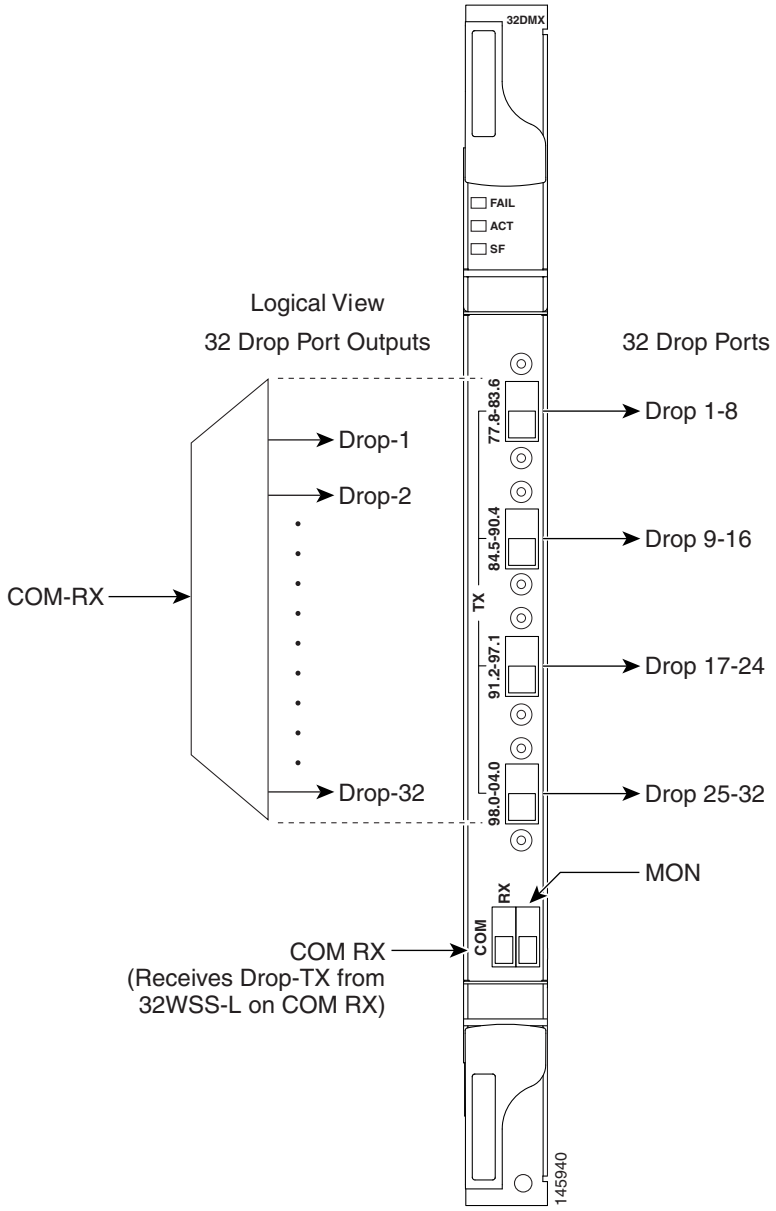
9.6.1 32DMX-L Faceplate Ports

The 32DMX-L card has two types of ports:

- COM RX port: COM RX is the input port for the aggregate optical signal being demultiplexed. This port is supported by both a VOA for optical power regulation and a photodiode for optical power monitoring.
- DROP TX ports (1 to 32): On its output, the 32DMX-L card provides 32 drop ports (listed in Table 9-25 on page 9-43) that are typically used for dropping channels within the ROADM node. These ports are connected using four 8-fiber MPO ribbon connectors. Each drop port has a photodiode for optical power monitoring. Unlike the two-slot 32DMX-O demultiplexer, the drop ports on the 32DMX-L do not have a VOA per channel for optical power regulation. For a description of the 32DMX-O card, see the "5.4 32DMX-O Card" section on page 5-17.

Figure 9-16 shows the 32DMX-L card front panel and the basic traffic flow through the ports.

Figure 9-16 32DMX-L Faceplate and Ports



9.6.2 32DMX-L Block Diagram

Figure 9-17 shows a block diagram of the 32DMX-L card.

Figure 9-17 32DMX-L Block Diagram

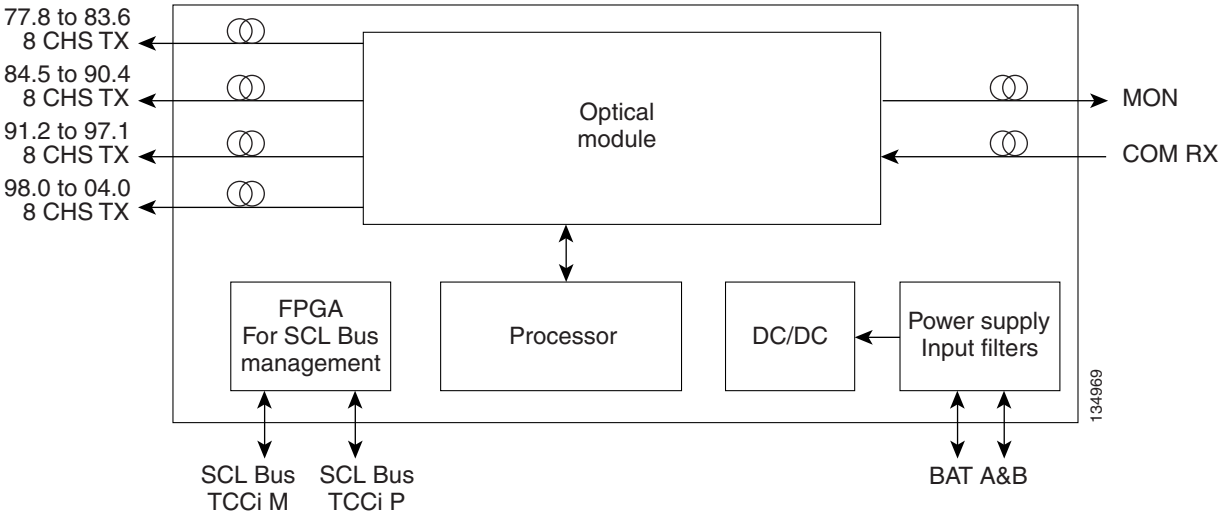
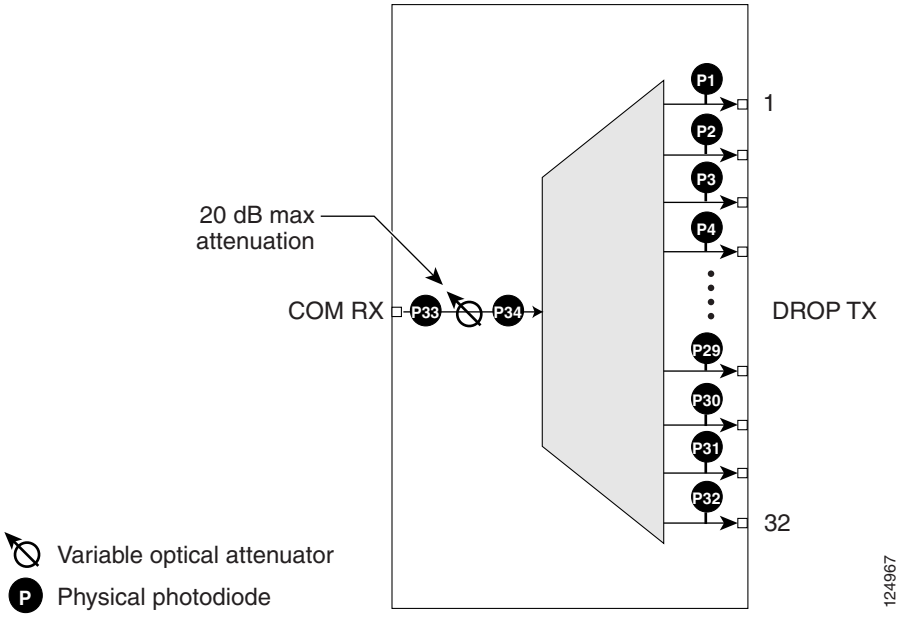


Figure 9-18 shows the 32DMX-L optical module functional block diagram.

Figure 9-18 32DMX-L Optical Module Functional Block Diagram



9.6.3 32DMX-L ROADM Functionality

The 32DMX-L card works in combination with the 32WSS-L card to implement ROADM functionality. AS a ROADM node, the ONS 15454 can be configured to add or drop individual optical channels using CTC, Cisco TransportPlanner, and CTM. ROADM functionality using the 32DMX-L card requires two 32DMX-L single-slot cards and two 32WSS-L double-slot cards (for a total of six slots in the ONS 15454 chassis).

For information about ROADM functionality for other cards, see that card's description in this chapter. For a diagram of a typical ROADM configuration, see the "11.1.3 ROADM Node" section on page 11-10.

Note A terminal site can be configured using only a 32WSS-L card and a 32DMX-L card plugged into the east or west side of the shelf.

9.6.4 32DMX-L Power Monitoring

Physical photodiodes P1 through P33 monitor the power for the 32DMX-L card. The returned power level values are calibrated to the ports as shown in Table 9-21.

Table 9-21 32DMX-L Port Calibration

Photodiode	CTC Type Name	Calibrated to Port
P1–P32	DROP	DROP TX
P33	INPUT COM	COM RX

For information on the associated TL1 AIDs for the optical power monitoring points, refer the "CTC Port Numbers and TL1 Aids" section in *Cisco ONS SONET TL1 Command Guide, Release 9.2*.

9.6.5 32DMX-L Channel Plan

The 32DMX-L card uses 32 banded channels on the ITU-T 100-GHz grid, as shown in Table 9-22.

Table 9-22 32DMX-L Channel Plan

Band ID	Channel Label	Frequency (THz)	Wavelength (nm)
B77.8	77.8	190	1577.86
	78.6	189.9	1578.69
	79.5	189.8	1579.52
	80.3	189.7	1580.35
B81.1	81.1	189.6	1581.18
	82.0	189.5	1582.02
	82.8	189.4	1582.85
	83.6	189.3	1583.69
B84.5	84.5	189.2	1584.53
	85.3	189.1	1585.36
	86.2	189	1586.20
	87.0	188.9	1587.04

Table 9-22 32DMX-L Channel Plan (continued)

Band ID	Channel Label	Frequency (THz)	Wavelength (nm)
B87.8	87.8	188.8	1587.88
	88.7	188.7	1588.73
	89.5	188.6	1589.57
	90.4	188.5	1590.41
B91.2	91.2	188.4	1591.26
	92.1	188.3	1592.10
	92.9	188.2	1592.95
	93.7	188.1	1593.79
B94.6	94.6	188	1594.64
	95.4	187.9	1595.49
	96.3	187.8	1596.34
	97.1	187.7	1597.19
B98.0	98.0	187.6	1598.04
	98.8	187.5	1598.89
	99.7	187.4	1599.75
	00.6	187.3	1600.60
B01.4	01.4	187.2	1601.46
	02.3	187.1	1602.31
	03.1	187	1603.17
	04.0	186.9	1604.03

9.6.6 32DMX-L Card-Level Indicators

Table 9-23 describes the three card-level LED indicators on the 32DMX-L card.

Table 9-23 32DMX-L Card-Level Indicators

Card-Level Indicators	Description
Red FAIL LED	The red FAIL LED indicates that the card's processor is not ready or that an internal hardware failure occurred. Replace the card if the red FAIL LED persists.
Green ACT LED	The green ACT LED indicates that the 32DMX-L card is carrying traffic or is traffic-ready.
Amber SF LED	The amber SF LED indicates a signal failure on one or more of the card's ports. The amber SF LED also turns on when the transmit and receive fibers are incorrectly connected. When the fibers are properly connected, the light turns off.

9.6.7 32DMX-L Port-Level Indicators

You can find the alarm status of the 32DMX-L card's ports using the LCD screen on the ONS 15454 fan-tray assembly. The screen displays the number and severity of alarms on a given port or slot. For the procedure to view these counts, refer to "Manage Alarms" in the *Cisco ONS 15454 DWDM Procedure Guide*.

9.7 40-DMX-C Card

(Cisco ONS 15454 and ONS 15454 M6 only)

Note See the "A.8.6 40-DMX-C Card Specifications" section on page A-30 for hardware specifications.

The single-slot 40-Channel Demultiplexer C-band (40-DMX-C) card demultiplexes 40 100-GHz-spaced channels identified in the channel plan (Table 9-25 on page 9-43), and sends them to dedicated output ports. The overall optical power can be adjusted using a single VOA that is common to all channels. The 40-DMX-C card is unidirectional, optically passive, and can be installed in Slots 1 to 6 and 12 to 17.

9.7.1 40-DMX-C Faceplate Ports

The 40-DMX-C has two types of ports:

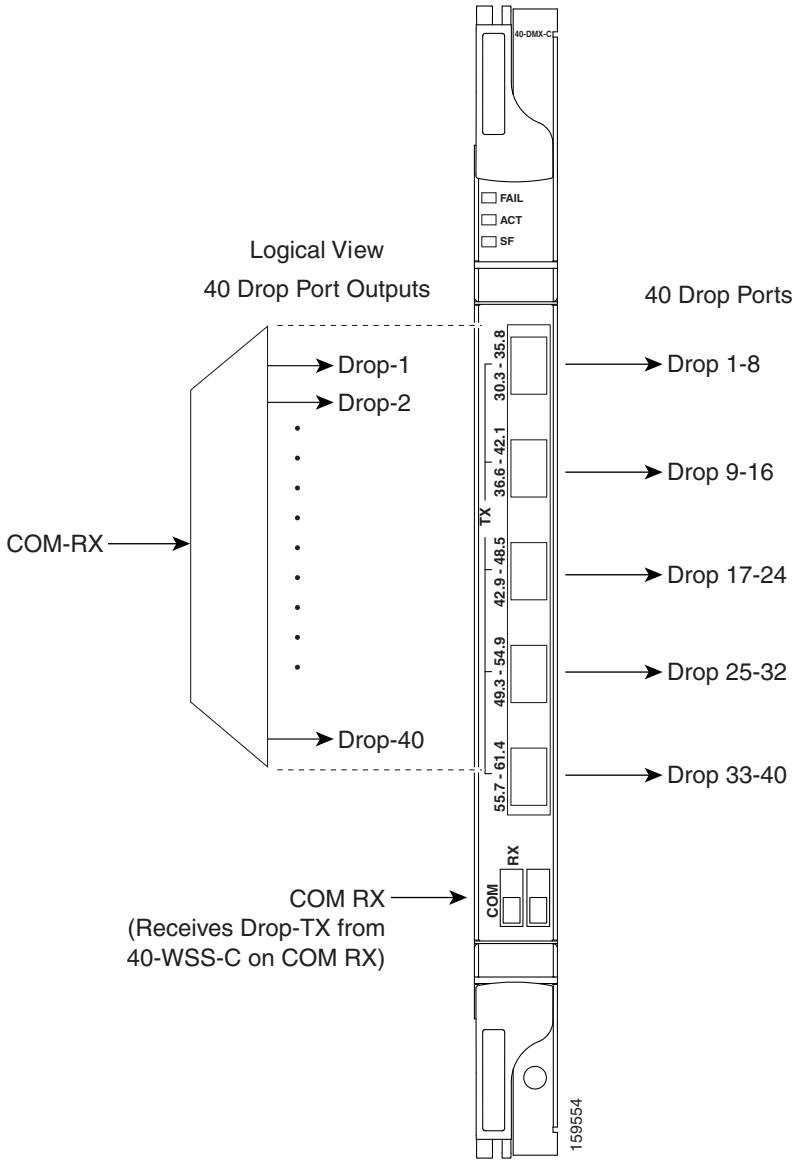
- COM RX port: COM RX is the line input port for the aggregate optical signal being demultiplexed. This port is supported by a VOA for optical power regulation and a photodiode for per channel optical power monitoring.

  Note By default, the VOA is set to its maximum attenuation for safety purposes (for example, electrical power failure). A manual VOA setting is also available.

- DROP TX ports (1 to 40): On its output, the 40-DMX-C card provides 40 drop ports that are typically used for dropping channels within the ROADM node. These ports are connected using five physical connectors on the front panel that accept MPO client input cables. (MPO cables break out into eight separate cables.) The 40-DMX-C card also has one LC-PC-II optical connector for the main input.

Figure 9-19 shows the 40-DMX-C card faceplate.

Figure 9-19 40-DMX-C Faceplate



9.7.2 40-DMX-C Block Diagram

Figure 9-20 shows a block diagram of the 40-DMX-C card.

Figure 9-20 40-DMX-C Block Diagram

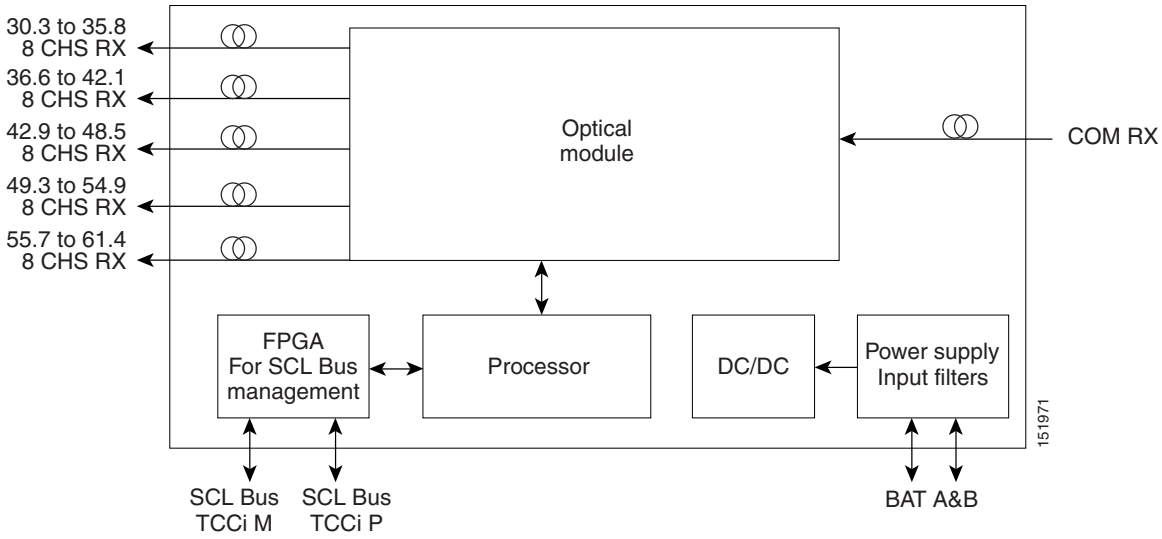
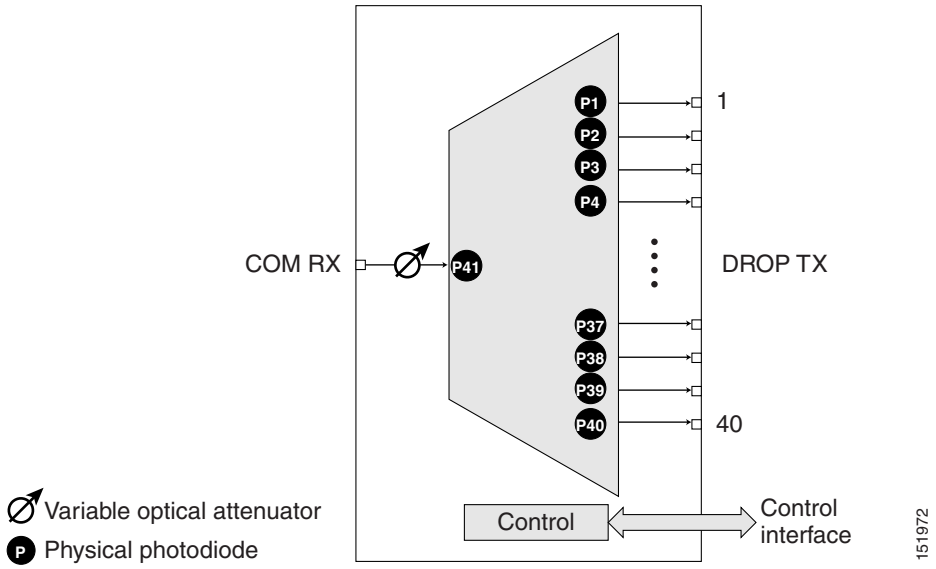


Figure 9-21 shows the 40-DMX-C optical module functional block diagram.

Figure 9-21 40-DMX-C Optical Module Functional Block Diagram



9.7.3 40-DMX-C ROADM Functionality

The 40-DMX-C card works in combination with the 40-WSS-C card to implement ROADM functionality. As a ROADM node, the ONS 15454 can be configured at the optical channel level using CTC, Cisco TransportPlanner, and CTM. ROADM functionality using the 40-DMX-C card requires two single-slot 40-DMX-C cards and two 40-WSS-C double-slot cards (for a total of six slots in the ONS 15454 chassis).

For other cards' ROADM functionality, see that card's description in this chapter. For a diagram of a typical ROADM configuration, see the "11.1.3 ROADM Node" section on page 11-10.

9.7.4 40-DMX-C Power Monitoring

Physical photodiodes P1 through P40 monitor the power at the outputs of the 40-DMX-C card. P41 monitors the total multiplexed power at the input, calibrated to the COM-RX port. Table 9-24 shows the returned power level values calibrated to each port.

Table 9-24 40-DMX-C Port Calibration

Photodiode	CTC Type Name	Calibrated to Port
P1–P40	DROP	DROP TX
P41	INPUT COM	COM RX

For information on the associated TL1 AIDs for the optical power monitoring points, refer the "CTC Port Numbers and TL1 Aids" section in *Cisco ONS SONET TL1 Command Guide, Release 9.2*.

9.7.5 40-DMX-C Channel Plan

Table 9-25 shows the 40 ITU-T 100-GHz-spaced, C-band channels (wavelengths) that are demultiplexed by the 40-DMX-C card.

Table 9-25 40-DMX-C Channel Plan

Band ID	Channel Label	Frequency (GHz)	Wavelength (nm)
B30.3	30.3	195.9	1530.33
	31.1	195.8	1531.12
	31.9	195.7	1531.90
	32.6	195.6	1532.68
	33.4	195.5	1533.47
B34.2	34.2	195.4	1534.25
	35.0	195.3	1535.04
	35.8	195.2	1535.82
	36.6	195.1	1536.61
	37.4	195	1537.40
B38.1	38.1	194.9	1538.19
	38.9	194.8	1538.98
	39.7	194.7	1539.77
	40.5	194.6	1540.56
	41.3	194.5	1541.35

Table 9-25 40-DMX-C Channel Plan (continued)

Band ID	Channel Label	Frequency (GHz)	Wavelength (nm)
B42.1	42.1	194.4	1542.14
	42.9	194.3	1542.94
	43.7	194.2	1543.73
	44.5	194.1	1544.53
	45.3	194	1545.32
B46.1	46.1	193.9	1546.12
	46.9	193.8	1546.92
	47.7	193.7	1547.72
	48.5	193.6	1548.51
	49.3	193.5	1549.32
B50.1	50.1	193.4	1550.12
	50.9	193.3	1550.92
	51.7	193.2	1551.72
	52.5	193.1	1552.52
	53.3	193	1553.33
B54.1	54.1	192.9	1554.13
	54.9	192.8	1554.94
	55.7	192.7	1555.75
	56.5	192.6	1556.55
	57.3	192.5	1557.36
B58.1	58.1	192.4	1558.17
	58.9	192.3	1558.98
	59.7	192.2	1559.79
	60.6	192.1	1560.61
	61.4	192	1561.42

9.7.6 40-DMX-C Card-Level Indicators

The 40-DMX-C card has three card-level LED indicators, described in Table 9-26.

Table 9-26 40-DMX-C Card-Level Indicators

Card-Level Indicators	Description
Red FAIL LED	The red FAIL LED indicates that the card's processor is not ready or that an internal hardware failure occurred. Replace the card if the red FAIL LED persists.
Green ACT LED	The green ACT LED indicates that the 40-DMX-C card is carrying traffic or is traffic-ready.
Amber SF LED	The amber SF LED indicates a signal failure on one or more of the card's ports. The amber SF LED also turns on when the transmit and receive fibers are incorrectly connected. When the fibers are properly connected, the light turns off.

9.7.7 40-DMX-C Port-Level Indicators

You can find the alarm status of the 40-DMX-C card ports using the LCD screen on the ONS 15454 fan-tray assembly. The screen displays the number and severity of alarms on a given port or slot. For the procedure to view these counts, refer to "Manage Alarms" in the *Cisco ONS 15454 DWDM Procedure Guide*.

9.8 40-DMX-CE Card

(Cisco ONS 15454 and ONS 15454 M6 only)

Note See the "A.8.7 40-DMX-CE Card Specifications" section on page A-31 for hardware specifications.

The single-slot 40-Channel Demultiplexer C-band, even channels (40-DMX-CE) card demultiplexes 40 100-GHz-spaced even-numbered channels identified in the channel plan (Table 9-28 on page 9-48), and sends them to dedicated output ports. The overall optical power can be adjusted using a single VOA that is common to all channels. The 40-DMX-CE card is unidirectional, optically passive, and can be installed in Slots 1 to 6 and 12 to 17.

9.8.1 40-DMX-CE Card Faceplate Ports

The 40-DMX-CE card has two types of ports:

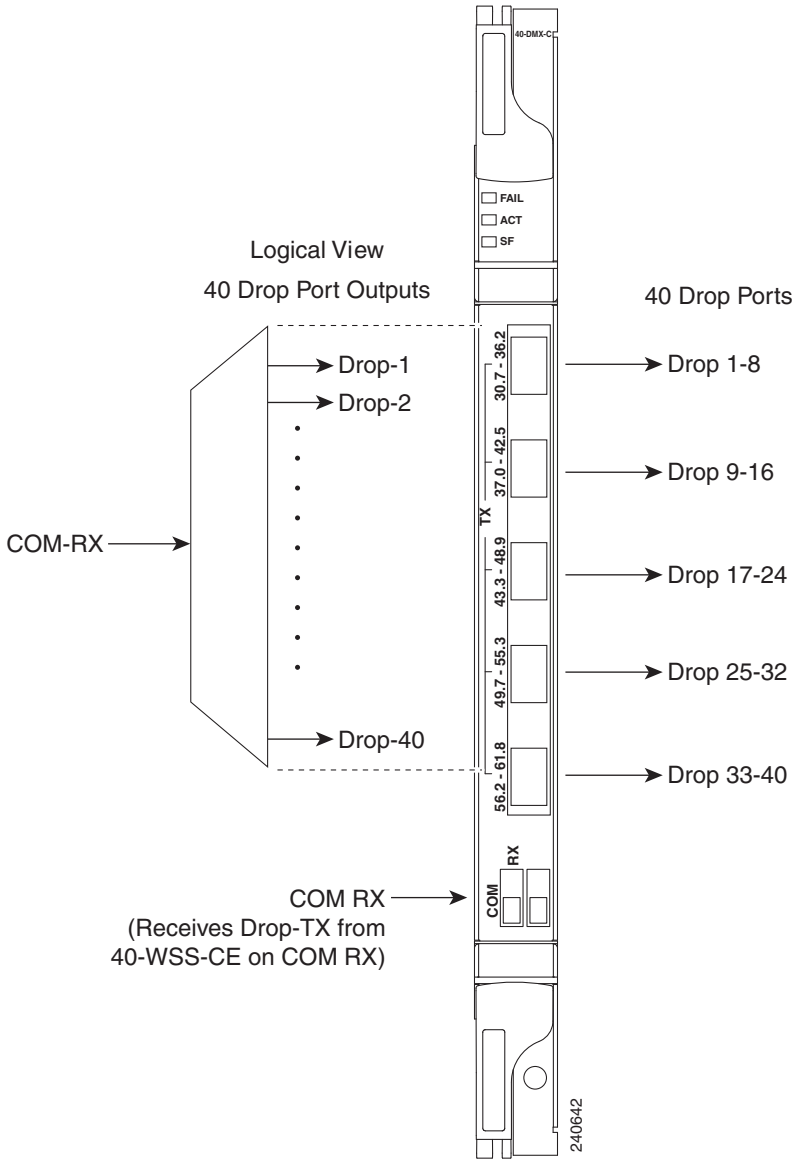
- COM RX port: COM RX is the line input port for the aggregate optical signal being demultiplexed. This port is supported by a VOA for optical power regulation and a photodiode for per channel optical power monitoring.

Note By default, the VOA is set to its maximum attenuation for safety purposes (for example, electrical power failure). A manual VOA setting is also available.

- DROP TX ports (1 to 40): On its output, the 40-DMX-CE card provides 40 drop ports that are typically used for dropping channels within the ROADM node. These ports are connected using five physical connectors on the front panel that accept MPO client input cables. (MPO cables break out into eight separate cables.) The 40-DMX-CE card also has one LC-PC-II optical connector for the main input.

Figure 9-22 shows the 40-DMX-CE card faceplate.

Figure 9-22 40-DMX-CE Card Faceplate



9.8.2 40-DMX-CE Card Block Diagram

Figure 9-23 shows a block diagram of the 40-DMX-CE card.

Figure 9-23 40-DMX-CE Card Block Diagram

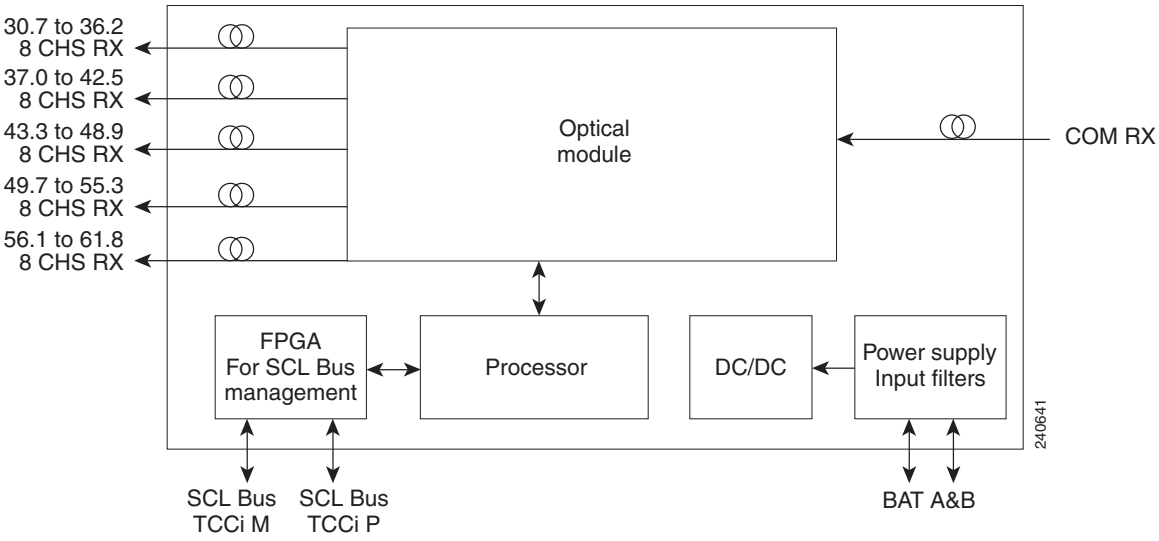
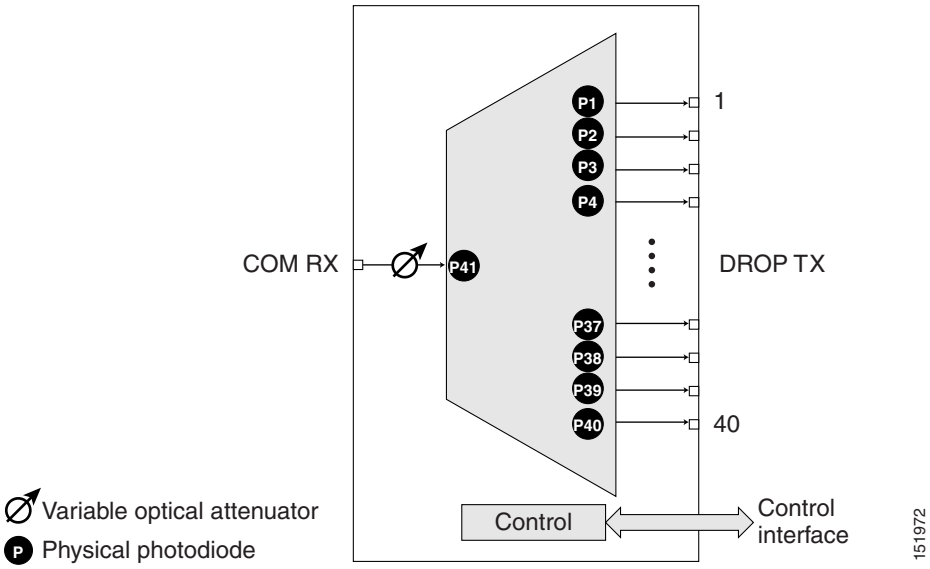


Figure 9-24 shows the 40-DMX-CE card optical module functional block diagram.

Figure 9-24 40-DMX-CE Card Optical Module Functional Block Diagram



9.8.3 40-DMX-CE Card ROADM Functionality

The 40-DMX-CE card works in combination with the 40-WSS-CE card to implement ROADM functionality. As a ROADM node, the ONS 15454 can be configured at the optical channel level using CTC, Cisco TransportPlanner, and CTM. ROADM functionality using the 40-DMX-CE card requires two single-slot 40-DMX-CE cards and two 40-WSS-CE double-slot cards (for a total of six slots in the ONS 15454 chassis).

For the ROADM functionality of other cards, see the description of that card in this chapter. For a diagram of a typical ROADM configuration, see the "11.1.3 ROADM Node" section on page 11-10.

9.8.4 40-DMX-CE Card Power Monitoring

Physical photodiodes P1 through P40 monitor the power at the outputs of the 40-DMX-CE card. P41 monitors the total multiplexed power at the input, calibrated to the COM-RX port. Table 9-27 shows the returned power level values calibrated to each port.

Table 9-27 40-DMX-CE Card Port Calibration

Photodiode	CTC Type Name	Calibrated to Port
P1–P40	DROP	DROP TX
P41	INPUT COM	COM RX

For information on the associated TL1 AIDs for the optical power monitoring points, refer the "CTC Port Numbers and TL1 Aids" section in *Cisco ONS SONET TL1 Command Guide, Release 9.2*.

9.8.5 40-DMX-CE Card Channel Plan

Table 9-28 shows the 40 ITU-T 100-GHz-spaced, C-band channels (wavelengths) that are demultiplexed by the 40-DMX-CE card.

Table 9-28 40-DMX-CE Card Channel Plan

Band ID	Channel Label	Frequency (GHz)	Wavelength (nm)
B30.7	30.7	195.85	1530.72
	31.5	195.75	1531.51
	32.3	195.65	1532.29
	33.1	195.55	1533.07
	33.9	195.45	1533.86
B34.6	34.6	195.35	1534.64
	35.4	195.25	1535.43
	36.2	195.15	1536.22
	37.0	195.05	1537.00
	37.8	194.95	1537.79
B38.6	38.6	194.85	1538.58
	39.4	194.75	1539.37
	40.1	194.65	1540.16
	40.9	194.55	1540.95
	41.8	194.45	1541.75

Table 9-28 40-DMX-CE Card Channel Plan (continued)

Band ID	Channel Label	Frequency (GHz)	Wavelength (nm)
B42.5	42.5	194.35	1542.54
	43.3	194.25	1543.33
	44.1	194.15	1544.13
	44.9	194.05	1544.92
	45.7	193.95	1545.72
B46.5	46.5	193.85	1546.52
	47.3	193.75	1547.32
	48.1	193.65	1548.11
	48.9	193.55	1548.91
	49.7	193.45	1549.72
B50.5	50.5	193.35	1550.52
	51.3	193.25	1551.32
	52.1	193.15	1552.12
	52.9	193.05	1552.93
	53.7	192.95	1553.73
B54.4	54.4	192.85	1554.54
	55.3	192.75	1555.34
	56.1	192.65	1556.15
	56.9	192.55	1556.96
	57.8	192.45	1557.77
B58.6	58.6	192.35	1558.58
	59.4	192.25	1559.39
	60.2	192.15	1560.20
	61.0	192.05	1561.01
	61.8	191.95	1561.83

9.8.6 40-DMX-CE Card-Level Indicators

The 40-DMX-CE card has three card-level LED indicators, described in Table 9-29.

Table 9-29 40-DMX-CE Card-Level Indicators

Card-Level Indicators	Description
Red FAIL LED	The red FAIL LED indicates that the card's processor is not ready or that an internal hardware failure occurred. Replace the card if the red FAIL LED persists.

Table 9-29 40-DMX-CE Card-Level Indicators (continued)

Card-Level Indicators	Description
Green ACT LED	The green ACT LED indicates that the 40-DMX-CE card is carrying traffic or is traffic-ready.
Amber SF LED	The amber SF LED indicates a signal failure on one or more of the card's ports. The amber SF LED also turns on when the transmit and receive fibers are incorrectly connected. When the fibers are properly connected, the light turns off.

9.8.7 40-DMX-CE Card Port-Level Indicators

You can find the alarm status of the 40-DMX-CE card ports using the LCD screen on the ONS 15454 fan-tray assembly. The screen displays the number and severity of alarms on a given port or slot. For the procedure to view these counts, refer to the "Manage Alarms" chapter in the *Cisco ONS 15454 DWDM Procedure Guide*.

9.9 40-MUX-C Card

(Cisco ONS 15454 and ONS 15454 M6 only)

Note See the "A.8.5 40-MUX-C Card Specifications" section on page A-30 for hardware specifications.

The single-slot 40-Channel Multiplexer C-band (40-MUX-C) card multiplexes forty ITU-T 100-GHz-spaced channels identified in the channel plan in Table 9-25 on page 9-43. The 40-MUX-C card can be installed in Slots 1 to 6 and 12 to 17. The 40-MUX-C card is typically used in hub nodes.

9.9.1 40-MUX-C Card Faceplate Ports

The 40-MUX-C card has two types of ports:

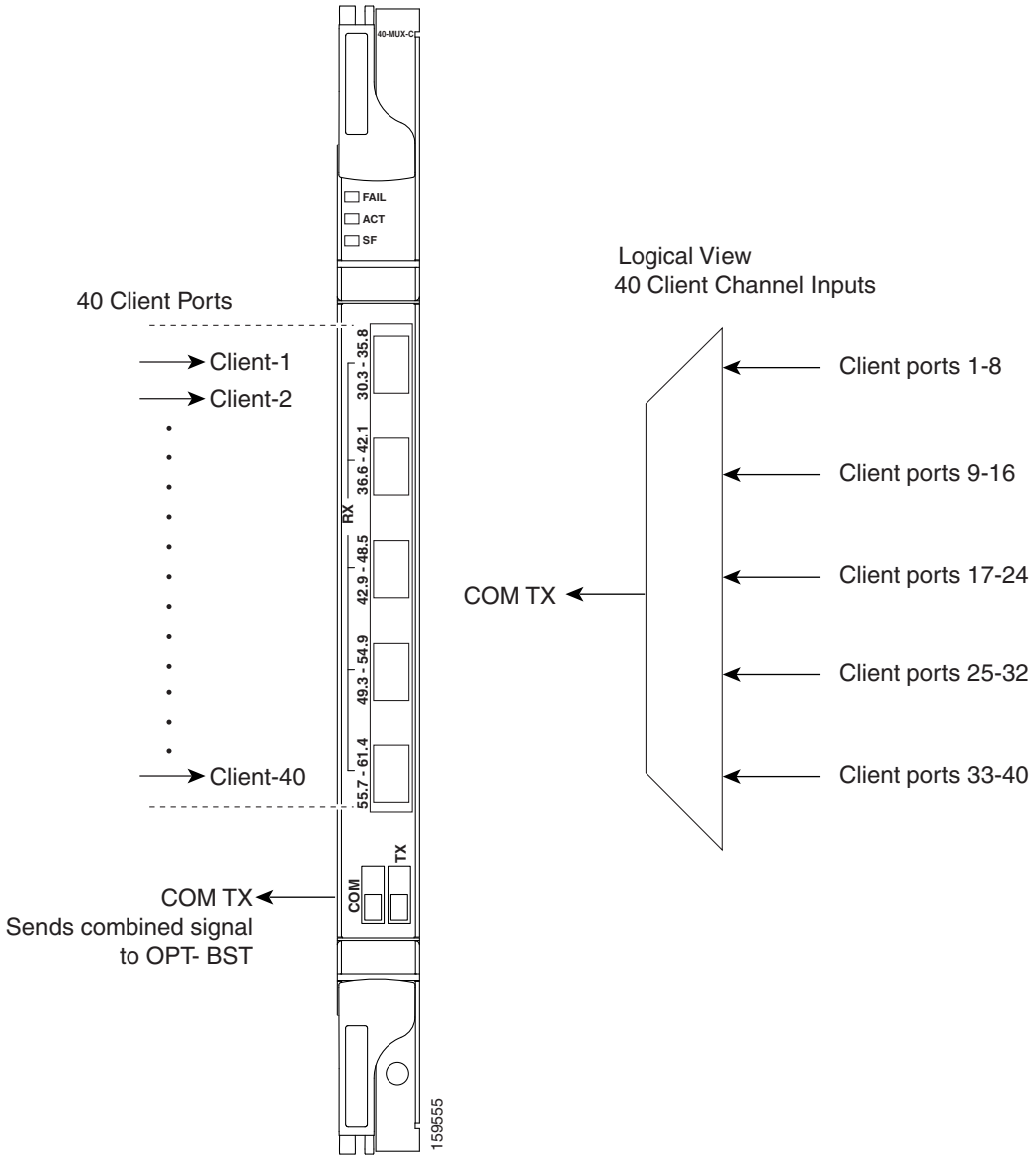
- COM TX port: COM TX is the line output port for the aggregate optical signal being multiplexed. This port is supported by both a VOA for optical power regulation and a photodiode for per channel optical power monitoring.

  Note By default, the VOA is set to its maximum attenuation for safety purposes (for example, electrical power failure). A manual VOA setting is also available.

- DROP RX ports (1 to 40): The 40-MUX-C card provides 40 input optical channels. These ports are connected using five physical receive connectors on the card's front panel that accept MPO cables for the client input interfaces. MPO cables break out into eight separate cables. The 40-DMX-C card also has one LC-PC-II optical connector for the main output. For the wavelength range, see Table 9-25 on page 9-43.

Figure 9-25 shows the 40-MUX-C card faceplate.

Figure 9-25 40-MUX-C Card Faceplate



9.9.2 40-MUX-C Card Block Diagram

Figure 9-26 shows a block diagram of the 40-MUX-C card.

Figure 9-26 40-MUX-C Card Block Diagram

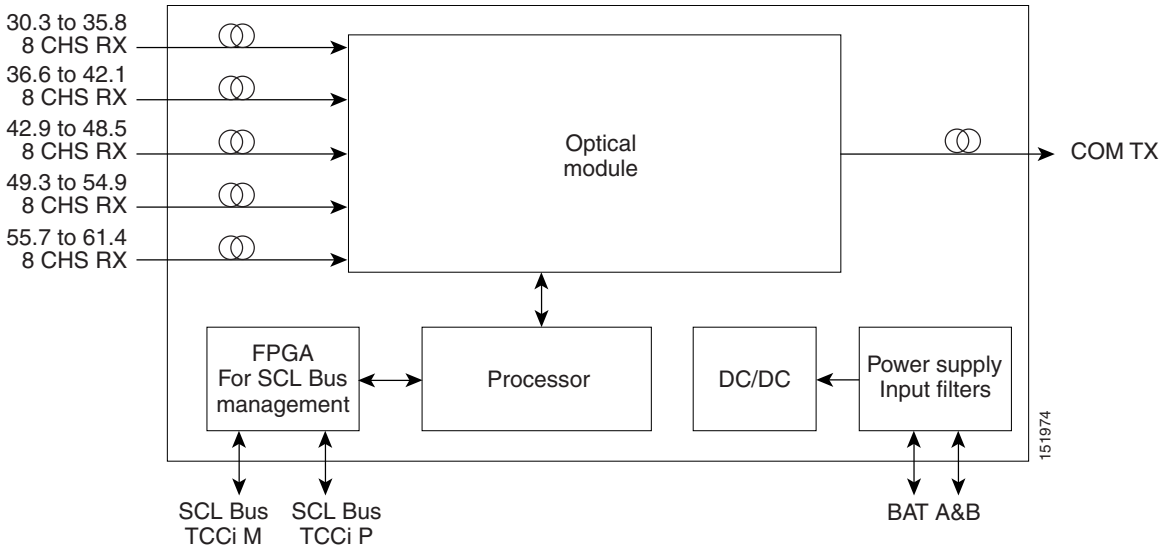
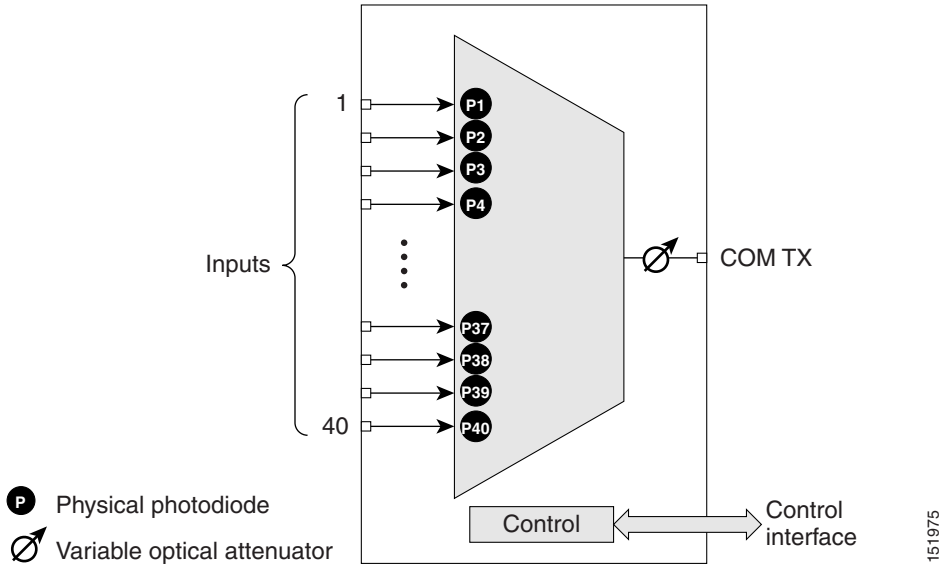


Figure 9-27 shows the 40-MUX-C optical module functional block diagram.

Figure 9-27 40-MUX-C Optical Module Functional Block Diagram



9.9.3 40-MUX-C Card Power Monitoring

Physical photodiodes P1 through P40 monitor the power of the individual input ports to the 40-MUX-C card. P41 monitors the total multiplexed output power, calibrated to the COM-TX port. Table 9-30 shows the returned power level values calibrated to each port.

Table 9-30 40-MUX-C Port Calibration

Photodiode	CTC Type Name	Calibrated to Port
P1–P40	ADD	ADD RX
P41	OUTPUT COM	COM-TX

For information on the associated TL1 AIDs for the optical power monitoring points, refer the "CTC Port Numbers and TL1 Aids" section in *Cisco ONS SONET TL1 Command Guide, Release 9.2*.

9.9.4 40-MUX-C Card Channel Plan

Table 9-31 shows the 40 ITU-T 100-GHz-spaced, C-band channels (wavelengths) that are multiplexed by the 40-MUX-C card.

Table 9-31 40-MUX-C Channel Plan

Band ID	Channel Label	Frequency (GHz)	Wavelength (nm)
B30.3	30.3	195.9	1530.33
	31.1	195.8	1531.12
	31.9	195.7	1531.90
	32.6	195.6	1532.68
	33.4	195.5	1533.47
B34.2	34.2	195.4	1534.25
	35.0	195.3	1535.04
	35.8	195.2	1535.82
	36.6	195.1	1536.61
	37.4	195	1537.40
B38.1	38.1	194.9	1538.19
	38.9	194.8	1538.98
	39.7	194.7	1539.77
	40.5	194.6	1540.56
	41.3	194.5	1541.35
B42.1	42.1	194.4	1542.14
	42.9	194.3	1542.94
	43.7	194.2	1543.73
	44.5	194.1	1544.53
	45.3	194	1545.32

Table 9-31 40-MUX-C Channel Plan (continued)

Band ID	Channel Label	Frequency (GHz)	Wavelength (nm)
B46.1	46.1	193.9	1546.12
	46.9	193.8	1546.92
	47.7	193.7	1547.72
	48.5	193.6	1548.51
	49.3	193.5	1549.32
B50.1	50.1	193.4	1550.12
	50.9	193.3	1550.92
	51.7	193.2	1551.72
	52.5	193.1	1552.52
	53.3	193	1553.33
B54.1	54.1	192.9	1554.13
	54.9	192.8	1554.94
	55.7	192.7	1555.75
	56.5	192.6	1556.55
	57.3	192.5	1557.36
B58.1	58.1	192.4	1558.17
	58.9	192.3	1558.98
	59.7	192.2	1559.79
	60.6	192.1	1560.61
	61.4	192	1561.42

9.9.5 40-MUX-C Card-Level Indicators

The 40-MUX-C card has three card-level LED indicators, described in Table 9-32.

Table 9-32 40-MUX-C Card-Level Indicators

Card-Level Indicators	Description
Red FAIL LED	The red FAIL LED indicates that the card's processor is not ready or that an internal hardware failure occurred. Replace the card if the red FAIL LED persists.
Green ACT LED	The green ACT LED indicates that the 40-MUX-C card is carrying traffic or is traffic-ready.
Amber SF LED	The amber SF LED indicates a signal failure on one or more of the card's ports. The amber SF LED also turns on when the transmit and receive fibers are incorrectly connected. When the fibers are properly connected, the light turns off.

9.9.6 40-MUX-C Port-Level Indicators

You can find the alarm status of the 40-MUX-C card ports using the LCD screen on the ONS 15454 fan-tray assembly. The screen displays the number and severity of alarms on a given port or slot. For the procedure to view these counts, refer to "Manage Alarms" in the *Cisco ONS 15454 DWDM Procedure Guide*.

9.10 40-WSS-C Card

(Cisco ONS 15454 and ONS 15454 M6 only)

Note See the "A.8.8 40-WSS-C Card Specifications" section on page A-32 for hardware specifications.

The double-slot 40-channel Wavelength Selective Switch C-Band (40-WSS-C) card switches 40 ITU-T 100-GHz-spaced channels identified in the channel plan (Table 9-25 on page 9-43) and sends them to dedicated output ports. The 40-WSS-C card is bidirectional and optically passive. The card can be installed in Slots 1 to 6 and 12 to 17

The 40-WSS-C features include:

- Receipt of an aggregate DWDM signal into 40 output optical channels from the Line receive port (EXP RX) in one direction and from the COM-RX port in the other direction.
- Per-channel optical power monitoring using photodiodes.
- Signal splitting in a 70%-to-30% ratio, sent to the 40-DMX-C for dropping signals, then to the other 40-WSS-C card.
- Aggregate DWDM signal monitoring and control through a variable optical attenuator (VOA). In the case of electrical power failure, the VOA is set to its maximum attenuation for safety purposes. A manual VOA setting is also available.

Within the 40-WSS-C card, the first AWG opens the spectrum and each wavelength is directed to one of the ports of a 1x2 optical switch. The same wavelength can be passed through or stopped. If the pass-through wavelength is stopped, a new channel can be added at the ADD port. The card's second AWG multiplexes all of the wavelengths, and the aggregate signal is output through the COM-TX port.

9.10.1 40-WSS-C Faceplate Ports

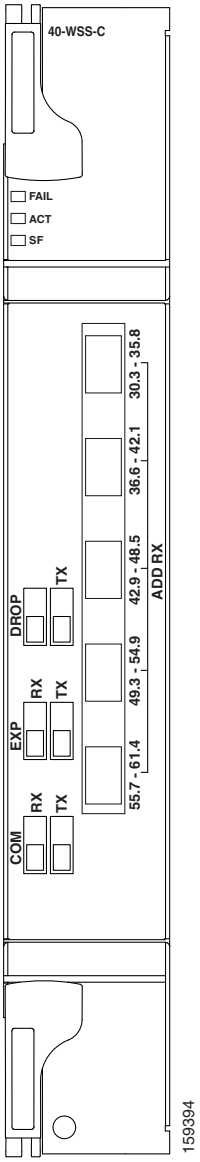
The 40-WSS-C has eight types of ports:

- ADD RX ports (1 to 40): These ports are used for adding channels. Each add channel is associated with an individual switch element that selects whether an individual channel is added. Each add port has optical power regulation provided by a VOA. The five connectors on the card faceplate accept MPO cables for the client input interfaces. MPO cables break out into eight separate cables. The 40-WSS-C card also has one LC-PC-II optical connector for the main input.
- COM RX: The COM RX port receives the optical signal from a preamplifier (such as the OPT-PRE) and sends it to the optical splitter.
- COM TX: The COM TX port sends an aggregate optical signal to a booster amplifier card (for example, the OPT-BST card) for transmission outside of the NE.

- EXP RX port: The EXP RX port receives an optical signal from another 40-WSS-C card in the same NE.
- EXP TX: The EXP TX port sends an optical signal to the other 40-WSS-C card within the NE.
- DROP TX port: The DROP TX port sends the split off optical signal that contains drop channels to the 40-DMX-C card, where the channels are further processed and dropped.

Figure 9-28 shows the 40-WSS-C card faceplate.

Figure 9-28 40-WSS-C Faceplate



9.10.2 40-WSS-C Block Diagram

Figure 9-29 shows a block diagram of the 40-WSS-C card.

Figure 9-29 40-WSS-C Block Diagram

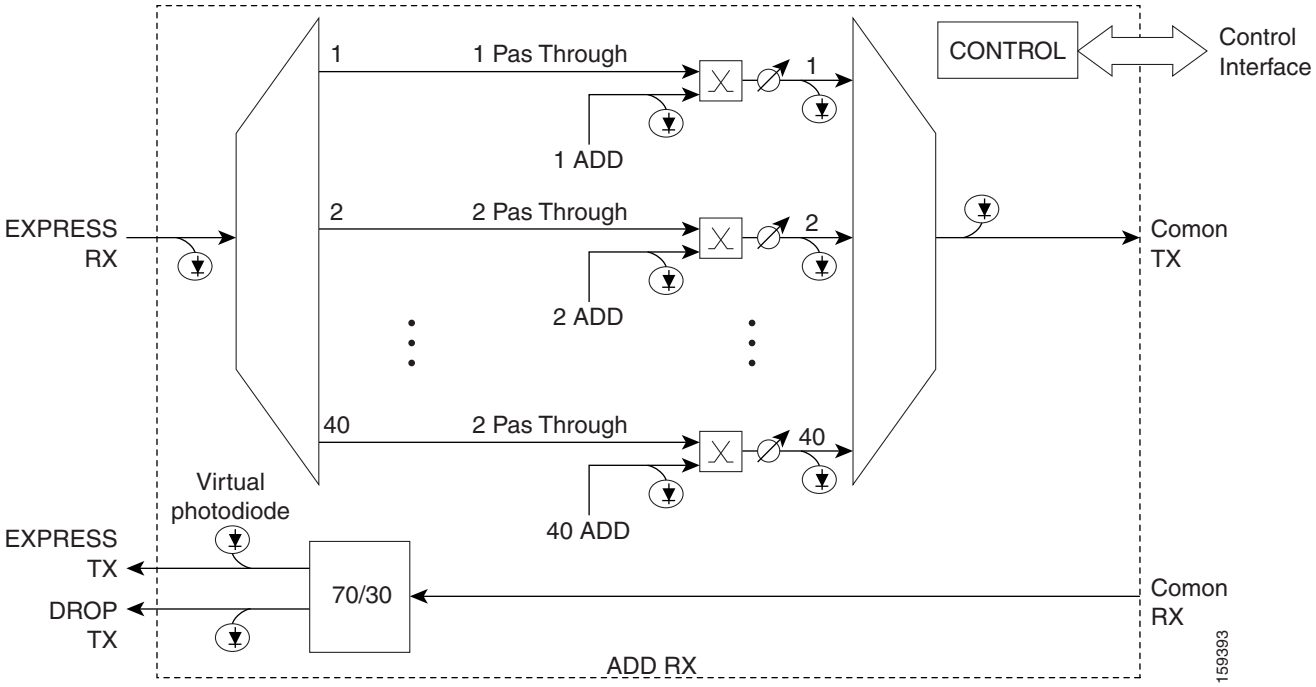
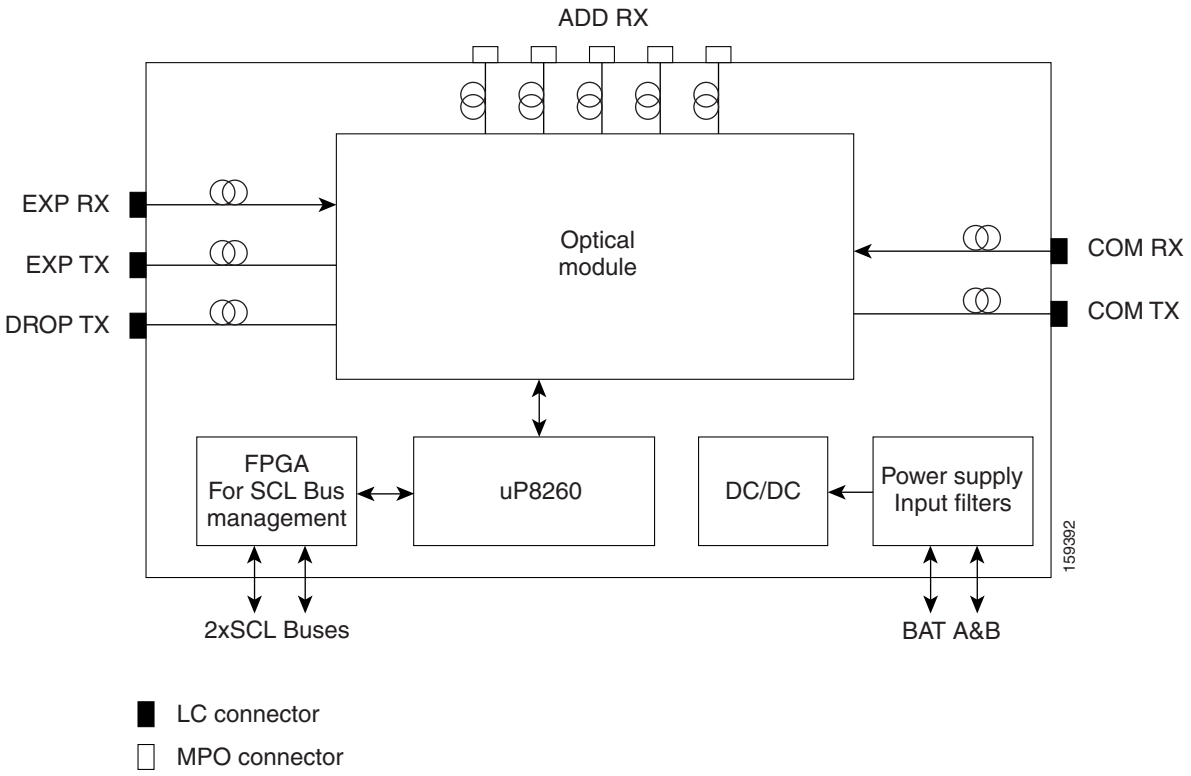


Figure 9-30 shows the 40-WSS-C optical module functional block diagram.

Figure 9-30 40-WSS-C Optical Module Functional Block Diagram



9.10.3 40-WSS-C ROADM Functionality

The 40-WSS-C card works in combination with the 40-DMX-C card to implement ROADM functionality. As a ROADM node, the ONS 15454 can be configured at the optical channel level using CTC, Cisco TransportPlanner, and CTM. ROADM functionality using the 40-WSS-C card requires two 40-WSS-C double-slot cards and two 40-DMX-C single-slot cards (for a total of six slots in the ONS 15454 chassis).

For information about ROADM functionality for other cards, see that card's description in this chapter. For a diagram of a typical ROADM configuration, see the "11.1.3 ROADM Node" section on page 11-10.

9.10.4 40-WSS-C Power Monitoring

The 40-WSS-C has physical diodes that monitor power at various locations on the card. Table 9-33 lists the physical diode descriptions.

Table 9-33 40-WSS-C Physical Photodiode Port Calibration

Physical Photodiode	CTC Type Name	Calibrated to Port(s)
P1	DROP	DROP TX
P2	EXP	EXP RX

Table 9-33 40-WSS-C Physical Photodiode Port Calibration (continued)

Physical Photodiode	CTC Type Name	Calibrated to Port(s)
PD*i*3[1]	RX	Add *i* RX ports (that is, channel input Add *i* RX power), up to 40 ports and therefore 40 PDs[1]
PD*i*4[1]	TX	COM TX port (that is, per channel output COM TX power) up to 40 channels and therefore 40 PDs
PD5	COM	COM TX port (that is, total output COM TX power)

1. *i* indicates any channel from 01 through 40.

For information on the associated TL1 AIDs for the optical power monitoring points, refer the "CTC Port Numbers and TL1 Aids" section in *Cisco ONS SONET TL1 Command Guide, Release 9.2*.

Additionally, the 40-WSS-C has two virtual diodes. Virtual diodes are monitor points for each physical photodiode; they are identified with a physical diode relative to the way that the physical diode is identified with one of the two interlink (ILK) ports. Table 9-34 lists the virtual diodes.

Table 9-34 40-WSS-C Virtual Photodiode Port Calibration

Virtual Photodiode	CTC Type Name	Calibrated to Port(s)
VPD1	COM	COM RX port (total input COM RX power)
VPD2	EXP	EXP TX port (total output EXP TX power)

9.10.5 40-WSS-C Channel Plan

Table 9-35 shows the 40 ITU-T 100-GHz-spaced, C-band channels (wavelengths) that are switched by the 40-WSS-C card.

Table 9-35 40-WSS-C Channel Plan

Band ID	Channel Label	Frequency (GHz)	Wavelength (nm)
B30.3	30.3	195.9	1530.33
	31.1	195.8	1531.12
	31.9	195.7	1531.90
	32.6	195.6	1532.68
	33.4	195.5	1533.47
B34.2	34.2	195.4	1534.25
	35.0	195.3	1535.04
	35.8	195.2	1535.82
	36.6	195.1	1536.61
	37.4	195	1537.40

Table 9-35 40-WSS-C Channel Plan (continued)

Band ID	Channel Label	Frequency (GHz)	Wavelength (nm)
B38.1	38.1	194.9	1538.19
	38.9	194.8	1538.98
	39.7	194.7	1539.77
	40.5	194.6	1540.56
	41.3	194.5	1541.35
B42.1	42.1	194.4	1542.14
	42.9	194.3	1542.94
	43.7	194.2	1543.73
	44.5	194.1	1544.53
	45.3	194	1545.32
B46.1	46.1	193.9	1546.12
	46.9	193.8	1546.92
	47.7	193.7	1547.72
	48.5	193.6	1548.51
	49.3	193.5	1549.32
B50.1	50.1	193.4	1550.12
	50.9	193.3	1550.92
	51.7	193.2	1551.72
	52.5	193.1	1552.52
	53.3	193	1553.33
B54.1	54.1	192.9	1554.13
	54.9	192.8	1554.94
	55.7	192.7	1555.75
	56.5	192.6	1556.55
	57.3	192.5	1557.36
B58.1	58.1	192.4	1558.17
	58.9	192.3	1558.98
	59.7	192.2	1559.79
	60.6	192.1	1560.61
	61.4	192	1561.42

9.10.6 40-WSS-C Card-Level Indicators

The 40-WSS-C card has three card-level LED indicators, described in Table 9-36.

Table 9-36 40-WSS-C Card-Level Indicators

Card-Level Indicators	Description
Red FAIL LED	The red FAIL LED indicates that the card's processor is not ready or that an internal hardware failure occurred. Replace the card if the red FAIL LED persists.
Green ACT LED	The green ACT LED indicates that the 40-WSS-C is carrying traffic or is traffic-ready.
Amber SF LED	The amber SF LED indicates a signal failure on one or more of the card's ports. The amber SF LED also turns on when the transmit and receive fibers are incorrectly connected. When the fibers are properly connected, the light turns off.

9.10.7 40-WSS-C Port-Level Indicators

You can find the alarm status of the 40-WSS-C card ports using the LCD screen on the ONS 15454 fan-tray assembly. The screen displays the number and severity of alarms on a given port or slot. For the procedure to view these counts, refer to the "Manage Alarms" chapter in the *Cisco ONS 15454 DWDM Procedure Guide*.

9.11 40-WSS-CE Card

(Cisco ONS 15454 and ONS 15454 M6 only)

Note See the "A.8.9 40-WSS-CE Card Specifications" section on page A-34 for hardware specifications.

The double-slot 40-channel Wavelength Selective Switch Even-Channel C-Band (40-WSS-CE) card switches 40 ITU-T 100-GHz-spaced channels identified in the channel plan (Table 9-39 on page 9-66) and sends them to dedicated output ports. The 40-WSS-CE card is bidirectional and optically passive. The card can be installed in Slots 1 to 6 and 12 to 17.

The 40-WSS-CE features include:

- Receipt of an aggregate DWDM signal into 40 output optical channels from the Line receive port (EXP RX) in one direction and from the COM-RX port in the other direction.
- Per-channel optical power monitoring using photodiodes.
- Signal splitting in a 70-to-30 percent ratio, sent to the 40-DMX-CE card for dropping signals, then to the other 40-WSS-CE card.
- Aggregate DWDM signal monitoring and control through a VOA. In the case of electrical power failure, the VOA is set to its maximum attenuation for safety purposes. A manual VOA setting is also available.

Within the 40-WSS-CE card, the first AWG opens the spectrum and each wavelength is directed to one of the ports of a 1x2 optical switch. The same wavelength can be passed through or stopped. If the pass-through wavelength is stopped, a new channel can be added at the ADD port. The card's second AWG multiplexes all of the wavelengths, and the aggregate signal is output through the COM-TX port.

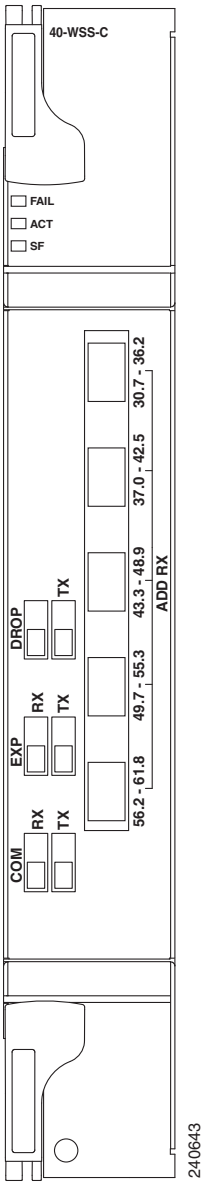
9.11.1 40-WSS-CE Faceplate Ports

The 40-WSS-CE card has eight types of ports:

- ADD RX ports (1 to 40): These ports are used for adding channels. Each add channel is associated with an individual switch element that selects whether an individual channel is added. Each add port has optical power regulation provided by a VOA. The five connectors on the card faceplate accept MPO cables for the client input interfaces. MPO cables break out into eight separate cables. The 40-WSS-CE card also has one LC-PC-II optical connector for the main input.
- COM RX: The COM RX port receives the optical signal from a preamplifier (such as the OPT-PRE) and sends it to the optical splitter.
- COM TX: The COM TX port sends an aggregate optical signal to a booster amplifier card (for example, the OPT-BST card) for transmission outside of the NE.
- EXP RX port: The EXP RX port receives an optical signal from another 40-WSS-CE card in the same NE.
- EXP TX: The EXP TX port sends an optical signal to the other 40-WSS-CE card within the NE.
- DROP TX port: The DROP TX port sends the split off optical signal that contains drop channels to the 40-DMX-C card, where the channels are further processed and dropped.

Figure 9-31 shows the 40-WSS-CE card faceplate.

Figure 9-31 40-WSS-CE Faceplate



9.11.2 40-WSS-CE Card Block Diagram

Figure 9-32 shows a block diagram of the 40-WSS-CE card.

Figure 9-32 40-WSS-CE Block Diagram

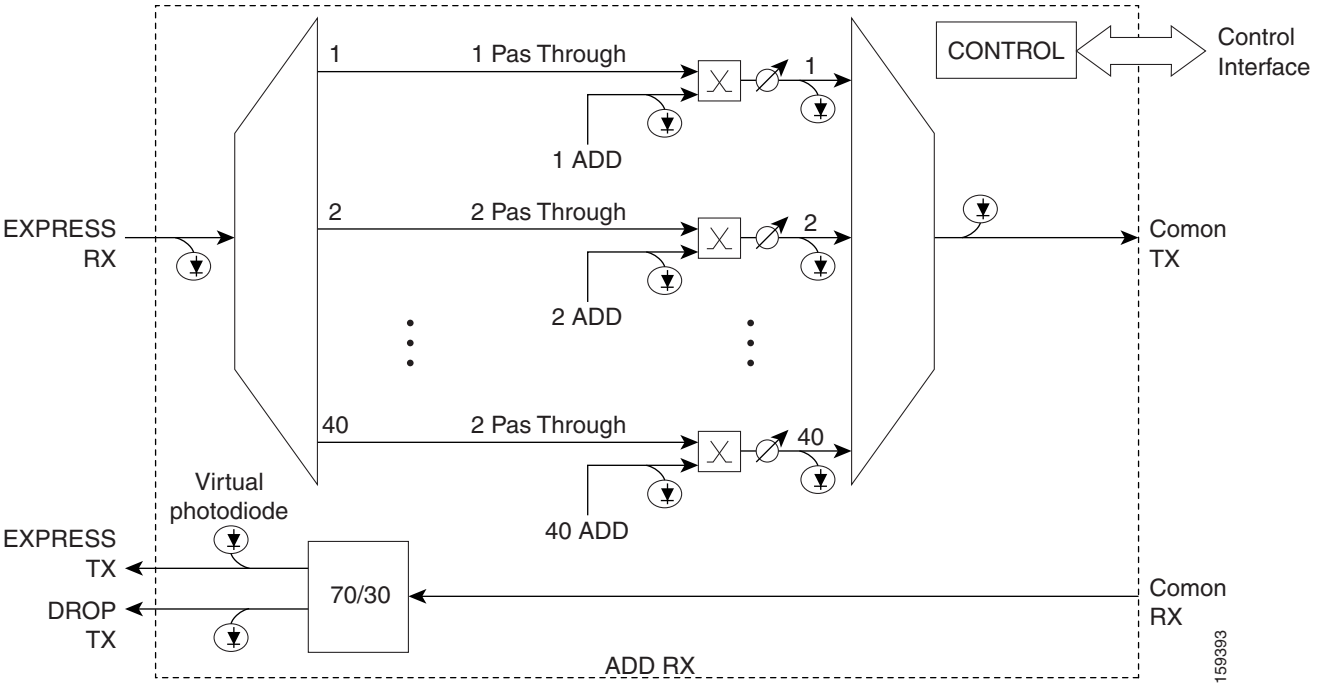
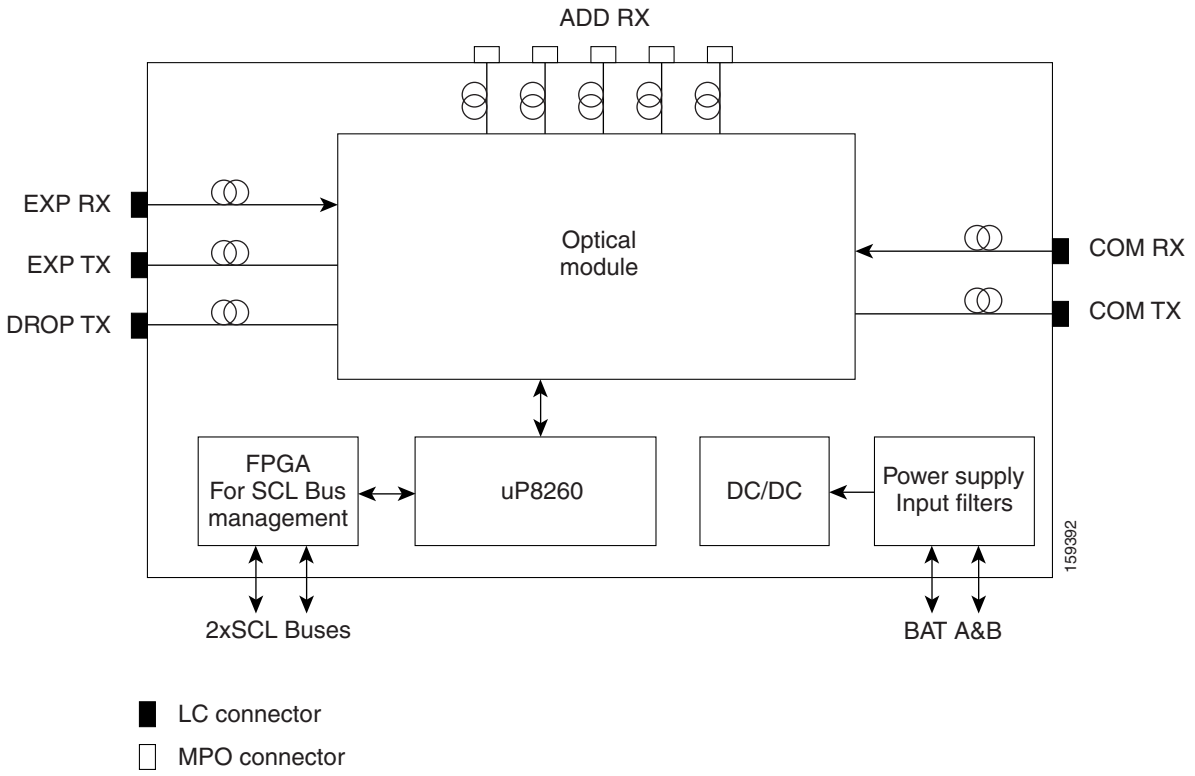


Figure 9-33 shows the 40-WSS-CE optical module functional block diagram.

Figure 9-33 40-WSS-CE Card Optical Module Functional Block Diagram



9.11.3 40-WSS-CE Card ROADM Functionality

The 40-WSS-CE card works in combination with the 40-DMX-CE card to implement ROADM functionality. As a ROADM node, the ONS 15454 can be configured at the optical channel level using CTC, Cisco TransportPlanner, and CTM. ROADM functionality using the 40-WSS-CE card requires two 40-WSS-CE double-slot cards and two 40-DMX-CE single-slot cards (for a total of six slots in the ONS 15454 chassis).

For information about ROADM functionality for another cards, see the description of that card in this chapter. For a diagram of a typical ROADM configuration, see the "11.1.3 ROADM Node" section on page 11-10.

9.11.4 40-WSS-CE Card Power Monitoring

The 40-WSS-CE card has physical diodes that monitor power at various locations on the card. Table 9-37 lists the physical diode descriptions.

Table 9-37 40-WSS-CE Physical Photodiode Port Calibration

Physical Photodiode	CTC Type Name	Calibrated to Port(s)
P1	DROP	DROP TX
P2	EXP	EXP RX

Table 9-37 40-WSS-CE Physical Photodiode Port Calibration (continued)

Physical Photodiode	CTC Type Name	Calibrated to Port(s)
PD*i*3[1]	RX	Add *i* RX ports (that is, channel input Add *i* RX power), up to 40 ports and therefore 40 PDs[1]
PD*i*4[1]	TX	COM TX port (that is, per channel output COM TX power) up to 40 channels and therefore 40 PDs
PD5	COM	COM TX port (that is, total output COM TX power)

1. *i* indicates any channel from 01 through 40.

For information on the associated TL1 AIDs for the optical power monitoring points, refer the "CTC Port Numbers and TL1 Aids" section in *Cisco ONS SONET TL1 Command Guide, Release 9.2*.

Additionally, the 40-WSS-CE card has two virtual diodes. Virtual diodes are monitor points for each physical photodiode; they are identified with a physical diode relative to the way that the physical diode is identified with one of the two interlink (ILK) ports. Table 9-38 lists the virtual diodes.

Table 9-38 40-WSS-CE Virtual Photodiode Port Calibration

Virtual Photodiode	CTC Type Name	Calibrated to Port(s)
VPD1	COM	COM RX port (total input COM RX power)
VPD2	EXP	EXP TX port (total output EXP TX power)

9.11.5 40-WSS-CE Card Channel Plan

Table 9-39 shows the 40 ITU-T 100-GHz-spaced, C-band channels (wavelengths) that are switched by the 40-WSS-CE card.

Table 9-39 40-WSS-CE Channel Plan

Band ID	Channel Label	Frequency (GHz)	Wavelength (nm)
B30.7	30.7	195.85	1530.72
	31.5	195.75	1531.51
	32.3	195.65	1532.29
	33.1	195.55	1533.07
	33.9	195.45	1533.86
B34.6	34.6	195.35	1534.64
	35.4	195.25	1535.43
	36.2	195.15	1536.22
	37.0	195.05	1537.00
	37.8	194.95	1537.79

Table 9-39 40-WSS-CE Channel Plan (continued)

Band ID	Channel Label	Frequency (GHz)	Wavelength (nm)
B38.6	38.6	194.85	1538.58
	39.4	194.75	1539.37
	40.1	194.65	1540.16
	40.9	194.55	1540.95
	41.8	194.45	1541.75
B42.5	42.5	194.35	1542.54
	43.3	194.25	1543.33
	44.1	194.15	1544.13
	44.9	194.05	1544.92
	45.7	193.95	1545.72
B46.5	46.5	193.85	1546.52
	47.3	193.75	1547.32
	48.1	193.65	1548.11
	48.9	193.55	1548.91
	49.7	193.45	1549.72
B50.5	50.5	193.35	1550.52
	51.3	193.25	1551.32
	52.1	193.15	1552.12
	52.9	193.05	1552.93
	53.7	192.95	1553.73
B54.4	54.4	192.85	1554.54
	55.3	192.75	1555.34
	56.1	192.65	1556.15
	56.9	192.55	1556.96
	57.8	192.45	1557.77
B58.6	58.6	192.35	1558.58
	59.4	192.25	1559.39
	60.2	192.15	1560.20
	61.0	192.05	1561.01
	61.8	191.95	1561.83

9.11.6 40-WSS-CE Card-Level Indicators

The 40-WSS-CE card has three card-level LED indicators, described in Table 9-40.

Table 9-40 40-WSS-CE Card-Level Indicators

Card-Level Indicators	Description
Red FAIL LED	The red FAIL LED indicates that the card's processor is not ready or that an internal hardware failure occurred. Replace the card if the red FAIL LED persists.
Green ACT LED	The green ACT LED indicates that the 40-WSS-CE card is carrying traffic or is traffic-ready.
Amber SF LED	The amber SF LED indicates a signal failure on one or more of the card's ports. The amber SF LED also turns on when the transmit and receive fibers are incorrectly connected. When the fibers are properly connected, the light turns off.

9.11.7 40-WSS-CE Card Port-Level Indicators

You can find the alarm status of the 40-WSS-CE card ports using the LCD screen on the ONS 15454 fan-tray assembly. The screen displays the number and severity of alarms on a given port or slot. For the procedure to view these counts, refer to the "Manage Alarms" chapter in the *Cisco ONS 15454 DWDM Procedure Guide*.

9.12 40-WXC-C Card

(Cisco ONS 15454 and ONS 15454 M6 only)

Note See the "A.8.10 40-WXC-C Card Specifications" section on page A-37 or hardware specifications.

The double-slot 40-channel Wavelength Cross-Connect C-band (40-WXC-C) card selectively sends any wavelength combination coming from nine input ports to a common output port. The device can manage up to 41 channels spaced at 100GHz on each port according to the channel grid in Table 9-10 on page 9-11. Each channel can be selected from any input. The card is optically passive and provides bidirectional capability. It can be installed in Slots 1 to 6 and 12 to 17.

.The 40-WXC-C card provides the following features:

- Demultiplexing, selection, and multiplexing of DWDM aggregate signal from input ports to common output port.
- Aggregate DWDM signal monitoring and control through a VOA.
- VOAs are deployed in every channel path in order to regulate the channel's optical power. In the case of an electrical power failure, VOAs are set to their maximum attenuation value, or to a fixed and configurable one. The VOA can also be set manually.
- Per-channel optical power monitoring using photodiodes.

The 40-WXC-C card acts as a selector element with the following characteristics:

- It is able to select a wavelength from one input port and pass the wavelength through to the common out port. Simultaneously, the card can block the same wavelength coming from the other eight input ports.
- It is able to stop wavelengths from all nine inputs.

- It is able to monitor optical power and control path attenuation using per channel VOA independently of the wavelength input-to-out port connection.

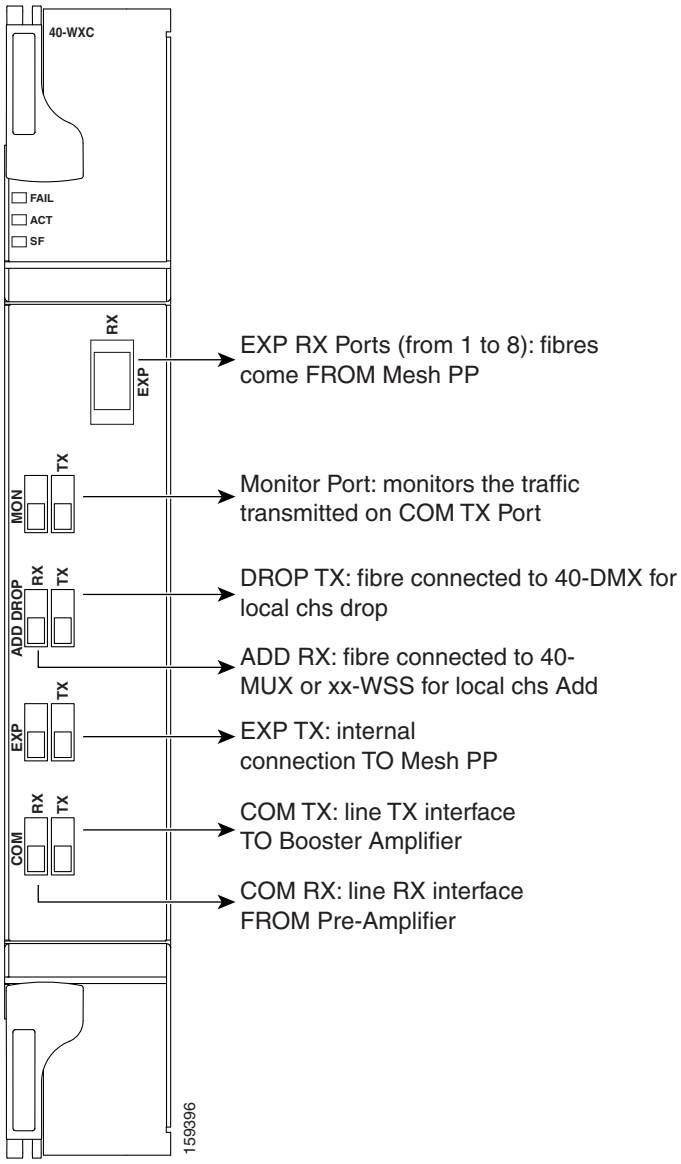
9.12.1 40-WXC-C Faceplate Ports

The 40-WXC-C card has six types of ports:

- COM RX: The COM RX port receives the optical signal from a preamplifier (such as the OPT-PRE) and sends it to the optical splitter.
- COM TX: The COM TX port sends an aggregate optical signal to a booster amplifier card (for example, the OPT-BST card) for transmission outside of the NE.
- EXP TX: The EXP TX port sends an optical signal to the other 40-WXC-C card within the NE.
- MON TX: The optical service channel (OSC) monitor.
- ADD/DROP RX: The 40-WXC-C card provides 40 input optical channels. For the wavelength range, see Table 9-43 on page 9-73.
- ADD/DROP TX: The DROP TX port sends the split off optical signal that contains drop channels to the 40-WXC-C card, where the channels are further processed and dropped.

Figure 9-34 shows the 40-WXC-C card faceplate.

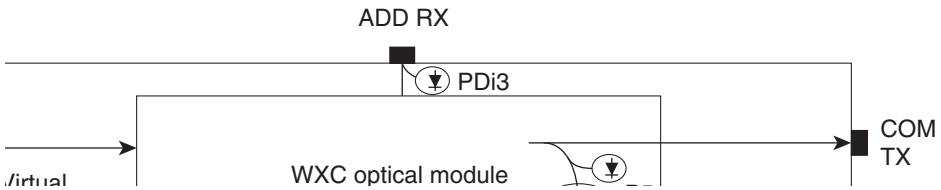
Figure 9-34 40-WXC-C Faceplate



9.12.2 40-WXC-C Block Diagram

Figure 9-35 shows the 40-WXC-C optical module functional block diagram.

Figure 9-35 40-WXC-C Optical Module Functional Block Diagram



9.12.3 40-WXC-C Power Monitoring

The 40-WXC-C has 83 physical diodes (P1 through P40) that monitor power at the outputs of the card. Table 9-41 describes the physical diodes.

Table 9-41 40-WXC-C Physical Photodiode Port Calibration

Physical Photodiode	CTC Type Name	Calibrated to Port(s)
P1	DROP	DROP TX
P2	EXP	EXP RX
PD*i*3[1]	RX	Add *i* RX ports (that is, channel input Add *i* RX power), up to 40 ports and therefore 40 PDs[1]
PD*i*4[1]	TX	COM TX port (that is, per channel output COM TX power) up to 40 channels and therefore 40 PDs
PD5	COM	COM TX port (that is, total output COM TX power)

1. *i* indicates any channel from 01 through 40.

For information on the associated TL1 AIDs for the optical power monitoring points, refer the "CTC Port Numbers and TL1 Aids" section in *Cisco ONS SONET TL1 Command Guide, Release 9.2.*

Additionally, the 40-WXC-C has two virtual diodes. Virtual diodes are monitor points for each physical photodiode; they are identified with a physical diode relative to the way that the physical diode is identified with one of the two interlink (ILK) ports. Table 9-42 lists the virtual diodes.

Table 9-42 40-WXC-C Virtual Photodiode Port Calibration

Virtual Photodiode	CTC Type Name	Calibrated to Port(s)
VPD1	COM	COM RX port (total input COM RX power)
VPD2	EXP	EXP TX port (total output EXP TX power)

The usage of WXC and mesh PP power readings to troubleshoot a LOS-P in WXC COM TX port in Side A is described in the following example. The example is explained assuming a single wavelength 1558.17 in the setup that comes from Side H to Side A. If there is more than one wavelength, then there is a risk of dropping traffic when pulling common fibers. The example is explained below:

When the wavelength from side H is 1558.17, you can check the power reading at WXC EXP TX port of the WXC card and verify the consistency with side H pre output power and WXC COMRX-EXPTX port loss. You can also check with a power meter connected to the 8th fiber (since it is from side H) of an MPO-FC (or LC) cable connected to the TAP-TX port of the MESH-PP. This value should be consistent with the previous reading, less than the insertion loss of the installed PP-MESH. If it is consistent, the issue is with the MPO between side A WXC and PP-MESH. If it is not consistent, the issue is with the PP-MESH or the LC-LC from side H. With only the PP-MESH already tested during installation, the only issue can be with the patch cord b.

You can check if the 1558.17 wavelength from side H is unequalized (that is, if the channel is not aligned with the linear fit of the power values of the other channels) by keeping the DMX COM-RX port of side H in maintenance, and checking both the signal and ASE levels of CHAN-TX ports of the DMX card. If the channel is equalized (that is, if the channel is aligned with the linear fit of the power values of the other channels), then the issue is in the WXC side A that cannot properly regulate the VOA for such channel. If the channel is unequalized, then the issue is on a remote node.

Note With an OSA or a spare 40 DMX, you can see the light coming from all the sides from TAP-TX of the PP-MESH.

9.12.4 40-WXC-C Channel Plan

Table 9-43 shows the 40 ITU-T 100-GHz-spaced, C-band channels (wavelengths) that are cross connected by the 40-WXC-C card.

Table 9-43 40-WXC-C Channel Plan

Band ID	Channel Label	Frequency (GHz)	Wavelength (nm)
Ch. 0[1]	29.5	196	1529.55
B30.3	30.3	195.9	1530.33
	31.1	195.8	1531.12
	31.9	195.7	1531.90
	32.6	195.6	1532.68
	33.4	195.5	1533.47
B34.2	34.2	195.4	1534.25
	35.0	195.3	1535.04
	35.8	195.2	1535.82
	36.6	195.1	1536.61
	37.4	195	1537.40
B38.1	38.1	194.9	1538.19
	38.9	194.8	1538.98
	39.7	194.7	1539.77
	40.5	194.6	1540.56
	41.3	194.5	1541.35
B42.1	42.1	194.4	1542.14
	42.9	194.3	1542.94
	43.7	194.2	1543.73
	44.5	194.1	1544.53
	45.3	194	1545.32
B46.1	46.1	193.9	1546.12
	46.9	193.8	1546.92
	47.7	193.7	1547.72
	48.5	193.6	1548.51
	49.3	193.5	1549.32
B50.1	50.1	193.4	1550.12
	50.9	193.3	1550.92
	51.7	193.2	1551.72
	52.5	193.1	1552.52
	53.3	193	1553.33

Table 9-43 40-WXC-C Channel Plan (continued)

Band ID	Channel Label	Frequency (GHz)	Wavelength (nm)
B54.1	54.1	192.9	1554.13
	54.9	192.8	1554.94
	55.7	192.7	1555.75
	56.5	192.6	1556.55
	57.3	192.5	1557.36
B58.1	58.1	192.4	1558.17
	58.9	192.3	1558.98
	59.7	192.2	1559.79
	60.6	192.1	1560.61
	61.4	192	1561.42

1. This channel is unused by the 40-WXC-C

9.12.5 40-WXC-C Card-Level Indicators

The 40-WXC-C card has three card-level LED indicators described in Table 9-44.

Table 9-44 40-WXC-C Card-Level Indicators

Card-Level Indicators	Description
Red FAIL LED	The red FAIL LED indicates that the card's processor is not ready or that an internal hardware failure occurred. Replace the card if the red FAIL LED persists.
Green ACT LED	The green ACT LED indicates that the 40-WXC-C is carrying traffic or is traffic-ready.
Amber SF LED	The amber SF LED indicates a signal failure on one or more of the card's ports. The amber SF LED also turns on when the transmit and receive fibers are incorrectly connected. When the fibers are properly connected, the light turns off.

9.12.6 40-WXC-C Port-Level Indicators

You can find the alarm status of the 40-WXC-C card ports using the LCD screen on the ONS 15454 fan-tray assembly. The screen displays the number and severity of alarms on a given port or slot. For the procedure to view these counts, refer to "Manage Alarms" in the *Cisco ONS 15454 DWDM Procedure Guide*.

9.13 80-WXC-C Card

(Cisco ONS 15454 and ONS 15454 M6 only)

Note See the "A.8.11 80-WXC-C Card Specifications" section on page A-38 or hardware specifications.

The double-slot 80-channel Wavelength Cross-Connect C-band (80-WXC-C) card manages up to 80 ITU-T 100-GHz-spaced channels identified in the channel plan (Table 9-10 on page 9-11) and sends them to dedicated output ports. Each channel can be selected from any input port to any output port. The card is optically passive, and provides bidirectional capability. It can be installed in Slots 1 to 5 and 12 to 16 the ONS 15454 chassis and Slots 2 to 6 in the ONS 15454 M6 chassis.

The 80-WXC-C card provides the following functionalities:

- When used in the multiplexer or bidirectional mode, the 80-WXC-C card allows selection of a single wavelength or any combination of wavelengths from any of the nine input ports to the common output port.
- When used in the bidirectional mode, the output wavelength from the COM-RX port is split to manage the express and drop wavelengths.
- When used in the demultiplexer mode, the 80-WXC-C card, allows selection of a single wavelength or a combination of wavelengths from the common input port to any of the nine output ports.
- Automatic VOA shutdown (AVS) blocking state on each wavelength and port.
- Per-channel (closed loop) power regulation on the output port based on OCM block feedback.
- Per-channel (open loop) attenuation regulation on the output port which is not based on the OCM feedback.

The OCM unit provides per-channel optical power monitoring on the following ports:

- COM port in output direction
- COM port in input direction
- DROP-TX port in output direction
- Eight Express/Add/Drop (EAD) ports and one Add/Drop (AD) port in both input and output directions

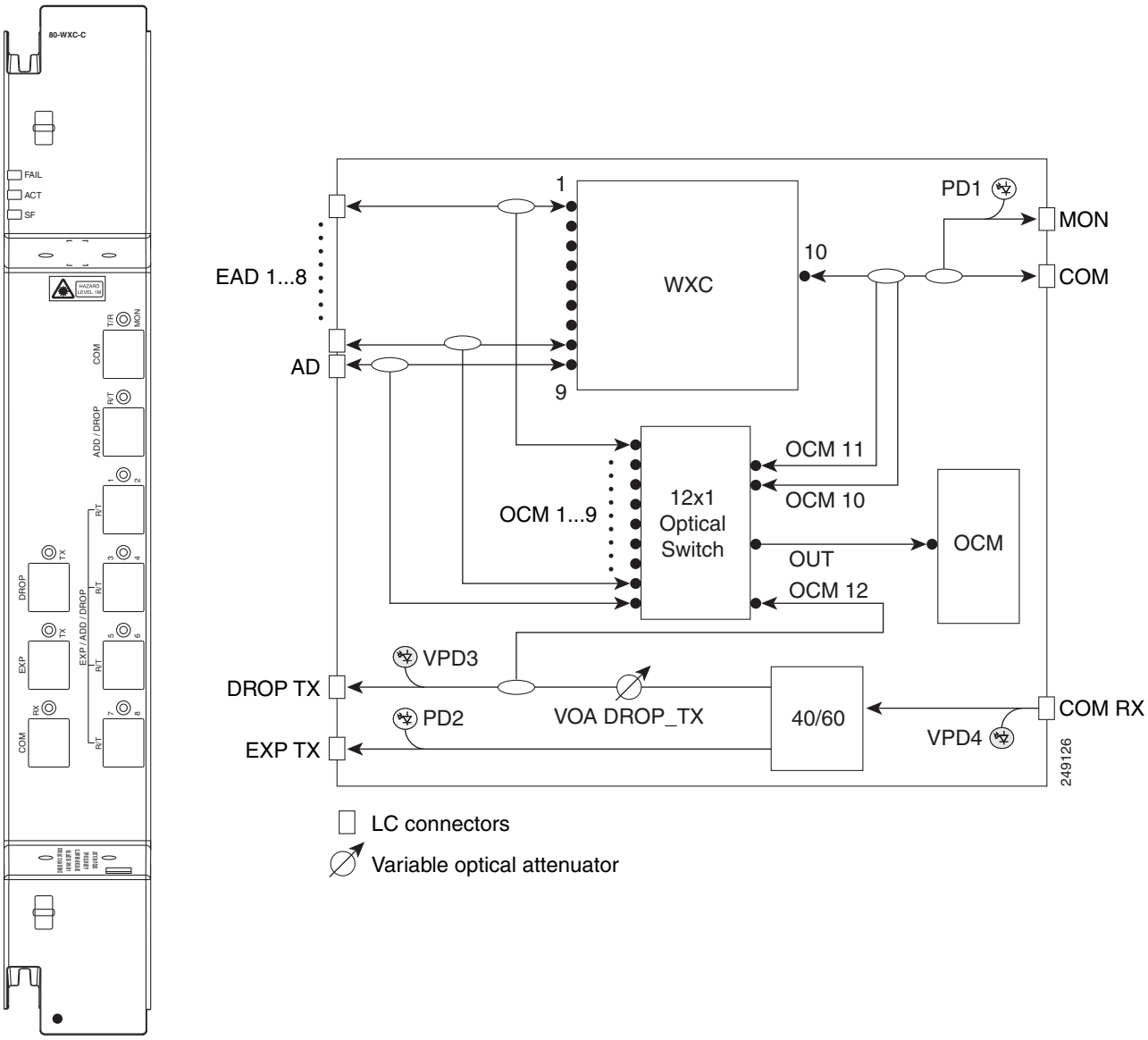
9.13.1 80-WXC-C Faceplate and Optical Module Functional Block Diagram

The 80-WXC-C card has 14 types of ports:

- MON: The MON port monitors power on the COM T/R port.
- COM RX: The COM RX port receives the optical signal from a preamplifier (such as the OPT-PRE) and sends it to the optical splitter.
- DROP TX: In the bidirectional mode, the DROP TX port sends the optical signal to the demultiplexer.
- EXP TX: The EXP TX port sends the split off optical signal that contains pass-through channels to the other side of the NE .
- COM T/R: The COM port is bidirectional. It functions as a COM TX port in the multiplexer mode and as a COM RX port in the demultiplexer mode.
- AD T/R: The AD port functions as ADD RX port in bidirectional and multiplexer modes and as a DROP port in the demultiplexer mode.
- EAD T/R *i* (where i = 1 to 8): The EAD ports function as EXP ports in the bidirectional mode, as ADD ports in the multiplexer mode, and as DROP ports in the demultiplexer mode.

Figure 9-36 shows the 80-WXC-C card faceplate and the optical module functional block diagram.

Figure 9-36 80-WXC-C Faceplate and the Optical Module Functional Block Diagram



The different units of the 80-WXC-C card are:

- 40/60 splitter with VOA on drop path—The preamplifier output signal from the preamplifier is split in a 40%-to-60% ratio; 40% is sent on the drop path (DROP-TX port) and 60% is sent on the pass-through path (EXP-TX port). The VOA equipped on the drop path is used to match the power range of the receiver photodiode without the need for bulk attenuation. If a channel is expected to be dropped in the 80-WXC-C card, the pass-through channel is stopped after the EXP-TX port either by a 40-WSS-C or a 40-WXC-C card.
- 50 Ghz 10 port WXC—The WXC block is optically passive and has bidirectional capability. The WXC block can selectively send any wavelength combination coming from the eight input EAD ports and one AD port to a common (COM) output port, when used as a multiplexer, whereas it can selectively send any wavelength combination coming from its common (COM) input port to any of the eight output EAD ports and one AD port, when used as a demultiplexer. The WXC block can manage (on each port) up to 80 channels according to the channel grid reported in Table 9-47. Each channel can be selected from any input and routed to any output.
- 50 Ghz Optical Channel Monitor (OCM)—The OCM provides per channel power monitoring on the COM T/R, DROP-TX, AD, and EAD*i* (*i*=1 to 8) ports. The power value for each wavelength is refreshed after a variable timer depending on the port and card activity.

9.13.2 80-WXC-C Power Monitoring

The 80-WXC-C has two physical photodiodes and an OCM unit that monitors power at the different ports of the card. Table 9-45 describes the physical photodiodes.

Table 9-45 80-WXC-C Port Calibration

Physical Photodiode	CTC Type Name	Calibrated to Port(s)
PD1	COM Total Power	COM
PD2	EXP-TX Total Power	EXP-TX
OCM1	EAD 1 Per-Channel and Total Power	EAD-1
OCM2	EAD 2 Per-Channel and Total Power	EAD-2
OCM3	EAD 3 Per-Channel and Total Power	EAD-3
OCM4	EAD 4 Per-Channel and Total Power	EAD-4
OCM5	EAD 5 Per-Channel and Total Power	EAD-5
OCM6	EAD 6 Per-Channel and Total Power	EAD-6
OCM7	EAD 7 Per-Channel and Total Power	EAD-7
OCM8	EAD 8 Per-Channel and Total Power	EAD-8
OCM9	AD Per-Channel and Total Power	AD
OCM10	Output Per-Channel and Total Power	COM
OCM11	Input Per-Channel and Total Power	COM
OCM12	Drop Per-Channel and Total Power	DROP-TX

For information on the associated TL1 AIDs for the optical power monitoring points, see the “CTC Port Numbers and TL1 Aids” section in the *Cisco ONS SONET TL1 Command Guide, Release 9.2.*

Additionally, the 80-WXC-C has two virtual photodiodes. Table 9-46 lists the virtual photodiodes.

Table 9-46 80-WXC-C Virtual Photodiode Port Calibration

Virtual Photodiode	CTC Type Name	Calibrated to Port(s)
VPD3	DROP-TX Total Power	DROP-TX
VPD4	COM-RX Total Power	COM-RX

9.13.3 80-WXC-C Channel Plan

Table 9-47 shows the 80 ITU-T 50-GHz-spaced, C-band channels (wavelengths) that are cross connected by the 80-WXC-C card.

Table 9-47 80-WXC-C Channel Plan

Band ID	Channel Label	Frequency (THz)	Wavelength (nm)
Ch. 0[1]	-	196	1529.55
30.3	30.3	195.9	1530.33
	30.7	195.85	1530.72
	31.1	195.8	1531.12
	31.5	195.75	1531.51
	31.9	195.7	1531.90
	32.3	195.65	1532.29
	32.7	195.6	1532.68
	33.1	195.55	1533.07
	33.5	195.5	1533.47
	33.9	195.45	1533.86
34.3	34.3	195.4	1534.25
	34.6	195.35	1534.64
	35.0	195.3	1535.04
	35.4	195.25	1535.43
	35.8	195.2	1535.82
	36.2	195.15	1536.22
	36.6	195.1	1536.61
	37.0	195.05	1537
	37.4	195	1537.40
	37.8	194.95	1537.79

Table 9-47 80-WXC-C Channel Plan (continued)

Band ID	Channel Label	Frequency (THz)	Wavelength (nm)
38.2	38.2	194.9	1538.19
	38.6	194.85	1538.58
	39.0	194.8	1538.98
	39.4	194.75	1539.37
	39.8	194.7	1539.77
	40.2	194.65	1540.16
	40.6	194.6	1540.56
	41.0	194.55	1540.95
	41.3	194.5	1541.35
	41.7	194.45	1541.75
42.1	42.1	194.4	1542.14
	42.5	194.35	1542.94
	42.9	194.3	1542.94
	43.3	194.25	1543.33
	43.7	194.2	1543.73
	44.1	194.15	1544.13
	44.5	194.1	1544.53
	44.9	194.05	1544.92
	45.3	194	1545.32
	45.7	193.95	1545.72
46.1	46.1	193.9	1546.12
	46.5	193.85	1546.52
	46.9	193.8	1546.92
	47.3	193.75	1547.32
	47.7	193.7	1547.72
	48.1	193.65	1548.11
	48.5	193.6	1548.51
	48.9	193.55	1548.91
	49.3	193.5	1549.32
	49.7	193.45	1549.72

Table 9-47 80-WXC-C Channel Plan (continued)

Band ID	Channel Label	Frequency (THz)	Wavelength (nm)
50.1	50.1	193.4	1550.12
	50.5	193.35	1550.52
	50.9	193.3	1550.92
	51.3	193.25	1551.32
	51.7	193.2	1551.72
	52.1	193.15	1552.12
	52.5	193.1	1552.52
	52.9	193.05	1552.93
	53.3	193	1553.33
	53.7	192.95	1553.73
54.1	54.1	192.9	1554.13
	54.5	192.85	1554.54
	54.9	192.8	1554.94
	55.3	192.75	1555.34
	55.7	192.7	1555.75
	56.2	192.65	1556.15
	56.6	192.6	1556.55
	57.0	192.55	1556.96
	57.4	192.5	1557.36
	57.8	192.45	1557.77
58.2	58.2	192.4	1558.17
	58.6	192.35	1558.58
	59.0	192.3	1558.98
	59.4	192.25	1559.39
	59.8	192.2	1559.79
	60.2	192.15	1560.20
	60.6	192.1	1560.61
	61.0	192.05	1561.01
	61.4	192	1561.42
	61.8	191.95	1561.83

1. This channel is unused by the 80-WXC-C

9.13.4 80-WXC-C Card-Level Indicators

The 80-WXC-C card has three card-level LED indicators described in Table 9-48.

Table 9-48 80-WXC-C Card-Level Indicators

Card-Level Indicators	Description
Red FAIL LED	The red FAIL LED indicates that the card's processor is not ready or that an internal hardware failure occurred. Replace the card if the red FAIL LED persists.
Green ACT LED	The green ACT LED indicates that the 80-WXC-C is carrying traffic or is traffic-ready.
Amber SF LED	The amber SF LED indicates a signal failure on one or more of the card's ports. The amber SF LED also turns on when the transmit and receive fibers are incorrectly connected. When the fibers are properly connected, the light turns off.

9.13.5 80-WXC-C Port-Level Indicators

You can find the alarm status of the 80-WXC-C card ports using the LCD screen or unit. The LCD screen is on the ONS 15454 and ONS 15454 M2 fan-tray assembly and is a separate unit in ONS 15454 M6. The screen displays the number and severity of alarms on a given port or slot. For the procedure to view these counts, see the "Manage Alarms" section in the *Cisco ONS 15454 DWDM Procedure Guide*.

9.14 Single Module ROADM (SMR-C) Cards

Note See the "A.8.12 40-SMR1-C Card Specifications" section on page A-39 and "A.8.13 40-SMR2-C Card Specifications" section on page A-40, or hardware specifications.

Note For 40-SMR1-C and 40-SMR2-C safety label information, see the "9.2 Safety Labels for Class 1M Laser Product Cards" section on page 9-14.

The single-slot 40-channel single module ROADM (SMR-C) cards integrate the following functional blocks onto a single line card:

- Optical preamplifier
- Optical booster amplifier
- Optical service channel (OSC) filter
- 2x1 wavelength cross-connect (WXC) or a 4x1 WXC
- Optical channel monitor (OCM)

The SMR-C cards are available in two versions:

- 9.14.2 40-SMR1-C Card
- 9.14.3 40-SMR2-C Card

The SMR-C cards can manage up to 40 channels spaced at 100GHz on each port according to the channel grid in Table 9-10. The cards can be installed in Slots 1 to 6 and 12 to 17.

9.14.1 SMR-C Card Key Features

The optical amplifier units in the SMR-C cards provide the following features:

- Embedded gain flattening filter
- Mid-stage access for dispersion compensation unit (only applicable for preamplifier erbium-doped fiber amplifier [EDFA])
- Fixed output power mode
- Fixed gain mode
- Nondistorting low-frequency transfer function
- Amplified spontaneous emissions (ASE) compensation in fixed gain and fixed output power mode
- Fast transient suppression
- Programmable tilt (only applicable for preamplifier EDFA)
- Full monitoring and alarm handling capability
- Optical safety support through signal loss detection and alarm at any input port, fast power down control, and reduced maximum output power in safe power mode.
- EDFA section calculates the signal power, by taking into account the expected ASE power contribution to the total output power. The signal output power or the signal gain can be used as feedback signals for the EDFA pump power control loop.

The 1x2 WXC unit (40-SMR1-C card) provides the following features:

- Selection of individual wavelength of the aggregated 100GHz signal from either the EXP-RX or ADD-RX ports
- Automatic VOA shutdown (AVS) blocking state on each wavelength and port
- Per-channel power regulation based on external OCM unit
- Open loop path attenuation control for each wavelength and port

The 1x4 WXC unit (40-SMR2-C card) provides the following features:

- Selection of individual wavelength of the aggregated 100GHz signal from either the EXP*i*-RX (where i = 1, 2, 3) or ADD-RX ports
- Automatic VOA shutdown (AVS) blocking state on each wavelength and port
- Per-channel power regulation based on external OCM unit
- Open loop path attenuation control for each wavelength and port

The OCM unit provides per channel optical power monitoring at EXP-RX, ADD-RX, DROP-TX, and LINE-TX ports.

9.14.2 40-SMR1-C Card

The 40-SMR1-C card includes a 100Ghz 1x2 WXC unit with integrated preamplifier unit (single EDFA).

9.14.2.1 40-SMR1-C Faceplate Ports

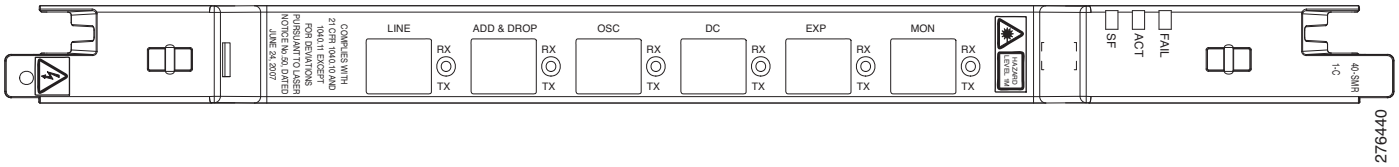
The 40-SMR1-C card has the following types of ports:

- MON RX: The MON RX port monitors power on the EXP-TX output port.

- MON TX: The MON TX port monitors power on the LINE-TX output port.
- DC RX: The DC RX port receives the optical signal from the dispersion compensating unit (DCU) and sends it to the second stage preamplifier input.
- DC TX: The DC TX port sends the optical signal from the first stage preamplifier output to the DCU.
- OSC RX: The OSC RX port is the OSC add input port.
- OSC TX: The OSC TX port is the OSC drop output port.
- ADD/DROP RX: The ADD RX port receives the optical signal from the multiplexer section of the NE and sends it to the 1x2 WXC unit.
- ADD/DROP TX: The DROP TX port sends the split off optical signal to the demultiplexer section of the NE.
- LINE RX: The LINE RX port is the input signal port.
- LINE TX: The LINE TX port is the output signal port.
- EXP RX: The EXP RX port receives the optical signal from the other side of the NE and sends it to the 1x2 WXC unit.
- EXP TX: The EXP TX port sends the split off optical signal that contains pass-through channels to the other side of the NE.

Figure 9-37 shows the 40-SMR1-C card faceplate.

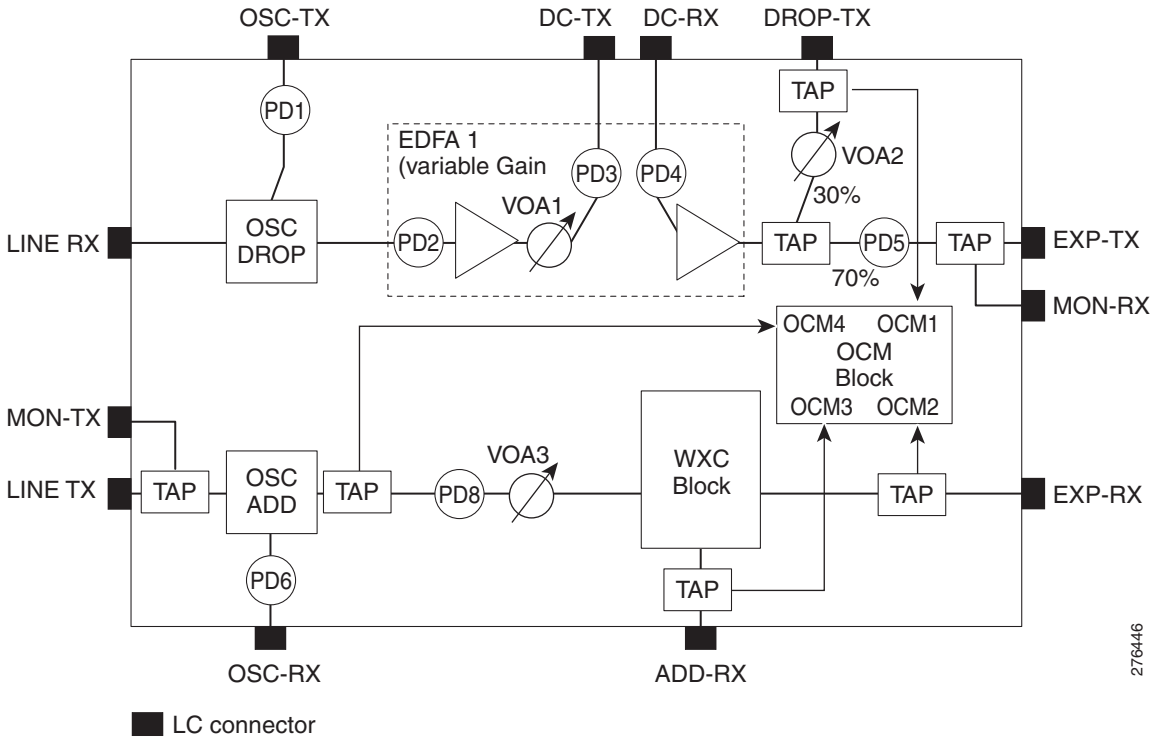
Figure 9-37 40-SMR1-C Faceplate



9.14.2.2 40-SMR1-C Block Diagram

Figure 9-38 shows a block diagram of the 40-SMR1-C card.

Figure 9-38 40-SMR1-C Block Diagram



The different units of the 40-SMR1-C card are:

- OSC filter—The OSC filter allows to add an OSC channel to the C-band in the transmission path and to drop an OSC channel on the receiving path. The OSCM card that is connected to the OSC-TX and OSC-RX ports generates the OSC channel.
- Double-stage variable gain EDFA preamplifier—The double-stage preamplifier allows the insertion of a DCU between the DC-TX and DC-RX ports to compensate for chromatic dispersion. It is also equipped with built-in variable optical attenuator (VOA) and gain flattening filter (GFF) that provides tilt compensation and enables the use of this device over an extended range of span losses (5 dB to 35 dB).
- 70/30 splitter and VOA—The output signal from the preamplifier is split in a 70%-to-30% ratio, 70% is sent on the pass-through path (EXP-TX port) and 30% is sent on the drop path (DROP-TX port). The VOA equipped on the drop path is used to match the power range of the receiver photo diode without the need for bulk attenuation. If a channel is expected to be dropped in the 40-SMR1-C card, the pass-through channel is stopped after the EXP-TX port either by a 40-WSS-C, 40-SMR1-C, or 40-SMR2-C card.
- 1x2 WXC—The 1x2 WXC aggregates on its output port a 100-GHz-spaced optical channel received from either its ADD-RX or EXP-RX port. In addition to the switching function, the 1x2 WXC allows to set a different per channel power for each of the managed wavelengths and also monitor the optical power.
- OCM—The OCM provides per channel power monitoring on the DROP-RX, EXP-RX, ADD-RX, and LINE-TX ports. The power value for each wavelength is refreshed after a variable timer depending on the port and card activity.

9.14.2.3 40-SMR1-C Power Monitoring

The 40-SMR1-C card has seven physical diodes (PD1 through PD6 and PD8) and an OCM unit that monitors power at the input and output ports of the card (see Table 9-49).

Table 9-49 40-SMR1-C Port Calibration

Physical Photodiode	CTC Type Name	Calibrated to Port(s)
PD1	LINE	LINE-RX
PD2	LINE	LINE-RX
PD3	DC	DC-TX
PD4	DC	DC-RX
PD5	EXP	EXP-TX
PD6	OSC	OSC-RX
PD8	LINE	LINE-TX
OCM1	LINE OCH	LINE-TX
OCM2	DROP OCH	DROP-TX
OCM3	ADD OCH	ADD-RX
OCM4	EXP OCH	EXP-RX

9.14.2.4 40-SMR1-C Channel Plan

Table 9-50 shows the 40 ITU-T 100-GHz-spaced, C-band channels (wavelengths) supported by the 40-SMR1-C card.

Table 9-50 40-SMR1-C Channel Plan

Band ID	Channel Label	Frequency (GHz)	Wavelength (nm)
B30.3	30.3	195.9	1530.33
	31.1	195.8	1531.12
	31.9	195.7	1531.90
	32.6	195.6	1532.68
	33.4	195.5	1533.47
B34.2	34.2	195.4	1534.25
	35.0	195.3	1535.04
	35.8	195.2	1535.82
	36.6	195.1	1536.61
	37.4	195	1537.40

Table 9-50 40-SMR1-C Channel Plan (continued)

Band ID	Channel Label	Frequency (GHz)	Wavelength (nm)
B38.1	38.1	194.9	1538.19
	38.9	194.8	1538.98
	39.7	194.7	1539.77
	40.5	194.6	1540.56
	41.3	194.5	1541.35
B42.1	42.1	194.4	1542.14
	42.9	194.3	1542.94
	43.7	194.2	1543.73
	44.5	194.1	1544.53
	45.3	194	1545.32
B46.1	46.1	193.9	1546.12
	46.9	193.8	1546.92
	47.7	193.7	1547.72
	48.5	193.6	1548.51
	49.3	193.5	1549.32
B50.1	50.1	193.4	1550.12
	50.9	193.3	1550.92
	51.7	193.2	1551.72
	52.5	193.1	1552.52
	53.3	193	1553.33
B54.1	54.1	192.9	1554.13
	54.9	192.8	1554.94
	55.7	192.7	1555.75
	56.5	192.6	1556.55
	57.3	192.5	1557.36
B58.1	58.1	192.4	1558.17
	58.9	192.3	1558.98
	59.7	192.2	1559.79
	60.6	192.1	1560.61
	61.4	192	1561.42

9.14.2.5 40-SMR1-C Card-Level Indicators

The 40-SMR1-C card has three card-level LED indicators described in Table 9-51.

Table 9-51 40-SMR1-C Card-Level Indicators

Card-Level Indicators	Description
Red FAIL LED	The red FAIL LED indicates that the card processor is not ready or that an internal hardware failure occurred. Replace the card if the red FAIL LED persists.
Green ACT LED	The green ACT LED indicates that the card is carrying traffic or is traffic-ready.
Amber SF LED	The amber SF LED indicates a signal failure on one or more of the card ports. The amber SF LED also turns on when the transmit and receive fibers are incorrectly connected. When the fibers are properly connected, the light turns off.

9.14.2.6 40-SMR1-C Port-Level Indicators

You can find the alarm status of the 40-SMR1-C card ports using the LCD screen on the ONS 15454 fan-tray assembly. The screen displays the number and severity of alarms on a given port or slot. For the procedure to view these counts, refer to "Manage Alarms" in the *Cisco ONS 15454 DWDM Procedure Guide*.

9.14.3 40-SMR2-C Card

The 40-SMR2-C card includes a 100Ghz 1x4 WXC unit with integrated preamplifier and booster amplifier units (double EDFA).

9.14.3.1 40-SMR2-C Faceplate Ports

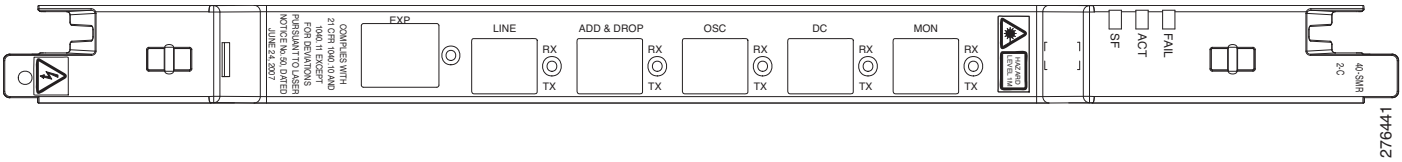
The 40-SMR2-C card has the following types of ports:

- MON RX: The MON RX port monitors power on the EXP-TX output port.
- MON TX: The MON TX port monitors power on the LINE-TX output port.
- DC RX: The DC RX port receives the optical signal from the dispersion compensating unit (DCU) and sends it to the second stage preamplifier input.
- DC TX: The DC TX port sends the optical signal from the first stage preamplifier output to the DCU.
- OSC RX: The OSC RX port is the OSC add input port.
- OSC TX: The OSC TX port is the OSC drop output port.
- ADD/DROP RX: The ADD RX port receives the optical signal from the multiplexer section of the NE and sends it to the 1x4 WXC unit.
- ADD/DROP TX: The DROP TX port sends the split off optical signal to the demultiplexer section of the NE.
- LINE RX: The LINE RX port is the input signal port.
- LINE TX: The LINE TX port is the output signal port.
- EXP TX: The EXP TX port sends the split off optical signal that contains pass-through channels to the other side of the NE.

- EXP*i*-RX (where *i* = 1, 2, 3): The EXP*i*-RX port receives the optical signal from the other side of the NE and sends it to the 1x4 WXC unit.

Figure 9-37 shows the 40-SMR2-C card faceplate.

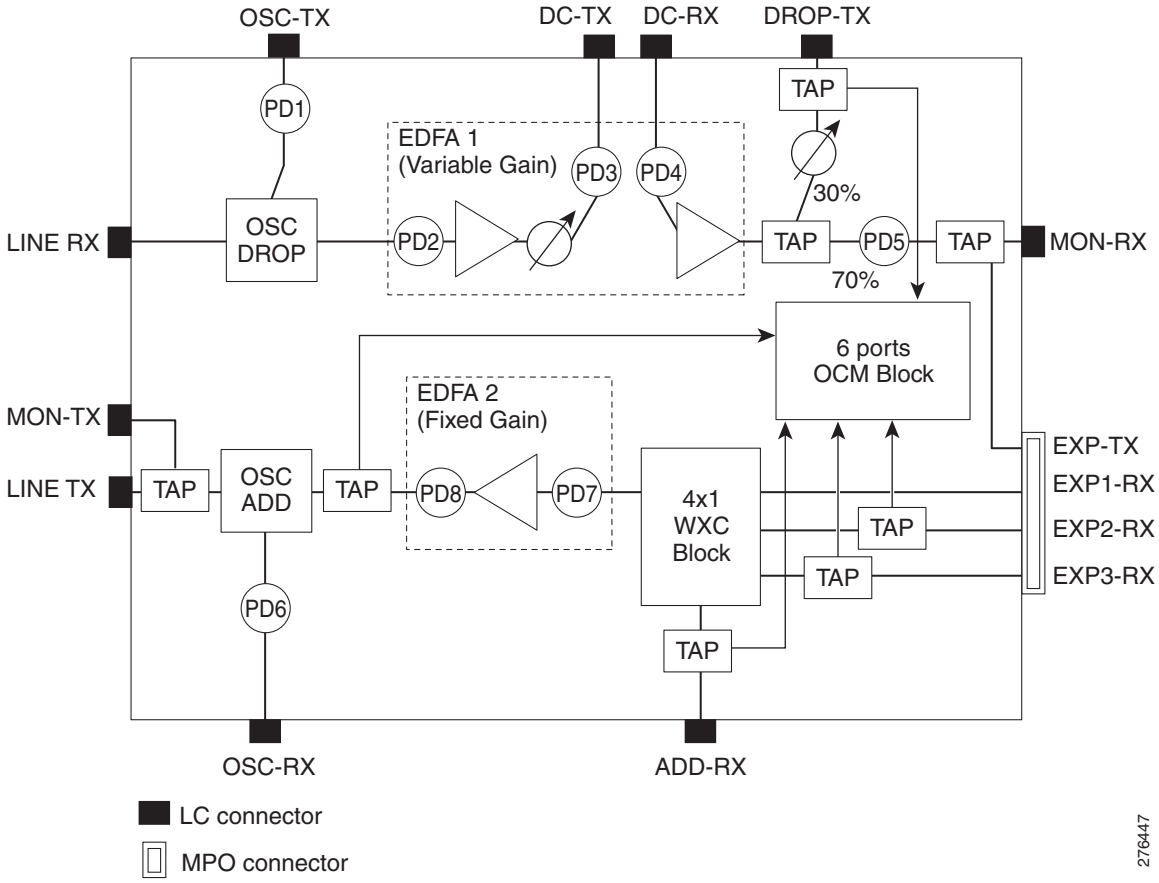
Figure 9-39 40-SMR2-C Faceplate



9.14.3.2 40-SMR2-C Block Diagram

Figure 9-38 shows a block diagram of the 40-SMR2-C card.

Figure 9-40 40-SMR2-C Block Diagram



The different units of the 40-SMR2-C card are:

- OSC filter—The OSC filter allows to add an OSC channel to the C-band in the transmission path and to drop an OSC channel on the receiving path. The OSCM card that is connected to the OSC-TX and OSC-RX ports generates the OSC channel.
- Double-stage variable gain EDFA preamplifier—The double-stage preamplifier allows the insertion of a DCU between the DC-TX and DC-RX ports to compensate for chromatic dispersion. It is also equipped with built-in variable optical attenuator (VOA) and gain flattening filter (GFF) that provides tilt compensation and enables the use of this device over an extended range of span losses (5 dB to 35 dB).
- 70/30 splitter and VOA—The output signal from the preamplifier is split in a 70%-to-30% ratio, 70% is sent on the pass-through path (EXP-TX port) and 30% is sent on the drop path (DROP-TX port). The VOA equipped on the drop path is used to match the power range of the receiver photo diode without the need for bulk attenuation. If a channel is expected to be dropped in the 40-SMR2-C card, the pass-through channel is stopped after the EXP-TX port by a 40-WSS-C, 40-SMR1-C, or 40-SMR2-C card.
- 1x4 WXC—The 1x4 WXC aggregates on its output port a 100-GHz-spaced optical channel received from either its ADD-RX or EXP*i*-RX (where *i* = 1, 2, 3) port. In addition to the switching function, the 1x4 WXC allows to set a different per channel power for each of the managed wavelengths and also monitor the optical power.
- Single-stage fixed gain EDFA booster amplifier—The booster amplifier amplifies the output signal from the 1x4 WXC unit before transmitting it into the fiber. Since it is a fixed gain (17 dB) amplifier, it does not allow gain tilt control.
- OCM—The OCM provides per channel power monitoring on the DROP-RX, EXP*i*-RX (where *i* = 1, 2, 3), ADD-RX, and LINE-TX ports. The power value for each wavelength is refreshed after a variable timer depending on the port and card activity.

9.14.3.3 40-SMR2-C Power Monitoring

The 40-SMR2-C card has eight physical diodes (PD1 through PD8) and an OCM unit that monitors power at the input and output ports of the card (see Table 9-52).

Table 9-52 40-SMR2-C Port Calibration

Physical Photodiode	CTC Type Name	Calibrated to Port(s)
PD1	LINE	LINE-RX
PD2	LINE	LINE-RX
PD3	DC	DC-TX
PD4	DC	DC-RX
PD5	EXP	EXP-TX
PD6	OSC	OSC-RX
PD7	Not reported on CTC	Internal port
PD8	LINE	LINE-TX
OCM1	LINE OCH	LINE-TX
OCM2	DROP OCH	DROP-TX
OCM3	ADD OCH	ADD-RX
OCM4	EXP-1 OCH	EXP1-RX

Table 9-52 40-SMR2-C Port Calibration (continued)

Physical Photodiode	CTC Type Name	Calibrated to Port(s)
OCM5	EXP-2 OCH	EXP2-RX
OCM6	EXP-3 OCH	EXP3-RX

9.14.3.4 40-SMR2-C Channel Plan

Table 9-53 shows the 40 ITU-T 100-GHz-spaced, C-band channels (wavelengths) supported by the 40-SMR2-C card.

Table 9-53 40-SMR2-C Channel Plan

Band ID	Channel Label	Frequency (GHz)	Wavelength (nm)
B30.3	30.3	195.9	1530.33
	31.1	195.8	1531.12
	31.9	195.7	1531.90
	32.6	195.6	1532.68
	33.4	195.5	1533.47
B34.2	34.2	195.4	1534.25
	35.0	195.3	1535.04
	35.8	195.2	1535.82
	36.6	195.1	1536.61
	37.4	195	1537.40
B38.1	38.1	194.9	1538.19
	38.9	194.8	1538.98
	39.7	194.7	1539.77
	40.5	194.6	1540.56
	41.3	194.5	1541.35
B42.1	42.1	194.4	1542.14
	42.9	194.3	1542.94
	43.7	194.2	1543.73
	44.5	194.1	1544.53
	45.3	194	1545.32
B46.1	46.1	193.9	1546.12
	46.9	193.8	1546.92
	47.7	193.7	1547.72
	48.5	193.6	1548.51
	49.3	193.5	1549.32

Table 9-53 40-SMR2-C Channel Plan (continued)

Band ID	Channel Label	Frequency (GHz)	Wavelength (nm)
B50.1	50.1	193.4	1550.12
	50.9	193.3	1550.92
	51.7	193.2	1551.72
	52.5	193.1	1552.52
	53.3	193	1553.33
B54.1	54.1	192.9	1554.13
	54.9	192.8	1554.94
	55.7	192.7	1555.75
	56.5	192.6	1556.55
	57.3	192.5	1557.36
B58.1	58.1	192.4	1558.17
	58.9	192.3	1558.98
	59.7	192.2	1559.79
	60.6	192.1	1560.61
	61.4	192	1561.42

9.14.3.5 40-SMR2-C Card-Level Indicators

The 40-SMR2-C card has three card-level LED indicators described in Table 9-54.

Table 9-54 40-SMR2-C Card-Level Indicators

Card-Level Indicators	Description
Red FAIL LED	The red FAIL LED indicates that the card processor is not ready or that an internal hardware failure occurred. Replace the card if the red FAIL LED persists.
Green ACT LED	The green ACT LED indicates that the card is carrying traffic or is traffic-ready.
Amber SF LED	The amber SF LED indicates a signal failure on one or more of the card ports. The amber SF LED also turns on when the transmit and receive fibers are incorrectly connected. When the fibers are properly connected, the light turns off.

9.14.3.6 40-SMR2-C Port-Level Indicators

You can find the alarm status of the 40-SMR2-C card ports using the LCD screen on the ONS 15454 fan-tray assembly. The screen displays the number and severity of alarms on a given port or slot. For the procedure to view these counts, refer to “Manage Alarms” in the *Cisco ONS 15454 DWDM Procedure Guide*.

9.15 MMU Card

(Cisco ONS 15454 only)

The single-slot Mesh Multi-Ring Upgrade Module (MMU) card supports multiring and mesh upgrades for ROADM nodes in both the C-band and the L-band. Mesh/multiring upgrade is the capability to optically bypass a given wavelength from one section of the network or ring to another one without requiring 3R regeneration. In each node, you need to install one east MMU and one west MMU. The card can be installed in Slots 1 through 6 and 12 through 17.

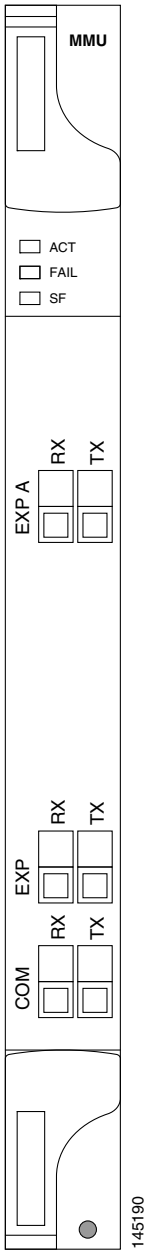
9.15.1 MMU Faceplate Ports

The MMU has six types of ports:

- EXP RX port: The EXP RX port receives the optical signal from the ROADM section available on the NE.
- EXP TX port: The EXP TX port sends the optical signal to the ROADM section available on the NE.
- EXP-A RX port: The EXP-A RX port receives the optical signal from the ROADM section available on other NEs or rings.
- EXP-A TX port: The EXP-A TX port sends the optical signal to the ROADM section available on other NEs or rings.
- COM TX port: The COM TX port sends the optical signal to the fiber stage section.
- COM RX port: The COM RX port receives the optical signal from the fiber stage section.

Figure 9-41 shows the MMU card faceplate.

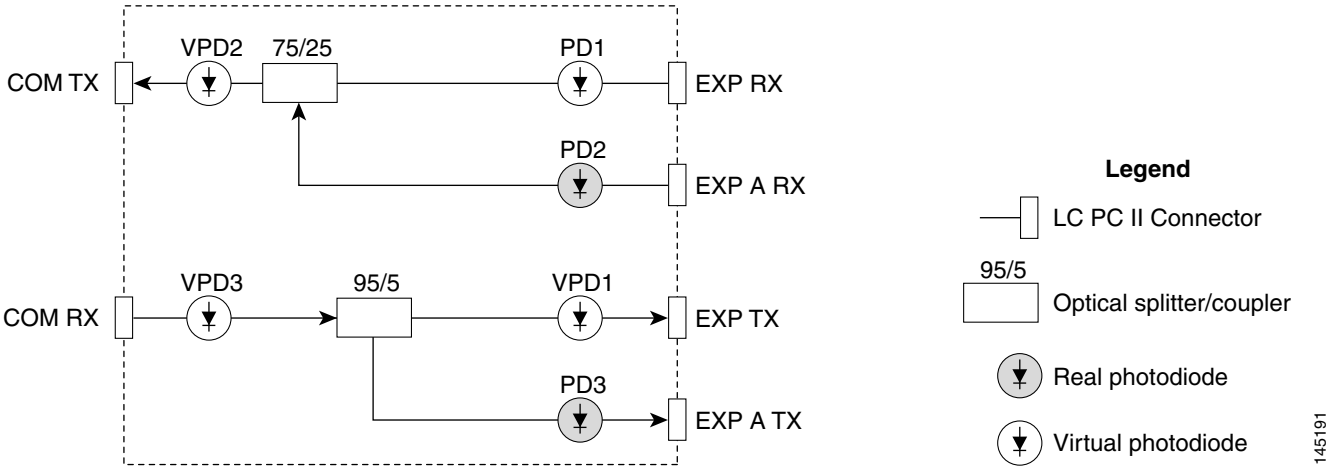
Figure 9-41 MMU Faceplate and Ports



9.15.2 MMU Block Diagram

Figure 9-42 provides a high-level functional block diagram of the MMU card.

Figure 9-42 MMU Block Diagram



9.15.3 MMU Power Monitoring

Physical photodiodes P1 through P3 monitor the power for the MMU card. The returned power level values are calibrated to the ports as shown in Table 9-55. VP1 to VP3 are virtual photodiodes that have been created by adding (by software computation) the relevant path insertion losses of the optical splitters (stored in the module) to the real photodiode (P1 to P3) measurement.

Table 9-55 MMU Port Calibration

Photodiode	CTC Type Name	Calibrated to Port
P1	1 (EXP-RX)	EXP RX
P2	5 (EXP A-RX)	EXP A RX
P3	6 (EXP A-TX)	EXP A TX
VP1	2 (EXP-TX)	EXP TX
VP2	4 (COM-TX)	COM TX
VP3	3 (COM-RX)	COM RX

For information on the associated TL1 AIDs for the optical power monitoring points, refer the "CTC Port Numbers and TL1 Aids" section in *Cisco ONS SONET TL1 Command Guide, Release 9.2*.

9.15.4 MMU Card-Level Indicators

Table 9-56 describes the three card-level LED indicators on the MMU card.

Table 9-56 MMU Card-Level Indicators

Card-Level Indicators	Description
Red FAIL LED	The red FAIL LED indicates that the card's processor is not ready or that n internal hardware failure occurred. Replace the card if the red FAIL LED persists.
Green ACT LED	The green ACT LED indicates that the MMU card is carrying traffic or is traffic-ready.
Amber SF LED	The amber SF LED indicates a signal failure on one or more of the card's ports. The amber SF LED also turns on when the transmit and receive fibers are incorrectly connected. When the fibers are properly connected, the light turns off.

9.15.5 MMU Port-Level Indicators

You can find the alarm status of the MMU card's ports using the LCD screen on the ONS 15454 fan-tray assembly. The screen displays the number and severity of alarms on a given port or slot. For the procedure to view these counts, refer to "Manage Alarms" in the *Cisco ONS 15454 DWDM Procedure Guide*.

CHAPTER 10

Transponder and Muxponder Cards

Note The terms "Unidirectional Path Switched Ring" and "UPSR" may appear in Cisco literature. These terms do not refer to using Cisco ONS 15xxx products in a unidirectional path switched ring configuration. Rather, these terms, as well as "Path Protected Mesh Network" and "PPMN," refer generally to Cisco's path protection feature, which may be used in any topological network configuration. Cisco does not recommend using its path protection feature in any particular topological network configuration.

This chapter describes Cisco ONS 15454 transponder (TXP), muxponder (MXP), GE_XP, 10GE_XP, GE_XPE, 10GE_XPE, ADM-10G, and OTU2_XP cards, as well as their associated plug-in modules (Small Form-factor Pluggables [SFPs or XFPs]). For installation and card turn-up procedures, refer to the *Cisco ONS 15454 DWDM Procedure Guide*. For card safety and compliance information, refer to the *Cisco Optical Transport Products Safety and Compliance Information* document.

Note Unless otherwise specified, "ONS 15454" refers to both ANSI and ETSI shelf assemblies.

Note The cards described in this chapter are supported on the Cisco ONS 15454, Cisco ONS 15454 M6, Cisco ONS 15454 M2 platforms, unless noted otherwise.

Chapter topics include:

- 10.1 Card Overview, page 10-2
- 10.2 Safety Labels, page 10-8
- 10.3 TXP_MR_10G Card, page 10-13
- 10.4 TXP_MR_10E Card, page 10-16
- 10.5 TXP_MR_10E_C and TXP_MR_10E_L Cards, page 10-21
- 10.6 TXP_MR_2.5G and TXPP_MR_2.5G Cards, page 10-25
- 10.7 MXP_2.5G_10G Card, page 10-29
- 10.8 MXP_2.5G_10E_C and MXP_2.5G_10E_L Cards, page 10-40
- 10.9 MXP_MR_2.5G and MXPP_MR_2.5G Cards, page 10-49
- 10.10 MXP_MR_10DME_C and MXP_MR_10DME_L Cards, page 10-55
- 10.11 40G-MXP-C Card, page 10-64
- 10.12 GE_XP, 10GE_XP, GE_XPE, and 10GE_XPE Cards, page 10-71

- 10.13 ADM-10G Card, page 10-96
- 10.14 OTU2_XP Card, page 10-111
- 10.15 MLSE UT, page 10-121
- 10.16 TXP_MR_10EX_C Card, page 10-121
- 10.17 MXP_2.5G_10EX_C card, page 10-125
- 10.18 MXP_MR_10DMEX_C Card, page 10-132
- 10.19 Y-Cable and Splitter Protection, page 10-139
- 10.20 Far-End Laser Control, page 10-142
- 10.21 Jitter Considerations, page 10-142
- 10.22 Termination Modes, page 10-143
- 10.23 SFP and XFP Modules, page 10-144

Note Cisco ONS 15454 DWDM supports IBM's 5G DDR (Double Data Rate) InfiniBand[1] interfaces.

10.1 Card Overview

The card overview section lists the cards described in this chapter and provides compatibility information.

Note Each card is marked with a symbol that corresponds to a slot (or slots) on the ONS 15454 shelf assembly. The cards are then installed into slots displaying the same symbols. For a list of slots and symbols, see the "Card Slot Requirements" section in the *Cisco ONS 15454 Hardware Installation Guide*.

The purpose of a TXP, MXP, GE_XP, 10GE_XP, GE_XPE, 10GE_XPE, ADM-10G, or OTU2_XP card is to convert the “gray” optical client interface signals into trunk signals that operate in the “colored” dense wavelength division multiplexing (DWDM) wavelength range. Client-facing gray optical signals generally operate at shorter wavelengths, whereas DWDM colored optical signals are in the longer wavelength range (for example, 1490 nm = violet; 1510 nm = blue; 1530 nm = green; 1550 nm = yellow; 1570 nm = orange; 1590 nm = red; 1610 nm = brown). Some of the newer client-facing SFPs, however, operate in the colored region. Transponding or muxponding is the process of converting the signals between the client and trunk wavelengths.

An MXP generally handles several client signals. It aggregates, or multiplexes, lower rate client signals together and sends them out over a higher rate trunk port. Likewise, it demultiplexes optical signals coming in on a trunk and sends them out to individual client ports. A TXP converts a single client signal to a single trunk signal and converts a single incoming trunk signal to a single client signal. GE_XP, 10GE_XP, GE_XPE, and 10GE_XPE cards can be provisioned as TXPs, as MXPs, or as Layer 2 switches.

All of the TXP and MXP cards perform optical to electrical to optical (OEO) conversion. As a result, they are not optically transparent cards. The reason for this is that the cards must operate on the signals passing through them, so it is necessary to do an OEO conversion.

1. 5G DDR InfiniBand is referred to as IB_5G.

On the other hand, the termination mode for all of the TXPs and MXPs, which is done at the electrical level, can be configured to be transparent. In this case, neither the Line nor the Section overhead is terminated. The cards can also be configured so that either Line or Section overhead can be terminated, or both can be terminated.

Note The MXP_2.5G_10G card, by design, when configured in the transparent termination mode, actually does terminate some of the bytes. See Table 10-64 on page 10-143 for details.

10.1.1 Card Summary

Table 10-1 lists and summarizes the functions of each TXP, TXPP, MXP, MXPP, GE_XP, 10GE_XP, GE_XPE, 10GE_XPE, ADM-10G, and OTU2_XP card.

Table 10-1 Cisco ONS 15454 Transponder and Muxponder Cards

Card	Port Description	For Additional Information
TXP_MR_10G	The TXP_MR_10G card has two sets of ports located on the faceplate.	See the "10.3 TXP_MR_10G Card" section on page 10-13.
TXP_MR_10E	The TXP_MR_10E card has two sets of ports located on the faceplate.	See the "10.4 TXP_MR_10E Card" section on page 10-16.
TXP_MR_10E_C and TXP_MR_10E_L	The TXP_MR_10E_C and TXP_MR_10E_L cards have two sets of ports located on the faceplate.	See the "10.5 TXP_MR_10E_C and TXP_MR_10E_L Cards" section on page 10-21.
TXP_MR_2.5G	The TXP_MR_2.5G card has two sets of ports located on the faceplate.	See the "10.6 TXP_MR_2.5G and TXPP_MR_2.5G Cards" section on page 10-25.
TXPP_MR_2.5G	The TXPP_MR_2.5G card has three sets of ports located on the faceplate.	See the "10.6 TXP_MR_2.5G and TXPP_MR_2.5G Cards" section on page 10-25.
MXP_2.5G_10G	The MXP_2.5G_10G card has nine sets of ports located on the faceplate.	See the "10.7 MXP_2.5G_10G Card" section on page 10-29.
MXP_2.5G_10E	The MXP_2.5G_10E card has nine sets of ports located on the faceplate.	See the "10.7.4 MXP_2.5G_10E Card" section on page 10-33.
MXP_2.5G_10E_C and MXP_2.5G_10E_L	The MXP_2.5G_10E_C and MXP_2.5G_10E_L cards have nine sets of ports located on the faceplate.	See the "10.8 MXP_2.5G_10E_C and MXP_2.5G_10E_L Cards" section on page 10-40.
MXP_MR_2.5G	The MXP_MR_2.5G card has nine sets of ports located on the faceplate.	See the "10.9 MXP_MR_2.5G and MXPP_MR_2.5G Cards" section on page 10-49.
MXPP_MR_2.5G	The MXPP_MR_2.5G card has ten sets of ports located on the faceplate.	See the "10.9 MXP_MR_2.5G and MXPP_MR_2.5G Cards" section on page 10-49.

Table 10-1 Cisco ONS 15454 Transponder and Muxponder Cards (continued)

Card	Port Description	For Additional Information
MXP_MR_10DME_C and MXP_MR_10DME_L	The MXP_MR_10DME_C and MXP_MR_10DME_L cards have eight sets of ports located on the faceplate.	See the "10.10 MXP_MR_10DME_C and MXP_MR_10DME_L Cards" section on page 10-55.
40G-MXP-C	The 40G-MXP-C card has five ports located on the faceplate.	See the "10.11 40G-MXP-C Card" section on page 10-64.
GE_XP and GE_XPE	The GE_XP and GE_XPE cards have twenty Gigabit Ethernet client ports and two 10 Gigabit Ethernet trunk ports.	See the "10.12 GE_XP, 10GE_XP, GE_XPE, and 10GE_XPE Cards" section on page 10-71.
10GE_XP and 10GE_XPE	The 10GE_XP and 10GE_XPE cards have two 10 Gigabit Ethernet client ports and two 10 Gigabit Ethernet trunk ports.	See the "10.12 GE_XP, 10GE_XP, GE_XPE, and 10GE_XPE Cards" section on page 10-71.
ADM-10G	The ADM-10G card has 19 sets of ports located on the faceplate.	See the "10.13 ADM-10G Card" section on page 10-96.
OTU2_XP	The OTU2_XP card has four ports located on the faceplate.	See the "10.14 OTU2_XP Card" section on page 10-111.
TXP_MR_10EX_C	The TXP_MR_10EX_C card has two sets of ports located on the faceplate.	See the "10.16 TXP_MR_10EX_C Card" section on page 10-121.
MXP_2.5G_10EX_C	The MXP_2.5G_10EX_C card has nine sets of ports located on the faceplate.	See the "10.17 MXP_2.5G_10EX_C card" section on page 10-125.
MXP_MR_10DMEX_C	The MXP_MR_10DMEX_C card has eight sets of ports located on the faceplate.	See the "10.18 MXP_MR_10DMEX_C Card" section on page 10-132.

10.1.2 Card Compatibility

Table 10-2 lists the platform and Cisco Transport Controller (CTC) software compatibility for each TXP, TXPP, MXP, MXPP, GE_XP, 10GE_XP, GE_XPE, 10GE_XPE, ADM-10G, and OTU2_XP card.

Table 10-2 Platform and Software Release Compatibility for Transponder and Muxponder Cards

Card Name	R4.5	R4.6	R4.7	R5.0	R6.0	R7.0	R7.2	R8.0	R8.5	R9.0	R9.1	R9.2
TXP_MR_10G	15454-DWDM	15454-DWDM	15454-DWDM	15454-DWDM	15454-DWDM	15454-DWDM	15454-DWDM	15454-DWDM	15454-DWDM	15454-DWDM	15454-DWDM	15454-DWDM
TXP_MR_10E	No	No	15454-DWDM	15454-DWDM	15454-DWDM	15454-DWDM	15454-DWDM	15454-DWDM	15454-DWDM	15454-DWDM	15454-DWDM	15454-DWDM, 15454-M2, 15454-M6
TXP_MR_10E_C	No	No	No	No	No	15454-DWDM	15454-DWDM	15454-DWDM	15454-DWDM	15454-DWDM	15454-DWDM	15454-DWDM, 15454-M2, 15454-M6
TXP_MR_10E_L	No	No	No	No	No	15454-DWDM	15454-DWDM	15454-DWDM	15454-DWDM	15454-DWDM	15454-DWDM	15454-DWDM
TXP_MR_2.5G	15454-DWDM	15454-DWDM	15454-DWDM	15454-DWDM	15454-DWDM	15454-DWDM	15454-DWDM	15454-DWDM	15454-DWDM	15454-DWDM	15454-DWDM	15454-DWDM, 15454-M2, 15454-M6
TXPP_MR_2.5G	15454-DWDM	15454-DWDM	15454-DWDM	15454-DWDM	15454-DWDM	15454-DWDM	15454-DWDM	15454-DWDM	15454-DWDM	15454-DWDM	15454-DWDM	15454-DWDM, 15454-M2, 15454-M6
MXP_2.5G_10G	15454-DWDM	15454-DWDM	15454-DWDM	15454-DWDM	15454-DWDM	15454-DWDM	15454-DWDM	15454-DWDM	15454-DWDM	15454-DWDM	15454-DWDM	15454-DWDM

Table 10-2 Platform and Software Release Compatibility for Transponder and Muxponder Cards

Card Name	R4.5	R4.6	R4.7	R5.0	R6.0	R7.0	R7.2	R8.0	R8.5	R9.0	R9.1	R9.2
MXP_2.5G_10E	No	No	15454-DWDM	15454-DWDM	15454-DWDM	15454-DWDM	15454-DWDM	15454-DWDM	15454-DWDM	15454-DWDM	15454-DWDM	15454-DWDM, 15454-M2, 15454-M6
MXP_2.5G_10E_C	No	No	No	No	No	15454-DWDM	15454-DWDM	15454-DWDM	15454-DWDM	15454-DWDM	15454-DWDM	15454-DWDM, 15454-M2, 15454-M6
MXP_2.5G_10E_L	No	No	No	No	No	15454-DWDM	15454-DWDM	15454-DWDM	15454-DWDM	15454-DWDM	15454-DWDM	15454-DWDM
MXP_MR_2.5G	No	No	15454-DWDM	15454-DWDM	15454-DWDM	15454-DWDM	15454-DWDM	15454-DWDM	15454-DWDM	15454-DWDM	15454-DWDM	15454-DWDM, 15454-M2, 15454-M6
MXPP_MR_2.5G	No	No	15454-DWDM	15454-DWDM	15454-DWDM	15454-DWDM	15454-DWDM	15454-DWDM	15454-DWDM	15454-DWDM	15454-DWDM	15454-DWDM, 15454-M2, 15454-M6
MXP_MR_10DME_C	No	No	No	No	No	15454-DWDM	15454-DWDM	15454-DWDM	15454-DWDM	15454-DWDM	15454-DWDM	15454-DWDM, 15454-M2, 15454-M6
MXP_MR_10DME_L	No	No	No	No	No	15454-DWDM	15454-DWDM	15454-DWDM	15454-DWDM	15454-DWDM	15454-DWDM	15454-DWDM

Table 10-2 Platform and Software Release Compatibility for Transponder and Muxponder Cards

Card Name	R4.5	R4.6	R4.7	R5.0	R6.0	R7.0	R7.2	R8.0	R8.5	R9.0	R9.1	R9.2
GE_XP	No	No	No	No	No	No	No	15454-DWDM	15454-DWDM	15454-DWDM	15454-DWDM	15454-DWDM, 15454-M2, 15454-M6
10GE_XP	No	No	No	No	No	No	No	15454-DWDM	15454-DWDM	15454-DWDM	15454-DWDM	15454-DWDM, 15454-M2, 15454-M6
GE_XPE	No	No	No	No	No	No	No	No	No	15454-DWDM	15454-DWDM	15454-DWDM, 15454-M2, 15454-M6
10GE_XPE	No	No	No	No	No	No	No	No	No	15454-DWDM	15454-DWDM	15454-DWDM, 15454-M2, 15454-M6
ADM-10G	No	No	No	No	No	No	No	15454-DWDM	15454-DWDM	15454-DWDM	15454-DWDM	15454-DWDM, 15454-M2, 15454-M6
OTU2_XP	No	No	No	No	No	No	No	No	No	15454-DWDM	15454-DWDM	15454-DWDM, 15454-M2, 15454-M6

Table 10-2 Platform and Software Release Compatibility for Transponder and Muxponder Cards

Card Name	R4.5	R4.6	R4.7	R5.0	R6.0	R7.0	R7.2	R8.0	R8.5	R9.0	R9.1	R9.2
TXP_MR_10EX_C	No	No	No	No	No	No	No	No	No	No	15454-DWDM	15454-DWDM, 15454-M2, 15454-M6
MXP_2.5G_10EX_C	No	No	No	No	No	No	No	No	No	No	15454-DWDM	15454-DWDM, 15454-M2, 15454-M6
MXP_MR_10DMEX_C	No	No	No	No	No	No	No	No	No	No	15454-DWDM	15454-DWDM, 15454-M2, 15454-M6
40G-MXP-C	No	No	No	No	No	No	No	No	No	No	No	15454-DWDM, 15454-M2, 15454-M6

10.2 Safety Labels

This section explains the significance of the safety labels attached to some of the cards. The faceplates of the cards are clearly labeled with warnings about the laser radiation levels. You must understand all warning labels before working on these cards.

10.2.1 Class 1 Laser Product Cards

The MXP_2.5G_10G, MXP_2.5G_10E, MXP_2.5G_10E_C, MXP_2.5G_10E_L, ADM-10G, GE_XP, 10GE_XP, GE_XPE, 10GE_XPE, and OTU2_XP cards have Class 1 lasers. The labels that appear on these cards are described in the following sections.

10.2.1.1 Class 1 Laser Product Label

The Class 1 Laser Product label is shown in Figure 10-1.

Figure 10-1 Class 1 Laser Product Label

Class 1 lasers are products whose irradiance does not exceed the Maximum Permissible Exposure (MPE) value. Therefore, for Class 1 laser products the output power is below the level at which it is believed eye damage will occur. Exposure to the beam of a Class 1 laser will not result in eye injury and can therefore be considered safe. However, some Class 1 laser products might contain laser systems of a higher Class but there are adequate engineering control measures to ensure that access to the beam is not reasonably likely. Anyone who dismantles a Class 1 laser product that contains a higher Class laser system is potentially at risk of exposure to a hazardous laser beam

10.2.1.2 Hazard Level 1 Label

The Hazard Level 1 label is shown in Figure 10-2. This label is displayed on the faceplate of the cards.

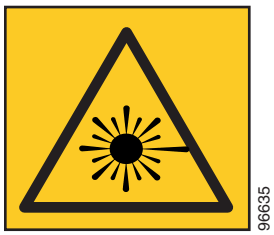
Figure 10-2 Hazard Level Label

The Hazard Level label warns users against exposure to laser radiation of Class 1 limits calculated in accordance with IEC60825-1 Ed.1.2.

10.2.1.3 Laser Source Connector Label

The Laser Source Connector label is shown in Figure 10-3.

Figure 10-3 Laser Source Connector Label



This label indicates that a laser source is present at the optical connector where the label has been placed.

10.2.1.4 FDA Statement Label

The FDA Statement labels are shown in Figure 10-4 and Figure 10-5. These labels show compliance to FDA standards and that the hazard level classification is in accordance with IEC60825-1 Am.2 or Ed.1.2.

Figure 10-4 FDA Statement Label

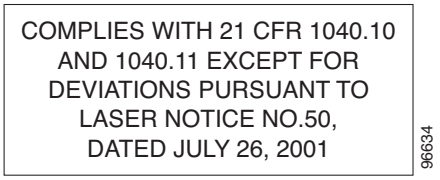
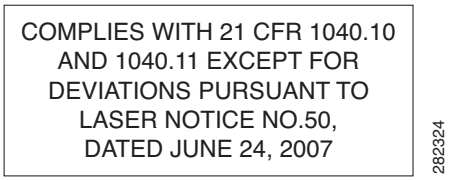


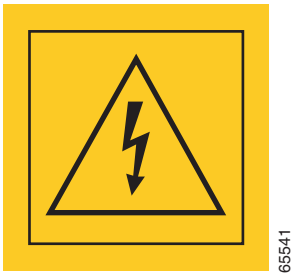
Figure 10-5 FDA Statement Label



10.2.1.5 Shock Hazard Label

The Shock Hazard label is shown in Figure 10-6.

Figure 10-6 Shock Hazard Label



This label alerts personnel to electrical hazard within the card. The potential of shock hazard exists when removing adjacent cards during maintenance, and touching exposed electrical circuitry on the card itself.

10.2.2 Class 1M Laser Product Cards

The TXP_MR_10G, TXP_MR_10E, TXP_MR_10E_C, TXP_MR_10E_L, TXP_MR_2.5G, TXPP_MR_2.5G, MXP_MR_2.5G, MXPP_MR_2.5G, MXP_MR_10DME_C, MXP_MR_10DME_L, and 40G-MXP-C cards have Class 1M lasers.

The labels that appear on these cards are described in the following subsections.

10.2.2.1 Class 1M Laser Product Statement

The Class 1M Laser Product statement is shown in Figure 10-7.

Figure 10-7 Class 1M Laser Product Statement

Class 1M lasers are products that produce either a highly divergent beam or a large diameter beam. Therefore, only a small part of the whole laser beam can enter the eye. However, these laser products can be harmful to the eye if the beam is viewed using magnifying optical instruments.

10.2.2.2 Hazard Level 1M Label

The Hazard Level 1M label is shown in Figure 10-8. This label is displayed on the faceplate of the cards.

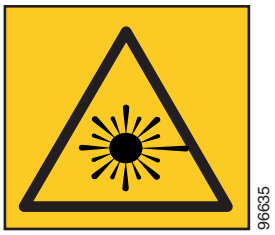
Figure 10-8 Hazard Level Label

The Hazard Level label warns users against exposure to laser radiation of Class 1 limits calculated in accordance with IEC60825-1 Ed.1.2.

10.2.2.3 Laser Source Connector Label

The Laser Source Connector label is shown in Figure 10-9.

Figure 10-9 Laser Source Connector Label



This label indicates that a laser source is present at the optical connector where the label has been placed.

10.2.2.4 FDA Statement Label

The FDA Statement labels are shown in Figure 10-10 and Figure 10-11. These labels show compliance to FDA standards and that the hazard level classification is in accordance with IEC60825-1 Am.2 or Ed.1.2.

Figure 10-10 FDA Statement Label

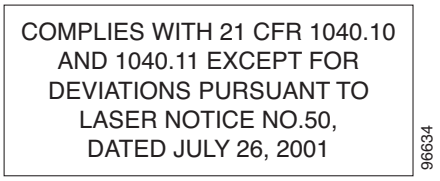
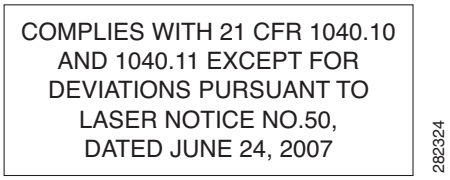


Figure 10-11 FDA Statement Label



10.2.2.5 Shock Hazard Label

The Shock Hazard label is shown in Figure 10-12.

Figure 10-12 Shock Hazard Label

This label alerts personnel to electrical hazard within the card. The potential of shock hazard exists when removing adjacent cards during maintenance, and touching exposed electrical circuitry on the card itself.

10.3 TXP_MR_10G Card

(Cisco ONS 15454 only)

The TXP_MR_10G processes one 10-Gbps signal (client side) into one 10-Gbps, 100-GHz DWDM signal (trunk side). It provides one 10-Gbps port per card that can be provisioned for an STM-64/OC-192 short reach (1310-nm) signal, compliant with ITU-T G.707, ITU-T G.709, ITU-T G.691, and Telcordia GR-253-CORE, or a 10GBASE-LR signal compliant with IEEE 802.3.

The TXP_MR_10G card is tunable over two neighboring wavelengths in the 1550-nm, ITU 100-GHz range. It is available in 16 different versions, each of which covers two wavelengths, for a total coverage of 32 different wavelengths in the 1550-nm range.

Note ITU-T G.709 specifies a form of forward error correction (FEC) that uses a “wrapper” approach. The digital wrapper lets you transparently take in a signal on the client side, wrap a frame around it and restore it to its original form. FEC enables longer fiber links because errors caused by the optical signal degrading with distance are corrected.

The trunk port operates at 9.95328 Gbps (or 10.70923 Gbps with ITU-T G.709 Digital Wrapper/FEC) and at 10.3125 Gbps (or 11.095 Gbps with ITU-T G.709 Digital Wrapper/FEC) over unamplified distances up to 80 km (50 miles) with different types of fiber such as C-SMF or dispersion compensated fiber limited by loss and/or dispersion.

Caution Because the transponder has no capability to look into the payload and detect circuits, a TXP_MR_10G card does not display circuits under card view.

Caution You must use a 15-dB fiber attenuator (10 to 20 dB) when working with the TXP_MR_10G card in a loopback on the trunk port. Do not use direct fiber loopbacks with the TXP_MR_10G card. Using direct fiber loopbacks causes irreparable damage to the TXP_MR_10G card.

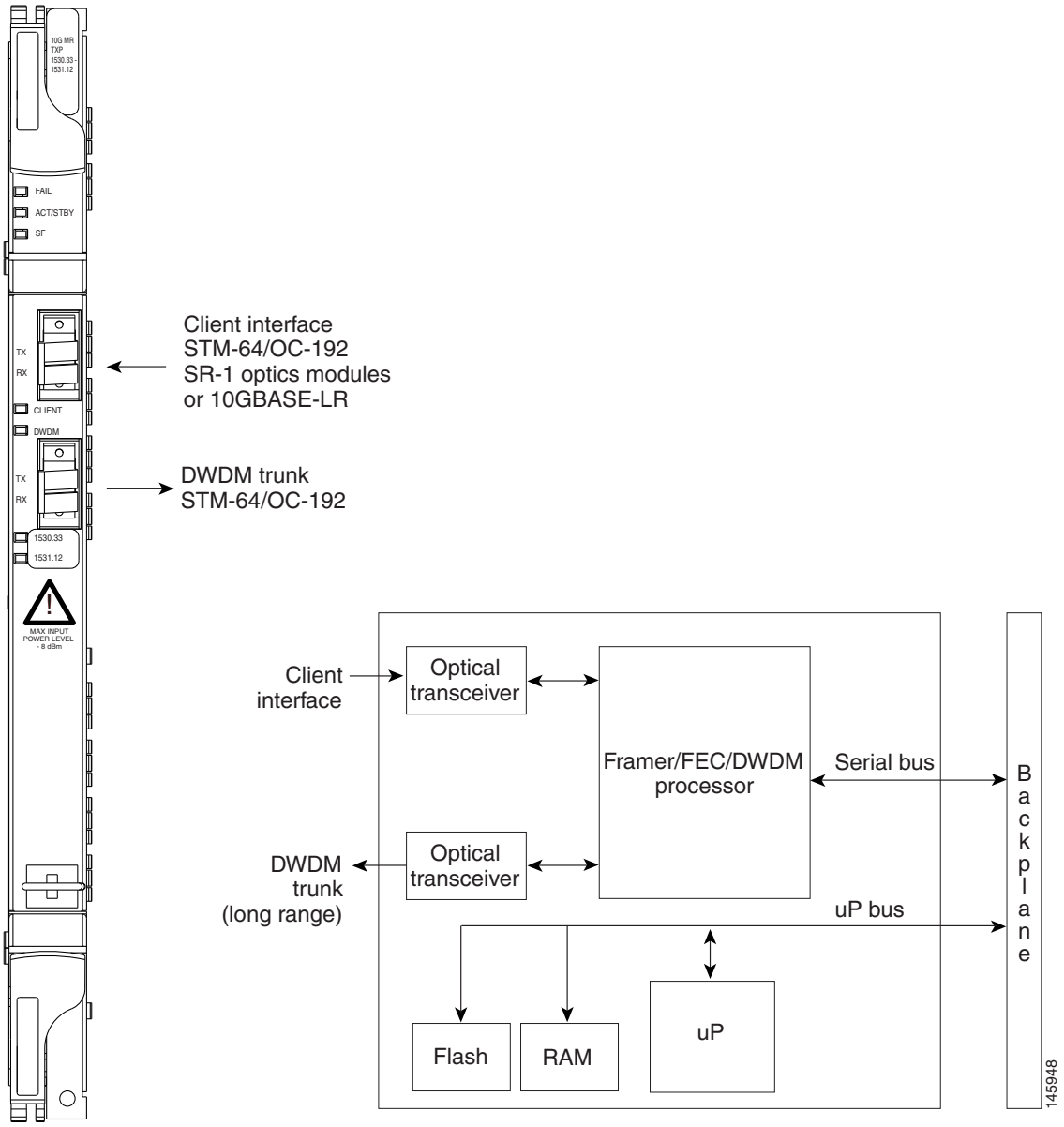
You can install TXP_MR_10G cards in Slots 1 to 6 and 12 to 17 and provision this card in a linear configuration. TXP_MR_10G cards cannot be provisioned as a bidirectional line switched ring (BLSR)/Multiplex Section - Shared Protection Ring (MS-SPRing), a path protection/single node control point (SNCP), or a regenerator. They can only be used in the middle of BLSR/MS-SPRing and 1+1 spans when the card is configured for transparent termination mode.

The TXP_MR_10G port features a 1550-nm laser for the trunk port and a 1310-nm laser for the for the client port and contains two transmit and receive connector pairs (labeled) on the card faceplate.

The MTU setting is used to display the OverSizePkts counters on the receiving trunk and client port interfaces. Traffic of frame sizes up to 65535 bytes pass without any packet drops, from the client port to the trunk port and vice versa irrespective of the MTU setting.

Figure 10-13 shows the TXP_MR_10G faceplate and block diagram.

Figure 10-13 TXP_MR_10G Faceplate and Block Diagram



For information on safety labels for the card, see the "10.2.2 Class 1M Laser Product Cards" section on page 10-10.

10.3.1 Automatic Laser Shutdown

The Automatic Laser Shutdown (ALS) procedure is supported on both client and trunk interfaces. On the client interface, ALS is compliant with ITU-T G.664 (6/99). On the data application and trunk interface, the switch on and off pulse duration is greater than 60 seconds and is user-configurable. For details on ALS provisioning for the card, refer to the *Cisco ONS 15454 DWDM Procedure Guide*.

10.3.2 TXP_MR_10G Card-Level Indicators

Table 10-3 lists the three card-level LEDs on the TXP_MR_10G card.

Table 10-3 TXP_MR_10G Card-Level Indicators

Card-Level LED	Description
FAIL LED (Red)	Red indicates that the card's processor is not ready. This LED is on during reset. The FAIL LED flashes during the boot process. Replace the card if the red FAIL LED persists.
ACT/STBY LED Green (Active) Amber (Standby)	Green indicates that the card is operational (one or both ports active) and ready to carry traffic. Amber indicates that the card is operational and in standby (protect) mode.
SF LED (Amber)	Amber indicates a signal failure or condition such as loss of signal (LOS), loss of frame (LOF), or high bit error rates (BERs) on one or more of the card's ports. The amber SF LED is also illuminated if the transmit and receive fibers are incorrectly connected. If the fibers are properly connected and the link is working, the LED turns off.

10.3.3 TXP_MR_10G Port-Level Indicators

Table 10-4 lists the four port-level LEDs in the TXP_MR_10G card.

Table 10-4 TXP_MR_10G Port-Level Indicators

Port-Level LED	Description
Green Client LED	The green Client LED indicates that the client port is in service and that it is receiving a recognized signal.
Green DWDM LED	The green DWDM LED indicates that the DWDM port is in service and that it is receiving a recognized signal.
Green Wavelength 1 LED	Each port supports two wavelengths on the DWDM side. Each wavelength LED matches one of the wavelengths. This LED indicates that the card is configured for Wavelength 1.
Green Wavelength 2 LED	Each port supports two wavelengths on the DWDM side. Each wavelength LED matches one of the wavelengths. This LED indicates that the card is configured for Wavelength 2.

10.4 TXP_MR_10E Card

The TXP_MR_10E card is a multirate transponder for the ONS 15454 platform. The card is fully backward compatible with the TXP_MR_10G card. It processes one 10-Gbps signal (client side) into one 10-Gbps, 100-GHz DWDM signal (trunk side) that is tunable over four wavelength channels (spaced at 100 GHz on the ITU grid) in the C band and tunable over eight wavelength channels (spaced at 50 GHz on the ITU grid) in the L band. There are eight versions of the C-band card, with each version covering four wavelengths, for a total coverage of 32 wavelengths. There are five versions of the L-band card, with each version covering eight wavelengths, for a total coverage of 40 wavelengths.

You can install TXP_MR_10E cards in Slots 1 to 6 and 12 to 17 and provision the cards in a linear configuration, BLSR/MS-SPRing, path protection/SNCP, or a regenerator. The card can be used in the middle of BLSR/MS-SPRing or 1+1 spans when the card is configured for transparent termination mode.

The TXP_MR_10E card features a 1550-nm tunable laser (C band) or a 1580-nm tunable laser (L band) for the trunk port and a separately orderable ONS-XC-10G-S1 1310-nm or ONS-XC-10G-L2 1550-nm laser XFP module for the client port.

Note When the ONS-XC-10G-L2 XFP is installed, the TXP_MR_10E card must be installed in Slots 6, 7, 12 or 13)

On its faceplate, the TXP_MR_10E card contains two transmit and receive connector pairs, one for the trunk port and one for the client port. Each connector pair is labeled.

10.4.1 Key Features

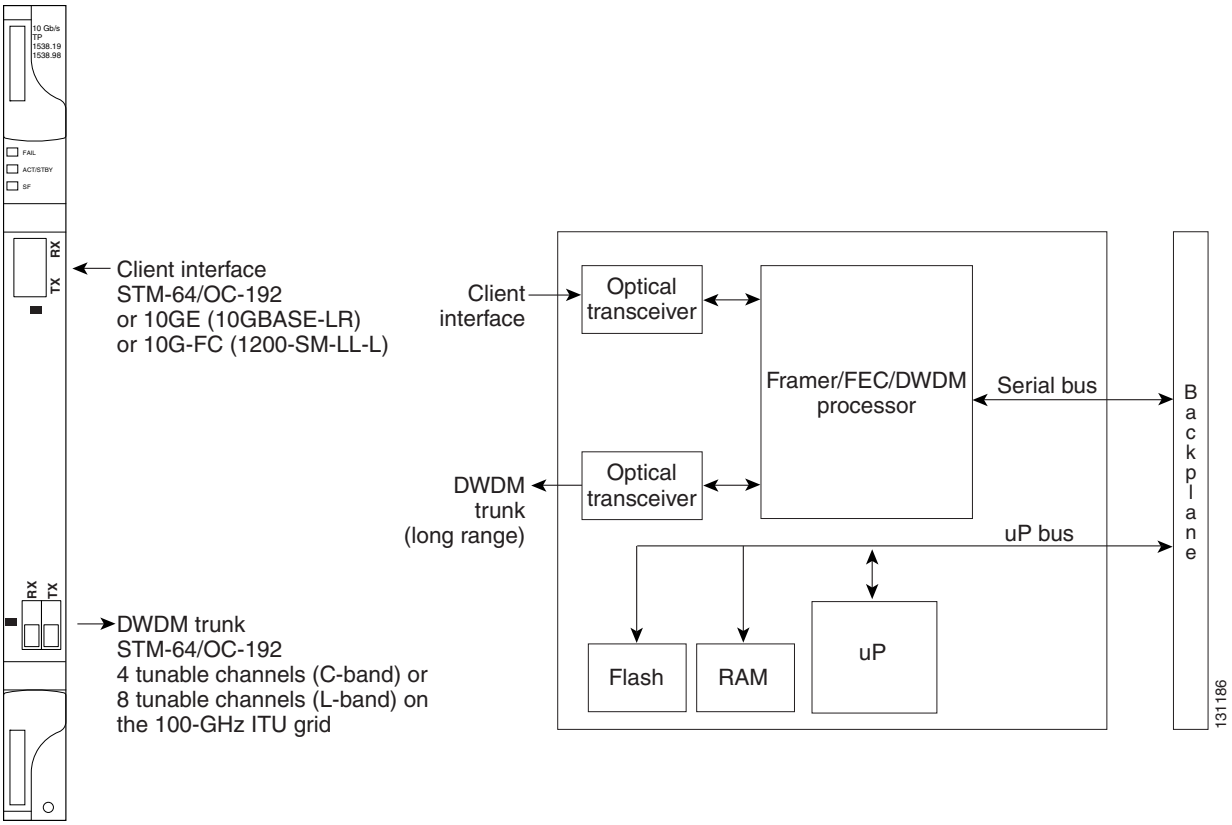
The key features of the TXP_MR_10E card are:

- A tri-rate client interface (available through the ONS-XC-10G-S1 XFP, ordered separately)
  - OC-192 (SR1)
  - 10GE (10GBASE-LR)
  - 10G-FC (1200-SM-LL-L)
- OC-192 to ITU-T G.709 OTU2 provisionable synchronous and asynchronous mapping
- The MTU setting is used to display the OverSizePkts counters on the receiving trunk and client port interfaces. Traffic of frame sizes up to 65535 bytes pass without any packet drops, from the client port to the trunk port and vice versa irrespective of the MTU setting.

10.4.2 Faceplate and Block Diagram

Figure 10-14 shows the TXP_MR_10E faceplate and block diagram.

Figure 10-14 TXP_MR_10E Faceplate and Block Diagram



For information on safety labels for the card, see the "10.2.2 Class 1M Laser Product Cards" section on page 10-10.

Caution You must use a 15-dB fiber attenuator (10 to 20 dB) when working with the TXP_MR_10E card in a loopback on the trunk port. Do not use direct fiber loopbacks with the TXP_MR_10E card. Using direct fiber loopbacks causes irreparable damage to the TXP_MR_10E card.

10.4.3 Client Interface

The client interface is implemented with a separately orderable XFP module. The module is a tri-rate transceiver, providing a single port that can be configured in the field to support an OC-192 SR-1 (Telcordia GR-253-CORE) or STM-64 I-64.1 (ITU-T G.691) optical interface, as well as 10GE LAN PHY (10GBASE-LR), 10GE WAN PHY (10GBASE-LW), or 10G FC signals.

The client side XFP pluggable module supports LC connectors and is equipped with a 1310-nm laser.

10.4.4 DWDM Trunk Interface

On the trunk side, the TXP_MR_10E card provides a 10-Gbps STM-64/OC-192 interface. There are four tunable channels available in the 1550-nm band or eight tunable channels available in the 1580-nm band on the 50-GHz ITU grid for the DWDM interface. The TXP_MR_10E card provides 3R (retime, reshape,

and regenerate) transponder functionality for this 10-Gbps trunk interface. Therefore, the card is suited for use in long-range amplified systems. The DWDM interface is complaint with ITU-T G.707, ITU-T G.709, and Telcordia GR-253-CORE standards.

The DWDM trunk port operates at a rate that is dependent on the input signal and the presence or absence of the ITU-T G.709 Digital Wrapper/FEC. The possible trunk rates are:

- OC192 (9.95328 Gbps)
- OTU2 (10.70923 Gbps)
- 10GE (10.3125 Gbps) or 10GE into OTU2 (ITU G.sup43 11.0957 Gbps)
- 10G FC (10.51875 Gbps) or 10G FC into OTU2 (nonstandard 11.31764 Gbps)

The maximum system reach in filterless applications without the use of optical amplification or regenerators is nominally rated at 23 dB over C-SMF fiber. This rating is not a product specification, but is given for informational purposes. It is subject to change.

10.4.5 Enhanced FEC (E-FEC) Feature

A key feature of the TXP_MR_10E is the availability to configure the forward error correction in three modes: NO FEC, FEC, and E-FEC. The output bit rate is always 10.7092 Gbps as defined in ITU-T G.709, but the error coding performance can be provisioned as follows:

- NO FEC—No forward error correction
- FEC—Standard ITU-T G.975 Reed-Solomon algorithm
- E-FEC—Standard ITU-T G.975.1 I.7 algorithm, which is a super FEC code

Note The E-FEC of the ONS 15454 and Cisco ASR 9000 are not compatible.

10.4.6 FEC and E-FEC Modes

As client side traffic passes through the TXP_MR_10E card, it can be digitally wrapped using FEC mode, E-FEC mode, or no error correction at all. The FEC mode setting provides a lower level of error detection and correction than the E-FEC mode setting of the card. As a result, using E-FEC mode allows higher sensitivity (lower optical signal-to-noise ratio [OSNR]) with a lower bit error rate than FEC mode. E-FEC enables longer distance trunk-side transmission than with FEC.

The E-FEC feature is one of three basic modes of FEC operation. FEC can be turned off, FEC can be turned on, or E-FEC can be turned on to provide greater range and lower BER. The default mode is FEC on and E-FEC off. E-FEC is provisioned using CTC.

Caution Because the transponder has no visibility into the data payload and detect circuits, the TXP_MR_10E card does not display circuits under the card view.

10.4.7 Client-to-Trunk Mapping

The TXP_MR_10E card can perform ODU2-to-OCh mapping, which allows operators to provision data payloads in a standard way across 10-Gbps optical links.

Digital wrappers that define client side interfaces are called Optical Data Channel Unit 2 (ODU2) entities in ITU-T G.709. Digital wrappers that define trunk side interfaces are called Optical Channels (OCh) in ITU-T G.709. ODU2 digital wrappers can include Generalized Multiprotocol Label Switching (G-MPLS) signaling extensions to ITU-T G.709 (such as Least Significant Part [LSP] and Generalized Payload Identifier [G-PID] values) to define client interfaces and payload protocols.

10.4.8 Automatic Laser Shutdown

The ALS procedure is supported on both client and trunk interfaces. On the client interface, ALS is compliant with ITU-T G.664 (6/99). On the data application and trunk interface, the switch on and off pulse duration is greater than 60 seconds. The on and off pulse duration is user-configurable. For details on ALS provisioning for the card, refer to the *Cisco ONS 15454 DWDM Procedure Guide.*

10.4.9 TXP_MR_10E Card-Level Indicators

Table 10-5 lists the three card-level LEDs on the TXP_MR_10E card.

Table 10-5 TXP_MR_10E Card-Level Indicators

Card-Level LED	Description
Red FAIL LED	The red FAIL LED indicates that the card's processor is not ready. This LED is on during reset. The FAIL LED flashes during the boot process. Replace the card if the red FAIL LED persists.
ACT/STBY LED Green (Active) Amber (Standby)	If the ACT/STBY LED is green, the card is operational (one or both ports active) and ready to carry traffic. If the ACT/STBY LED is amber, the card is operational and in standby (protect) mode.
Amber SF LED	The amber SF LED indicates a signal failure or condition such as LOS, LOF, or high BERs on one or more of the card's ports. The amber SF LED is also on if the transmit and receive fibers are incorrectly connected. If the fibers are properly connected and the link is working, the light turns off.

10.4.10 TXP_MR_10E Port-Level Indicators

Table 10-6 lists the two port-level LEDs in the TXP_MR_10E card.

Table 10-6 TXP_MR_10E Port-Level Indicators

Port-Level LED	Description
Green Client LED	The green Client LED indicates that the client port is in service and that it is receiving a recognized signal.
Green DWDM LED	The green DWDM LED indicates that the DWDM port is in service and that it is receiving a recognized signal.

10.5 TXP_MR_10E_C and TXP_MR_10E_L Cards

TXP_MR_10E_L: (Cisco ONS 15454 only)

The TXP_MR_10E_C and TXP_MR_10E_L cards are multirate transponders for the ONS 15454 platform. The cards are fully backward compatible with the TXP_MR_10G and TXP_MR_10E cards. They processes one 10-Gbps signal (client side) into one 10-Gbps, 100-GHz DWDM signal (trunk side). The TXP_MR_10E_C is tunable over the entire set of C-band wavelength channels (82 channels spaced at 50 GHz on the ITU grid). The TXP_MR_10E_L is tunable over the entire set of L-band wavelength channels (80 channels spaced at 50 GHz on the ITU grid) and is particularly well suited for use in networks that employ DS fiber or SMF-28 single-mode fiber.

The advantage of these cards over previous versions (TXP_MR_10G and TXP_MR_10E) is that there is only one version of each card (one C-band version and one L-band version) instead of several versions needed to cover each band.

You can install TXP_MR_10E_C and TXP_MR_10E_L cards in Slots 1 to 6 and 12 to 17 and provision the cards in a linear configuration, BLSR/MS-SPRing, path protection/SNCP, or a regenerator. The cards can be used in the middle of BLSR/MS-SPRing or 1+1 spans when the cards are configured for transparent termination mode.

The TXP_MR_10E_C and TXP_MR_10E_L cards feature a universal transponder 2 (UT2) 1550-nm tunable laser (C band) or a UT2 1580-nm tunable laser (L band) for the trunk port and a separately orderable ONS-XC-10G-S1 1310-nm or ONS-XC-10G-L2 1550-nm laser XFP module for the client port.

Note When the ONS-XC-10G-L2 XFP is installed, the TXP_MR_10E_C or TXP_MR_10E-L card is required to be installed in a high-speed slot (slot 6, 7, 12, or 13)

On its faceplate, the TXP_MR_10E_C and TXP_MR_10E_L cards contain two transmit and receive connector pairs, one for the trunk port and one for the client port. Each connector pair is labeled.

10.5.1 Key Features

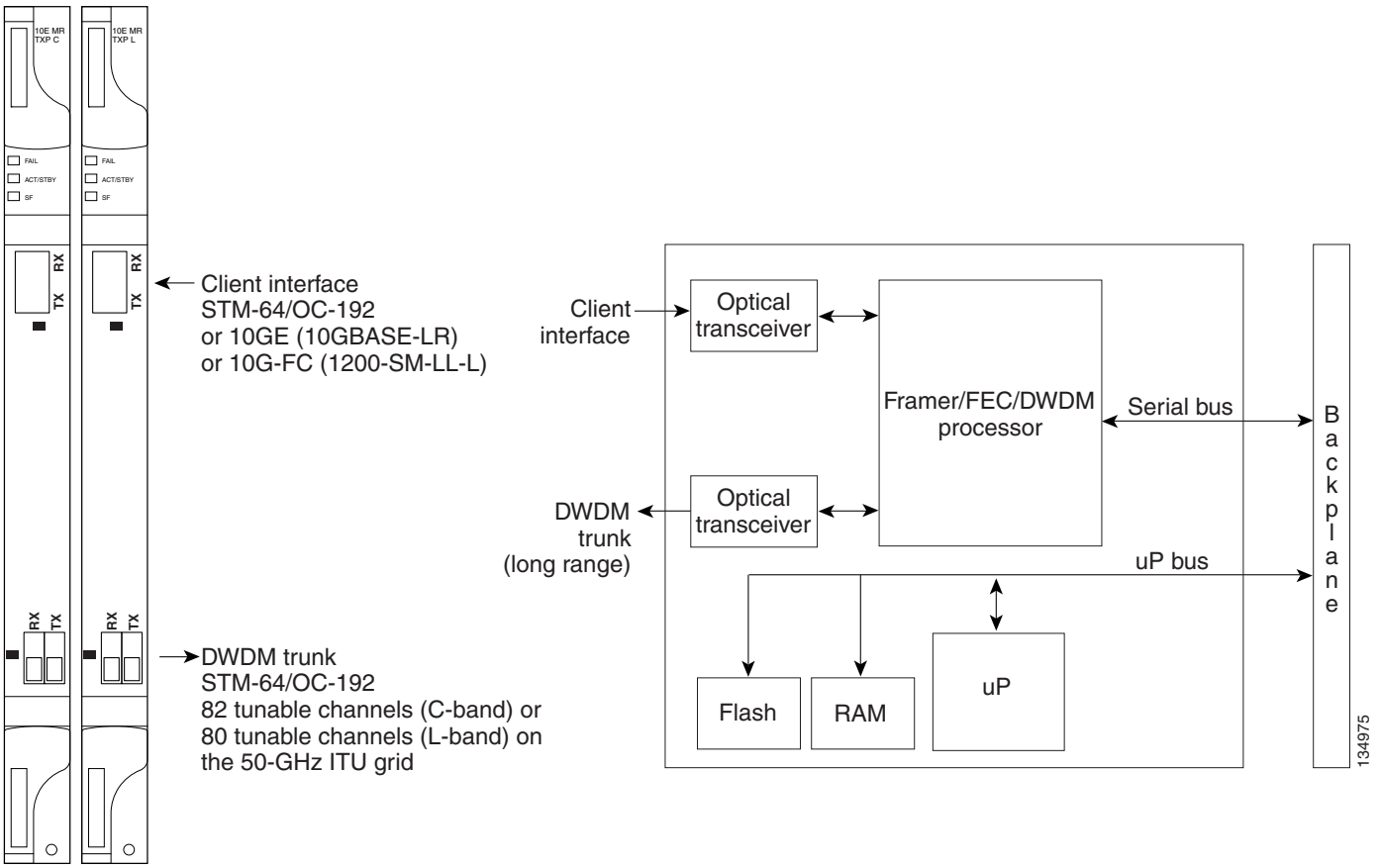
The key features of the TXP_MR_10E_C and TXP_MR_10E_L cards are:

- A tri-rate client interface (available through the ONS-XC-10G-S1 XFP, ordered separately):
  - OC-192 (SR1)
  - 10GE (10GBASE-LR)
  - 10G-FC (1200-SM-LL-L)
- A UT2 module tunable through the entire C band (TXP_MR_10E_C card) or L band (TXP_MR_10E_L card). The channels are spaced at 50 GHz on the ITU grid.
- OC-192 to ITU-T G.709 OTU2 provisionable synchronous and asynchronous mapping.
- The MTU setting is used to display the OverSizePkts counters on the receiving trunk and client port interfaces. Traffic of frame sizes up to 65535 bytes pass without any packet drops, from the client port to the trunk port and vice versa irrespective of the MTU setting.

10.5.2 Faceplates and Block Diagram

Figure 10-15 shows the TXP_MR_10E_C and TXP_MR_10E_L faceplates and block diagram.

Figure 10-15 TXP_MR_10E_C and TXP_MR_10E_L Faceplates and Block Diagram



For information on safety labels for the cards, see the "10.2.2 Class 1M Laser Product Cards" section on page 10-10.

Caution You must use a 15-dB fiber attenuator (10 to 20 dB) when working with the TXP_MR_10E_C or TXP_MR_10E_L card in a loopback on the trunk port. Do not use direct fiber loopbacks with the cards. Using direct fiber loopbacks causes irreparable damage to the cards.

10.5.3 Client Interface

The client interface is implemented with a separately orderable XFP module. The module is a tri-rate transceiver, providing a single port that can be configured in the field to support an OC-192 SR-1 (Telcordia GR-253-CORE) or STM-64 I-64.1 (ITU-T G.691) optical interface, as well as 10GE LAN PHY (10GBASE-LR), 10GE WAN PHY (10GBASE-LW), or 10G-FC signals.

The client side XFP pluggable module supports LC connectors and is equipped with a 1310-nm laser.

10.5.4 DWDM Trunk Interface

On the trunk side, the TXP_MR_10E_C and TXP_MR_10E_L cards provide a 10-Gbps STM-64/OC-192 interface. There are 80 tunable channels available in the 1550-nm C band or 82 tunable channels available in the 1580-nm L band on the 50-GHz ITU grid for the DWDM interface. The TXP_MR_10E_C and TXP_MR_10E_C cards provide 3R transponder functionality for this 10-Gbps trunk interface. Therefore, the card is suited for use in long-range amplified systems. The DWDM interface is compliant with ITU-T G.707, ITU-T G.709, and Telcordia GR-253-CORE standards.

The DWDM trunk port operates at a rate that is dependent on the input signal and the presence or absence of the ITU-T G.709 Digital Wrapper/FEC. The possible trunk rates are:

- OC192 (9.95328 Gbps)
- OTU2 (10.70923 Gbps)
- 10GE (10.3125 Gbps) or 10GE into OTU2 (ITU G.sup43 11.0957 Gbps)
- 10G-FC (10.51875 Gbps) or 10G-FC into OTU2 (nonstandard 11.31764 Gbps)

The maximum system reach in filterless applications without the use of optical amplification or regenerators is nominally rated at 23 dB over C-SMF fiber. This rating is not a product specification, but is given for informational purposes. It is subject to change.

10.5.5 Enhanced FEC (E-FEC) Feature

A key feature of the TXP_MR_10E_C and TXP_MR_10E_L cards is the availability to configure the forward error correction in three modes: NO FEC, FEC, and E-FEC. The output bit rate is always 10.7092 Gbps as defined in ITU-T G.709, but the error coding performance can be provisioned as follows:

- NO FEC—No forward error correction
- FEC—Standard ITU-T G.975 Reed-Solomon algorithm
- E-FEC—Standard ITU-T G.975.1 I.7 algorithm, which is a super FEC code

10.5.6 FEC and E-FEC Modes

As client side traffic passes through the TXP_MR_10E_C and TXP_MR_10E_L cards, it can be digitally wrapped using FEC mode, E-FEC mode, or no error correction at all. The FEC mode setting provides a lower level of error detection and correction than the E-FEC mode setting of the card. As a result, using E-FEC mode allows higher sensitivity (lower OSNR) with a lower bit error rate than FEC mode. E-FEC enables longer distance trunk-side transmission than with FEC.

The E-FEC feature is one of three basic modes of FEC operation. FEC can be turned off, FEC can be turned on, or E-FEC can be turned on to provide greater range and lower BER. The default mode is FEC on and E-FEC off. E-FEC is provisioned using CTC.

Caution Because the transponder has no visibility into the data payload and detect circuits, the TXP_MR_10E_C and TXP_MR_10E_L cards do not display circuits under the card view.

10.5.7 Client-to-Trunk Mapping

The TXP_MR_10E_C and TXP_MR_10E_L cards can perform ODU2-to-OCh mapping, which allows operators to provision data payloads in a standard way across 10-Gbps optical links.

Digital wrappers that define client side interfaces are called ODU2 entities in ITU-T G.709. Digital wrappers that define trunk side interfaces are called OCh in ITU-T G.709. ODU2 digital wrappers can include G-MPLS signaling extensions to ITU-T G.709 (such as LSP and G-PID values) to define client interfaces and payload protocols.

10.5.8 Automatic Laser Shutdown

The ALS procedure is supported on both client and trunk interfaces. On the client interface, ALS is compliant with ITU-T G.664 (6/99). On the data application and trunk interface, the switch on and off pulse duration is greater than 60 seconds. The on and off pulse duration is user-configurable. For details regarding ALS provisioning for the TXP_MR_10E_C and TXP_MR_10E_L cards, refer to the *Cisco ONS 15454 DWDM Procedure Guide*.

10.5.9 TXP_MR_10E_C and TXP_MR_10E_L Card-Level Indicators

Table 10-7 lists the three card-level LEDs on the TXP_MR_10E_C and TXP_MR_10E_L cards.

Table 10-7 TXP_MR_10E _C and TXP_MR_10E_L Card-Level Indicators

Card-Level LED	Description
Red FAIL LED	The red FAIL LED indicates that the card's processor is not ready. This LED is on during reset. The FAIL LED flashes during the boot process. Replace the card if the red FAIL LED persists.
ACT/STBY LED Green (Active) Amber (Standby)	If the ACT/STBY LED is green, the card is operational (one or both ports active) and ready to carry traffic. If the ACT/STBY LED is amber, the card is operational and in standby (protect) mode.
Amber SF LED	The amber SF LED indicates a signal failure or condition such as LOS, LOF, or high BERs on one or more of the card's ports. The amber SF LED is also on if the transmit and receive fibers are incorrectly connected. If the fibers are properly connected and the link is working, the light turns off.

10.5.10 TXP_MR_10E_C and TXP_MR_10E_L Port-Level Indicators

Table 10-8 lists the two port-level LEDs in the TXP_MR_10E_C and TXP_MR_10E_L cards.

Table 10-8 TXP_MR_10E_C and TXP_MR_10E_L Port-Level Indicators

Port-Level LED	Description
Green Client LED	The green Client LED indicates that the client port is in service and that it is receiving a recognized signal.
Green DWDM LED	The green DWDM LED indicates that the DWDM port is in service and that it is receiving a recognized signal.

10.6 TXP_MR_2.5G and TXPP_MR_2.5G Cards

The TXP_MR_2.5G card processes one 8-Mbps to 2.488-Gbps signal (client side) into one 8-Mbps to 2.5-Gbps, 100-GHz DWDM signal (trunk side). It provides one long-reach STM-16/OC-48 port per card, compliant with ITU-T G.707, ITU-T G.709, ITU-T G.957, and Telcordia GR-253-CORE.

The TXPP_MR_2.5G card processes one 8-Mbps to 2.488-Gbps signal (client side) into two 8-Mbps to 2.5-Gbps, 100-GHz DWDM signals (trunk side). It provides two long-reach STM-16/OC-48 ports per card, compliant with ITU-T G.707, ITU-T G.957, and Telcordia GR-253-CORE.

The TXP_MR_2.5G and TXPP_MR_2.5G cards are tunable over four wavelengths in the 1550-nm, ITU 100-GHz range. They are available in eight versions, each of which covers four wavelengths, for a total coverage of 32 different wavelengths in the 1550-nm range.

Note ITU-T G.709 specifies a form of FEC that uses a "wrapper" approach. The digital wrapper lets you transparently take in a signal on the client side, wrap a frame around it, and restore it to its original form. FEC enables longer fiber links because errors caused by the optical signal degrading with distance are corrected.

The trunk/line port operates at up to 2.488 Gbps (or up to 2.66 Gbps with ITU-T G.709 Digital Wrapper/FEC) over unamplified distances up to 360 km (223.7 miles) with different types of fiber such as C-SMF or higher if dispersion compensation is used.

Caution Because the transponder has no capability to look into the payload and detect circuits, a TXP_MR_2.5G or TXPP_MR_2.5G card does not display circuits under card view.

The TXP_MR_2.5G and TXPP_MR_2.5G cards support 2R (retime, regenerate) and 3R (retime, reshape, and regenerate) modes of operation where the client signal is mapped into a ITU-T G.709 frame. The mapping function is simply done by placing a digital wrapper around the client signal. Only OC-48/STM-16 client signals are fully ITU-T G.709 compliant, and the output bit rate depends on the input client signal. Table 10-9 shows the possible combinations of client interfaces, input bit rates, 2R and 3R modes, and ITU-T G.709 monitoring.

Table 10-9 2R and 3R Mode and ITU-T G.709 Compliance by Client Interface

Client Interface	Input Bit Rate	3R vs. 2R	ITU-T G.709
OC-48/STM-16	2.488 Gbps	3R	On or Off
DV-6000	2.38 Gbps	2R	—
2 Gigabit Fibre Channel (2G-FC)/fiber connectivity (FICON)	2.125 Gbps	3R[1]	On or Off
High-Definition Television (HDTV)	1.48 Gbps	2R	—
Gigabit Ethernet (GE)	1.25 Gbps	3R	On or Off
1 Gigabit Fibre Channel (1G-FC)/FICON	1.06 Gbps	3R	On or Off
OC-12/STM-4	622 Mbps	3R	On or Off
OC-3/STM-1	155 Mbps	3R	On or Off
Enterprise System Connection (ESCON)	200 Mbps	2R	—
SDI/D1/DVB-ASI video	270 Mbps	2R	—

Table 10-9 2R and 3R Mode and ITU-T G.709 Compliance by Client Interface (continued)

Client Interface	Input Bit Rate	3R vs. 2R	ITU-T G.709
ISC-1 Compat	1.06 Gbps	2R	Off
ISC-3	1.06 or 2.125 Gbps	2R	—
ETR_CLO	16 Mbps	2R	—

1. No monitoring

Note ITU-T G.709 and FEC support is disabled for all the 2R payload types in the TXP_MR_2.5G and TXPP_MR_2.5G cards.

The output bit rate is calculated for the trunk bit rate by using the 255/238 ratio as specified in ITU-T G.709 for OTU1. Table 10-10 lists the calculated trunk bit rates for the client interfaces with ITU-T G.709 enabled.

Table 10-10 Trunk Bit Rates With ITU-T G.709 Enabled

Client Interface	ITU-T G.709 Disabled	ITU-T G.709 Enabled
OC-48/STM-16	2.488 Gbps	2.66 Gbps
2G-FC	2.125 Gbps	2.27 Gbps
GE	1.25 Gbps	1.34 Gbps
1G-FC	1.06 Gbps	1.14 Gbps
OC-12/STM-3	622 Mbps	666.43 Mbps
OC-3/STM-1	155 Mbps	166.07 Mbps

For 2R operation mode, the TXP_MR_2.5G and TXPP_MR_2.5G cards have the ability to pass data through transparently from client side interfaces to a trunk side interface, which resides on an ITU grid. The data might vary at any bit rate from 200-Mbps up to 2.38-Gbps, including ESCON, DVB-ASI, ISC-1, and video signals. In this pass-through mode, no performance monitoring (PM) or digital wrapping of the incoming signal is provided, except for the usual PM outputs from the SFPs. Similarly, this card has the ability to pass data through transparently from the trunk side interfaces to the client side interfaces with bit rates varying from 200-Mbps up to 2.38-Gbps. Again, no PM or digital wrapping of received signals is available in this pass-through mode.

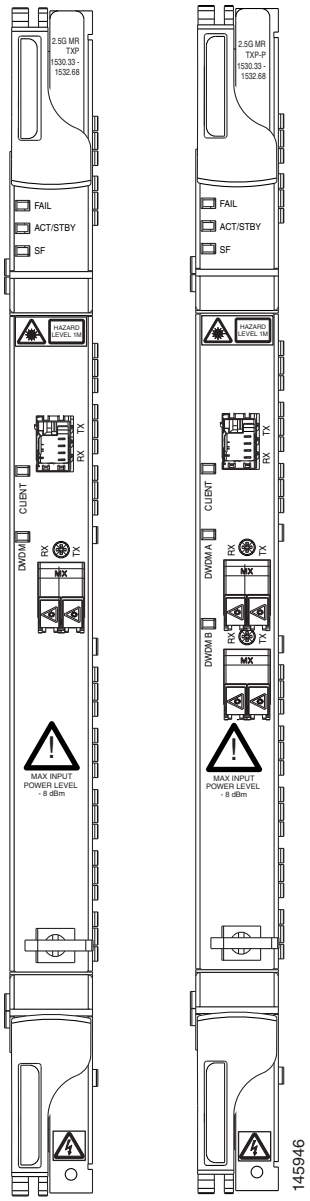
For 3R operation mode, the TXP_MR_2.5G and TXPP_MR_2.5G cards apply a digital wrapper to the incoming client interface signals (OC-N/STM-N, 1G-FC, 2G-FC, GE). PM is available on all of these signals except for 2G-FC, and varies depending upon the type of signal. For client inputs other than OC-48/STM-16, a digital wrapper might be applied but the resulting signal is not ITU-T G.709 compliant. The card applies a digital wrapper that is scaled to the frequency of the input signal.

The TXP_MR_2.5G and TXPP_MR_2.5G cards have the ability to take digitally wrapped signals in from the trunk interface, remove the digital wrapper, and send the unwrapped data through to the client interface. PM of the ITU-T G.709 OH and SONET/SDH OH is implemented.

10.6.1 Faceplate

Figure 10-16 shows the TXP_MR_2.5G and TXPP_MR_2.5G faceplates.

Figure 10-16 TXP_MR_2.5G and TXPP_MR_2.5G Faceplates

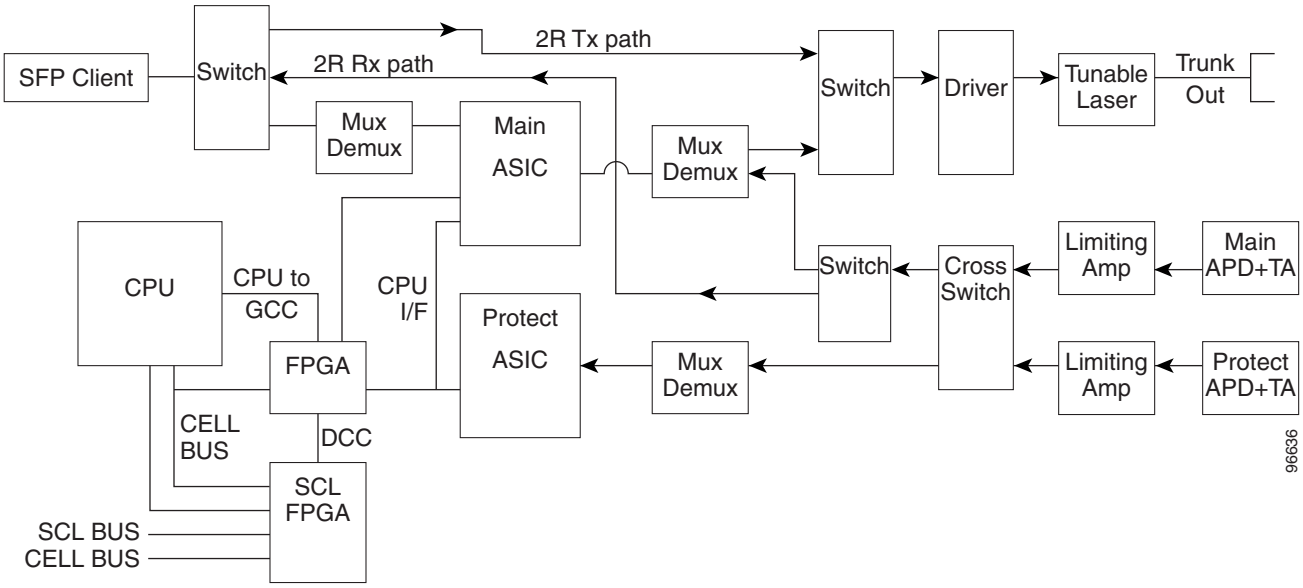


For information on safety labels for the cards, see the "10.2.2 Class 1M Laser Product Cards" section on page 10-10.

10.6.2 Block Diagram

Figure 10-17 shows a block diagram of the TXP_MR_2.5G and TXPP_MR_2.5G cards.

Figure 10-17 TXP_MR_2.5G and TXPP_MR_2.5G Block Diagram



Caution You must use a 20-dB fiber attenuator (15 to 25 dB) when working with the TXP_MR_2.5G and TXPP_MR_2.5G cards in a loopback on the trunk port. Do not use direct fiber loopbacks with the TXP_MR_2.5G and TXPP_MR_2.5G cards. Using direct fiber loopbacks causes irreparable damage to the TXP_MR_2.5G and TXPP_MR_2.5G cards.

You can install TXP_MR_2.5G and TXPP_MR_2.5G cards in Slots 1 to 6 and 12 to 17. You can provision this card in a linear configuration. TXP_MR_10G and TXPP_MR_2.5G cards cannot be provisioned as a BLSR/MS-SPRing, a path protection/SNCP, or a regenerator. They can be used in the middle of BLSR/MS-SPRing or 1+1 spans only when the card is configured for transparent termination mode.

The TXP_MR_2.5G card features a 1550-nm laser for the trunk/line port and a 1310-nm laser for the client port. It contains two transmit and receive connector pairs (labeled) on the card faceplate. The card uses dual LC connectors for optical cable termination.

The TXPP_MR_2.5G card features a 1550-nm laser for the trunk/line port and a 1310-nm or 850-nm laser (depending on the SFP) for the client port and contains three transmit and receive connector pairs (labeled) on the card faceplate. The card uses dual LC connectors for optical cable termination.

10.6.3 Automatic Laser Shutdown

The ALS procedure is supported on both client and trunk interfaces. On the client interface, ALS is compliant with ITU-T G.664 (6/99). On the data application and trunk interface, the switch on and off pulse duration is greater than 60 seconds. The on and off pulse duration is user-configurable. For details regarding ALS provisioning for the TXP_MR_2.5G and TXPP_MR_2.5G cards, refer to the *Cisco ONS 15454 DWDM Procedure Guide*.

10.6.4 TXP_MR_2.5G and TXPP_MR_2.5G Card-Level Indicators

Table 10-11 lists the three card-level LEDs on the TXP_MR_2.5G and TXPP_MR_2.5G cards.

Table 10-11 TXP_MR_2.5G and TXPP_MR_2.5G Card-Level Indicators

Card-Level LED	Description
Red FAIL LED	The red FAIL LED indicates that the card's processor is not ready. This LED is on during reset. The FAIL LED flashes during the boot process. Replace the card if the red FAIL LED persists.
ACT/STBY LED Green (Active) Amber (Standby)	If the ACT/STBY LED is green, the card is operational (one or both ports active) and ready to carry traffic. If the ACT/STBY LED is amber, the card is operational and in standby (protect) mode.
Amber SF LED	The amber SF LED indicates a signal failure or condition such as LOS, LOF, or high BERs on one or more of the card's ports. The amber SF LED is also on if the transmit and receive fibers are incorrectly connected. If the fibers are properly connected and the link is working, the light turns off.

10.6.5 TXP_MR_2.5G and TXPP_MR_2.5G Port-Level Indicators

Table 10-12 lists the four port-level LEDs on the TXP_MR_2.5G and TXPP_MR_2.5G cards.

Table 10-12 TXP_MR_2.5G and TXPP_MR_2.5G Port-Level Indicators

Port-Level LED	Description
Green Client LED	The green Client LED indicates that the client port is in service and that it is receiving a recognized signal.
Green DWDM LED (TXP_MR_2.5G only)	The green DWDM LED indicates that the DWDM port is in service and that it is receiving a recognized signal.
Green DWDM A LED (TXPP_MR_2.5G only)	The green DWDM A LED indicates that the DWDM A port is in service and that it is receiving a recognized signal.
Green DWDM B LED (TXPP_MR_2.5G only)	The green DWDM B LED indicates that the DWDM B port is in service and that it is receiving a recognized signal.

10.7 MXP_2.5G_10G Card

(Cisco ONS 15454 only)

The MXP_2.5G_10G card multiplexes/demultiplexes four 2.5-Gbps signals (client side) into one 10-Gbps, 100-GHz DWDM signal (trunk side). It provides one extended long-range STM-64/OC-192 port per card on the trunk side (compliant with ITU-T G.707, ITU-T G.709, ITU-T G.957, and Telcordia GR-253-CORE) and four intermediate- or short-range OC-48/STM-16 ports per card on the client side. The port operates at 9.95328 Gbps over unamplified distances up to 80 km (50 miles) with different types of fiber such as C-SMF or dispersion compensated fiber limited by loss and/or dispersion.

Client ports on the MXP_2.5G_10G card are also interoperable with SONET OC-1 (STS-1) fiber optic signals defined in Telcordia GR-253-CORE. An OC-1 signal is the equivalent of one DS-3 channel transmitted across optical fiber. OC-1 is primarily used for trunk interfaces to phone switches in the United States. There is no SDH equivalent for SONET OC-1.

The MXP_2.5G_10G card is tunable over two neighboring wavelengths in the 1550-nm, ITU 100-GHz range. It is available in 16 different versions, each of which covers two wavelengths, for a total coverage of 32 different wavelengths in the 1550-nm range.

Note ITU-T G.709 specifies a form of FEC that uses a "wrapper" approach. The digital wrapper lets you transparently take in a signal on the client side, wrap a frame around it and restore it to its original form. FEC enables longer fiber links because errors caused by the optical signal degrading with distance are corrected.

The port can also operate at 10.70923 Gbps in ITU-T G.709 Digital Wrapper/FEC mode.

Caution Because the transponder has no capability to look into the payload and detect circuits, an MXP_2.5G_10G card does not display circuits under card view.

Caution You must use a 20-dB fiber attenuator (15 to 25 dB) when working with the MXP_2.5G_10G card in a loopback on the trunk port. Do not use direct fiber loopbacks with the MXP_2.5G_10G card. Using direct fiber loopbacks causes irreparable damage to the MXP_2.5G_10G card.

You can install MXP_2.5G_10G cards in Slots 1 to 6 and 12 to 17.

Caution Do not install an MXP_2.5G_10G card in Slot 3 if you have installed a DS3/EC1-48 card in Slots 1or 2. Likewise, do not install an MXP_2.5G_10G card in Slot 17 if you have installed a DS3/EC1-48 card in Slots 15 or 16. If you do, the cards will interact and cause DS-3 bit errors.

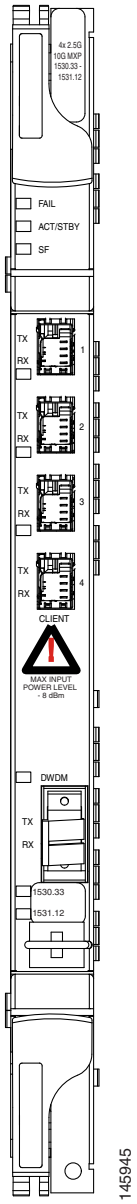
You can provision this card in a linear configuration. MXP_2.5G_10G cards cannot be provisioned as a BLSR/MS-SPRing, a path protection/SNCP, or a regenerator. They can be used in the middle of BLSR/MS-SPRing or 1+1 spans only when the card is configured for transparent termination mode.

The MXP_2.5G_10G port features a 1550-nm laser on the trunk port and four 1310-nm lasers on the client ports and contains five transmit and receive connector pairs (labeled) on the card faceplate. The card uses a dual LC connector on the trunk side and SFP connectors on the client side for optical cable termination.

Note When you create a 4xOC-48 OCHCC circuit, you need to select the G.709 and Synchronous options. A 4xOC-48 OCHCC circuit is supported by G.709 and synchronous mode. This is necessary to provision a 4xOC-48 OCHCC circuit.

Figure 10-18 shows the MXP_2.5G_10G faceplate.

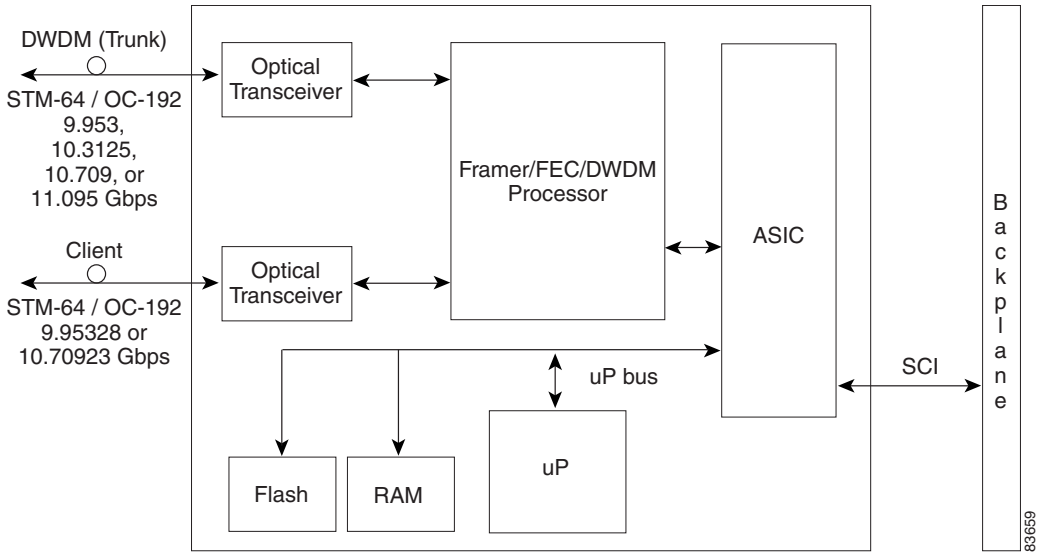
Figure 10-18 MXP_2.5G_10G Faceplate



For information on safety labels for the card, see the "10.2.1 Class 1 Laser Product Cards" section on page 10-8.

Figure 10-19 shows a block diagram of the MXP_2.5G_10G card.

Figure 10-19 MXP_2.5G_10G Card Block Diagram



10.7.1 Timing Synchronization

The MXP_2.5G_10G card is synchronized to the TCC2/TCC2P/TCC3 clock during normal conditions and transmits the ITU-T G.709 frame using this clock. The TCC2/TCC2P/TCC3 card can operate from an external building integrated timing supply (BITS) clock, an internal Stratum 3 clock, or from clock recovered from one of the four valid client clocks. If clocks from both TCC2/TCC2P/TCC3 cards are not available, the MXP_2.5G_10G card switches automatically (with errors, not hitless) to an internal 19.44 MHz clock that does not meet SONET clock requirements. This will result in a clock alarm.

10.7.2 Automatic Laser Shutdown

The ALS procedure is supported on both client and trunk interfaces. On the client interface, ALS is compliant with ITU-T G.664 (6/99). On the data application and trunk interface, the switch on and off pulse duration is greater than 60 seconds. The on and off pulse duration is user-configurable. For details regarding ALS provisioning for the MXP_2.5G_10G card, refer to the *Cisco ONS 15454 DWDM Procedure Guide.*

10.7.3 MXP_2.5G_10G Card-Level Indicators

Table 10-13 describes the three card-level LEDs on the MXP_2.5G_10G card.

Table 10-13 MXP_2.5G_10G Card-Level Indicators

Card-Level LED	Description
Red FAIL LED	The red FAIL LED indicates that the card's processor is not ready. This LED is on during reset. The FAIL LED flashes during the boot process. Replace the card if the red FAIL LED persists.
ACT/STBY LED Green (Active) Amber (Standby)	If the ACT/STBY LED is green, the card is operational (one or more ports active) and ready to carry traffic. If the ACT/STBY LED is amber, the card is operational and in standby (protect) mode.
Amber SF LED	The amber SF LED indicates a signal failure or condition such as LOS, LOF, or high BERs on one or more of the card's ports. The amber SF LED is also on if the transmit and receive fibers are incorrectly connected. If the fibers are properly connected and the link is working, the light turns off.

10.7.3.1 MXP_2.5G_10G Port-Level Indicators

Table 10-14 describes the four port-level LEDs on the MXP_2.5G_10G card.

Table 10-14 MXP_2.5G_10G Port-Level Indicators

Port-Level LED	Description
Green Client LED (four LEDs)	The green Client LED indicates that the client port is in service and that it is receiving a recognized signal. The card has four client ports, and so has four Client LEDs.
Green DWDM LED	The green DWDM LED indicates that the DWDM port is in service and that it is receiving a recognized signal.
Green Wavelength 1 LED	Each port supports two wavelengths on the DWDM side. Each wavelength LED matches one of the wavelengths. This LED indicates that the card is configured for Wavelength 1.
Green Wavelength 2 LED	Each port supports two wavelengths on the DWDM side. Each wavelength LED matches one of the wavelengths. This LED indicates that the card is configured for Wavelength 2.

10.7.4 MXP_2.5G_10E Card

The faceplate designation of the card is "4x2.5G 10E MXP." The MXP_2.5G_10E card is a DWDM muxponder for the ONS 15454 platform that supports full transparent termination the client side. The card multiplexes four 2.5 Gbps client signals (4 x OC48/STM-16 SFP) into a single 10-Gbps DWDM optical signal on the trunk side. The MXP_2.5G_10E provides wavelength transmission service for the four incoming 2.5 Gbps client interfaces. The MXP_2.5G_10E muxponder passes all SONET/SDH overhead bytes transparently.

The digital wrapper function (ITU-T G.709 compliant) formats the DWDM wavelength so that it can be used to set up generic communications channels (GCCs) for data communications, enable FEC, or facilitate performance monitoring.

The MXP_2.5G_10E works with optical transport network (OTN) devices defined in ITU-T G.709. The card supports ODU1 to OTU2 multiplexing, an industry standard method for asynchronously mapping a SONET/SDH payload into a digitally wrapped envelope. See the "10.7.7 Multiplexing Function" section on page 10-36.

The MXP_2.5G_10E card is not compatible with the MXP_2.5G_10G card, which does not support full transparent termination. You can install MXP_2.5G_10E cards in Slots 1 to 6 and 12 to 17. You can provision this card in a linear configuration, as a BLSR/MS-SPRing, a path protection/SNCP, or a regenerator. The card can be used in the middle of BLSR/MS-SPRing or 1+1 spans when the card is configured for transparent termination mode.

The MXP_2.5G_10E features a 1550-nm laser on the trunk port and four 1310-nm lasers on the client ports and contains five transmit and receive connector pairs (labeled) on the card faceplate. The card uses a dual LC connector on the trunk side and uses SFP modules on the client side for optical cable termination. The SFP pluggable modules are short reach (SR) or intermediate reach (IR) and support an LC fiber connector.

Note When you create a 4xOC-48 OCHCC circuit, you need to select the G.709 and Synchronous options. A 4xOC-48 OCHCC circuit is supported by G.709 and synchronous mode. This is necessary to provision a 4xOC-48 OCHCC circuit.

10.7.4.1 Key Features

The MXP_2.5G_10E card has the following high level features:

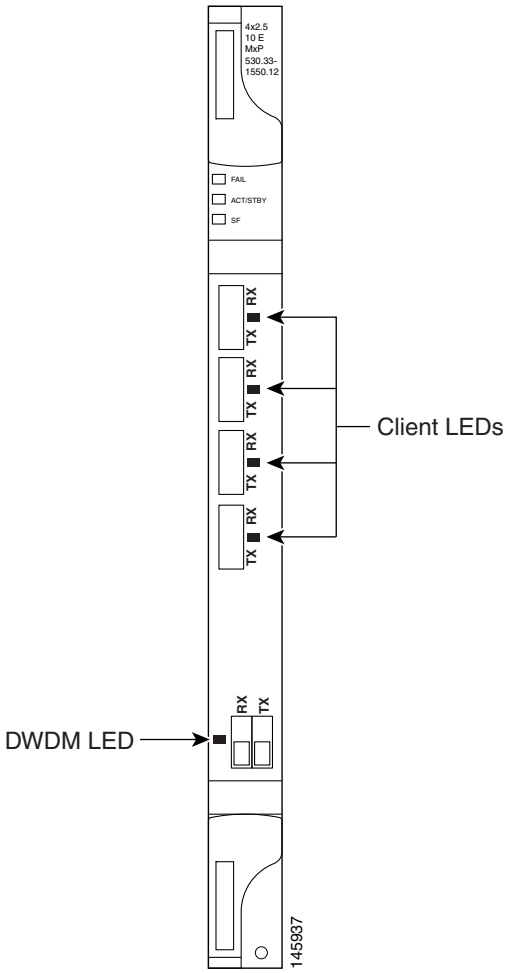
- Four 2.5 Gbps client interfaces (OC-48/STM-16) and one 10 Gbps trunk. The four OC-48 signals are mapped into a ITU-T G.709 OTU2 signal using standard ITU-T G.709 multiplexing.
- Onboard E-FEC processor: The processor supports both standard Reed-Solomon (RS, specified in ITU-T G.709) and E-FEC, which allows an improved gain on trunk interfaces with a resultant extension of the transmission range on these interfaces. The E-FEC functionality increases the correction capability of the transponder to improve performance, allowing operation at a lower OSNR compared to the standard RS (237,255) correction algorithm. A new block code (BCH) algorithm implemented in E-FEC allows recovery of an input BER up to 1E-3.
- Pluggable client interface optic modules: The MXP_2.5G_10E card has modular interfaces. Two types of optics modules can be plugged into the card. These include an OC-48/STM 16 SR-1 interface with a 7-km (4.3-mile) nominal range (for short range and intra-office applications) and an IR-1 interface with a range up to 40 km (24.9 miles). SR-1 is defined in Telcordia GR-253-CORE and in I-16 (ITU-T G.957). IR-1 is defined in Telcordia GR-253-CORE and in S-16-1 (ITU-T G.957).
- High level provisioning support: The MXP_2.5G_10E card is initially provisioned using Cisco TransportPlanner software. Subsequently, the card can be monitored and provisioned using CTC software.
- Link monitoring and management: The MXP_2.5G_10E card uses standard OC-48 OH (overhead) bytes to monitor and manage incoming interfaces. The card passes the incoming SDH/SONET data stream and its overhead bytes transparently.
- Control of layered SONET/SDH transport overhead: The card is provisionable to terminate regenerator section overhead. This is used to eliminate forwarding of unneeded layer overhead. It can help reduce the number of alarms and help isolate faults in the network.

- Automatic timing source synchronization: The MXP_2.5G_10E normally synchronizes from the TCC2/TCC2P/TCC3/TNC/TSC card. If for some reason, such as maintenance or upgrade activity, the TCC2/TCC2P/TCC3/TNC/TSC is not available, the MXP_2.5G_10E automatically synchronizes to one of the input client interface clocks.
- Configurable squelching policy: The card can be configured to squelch the client interface output if there is LOS at the DWDM receiver or if there is a remote fault. In the event of a remote fault, the card manages multiplex section alarm indication signal (MS-AIS) insertion.

10.7.5 Faceplate

Figure 10-20 shows the MXP_2.5G_10E faceplate.

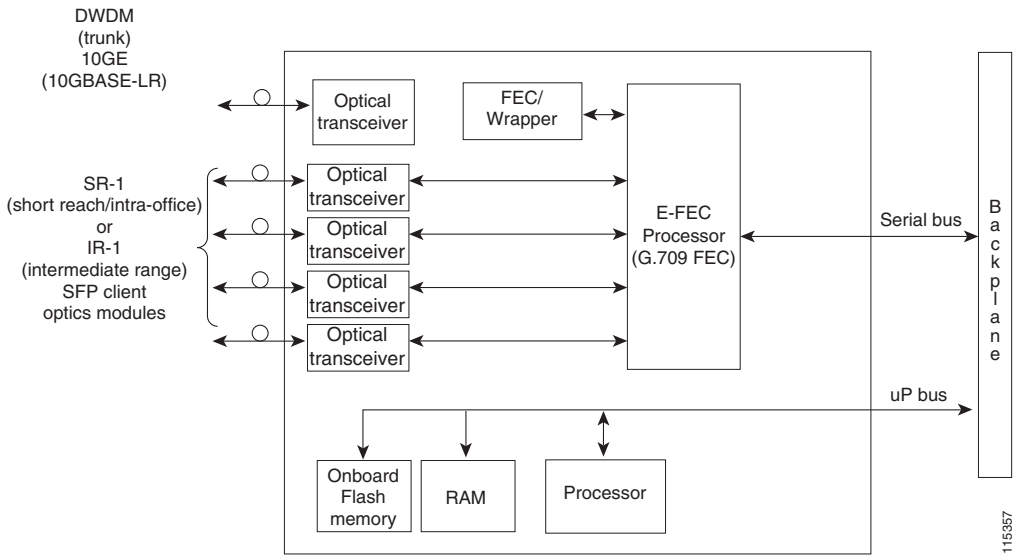
Figure 10-20 MXP_2.5G_10E Faceplate



For information on safety labels for the card, see the "10.2.1 Class 1 Laser Product Cards" section on page 10-8.

Figure 10-21 shows a block diagram of the MXP_2.5G_10E card.

Figure 10-21 MXP_2.5G_10E Block Diagram



10.7.6 Client Interfaces

The MXP_2.5G_10E provides four intermediate- or short-range OC-48/STM-16 ports per card on the client side. Both SR-1 or IR-1 optics can be supported and the ports use SFP connectors. The client interfaces use four wavelengths in the 1310-nm, ITU 100-MHz-spaced, channel grid.

10.7.6.1 DWDM Interface

The MXP_2.5G_10E serves as an OTN multiplexer, transparently mapping four OC-48 channels asynchronously to ODU1 into one 10-Gbps trunk. The DWDM trunk is tunable for transmission over four wavelengths in the 1550-nm, ITU 100-GHz spaced channel grid.

Caution You must use a 20-dB fiber attenuator (15 to 25 dB) when working with the MXP_2.5G_10E card in a loopback on the trunk port. Do not use direct fiber loopbacks with the MXP_2.5G_10E card. Using direct fiber loopbacks causes irreparable damage to the MXP_2.5G_10E card.

10.7.7 Multiplexing Function

The muxponder is an integral part of the reconfigurable optical add/drop multiplexer (ROADM) network. The key function of MXP_2.5G_10E is to multiplex 4 OC-48/STM16 signals onto one ITU-T G.709 OTU2 optical signal (DWDM transmission). The multiplexing mechanism allows the signal to be terminated at a far-end node by another MXP_2.5G_10E card.

Termination mode transparency on the muxponder is configured using OTUx and ODUx OH bytes. The ITU-T G.709 specification defines OH byte formats that are used to configure, set, and monitor frame alignment, FEC mode, section monitoring, tandem connection monitoring, and termination mode transparency.

The MXP_2.5G_10E card performs ODU to OTU multiplexing as defined in ITU-T G.709. The ODU is the framing structure and byte definition (ITU-T G.709 digital wrapper) used to define the data payload coming into one of the SONET/SDH client interfaces on MXP_2.5G_10E. The term ODU1 refers to an ODU that operates at 2.5-Gbps line rate. On the MXP_2.5G_10E, there are four client interfaces that can be defined using ODU1 framing structure and format by asserting a ITU-T G.709 digital wrapper.

The output of the muxponder is a single 10-Gbps DWDM trunk interface defined using OTU2. It is within the OTU2 framing structure that FEC or E-FEC information is appended to enable error checking and correction.

10.7.8 Timing Synchronization

The MXP_2.5G_10E card is synchronized to the TCC2/TCC2P/TCC3/TNC/TSC clock during normal conditions and transmits the ITU-T G.709 frame using this clock. No holdover function is implemented. If neither TCC2/TCC2P/TCC3/TNC/TSC clock is available, the MXP_2.5G_10E switches automatically (hitless) to the first of the four valid client clocks with no time restriction as to how long it can run on this clock. The MXP_2.5G_10E continues to monitor the TCC2/TCC2P/TCC3/TNC/TSC card. If a TCC2/TCC2P/TCC3/TNC/TSC card is restored to working order, the MXP_2.5G_10E reverts to the normal working mode of running from the TCC2/TCC2P/TCC3/TNC/TSC clock. If there is no valid TCC2/TCC2P/TCC3/TNC/TSC clock and all of the client channels become invalid, the card waits (no valid frames processed) until one of the TCC2/TCC2P/TCC3/TNC/TSC cards supplies a valid clock. In addition, the card is allowed to select the recovered clock from one active and valid client channel and supply that clock to the TCC2/TCC2P/TCC3/TNC/TSC card.

10.7.9 Enhanced FEC (E-FEC) Capability

The MXP_2.5G_10E can configure the FEC in three modes: NO FEC, FEC, and E-FEC. The output bit rate is always 10.7092 Gbps as defined in ITU-T G.709, but the error coding performance can be provisioned as follows:

- NO FEC—No FEC
- FEC—Standard ITU-T G.975 Reed-Solomon algorithm
- E-FEC—Standard ITU-T G.975.1 I.7, two orthogonally concatenated BCH super FEC code. This FEC scheme contains three parameterizations of the same scheme of two orthogonally interleaved BCH. The constructed code is decoded iteratively to achieve the expected performance.

10.7.10 FEC and E-FEC Modes

As client side traffic passes through the MXP_2.5G_10E card, it can be digitally wrapped using FEC mode error correction or E-FEC mode error correction (or no error correction at all). The FEC mode setting provides a lower level of error detection and correction than the E-FEC mode setting of the card. As a result, using E-FEC mode allows higher sensitivity (lower OSNR) with a lower BER than FEC mode. E-FEC enables longer distance trunk-side transmission than with FEC.

The E-FEC feature is one of three basic modes of FEC operation. FEC can be turned off, FEC can be turned on, or E-FEC can be turned on to provide greater range and lower BER. The default mode is FEC on and E-FEC off. E-FEC is provisioned using CTC.

10.7.11 SONET/SDH Overhead Byte Processing

The card passes the incoming SONET/SDH data stream and its overhead bytes for the client signal transparently. The card can be provisioned to terminate regenerator section overhead. This is used to eliminate forwarding of unneeded layer overhead. It can help reduce the number of alarms and help isolate faults in the network.

10.7.12 Client Interface Monitoring

The following parameters are monitored on the MXP_2.5G_10E card:

- Laser bias current is measured as a PM parameter
- LOS is detected and signaled
- Transmit (TX) and receive (RX) power are monitored

The following parameters are monitored in real time mode (one second):

- Optical power transmitted (client)
- Optical power received (client)

In case of loss of communication (LOC) at the DWDM receiver or far-end LOS, the client interface behavior is configurable. AIS can be invoked or the client signal can be squelched.

10.7.13 Wavelength Identification

The card uses trunk lasers that are wave-locked, which allows the trunk transmitter to operate on the ITU grid effectively. Table 10-15 describes the required trunk transmit laser wavelengths. The laser is tunable over eight wavelengths at 50-GHz spacing or four at 100-GHz spacing.

Table 10-15 MXP_2.5G_10E Trunk Wavelengths

Band	Wavelength (nm)
30.3	1530.33
30.3	1531.12
30.3	1531.90
30.3	1532.68
34.2	1534.25
34.2	1535.04
34.2	1535.82
34.2	1536.61
38.1	1538.19
38.1	1538.98
38.1	1539.77
38.1	1540.56
42.1	1542.14
42.1	1542.94

Table 10-15 MXP_2.5G_10E Trunk Wavelengths (continued)

Band	Wavelength (nm)
42.1	1543.73
42.1	1544.53
46.1	1546.12
46.1	1546.92
46.1	1547.72
46.1	1548.51
50.1	1550.12
50.1	1550.92
50.1	1551.72
50.1	1552.52
54.1	1554.13
54.1	1554.94
54.1	1555.75
54.1	1556.55
58.1	1558.17
58.1	1558.98
58.1	1559.79
58.1	1560.61

10.7.14 Automatic Laser Shutdown

The ALS procedure is supported on both client and trunk interfaces. On the client interface, ALS is compliant with ITU-T G.664 (6/99). On the data application and trunk interface, the switch on and off pulse duration is greater than 60 seconds. The on and off pulse duration is user-configurable. For details regarding ALS provisioning for the MXP_2.5G_10E card, refer to the *Cisco ONS 15454 DWDM Procedure Guide*.

10.7.15 Jitter

For SONET and SDH signals, the MXP_2.5G_10E card complies with Telcordia GR-253-CORE, ITU-T G.825, and ITU-T G.873 for jitter generation, jitter tolerance, and jitter transfer. See the "10.21 Jitter Considerations" section on page 10-142 for more information.

10.7.16 Lamp Test

The MXP_2.5G_10E card supports a lamp test function that is activated from the ONS 15454 front panel or through CTC to ensure that all LEDs are functional.

10.7.17 Onboard Traffic Generation

The MXP_2.5G_10E card provides internal traffic generation for testing purposes according to pseudo-random bit sequence (PRBS), SONET/SDH, or ITU-T G.709.

10.7.18 MXP_2.5G_10E Card-Level Indicators

Table 10-16 describes the three card-level LEDs on the MXP_2.5G_10E card.

Table 10-16 MXP_2.5G_10E Card-Level Indicators

Card-Level LED	Description
Red FAIL LED	The red FAIL LED indicates that the card's processor is not ready. This LED is on during reset. The FAIL LED flashes during the boot process. Replace the card if the red FAIL LED persists.
ACT/STBY LED Green (Active) Amber (Standby)	If the ACT/STBY LED is green, the card is operational (one or more ports active) and ready to carry traffic. If the ACT/STBY LED is amber, the card is operational and in standby (protect) mode.
Amber SF LED	The amber SF LED indicates a signal failure or condition such as LOS, LOF, or high BERs on one or more of the card's ports. The amber SF LED is also on if the transmit and receive fibers are incorrectly connected. If the fibers are properly connected and the link is working, the light turns off.

10.7.19 MXP_2.5G_10E Port-Level Indicators

Table 10-17 describes the port-level LEDs on the MXP_2.5G_10E card.

Table 10-17 MXP_2.5G_10E Port-Level Indicators

Port-Level LED	Description
Green Client LED (four LEDs)	A green Client LED indicates that the client port is in service and that it is receiving a recognized signal. The card has four client ports, and so has four Client LEDs.
Green DWDM LED	The green DWDM LED indicates that the DWDM port is in service and that it is receiving a recognized signal.

10.8 MXP_2.5G_10E_C and MXP_2.5G_10E_L Cards

MXP_2.5G_10E_L: (Cisco ONS 15454 only)

The MXP_2.5G_10E_C and MXP_2.5G_10E_L cards are DWDM muxponders for the ONS 15454 platform that support transparent termination mode on the client side. The faceplate designation of the cards is "4x2.5G 10E MXP C" for the MXP_2.5G_10E_C card and "4x2.5G 10E MXP L" for the MXP_2.5G_10E_L card. The cards multiplex four 2.5-Gbps client signals (4 x OC48/STM-16 SFP) into a single 10-Gbps DWDM optical signal on the trunk side. The MXP_2.5G_10E_C and

MXP_2.5G_10E_L cards provide wavelength transmission service for the four incoming 2.5 Gbps client interfaces. The MXP_2.5G_10E_C and MXP_2.5G_10E_L muxponders pass all SONET/SDH overhead bytes transparently.

The digital wrapper function (ITU-T G.709 compliant) formats the DWDM wavelength so that it can be used to set up GCCs for data communications, enable FEC, or facilitate PM.

The MXP_2.5G_10E_C and MXP_2.5G_10E_L cards work with OTN devices defined in ITU-T G.709. The cards support ODU1 to OTU2 multiplexing, an industry standard method for asynchronously mapping a SONET/SDH payload into a digitally wrapped envelope. See the "10.8.5 Multiplexing Function" section on page 10-44.

The MXP_2.5G_10E_C and MXP_2.5G_10E_L cards are not compatible with the MXP_2.5G_10G card, which does not support transparent termination mode.

You can install MXP_2.5G_10E_C and MXP_2.5G_10E_L cards in Slots 1 to 6 and 12 to 17. You can provision a card in a linear configuration, as a BLSR/MS-SPRing, a path protection/SNCP, or a regenerator. The cards can be used in the middle of BLSR/MS-SPRing or 1+1 spans when the cards are configured for transparent termination mode.

The MXP_2.5G_10E_C card features a tunable 1550-nm C-band laser on the trunk port. The laser is tunable across 82 wavelengths on the ITU grid with 50-GHz spacing between wavelengths. The MXP_2.5G_10E_L features a tunable 1580-nm L-band laser on the trunk port. The laser is tunable across 80 wavelengths on the ITU grid, also with 50-GHz spacing. Each card features four 1310-nm lasers on the client ports and contains five transmit and receive connector pairs (labeled) on the card faceplate. The cards uses dual LC connectors on the trunk side and use SFP modules on the client side for optical cable termination. The SFP pluggable modules are SR or IR and support an LC fiber connector.

Note When you create a 4xOC-48 OCHCC circuit, you need to select the G.709 and Synchronous options. A 4xOC-48 OCHCC circuit is supported by G.709 and synchronous mode. This is necessary to provision a 4xOC-48 OCHCC circuit.

10.8.1 Key Features

The MXP_2.5G_10E_C and MXP_2.5G_10E_L cards have the following high level features:

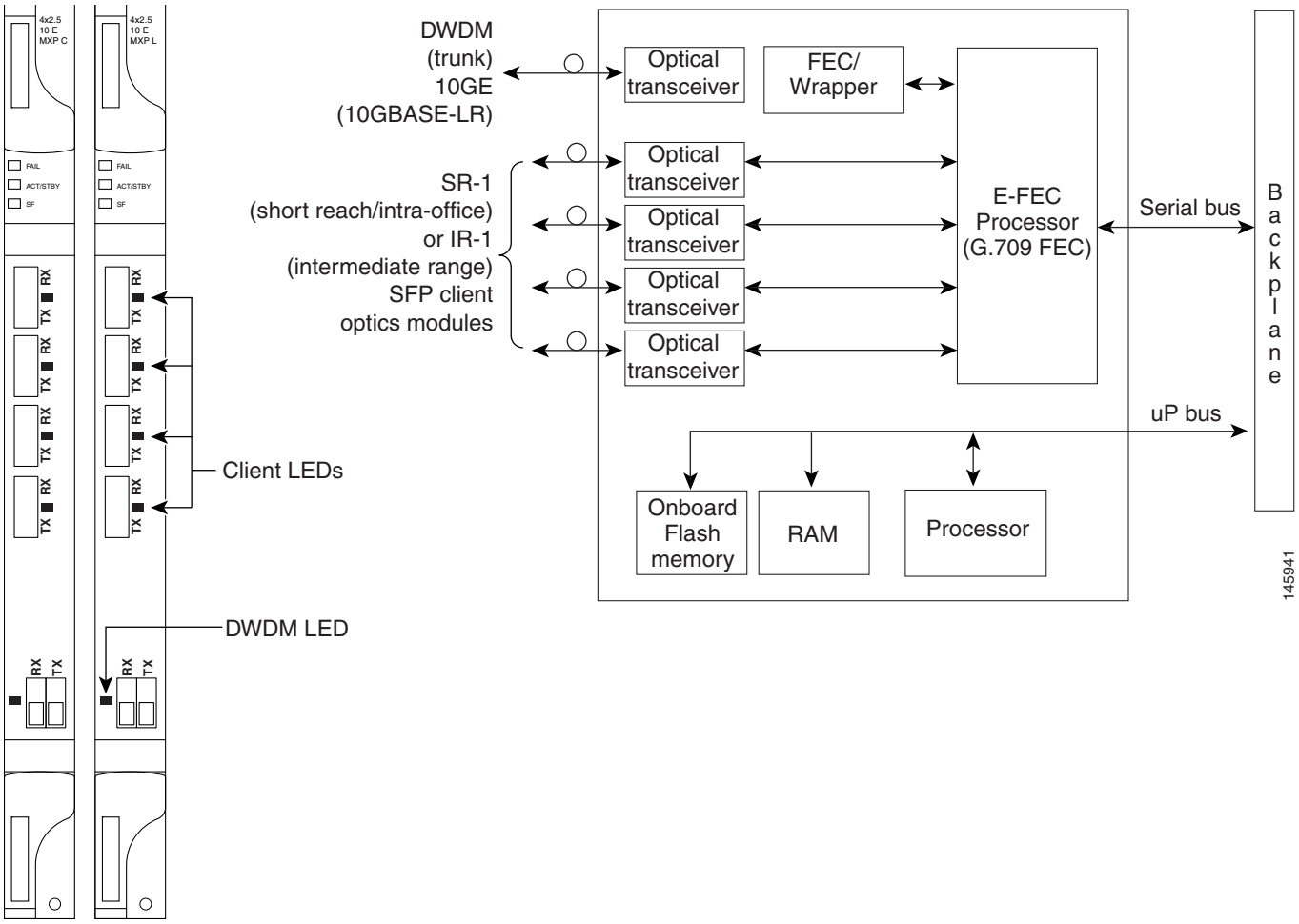
- Four 2.5 Gbps client interfaces (OC-48/STM-16) and one 10 Gbps trunk. The four OC-48 signals are mapped into a ITU-T G.709 OTU2 signal using standard ITU-T G.709 multiplexing.
- Onboard E-FEC processor: The processor supports both standard RS (specified in ITU-T G.709) and E-FEC, which allows an improved gain on trunk interfaces with a resultant extension of the transmission range on these interfaces. The E-FEC functionality increases the correction capability of the transponder to improve performance, allowing operation at a lower OSNR compared to the standard RS (237,255) correction algorithm. A new BCH algorithm implemented in E-FEC allows recovery of an input BER up to 1E-3.
- Pluggable client interface optic modules: The MXP_2.5G_10E_C and MXP_2.5G_10E_L cards have modular interfaces. Two types of optics modules can be plugged into the card. These include an OC-48/STM 16 SR-1 interface with a 7-km (4.3-mile) nominal range (for short range and intra-office applications) and an IR-1 interface with a range up to 40 km (24.9 miles). SR-1 is defined in Telcordia GR-253-CORE and in I-16 (ITU-T G.957). IR-1 is defined in Telcordia GR-253-CORE and in S-16-1 (ITU-T G.957).
- High level provisioning support: The cards are initially provisioned using Cisco TransportPlanner software. Subsequently, the card can be monitored and provisioned using CTC software.

- Link monitoring and management: The cards use standard OC-48 OH (overhead) bytes to monitor and manage incoming interfaces. The cards pass the incoming SDH/SONET data stream and its overhead bytes transparently.
- Control of layered SONET/SDH transport overhead: The cards are provisionable to terminate regenerator section overhead. This is used to eliminate forwarding of unneeded layer overhead. It can help reduce the number of alarms and help isolate faults in the network.
- Automatic timing source synchronization: The MXP_2.5G_10E_C and MXP_2.5G_10E_L cards normally synchronize from the TCC2/TCC2P/TCC3 card. If for some reason, such as maintenance or upgrade activity, the TCC2/TCC2P/TCC3 is not available, the cards automatically synchronize to one of the input client interface clocks.
- Configurable squelching policy: The cards can be configured to squelch the client interface output if there is LOS at the DWDM receiver or if there is a remote fault. In the event of a remote fault, the card manages MS-AIS insertion.
- The cards are tunable across the full C band (MXP_2.5G_10E_C) or full L band (MXP_2.5G_10E_L), thus eliminating the need to use different versions of each card to provide tunability across specific wavelengths in a band.

10.8.2 Faceplate

Figure 10-22 shows the MXP_2.5G_10E_C and MXP_2.5G_10E_L faceplates and block diagram.

Figure 10-22 MXP_2.5G_10E _C and MXP_2.5G_10E_L Faceplates and Block Diagram



For information on safety labels for the cards, see the "10.2.1 Class 1 Laser Product Cards" section on page 10-8.

10.8.3 Client Interfaces

The MXP_2.5G_10E_C and MXP_2.5G_10E_L cards provide four intermediate- or short-range OC-48/STM-16 ports per card on the client side. Both SR-1 and IR-1 optics can be supported and the ports use SFP connectors. The client interfaces use four wavelengths in the 1310-nm, ITU 100-GHz-spaced, channel grid.

10.8.4 DWDM Interface

The MXP_2.5G_10E_C and MXP_2.5G_10E_L cards serve as OTN multiplexers, transparently mapping four OC-48 channels asynchronously to ODU1 into one 10-Gbps trunk. For the MXP_2.5G_10E_C card, the DWDM trunk is tunable for transmission over the entire C band and for the MXP_2.5G_10E_L card, the DWDM trunk is tunable for transmission over the entire L band. Channels are spaced at 50-GHz on the ITU grid.

Caution You must use a 20-dB fiber attenuator (15 to 25 dB) when working with the cards in a loopback on the trunk port. Do not use direct fiber loopbacks with the cards. Using direct fiber loopbacks causes irreparable damage to the MXP_2.5G_10E_C and MXP_2.5G_10E_L cards.

10.8.5 Multiplexing Function

The muxponder is an integral part of the ROADM network. The key function of the MXP_2.5G_10E_C and MXP_2.5G_10E_L cards is to multiplex four OC-48/STM16 signals onto one ITU-T G.709 OTU2 optical signal (DWDM transmission). The multiplexing mechanism allows the signal to be terminated at a far-end node by another similar card.

Transparent termination on the muxponder is configured using OTUx and ODUx OH bytes. The ITU-T G.709 specification defines OH byte formats that are used to configure, set, and monitor frame alignment, FEC mode, section monitoring, tandem connection monitoring, and transparent termination mode.

The MXP_2.5G_10E and MXP_2.5G_10E_L cards perform ODU to OTU multiplexing as defined in ITU-T G.709. The ODU is the framing structure and byte definition (ITU-T G.709 digital wrapper) used to define the data payload coming into one of the SONET/SDH client interfaces on the cards. The term ODU1 refers to an ODU that operates at 2.5-Gbps line rate. On the cards, there are four client interfaces that can be defined using ODU1 framing structure and format by asserting a ITU-T G.709 digital wrapper.

The output of the muxponder is a single 10-Gbps DWDM trunk interface defined using OTU2. It is within the OTU2 framing structure that FEC or E-FEC information is appended to enable error checking and correction.

10.8.6 Timing Synchronization

The MXP_2.5G_10E_C and MXP_2.5G_10E_L cards are synchronized to the TCC2/TCC2P/TCC3 clock during normal conditions and transmit the ITU-T G.709 frame using this clock. No holdover function is implemented. If neither TCC2/TCC2P/TCC3 clock is available, the card switches automatically (hitless) to the first of the four valid client clocks with no time restriction as to how long it can run on this clock. The card continues to monitor the TCC2/TCC2P/TCC3 card. If a TCC2/TCC2P/TCC3 card is restored to working order, the card reverts to the normal working mode of running from the TCC2/TCC2P/TCC3 clock. If there is no valid TCC2/TCC2P/TCC3 clock and all of the client channels become invalid, the card waits (no valid frames processed) until one of the TCC2/TCC2P/TCC3 cards supplies a valid clock. In addition, the card is allowed to select the recovered clock from one active and valid client channel and supply that clock to the TCC2/TCC2P/TCC3 card.

10.8.7 Enhanced FEC (E-FEC) Capability

The MXP_2.5G_10E_C and MXP_2.5G_10E_L cards can configure the FEC in three modes: NO FEC, FEC, and E-FEC. The output bit rate is always 10.7092 Gbps as defined in ITU-T G.709, but the error coding performance can be provisioned as follows:

- NO FEC—No FEC
- FEC—Standard ITU-T G.975 Reed-Solomon algorithm

- E-FEC—Standard ITU-T G.975.1 I.7, two orthogonally concatenated BCH super FEC code. This FEC scheme contains three parameterizations of the same scheme of two orthogonally interleaved block codes (BCH). The constructed code is decoded iteratively to achieve the expected performance.

10.8.8 FEC and E-FEC Modes

As client side traffic passes through the card, it can be digitally wrapped using FEC mode error correction or E-FEC mode error correction (or no error correction at all). The FEC mode setting provides a lower level of error detection and correction than the E-FEC mode setting of the card. As a result, using E-FEC mode allows higher sensitivity (lower OSNR) with a lower BER than FEC mode. E-FEC enables longer distance trunk-side transmission than with FEC.

The E-FEC feature is one of three basic modes of FEC operation. FEC can be turned off, FEC can be turned on, or E-FEC can be turned on to provide greater range and lower BER. The default mode is FEC on and E-FEC off. E-FEC is provisioned using CTC.

10.8.9 SONET/SDH Overhead Byte Processing

The card passes the incoming SONET/SDH data stream and its overhead bytes for the client signal transparently. The card can be provisioned to terminate regenerator section overhead. This is used to eliminate forwarding of unneeded layer overhead. It can help reduce the number of alarms and help isolate faults in the network.

10.8.10 Client Interface Monitoring

The following parameters are monitored on the MXP_2.5G_10E_C and MXP_2.5G_10E_L cards:

- Laser bias current is measured as a PM parameter.
- LOS is detected and signaled.
- Rx and Tx power are monitored.

The following parameters are monitored in real time mode (one second):

- Optical power transmitted (client)
- Optical power received (client)

In case of LOC at the DWDM receiver or far-end LOS, the client interface behavior is configurable. AIS can be invoked or the client signal can be squelched.

10.8.11 Wavelength Identification

The card uses trunk lasers that are wavelocked, which allows the trunk transmitter to operate on the ITU grid effectively. Both the MXP_2.5G_10E_C and MXP_2.5G_10E_L cards implement the UT2 module. The MXP_2.5G_10E_C card uses a C-band version of the UT2 and the MXP_2.5G_10E_L card uses an L-band version.

Table 10-18 describes the required trunk transmit laser wavelengths for the MXP_2.5G_10E_C card. The laser is tunable over 82 wavelengths in the C band at 50-GHz spacing on the ITU grid.

Table 10-18 MXP_2.5G_10E_C Trunk Wavelengths

Channel Number	Frequency (THz)	Wavelength (nm)	Channel Number	Frequency (THz)	Wavelength (nm)
1	196.00	1529.55	42	193.95	1545.72
2	195.95	1529.94	43	193.90	1546.119
3	195.90	1530.334	44	193.85	1546.518
4	195.85	1530.725	45	193.80	1546.917
5	195.80	1531.116	46	193.75	1547.316
6	195.75	1531.507	47	193.70	1547.715
7	195.70	1531.898	48	193.65	1548.115
8	195.65	1532.290	49	193.60	1548.515
9	195.60	1532.681	50	193.55	1548.915
10	195.55	1533.073	51	193.50	1549.32
11	195.50	1533.47	52	193.45	1549.71
12	195.45	1533.86	53	193.40	1550.116
13	195.40	1534.250	54	193.35	1550.517
14	195.35	1534.643	55	193.30	1550.918
15	195.30	1535.036	56	193.25	1551.319
16	195.25	1535.429	57	193.20	1551.721
17	195.20	1535.822	58	193.15	1552.122
18	195.15	1536.216	59	193.10	1552.524
19	195.10	1536.609	60	193.05	1552.926
20	195.05	1537.003	61	193.00	1553.33
21	195.00	1537.40	62	192.95	1553.73
22	194.95	1537.79	63	192.90	1554.134
23	194.90	1538.186	64	192.85	1554.537
24	194.85	1538.581	65	192.80	1554.940
25	194.80	1538.976	66	192.75	1555.343
26	194.75	1539.371	67	192.70	1555.747
27	194.70	1539.766	68	192.65	1556.151
28	194.65	1540.162	69	192.60	1556.555
29	194.60	1540.557	70	192.55	1556.959
30	194.55	1540.953	71	192.50	1557.36
31	194.50	1541.35	72	192.45	1557.77
32	194.45	1541.75	73	192.40	1558.173
33	194.40	1542.142	74	192.35	1558.578
34	194.35	1542.539	75	192.30	1558.983
35	194.30	1542.936	76	192.25	1559.389

Table 10-18 MXP_2.5G_10E_C Trunk Wavelengths (continued)

Channel Number	Frequency (THz)	Wavelength (nm)	Channel Number	Frequency (THz)	Wavelength (nm)
36	194.25	1543.333	77	192.20	1559.794
37	194.20	1543.730	78	192.15	1560.200
38	194.15	1544.128	79	192.10	1560.606
39	194.10	1544.526	80	192.05	1561.013
40	194.05	1544.924	81	192.00	1561.42
41	194.00	1545.32	82	191.95	1561.83

Table 10-19 describes the required trunk transmit laser wavelengths for the MXP_2.5G_10E_L card. The laser is fully tunable over 80 wavelengths in the L band at 50-GHz spacing on the ITU grid.

Table 10-19 MXP_2.5G_10E_L Trunk Wavelengths

Channel Number	Frequency (THz)	Wavelength (nm)	Channel Number	Frequency (THz)	Wavelength (nm)
1	190.85	1570.83	41	188.85	1587.46
2	190.8	1571.24	42	188.8	1587.88
3	190.75	1571.65	43	188.75	1588.30
4	190.7	1572.06	44	188.7	1588.73
5	190.65	1572.48	45	188.65	1589.15
6	190.6	1572.89	46	188.6	1589.57
7	190.55	1573.30	47	188.55	1589.99
8	190.5	1573.71	48	188.5	1590.41
9	190.45	1574.13	49	188.45	1590.83
10	190.4	1574.54	50	188.4	1591.26
11	190.35	1574.95	51	188.35	1591.68
12	190.3	1575.37	52	188.3	1592.10
13	190.25	1575.78	53	188.25	1592.52
14	190.2	1576.20	54	188.2	1592.95
15	190.15	1576.61	55	188.15	1593.37
16	190.1	1577.03	56	188.1	1593.79
17	190.05	1577.44	57	188.05	1594.22
18	190	1577.86	58	188	1594.64
19	189.95	1578.27	59	187.95	1595.06
20	189.9	1578.69	60	187.9	1595.49
21	189.85	1579.10	61	187.85	1595.91
22	189.8	1579.52	62	187.8	1596.34
23	189.75	1579.93	63	187.75	1596.76

Table 10-19 MXP_2.5G_10E_L Trunk Wavelengths (continued)

Channel Number	Frequency (THz)	Wavelength (nm)	Channel Number	Frequency (THz)	Wavelength (nm)
24	189.7	1580.35	64	187.7	1597.19
25	189.65	1580.77	65	187.65	1597.62
26	189.6	1581.18	66	187.6	1598.04
27	189.55	1581.60	67	187.55	1598.47
28	189.5	1582.02	68	187.5	1598.89
29	189.45	1582.44	69	187.45	1599.32
30	189.4	1582.85	70	187.4	1599.75
31	189.35	1583.27	71	187.35	1600.17
32	189.3	1583.69	72	187.3	1600.60
33	189.25	1584.11	73	187.25	1601.03
34	189.2	1584.53	74	187.2	1601.46
35	189.15	1584.95	75	187.15	1601.88
36	189.1	1585.36	76	187.1	1602.31
37	189.05	1585.78	77	187.05	1602.74
38	189	1586.20	78	187	1603.17
39	188.95	1586.62	79	186.95	1603.60
40	188.9	1587.04	80	186.9	1604.03

10.8.12 Automatic Laser Shutdown

The ALS procedure is supported on both client and trunk interfaces. On the client interface, ALS is compliant with ITU-T G.664 (6/99). On the data application and trunk interface, the switch on and off pulse duration is greater than 60 seconds. The on and off pulse duration is user-configurable. For details regarding ALS provisioning for the MXP_2.5G_10E_C and MXP_2.5G_10E_L cards, see the *Cisco ONS 15454 DWDM Procedure Guide*.

10.8.13 Jitter

For SONET and SDH signals, the MXP_2.5G_10E_C and MXP_2.5G_10E_L cards comply with Telcordia GR-253-CORE, ITU-T G.825, and ITU-T G.873 for jitter generation, jitter tolerance, and jitter transfer. See the "10.21 Jitter Considerations" section on page 10-142 for more information.

10.8.14 Lamp Test

The MXP_2.5G_10E_C and MXP_2.5G_10E_L cards support a lamp test function that is activated from the ONS 15454 front panel or through CTC to ensure that all LEDs are functional.

10.8.15 Onboard Traffic Generation

The MXP_2.5G_10E_C and MXP_2.5G_10E_L cards provide internal traffic generation for testing purposes according to PRBS, SONET/SDH, or ITU-T G.709.

10.8.16 MXP_2.5G_10E_C and MXP_2.5G_10E_L Card-Level Indicators

Table 10-20 describes the three card-level LEDs on the MXP_2.5G_10E_C and MXP_2.5G_10E_L cards.

Table 10-20 MXP_2.5G_10E_C and MXP_2.5G_10E_L Card-Level Indicators

Card-Level LED	Description
Red FAIL LED	The red FAIL LED indicates that the card's processor is not ready. This LED is on during reset. The FAIL LED flashes during the boot process. Replace the card if the red FAIL LED persists.
ACT/STBY LED Green (Active) Amber (Standby)	If the ACT/STBY LED is green, the card is operational (one or more ports active) and ready to carry traffic. If the ACT/STBY LED is amber, the card is operational and in standby (protect) mode.
Amber SF LED	The amber SF LED indicates a signal failure or condition such as LOS, LOF, or high BERs on one or more of the card's ports. The amber SF LED is also on if the transmit and receive fibers are incorrectly connected. If the fibers are properly connected and the link is working, the light turns off.

10.8.17 MXP_2.5G_10E and MXP_2.5G_10E_L Port-Level Indicators

Table 10-21 describes the port-level LEDs on the MXP_2.5G_10E_C and MXP_2.5G_10E_L cards.

Table 10-21 MXP_2.5G_10E_C and MXP_2.5G_10E_L Port-Level Indicators

Port-Level LED	Description
Green Client LED (four LEDs)	A green Client LED indicates that the client port is in service and that it is receiving a recognized signal. The card has four client ports, and so has four Client LEDs.
Green DWDM LED	The green DWDM LED indicates that the DWDM port is in service and that it is receiving a recognized signal.

10.9 MXP_MR_2.5G and MXPP_MR_2.5G Cards

The MXP_MR_2.5G card aggregates a mix and match of client Storage Area Network (SAN) service client inputs (GE, FICON, Fibre Channel, and ESCON) into one 2.5 Gbps STM-16/OC-48 DWDM signal on the trunk side. It provides one long-reach STM-16/OC-48 port per card and is compliant with Telcordia GR-253-CORE.

Note In Software Release 7.0 and later, two additional operating modes have been made available to the user: pure ESCON (all 8 ports running ESCON), and mixed mode (Port 1 running FC/GE/FICON, and Ports 5 through 8 running ESCON). When the card is part of a system running Software Release 6.0 or below, only one operating mode, (FC/GE) is available for use.

The 2.5-Gbps Multirate Muxponder–Protected–100 GHz–Tunable 15xx.xx-15yy.yy (MXPP_MR_2.5G) card aggregates various client SAN service client inputs (GE, FICON, Fibre Channel, and ESCON) into one 2.5 Gbps STM-16/OC-48 DWDM signal on the trunk side. It provides two long-reach STM-16/OC-48 ports per card and is compliant with ITU-T G.957 and Telcordia GR-253-CORE.

Because the cards are tunable to one of four adjacent grid channels on a 100-GHz spacing, each card is available in eight versions, with 15xx.xx representing the first wavelength and 15yy.yy representing the last wavelength of the four available on the card. In total, 32 DWDM wavelengths are covered in accordance with the ITU-T 100-GHz grid standard, G.692, and Telcordia GR-2918-CORE, Issue 2. The card versions along with their corresponding wavelengths are shown in Table 10-22.

Table 10-22 Card Versions

Card Version	Frequency Channels at 100 GHz (0.8 nm) Spacing			
1530.33–1532.68	1530.33 nm	1531.12 nm	1531.90 nm	1532.68 nm
1534.25–1536.61	1534.25 nm	1535.04 nm	1535.82 nm	1536.61 nm
1538.19–1540.56	1538.19 nm	1538.98 nm	1539.77 nm	1540.56 nm
1542.14–1544.53	1542.14 nm	1542.94 nm	1543.73 nm	1544.53 nm
1546.12–1548.51	1546.12 nm	1546.92 nm	1547.72 nm	1548.51 nm
1550.12–1552.52	1550.12 nm	1550.92 nm	1551.72 nm	1552.52 nm
1554.13–1556.55	1554.13 nm	1554.94 nm	1555.75 nm	1556.55 nm
1558.17–1560.61	1558.17 nm	1558.98 nm	1559.79 nm	1560.61 nm

The muxponders are intended to be used in applications with long DWDM metro or regional unregenerated spans. Long transmission distances are achieved through the use of flat gain optical amplifiers.

The client interface supports the following payload types:

- 2G FC
- 1G FC
- 2G FICON
- 1G FICON
- GE
- ESCON

Note Because the client payload cannot oversubscribe the trunk, a mix of client signals can be accepted, up to a maximum limit of 2.5 Gbps.

Table 10-23 shows the input data rate for each client interface, and the encapsulation method. The current version of the ITU-T Transparent Generic Framing Procedure (GFP-T) G.7041 supports transparent mapping of 8B/10B block-coded protocols, including Gigabit Ethernet, Fibre Channel, and FICON.

In addition to the GFP mapping, 1-Gbps traffic on Port 1 or 2 of the high-speed serializer/deserializer (SERDES) is mapped to an STS-24c channel. If two 1-Gbps client signals are present at Port 1 and Port 2 of the SERDES, the Port 1 signal is mapped into the first STS-24c channel and the Port 2 signal into the second STS-24c channel. The two channels are then mapped into an OC-48 trunk channel.

Table 10-23 MXP_MR_2.5G and MXPP_MR_2.5G Client Interface Data Rates and Encapsulation

Client Interface	Input Data Rate	ITU-T GFP-T G.7041 Encapsulation
2G FC	2.125 Gbps	Yes
1G FC	1.06 Gbps	Yes
2G FICON	2.125 Gbps	Yes
1G FICON	1.06 Gbps	Yes
GE	1.25 Gbps	Yes
ESCON	0.2 Gbps	Yes

Table 10-24 shows some of the mix and match possibilities on the various client ports. The table is intended to show the full client payload configurations for the card.

Table 10-24 Client Data Rates and Ports

Mode	Port(s)	Aggregate Data Rate
2G FC	1	2.125 Gbps
1G FC	1, 2	2.125 Gbps
2G FICON	1	2.125 Gbps
1G FICON	1, 2	2.125 Gbps
GE	1, 2	2.5 Gbps
1G FC ESCON (mixed mode)	1 5, 6, 7, 8	1.06 Gbps 0.8 Gbps 1.86 Gbps total
1G FICON ESCON (mixed mode)	1 5, 6, 7, 8	1.06 Gbps 0.8 Gbps 1.86 Gbps total
GE ESCON (mixed mode)	1 5, 6, 7, 8	1.25 Gbps 0.8 Gbps Total 2.05 Gbps
ESCON	1, 2, 3, 4, 5, 6, 7, 8	1.6 Gbps

10.9.1 Performance Monitoring

GFP-T performance monitoring (GFP-T PM) is available via remote monitoring (RMON), and trunk PM is managed according to Telcordia GR-253-CORE and ITU G.783/826. Client PM is achieved through RMON for FC and GE.

10.9.2 Distance Extension

A buffer-to-buffer credit management scheme provides FC flow control. With this feature enabled, a port indicates the number of frames that can be sent to it (its buffer credit), before the sender is required to stop transmitting and wait for the receipt of a "ready" indication The MXP_MR_2.5G and MXPP_MR_2.5 cards support FC credit-based flow control with a buffer-to-buffer credit extension of up to 1600 km (994.2 miles) for 1G FC and up to 800 km (497.1 miles) for 2G FC. The feature can be enabled or disabled.

10.9.3 Slot Compatibility

You can install MXP_MR_2.5G and MXPP_MR_2.5G cards in Slots 1 to 6 and 12 to 17. The TCC2/TCC2P/TCC3/TNC/TSC card is the only other card required to be used with these muxponder cards. Cross-connect cards do not affect the operation of the muxponder cards.

10.9.4 Interoperability with Cisco MDS Switches

You can provision a string (port name) for each fiber channel/FICON interface on the MXP_MR_2.5G and MXPP_MR_2.5G cards, which allows the MDS Fabric Manager to create a link association between that SAN port and a SAN port on a Cisco MDS 9000 switch.

10.9.5 Client and Trunk Ports

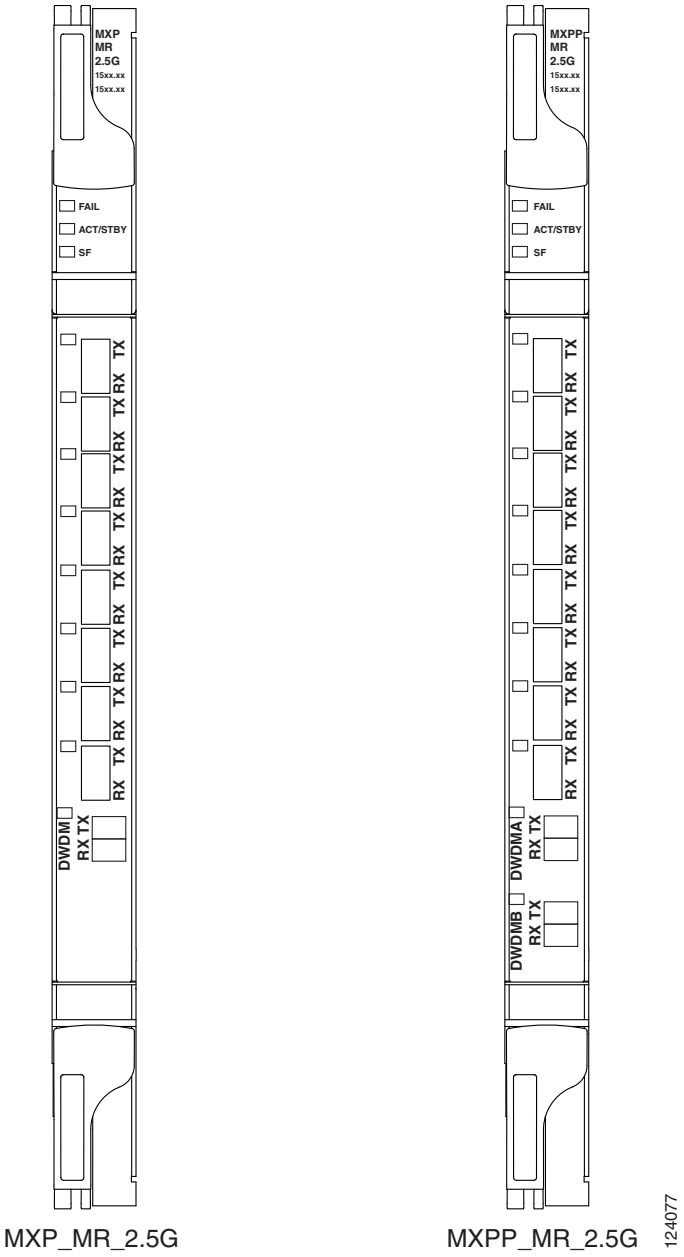
The MXP_MR_2.5G card features a 1550-nm laser for the trunk/line port and a 1310-nm or 850-nm laser (depending on the SFP) for the client ports. The card contains eight 12.5 degree downward tilt SFP modules for the client interfaces. For optical termination, each SFP uses two LC connectors, which are labeled TX and RX on the faceplate. The trunk port is a dual-LC connector with a 45 degree downward angle.

The MXPP_MR_2.5G card features a 1550-nm laser for the trunk/line port and a 1310-nm or 850-nm laser (depending on the SFP) for the client port. The card contains eight 12.5 degree downward tilt SFP modules for the client interfaces. For optical termination, each SFP uses two LC connectors, which are labeled TX and RX on the faceplate. There are two trunk port connectors (one for working and one for protect). Each is a dual-LC connector with a 45-degree downward angle.

10.9.6 Faceplates

Figure 10-23 shows the MXP_MR_2.5G and MXPP_MR_2.5G faceplates.

Figure 10-23 MXP_MR_2.5G and MXPP_MR_2.5G Faceplates



For information on safety labels for the cards, see the "10.2.2 Class 1M Laser Product Cards" section on page 10-10.

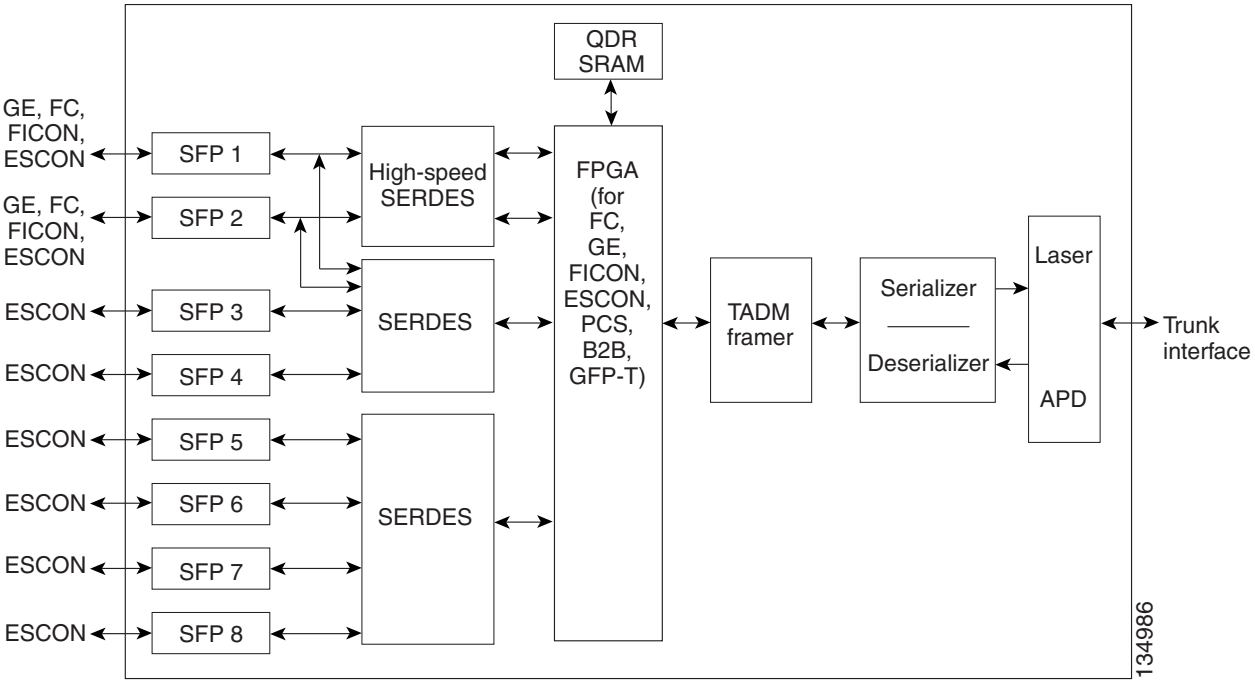
10.9.7 Block Diagram

Figure 10-24 shows a block diagram of the MXP_MR_2.5G card. The card has eight SFP client interfaces. Ports 1 and 2 can be used for GE, FC, FICON, or ESCON. Ports 3 through 8 are used for ESCON client interfaces. There are two SERDES blocks dedicated to the high-speed interfaces (GE, FC, FICON, and ESCON) and two SERDES blocks for the ESCON interfaces. A FPGA is provided to support different configurations for different modes of operation. This FPGA has a Universal Test and

Operations Physical Interface for ATM (UTOPIA) interface. A transceiver add/drop multiplexer (TADM) chip supports framing. Finally, the output signal is serialized and connected to the trunk front end with a direct modulation laser. The trunk receive signal is converted into an electrical signal with an avalanche photodiode (APD), is deserialized, and is then sent to the TADM framer and FPGA.

The MXPP_MR_2.5G is the same, except a 50/50 splitter divides the power at the trunk interface. In the receive direction, there are two APDs, two SERDES blocks, and two TADM framers. This is necessary to monitor both the working and protect paths. A switch selects one of the two paths to connect to the client interface.

Figure 10-24 MXP_MR_2.5G and MXPP_MR_2.5G Block Diagram



Caution You must use a 20-dB fiber attenuator (15 to 25 dB) when working with the MXP_MR_2.5G and MXPP_MR_2.5G cards in a loopback configuration on the trunk port. Do not use direct fiber loopbacks with the MXP_MR_2.5G and MXPP_MR_2.5G cards. Using direct fiber loopbacks causes irreparable damage to the MXP_MR_2.5G and MXPP_MR_2.5G cards.

10.9.8 Automatic Laser Shutdown

The ALS procedure is supported on both client and trunk interfaces. On the client interface, ALS is compliant with ITU-T G.664 (6/99). On the data application and trunk interface, the switch on and off pulse duration is greater than 60 seconds. The on and off pulse duration is user-configurable. For details regarding ALS provisioning for the MXP_MR_2.5G and MXPP_MR_2.5G cards, refer to the *Cisco ONS 15454 DWDM Procedure Guide*.

10.9.9 MXP_MR_2.5G and MXPP_MR_2.5G Card-Level Indicators

Table 10-25 lists the card-level LEDs on the MXP_MR_2.5G and MXPP_MR_2.5G cards.

Table 10-25 MXP_MR_2.5G and MXPP_MR_2.5G Card-Level Indicators

Card-Level LED	Description
FAIL LED (Red)	Red indicates that the card's processor is not ready. This LED is on during reset. The FAIL LED flashes during the boot process. Replace the card if the red FAIL LED persists.
ACT/STBY LED Green (Active) Amber (Standby)	Green indicates that the card is operational (one or both ports active) and ready to carry traffic. Amber indicates that the card is operational and in standby (protect) mode.
SF LED (Amber)	Amber indicates a signal failure or condition such as LOS, LOF, or high BERs on one or more of the card's ports. The amber SF LED is also illuminated if the transmit and receive fibers are incorrectly connected. If the fibers are properly connected and the link is working, the LED turns off.

10.9.10 MXP_MR_2.5G and MXPP_MR_2.5G Port-Level Indicators

Table 10-26 lists the port-level LEDs on the MXP_MR_2.5G and MXPP_MR_2.5G cards.

Table 10-26 MXP_MR_2.5G and MXPP_MR_2.5G Port-Level Indicators

Port-Level LED	Description
Client LEDs (eight LEDs)	Green indicates that the port is carrying traffic (active) on the interface. Amber indicates that the port is carrying protect traffic (MXPP_MR_2.5G). Red indicates that the port has detected a loss of signal.
DWDM LED (MXP_MR_2.5G)	
Green (Active)	Green indicates that the card is carrying traffic (active) on the interface.
Red (LOS)	A red LED indicates that the interface has detected an LOS or LOC.
DWDMA and DWDMB LEDs (MXPP_MR_2.5G)	
Green (Active)	Green indicates that the card is carrying traffic (active) on the interface.
Amber (Protect Traffic)	When the LED is amber, it indicates that the interface is carrying protect traffic in a splitter protection card (MXPP_MR_2.5G).
Red (LOS)	A red LED indicates that the interface has detected an LOS or LOC.

10.10 MXP_MR_10DME_C and MXP_MR_10DME_L Cards

MXP_MR_10DME_L: (Cisco ONS 15454 only)

The MXP_MR_10DME_C and MXP_MR_10DME_L cards aggregate a mix of client SAN service client inputs (GE, FICON, and Fibre Channel) into one 10.0 Gbps STM-64/OC-192 DWDM signal on the trunk side. It provides one long-reach STM-64/OC-192 port per card and is compliant with Telcordia GR-253-CORE and ITU-T G.957.

The cards support aggregation of the following signal types:

- 1-Gigabit Fibre Channel
- 2-Gigabit Fibre Channel
- 4-Gigabit Fibre Channel
- 1-Gigabit Ethernet
- 1-Gigabit ISC-Compatible (ISC-1)
- 2-Gigabit ISC-Peer (ISC-3)

Note On the card faceplates, the MXP_MR_10DME_C and MXP_MR_10DME_L cards are displayed as 10DME_C and 10DME_L, respectively.

Caution The card can be damaged by dropping it. Handle it safely.

The MXP_MR_10DME_C and MXP_MR_10DME_L muxponders pass all SONET/SDH overhead bytes transparently.

The digital wrapper function (ITU-T G.709 compliant) formats the DWDM wavelength so that it can be used to set up GCCs for data communications, enable FEC, or facilitate PM. The MXP_MR_10DME_C and MXP_MR_10DME_L cards work with the OTN devices defined in ITU-T G.709. The cards support ODU1 to OTU2 multiplexing, an industry standard method for asynchronously mapping a SONET/SDH payload into a digitally wrapped envelope. See the "10.7.7 Multiplexing Function" section on page 10-36.

Note Because the client payload cannot oversubscribe the trunk, a mix of client signals can be accepted, up to a maximum limit of 10 Gbps.

You can install MXP_MR_10DME_C and MXP_MR_10DME_L cards in Slots 1 to 6 and 12 to 17.

Note The MXP_MR_10DME_C and MXP_MR_10DME_L cards are not compatible with the MXP_2.5G_10G card, which does not support transparent termination mode.

The MXP_MR_10DME_C card features a tunable 1550-nm C-band laser on the trunk port. The laser is tunable across 82 wavelengths on the ITU grid with 50-GHz spacing between wavelengths. The MXP_MR_10DME_L features a tunable 1580-nm L-band laser on the trunk port. The laser is tunable across 80 wavelengths on the ITU grid, also with 50-GHz spacing. Each card features four 1310-nm lasers on the client ports and contains five transmit and receive connector pairs (labeled) on the card faceplate. The cards uses dual LC connectors on the trunk side and use SFP modules on the client side for optical cable termination. The SFP pluggable modules are SR or IR and support an LC fiber connector.

Table 10-27 shows the input data rate for each client interface, and the encapsulation method. The current version of the GFP-T G.7041 supports transparent mapping of 8B/10B block-coded protocols, including Gigabit Ethernet, Fibre Channel, ISC, and FICON.

In addition to the GFP mapping, 1-Gbps traffic on Port 1 or 2 of the high-speed SERDES is mapped to an STS-24c channel. If two 1-Gbps client signals are present at Port 1 and Port 2 of the high-speed SERDES, the Port 1 signal is mapped into the first STS-24c channel and the Port 2 signal into the second STS-24c channel. The two channels are then mapped into an OC-48 trunk channel.

Table 10-27 MXP_MR_10DME_C and MXP_MR_10DME_L Client Interface Data Rates and Encapsulation

Client Interface	Input Data Rate	GFP-T G.7041 Encapsulation
2G FC	2.125 Gbps	Yes
1G FC	1.06 Gbps	Yes
2G FICON/2G ISC-Compatible (ISC-1)/ 2G ISC-Peer (ISC-3)	2.125 Gbps	Yes
1G FICON/1G ISC-Compatible (ISC-1)/ 1G ISC-Peer (ISC-3)	1.06 Gbps	Yes
Gigabit Ethernet	1.25 Gbps	Yes

There are two FPGAs on each MXP_MR_10DME_C and MXP_MR_10DME_L, and a group of four ports is mapped to each FPGA. Group 1 consists of Ports 1 through 4, and Group 2 consists of Ports 5 through 8. Table 10-28 shows some of the mix and match possibilities on the various client data rates for Ports 1 through 4, and Ports 5 through 8. An X indicates that the data rate is supported in that port.

Table 10-28 Supported Client Data Rates for Ports 1 through 4 and Ports 5 through 8

Port (Group 1)	Port (Group 2)	Gigabit Ethernet	1G FC	2G FC	4G FC
1	5	X	X	X	X
2	6	X	X	—	—
3	7	X	X	X	—
4	8	X	X	—	—

GFP-T PM is available through RMON and trunk PM is managed according to Telcordia GR-253-CORE and ITU G.783/826. Client PM is achieved through RMON for FC and GE.

A buffer-to-buffer credit management scheme provides FC flow control. With this feature enabled, a port indicates the number of frames that can be sent to it (its buffer credit), before the sender is required to stop transmitting and wait for the receipt of a “ready” indication The MXP_MR_10DME_C and MXP_MR_10DME_L cards support FC credit-based flow control with a buffer-to-buffer credit extension of up to 1600 km (994.1 miles) for 1G FC, up to 800 km (497.1 miles) for 2G FC, or up to 400 km (248.5 miles) for 4G FC. The feature can be enabled or disabled.

The MXP_MR_10DME_C and MXP_MR_10DME_L cards feature a 1550-nm laser for the trunk/line port and a 1310-nm or 850-nm laser (depending on the SFP) for the client ports. The cards contains eight 12.5 degree downward tilt SFP modules for the client interfaces. For optical termination, each SFP uses two LC connectors, which are labeled TX and RX on the faceplate. The trunk port is a dual-LC connector with a 45 degree downward angle.

The throughput of the MXP_MR_10DME_C and MXP_MR_10DME_L cards is affected by the following parameters:

- Distance extension—If distance extension is enabled on the card, it provides more throughput but more latency. If distance extension is disabled on the card, the buffer to buffer credits on the storage switch affects the throughput; higher the buffer to buffer credits higher is the throughput.

  Note For each link to operate at the maximum throughput, it requires a minimum number of buffer credits to be available on the devices which the link connects to. The number of buffer credits required is a function of the distance between the storage switch extension ports and the link bandwidth, that is, 1G, 2G, or 4G. These buffer credits are provided by either the storage switch (if distance extension is disabled) or by both the storage switch and the card (if distance extension is enabled).

- Forward Error Correction (FEC)—If Enhanced FEC (E-FEC) is enabled on the trunk port of the card, the throughout is significantly reduced in comparison to standard FEC being set on the trunk port.

  Note If distance extension is enabled on the card, the FEC status does not usually affect the throughput of the card.

- Payload size—The throughput of the card decreases with decrease in payload size.

The resultant throughput of the card is usually the combined effect of the above parameters.

10.10.1 Key Features

The MXP_MR_10DME_C and MXP_MR_10DME_L cards have the following high-level features:

- Onboard E-FEC processor: The processor supports both standard RS (specified in ITU-T G.709) and E-FEC, which allows an improved gain on trunk interfaces with a resultant extension of the transmission range on these interfaces. The E-FEC functionality increases the correction capability of the transponder to improve performance, allowing operation at a lower OSNR compared to the standard RS (237,255) correction algorithm. A new BCH algorithm implemented in E-FEC allows recovery of an input BER up to 1E-3.
- Pluggable client interface optic modules: The MXP_MR_10DME_C and MXP_MR_10DME_L cards have modular interfaces. Two types of optics modules can be plugged into the card. These include an OC-48/STM 16 SR-1 interface with a 7-km (4.3-mile) nominal range (for short range and intra-office applications) and an IR-1 interface with a range up to 40 km (24.9 miles). SR-1 is defined in Telcordia GR-253-CORE and in I-16 (ITU-T G.957). IR-1 is defined in Telcordia GR-253-CORE and in S-16-1 (ITU-T G.957).
- Y-cable protection: Supports Y-cable protection between the same card type only, on ports with the same port number and signal rate. See the "10.19.1 Y-Cable Protection" section on page 10-139 for more detailed information.
- High level provisioning support: The cards are initially provisioned using Cisco TransportPlanner software. Subsequently, the card can be monitored and provisioned using CTC software.
- ALS: A safety mechanism used in the event of a fiber cut. For details regarding ALS provisioning for the MXP_MR_10DME_C and MXP_MR_10DME_L cards, refer to the *Cisco ONS 15454 DWDM Procedure Guide*.

- Link monitoring and management: The cards use standard OC-48 OH bytes to monitor and manage incoming interfaces. The cards pass the incoming SDH/SONET data stream and its OH bytes transparently.
- Control of layered SONET/SDH transport overhead: The cards are provisionable to terminate regenerator section overhead. This is used to eliminate forwarding of unneeded layer overhead. It can help reduce the number of alarms and help isolate faults in the network.
- Automatic timing source synchronization: The MXP_MR_10DME_C and MXP_MR_10DME_L cards normally synchronize from the TCC2/TCC2P/TCC3 card. If for some reason, such as maintenance or upgrade activity, the TCC2/TCC2P/TCC3 is not available, the cards automatically synchronize to one of the input client interface clocks.

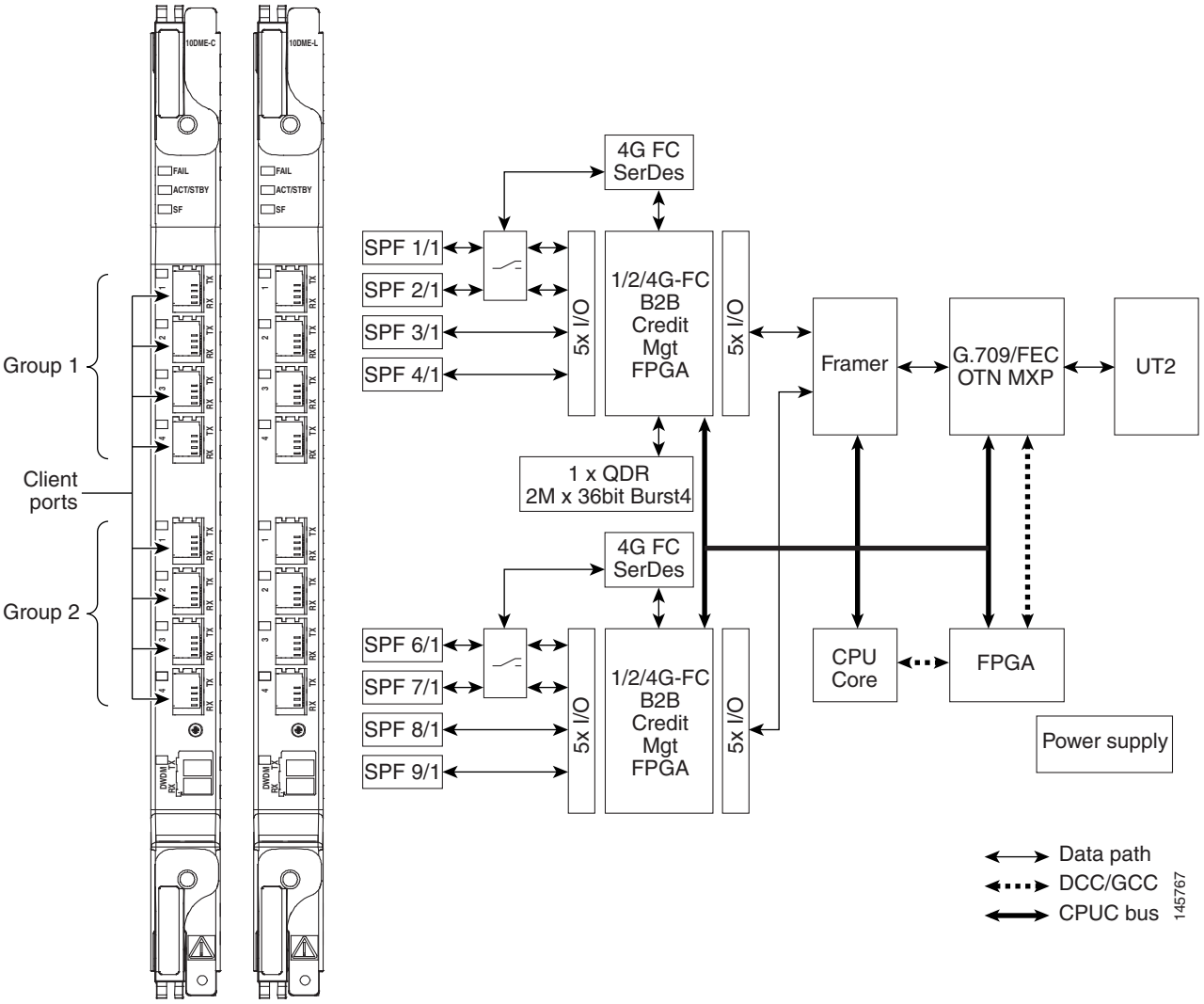
Note MXP_MR_10DME_C and MXP_MR_10DME_L cards cannot be used for line timing.

- Configurable squelching policy: The cards can be configured to squelch the client interface output if there is LOS at the DWDM receiver or if there is a remote fault. In the event of a remote fault, the card manages MS-AIS insertion.
- The cards are tunable across the full C band (MXP_MR_10DME_C) or full L band (MXP_MR_10DME_L), thus eliminating the need to use different versions of each card to provide tunability across specific wavelengths in a band.
- You can provision a string (port name) for each fiber channel/FICON interface on the MXP_MR_10DME_C and MXP_MR_10DME_L cards, which allows the MDS Fabric Manager to create a link association between that SAN port and a SAN port on a Cisco MDS 9000 switch.
- From Software Release 9.0, the fast switch feature of MXP_MR_10DME_C and MXP_MR_10DME_L cards along with the buffer-to-buffer credit recovery feature of MDS switches, prevents reinitialization of ISL links during Y-cable switchovers.

10.10.2 Faceplate

Figure 10-25 shows the MXP_MR_10DME_C and MXP_MR_10DME_L faceplates and block diagram.

Figure 10-25 MXP_MR_10DME_C and MXP_MR_10DME_L Faceplates and Block Diagram



For information on safety labels for the cards, see the "10.2.2 Class 1M Laser Product Cards" section on page 10-10.

Caution You must use a 20-dB fiber attenuator (15 to 25 dB) when working with the cards in a loopback on the trunk port. Do not use direct fiber loopbacks with the cards. Using direct fiber loopbacks causes irreparable damage to the MXP_MR_10DME_C and MXP_MR_10DME_L cards.

10.10.3 Wavelength Identification

The card uses trunk lasers that are wavelocked, which allows the trunk transmitter to operate on the ITU grid effectively. Both the MXP_MR_10DME_C and MXP_MR_10DME_L cards implement the UT2 module. The MXP_MR_10DME_C card uses a C-band version of the UT2 and the MXP_MR_10DME_L card uses an L-band version.

Table 10-29 describes the required trunk transmit laser wavelengths for the MXP_MR_10DME_C card. The laser is tunable over 82 wavelengths in the C band at 50-GHz spacing on the ITU grid.

Table 10-29 MXP_MR_10DME_C Trunk Wavelengths

Channel Number	Frequency (THz)	Wavelength (nm)	Channel Number	Frequency (THz)	Wavelength (nm)
1	196.00	1529.55	42	193.95	1545.72
2	195.95	1529.94	43	193.90	1546.119
3	195.90	1530.334	44	193.85	1546.518
4	195.85	1530.725	45	193.80	1546.917
5	195.80	1531.116	46	193.75	1547.316
6	195.75	1531.507	47	193.70	1547.715
7	195.70	1531.898	48	193.65	1548.115
8	195.65	1532.290	49	193.60	1548.515
9	195.60	1532.681	50	193.55	1548.915
10	195.55	1533.073	51	193.50	1549.32
11	195.50	1533.47	52	193.45	1549.71
12	195.45	1533.86	53	193.40	1550.116
13	195.40	1534.250	54	193.35	1550.517
14	195.35	1534.643	55	193.30	1550.918
15	195.30	1535.036	56	193.25	1551.319
16	195.25	1535.429	57	193.20	1551.721
17	195.20	1535.822	58	193.15	1552.122
18	195.15	1536.216	59	193.10	1552.524
19	195.10	1536.609	60	193.05	1552.926
20	195.05	1537.003	61	193.00	1553.33
21	195.00	1537.40	62	192.95	1553.73
22	194.95	1537.79	63	192.90	1554.134
23	194.90	1538.186	64	192.85	1554.537
24	194.85	1538.581	65	192.80	1554.940
25	194.80	1538.976	66	192.75	1555.343
26	194.75	1539.371	67	192.70	1555.747
27	194.70	1539.766	68	192.65	1556.151
28	194.65	1540.162	69	192.60	1556.555
29	194.60	1540.557	70	192.55	1556.959
30	194.55	1540.953	71	192.50	1557.36
31	194.50	1541.35	72	192.45	1557.77
32	194.45	1541.75	73	192.40	1558.173
33	194.40	1542.142	74	192.35	1558.578

Table 10-29 MXP_MR_10DME_C Trunk Wavelengths (continued)

Channel Number	Frequency (THz)	Wavelength (nm)	Channel Number	Frequency (THz)	Wavelength (nm)
34	194.35	1542.539	75	192.30	1558.983
35	194.30	1542.936	76	192.25	1559.389
36	194.25	1543.333	77	192.20	1559.794
37	194.20	1543.730	78	192.15	1560.200
38	194.15	1544.128	79	192.10	1560.606
39	194.10	1544.526	80	192.05	1561.013
40	194.05	1544.924	81	192.00	1561.42
41	194.00	1545.32	82	191.95	1561.83

Table 10-30 describes the required trunk transmit laser wavelengths for the MXP_MR_10DME_L card. The laser is fully tunable over 80 wavelengths in the L band at 50-GHz spacing on the ITU grid.

Table 10-30 MXP_MR_10DME_L Trunk Wavelengths

Channel Number	Frequency (THz)	Wavelength (nm)	Channel Number	Frequency (THz)	Wavelength (nm)
1	190.85	1570.83	41	188.85	1587.46
2	190.8	1571.24	42	188.8	1587.88
3	190.75	1571.65	43	188.75	1588.30
4	190.7	1572.06	44	188.7	1588.73
5	190.65	1572.48	45	188.65	1589.15
6	190.6	1572.89	46	188.6	1589.57
7	190.55	1573.30	47	188.55	1589.99
8	190.5	1573.71	48	188.5	1590.41
9	190.45	1574.13	49	188.45	1590.83
10	190.4	1574.54	50	188.4	1591.26
11	190.35	1574.95	51	188.35	1591.68
12	190.3	1575.37	52	188.3	1592.10
13	190.25	1575.78	53	188.25	1592.52
14	190.2	1576.20	54	188.2	1592.95
15	190.15	1576.61	55	188.15	1593.37
16	190.1	1577.03	56	188.1	1593.79
17	190.05	1577.44	57	188.05	1594.22
18	190	1577.86	58	188	1594.64
19	189.95	1578.27	59	187.95	1595.06
20	189.9	1578.69	60	187.9	1595.49
21	189.85	1579.10	61	187.85	1595.91

Table 10-30 MXP_MR_10DME_L Trunk Wavelengths (continued)

Channel Number	Frequency (THz)	Wavelength (nm)	Channel Number	Frequency (THz)	Wavelength (nm)
22	189.8	1579.52	62	187.8	1596.34
23	189.75	1579.93	63	187.75	1596.76
24	189.7	1580.35	64	187.7	1597.19
25	189.65	1580.77	65	187.65	1597.62
26	189.6	1581.18	66	187.6	1598.04
27	189.55	1581.60	67	187.55	1598.47
28	189.5	1582.02	68	187.5	1598.89
29	189.45	1582.44	69	187.45	1599.32
30	189.4	1582.85	70	187.4	1599.75
31	189.35	1583.27	71	187.35	1600.17
32	189.3	1583.69	72	187.3	1600.60
33	189.25	1584.11	73	187.25	1601.03
34	189.2	1584.53	74	187.2	1601.46
35	189.15	1584.95	75	187.15	1601.88
36	189.1	1585.36	76	187.1	1602.31
37	189.05	1585.78	77	187.05	1602.74
38	189	1586.20	78	187	1603.17
39	188.95	1586.62	79	186.95	1603.60
40	188.9	1587.04	80	186.9	1604.03

10.10.4 MXP_MR_10DME_C and MXP_MR_10DME_L Card-Level Indicators

Table 10-31 describes the three card-level LEDs on the MXP_MR_10DME_C and MXP_MR_10DME_L cards.

Table 10-31 MXP_MR_10DME_C and MXP_MR_10DME_L Card-Level Indicators

Card-Level LED	Description
Red FAIL LED	The red FAIL LED indicates that the card's processor is not ready. This LED is on during reset. The FAIL LED flashes during the boot process. Replace the card if the red FAIL LED persists.
ACT/STBY LED Green (Active) Amber (Standby)	If the ACT/STBY LED is green, the card is operational (one or more ports active) and ready to carry traffic. If the ACT/STBY LED is amber, the card is operational and in standby (protect) mode.
Amber SF LED	The amber SF LED indicates a signal failure or condition such as LOS, LOF, or high BERs on one or more of the card's ports. The amber SF LED is also on if the transmit and receive fibers are incorrectly connected. If the fibers are properly connected and the link is working, the light turns off.

10.10.5 MXP_MR_10DME_C and MXP_MR_10DME_L Port-Level Indicators

Table 10-32 describes the port-level LEDs on the MXP_MR_10DME_C and MXP_MR_10DME_L cards.

Table 10-32 MXP_MR_10DME_C and MXP_MR_10DME_L Port-Level Indicators

Port-Level LED	Description
Port LED (eight LEDs, four for each group, one for each SFP)	When green, the port LED indicates that the client port is either in service and receiving a recognized signal (that is, no signal fail), or Out of Service and Maintenance (OOS,MT or locked, maintenance) and the signal fail and alarms are being ignored.
Green/Red/Amber/Off	When red, the port LED indicates that the client port is in service but is receiving a signal fail (LOS). When amber, the port LED indicates that the port is provisioned and in a standby state. When off, the port LED indicates that the SFP is either not provisioned, out of service, not properly inserted, or the SFP hardware has failed.
Green DWDM LED	The green DWDM LED indicates that the DWDM port is in service and that it is receiving a recognized signal.

10.11 40G-MXP-C Card

The 40G-MXP-C card aggregates a variety of client service inputs (GigabitEthernet, Fibre Channel, OTU2, OTU2e, and OC192) into one 40.0 Gbps OTU3/OTU3e signal on the trunk side. The 40G-MXP-C card supports aggregation of the following signals:

- With overclock enabled on the trunk port:
  - 10-Gigabit Fibre Channel
  - OTU2e
- With overclock disabled on the trunk port:
  - 8-Gigabit Fibre Channel
  - 10-GigabitEthernet LAN-Phy (GFP framing)
  - 10-GigabitEthernet LAN-Phy (WIS framing)
  - OC-192/STM-64
  - OTU2

Caution Handle the card with care. Dropping or misuse of the card could result in permanent damage.

The 40G-MXP-C muxponder passes all SONET/SDH overhead bytes transparently, section, or line termination.

The digital wrapper function (ITU-T G.709 compliant) formats the DWDM wavelength so that it can be used to set up GCCs for data communications, enable FEC, or facilitate performance monitoring. The 40G-MXP-C card work with the OTN devices defined in ITU-T G.709. The card supports ODTU23 multiplexing, an industry standard method for asynchronously mapping client payloads into a digitally wrapped envelope. See the "10.7.7 Multiplexing Function" section on page 10-36.

You can install and provision the 40G-MXP-C card in a linear configuration in:

- Slots 1 to 5 and 12 to 16 in ONS 15454 DWDM chassis
- Slot 2 in ONS 15454 M2 chassis
- Slots 2 to 6 in ONS 15454 M6 chassis

The 40G-MXP-C card client port interoperates with all the existing TXP/MXP (OTU2 trunk) cards. The 40G-MXP-C card client port does not interoperate with OTU2_XP card when the signal rate is OTU1e (11.049 Gbps) and the "No Fixed Stuff" option is enabled on the trunk port of OTU2_XP card.

For OTU2 and OTU2e client protocols, Enhanced FEC (EFEC) is not supported in Port 1 of the 40G-MXP-C card. Table 10-33 lists the FEC configuration supported on OTU2/OTU2e protocol for 40G-MXP-C card.

Table 10-33 40G-MXP-C Client Interface Data Rates

40G-MXP-C Client Port	FEC Configuration Supported on OTU2/OTU2e Client Protocol
Port 1	Only Standard FEC
Port 2	Standard and Enhanced FEC
Port 3	Standard and Enhanced FEC
Port 4	Standard and Enhanced FEC

When setting up the card for the first time, or when the card comes up after clearing the LOS-P condition due to fiber cut, the trunk port of the 40G-MXP-C card takes a about six minutes to lock a signal. The trunk port of the 40G-MXP-C card raises an OTUK-LOF alarm when the card is comes up. The alarm clears when the trunk port locks the signal.

When protection switch occurs on the 40G-MXP-C card, the recovery from PSM protection switch takes about 3 to 4 minutes.

The 40G-MXP-C card is tunable over C-band on the trunk port. The 40G-MXP-C card supports pluggable XFPs on the client ports on the card faceplate. The card uses dual LC connectors on the trunk side, and XFP modules on the client side for optical cable termination. The XFP pluggable modules are SR, LR, MM, DWDM, or CWDM and support an LC fiber connector. The 40G-MXP-C card contains four XFP modules for the client interfaces. For optical termination, each XFP uses two LC connectors, which are labeled TX and RX on the faceplate. The trunk port is a dual-LC connector facing downward at 45 degrees.

Table 10-34 shows the input data rate for each client interface.

Table 10-34 40G-MXP-C Client Interface Input Data Rates

Client Interface	Input Data Rate
8-Gigabit Fibre Channel	8.48 Gbps
10-Gigabit Fibre Channel	10.519 Gbps
10-GigabitEthernet LAN-Phy	10.312 Gbps

Table 10-34 40G-MXP-C Client Interface Input Data Rates (continued)

Client Interface	Input Data Rate
10-GigabitEthernet WAN-Phy	9.953 Gbps
OC-192/STM-64	9.953 Gbps
OTU2	10.709 Gbps
OTU2e	11.096 Gbps

10.11.1 Key Features

The 40G-MXP-C card comprises of the following key features:

- The 40G-MXP-C card uses the RZ-DQPSK 40G modulation format.
- Onboard E-FEC processor: The E-FEC functionality improves the correction capability of the transponder to improve performance, allowing operation at a lower OSNR compared to the standard RS (239,255) correction algorithm. A new BCH algorithm implemented (according to G.975.1 I.7) in E-FEC allows recovery of an input BER up to 1E-3. The 40G-MXP-C card supports both standard RS (specified in ITU-T G.709) and E-FEC standard, which allows an improved gain on trunk interfaces with a resultant extension of the transmission range on these interfaces.
- Y-cable protection: Supports Y-cable protection between the same card type only, on ports with the same port number and signal rate. For more information on Y-cable protection, see "10.19 Y-Cable and Splitter Protection" section on page 10-139.

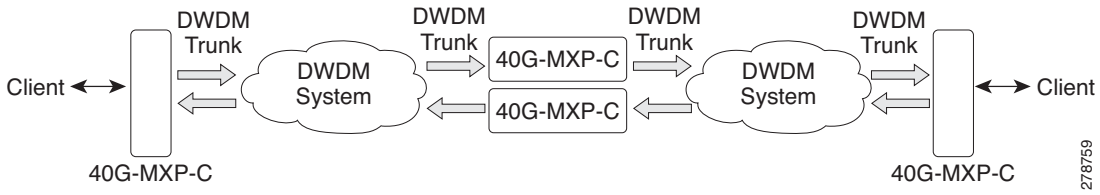
Note Y-cable cannot be created on 10 GE port when WIS framing is enabled on the 40G-MXP-C card.

- Unidirectional regeneration: The 40G-MXP-C card supports unidirectional regeneration configuration. Each 40G-MXP-C card in the configuration regenerates the signal received from another 40G-MXP-C card in one direction.

Note When you configure the 40G-MXP-C card in Unidirectional Regen mode, ensure that the payload is not configured on pluggable port modules of the 40G-MXP-C card.

Figure 10-26 shows a typical unidirectional regeneration configuration.

Figure 10-26 40G-MXP-C Cards in Unidirectional Regeneration Configuration



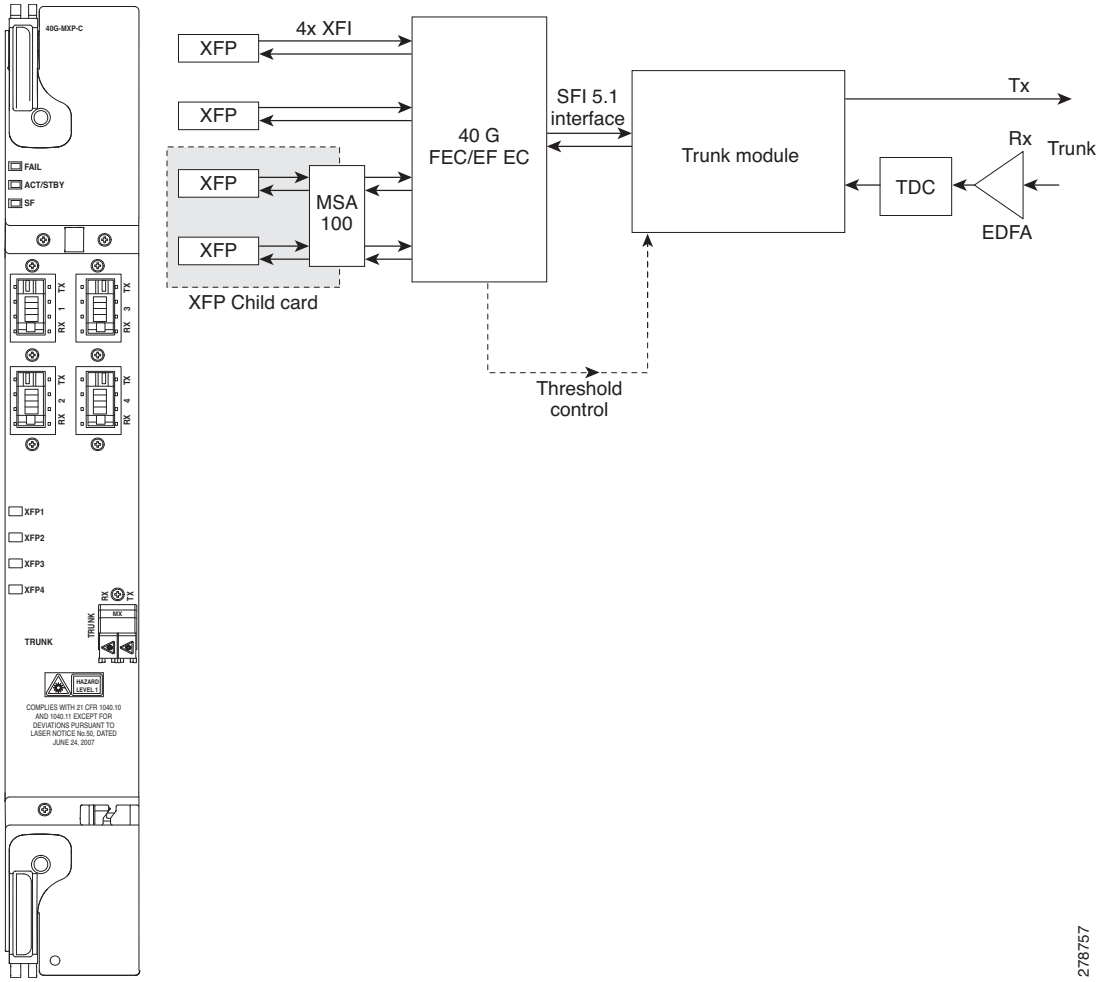
- High level provisioning support: The cards are initially provisioned using Cisco Transport Planner software. Subsequently, the card can be monitored and provisioned using CTC software.

- Automatic Laser Shutdown (ALS): A safety mechanism used in the event of a fiber cut. The Auto Restart ALS option is supported only for OC192/STM64 and OTU2 payloads. The Manual Restart ALS option is supported for all payloads. For more information on ALS provisioning for the 40G-MXP-C card, see the *Cisco ONS 15454 DWDM Procedure Guide*.
- Control of layered SONET/SDH transport overhead: The cards are provisionable to terminate regenerator section overhead. This is used to eliminate forwarding of unneeded layer overhead. It can help reduce the number of alarms and help isolate faults in the network.
- Automatic timing source synchronization: The 40G-MXP-C card synchronizes to the TCC2/TCC2P/TCC3/TNC/TSC card. If for some reason, such as maintenance or upgrade activity, the TCC2/TCC2P/TCC3/TNC/TSC card is not available, the cards automatically synchronize to one of the input client interface clocks.
- Squelching policy: The cards are set to squelch the client interface output if there is LOS at the DWDM receiver, or if there is a remote fault. In the event of a remote fault, the card manages MS-AIS insertion.
- The card is tunable across the full C band wavelength.

10.11.2 Faceplate and Block Diagram

Figure 10-27 shows the 40G-MXP-C card faceplate and block diagram.

Figure 10-27 40G-MXP-C Faceplate and Block Diagram



For information on safety labels for the cards, see the "10.2.2 Class 1M Laser Product Cards" section on page 10-10.

Caution You must use a 20-dB fiber attenuator (15 to 25 dB) when working with the cards in a loopback on the trunk port. Do not use direct fiber loopbacks with the cards. Using direct fiber loopbacks causes irreparable damage to the 40G-MXP-C card.

10.11.3 Wavelength Identification

The card uses trunk lasers that are wavelocked, which allows the trunk transmitter to operate on the ITU grid effectively. The 40G-MXP-C card implements the UT2 module. The 40G-MXP-C card uses a C-band version of the UT2.

Table 10-35 lists the required trunk transmit laser wavelengths for the 40G-MXP-C card. The laser is tunable over 82 wavelengths in the C band at 50-GHz spacing on the ITU grid.

Table 10-35 40G-MXP-C Trunk Wavelengths

Channel Number	Frequency (THz)	Wavelength (nm)	Channel Number	Frequency (THz)	Wavelength (nm)
1	196.00	1529.55	42	193.95	1545.72
2	195.95	1529.94	43	193.90	1546.119
3	195.90	1530.334	44	193.85	1546.518
4	195.85	1530.725	45	193.80	1546.917
5	195.80	1531.116	46	193.75	1547.316
6	195.75	1531.507	47	193.70	1547.715
7	195.70	1531.898	48	193.65	1548.115
8	195.65	1532.290	49	193.60	1548.515
9	195.60	1532.681	50	193.55	1548.915
10	195.55	1533.073	51	193.50	1549.32
11	195.50	1533.47	52	193.45	1549.71
12	195.45	1533.86	53	193.40	1550.116
13	195.40	1534.250	54	193.35	1550.517
14	195.35	1534.643	55	193.30	1550.918
15	195.30	1535.036	56	193.25	1551.319
16	195.25	1535.429	57	193.20	1551.721
17	195.20	1535.822	58	193.15	1552.122
18	195.15	1536.216	59	193.10	1552.524
19	195.10	1536.609	60	193.05	1552.926
20	195.05	1537.003	61	193.00	1553.33
21	195.00	1537.40	62	192.95	1553.73
22	194.95	1537.79	63	192.90	1554.134
23	194.90	1538.186	64	192.85	1554.537
24	194.85	1538.581	65	192.80	1554.940
25	194.80	1538.976	66	192.75	1555.343
26	194.75	1539.371	67	192.70	1555.747
27	194.70	1539.766	68	192.65	1556.151
28	194.65	1540.162	69	192.60	1556.555
29	194.60	1540.557	70	192.55	1556.959
30	194.55	1540.953	71	192.50	1557.36
31	194.50	1541.35	72	192.45	1557.77
32	194.45	1541.75	73	192.40	1558.173
33	194.40	1542.142	74	192.35	1558.578
34	194.35	1542.539	75	192.30	1558.983
35	194.30	1542.936	76	192.25	1559.389

Table 10-35 40G-MXP-C Trunk Wavelengths (continued)

Channel Number	Frequency (THz)	Wavelength (nm)	Channel Number	Frequency (THz)	Wavelength (nm)
36	194.25	1543.333	77	192.20	1559.794
37	194.20	1543.730	78	192.15	1560.200
38	194.15	1544.128	79	192.10	1560.606
39	194.10	1544.526	80	192.05	1561.013
40	194.05	1544.924	81	192.00	1561.42
41	194.00	1545.32	82	191.95	1561.83

10.11.4 40G-MXP-C Card-Level Indicators

Table 10-36 describes the three card-level indicators on the 40G-MXP-C card.

Table 10-36 40G-MXP-C Card-Level Indicators

Card-Level Indicator	Description
Red FAIL LED	The red FAIL LED indicates that the card's processor is not ready. This LED is on during reset. The FAIL LED flashes during the boot process. Replace the card if the red FAIL LED persists.
ACT/STBY LED Green (Active) Amber (Standby)	If the ACT/STBY LED is green, the card is operational (one or more ports active) and ready to carry traffic. If the ACT/STBY LED is amber, the card is operational and in standby (protect) mode.
Amber SF LED	The amber SF LED indicates a signal failure or condition such as LOS, LOF, or high BERs on one or more of the card's ports. The amber SF LED is also on if the transmit and receive fibers are incorrectly connected. If the fibers are properly connected and the link is working, the light turns off.

10.11.5 40G-MXP-C Card Port-Level Indicators

Table 10-37 describes the port-level indicators on the 40G-MXP-C card.

Table 10-37 40G-MXP-C Card Port-Level Indicators

Port-Level Indicator	Description
Port LED (eight LEDs, four for each group, one for each XFP)	The green port LED indicates that the client port is either in service and receiving a recognized signal (that is, no signal fail), or Out of Service and Maintenance (OOS,MT or locked, maintenance) and the signal fail and alarms are being ignored.
Green/Red/Amber/Off	The red port LED indicates that the client port is in service but is receiving a signal fail (LOS). The amber port LED indicates that the port is provisioned and in a standby state. The port LED, when switched off, indicates that the SFP is either not provisioned, out of service, not properly inserted, or the SFP hardware failed.
Green DWDM LED	The green DWDM LED indicates that the DWDM port is in service and that it is receiving a recognized signal.

10.12 GE_XP, 10GE_XP, GE_XPE, and 10GE_XPE Cards

GE_XP, 10GE_XP, GE_XPE, and 10GE_XPE cards are Gigabit Ethernet Xponders for the ONS 15454 ANSI and ETSI platforms.

Note GE_XPE card is the enhanced version of the GE_XP card and 10GE_XPE card is the enhanced version of the 10GE_XP card.

The cards aggregate Ethernet packets received on the client ports for transport on C-band trunk ports that operate on a 100-GHz grid. The trunk ports operate with ITU-T G.709 framing and either FEC or E-FEC. The GE_XP and 10GE_XP cards are designed for bulk point-to-point transport over 10GE LAN PHY wavelengths for Video-on-Demand (VOD), or broadcast video across protected 10GE LAN PHY wavelengths. The GE_XPE and 10GE_XPE cards are designed for bulk GE_XPE or 10GE_XPE point-to-point, point-to-multipoint, multipoint-to-multipoint transport over 10GE LAN PHY wavelengths for Video-on-Demand (VOD), or broadcast video across protected 10GE LAN PHY wavelengths.

You can install and provision the GE_XP, and GE_XPE cards in a linear configuration in:

- Slots 1 to 5 and 12 to 16 in ONS 15454 DWDM chassis
- Slot 2 in ONS 15454 M2 chassis
- Slots 2 to 6 in ONS 15454 M6 chassis

The 10GE_XP and 10GE_XPE cards can be installed in Slots 1 through 6 or 12 through 17. The GE_XP and GE_XPE are double-slot cards with twenty Gigabit Ethernet client ports and two 10 Gigabit Ethernet trunk ports. The 10GE_XP and 10GE_XPE are single-slot cards with two 10 Gigabit Ethernet client ports and two 10 Gigabit Ethernet trunk ports. The client ports support SX, LX, and ZX SFPs and SR and 10GBASE-LR XFPs. (LR2 XFPs are not supported.) The trunk ports support a DWDM XFP.

The RAD pluggables (ONS-SC-E3-T3-PW= and ONS-SC-E1-T1-PW=) do not support:

- No loopbacks (Terminal or Facility)
- RAI (Remote Alarm Indication) alarm
- AIS and LOS alarm

Caution A fan-tray assembly (15454E-CC-FTA for the ETSI shelf, or 15454-CC-FTA for the ANSI shelf) must be installed in a shelf where a GE_XP, 10GE_XP, GE_XPE, or 10GE_XPE card is installed.

GE_XP, 10GE_XP, GE_XPE, and 10GE_XPE cards can be provisioned to perform different Gigabit Ethernet transport roles. All the cards can work as Layer 2 switches. However, the 10GE_XP and 10GE_XPE cards can also perform as a 10 Gigabit Ethernet transponders (10GE TXP mode), and the GE_XP and GE_XPE can perform as a 10 Gigabit Ethernet or 20 Gigabit Ethernet muxponders (10GE MXP or 20GE MXP mode). Table 10-38 shows the card modes supported by each card.

Note Changing the GE_XP, 10GE_XP, GE_XPE, or 10GE_XPE card mode requires the ports to be in a OOS-DSBL (ANSI) or Locked, disabled (ETSI) service state. In addition, no circuits can be provisioned on the cards when the mode is being changed.

Table 10-38 GE_XP, 10GE_XP, GE_XPE, and 10GE_XPE Card Modes

Card Mode	Cards	Description
Layer 2 Ethernet switch	GE_XP 10GE_XP GE_XPE 10GE_XPE	Provides capability to switch between any two ports irrespective of client or trunk port. Supported Ethernet protocols and services include 1+1 protection, QoS (Quality of Service), CoS (Class of Service), QinQ, MAC learning, MAC address retrieval, service provider VLANs (SVLANs), IGMP snooping and Multicast VLAN Registration (MVR), link integrity, and other Ethernet switch services.
10GE TXP	10GE_XP 10GE_XPE	Provides a point-to-point application in which each 10 Gigabit Ethernet client port is mapped to a 10 Gigabit Ethernet trunk port.
10GE MXP 20GE MXP	GE_XP GE_XPE	Provides the ability to multiplex the twenty Gigabit Ethernet client ports on the card to one or both of its 10 Gigabit Ethernet trunk ports. The card can be provisioned as a single MXP with twenty Gigabit Ethernet client ports mapped to one trunk port (Port 21) or as two MXPs with ten Gigabit Ethernet client ports mapped to a trunk port (Ports 1 to 10 mapped to Port 21, and Ports 11-20 mapped to Port 22).

10.12.1 Key Features

The GE_XP, 10GE_XP, GE_XPE, and 10GE_XPE cards have the following high-level features:

- Link Aggregation Control Protocol (LACP) that allows you to bundle several physical ports together to form a single logical channel.
- Ethernet Connectivity Fault Management (CFM) protocol that facilitates proactive connectivity monitoring, fault verification, and fault isolation.

- Ethernet Operations, Administration, and Maintenance (OAM) protocol that facilitates link monitoring, remote failure indication, and remote loopback.
- Resilient Ethernet Protocol (REP) that controls network loops, handles link failures, and improves convergence time.
- Configurable service VLANs (SVLANs) and customer VLANs (CVLANs).
- Ingress rate limiting that can be applied on both SVLANs and CVLANs. You can create SVLAN and CVLAN profiles and can associate a SVLAN profile to both UNI and NNI ports; however, you can associate a CVLAN profile only to UNI ports.
- CVLAN rate limiting that is supported for QinQ service in selective add mode.
- Differentiated Services Code Point (DSCP) to class of service (CoS) mapping that you can configure for each port. You can configure the CoS of the outer VLAN based on the incoming DSCP bits. This feature is supported only on GE_XPE and 10GE_XPE cards.
- Ports, in Layer 2 switch mode, can be provisioned as network-to-network interfaces (NNIs) or user-network interfaces (UNIs) to facilitate service provider to customer traffic management.
- Broadcast drop-and-continue capability for VOD and broadcast video applications.
- Gigabit Ethernet MXP, TXP, and Layer 2 switch capability over the ONS 15454 DWDM platform.
- Compatible with the ONS 15454 ANSI high-density shelf assembly, the ONS 15454 ETSI shelf assembly, ONS 15454 ETSI high-density shelf assembly, ONS 15454 M2, and the ONS 15454 M6 shelf assemblies. Compatible with TCC2, TCC2P, TCC3, TNC, and TSC cards.
- Far-End Laser Control (FELC) that is supported on copper SFPs from Release 8.52 and later releases. For more information on FELC, see the "10.20 Far-End Laser Control" section on page 10-142.
- Layer 2 switch mode that provides VLAN translation, QinQ, ingress CoS, egress QoS, Fast Ethernet protection switching, and other Layer 2 Ethernet services.
- Interoperable with TXP_MR_10E and TXP_MR_10E_C cards. Also interoperable with Cisco Catalyst 6500 and Cisco 7600 series Gigabit Ethernet, 10 GE interfaces and CRS-1 10GE interfaces.
- The GE_XP and GE_XPE cards have twenty Gigabit Ethernet client ports and two 10 Gigabit Ethernet trunk ports. The 10GE_XP and 10GE_XPE cards have two 10 Gigabit Ethernet client ports and two 10 Gigabit Ethernet trunk ports. The client Gigabit Ethernet signals are mapped into an ITU-T G.709 OTU2 signal using standard ITU-T G.709 multiplexing when configured in one of the MXP modes (10GE MXP or 20GE MXP).
- ITU-T G.709 framing with standard Reed-Soloman (RS) (255,237) FEC. Performance monitoring and ITU-T G.709 Optical Data Unit (ODU) synchronous and asynchronous mapping. E-FEC with ITU-T G.709 ODU and 2.7 Gbps with greater than 8 dB coding gain.
- IEEE 802.3 frame format that is supported for 10 Gigabit Ethernet interfaces. The minimum frame size is 64 bytes. The maximum frame size is user-provisionable.
- MAC learning capability in Layer 2 switch mode.
- MAC address retrieval in cards provisioned in the L2-over-DWDM mode.
- When a port is in UNI mode, tagging can be configured as transparent or selective. In transparent mode, only SVLANs in the VLAN database of the node can be configured. In selective mode, a CVLAN- to-SVLAN relationship can be defined.
- Layer 2 VLAN port mapping that allows the cards to be configured as multiple Gigabit Ethernet TXPs and MXPs.
- Y-cable protection is configurable in TXP and MXP modes.

- Two protection schemes are available in Layer 2 mode. They are:
  - 1+1 protection—Protection scheme to address card, port, or shelf failures for client ports.
  - Fast Automatic Protection—Protection scheme to address card, port, or shelf failures for trunk ports.
- End-to-end Ethernet link integrity.
- Pluggable client interface optic modules (SFPs and XFPs)—Client ports support tri-rate SX, LX, and ZX SFPs, and 10-Gbps SR1 XFPs.
- Pluggable trunk interface optic modules; trunk ports support the DWDM XFP.
- Internet Group Management Protocol (IGMP) snooping that restricts the flooding of multicast traffic by forwarding multicast traffic to those interfaces where a multicast device is present.
- Multicast VLAN Registration (MVR) for applications using wide-scale deployment of multicast traffic across an Ethernet ring-based service provider network.
- Ingress CoS that assigns a CoS value to the port from 0 (highest) to 7 (lowest) and accepts CoS of incoming frames.
- Egress QoS that defines the QoS capabilities for the egress port.
- MAC address learning that facilitates switch processing.
- Storm Control that limits the number of packets passing through a port. You can define the maximum number of packets allowed per second for the following types of traffic: Broadcast, Multicast, and Unicast. The threshold for each type of traffic is independent and the maximum number of packets allowed per second for each type of traffic is 16777215.

10.12.2 Protocol Compatibility list

Table 10-39 lists the protocol compatibility for GE_XP, 10GE_XP, GE_XPE, and 10GE_XPE cards.

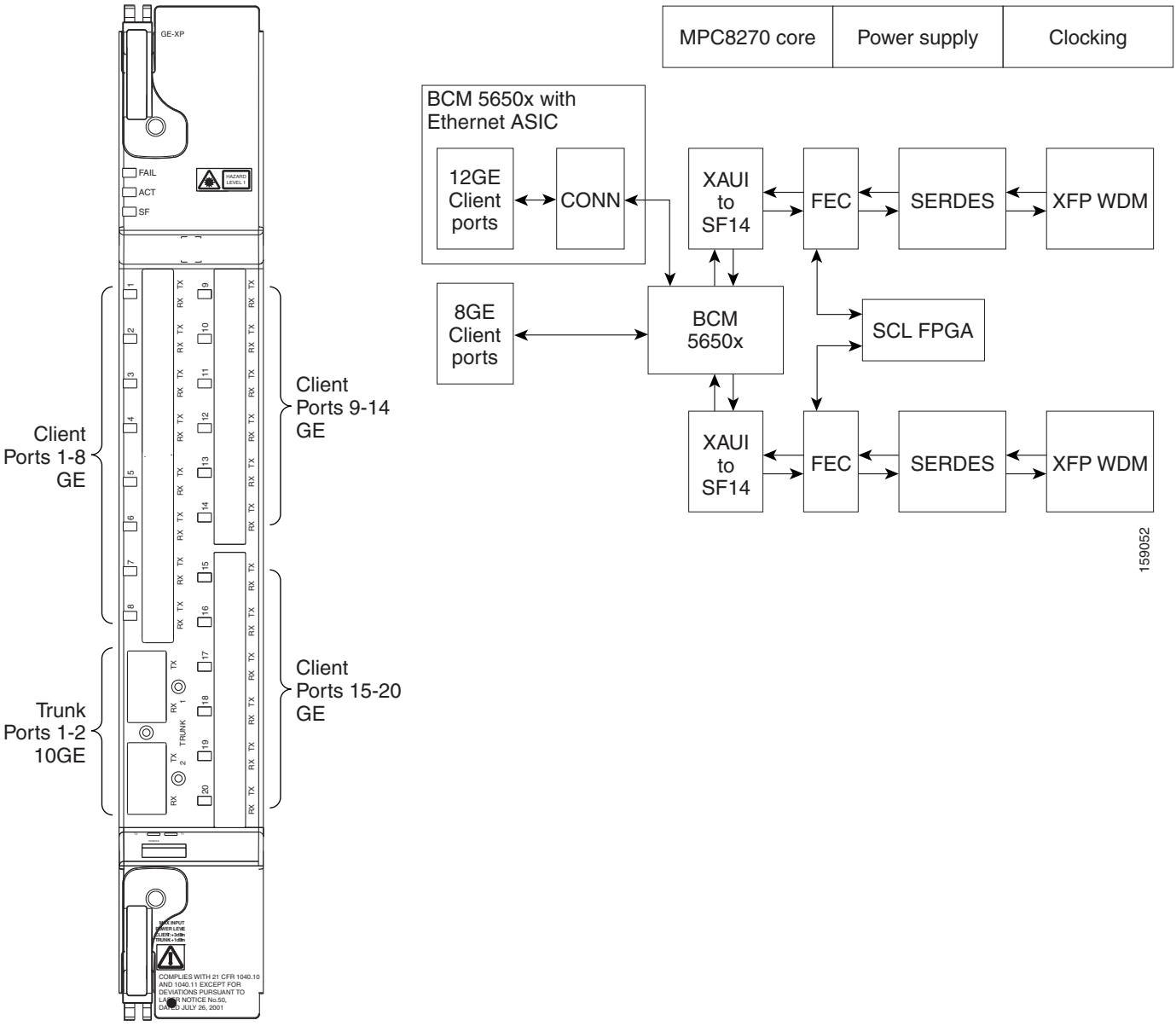
Table 10-39 Protocol Compatibility List for GE_XP, 10GE_XP, GE_XPE, and 10GE_XPE Cards

Protocol	L1	1+1	FAPS	IGMP	REP	LACP	CFM	EFM
L1		No	Yes	Yes	No	No	Yes	No
1+1	No		Yes	Yes	No	No	Yes	No
FAPS	Yes	Yes		Yes	No	No	Yes	No
IGMP	Yes	Yes	Yes		Yes	No	Yes	No
REP	No	No	No	Yes		No	Yes	No
LACP	No	No	No	No	No		No	No
CFM	Yes	Yes	Yes	Yes	Yes	No		No
EFM	No	No	No	No	No	No	No	

10.12.3 Faceplate and Block Diagram

Figure 10-28 shows the GE_XP faceplate and block diagram. The GE_XPE faceplate and block diagram looks the same.

Figure 10-28 GE_XP and GE_XPE Faceplates and Block Diagram

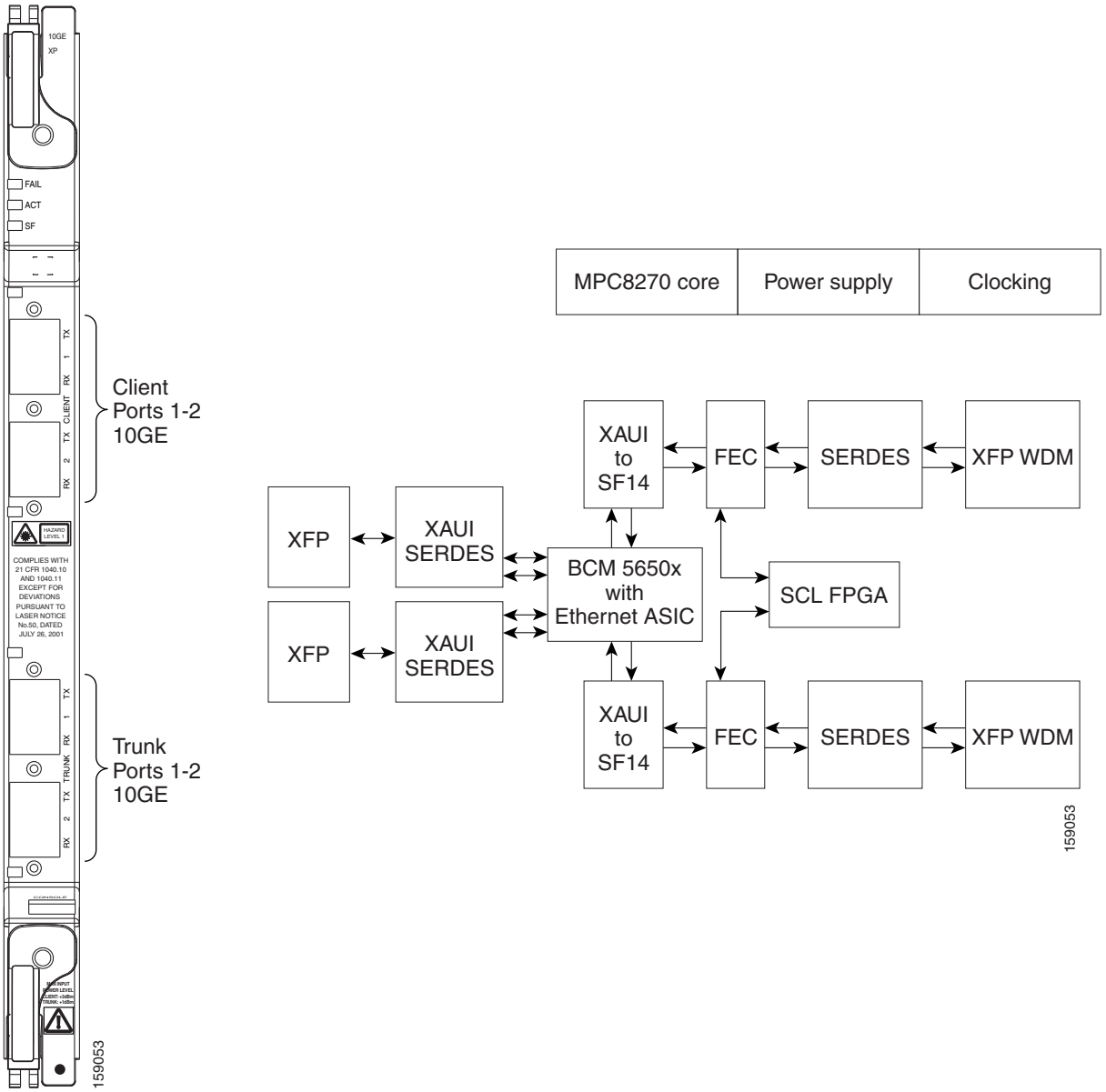


The GE_XP, 10GE_XP, GE_XPE, and 10GE_XPE cards have two trunk ports. The GE_XP and GE_XPE trunk ports are displayed as follows:

- Trunk 1 and Trunk 2 on the faceplate
- 21-1 and 22-1 on CTC
- 21 (Trunk) and 22 (Trunk) on the Optics Thresholds table

Figure 10-29 shows the 10GE_XP faceplate and block diagram. The 10 GE_XPE faceplate and block diagram looks the same.

Figure 10-29 10GE_XP and 10GE_XPE Faceplates and Block Diagram



The 10GE_XP and 10GE_XPE card trunk ports are displayed as follows:

- Trunk 1 and Trunk 2 on the faceplate
- 3-1 and 4-1 on CTC
- 3 (Trunk) and 4 (Trunk) on the Optics Thresholds table

For information on safety labels for the cards, see the "10.2.2 Class 1M Laser Product Cards" section on page 10-10.

Caution You must use a 20-dB fiber attenuator (15 to 25 dB) when working with the cards in a loopback on the trunk port. Do not use direct fiber loopbacks with the cards. Using direct fiber loopbacks causes irreparable damage to the GE_XP, 10GE_XP, GE_XPE, and 10GE_XPE cards.

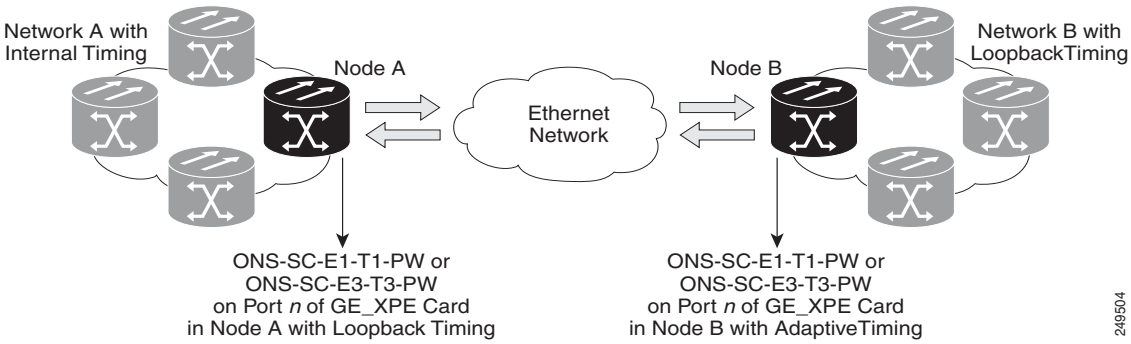
10.12.4 Client Interface

The client interface is implemented with separately orderable SFP or XFP modules. The client interfaces support the following tri-rate SFPs and XFPs using dual LC connectors and multimode fiber:

- SFP - GE/1G-FC/2G-FC - 850 nm - MM - LC (PID ONS-SE-G2F-SX)
- SFP - GE/1G-FC/2G-FC 1300 nm - SM - LC (PID ONS-SE-G2F-LX)
- SFP - GE/1G-FC/2G-FC 1300 nm - SM - LC (PID ONS-SE-G2F-ZX)
- SFP - 10/100/1000Base-T - Copper (PID ONS-SE-ZE-EL) Intra office up to 100; Cable: RJ45 STP CAT5, CAT5E, and CAT6
- SFP - 1000Base BX D/Gigabit Ethernet 1550 nm - SM - LC (PID ONS-SE-GE-BXD)
- SFP - 1000Base BX U/Gigabit Ethernet 1550 nm - SM - LC (PID ONS-SE-GE-BXU)
- SFP - Fast Ethernet 1310 nm - SM - LC (PID ONS-SI-100-LX10)
- SFP - Fast Ethernet 1310 nm - MM - LC (PID ONS-SI-100-FX)
- SFP - Fast Ethernet over DS1/E1 - SM - LC (PID ONS-SC-EOP1) (GE_XPE only)
- SFP - Fast Ethernet over DS3/E3 - SM - LC (PID ONS-SC-EOP3) (GE_XPE only)
- SFP - E1/DS1 over Fast Ethernet - SM - LC (PID ONS-SC-E1-T1-PW) (GE_XPE only)
- SFP - E3/DS3 PDH over Fast Ethernet - SM - LC (PID ONS-SC-E3-T3-PW) (GE_XPE only)

Note The resommended topology for using ONS-SC-E1-T1-PW and ONS-SC-E3-T3-PW SFPs is shown in Figure 10-30.

Figure 10-30 Recommended Topology for Using ONS-SC-E1-T1-PW and ONS -SC-E3-T3-PW SFPs



The client interfaces support the following dual-rate XFP using dual LC connectors and single-mode fiber:

- XFP - OC-192/STM-64/10GE/10-FC/OTU2 - 1310 SR - SM LC (PID: ONS-XC-10G-S1)
- XFP - 10GE - 1550 nm - SM - LC (PID ONS-XC-10G-L2)
- XFP - 10GE - 1550 nm - SM - LC (PID ONS-XC-10G-C)

Note If ONS-XC-10G-C XFP is used on GE_XP, 10GE_XP, GE_XPE, and 10GE_XPE cards on client port 1, the maximum temperature at which the system qualifies is +45 degree Celsius.

The client interfaces support the following multimode XFP using dual LC connectors and multi-mode fiber:

- XFP - OC-192/10GFC/10GE - 850 nm MM LC (PID ONS-XC-10G-SR-MM)

10.12.5 GE_XP, 10GE_XP, GE_XPE, and 10GE_XPE Card-Level Indicators

Table 10-40 describes the three card-level LEDs on the GE_XP, 10GE_XP, GE_XPE, and 10GE_XPE cards.

Table 10-40 GE_XP, 10GE_XP, GE_XPE, and 10GE_XPE Card-Level Indicators

Card-Level LED	Description
Red FAIL LED	The red FAIL LED indicates that the card's processor is not ready. This LED is on during reset. The FAIL LED flashes during the boot process. Replace the card if the red FAIL LED persists.
ACT LED Green (Active)	If the ACT LED is green, the card is operational (one or more ports active) and ready to carry traffic.
Amber SF LED	The amber SF LED indicates that a signal failure or condition such as LOS, LOF, or high BERs is present one or more of the card's ports. The amber SF LED is also on if the transmit and receive fibers are incorrectly connected. If the fibers are properly connected and the link is working, the light turns off.

10.12.6 GE_XP, 10GE_XP, GE_XPE, and 10GE_XPE Port-Level Indicators

Table 10-41 describes the port-level LEDs on the GE_XP, 10GE_XP, GE_XPE, and 10GE_XPE cards.

Table 10-41 GE_XP, 10GE_XP, GE_XPE, and 10GE_XPE Port-Level Indicators

Port-Level LED	Description
Port LEDs Green/Red/Amber/Off	Green—The client port is either in service and receiving a recognized signal (that is, no signal fail), or Out of Service and Maintenance (OOS,MT or locked, maintenance) in which case the signal fail and alarms will be ignored. Red—The client port is in service but is receiving a signal fail (LOS). Amber—The port is provisioned and in a standby state. Off—The SFP is either not provisioned, out of service, not properly inserted, or the SFP hardware has failed.
Green DWDM LED	Green—The green DWDM LED indicates that the DWDM port is in service and receiving a recognized signal (that is, no signal fail), or Out of Service and Maintenance (OOS,MT or locked, maintenance) in which case the signal fail and alarms will be ignored. Red—The client port is in service but is receiving a signal fail (LOS). Amber—The port is provisioned and in a standby state. Off—The SFP is either not provisioned, out of service, not properly inserted, or the SFP hardware has failed.

10.12.7 DWDM Trunk Interface

The GE_XP, 10GE_XP, GE_XPE, and 10GE_XPE cards have two 10 Gigabit Ethernet trunk ports operating at 10 Gigabit Ethernet (10.3125 Gbps) or 10 Gigabit Ethernet into OTU2 (nonstandard 11.0957 Gbps). The ports are compliant with ITU-T G.707, ITU-T G.709, and Telcordia GR-253-CORE standards. The ports are capable of carrying C-band and L-band wavelengths through insertion of DWDM XFPs. Forty channels are available in the 1550-nm C band 100-GHz ITU grid, and forty channels are available in the L band.

The maximum system reach in filterless applications without the use of optical amplification or regenerators is nominally rated at 23 dB over C-SMF fiber. This rating is not a product specification, but is given for informational purposes. It is subject to change.

10.12.8 Configuration Management

The GE_XP, 10GE_XP, GE_XPE, and 10GE_XPE cards support the following configuration management parameters:

- Port name—User-assigned text string.
- Admin State/Service State—Administrative and service states to manage and view port status.
- MTU—Provisionable maximum transfer unit (MTU) to set the maximum number of bytes per frames accepted on the port.
- Mode—Provisional port mode, either Autonegotiation or the port speed.
- Flow Control—Flow control according to IEEE 802.1x pause frame specification can be enabled or disabled for TX and RX ports.
- Bandwidth—Provisionable maximum bandwidth allowed for the port.
- Ingress CoS—Assigns a CoS value to the port from 0 (highest) to 7 (lowest) and accepts CoS of incoming frames.
- Egress QoS—Defines the QoS capabilities at the egress port.
- NIM—Defines the port network interface management type based on Metro Ethernet Forum specifications. Ports can be defined as UNI or NNI.
- MAC Learning—MAC address learning to facilitate switch processing.
- VLAN tagging provided according to the IEEE 802.1Q standard.

Note When the GE_XP, 10GE_XP, GE_XPE, and 10GE_XPE cards are provisioned in a MXP or TXP mode, only the following parameters are available: Port Name, State, MTU, Mode, Flow control, and Bandwidth.

10.12.9 Security

GE_XP, 10GE_XP, GE_XPE, and 10GE_XPE card ports can be provisioned to block traffic from a user-defined set of MAC addresses. The remaining traffic is normally switched. You can manually specify the set of blocked MAC addresses for each port. Each port of the card can receive traffic from a limited predefined set of MAC addresses. The remaining traffic will be dropped. This capability is a subset of the Cisco IOS “Port Security” feature.

10.12.10 Card Protection

The following section describes various card protection schemes available for the GE_XP, 10GE_XP, GE_XPE, and 10GE_XPE cards.

10.12.10.1 1+1 Protection

1+1 protection of GE_XP, 10GE_XP, GE_XPE, and 10GE_XPE cards is provided in the Layer 2 (L2) card mode to protect against client port and card failure.

1+1 protection is supported in both single shelf and multishelf setup. This means that the working card can be in one shelf and the protect card can be in another shelf of a multishelf setup. Communication between the two cards is across 10 Gigabit Ethernet interconnection interface using Ethernet packets. The Inter link (ILK) trunk or internal pathcord must be provisioned on both the cards. This link is used to transmit protection switching messages and data. For information on how to provision ILK or internal patchcords, refer *Cisco ONS 15454 DWDM Procedure Guide*.

Note With 1+1 protection mechanisms, the switch time of a copper SFP is 1 second.

With 1+1 protection, ports on the protect card can be assigned to protect the corresponding ports on the working card. A working card must be paired with a protect card of the same type and number of ports. The protection takes place on the port level, and any number of ports on the protect card can be assigned to protect the corresponding ports on the working card.

To make the 1+1 protection scheme fully redundant, enable L2 protection for the entire VLAN ring. This enables Fast Automatic Protection Switch (FAPS). The VLAN configured on the 1+1 port must be configured as protected SVLAN. For information on how to enable FAPS, see *Cisco ONS 15454 DWDM Procedure Guide*.

1+1 protection can be either revertive or nonrevertive. With nonrevertive 1+1 protection, when a failure occurs and the signal switches from the working card to the protect card, the signal remains on the protect card until it is manually changed. Revertive 1+1 protection automatically switches the signal back to the working card when the working card comes back online. 1+1 protection uses trunk ports to send control traffic between working and protect cards. This trunk port connection is known as ILK trunk ports and can be provisioned via CTC. For information on how to provision an ILK link, see "DLP-G460 Provision an ILK Link" in the *Cisco ONS 15454 DWDM Procedure Guide*.

The standby port can be configured to turn ON or OFF but the traffic coming to and from the standby port will be down. If the laser is ON at the standby port, the other end port (where traffic originates) will not be down in a parallel connection. Traffic is blocked on the standby port.

1+1 protection is bidirectional and nonrevertive by default; revertive switching can be provisioned using CTC. For information on how to provision the cards, refer to the *Cisco ONS 15454 DWDM Procedure Guide*.

10.12.10.2 Y-Cable Protection

The GE_XP and GE_XPE cards support Y-cable protection when they are provisioned in 10 Gigabit Ethernet or 20 Gigabit Ethernet MXP card mode. The 10GE_XP and 10GE_XPE cards support Y-cable protection when they are provisioned in 10GE TXP card mode. Two cards can be joined in a Y-cable protection group with one card assigned as the working card and the other defined as the protection card. This protection mechanism provides redundant bidirectional paths. See the "10.19.1 Y-Cable Protection" section on page 10-139 for more detailed information. The Y-cable protection mechanism is

provisionable and can be set ON or OFF (OFF is the default mode). When a signal fault is detected (LOS, LOF, SD, or SF on the DWDM receiver port in the case of ITU-T G.709 mode) the protection mechanism software automatically switches between paths. Y-cable protection also supports revertive and nonrevertive mode.

10.12.10.3 Layer 2 Over DWDM Protection

When the GE_XP, 10GE_XP, GE_XPE, or 10GE_XPE cards are in L2-over-DWDM card mode, protection is handled by the hardware at the Layer 1 and Layer 2 levels. Fault detection and failure propagation is communicated through the ITU-T G.709 frame overhead bytes. For protected VLANs, traffic is flooded around the 10 Gigabit Ethernet DWDM ring. To set up the Layer 2 protection, you identify a node and the GE_XP, 10GE_XP, GE_XPE, or 10GE_XPE port that is to serve as the master node and port for the VLAN ring on the card view Provisioning > Protection tab. If a failure occurs, the node and port are responsible for opening and closing VLAN loops.

Note The Forced option in the Protection drop-down list converts all the SVLANs to protected SVLANs irrespective of the SVLAN protection configuration in the SVLAN database. This is applicable to a point-to-point linear topology. The SVLAN protection must be forced to move all SVLANs, including protected and unprotected SVLANs, to the protect path irrespective of provisioned SVLAN attributes.

A FAPS switchover happens in the following failure scenarios:

- DWDM line failures caused by a fiber cut
- Unidirectional failure in the DWDM network caused by a fiber cut
- Fiber pull on the master card trunk port followed by a hard reset on the master card
- Hard reset on the master card
- Hard reset on the slave card
- An OTN failure is detected (LOS, OTUK-LOF, OTUK-LOM, OTUK-LOM, OTUK-SF, or OTUK-BDI on the DWDM receiver port in the case of ITU-T G.709 mode)
- Trunk ports are moved to OOS,DSBLD (Locked,disabled) state
- Improper removal of XFPs

A FAPS switchover does not happen in the following scenarios:

- Slave card trunk port in OOS,DSBLD (Locked,disabled) state followed by a hard reset of the slave card
- OTN alarms raised on the slave card trunk port followed by a hard reset of the slave card

10.12.11 IGMP Snooping

As networks increase in size, multicast routing becomes critically important as a means to determine which segments require multicast traffic and which do not. IP multicasting allows IP traffic to be propagated from one source to a number of destinations, or from many sources to many destinations. Rather than sending one packet to each destination, one packet is sent to the multicast group identified by a single IP destination group address. GE_XP, 10GE_XP, GE_XPE, and 10GE_XPE cards can learn upto a maximum of 1024 multicast groups. This includes groups on all the VLANs.

Internet Group Management Protocol (IGMP) snooping restricts the flooding of multicast traffic by forwarding multicast traffic to those interfaces where a multicast device is present.

When the GE_XP, 10GE_XP, GE_XPE, or 10GE_XPE card receives an IGMP leave group message from a host, it removes the host port from the multicast forwarding table after generating group specific queries to ensure that no other hosts interested in traffic for the particular group are present on that port. Even in the absence of any "leave" message, the cards have a timeout mechanism to update the group table with the latest information. After a card relays IGMP queries from the multicast router, it deletes entries periodically if it does not receive any IGMP membership reports from the multicast clients.

In a multicast router, general queries are sent on a VLAN when Protocol Independent Multicast (PIM) is enabled on the VLAN. The GE_XP, 10GE_XP, GE_XPE, or 10GE_XPE card forwards queries to all ports belonging to the VLAN. All hosts interested in this multicast traffic send Join requests and are added to the forwarding table entry. The Join requests are forwarded only to router ports. By default, these router ports are learned dynamically. However, they can also be statically configured at the port level in which case the static configuration overrides dynamic learning.

For information on interaction of IGMP with other protocols, see the 10.12.2 Protocol Compatibility list.

10.12.11.1 IGMP Snooping Guidelines and Restrictions

The following guidelines and restrictions apply to IGMP snooping on GE_XP, 10GE_XP, GE_XPE, and 10GE_XPE cards:

- IGMP snooping V2 is supported as specified in RFC 4541.
- IGMP snooping V3 is not supported and the packets are flooded in the SVLAN.
- Layer 2 multicast groups learned through IGMP snooping are dynamic.
- GE_XP and 10GE_XP cards support IGMP snooping on 128 stacked VLANs and GE_XPE and 10GE_XPE cards support up to 256 stacked VLANs that are enabled.
- IGMP snooping can be configured per SVLAN or CVLAN. By default, IGMP snooping is disabled on all SVLANs and CVLANs.
- IGMP snooping on CVLAN is enabled only when:
  - MVR is enabled.
  - UNI ports are in selective add and selective translate modes. For each UNI port, a CVLAN must be specified for which IGMP snooping is to be enabled.
- IGMP snooping can be enabled only on one CVLAN per port. If you enable IGMP snooping on CVLAN, you cannot enable IGMP snooping on the associated SVLAN and vice versa. The number of VLANs that can be enabled for IGMP snooping cannot exceed 128.
- When IGMP snooping is enabled on double-tagged packets, CVLAN has to be the same on all ports attached to the same SVLAN.
- When IGMP snooping is working with the Fast Automatic Protection Switch (FAPS) in a ring-based setup, it is advisable to configure all NNI ports as static router ports. This minimizes the multicast traffic hit when a FAPS switchover occurs.

The following conditions are raised from IGMP snooping at the card:

- MCAST-MAC-TABLE-FULL—This condition is raised when the multicast table is full and a new join request is received. This table is cleared when at least one entry gets cleared from the multicast table after the alarm is raised.
- MCAST-MAC-ALIASING—This condition is raised when there are multiple L3 addresses that map to the same L2 address in a VLAN. This is a transient condition.

For more information on severity level of these conditions and procedure to clear these alarms, refer to the *Cisco ONS 15454 Troubleshooting Guide*.

10.12.11.2 Fast-Leave Processing

Note Fast-Leave processing is also known as Immediate-Leave.

IGMP snooping Fast-Leave processing allows the GE_XP, 10GE_XP, GE_XPE, or 10GE_XPE to remove an interface that sends a leave message from the forwarding table without first sending group specific queries to the interface. When you enable IGMP Fast-Leave processing, the card immediately removes a port from the IP multicast group when it detects an IGMP, version 2 (IGMPv2) leave message on that port.

10.12.11.3 Static Router Port Configuration

Multicast-capable ports are added to the forwarding table for every IP multicast entry. The card learns of such ports through the PIM method.

10.12.11.4 Report Suppression

Report suppression is used to avoid a storm of responses to an IGMP query. When this feature is enabled, a single IGMP report is sent to each multicast group in response to a single query. Whenever an IGMP snooping report is received, report suppression happens if the report suppression timer is running. The Report suppression timer is started when the first report is received for a general query. Then this time is set to the response time specified in general query.

10.12.11.5 IGMP Statistics and Counters

An entry in a counter contains multicasting statistical information for the IGMP snooping capable GE_XP, 10GE_XP, GE_XPE, or 10GE_XPE card. It provides statistical information about IGMP messages that have been transmitted and received. IGMP statistics and counters can be viewed via CTC from the Performance > Ether Ports > Statistics tab.

This information can be stored in the following counters:

- cisTxGeneralQueries—Number of general queries transmitted through an interface.
- cisTxGroupSpecificQueries—Total group specific queries transmitted through an interface.
- cisTxReports—Total membership reports transmitted through an interface.
- cisTxLeaves—Total Leave messages transmitted through an interface.
- cisRxGeneralQueries—Total general queries received at an interface.
- cisRxGroupSpecificQueries—Total Group Specific Queries received at an interface.
- cisRxReports—Total Membership Reports received at an interface.
- cisRxLeaves—Total Leave messages received at an interface.
- cisRxValidPackets—Total valid IGMP packets received at an interface.
- cisRxInvalidPackets—Total number of packets that are not valid IGMP messages received at an interface.

10.12.12 Multicast VLAN Registration

Multicast VLAN Registration (MVR) is designed for applications using wide-scale deployment of multicast traffic across an Ethernet-ring-based service provider network (for example, the broadcast of multiple television channels over a service-provider network). MVR allows a subscriber on a port to subscribe and unsubscribe to a multicast stream on the network-wide multicast VLAN. It allows the single multicast VLAN to be shared in the network while subscribers remain in separate VLANs. MVR provides the ability to continuously send multicast streams in the multicast VLAN, but to isolate the streams from the subscriber VLANs for bandwidth and security reasons.

MVR assumes that subscriber ports subscribe and unsubscribe ("Join" and "Leave") these multicast streams by sending out IGMP Join and Leave messages. These messages can originate from an IGMP version-2-compatible host with an Ethernet connection. MVR operates on the underlying mechanism of IGMP snooping. MVR works only when IGMP snooping is enabled.

The card identifies the MVR IP multicast streams and their associated MAC addresses in the card forwarding table, intercepts the IGMP messages, and modifies the forwarding table to include or remove the subscriber as a receiver of the multicast stream, even though the receivers is in a different VLAN than the source. This forwarding behavior selectively allows traffic to cross between different VLANs.

Note When MVR is configured, the port facing the router must be configured as NNI in order to allow the router to generate or send multicast stream to the host with the SVLAN. If router port is configured as UNI, the MVR will not work properly.

10.12.13 MAC Address Learning

The GE_XPE and 10 GE_XPE cards support 32K MAC addresses. MAC address learning can be enabled or disabled per SVLAN on GE_XPE and 10 GE_XPE cards. The cards learn the MAC address of packets they receive on each port and add the MAC address and its associated port number to the MAC address learning table. As stations are added or removed from the network, the GE_XPE and 10 GE_XPE cards update the MAC address learning table, adding new dynamic addresses and aging out those that are currently not in use.

MAC address learning can be enabled or disabled per SVLAN. When the configuration is changed from enable to disable, all the related MAC addresses are cleared. The following conditions apply:

- If MAC address learning is enabled on per port basis, the MAC address learning is not enabled on all VLANs, but only on VLANs that have MAC address learning enabled.
- If per port MAC address learning is disabled then the MAC address learning is disabled on all VLANs, even if it is enabled on some of the VLAN supported by the port.
- If the per port MAC address learning is configured on GE-XP and 10 GE-XP cards, before upgrading to GE-XPE or 10 GE-XPE cards, enable MAC address learning per SVLAN. Failing to do so disables MAC address learning.

10.12.14 MAC Address Retrieval

MAC addresses learned can be retrieved or cleared on GE_XP, 10GE_XP, GE_XPE, and 10GE_XPE cards provisioned in L2-over-DWDM mode. The MAC addresses can be retrieved using the CTC or TL1 interface.

GE_XPE and 10GE_XPE cards support 32K MAC addresses and GE_XP and 10GE_XP cards support 16K MAC addresses. To avoid delay in processing requests, the learned MAC addresses are retrieved using an SVLAN range. The valid SVLAN range is from 1 to 4093.

The MAC addresses of the GE_XP, 10GE_XP, GE_XPE, and 10GE_XPE cards can also be retrieved. The card MAC addresses are static and are used for troubleshooting activities. One MAC address is assigned to each client, trunk, and CPU ports of the GE_XP, 10GE_XP, GE_XPE, or 10GE_XPE card. These internal MAC addresses can be used to determine if the packets received on the far-end node are generated by GE_XP, 10GE_XP, GE_XPE, and 10GE_XPE cards.

For MAC address retrieval, the following conditions apply:

- The cards must be provisioned in L2-over-DWDM mode.
- MAC address learning must be enabled per SVLAN on GE_XPE or 10 GE_XPE cards.
- MAC address learning must be enabled per port on GE_XP or 10 GE_XP cards.

For information on how to retrieve or clear MAC addresses learned, refer to the "Provision Transponder and Muxponder Cards" chapter in the *Cisco ONS 15454 DWDM Procedure Guide*.

10.12.15 Link Integrity

The GE_XP, 10GE_XP, GE_XPE, and 10GE_XPE card support end-to-end Ethernet link integrity. This capability is integral to providing an Ethernet private line service and correct operation of Layer 2 and Layer 3 protocols on the attached Ethernet devices.

The link integrity feature propagates a trunk fault on all the affected SVLAN circuits in order to squelch the far end client interface. Ethernet-Advanced IP Services (E-AIS) packets are generated on a per-port/SVLAN basis. An E-AIS format is compliant with ITU Y.1731.

Note E-AIS packets are marked with a CoS value of 7 (also called .1p bits). Ensure that the network is not overloaded and there is sufficient bandwidth for this queue in order to avoid packet drops.

When link integrity is enabled on a per-port SVLAN basis, E-AIS packets are generated when the following alarms are raised;

- LOS-P
- OTUKLOF/LOM
- SIGLOSS
- SYNCHLOSS
- OOS
- PPM not present

When link integrity is enabled, GE_XP and 10 GE_XP card supports up to128 SVLANs and GE_XPE, 10 GE_XPE can support up to 256 SVLANs.

10.12.16 Ingress CoS

Ingress CoS functionality enables differentiated services across the GE_XPE and 10GE_XPE cards. A wide range of networking requirements can be provisioned by specifying the class of service applicable to each transmitted traffic.

When a CVLAN is configured as ingress CoS, the per-port settings are not considered. A maximum of 128 CVLAN and CoS relationships can be configured.

10.12.17 CVLAN Rate Limiting

CVLAN rate limiting is supported on GE_XP, 10GE_XP, GE_XPE, and 10GE_XPE cards. CVLAN rate limiting is supported for QinQ service in selective add mode. The following limitations and restrictions apply to CVLAN rate limiting:

- CVLAN rate limiting is not supported for the following service types:
  - Selective translate mode
  - Transparent mode
  - Selective double add mode
  - Selective translate add mode
  - Untagged packets
  - CVLAN range
  - Services associated with the channel group
- CVLAN rate limiting and SVLAN rate limiting cannot be applied to the same service instance.
- Pseudo-IOS command line interface (PCLI) is not supported for CVLAN rate limiting.
- A VLAN profile with Link Integrity option enabled cannot be used to perform CVLAN rate limiting.
- On GE_XP and 10 GE_XP cards, CVLAN rate limiting can be applied to up to 128 services. However, the number of provisionable CVLAN rate limiting service instances is equal to 192 minus the number of SVLAN rate limiting service instances present on the card (subject to a minimum of 64 CVLAN rate limiting service instances).
- On GE_XPE and 10 GE_XPE cards, CVLAN rate limiting can be applied to up to 256 services. However, the number of provisionable CVLAN rate limiting service instances is equal to 384 minus the number of SVLAN rate limiting service instances present on the card (subject to a minimum of 128 CVLAN rate limiting service instances).

10.12.18 DSCP to CoS Mapping

DSCP to CoS mapping can be configured for each port. You can configure the CoS of the outer VLAN based on the incoming DSCP bits. This feature is supported only on GE_XPE and 10GE_XPE cards. PCLI is not supported for DSCP to CoS mapping.

DSCP to CoS mapping is supported for the following service types:

- Selectice add mode
- Selective translate mode
- Transparent mode
- Selective double add mode
- Selective translate add mode
- Untagged packets
- CVLAN range

– Services associated with the channel group

10.12.19 Link Aggregation Control Protocol

Link Aggregation Control Protocol (LACP) is part of the IEEE802.3ad standard that allows you to bundle several physical ports together to form a single logical channel. LACP allows a network device such as a switch to negotiate an automatic bundling of links by sending LACP packets to the peer device.

LACP allows you to form a single Layer 2 link automatically from two or more Ethernet links. This protocol ensures that both ends of the Ethernet link are functional and agree to be members of the aggregation group before the link is added to the group. LACP must be enabled at both ends of the link to be operational.

For more information on LACP, refer to the IEEE802.3ad standard. For information on interaction of LACP with other protocols, see the 10.12.2 Protocol Compatibility list.

10.12.19.1 Advantages of LACP

LACP provides the following advantages:

- High-speed network that transfers more data than any single port or device.
- High reliability and redundancy. If a port fails, traffic continues on the remaining ports.
- Hashing algorithm that allows to apply load balancing policies on the bundled ports.

10.12.19.2 Functions of LACP

LACP performs the following functions in the system:

- Maintains configuration information to control aggregation.
- Exchanges configuration information with other peer devices.
- Attaches or detaches ports from the link aggregation group based on the exchanged configuration information.
- Enables data flow when both sides of the aggregation group are synchronized.

10.12.19.3 Modes of LACP

LACP can be configured in the following modes:

- On — Default. In this mode, the ports do not exchange LACP packets with the partner ports.
- Active — In this mode, the ports send LACP packets at regular intervals to the partner ports.
- Passive — In this mode, the ports do not send LACP packets until the partner sends LACP packets. After receiving the LACP packets from the partner ports, the ports send LACP packets.

10.12.19.4 Parameters of LACP

LACP uses the following parameters to control aggregation:

- System Identifier—A unique identification assigned to each system. It is the concatenation of the system priority and a globally administered individual MAC address.

- Port Identification—A unique identifier for each physical port in the system. It is the concatenation of the port priority and the port number.
- Port Capability Identification—An integer, called a key, that identifies the capability of one port to aggregate with another port. There are two types of keys:
  - Administrative key—The network administrator configures this key.
  - Operational key—The LACP assigns this key to a port, based on its aggregation capability.
- Aggregation Identifier—A unique integer that is assigned to each aggregator and is used for identification within the system.

10.12.19.5 Unicast Hashing Schemes

LACP supports the following unicast hashing schemes:

- Ucast SA VLAN Incoming Port
- Ucast DA VLAN Incoming Port
- Ucast SA DA VLAN Incoming port
- Ucast Src IP TCP UDP
- Ucast Dst IP TCP UDP
- Ucast Src Dst IP TCP UDP

Note Unicast hashing schemes apply to unicast traffic streams only when the destination MAC address is already learned by the card. Hence, MAC learning must be enabled to support load balancing as per the configured hashing scheme. If the destination MAC address is not learned, the hashing scheme is Ucast Src Dst IP TCP UDP.

10.12.19.6 Supported LACP Features

The GE_XP, 10GE_XP, GE_XPE, and 10GE_XPE cards support the following LACP features as per the IEEE802.3ad standard:

- *DLP-G611 Create a Channel Group Using CTC*
- *DLP-G612 Modify the Parameters of the Channel Group Using CTC*
- *DLP-G613 Add or Remove Ports to or from an Existing Channel Group Using CTC*
- *DLP-G614 Delete a Channel Group Using CTC*

See the *Cisco ONS 15454 DWDM Procedure Guide* for information on these procedures.

10.12.19.7 LACP Limitations and Restrictions

The LACP on the GE_XP, 10GE_XP, GE_XPE, and 10GE_XPE cards has the following limitations and restrictions:

- Hot standby link state is not supported on the channel group.
- Marker protocol generator is not supported.
- ALS cannot be configured on the channel group.
- Loopback configuration cannot be applied on the channel group.

10.12.20 Ethernet Connectivity Fault Management

Ethernet Connectivity Fault Management (CFM) is part of the IEEE 802.1ag standard. The Ethernet CFM is an end-to-end per service instance that supports the Ethernet layer Operations, Administration, and Management (OAM) protocol. It includes proactive connectivity monitoring, link trace on a per service basis, fault verification, and fault isolation for large Ethernet metropolitan-area networks (MANs) and WANs.

CFM is disabled on the card by default. CFM is enabled on all the ports by default.

For more information on CFM, refer to the IEEE 802.1ag standard. For information on interaction of CFM with other protocols, see the 10.12.2 Protocol Compatibility list. The following sections contain conceptual information about Ethernet CFM.

10.12.20.1 Maintenance Domain

A maintenance domain is an administrative domain that manages and administers a network. You can assign a unique maintenance level (from 0 to 7) to define the hierarchical relationship between domains. The larger the domain, the higher the maintenance level for that domain. For example, a service provider domain would be larger than an operator domain and might have a maintenance level of 6, while the operator domain maintenance level would be 3 or 4.

Maintenance domains cannot intersect or overlap because that would require more than one entity to manage it, which is not allowed. Domains can touch or nest if the outer domain has a higher maintenance level than the nested domain. Maintenance levels of nesting domains must be communicated among the administrating organizations. For example, one approach would be to have the service provider assign maintenance levels to operators.

The CFM protocol supports up to eight maintenance domains on GE_XP, 10GE_XP, GE_XPE, and 10GE_XPE cards.

10.12.20.2 Maintenance Association

A maintenance association identifies a service within the maintenance domain. You can have any number of maintenance associations within each maintenance domain. The CFM protocol supports up to 1500 maintenance associations on GE_XP, 10GE_XP, GE_XPE, and 10GE_XPE cards.

Note Each maintenance association is mapped to a maintenance domain. This mapping is done to configure a Maintenance End Point (MEP). The CFM protocol supports up to 1000 mappings on GE_XP, 10GE_XP, GE_XPE, and 10GE_XPE cards.

10.12.20.3 Maintenance End Points

Maintenance End Points (MEPs) reside at the edge of the maintenance domain and are active elements of the Ethernet CFM. MEPs transmit Continuity Check messages at periodic intervals and receive similar messages from other MEPs within a domain. MEPs also transmit Loopback and Traceroute messages at the request of the administrator. MEPs confine CFM messages within the boundary of a maintenance domain through the maintenance level. There are two types of MEPs:

- Up (Inwards, towards the bridge)
- Down (Outwards, towards the wire).

You can create up to 255 MEPs and MIPs together on GE_XP and 10GE_XP cards. You can create up to 500 MEPs and MIPs together on GE_XPE and 10GE_XPE cards.

The MEP continuity check database (CCDB) stores information that is received from other MEPs in the maintenance domain. The card can store up to 4000 MEP CCDB entries.

10.12.20.4 Maintenance Intermediate Points

Maintenance Intermediate Points (MIPs) are internal to the maintenance domain and are passive elements of the Ethernet CFM. They store information received from MEPs and respond to Linktrace and Loopback CFM messages. MIPs forward CFM frames received from MEPs and other MIPs, drop all CFM frames at a lower level, and forward all CFM frames at a higher level.

You can create up to 255 MEPs and MIPs together on GE_XP and 10GE_XP cards. You can create up to 500 MEPs and MIPs together on GE_XPE and 10GE_XPE cards.

The MIP CCDB maintains the information received for all MEPs in the maintenance domain. The card can store up to 4000 MIP CCDB entries.

10.12.20.5 CFM Messages

The Ethernet CFM on GE_XP, 10GE_XP, GE_XPE, and 10GE_XPE cards supports the following messages:

- Continuity Check—These messages are exchanged periodically among MEPs. They allow MEPs to discover other MEPs within a domain and allow MIPs to discover MEPs. These messages are confined to a domain.
- Loopback—These messages are unicast messages that a MEP transmits, at the request of an administrator, to verify connectivity to a specific maintenance point. A reply to a loopback message indicates whether a destination is reachable.
- Traceroute—These messages are multicast messages that a MEP transmits, at the request of an administrator, to track the path to a destination MEP.

10.12.20.6 Supported CFM Features

The GE_XP, 10GE_XP, GE_XPE, and 10GE_XPE cards support the following Ethernet CFM features as per the IEEE 802.1ag standard:

- *DLP-G621 Enable or Disable CFM on the Card Using CTC*
- *DLP-G622 Enable or Disable CFM for Each Port Using CTC*
- *DLP-G623 Create a Maintenance Domain Profile Using CTC*
- *DLP-G625 Create a Maintenance Association Profile Using CTC*
- *DLP-G628 Map a Maintenance Association Profile to a Maintenance Domain Profile Using CTC*
- *DLP-G629 Create a MEP Using CTC*
- *DLP-G631 Create a MIP Using CTC*
- *DLP-G633 Ping MEP Using CTC*
- *DLP-G634 Traceroute MEP Using CTC*

See the *Cisco ONS 15454 DWDM Procedure Guide* for information on these procedures.

10.12.20.7 CFM Limitations and Restrictions

The CFM on the GE_XP, 10GE_XP, GE_XPE, and 10GE_XPE cards has the following limitations and restrictions:

- CFM is not supported on channel groups.
- CFM is not enabled on ptotected ports running REP, FAPS, and 1+1.
- Y.1731 enhancements including AIS, LCK, and performance monitoring messages along with CFM are not supported.
- IEEE CFM MIB is not supported.
- L1 and CFM are mutually exclusive on a SVLAN because LI and CFM use the same MAC address.
- MAC security and CFM are mutually exclusive on the card due to hardware resource constraints.

10.12.21 Ethernet OAM

The Ethernet OAM protocol is part of the IEEE 802.3ah standard and is used for installing, monitoring, and troubleshooting Ethernet MANs and Ethernet WANs. This protocol relies on an optional sublayer in the data link layer of the OSI model. The Ethernet OAM protocol was developed for Ethernet in the First Mile (EFM) applications. The terms Ethernet OAM and EFM are interchangeably used and both mean the same.

Normal link operation does not require Ethernet OAM. You can implement Ethernet OAM on any full-duplex point-to-point or emulated point-to-point Ethernet link for a network or part of a network (specified interfaces). OAM frames, called OAM Protocol Data Units (OAM PDUs), use the slow protocol destination MAC address 0180.c200.0002. OAM PDUs are intercepted by the MAC sublayer and cannot propagate beyond a single hop within an Ethernet network.

Ethernet OAM is disabled on all interfaces by default. When Ethernet OAM is enabled on an interface, link monitoring is automatically turned on.

For more information on Ethernet OAM protocol, refer to IEEE 802.3ah standard. For information on interaction of Ethernet OAM with other protocols, see the 10.12.2 Protocol Compatibility list.

10.12.21.1 Components of the Ethernet OAM

Ethernet OAM consists of two major components, the OAM Client and the OAM Sublayer.

10.12.21.1.1 OAM Client

The OAM client establishes and manages the Ethernet OAM on a link. The OAM client also enables and configures the OAM sublayer. During the OAM discovery phase, the OAM client monitors the OAM PDUs received from the remote peer and enables OAM functionality. After the discovery phase, the OAM client manages the rules of response to OAM PDUs and the OAM remote loopback mode.

10.12.21.1.2 OAM Sublayer

The OAM sublayer presents two standard IEEE 802.3 MAC service interfaces:

- One interface facing toward the superior sublayers, which include the MAC client (or link aggregation).
- Other interface facing toward the subordinate MAC control sublayer.

The OAM sublayer provides a dedicated interface for passing OAM control information and OAM PDUs to and from the client.

10.12.21.2 Benefits of the Ethernet OAM

Ethernet OAM provides the following benefits:

- Competitive advantage for service providers
- Standardized mechanism to monitor the health of a link and perform diagnostics

10.12.21.3 Features of the Ethernet OAM

The Ethernet OAM protocol has the following OAM features:

- Discovery—Identifies devices in the network and their OAM capabilities. The Discovery feature uses periodic OAM PDUs to advertise the OAM mode, configuration, and capabilities. An optional phase allows the local station to accept or reject the configuration of the peer OAM entity.
- Link Monitoring—Detects and indicates link faults under a variety of conditions. It uses the event notification OAM PDU to notify the remote OAM device when it detects problems on the link.
- Remote Failure Indication—Allows an OAM entity to convey the failure conditions to its peer through specific flags in the OAM PDU.
- Remote Loopback—Ensures link quality with a remote peer during installation or troubleshooting.

10.12.21.4 Ethernet OAM Supported Features

The GE_XP, 10GE_XP, GE_XPE, and 10GE_XPE cards support the following Ethernet OAM features as per the IEEE 802.3ah standard:

- *DLP-G639 Enable or Disable EFM for Each Port Using CTC*
- *DLP-G640 Configure EFM Parameters Using CTC*
- *DLP-G641 Configure EFM Link Monitoring Parameters Using CTC*
- *DLP-G642 Enable Remote Loopback for Each Port Using CTC*

See the *Cisco ONS 15454 DWDM Procedure Guide* for information on these procedures.

10.12.21.5 Ethernet OAM Limitations and Restrictions

The Ethernet OAM on the GE_XP, 10GE_XP, GE_XPE, and 10GE_XPE cards has the following limitations and restrictions:

- CFM, REP, link integrity, LACP, FAPS, IGMP on SVLAN and L2 1+1 protection are not supported with EFM.
- IEEE EFM MIB is not supported.
- EFM cannot be enabled or disabled at the card level.
- Unidirectional functionality is not supported.
- Errored Symbol Period, Rx CRC errors, Tx CRC errors are not supported.
- OAM PDUs are limited to 1 frame per second.
- Dying Gasp and critical events are not supported.

Note Dying Gasp RFI is not generated on GE_XP, 10GE_XP, GE_XPE, and 10GE_XPE cards. However, if the peer device sends a dying gasp RFI, the card detects it and raises an alarm.

10.12.22 Resilient Ethernet Protocol

The Resilient Ethernet Protocol (REP) is a protocol used to control network loops, handle link failures, and improve convergence time.

REP performs the following tasks:

- Controls a group of ports connected in a segment.
- Ensures that the segment does not create any bridging loops.
- Responds to link failures within the segment.
- Supports VLAN load balancing.

For information on interaction of REP with other protocols, see the 10.12.2 Protocol Compatibility list.

10.12.22.1 REP Segments

A REP segment is a chain of ports connected to each other and configured with a segment ID. Each segment consists of regular segment ports and two edge ports. A GE_XP, 10GE_XP, GE_XPE, or 10GE_XPE card can have up to 2 ports that belong to the same segment, and each segment port can have only one external neighbor port.

A segment protects only against a single link failure. Any more failures within the segment result in loss of connectivity.

10.12.22.2 Characteristics of REP Segments

REP segments have the following characteristics:

- If all the ports in the segment are operational, one port blocks traffic for each VLAN. If VLAN load balancing is configured, two ports in the segment control the blocked state of VLANs.
- If any port in the segment is not operational, all the other operational ports forward traffic on all VLANs to ensure connectivity.
- In case of a link failure, the alternate ports are immediately unblocked. When the failed link comes up, a logically blocked port per VLAN is selected with minimal disruption to the network.

10.12.22.3 REP Port States

Ports in REP segments take one of three roles or states: Failed, Open, or Alternate.

- A port configured as a regular segment port starts as a failed port.
- When the neighbor adjacencies are determined, the port transitions to the alternate port state, blocking all the VLANs on the interface. Blocked port negotiations occur and when the segment settles, one blocked port remains in the alternate role and all the other ports become open ports.
- When a failure occurs in a link, all the ports move to the failed state. When the alternate port receives the failure notification, it changes to the open state, forwarding all VLANs.

10.12.22.4 Link Adjacency

Each segment port creates an adjacency with its immediate neighbor. Link failures are detected and acted upon locally. If a port detects a problem with its neighbor, the port declares itself non-operational and REP converges to a new topology.

REP Link Status Layer (LSL) detects its neighbor port and establishes connectivity within the segment. All VLANs are blocked on an interface until the neighbor port is identified. After the neighbor port is identified, REP determines the neighbor port that must be the alternate port and the ports that must forward traffic.

Each port in a segment has a unique port ID. When a segment port starts, the LSL layer sends packets that include the segment ID and the port ID.

A segment port does not become operational if the following conditions are satisfied:

- No neighbor port has the same segment ID or more than one neighbor port has the same segment ID.
- The neighbor port does not acknowledge the local port as a peer.

10.12.22.5 Fast Reconvergence

REP runs on a physical link and not on per VLAN. Only one hello message is required for all VLANs that reduces the load on the protocol.

REP Hardware Flood Layer (HFL) is a transmission mechanism that floods packets in hardware on an admin VLAN. HFL avoids the delay that is caused by relaying messages in software. HFLis used for fast reconvergence in the order of 50 to 200 milliseconds.

10.12.22.6 VLAN Load Balancing

You must configure two edge ports in the segment for VLAN load balancing. One edge port in the REP segment acts as the primary edge port; the other edge port as the secondary edge port. The primary edge port always participates in VLAN load balancing in the segment. VLAN load balancing is achieved by blocking certain VLANs at a configured alternate port and all the other VLANs at the primary edge port.

10.12.22.7 REP Configuration Sequence

You must perform the following tasks in sequence to configure REP:

- Configure the REP administrative VLAN or use the default VLAN 1. The range of REP admin VLAN is 1 to 4093. VLAN 4094 is not allowed.
- Add ports to the segment in interface configuration mode.
- Enable REP on ports and assign a segment ID to it. REP is disabled on all ports by default. The range of segment ID is 1 to 1024.
- Configure two edge ports in the segment; one port as the primary edge port and the other as the secondary edge port.
- If you configure two ports in a segment as the primary edge port, for example, ports on different switches, REP selects one of the ports to serve as the primary edge port based on port priority. The Primary option is enabled only on edge ports.
- Configure the primary edge port to send segment topology change notifications (STCNs) and VLAN load balancing to another port or to other segments. STCNs and VLAN load balancing configurations are enabled only for edge ports.

Note A port can belong to only one segment. Only two ports can belong to the same segment. Both the ports must be either regular ports or edge ports. However, if the No-neighbor port is configured, one port can be an edge port and another port can be a regular port.

10.12.22.8 REP Supported Interfaces

REP supports the following interfaces:

- REP is supported on client (UNI) and trunk (NNI) ports.
- Enabling REP on client ports allows protection at the access or aggregation layer when the cards are connected to the L2 network.
- Enabling REP on trunk ports allows protection at the edge layer when the cards are connected in a ring.

10.12.22.9 REP Limitations and Restrictions

The REP on the GE_XP, 10GE_XP, GE_XPE, and 10GE_XPE cards has the following limitations and restrictions:

- Fast re-convergence and VLAN load balancing are not supported on UNI ports in transparent mode.
- Native VLAN is not supported.
- CFM, EFM, link integrity, LACP, FAPS, and L2 1+1 protection are not supported on ports that are configured as part of REP segment and vice versa.
- NNI ports cannot be configured as the primary edge port or blocking port at the access or aggregation layer.
- Only three REP segments can be configured on GE_XP, 10GE_XP, GE_XPE, and 10GE_XPE cards.
- Consider the following configuration:

  More than one REP closed segment is configured on the GE_XP, 10GE_XP, GE_XPE, and 10GE_XPE cards and the same HFL admin VLAN is enabled on the switches.

  If two different segments are configured on more than one common switch, the following consequences happen.

  - Layer 1 loop
  - Flooding of HFL packets across segments if one REP segment fails
  - Segment goes down due to LSL time out even if the segment does not have faults

  Hence, it is recommended not to configure two different segments on more than one common switch.
- Consider the following configuration:
  - VLAN Load Balancing is configured on GE_XP, 10GE_XP, GE_XPE, and 10GE_XPE cards by specifying the VLB preempt delay.
  - Primary and secondary edge ports are configured on the same switch.
  - HFL or LSL is activated.

  This configuration leads to high convergence time during manual premption, VLB activation, and deactivation (400 to 700 milliseconds).

10.13 ADM-10G Card

The ADM-10G card operates on ONS 15454 SONET, ONS 15454 SDH, ONS 15454 M2, ONS 15454 M6, and DWDM networks to carry optical signals and Gigabit Ethernet signals over DWDM wavelengths for transport. The card aggregates lower bit-rate client SONET or SDH signals (OC-3/STM-1, OC-12/STM-4, OC-48/STM-16, or Gigabit Ethernet) onto a C-band tunable DWDM trunk operating at a higher OC-192/STM-64 rate. In a DWDM network, the ADM-10G card transports traffic over DWDM by mapping Gigabit Ethernet and SONET or SDH circuits onto the same wavelength with multiple protection options.

You can install and provision the ADM-10G card in a linear configuration in:

- Slots 1 to 5 and 12 to 16 in standard and high-density ONS 15454 ANSI shelves (15454-SA-ANSI or 15454-SA-HD), the ETSI ONS 15454 standard shelf assembly, or the ONS 15454 ETSI high-density shelf assembly
- Slot 2 in ONS 15454 M2 chassis
- Slots 2 to 6 in ONS 15454 M6 chassis

Caution Fan-tray assembly 15454E-CC-FTA (ETSI shelf)/15454-CC-FTA (ANSI shelf) must be installed in a shelf where the ADM-10G card is installed.

The card is compliant with ITU-T G.825 and ITU-T G.783 for SDH signals. It supports concatenated and nonconcatenated AU-4 mapped STM-1, STM-4, and STM-16 signals as specified in ITU-T G.707. The card also complies with Section 5.6 of Telcordia GR-253-CORE and supports synchronous transport signal (STS) mapped OC-3, OC-12, and OC-48 signals as specified in the standard.

The client SFP and trunk XFP are compliant with interface requirements in Telcordia GR-253-CORE, ITU-T G.957 and/or ITU-T G.959.1, and IEEE 802.3.

10.13.1 Key Features

The ADM-10G card has the following high-level features:

- Operates with the TCC2, TCC2P, TCC3, TNC, or TSC.
- Interoperable with TXP_MR_10E, TXP_MR_10E_C, TXP_MR_10EX_C, and OTU2_XP cards.
- Has built-in OC-192/STM-64 add/drop multiplexing function including client, trunk, and STS cross-connect.
- Supports both single-card and double-card (ADM-10G peer group) configuration.
- Supports path protection/SNCP on client and trunk ports for both single-card and double-card configuration. The card does not support path protection/SNCP between a client port and a trunk port. Path protection/SNCP is supported only between two client ports or two trunk ports.
- Supports 1+1 protection on client ports for double-card configuration only.
- Supports SONET, SDH, and Gigabit Ethernet protocols on client SFPs.
- Supports XFP DWDM trunk interface single wavelengths.
- Returns zero bit errors when a TCC2/TCC2P/TCC3/TNC/TSC card switches from active to standby or when manual or forced protection switches occur.
- Has 16 SFP-based client interfaces (gray, colored, coarse wavelength division multiplexing (CWDM), and DWDM optics available).

- Supports STM1, STM4, STM16, and Gigabit Ethernet client signals (8 Gigabit Ethernet maximum).
- Has one XFP-based trunk interface supporting E-FEC/FEC and ITU-T G.709 for double-card configuration.
- Has two XFP-based trunk interface supporting E-FEC/FEC and ITU-T G.709 for single-card configuration.
- Has two SR XFP interlink interfaces supporting redundancy connection with protection board and pass-through traffic for double-card configuration.
- Supports frame-mapped generic framing procedure (GFP-F) and LEX mapping for Ethernet over SONET or SDH.
- Can be installed or pulled from operation, in any slot, without impacting other service cards in the shelf.
- Supports client to client hairpinning, that is, creation of circuits between two client ports for both single-card and double-card configuration. See the "10.13.11 Circuit Provisioning" section on page 10-104 for more detailed information.

10.13.2 ADM-10G POS Encapsulation, Framing, and CRC

The ADM-10G card supports Cisco EoS LEX (LEX) and generic framing procedure framing (GFP-F) encapsulation on 8 POS ports corresponding to 8 GigE ports (Port 1 to Port 8) in both single-card and double-card (ADM-10G peer group) configuration.

You can provision framing on the ADM-10G card as either the default GFP-F or LEX framing. With GFP-F framing, you can configure a 32-bit cyclic redundancy check (CRC) or none (no CRC) (the default). LEX framing supports 16-bit or 32-bit CRC configuration. The framing type cannot be changed when there is a circuit on the port.

On the CTC, navigate to card view and click the Provisioning > Line> Ethernet Tab. To see the various parameters that can be configured on the ethernet ports, see "CTC Display of ethernet Port Provisioning Status". Parameters such as, admin state, service state, framing type, CRC, MTU and soak time for a port can be configured.

It is possible to create an end-to-end circuit between equipment supporting different kinds of encapsulation (for example, LEX on one side and GFP-F on other side). But, under such circumstances, traffic does not pass through, and an alarm is raised if there is a mismatch.

10.13.2.1 POS Overview

Ethernet data packets need to be framed and encapsulated into a SONET/SDH frame for transport across the SONET/SDH network. This framing and encapsulation process is known as packet over SONET/SDH (POS).

The Ethernet frame comes into the ADM-10G card on a standard Gigabit Ethernet port and is processed through the card's framing mechanism and encapsulated into a POS frame. When the POS frame exits, the ADM-10G card is in a POS circuit, and this circuit is treated as any other SONET circuit (STS) or SDH circuit (VC) in the ONS node. It is cross-connected and rides the SONET/SDH signal out the port of an optical card and across the SONET/SDH network.

The destination of the POS circuit is a card or a device that supports the POS interface. Data packets in the destination card frames are removed and processed into ethernet frames. The Ethernet frames are then sent to a standard Ethernet port of the card and transmitted onto an Ethernet network.

10.13.2.2 POS Framing Modes

A POS framing mode is the type of framing mechanism employed by the ADM-10G card to frame and encapsulate data packets into a POS signal. These data packets were originally encapsulated in Ethernet frames that entered the standard Gigabit Ethernet interface of the ADM-10G card.

10.13.2.2.1 GFP-F Framing

The GFP-F framing represent standard mapped Ethernet over GFP-F according to ITU-T G.7041. GFP-F defines a standard-based mapping of different types of services onto SONET/SDH. GFP-F maps one variable length data packet onto one GFP packet. GFP-F comprises of common functions and payload specific functions. Common functions are those shared by all payloads. Payload-specific functions are different depending on the payload type. GFP-F is detailed in the ITU recommendation G.7041.

10.13.2.2.2 LEX Framing

LEX encapsulation is a HDLC frame based Cisco Proprietary protocol, where the field is set to values specified in Internet Engineering Task Force (IETF) RFC 1841. HDLC is one of the most popular Layer 2 protocols. The HDLC frame uses the zero insertion/deletion process (commonly known as bit stuffing) to ensure that the bit pattern of the delimiter flag does not occur in the fields between flags. The HDLC frame is synchronous and therefore relies on the physical layer to provide a method of clocking and synchronizing the transmission and reception of frames. The HDLC framing mechanism is detailed in the IETF's RFC 1662, "PPP in HDLC-like Framing."

10.13.2.3 GFP Interoperability

The ADM-10G card defaults to GFP-F encapsulation that is compliant with ITU-T G.7041. This mode allows the card to operate with ONS 15310-CL, ONS 15310-MA, ONS 15310-MA SDH, or ONS 15454 data cards (for example, ONS 15454 CE100T-8 or ML1000-2 cards). GFP encapsulation also allows the ADM-10G card to interoperate with other vendors Gigabit Ethernet interfaces that adhere to the ITU-T G.7041 standard.

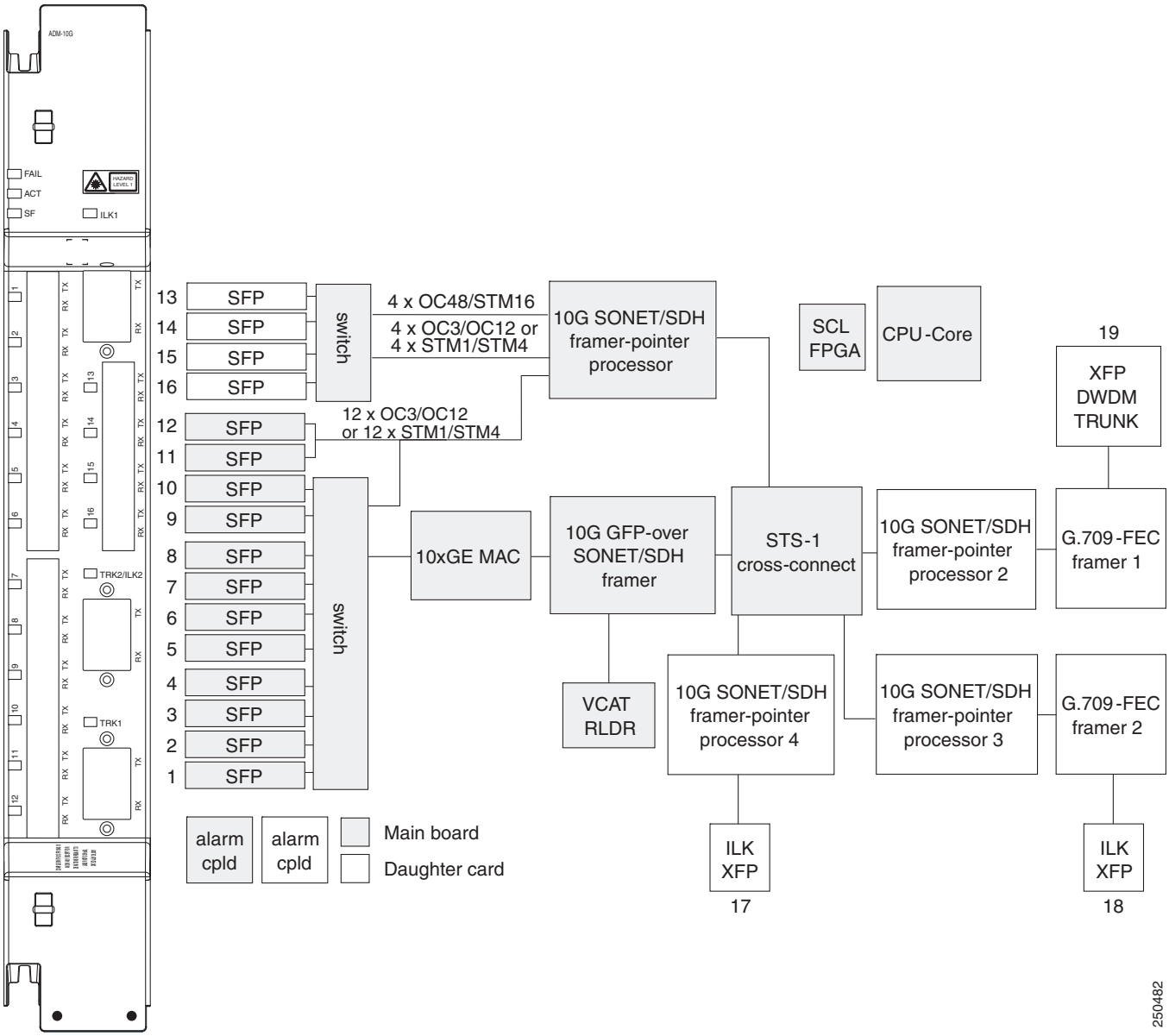
10.13.2.4 LEX Interoperability

The LEX encapsulation is compliant with RFC 1841. This mode allows the card to operate with ONS 15310-CL, ONS 15310-MA, ONS 15310-MA SDH, or ONS 15454 data cards (for example, G1000-4/G1K-4 cards, CE-1000-4, ONS 15454 CE100T-8 or ML1000-2 cards).

10.13.3 Faceplate

Figure 10-31 shows the ADM-10G card faceplate.

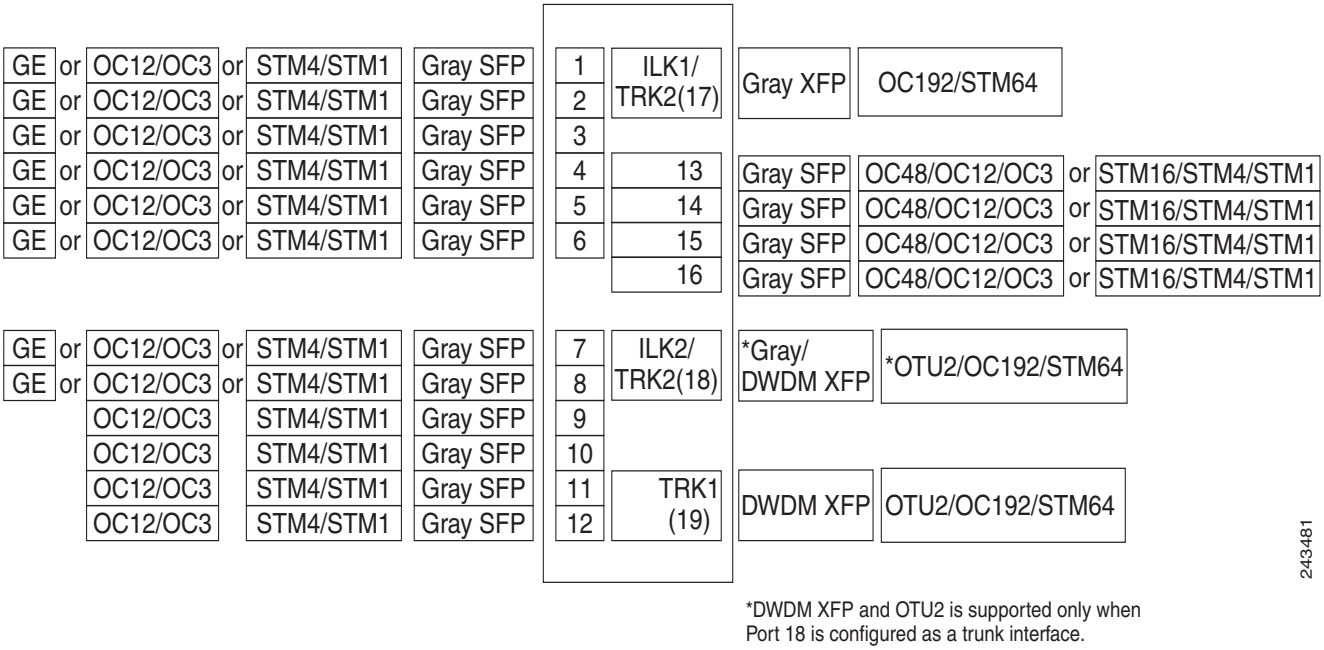
Figure 10-31 ADM-10G Card Faceplate and Block Diagram



10.13.4 Port Configuration Rules

ADM-10G card client and trunk port capacities are shown in Figure 10-32.

Figure 10-32 ADM-10G Card Port Capacities



Port 17 acts as trunk2 or ILK1 interface based on single-card or double-card configuration.

10.13.5 Client Interfaces

The ADM-10G card uses LC optical port connectors and, as shown in Figure 10-32, supports up to 16 SFPs that can be utilized for OC-N/STM-N traffic. Eight of the SFPs can be used for Gigabit Ethernet. The interfaces can support any mix of OC-3/STM-1, OC-12/STM-4, OC-48/STM-16, or Gigabit Ethernet of any reach, such as SX, LX, ZX, SR, IR, or LR. The interfaces support a capacity of:

- 4 x OC-48/STM-16
- 16 x OC-12/STM-4
- 16 x OC-3/STM-1
- 8 x GE

The supported client SFPs and XFPs are:

- Gray SFPs
  - 1000Base-SX SFP 850 nm (ONS-SE-G2F-SX=)
  - 1000Base-LX SFP 1310 nm (ONS-SE-G2F-LX=)
  - OC48/STM16 IR1, OC12/STM4 SR1, OC3/STM1 SR1, GE-LX multirate SFP 1310 nm (ONS-SE-Z1=)
  - OC3/STM1 IR1, OC12/STM4 IR1 multirate SFP 1310 nm (ONS-SI-622-I1=)
  - OC48/STM16 SR1 SFP 1310 nm (ONS-SI-2G-S1=)
  - OC48/STM16 IR1 SFP 1310 nm (ONS-SI-2G-I1=)
  - OC48/STM16, 1550 LR2, SM LC (ONS-SE-2G-L2=)

- Colored DWDM SFPs
  - 1000Base-ZX SFP 1550 nm (ONS-SI-GE-ZX=)
  - OC3/STM1 LR2 SFP 1550 nm (ONS-SI-155-L2=)
  - OC48/STM16 LR2 SFP 1550 nm (ONS-SI-2G-L2=)
  - OC48/STM16 SFP (ONS-SC-2G-xx.x)

Note xx.x = 28.7 to 60.6. ONS-SC-2G-28.7, ONS-SC-2G-33.4, ONS-SC-2G-41.3, ONS-SC-2G-49.3, and ONS-SC-2G-57.3 are supported from Release 8.5 and later.

- CWDM SFPs
  - OC48/STM16/GE CWDM SFP (ONS-SC-Z3-xxxx)
- XFPs
  - OC-192/STM-64/10GE XFP 1550 nm (ONS-XC-10G-I2)

10.13.6 Interlink Interfaces

Two 2R interlink interfaces, called ILK1 (Port 17) and ILK2 (Port 18), are provided for creation of ADM-10G peer groups in double-card configurations. In a single-card configuration, Port 17 (OC-192/STM-64) and Port 18 (OC-192/STM-64 or OTU2 payload) must be configured as trunk interfaces. In a double-card configuration (ADM-10G peer group), Ports 17 and 18 must be configured as ILK1 and ILK2 interfaces, respectively. Physically cabling these ports between two ADM-10G cards, located on the same shelf, allows you to configure them as an ADM-10G peer group.The ILK ports carry 10 Gb of traffic each.

The interlink interfaces support STM64 SR1 (ONS-XC-10G-S1=) and 10GE BASE SR (ONS-XC-10G-SR-MM=) XFPs.

10.13.7 DWDM Trunk Interface

The ADM-10G card supports OC-192/STM-64 signal transport and ITU-T G.709 digital wrapping according to the ITU-T G.709 standard.The ADM-10G card supports three trunk XFPs:

- Two DWDM trunks, and one trunk interface in a single-card configuration.
- One DWDM trunk XFP in a double-card configuration.

The supported DWDM trunk XFPs are:

- 10G DWDM (ONS-XC-10G-xx.x=) (colored XFP)
- STM64 SR1 (ONS-XC-10G-S1=) (gray XFP)

10.13.8 Configuration Management

When using OC-48/STM-16 traffic, some contiguous port configurations, listed in Table 10-42, are unavailable due to hardware limitations. This limitation does not impact the Gigabit Ethernet payload.

Note The ADM-10G card cannot be used in the same shelf with SONET or SDH cross-connect cards.

Table 10-42 OC-48/STM-16 Configuration Limitations

OC-48/STM-16 Port Number	Ports Restricted from Optical Traffic
OC-48/STM-16 on Port 13	No OC-N/STM-N on Port 1 through Port 3
OC-48/STM-16 on Port 14	No OC-N/STM-N on Port 4 through Port 6
OC-48/STM-16 on Port 15	No OC-N/STM-N on Port 7 through Port 9
OC-48/STM-16 on Port 16	No OC-N/STM-N on Port 10 through Port 12

Note The total traffic rate for each trunk cannot exceed OC-192/STM-64 on each ADM-10G card, or for each ADM-10G peer group.

Note Gigabit Ethernet is supported on Ports 1 through 8. Ports 9 through Port 12 support only OC-3/STM-1 or OC-12/STM-4.

Additionally, the following guidelines apply to the ADM-10G card:

- Trunk Port 17 supports OC-192/STM-64.
- Trunk Ports 18 and 19 support OC-192/STM-64 and OTU2.
- The interlink port supports OC-192/STM-64.
- Up to six ADM-10G cards can be installed in one shelf.
- Up to 24 ADM-10G cards can be installed per network element (NE) regardless of whether the card is installed in one shelf or in multiple shelves.
- The card can be used in all 15454-SA-ANSI and 15454-SA-HD shelves as well as ETSI ONS 15454 standard and high-density shelves.
- A lamp test function can be activated from CTC to ensure that all LEDs are functional.
- The card can operate as a working protected or working nonprotected card.
- In a redundant configuration, an active card hardware or software failure triggers a switch to the standby card. This switch is detected within 10 ms and is completed within 50 ms.
- ADM-10G cards support jumbo frames with MTU sizes of 64 to 9,216 bytes; the maximum is 9,216.
- After receiving a link or path failure, the ADM-10G card can shut down only the downstream Gigabit Ethernet port.

Note In ADM-10G cards, the Gigabit Ethernet port does not support flow control.

10.13.9 Security

The ADM-10G card that an SFP or XFP is plugged into implements the Cisco Standard Security Code Check Algorithm that keys on the vendor ID and serial number.

If a pluggable port module (PPM) is plugged into a port on the card but fails the security code check because it is not a Cisco PPM, a minor NON-CISCO-PPM alarm is raised.

If a PPM with a nonqualified product ID is plugged into a port on this card—that is, the PPM passes the security code as a Cisco PPM but it has not been qualified for use on the ADM-10G card— a minor UNQUAL-PPM alarm is raised.

10.13.10 Protection

The ADM-10G card supports 1+1 and SONET path protection and SDH SNCP protection architectures in compliance with Telcordia GR-253-CORE, Telcordia GR-1400-CORE, and ITU-T G.841 specifications.

10.13.10.1 Circuit Protection Schemes

The ADM-10G card supports path protection/SNCP circuits at the STS/VC4 (high order) level and can be configured to switch based on signal degrade calculations. The card supports path protection/SNCP on client and trunk ports for both single-card and double-card configuration.

Note The ADM-10G card supports path protection/SNCP between client ports and trunk port 17. The card does not support path protection/SNCP between client ports and trunk ports 18 or 19. The card does not support path protection/SNCP between port 17 and trunk ports 18 and 19.

The card allows open-ended path protection/SNCP configurations incorporating other vendor equipment. In an open-ended path protection/SNCP, you can specify one source point and two possible endpoints (or two possible source points and one endpoint) and the legs can include other vendor equipment. The source and endpoints are part of the network discovered by CTC.

For detailed information about path protection configurations and SNCPs, refer to the *Cisco ONS 15454 Reference Manual*.

10.13.10.2 Port Protection Schemes

The ADM-10G card supports unidirectional and bidirectional 1+1 APS protection schemes on client ports for double-card configuration (ADM-10G peer group) only. 1+1 APS protection scheme is not supported in single-card configuration. For 1+1 optical client port protection, you can configure the system to use any pair of like facility interfaces that are on different cards of the ADM-10G peer group. For information on optical port protection, refer to the *Cisco ONS 15454 Reference Manual*.

10.13.10.3 Flexible Protection Mechanism

The ADM-10G card can be provisioned as unidirectional path switched ring (UPSR[2]) or subnetwork connection protection (SNCP) on both Trunk and client side. UPSR or SNCP is supported both in single and double card operation. The ADM-10G card supports up to 288 unprotected high-order (HO) cross connect circuits and up to 192 protected (UPSR or SNCP) per card, resulting in 1728/1152 HO cross

connect circuits per shelf. The HO cross connect circuits provide grooming capabilities for STS level connections, such as STS-1, STS-3c, STS-9c, STS-12c, and STS-24c (CCAT or VCAT) with STS1 level granularity. When installed in a typical central-office bay assembly, a shelf can support up to 5178/3456 HO bidirectional cross connect circuits.

10.13.11 Circuit Provisioning

The ADM-10G card supports STS circuit provisioning both in single-card and double-card (ADM-10G peer group) configuration. The card allows you to create STS circuits between:

- Client and trunk ports
- Two trunk ports
- Two client ports (client-to-client hairpinning)

Note Circuits between two trunk ports are called pass-through circuits.

For an ADM-10G card in single-card configuration, if you are creating STS circuits between two client ports, the following limitation must be considered:

- Gigabit Ethernet to Gigabit Ethernet connections are not supported.

For an ADM-10G card that is part of an ADM-10G peer group, if you are creating STS circuits between two client ports or between client and trunk ports, the following limitations must be considered:

- Gigabit Ethernet to Gigabit Ethernet connections are not supported.
- Optical channel (OC) to OC, OC to Gigabit Ethernet, and Gigabit Ethernet to OC connections between two peer group cards are supported. Peer group connections use interlink port bandwidth, hence, depending on the availability/fragmentation of the interlink port bandwidth, it may not be possible to create an STS circuit from the Gigabit Ethernet/OC client port to the peer card trunk port. This is because, contiguous STSs (that is, STS-3c, STS-12c, STS-24c, and so on) must be available on the interlink port for circuit creation.

Note There are no limitations to create an STS circuit between two trunk ports.

10.13.12 ADM-10G CCAT and VCAT Characteristics

The ADM-10G card supports high-order (HO) contiguous concatenation (CCAT) and HO virtual concatenation (VCAT) circuits on 8 GigE ports (Port 1 to Port 8) in both single-card and double-card (ADM-10G peer group) configuration.

To enable end-to-end connectivity in a VCAT circuit that traverses through a third-party network, you can use Open-Ended VCAT circuit creation. For more details, refer to the “Create Circuits and Provisionable Patchcords” chapter in the *Cisco ONS 15454 Procedure Guide*.

The ADM-10G card supports flexible non-LCAS VCAT groups (VCGs). With flexible VCGs, the ADM-10G can perform the following operations:

2. The terms “Unidirectional Path Switched Ring” and “UPSR” may appear in Cisco literature. These terms do not refer to using Cisco ONS 15xxx products in a unidirectional path switched ring configuration. Rather, these terms, as well as “Path Protected Mesh Network” and “PPMN,” refer generally to Cisco’s path protection feature, which may be used in any topological network configuration. Cisco does not recommend using its path protection feature in any particular topological network configuration.

- Add or remove members from groups
- Put members into or out of service, which also adds/removes them from the group
- Add or remove cross-connect circuits from VCGs

Any operation on the VCG member is service effecting (for instance, adding or removing members from the VCG). Adding or removing cross-connect circuits is not service-affecting, if the associated members are not in the group

The ADM-10G card allows independent routing and protection preferences for each member of a VCAT circuit. You can also control the amount of VCAT circuit capacity that is fully protected, unprotected, or uses Protection Channel Access (PCA) (when PCA is available). Alarms are supported on a per-member as well as per virtual concatenation group (VCG) basis.

The ADM-10G card supports both automatic and manual routing for VCAT circuit, that is, all members are manually or automatically routed. Bidirectional VCAT circuits are symmetric, which means that the same number of members travel in each direction. With automatic routing, you can specify the constraints for individual members; with manual routing, you can select different spans for different members. Two types of automatic and manual routing are available for VCAT members: common fiber routing and split routing.

The ADM-10G card supports VCAT common fiber routing and VCAT split fiber (diverse) routing. With VCAT split fiber routing, each member can be routed independently through the SONET or SDH or DWDM network instead of having to follow the same path as required by CCAT and VCAT common fiber routing. This allows a more efficient use of network bandwidth, but the different path lengths and different delays encountered may cause slightly different arrival times for the individual members of the VCG. The VCAT differential delay is this relative arrival time measurement between members of a VCG. The maximum tolerable VCAT split fiber routing differential delay for the ADM-10G card is approximately 55 milliseconds. A loss of alignment alarm is generated if the maximum differential delay supported is exceeded.

The differential delay compensation function is automatically enabled when you choose split fiber routing during the CTC circuit configuration process. CCAT and VCAT common fiber routing do not enable or need differential delay support.

Caution Protection switches with switching time of less than 60 milliseconds are not guaranteed with the differential delay compensation function enabled. The compensation time is added to the switching time.

Note For TL1, EXPBUFFERS parameter must be set to ON in the ENT-VCG command to enable support for split fiber routing.

Available Circuit Sizes

Table 10-43 and Table 10-44 show the circuit sizes available for the ADM-10G card.

Table 10-43 Supported SONET Circuit Sizes of ADM-10G card on ONS 15454

CCAT	VCAT High Order
STS-1	STS-1-1*n*V (*n*= 1 to 21)
STS-3c	STS-3c-*m*v (*m*= 1 to 7)
STS-6c	

Table 10-43 Supported SONET Circuit Sizes of ADM-10G card on ONS 15454

CCAT	VCAT High Order
STS-9c	
STS-12c	
STS-24c	

Table 10-44 Supported SDH Circuit Sizes of ADM-10G card on ONS 15454 SDH

CCAT	VCAT High Order
VC-4	VC-4-*m*v (*m*= 1 to 7)
VC-4-2c	
VC-4-3c	
VC-4-4c	
VC-4-8c	

10.13.13 Automatic Laser Shutdown

The ALS procedure is supported on both client and trunk interfaces. On the client interface, ALS is compliant with ITU-T G.664 (6/99). On the data application and trunk interface, the switch on and off pulse duration is greater than 60 seconds. The on and off pulse duration is user-configurable. For details on ALS provisioning for the card, refer to the *Cisco ONS 15454 DWDM Procedure Guide*.

Intermediate Path Performance Monitoring

Intermediate path performance monitoring (IPPM) allows a node to monitor the constituent channel of an incoming transmission signal. You can enable IPPM for STS/VC-4s payload on OCn and Trunk ports of ADM-10G card. The IPPM is complaint with GR253/G.826.

Software Release 9.2 and higher enables the ADM-10G card to monitor the near-end and far-end PM data on individual STS/VC-4 payloads by enabling IPPM. After provisioning IPPM on the card, service providers can monitor large amounts of STS/VC-4 traffic through intermediate nodes, thus making troubleshooting and maintenance activities more efficient. IPPM occurs only on STS/VC-4 paths that have IPPM enabled, and TCAs are raised only for PM parameters on the selected IPPM paths.

For a CCAT circuit, you can enable IPPM only on the first STS/VC-4 of the concatenation group. For a VCAT circuit, you can enable IPPM independently on each member STS/VC-4 of the concatenation group.

Pointer Justification Count Performance Monitoring

Pointers are used to compensate for frequency and phase variations. Pointer justification counts indicate timing errors on SONET networks. When a network is out of synchronization, jitter and wander occur on the transported signal. Excessive wander can cause terminating equipment to slip.

Slips cause different effects in service. Voice service has intermittent audible clicks. Compressed voice technology has short transmission errors or dropped calls. Fax machines lose scanned lines or experience dropped calls. Digital video transmission has distorted pictures or frozen frames. Encryption service loses the encryption key, causing data to be transmitted again.

Pointers provide a way to align the phase variations in STS and VC4 payloads. The STS payload pointer is located in the H1 and H2 bytes of the line overhead. Clocking differences are measured by the offset in bytes from the pointer to the first byte of the STS synchronous payload envelope (SPE) called the J1 byte. Clocking differences that exceed the normal range of 0 to 782 can cause data loss.

There are positive (PPJC) and negative (NPJC) pointer justification count parameters. PPJC is a count of path-detected (PPJC-PDET-P) or path-generated (PPJC-PGEN-P) positive pointer justifications. NPJC is a count of path-detected (NPJC-PDET-P) or path-generated (NPJC-PGEN-P) negative pointer justifications depending on the specific PM name. PJCDIFF is the absolute value of the difference between the total number of detected pointer justification counts and the total number of generated pointer justification counts. PJCS-PDET-P is a count of the one-second intervals containing one or more PPJC-PDET or NPJC-PDET. PJCS-PGEN-P is a count of the one-second intervals containing one or more PPJC-PGEN or NPJC-PGEN.

A consistent pointer justification count indicates clock synchronization problems between nodes. A difference between the counts means that the node transmitting the original pointer justification has timing variations with the node detecting and transmitting this count. Positive pointer adjustments occur when the frame rate of the SPE is too slow in relation to the rate of the STS-1.

You must enable PPJC and NPJC performance monitoring parameters for ADM-10Gcard. In CTC, the count fields for PPJC and NPJC PMs appear white and blank unless they are enabled on the card view Provisioning tab.

Performance Monitoring Parameter Definitions

This section describes the STS and VC-4 path performance monitoring parameters that ADM-10G card support.

Table 10-45 lists the STS near-end path performance monitoring parameters.

Table 10-45 STS Near-end Path Performance Monitoring Parameters

Parameter	Definition
CV-P	Near-End STS Path Coding Violations (CV-P) is a count of BIP errors detected at the STS path layer (that is, using the B3 byte). Up to eight BIP errors can be detected per frame; each error increments the current CV-P second register.
ES-P	Near-End STS Path Errored Seconds (ES-P) is a count of the seconds when at least one STS path BIP error was detected. An AIS Path (AIS-P) defect (or a lower-layer, traffic-related, near-end defect) or a Loss of Pointer Path (LOP-P) defect can also cause an ES-P.
SES-P	Near-End STS Path Severely Errored Seconds (SES-P) is a count of the seconds when K (2400) or more STS path BIP errors were detected. An AIS-P defect (or a lower-layer, traffic-related, near-end defect) or an LOP-P defect can also cause an SES-P.

Table 10-45 STS Near-end Path Performance Monitoring Parameters

Parameter	Definition
UAS-P	Near-End STS Path Unavailable Seconds (UAS-P) is a count of the seconds when the STS path was unavailable. An STS path becomes unavailable when ten consecutive seconds occur that qualify as SES-Ps, and continues to be unavailable until ten consecutive seconds occur that do not qualify as SES-Ps.
FC-P	Near-End STS Path Failure Counts (FC-P) is a count of the number of near-end STS path failure events. A failure event begins when an AIS-P failure, an LOP-P failure, a UNEQ-P failure, or a Section Trace Identifier Mismatch Path (TIM-P) failure is declared. A failure event also begins if the STS PTE that is monitoring the path supports Three-Bit (Enhanced) Remote Failure Indication Path Connectivity (ERFI-P-CONN) for that path. The failure event ends when these failures are cleared.
PPJC-PDET-P	Positive Pointer Justification Count, STS Path Detected (PPJC-PDET-P) is a count of the positive pointer justifications detected on a particular path in an incoming SONET signal.
PPJC-PGEN-P	Positive Pointer Justification Count, STS Path Generated (PPJC-PGEN-P) is a count of the positive pointer justifications generated for a particular path to reconcile the frequency of the SPE with the local clock.
NPJC-PDET-P	Negative Pointer Justification Count, STS Path Detected (NPJC-PDET-P) is a count of the negative pointer justifications detected on a particular path in an incoming SONET signal.
NPJC-PGEN-P	Negative Pointer Justification Count, STS Path Generated (NPJC-PGEN-P) is a count of the negative pointer justifications generated for a particular path to reconcile the frequency of the SPE with the local clock.
PJCDIFF-P	Pointer Justification Count Difference, STS Path (PJCDIFF-P) is the absolute value of the difference between the total number of detected pointer justification counts and the total number of generated pointer justification counts. That is, PJCDiff-P is equal to (PPJC-PGEN-P - NPJC-PGEN-P) - (PPJC-PDET-P - NPJC-PDET-P).
PJCS-PDET-P	Pointer Justification Count Seconds, STS Path Detect (NPJCS-PDET-P) is a count of the one-second intervals containing one or more PPJC-PDET or NPJC-PDET.
PJCS-PGEN-P	Pointer Justification Count Seconds, STS Path Generate (PJCS-PGEN-P) is a count of the one-second intervals containing one or more PPJC-PGEN or NPJC-PGEN.

Table 10-46 gives the VC-4 near-end path performance monitoring parameters definition that ADM-10G card support.

Table 10-46 VC-4 Near-end Path Performance Monitoring Parameters

Parameter	Definition
HP-EB	High-Order Path Errored Block (HP-EB) indicates that one or more bits are in error within a block.
HP-BBE	High-Order Path Background Block Error (HP-BBE) is an errored block not occurring as part of an SES.
HP-ES	High-Order Path Errored Second (HP-ES) is a one-second period with one or more errored blocks or at least one defect.
HP-SES	High-Order Path Severely Errored Seconds (HP-SES) is a one-second period containing 30 percent or more errored blocks or at least one defect. SES is a subset of ES.
HP-UAS	High-Order Path Unavailable Seconds (HP-UAS) is a count of the seconds when the VC path was unavailable. A high-order path becomes unavailable when ten consecutive seconds occur that qualify as HP-SESs, and it continues to be unavailable until ten consecutive seconds occur that do not qualify as HP-SESs.
HP-BBER	High-Order Path Background Block Error Ratio (HP-BBER) is the ratio of BBE to total blocks in available time during a fixed measurement interval. The count of total blocks excludes all blocks during SESs.
HP-ESR	High-Order Path Errored Second Ratio (HP-ESR) is the ratio of errored seconds to total seconds in available time during a fixed measurement interval.
HP-SESR	High-Order Path Severely Errored Second Ratio (HP-SESR) is the ratio of SES to total seconds in available time during a fixed measurement interval.
HP-PPJC-PDET	High-Order, Positive Pointer Justification Count, Path Detected (HP-PPJC-Pdet) is a count of the positive pointer justifications detected on a particular path on an incoming SDH signal.
HP-NPJC-PDET	High-Order, Negative Pointer Justification Count, Path Detected (HP-NPJC-Pdet) is a count of the negative pointer justifications detected on a particular path on an incoming SDH signal.
HP-PPJC-PGEN	High-Order, Positive Pointer Justification Count, Path Generated (HP-PPJC-Pgen) is a count of the positive pointer justifications generated for a particular path.
HP-NPJC-PGEN	High-Order, Negative Pointer Justification Count, Path Generated (HP-NPJC-Pgen) is a count of the negative pointer justifications generated for a particular path.
HP-PJCDIFF	High-Order Path Pointer Justification Count Difference (HP-PJCDiff) is the absolute value of the difference between the total number of detected pointer justification counts and the total number of generated pointer justification counts. That is, HP-PJCDiff is equal to (HP-PPJC-PGen - HP-NPJC-PGen) - (HP-PPJC-PDet - HP-NPJC-PDet).

Table 10-46 VC-4 Near-end Path Performance Monitoring Parameters

Parameter	Definition
HP-PJCS-PDET	High-Order Path Pointer Justification Count Seconds (HP-PJCS-PDet) is a count of the one-second intervals containing one or more HP-PPJC-PDet or HP-NPJC-PDet.
HP-PJCS-PGEN	High-Order Path Pointer Justification Count Seconds (HP-PJCS-PGen) is a count of the one-second intervals containing one or more HP-PPJC-PGen or HP-NPJC-PGen.

10.13.14 ADM-10G Card-Level Indicators

Table 10-47 describes the card-level LEDs on the ADM-10G card.

Table 10-47 ADM-10G Card-Level Indicators

Card-Level LED	Description
ACT LED Green (Active) Amber (Standby)	Green indicates that the card is operational (one or both ports active) and ready to carry traffic. Amber indicates that the card is operational and in standby (protect) mode.
Red FAIL LED	The red FAIL LED indicates that the card's processor is not ready. This LED is on during reset. The FAIL LED flashes during the boot process. It the card is inserted in a slot that is preprovisioned for a different card, this LED flashes until a Missing Equipment Attribute (MEA) condition is raised. You might also need to replace the card if the red FAIL LED persists.
Amber SF LED	The amber SF LED indicates a signal failure or condition such as LOS, LOF, or high BER errors on one or more of the card's ports. The amber SF LED is also on if the transmit and receive fibers are incorrectly connected. If the fibers are properly connected and the link is working, the light turns off.

10.13.15 ADM-10G Card Port-Level Indicators

Table 10-48 describes the port-level LEDs on the ADM-10G card.

Note Client or trunk ports can each be in active or standby mode as defined in the related section for each specific protection type. For example, fiber-switched protection has active or standby trunk ports; 1+1 APS protection has active or standby client ports, and client 1+1 protection does not utilize active or standby ports.

Table 10-48 ADM-10G Card Port-Level LED Indications

Port-Level Status	Tri-color LED Description
The port-level LED is active and unprotected.	• If a port is in OOS/locked state for any reason, the LED is turned off. • If a port is in IS/unlocked state and the PPM is preprovisioned or is physically equipped with no alarms, the LED is green. • If a port is in IS state and the PPM is physically equipped but does have alarms, the LED is red.
The port-level LED is in standby.	• If a port is in OOS/locked state for any reason, the LED is turned off. • If a port is in the IS/unlocked state and the PPM is preprovisioned or is physically equipped with no alarms, the LED is amber. • If a port is in IS state and physically equipped but does have alarms, the LED is red.

10.14 OTU2_XP Card

The OTU2_XP card is a single-slot card with four ports with XFP-based multirate (OC-192/STM-64, 10GE, 10G FC, IB_5G) Xponder for the ONS 15454 ANSI and ETSI platforms. The OTU2_XP card supports multiple configurations.

Table 10-49 describes the different configurations supported by the OTU2_XP card and the ports that must be used for these configurations.

Table 10-49 OTU2_XP Card Configurations and Ports

Configuration	Port 1	Port 2	Port 3	Port 4
2 x 10G transponder	Client port 1	Client port 2	Trunk port 1	Trunk port 2
2 x 10G standard regenerator (with enhanced FEC (E-FEC) only on one port)	Trunk port 1	Trunk port 2	Trunk port 1	Trunk port 2
10 GE LAN Phy to WAN Phy	Client port	Client port in transponder or trunk port in regenerator configuration	Trunk port	Trunk port in transponder or regenerator configuration
1 x 10G E-FEC regenerator (with E-FEC on two ports)	Not used	Not used	Trunk port	Trunk port
1 x 10G splitter protected transponder	Client port	Not used	Trunk port (working)	Trunk port (protect)

All the four ports are ITU-T G.709 compliant and support 40 channels (wavelengths) at 100-GHz channel spacing in the C-band (that is, the 1530.33 nm to 1561.42 nm wavelength range).

The OTU2_XP card can be installed in Slots 1 through 6 or 12 through 17. The OTU2_XP card supports SONET SR1, IR2, and LR2 XFPs, 10GE BASE SR, SW, LR, LW, ER, EW, and ZR XFPs, and 10G FC MX-SN-I and SM-LL-L XFPs.

Caution Fan-tray assembly 15454E-CC-FTA (ETSI shelf)/15454-CC-FTA (ANSI shelf) must be installed in a shelf where the OTU2_XP card is installed.

10.14.1 Key Features

The OTU2_XP card has the following high-level features:

- 10G transponder, regenerator, and splitter protection capability on the ONS 15454 DWDM platform.
- Compatible with the ONS 15454 ANSI high-density shelf assembly, the ETSI ONS 15454 shelf assembly, and the ETSI ONS 15454 high-density shelf assembly. Compatible with TCC2/TCC2P/ TCC3/TNC/TSC cards.
- Interoperable with TXP_MR_10E and TXP_MR_10E_C cards.
- Four port, multirate (OC-192/STM-64, 10G Ethernet WAN Phy, 10G Ethernet LAN Phy, 10G Fibre Channel, IB_5G) client interface. The client signals are mapped into an ITU-T G.709 OTU2 signal using standard ITU-T G.709 multiplexing.
- ITU-T G.709 framing with standard Reed-Soloman (RS) (255,237) FEC. Performance monitoring and ITU-T G.709 Optical Data Unit (ODU) synchronous mapping. Enhanced FEC (E-FEC) with ITU-T G.709 ODU with greater than 8 dB coding gain.
- The trunk rate remains the same irrespective of the FEC configuration. The error coding performance can be provisioned as follows::
  - FEC—Standard ITU-T G.709.
  - E-FEC—Standard ITU-T G.975.1 I.7.
- IEEE 802.3 frame format supported for 10 Gigabit Ethernet interfaces. The minimum frame size is 64 bytes. The maximum frame size is user-provisionable.
- Supports fixed/no fixed stuff mapping (insertion of stuffing bytes) for 10G Ethernet LAN Phy signals (only in transponder configuration).
- Supports 10G Ethernet LAN Phy to 10G Ethernet WAN Phy conversion on Ports 1 (client port) and 3 (trunk port).
- Supports 10G Ethernet LAN Phy to WAN Phy conversion using CTC and TL1. When enabled on the OTU2_XP card, the first Channel (Ports 1 and 3) supports LAN to WAN conversion. The second channel carries normal 10GE, 10G FC, and OC192/STM64 traffic.
- The LAN Phy to WAN Phy conversion functions in accordance to WAN Interface Sublayer (WIS) mechanism as defined by IEEE802.3ae (IEEE Std 802.3ae-2002, Amendment to CSMA/CD).
- Default configuration is transponder, with trunk ports configured as ITU-T G.709 standard FEC.
- In transponder or regenerator configuration, if one of the ports is configured the corresponding port is automatically created.
- In regenerator configuration, only Ports 3 and 4 can be configured as E-FEC. Ports 1 and 2 can be configured only with standard FEC.
- When port pair 1-3 or 2-4 is configured as regenerator (that is, card mode is standard regenerator), the default configuration on Ports 3 and 4 is automatically set to standard FEC.
- When Ports 3 and 4 are configured as regenerator (that is, card mode is E-FEC regenerator), the default configuration on both these ports is automatically set to E-FEC.

- In splitter protected transponder configuration, the trunk ports (Ports 3 and 4) are configured as ITU-T G.709 standard FECor E-FEC.
- Supports protection through Y-cable protection scheme.

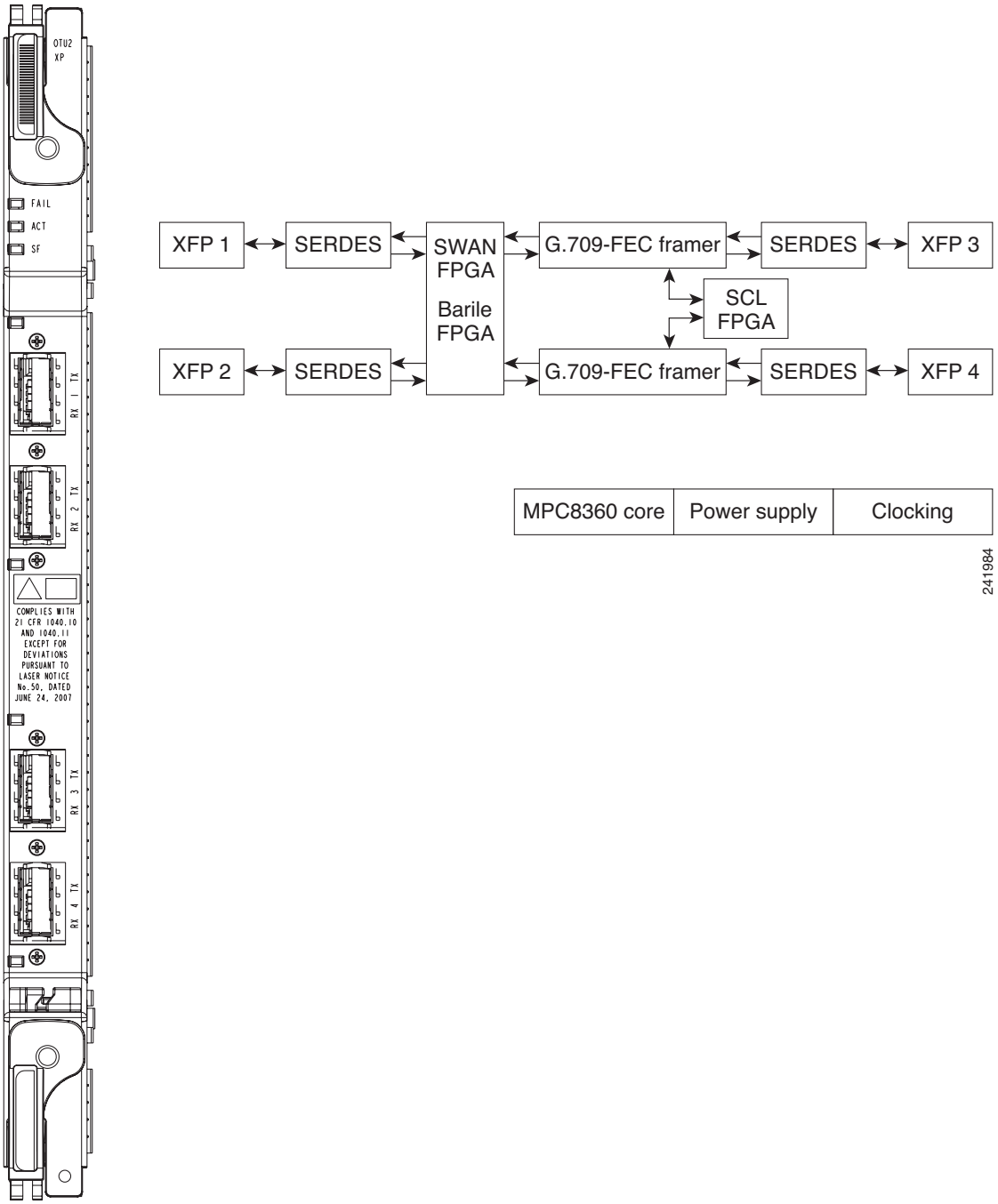
Note When enabled, the 10G Ethernet LAN Phy to WAN Phy conversion feature does not support Y-cable protection on the LAN to WAN interface (ports 1 and 3).

- Client ports support SONET SR1, IR2, and LR2 XFPs, 10GE BASE SR, SW, LR, LW, ER, EW, and ZR XFPs, and 10G FC MX-SN-I and SM-LL-L XFPs.
- Following are the OTU2 link rates that are supported on the OTU2_XP trunk port:
  - Standard G.709 (10.70923 Gbps) when the client is provisioned as “SONET” (including 10G Ethernet WAN PHY) (9.95328 Gbps).
  - G.709 overclocked to transport 10GE as defined by ITU-T G. Sup43 Clause 7.2 (11.0491 Gbps) when the client is provisioned as “10G Ethernet LAN Phy” (10.3125 Gbps) with “No Fixed Stuff” enabled.
  - G.709 overclocked to transport 10GE as defined by ITU-T G. Sup43 Clause 7.1 (11.0957 Gbps) when the client is provisioned as “10G Ethernet LAN Phy” (10.3125 Gbps) with “No Fixed Stuff” disabled.
  - G.709 proprietary overclocking mode to transport 10G FC (11.3168 Gbps) when the client is provisioned as “10G Fiber Channel” (10.518 Gbps).
  - Proprietary rate at the trunk when the client is provisioned as IB_5G.
- The MTU setting is used to display the ifInerrors and OverSizePkts counters on the receiving trunk and client port interfaces. Traffic of frame sizes up to 65535 bytes pass without any packet drops, from the client port to the trunk port and vice versa irrespective of the MTU setting.

10.14.2 Faceplate and Block Diagram

Figure 10-33 shows the OTU2_XP card faceplate and block diagram.

Figure 10-33 OTU2_XP Card Faceplate and Block Diagram



Note The Swan FPGA is automatically loaded when the LAN Phy to WAN Phy conversion feature is enabled on the OTU2_XP card. The Barile FPGA is automatically loaded when the LAN Phy to WAN Phy conversion feature is disabled on the OTU2_XP card.

10.14.3 OTU2_XP Card-Level Indicators

Table 10-50 describes the card-level LEDs on the OTU2_XP card.

Table 10-50 OTU2_XP Card-Level Indicators

Card-Level LED	Description
Red FAIL LED	The red FAIL LED indicates that the card processor is not ready. This LED is on during reset. The FAIL LED flashes during the boot process. If the card is inserted in a slot that is preprovisioned for a different card, this LED flashes until a Missing Equipment Attribute (MEA) condition is raised. You might also need to replace the card if the red FAIL LED persists.
ACT LED Green (Active)	If the ACT LED is green, the card is operational (one or more ports active) and ready to carry traffic.
Amber SF LED	The amber SF LED indicates a signal failure or condition such as LOS, LOF, or high BER errors on one or more of the card ports. The amber SF LED is also on if the transmit and receive fibers are incorrectly connected. If the fibers are properly connected and the link is working, the light turns off.

10.14.4 OTU2_XP Port-Level Indicators

Table 10-51 describes the PPM port-level LEDs on the OTU2_XP card for both client and trunk ports.

Note Client or trunk ports can each be in active or standby mode as defined in the related section for each specific protection type. For example, fiber-switched protection has active or standby trunk ports; 1+1 APS protection has active or standby client ports, and client 1+1 protection does not utilize active or standby ports.

Table 10-51 OTU2_XP PPM Port-Level Indicators

Port-Level Status	Tri-color LED Description
The port-level LED is active and unprotected.	• If a port is in OOS/locked state for any reason, the LED is turned off. • If a port is in IS/unlocked state and the PPM is preprovisioned or is physically equipped with no alarms, the LED is green. • If a port is in IS state and the PPM is physically equipped but does have alarms, the LED is red.
The port-level LED is in standby.	• If a port is in OOS/locked state for any reason, the LED is turned off. • If a port is in the IS/unlocked state and the PPM is preprovisioned or is physically equipped with no alarms, the LED is amber. • If a port is in IS state and physically equipped but does have alarms, the LED is red.

10.14.5 OTU2_XP Card Interface

The OTU2_XP card is a multi-functional card that operates in different configurations, such as transponder, standard regenerator, E-FEC regenerator, and 10G Ethernet LAN Phy to WAN Phy conversion mode. The OTU2_XP card acts as a protected transponder, when the 10G Ethernet LAN Phy to WAN Phy is in splitter protected transponder configuration mode.

Depending on the configuration of the OTU2_XP card, the ports act as client or trunk ports (see Table 10-49). This following section describes the client and trunk rates supported on the OTU2_XP card for different card configurations:

10.14.5.1 Client Interface

In transponder and 10G Ethernet LAN Phy to WAN Phy card configurations, Ports 1 and 2 act as client ports and in splitter protected transponder configuration, Port 1 acts as a client port. For these card configurations, the client rates supported are:

- OC-192/STM-64
- 10G Ethernet WAN Phy
- 10G Ethernet LAN Phy
- 10G Fibre Channel
- IB_5G

10.14.5.2 Trunk Interface

In transponder, 10G Ethernet LAN Phy to WAN Phy, and splitter protected transponder card configurations, Ports 3 and 4 act as trunk ports. For these card configurations, the trunk rates supported are:

- OC-192/STM-64
- 10G Ethernet WAN Phy
- 10G Ethernet LAN Phy
- 10G Fibre Channel
- OTU2 G.709
- Proprietary rate at the trunk when the client is provisioned as IB_5G.

In standard regenerator card configuration, all four ports act as trunk ports and in E-FEC regenerator configuration, Ports 3 and 4 act as the trunk ports. For these card configurations, the trunk rate supported is OTU2 G.709

Note The above mentioned OTU2 signal must be an OC-192/STM-64, 10G Ethernet WAN Phy, 10G Ethernet LAN Phy, or 10G Fibre Channel signal packaged into an OTU2 G.709 frame. Additionally, the standard regenerator and E-FEC regenerator configuration supports an OTU2 signal that is OTU2 has been generated by multiplexing four ODU1 signals.

10.14.6 Configuration Management

The OTU2_XP card supports the following configuration management parameters:

- Card Configuration—Provisionable card configuration: Transponder, Standard Regen, Enhanced FEC, or Mixed, or 10G Ethernet LAN Phy to WAN Phy.
- Port Mode—Provisionable port mode when the card configuration is set as Mixed. The port mode can be chosen as either Transponder or Standard Regen for each port pair (1-3 and 2-4). For card configurations other than Mixed, CTC automatically sets the port mode depending on the selected card configuration. For 10G Ethernet LAN Phy to WAN Phy mode, CTC automatically selects the port pair (1-3) as 10G Ethernet LAN Phy to WAN Phy. Port pair (2-4) in 10G Ethernet LAN Phy to WAN Phy mode is selected as Transponder or Standard Regen.
- Termination Mode—Provisionable termination mode when the card configuration is set as either Transponder or Mixed. The termination mode can be chosen as Transparent, Section, or Line. For Standard Regen and Enhanced FEC card configurations, CTC automatically sets the termination mode as Transparent. For 10G Ethernet LAN Phy to WAN Phy mode, CTC automatically selects the Termination Mode of port pair (1-3) as Line. You cannot provision the Termination Mode parameter.
- AIS/Squelch—Provisionable AIS/Squelch mode configuration when the card configuration is set as either Transponder or Mixed. The termination mode configuration can be chosen as AIS or Squelch. For Standard Regen and Enhanced FEC card configurations, CTC automatically sets the termination mode configuration as AIS. For 10G Ethernet LAN Phy to WAN Phy mode, the CTC automatically selects the AIS/Squelch of port pair (1-3) as Squelch. You cannot provision the AIS/Squelch parameter.

Note When you choose the 10G Ethernet LAN Phy to WAN Phy conversion, the Termination mode is automatically set to LINE. The AIS/Squelch is set to SQUELCH and ODU Transparency is set to Cisco Extended Use for Ports 1 and 3.

- Regen Line Name—User-assigned text string for regeneration line name.
- ODU Transparency—Provisionable ODU overhead byte configuration, either Transparent Standard Use or Cisco Extended Use. See the "10.14.10 ODU Transparency" section on page 10-120 for more detailed information. For 10G Ethernet LAN Phy to WAN Phy mode, CTC automatically selects the ODU Transparency as Cisco Extended Use. You cannot provision the ODU Transparency parameter.
- Port name—User-assigned text string.
- Admin State/Service State—Administrative and service states to manage and view port status.
- ALS Mode—Provisionable ALS function.
- Reach—Provisionable optical reach distance of the port.
- Wavelength—Provisionable wavelength of the port.
- AINS Soak—Provisionable automatic in-service soak period.

10.14.7 OTU2_XP Card Configuration Rules

The following rules apply to OTU2_XP card configurations:

- When you preprovision the card, port pairs 1-3 and 2-4 come up in the default Transponder configuration.

- The port pairs 1-3 and 2-4 can be configured in different modes only when the card configuration is Mixed. If the card configuration is Mixed, you must choose different modes on port pairs 1-3 and 2-4 (that is, one port pair in Transponder mode and the other port pair in Standard Regen mode).
- If the card is in Transponder configuration, you can change the configuration to Standard Regen or Enhanced FEC.
- If the card is in Standard Regen configuration and you have configured only one port pair, then configuring payload rates for the other port pair automatically changes the card configuration to Mixed, with the new port pair in Transponder mode.
- If the card is in Standard Regen configuration, you cannot directly change the configuration to Enhanced FEC. You have to change to Transponder configuration and then configure the card as Enhanced FEC.
- If the card is in Enhanced FEC configuration, Ports 1 and 2 are disabled. Hence, you cannot directly change the configuration to Standard Regen or Mixed. You must remove the Enhanced FEC group by moving the card to Transponder configuration, provision PPM on Ports 1 and 2, and then change the card configuration to Standard Regen or Mixed.
- If the card is in Standard Regen or Enhanced FEC configuration, you cannot change the payload rate of the port pairs. You have to change the configuration to Transponder, change the payload rate, and then move the card configuration back to Standard Regen or Enhanced FEC.
- If any of the affected ports are in IS (ANSI) or Unlocked-enabled (ETSI) state, you cannot change the card configuration.
- If IB_5G payload has to be provisioned, the NE Default should match the values listed in the Table 10-52. For more information on editing the NE Default values, see the "NTP-G135 Edit Network Element Defaults" task.

Table 10-52 OTU2_XP Card Configuration for IB_5G Payload Provisioning

Parameter	NE Default Name	Value
FEC	OTU2-XP.otn.otnLines.FEC	Standard
ITU-T G.709 OTN	OTU2-XP.otn.otnLines.G709OTN	Enable
Termination Mode	OTU2-XP.config.port.TerminationMode	Transparent
ODU Transparency	OTU2-XP.config.port.OduTransparency	Cisco Extended Use
AIS/Squelch	OTU2-XP.config.port.AisSquelchMode	Squelch

- If the card is changed to 10G Ethernet LAN Phy to WAN Phy, the first PPM port is deleted and replaced by a 10G Ethernet port; the third PPM port is deleted and automatically replaced with OC192/STM64 (SONET/SDH) port. The third PPM port is automatically deleted and the third PPM port is replaced with OC192/STM64 (SONET/SDH).

Table 10-53 provides a summary of transitions allowed for the OTU2_XP card configurations.

Table 10-53 Card Configuration Transition Summary

	Transition To				
Card Configuration	**Transponder**	**Standard Regen**	**Enhanced FEC**	**Mixed**	**10G Ethernet LAN Phy to WAN Phy**
Transponder	—	Yes	Yes	Yes	Yes
Standard Regen	Yes	—	No	Yes	Yes

Table 10-53 Card Configuration Transition Summary (continued)

Card Configuration	Transition To				
	Transponder	Standard Regen	Enhanced FEC	Mixed	10G Ethernet LAN Phy to WAN Phy
Enhanced FEC	Yes	No	—	No	No
Mixed	Yes	Yes	No	—	Yes
10G Ethernet LAN Phy to WAN Phy	Yes	Yes	No	The 10G Ethernet LAN Phy to WAN Phy to Mixed is supported if the Port pair 1-3 is chosen as Transponder. The 10G Ethernet LAN Phy to WAN Phy to Mixed is not supported if the Port pair 1-3 is chosen as Standard Regen.	—

10.14.8 Security

The OTU2_XP card, when an XFP is plugged into it, implements the Cisco Standard Security Code Check Algorithm that keys on vendor ID and serial number.

If a PPM is plugged into a port on the card but fails the security code check because it is not a Cisco PPM, a NON-CISCO-PPM Not Reported (NR) condition occurs.

If a PPM with a nonqualified product ID is plugged into a port on this card, that is, the PPM passes the security code as a Cisco PPM but it has not been qualified for use on the OTU2_XP card, a UNQUAL-PPM NR condition occurs.

10.14.9 Automatic Laser Shutdown

The ALS procedure is supported on both client and trunk interfaces. On the client interface, ALS is compliant with ITU-T G.664 (6/99). On the data application and trunk interface, the switch on and off pulse duration is greater than 60 seconds. The on and off pulse duration is user-configurable. For details on ALS provisioning for the card, refer to the *Cisco ONS 15454 DWDM Procedure Guide*.

10.14.10 ODU Transparency

A key feature of the OTU2_XP card is the ability to configure the ODU overhead bytes (EXP bytes and RES bytes 1 and 2) using the ODU Transparency parameter. The two options available for this parameter are:

- Transparent Standard Use—ODU overhead bytes are transparently passed through the card. This option allows the OTU2_XP card to act transparently between two trunk ports (when the card is configured in Standard Regen or Enhanced FEC).
- Cisco Extended Use—ODU overhead bytes are terminated and regenerated on both ports of the regenerator group.

The ODU Transparency parameter is configurable only for Standard Regen and Enhanced FEC card configuration. For Transponder card configuration, this parameter defaults to Cisco Extended Use and cannot be changed.

Note The Forward Error Correction (FEC) Mismatch (FEC-MISM) alarm will not be raised on OTU2_XP card when you choose Transparent Standard Use.

10.14.11 Protection

The OTU2_XP card supports Y-cable and splitter protection. Y-cable protection is provided at the client port level. Splitter protection is provided at the trunk port level.

10.14.11.1 Y-Cable Protection

The OTU2_XP card supports Y-cable protection on client ports when it is provisioned in the transponder card configuration. Two cards can be joined in a Y-cable protection group with one card assigned as the working card and the other defined as the protection card. This protection mechanism provides redundant bidirectional paths. See the "10.19.1 Y-Cable Protection" section on page 10-139 for more detailed information. When a signal fault is detected (LOS, LOF, SD, or SF on the DWDM receiver port in the case of ITU-T G.709 mode) the protection mechanism software automatically switches between paths.

Note When the 10G Ethernet LAN Phy to WAN Phy conversion feature is enabled, Y-cable protection is not supported on the LAN to WAN interface (ports 1 and 3).

10.14.11.2 Splitter Protection

The OTU2_XP card supports splitter protection on trunk ports that are not part of a regenerator group (see Table 10-49 for port details). You can create and delete splitter protection groups in OTU2_XP card. In splitter protection method, a client injects a single signal into the client RX port. An optical splitter internal to the card then splits the signal into two separate signals and routes them to the two trunk TX ports. See the "10.19.2 Splitter Protection" section on page 10-141 for more detailed information.

In the splitter protected 10G Ethernet LAN Phy to WAN Phy mode, AIS-P and LOP-P acts as trigger (when G.709 is enabled) for the Protection Switch, in addition to the existing switching criteria.

The STS parameters such as, SF /SD thresholds, Path PM thresholds, and Path Trace is set for the working path (Port 3). The same parameters are also applicable for the protected path (Port 4).

10.15 MLSE UT

The maximum likelihood sequence estimation (MLSE) based universal transponder (UT) modules are added to the TXP_MR_10EX_C, MXP_2.5G_10EX_C, and MXP_MR_10DMEX_C cards to support the error decorrelator functionality to enhance system performance.

10.15.1 Error Decorrelator

The MLSE feature uses the error decorrelator functionality to reduce the chromatic dispersion (CD) and polarization mode dispersion (PMD), thereby extending the transmission range on the trunk interface. You can enable or disable the error decorrelator functionality using CTC or TL1. The dispersion compensation unit (DCU) is also used to reduce CD and PMD. The MLSE-based UT module helps to reduce CD and PMD without the use of a DCU.

10.16 TXP_MR_10EX_C Card

The TXP_MR_10EX_C card is a multirate transponder for the ONS 15454 platform. The card is fully backward compatible with TXP_MR_10E_C cards (only when the error decorrelator is disabled in the CTC on the TXP_MR_10EX_C card). It processes one 10-Gbps signal (client side) into one 10-Gbps, 100-GHz DWDM signal (trunk side). The TXP_MR_10EX_C card is tunable over the 82 channels of C-band (82 channels spaced at 50 GHz on the ITU grid).

You can install TXP_MR_10EX_C card in Slots 1 to 6 and 12 to 17. The card can be provisioned in linear, BLSR/MS-SPRing, path protection/SNCP configurations or as a regenerator. The card can be used in the middle of BLSR/MS-SPRing or 1+1 spans when the card is configured for transparent termination mode. The TXP_MR_10EX_C card features an MLSE-based Universal Transponder 1550-nm tunable laser and a separately orderable ONS-XC-10G-S1 1310-nm or ONS-XC-10G-L2 1550-nm laser XFP module for the client port.

Note The PRE FEC BER performance of the TXP_MR_10EX_C card may be significantly low when compared to the TXP_MR_10E card. However, this does not affect the Post FEC BER performance, but could possibly affect any specific monitoring application that relies on the PRE FEC BER value (for example, protection switching). In this case, the replacement of TXP_MR_10E card with the TXP_MR_10EX_C may not work properly.

Note When the ONS-XC-10G-L2 XFP is installed, the TXP_MR_10EX_C card must be installed in a high-speed slot (slot 6, 7, 12, or 13)

On its faceplate, the TXP_MR_10EX_C card contains two transmit and receive connector pairs, one for the trunk port and one for the client port. Each connector pair is labeled.

10.16.1 Key Features

The key features of the TXP_MR_10EX_C card are:

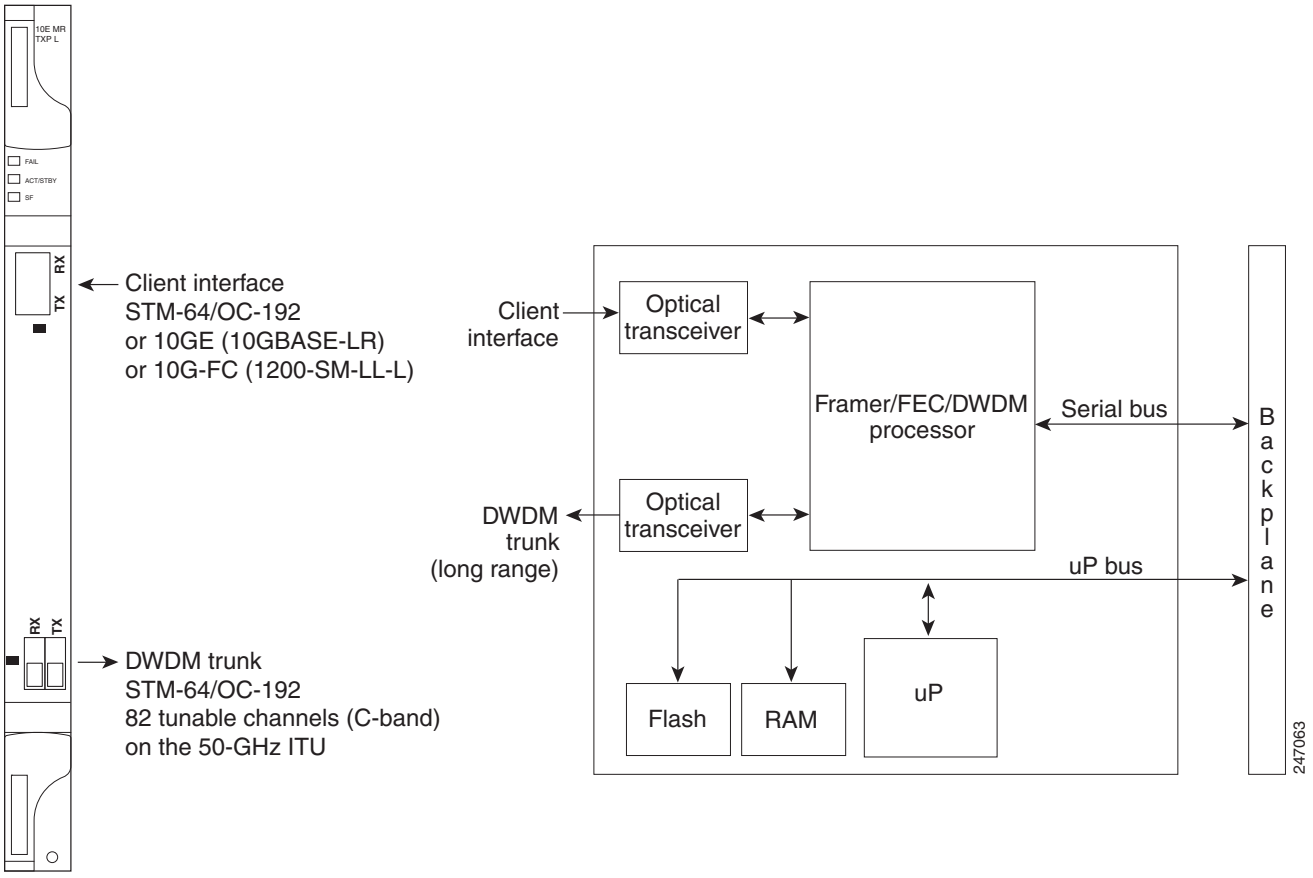
- A multi-rate client interface (available through the ONS-XC-10G-S1 XFP, ordered separately):

  - OC-192 (SR1)
  - 10GE (10GBASE-LR)
  - 10G-FC (1200-SM-LL-L)
  - (ONS-XC-10G-S1 version 3 only) IB_5G
- An MLSE-based UT module tunable through 82 channels of C-band. The channels are spaced at 50 GHz on the ITU grid.
- OC-192 to ITU-T G.709 OTU2 provisionable synchronous and asynchronous mapping.
- Proprietary rate at the trunk when the client is provisioned as IB_5G.
- The MTU setting is used to display the OverSizePkts counters on the receiving trunk and client port interfaces. Traffic of frame sizes up to 65535 bytes pass without any packet drops, from the client port to the trunk port and vice versa irrespective of the MTU setting.

10.16.2 Faceplate and Block Diagram

Figure 10-34 shows the TXP_MR_10EX_C faceplate and block diagram.

Figure 10-34 TXP_MR_10EX_C Faceplate and Block Diagram



For information on safety labels for the card, see the "10.2.2 Class 1M Laser Product Cards" section on page 10-10.

Caution You must use a 15-dB fiber attenuator (10 to 20 dB) when working with the TXP_MR_10EX_C card in a loopback on the trunk port. Do not use direct fiber loopbacks with this card, because they can cause irreparable damage to the card.

10.16.3 Client Interface

The client interface is implemented with a separately orderable XFP module. The module is a tri-rate transceiver, providing a single port that can be configured in the field to support an OC-192 SR-1 (Telcordia GR-253-CORE) or STM-64 I-64.1 (ITU-T G.691) optical interface, as well as 10GE LAN PHY (10GBASE-LR), 10GE WAN PHY (10GBASE-LW), 10G-FC signals, or IB_5G signals.

The client-side XFP pluggable module supports LC connectors and is equipped with a 1310-nm laser.

10.16.4 DWDM Trunk Interface

On the trunk side, the TXP_MR_10EX_C card provides a 10-Gbps STM-64/OC-192 interface. In the 1550-nm C-band on the 50-GHz ITU grid for the DWDM interface, 82 tunable channels are available. The TXP_MR_10EX_C card provides 3R transponder functionality for this 10-Gbps trunk interface. Therefore, the card is suited for use in long-range amplified systems. The DWDM interface is compliant with ITU-T G.707, ITU-T G.709, and Telcordia GR-253-CORE standards.

The DWDM trunk port operates at a rate that depends on the input signal and the presence of the ITU-T G.709 Digital Wrapper/FEC. The possible trunk rates are:

- OC192 (9.95328 Gbps)
- OTU2 (10.70923 Gbps)
- 10GE (10.3125 Gbps) or 10GE into OTU2 (ITU G.sup43 11.0957 Gbps)
- 10G-FC (10.51875 Gbps) or 10G-FC into OTU2 (nonstandard 11.31764 Gbps)
- Proprietary rate at the trunk when the client is provisioned as IB_5G.

The maximum system reach in filterless applications without the use of optical amplification or regenerators is nominally rated at 23 dB over C-SMF fiber. This rating is not a product specification, but is given for informational purposes. It is subject to change.

Note You cannot disable ITU-T G.709 on the trunk side. If ITU-T G.709 is enabled, then FEC cannot be disabled.

10.16.5 Enhanced FEC (E-FEC) Feature

A key feature of the TXP_MR_10EX_C card is the availability to configure the forward error correction feature in two modes: FEC and E-FEC. The output bit rate is always 10.7092 Gbps as defined in ITU-T G.709, but the error coding performance can be provisioned as follows:

- FEC—Standard ITU-T G.975 Reed-Solomon algorithm
- E-FEC—Standard ITU-T G.975.1 I.7 algorithm, (a super FEC code)

10.16.6 FEC and E-FEC Modes

As client-side traffic passes through the TXP_MR_10EX_C card, it can be digitally wrapped using FEC mode or E-FEC mode. The FEC mode setting provides a lower level of error detection and correction than the E-FEC mode setting of the card. As a result, using E-FEC mode allows higher sensitivity (lower OSNR) with a lower bit error rate than FEC mode. E-FEC enables longer distance trunk-side transmission than with FEC.

The E-FEC feature is one of three basic modes of FEC operation. FEC can be turned on, or E-FEC can be turned on to provide greater range and lower BER. The default mode is FEC on and E-FEC off. E-FEC is provisioned using CTC.

Caution Because the transponder has no visibility into the data payload and detect circuits, the TXP_MR_10EX_C card does not display circuits under the card view.

10.16.7 Client-to-Trunk Mapping

The TXP_MR_10EX_C card can perform ODU2-to-OCh mapping, which allows operators to provision data payloads in a standard way across 10-Gbps optical links.

Digital wrappers that define client-side interfaces are called ODU2 entities in ITU-T G.709. Digital wrappers that define trunk-side interfaces are called OCh in ITU-T G.709. ODU2 digital wrappers can include G-MPLS signaling extensions to ITU-T G.709 (such as LSP and G-PID values) to define client interfaces and payload protocols.

10.16.8 Automatic Laser Shutdown

The ALS procedure is supported on both client and trunk interfaces. On the client interface, ALS is compliant with ITU-T G.664 (6/99). On the data application and trunk interface, the switch on and off pulse duration is greater than 60 seconds and is user-configurable. For details regarding ALS provisioning for the TXP_MR_10EX_C card, refer to the *Cisco ONS 15454 DWDM Procedure Guide*.

10.16.9 TXP_MR_10EX_C Card-Level Indicators

Table 10-54 lists the card-level LEDs on the TXP_MR_10EX_C card.

Table 10-54 TXP_MR_10EX_C Card-Level Indicators

Card-Level LED	Description
Red FAIL LED	The red FAIL LED indicates that the card's processor is not ready. This LED is on during reset. The FAIL LED flashes during the boot process. Replace the card if the red FAIL LED persists.

Table 10-54 TXP_MR_10EX_C Card-Level Indicators (continued)

Card-Level LED	Description
ACT/STBY LED Green (Active) Amber (Standby)	If the ACT/STBY LED is green, the card is operational (one or both ports active) and ready to carry traffic. If the ACT/STBY LED is amber, the card is operational and in standby (protect) mode.
Amber SF LED	The amber SF LED indicates a signal failure or condition such as LOS, LOF, or high BERs on one or more of the card's ports. The amber SF LED is also on if the transmit and receive fibers are incorrectly connected. If the fibers are properly connected and the link is working, the light turns off.

10.16.10 TXP_MR_10EX_C Port-Level Indicators

Table 10-55 lists the port-level LEDs on the TXP_MR_10EX_C card.

Table 10-55 TXP_MR_10EX _C Port-Level Indicators

Port-Level LED	Description
Green Client LED	The green Client LED indicates that the client port is in service and that it is receiving a recognized signal.
Green DWDM LED	The green DWDM LED indicates that the DWDM port is in service and that it is receiving a recognized signal.

10.17 MXP_2.5G_10EX_C card

The MXP_2.5G_10EX_C card is a DWDM muxponder for the ONS 15454 platform that supports transparent termination mode on the client side. The faceplate designation of the card is "4x2.5G 10EX MXP." The card multiplexes four 2.5-Gbps client signals (4xOC48/STM-16 SFP) into a single 10-Gbps DWDM optical signal on the trunk side. The card provides wavelength transmission service for the four incoming 2.5-Gbps client interfaces. The MXP_2.5G_10EX_C muxponder passes all SONET/SDH overhead bytes transparently.

The digital wrapper function (ITU-T G.709 compliant) formats the DWDM wavelength so that it can be used to set up GCCs for data communications, enable FEC, or facilitate PM.

The MXP_2.5G_10EX_C card works with OTN devices defined in ITU-T G.709. The card supports ODU1 to OTU2 multiplexing, an industry standard method for asynchronously mapping a SONET/SDH payload into a digitally wrapped envelope. See the "10.8.5 Multiplexing Function" section on page 10-44.

The MXP_2.5G_10EX_C card is not compatible with the MXP_2.5G_10G card, which does not support transparent termination mode.

You can install the MXP_2.5G_10EX_C card in slots 1 to 6 and 12 to 17. You can provision a card in a linear configuration, a BLSR/MS-SPRing, a path protection/SNCP, or a regenerator. The card can be used in the middle of BLSR/MS-SPRing or 1+1 spans when the card is configured for transparent termination mode.

The MXP_2.5G_10EX_C card features a tunable 1550-nm C-band laser on the trunk port. The laser is tunable across 82 wavelengths on the ITU grid with 50-GHz spacing between wavelengths. The card features four 1310-nm lasers on the client ports and contains five transmit and receive connector pairs

(labeled) on the card faceplate. The card uses dual LC connectors on the trunk side and SFP modules on the client side for optical cable termination. The SFP pluggable modules are SR or IR and support an LC fiber connector.

Note When you create a 4xOC-48 OCHCC circuit, you need to select the G.709 and Synchronous options. A 4xOC-48 OCHCC circuit is supported by G.709 and synchronous mode, which are necessary to provision the 4xOC-48 OCHCC circuit.

10.17.1 Key Features

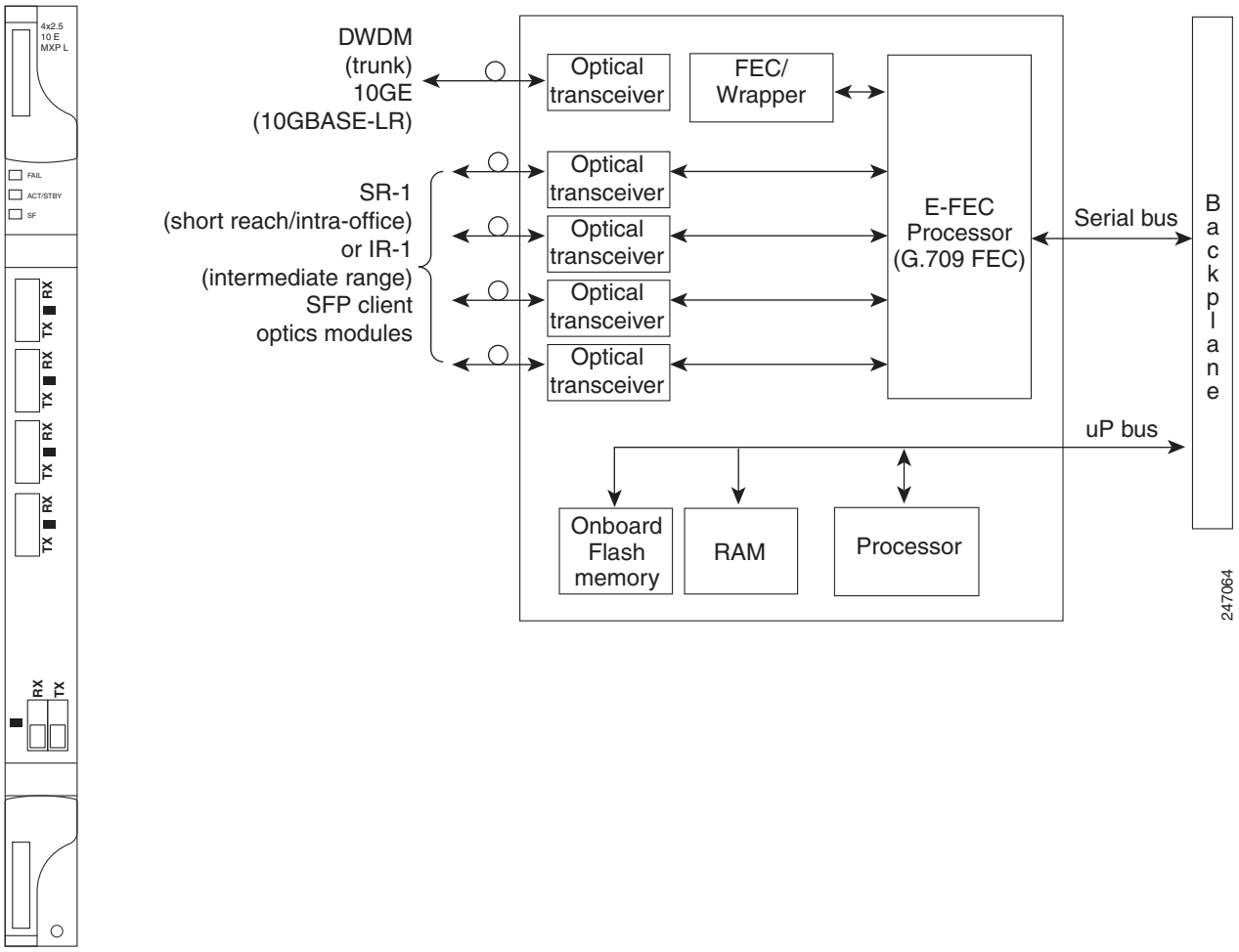
The MXP_2.5G_10EX_C card has the following high-level features:

- Four 2.5-Gbps client interfaces (OC-48/STM-16) and one 10-Gbps trunk. The four OC-48 signals are mapped into an ITU-T G.709 OTU2 signal using standard ITU-T G.709 multiplexing.
- Onboard E-FEC processor: The processor supports both standard RS (specified in ITU-T G.709) and E-FEC, which allows an improved gain on trunk interfaces with a resultant extension of the transmission range on these interfaces. The E-FEC functionality increases the correction capability of the transponder to improve performance, allowing operation at a lower OSNR compared to the standard RS (237,255) correction algorithm.
- Pluggable client-interface optic modules: The MXP_2.5G_10EX_C card has modular interfaces. Two types of optic modules can be plugged into the card. These modules include an OC-48/STM-16 SR-1 interface with a 7-km (4.3-mile) nominal range (for short range and intra-office applications) and an IR-1 interface with a range of up to 40 km (24.9 miles). SR-1 is defined in Telcordia GR-253-CORE and in I-16 (ITU-T G.957). IR-1 is defined in Telcordia GR-253-CORE and in S-16-1 (ITU-T G.957).
- High-level provisioning support: The card is initially provisioned using Cisco TransportPlanner software. Subsequently, the card can be monitored and provisioned using CTC software.
- Link monitoring and management: The card uses standard OC-48 OH (overhead) bytes to monitor and manage incoming interfaces. The card passes the incoming SDH/SONET data stream and its overhead bytes transparently.
- Control of layered SONET/SDH transport overhead: The card is provisionable to terminate regenerator section overhead, which eliminates forwarding of unneeded layer overhead. It can help reduce the number of alarms and help isolate faults in the network.
- Automatic timing source synchronization: The MXP_2.5G_10EX_C card normally synchronizes from the TCC2/TCC2P/TCC3/TNC/TSC card. If for some reason, such as maintenance or upgrade activity, the TCC2/TCC2P/TCC3/TNC/TSC is not available, the card automatically synchronize to one of the input client-interface clocks.
- Configurable squelching policy: The card can be configured to squelch the client interface output if LOS occurs at the DWDM receiver or if a remote fault occurs. In the event of a remote fault, the card manages MS-AIS insertion.
- The card is tunable across the full C-band, thus eliminating the need to use different versions of each card to provide tunability across specific wavelengths in a band.
- The MTU setting is used to display the ifInerrors and OverSizePkts counters on the receiving trunk and client port interfaces. Traffic of frame sizes up to 65535 bytes pass without any packet drops, from the client port to the trunk port and vice versa irrespective of the MTU setting.

10.17.2 Faceplate

Figure 10-35 shows the MXP_2.5G_10EX_C faceplate and block diagram.

Figure 10-35 MXP_2.5G_10EX_C Faceplate and Block Diagram



For information on safety labels for the card, see the "10.2.1 Class 1 Laser Product Cards" section on page 10-8.

10.17.3 Client Interfaces

The MXP_2.5G_10EX_C card provides four intermediate- or short-range OC-48/STM-16 ports per card on the client side. Both SR-1 and IR-1 optics can be supported and the ports use SFP connectors. The client interfaces use four wavelengths in the 1310-nm, ITU 100-GHz-spaced, channel grid.

10.17.4 DWDM Interface

The MXP_2.5G_10EX_C card serves as OTN multiplexers, transparently mapping four OC-48 channels asynchronously to ODU1 into one 10-Gbps trunk. For the MXP_2.5G_10EX_C card, the DWDM trunk is tunable for transmission over the entire C-band. Channels are spaced at 50-GHz on the ITU grid.

Caution You must use a 20-dB fiber attenuator (15 to 25 dB) when working with the card in a loopback on the trunk port. Do not use direct fiber loopbacks with the card, because they can cause irreparable damage to the MXP_2.5G_10EX_C card.

Note You cannot disable ITU-T G.709 on the trunk side. If ITU-T G.709 is enabled, then FEC cannot be disabled.

10.17.5 Multiplexing Function

The muxponder is an integral part of the ROADM network. The key function of the MXP_2.5G_10EX_C card is to multiplex four OC-48/STM-16 signals onto one ITU-T G.709 OTU2 optical signal (DWDM transmission). The multiplexing mechanism allows the signal to be terminated at a far-end node by another similar card.

Transparent termination on the muxponder is configured using OTUx and ODUx OH bytes. The ITU-T G.709 specification defines OH byte formats that are used to configure, set, and monitor frame alignment, FEC mode, section monitoring, tandem connection monitoring, and transparent termination mode.

The MXP_2.5G_10EX_C card performs ODU to OTU multiplexing as defined in ITU-T G.709. The ODU is the framing structure and byte definition (ITU-T G.709 digital wrapper) used to define the data payload coming into one of the SONET/SDH client interfaces on the card. The term ODU1 refers to an ODU that operates at 2.5-Gbps line rate. On the card, four client interfaces can be defined using ODU1 framing structure and format by asserting an ITU-T G.709 digital wrapper.

The output of the muxponder is a single 10-Gbps DWDM trunk interface defined using OTU2. It is within the OTU2 framing structure that FEC or E-FEC information is appended to enable error checking and correction.

10.17.6 Timing Synchronization

The MXP_2.5G_10EX_C card is synchronized to the TCC2/TCC2P /TCC3/TNC/TSC clock during normal conditions and transmits the ITU-T G.709 frame using this clock. No holdover function is implemented. If neither TCC2/TCC2P/TCC3/TNC/TSC clock is available, the card switches automatically (hitless) to the first of the four valid client clocks with no time restriction as to how long it can run on this clock. The card continues to monitor the TCC2/TCC2P/TCC3/TNC/TSC card. If a TCC2/TCC2P/TCC3/TNC/TSC card is restored to working order, the card reverts to the normal working mode of running from the TCC2/TCC2P/TCC3/TNC/TSC clock. If no valid TCC2/TCC2P/TCC3/TNC/TSC clock is available and all of the client channels become invalid, the card waits (no valid frames processed) until one of the TCC2/TCC2P/TCC3/TNC/TSC cards supplies a valid clock. In addition, the card is allowed to select the recovered clock from one active and valid client channel and supply that clock to the TCC2/TCC2P/TCC3/TNC/TSC card.

10.17.7 Enhanced FEC (E-FEC) Capability

The MXP_2.5G_10EX_C card can configure the FEC in two modes: FEC and E-FEC. The output bit rate is always 10.7092 Gbps as defined in ITU-T G.709, but the error coding performance can be provisioned as follows:

- FEC—Standard ITU-T G.975 Reed-Solomon algorithm
- E-FEC—Standard ITU-T G.975.1 I.7, two orthogonally concatenated BCH super FEC codes. This FEC scheme contains three parameterizations of the same scheme of two orthogonally interleaved block codes (BCH). The constructed code is decoded iteratively to achieve the expected performance.

10.17.8 FEC and E-FEC Modes

As client-side traffic passes through the card, it can be digitally wrapped using FEC mode error correction or E-FEC mode error correction. The FEC mode setting provides a lower level of error detection and correction than the E-FEC mode setting of the card. As a result, using E-FEC mode allows higher sensitivity (lower OSNR) with a lower BER than FEC mode. E-FEC enables longer distance trunk-side transmission than with FEC.

The E-FEC feature is one of three basic modes of FEC operation. FEC can be turned on, or E-FEC can be turned on to provide greater range and lower BER. The default mode is FEC on and E-FEC off. E-FEC is provisioned using CTC.

10.17.9 SONET/SDH Overhead Byte Processing

The card passes the incoming SONET/SDH data stream and its overhead bytes for the client signal transparently. The card can be provisioned to terminate regenerator section overhead, which eliminates forwarding of unneeded layer overhead. It can help reduce the number of alarms and help isolate faults in the network.

10.17.10 Client Interface Monitoring

The following parameters are monitored on the MXP_2.5G_10EX_C card:

- Laser bias current is measured as a PM parameter.
- LOS is detected and signaled.
- Rx and Tx power are monitored.

The following parameters are monitored in real-time mode (one second):

- Optical power transmitted (client)
- Optical power received (client)

In the case of LOC at the DWDM receiver or far-end LOS, the client interface behavior is configurable. AIS can be invoked or the client signal can be squelched.

10.17.11 Wavelength Identification

The card uses trunk lasers that are wavelocked, which allows the trunk transmitter to operate on the ITU grid effectively. The MXP_2.5G_10EX_C card implements the MLSE-based UT module. The MXP_2.5G_10EX_C card uses a C-band version of the UT2.

Table 10-56 describes the required trunk transmit laser wavelengths for the MXP_2.5G_10EX_C card. The laser is tunable over 82 wavelengths in the C-band at 50-GHz spacing on the ITU grid.

Table 10-56 MXP_2.5G_10EX_C Trunk Wavelengths

Channel Number	Frequency (THz)	Wavelength (nm)	Channel Number	Frequency (THz)	Wavelength (nm)
1	196.00	1529.55	42	193.95	1545.72
2	195.95	1529.94	43	193.90	1546.119
3	195.90	1530.334	44	193.85	1546.518
4	195.85	1530.725	45	193.80	1546.917
5	195.80	1531.116	46	193.75	1547.316
6	195.75	1531.507	47	193.70	1547.715
7	195.70	1531.898	48	193.65	1548.115
8	195.65	1532.290	49	193.60	1548.515
9	195.60	1532.681	50	193.55	1548.915
10	195.55	1533.073	51	193.50	1549.32
11	195.50	1533.47	52	193.45	1549.71
12	195.45	1533.86	53	193.40	1550.116
13	195.40	1534.250	54	193.35	1550.517
14	195.35	1534.643	55	193.30	1550.918
15	195.30	1535.036	56	193.25	1551.319
16	195.25	1535.429	57	193.20	1551.721
17	195.20	1535.822	58	193.15	1552.122
18	195.15	1536.216	59	193.10	1552.524
19	195.10	1536.609	60	193.05	1552.926
20	195.05	1537.003	61	193.00	1553.33
21	195.00	1537.40	62	192.95	1553.73
22	194.95	1537.79	63	192.90	1554.134
23	194.90	1538.186	64	192.85	1554.537
24	194.85	1538.581	65	192.80	1554.940
25	194.80	1538.976	66	192.75	1555.343
26	194.75	1539.371	67	192.70	1555.747
27	194.70	1539.766	68	192.65	1556.151
28	194.65	1540.162	69	192.60	1556.555
29	194.60	1540.557	70	192.55	1556.959

Table 10-56 MXP_2.5G_10EX_C Trunk Wavelengths (continued)

Channel Number	Frequency (THz)	Wavelength (nm)	Channel Number	Frequency (THz)	Wavelength (nm)
30	194.55	1540.953	71	192.50	1557.36
31	194.50	1541.35	72	192.45	1557.77
32	194.45	1541.75	73	192.40	1558.173
33	194.40	1542.142	74	192.35	1558.578
34	194.35	1542.539	75	192.30	1558.983
35	194.30	1542.936	76	192.25	1559.389
36	194.25	1543.333	77	192.20	1559.794
37	194.20	1543.730	78	192.15	1560.200
38	194.15	1544.128	79	192.10	1560.606
39	194.10	1544.526	80	192.05	1561.013
40	194.05	1544.924	81	192.00	1561.42
41	194.00	1545.32	82	191.95	1561.83

10.17.12 Automatic Laser Shutdown

The ALS procedure is supported on both client and trunk interfaces. On the client interface, ALS is compliant with ITU-T G.664 (6/99). On the data application and trunk interface, the switch on and off pulse duration is greater than 60 seconds and is user-configurable. For details regarding ALS provisioning for the MXP_2.5G_10EX_C card, see the *Cisco ONS 15454 DWDM Procedure Guide*.

10.17.13 Jitter

For SONET and SDH signals, the MXP_2.5G_10EX_C card complies with Telcordia GR-253-CORE, ITU-T G.825, and ITU-T G.873 for jitter generation, jitter tolerance, and jitter transfer. See the "10.21 Jitter Considerations" section on page 10-142 for more information.

10.17.14 Lamp Test

The MXP_2.5G_10EX_C card supports a lamp test function that is activated from the ONS 15454 front panel or through CTC to ensure that all LEDs are functional.

10.17.15 Onboard Traffic Generation

The MXP_2.5G_10EX_C card provides internal traffic generation for testing purposes according to PRBS, SONET/SDH, or ITU-T G.709.

10.17.16 MXP_2.5G_10EX_C Card-Level Indicators

Table 10-57 describes the card-level LEDs on the MXP_2.5G_10EX_C card.

Table 10-57 MXP_2.5G_10EX_C Card-Level Indicators

Card-Level LED	Description
Red FAIL LED	The red FAIL LED indicates that the card's processor is not ready. This LED is on during reset. The FAIL LED flashes during the boot process. Replace the card if the red FAIL LED persists.
ACT/STBY LED Green (Active) Amber (Standby)	If the ACT/STBY LED is green, the card is operational (one or more ports active) and ready to carry traffic. If the ACT/STBY LED is amber, the card is operational and in standby (protect) mode.
Amber SF LED	The amber SF LED indicates a signal failure or condition such as LOS, LOF, or high BERs on one or more of the card's ports. The amber SF LED is also on if the transmit and receive fibers are incorrectly connected. If the fibers are properly connected and the link is working, the light turns off.

10.17.17 MXP_2.5G_10EX_C Port-Level Indicators

Table 10-58 describes the port-level LEDs on the MXP_2.5G_10EX_C card.

Table 10-58 MXP_2.5G_10E_C and MXP_2.5G_10E_L Port-Level Indicators

Port-Level LED	Description
Green Client LED (four LEDs)	A green Client LED indicates that the client port is in service and that it is receiving a recognized signal. The card has four client ports, and so has one Client LED for each port.
Green DWDM LED	The green DWDM LED indicates that the DWDM port is in service and that it is receiving a recognized signal.

10.18 MXP_MR_10DMEX_C Card

The MXP_MR_10DMEX_C card aggregates a mix of client SAN service-client inputs (GE, FICON, and Fibre Channel) into one 10-Gbps STM-64/OC-192 DWDM signal on the trunk side. It provides one long-reach STM-64/OC-192 port per card and is compliant with Telcordia GR-253-CORE and ITU-T G.957.

The card supports aggregation of the following signal types:

- 1-Gigabit Fibre Channel
- 2-Gigabit Fibre Channel
- 4-Gigabit Fibre Channel
- 1-Gigabit Ethernet
- 1-Gigabit ISC-Compatible (ISC-1)
- 2-Gigabit ISC-Peer (ISC-3)

Caution The card can be damaged by dropping it. Handle it carefully.

The MXP_MR_10DMEX_C muxponder passes all SONET/SDH overhead bytes transparently.

The digital wrapper function (ITU-T G.709 compliant) formats the DWDM wavelength so that it can be used to set up GCCs for data communications, enable FEC, or facilitate PM. The MXP_MR_10DMEX_C card works with the OTN devices defined in ITU-T G.709. The card supports ODU1 to OTU2 multiplexing, an industry standard method for asynchronously mapping a SONET/SDH payload into a digitally wrapped envelope. See the "10.7.7 Multiplexing Function" section on page 10-36.

Note You cannot disable ITU-T G.709 on the trunk side. If ITU-T G.709 is enabled, then FEC cannot be disabled.

Note Because the client payload cannot oversubscribe the trunk, a mix of client signals can be accepted, up to a maximum limit of 10 Gbps.

You can install the MXP_MR_10DMEX_C card in slots 1 to 6 and 12 to 17.

Note The MXP_MR_10DMEX_C card is not compatible with the MXP_2.5G_10G card, which does not support transparent termination mode.

The MXP_MR_10DMEX_C card features a tunable 1550-nm C-band laser on the trunk port. The laser is tunable across 82 wavelengths on the ITU grid with 50-GHz spacing between wavelengths. Each card features four 1310-nm lasers on the client ports and contains five transmit and receive connector pairs (labeled) on the card faceplate. The card uses dual LC connectors on the trunk side and SFP modules on the client side for optical cable termination. The SFP pluggable modules are SR or IR and support an LC fiber connector.

Table 10-59 shows the input data rate for each client interface, and the encapsulation method. The current version of the GFP-T G.7041 supports transparent mapping of 8B/10B block-coded protocols, including Gigabit Ethernet, Fibre Channel, ISC, and FICON.

In addition to the GFP mapping, 1-Gbps traffic on Port 1 or 2 of the high-speed SERDES is mapped to an STS-24c channel. If two 1-Gbps client signals are present at Port 1 and Port 2 of the high-speed SERDES, the Port 1 signal is mapped into the first STS-24c channel and the Port 2 signal into the second STS-24c channel. The two channels are then mapped into an OC-48 trunk channel.

Table 10-59 MXP_MR_10DMEX_C Client Interface Data Rates and Encapsulation

Client Interface	Input Data Rate	GFP-T G.7041 Encapsulation
2G FC	2.125 Gbps	Yes
1G FC	1.06 Gbps	Yes
2G FICON/2G ISC-Compatible (ISC-1)/ 2G ISC-Peer (ISC-3)	2.125 Gbps	Yes

Table 10-59 MXP_MR_10DMEX_C Client Interface Data Rates and Encapsulation (continued)

Client Interface	Input Data Rate	GFP-T G.7041 Encapsulation
1G FICON/1G ISC-Compatible (ISC-1)/ 1G ISC-Peer (ISC-3)	1.06 Gbps	Yes
Gigabit Ethernet	1.25 Gbps	Yes

The MXP_MR_10DMEX_C card includes two FPGAs, and a group of four ports is mapped to each FPGA. Group 1 consists of Ports 1 through 4, and Group 2 consists of Ports 5 through 8. Table 10-60 shows some of the mix and match possibilities on the various client data rates for Ports 1 through 4, and Ports 5 through 8. An X indicates that the data rate is supported in that port.

Table 10-60 Supported Client Data Rates for Ports 1 through 4 and Ports 5 through 8

Port (Group 1)	Port (Group 2)	Gigabit Ethernet	1G FC	2G FC	4G FC
1	5	X	X	X	X
2	6	X	X	—	—
3	7	X	X	X	—
4	8	X	X	—	—

GFP-T PM is available through RMON and trunk PM is managed according to Telcordia GR-253-CORE and ITU G.783/826. Client PM is achieved through RMON for FC and GE.

A buffer-to-buffer credit management scheme provides FC flow control. With this feature enabled, a port indicates the number of frames that can be sent to it (its buffer credit), before the sender is required to stop transmitting and wait for the receipt of a “ready” indication. The MXP_MR_10DMEX_C card supports FC credit-based flow control with a buffer-to-buffer credit extension of up to 1600 km (994.1 miles) for 1G FC, up to 800 km (497.1 miles) for 2G FC, or up to 400 km (248.5 miles) for 4G FC. The feature can be enabled or disabled.

The MXP_MR_10DMEX_C card features a 1550-nm laser for the trunk/line port and a 1310-nm or 850-nm laser (depending on the SFP) for the client ports. The card contains eight 12.5-degree downward-tilt SFP modules for the client interfaces. For optical termination, each SFP uses two LC connectors, which are labeled TX and RX on the faceplate. The trunk port is a dual-LC connector with a 45-degree downward angle.

10.18.1 Key Features

The MXP_MR_10DMEX_C card has the following high-level features:

- Onboard E-FEC processor: The processor supports both standard RS (specified in ITU-T G.709) and E-FEC, which allows an improved gain on trunk interfaces with a resultant extension of the transmission range on these interfaces. The E-FEC functionality increases the correction capability of the transponder to improve performance, allowing operation at a lower OSNR compared to the standard RS (237,255) correction algorithm.
- Pluggable client-interface optic modules: The MXP_MR_10DMEX_C card has modular interfaces. Two types of optics modules can be plugged into the card. These modules include an OC-48/STM-16 SR-1 interface with a 7-km (4.3-mile) nominal range (for short range and

intra-office applications) and an IR-1 interface with a range of up to 40 km (24.9 miles). SR-1 is defined in Telcordia GR-253-CORE and in I-16 (ITU-T G.957). IR-1 is defined in Telcordia GR-253-CORE and in S-16-1 (ITU-T G.957).

- Y-cable protection: The card supports Y-cable protection between the same card type only, on ports with the same port number and signal rate. See the "10.19.1 Y-Cable Protection" section on page 10-139 for more detailed information.
- High-level provisioning support: The card is initially provisioned using Cisco TransportPlanner software. Subsequently, the card can be monitored and provisioned using CTC software.
- ALS: This safety mechanism is used in the event of a fiber cut. For details regarding ALS provisioning for the MXP_MR_10DMEX_C card, refer to the *Cisco ONS 15454 DWDM Procedure Guide*.
- Link monitoring and management: The card uses standard OC-48 OH(overhead) bytes to monitor and manage incoming interfaces. The card passes the incoming SDH/SONET data stream and its OH(overhead) bytes transparently.
- Control of layered SONET/SDH transport overhead: The card is provisionable to terminate regenerator section overhead, which eliminates forwarding of unneeded layer overhead. It can help reduce the number of alarms and help isolate faults in the network.
- Automatic timing source synchronization: The MXP_MR_10DMEX_C card normally synchronizes from the TCC2/TCC2P/TCC3/TNC/TSC card. If for some reason, such as maintenance or upgrade activity, the TCC2/TCC2P/TCC3/TNC/TSC is not available, the card automatically synchronizes to one of the input client-interface clocks.

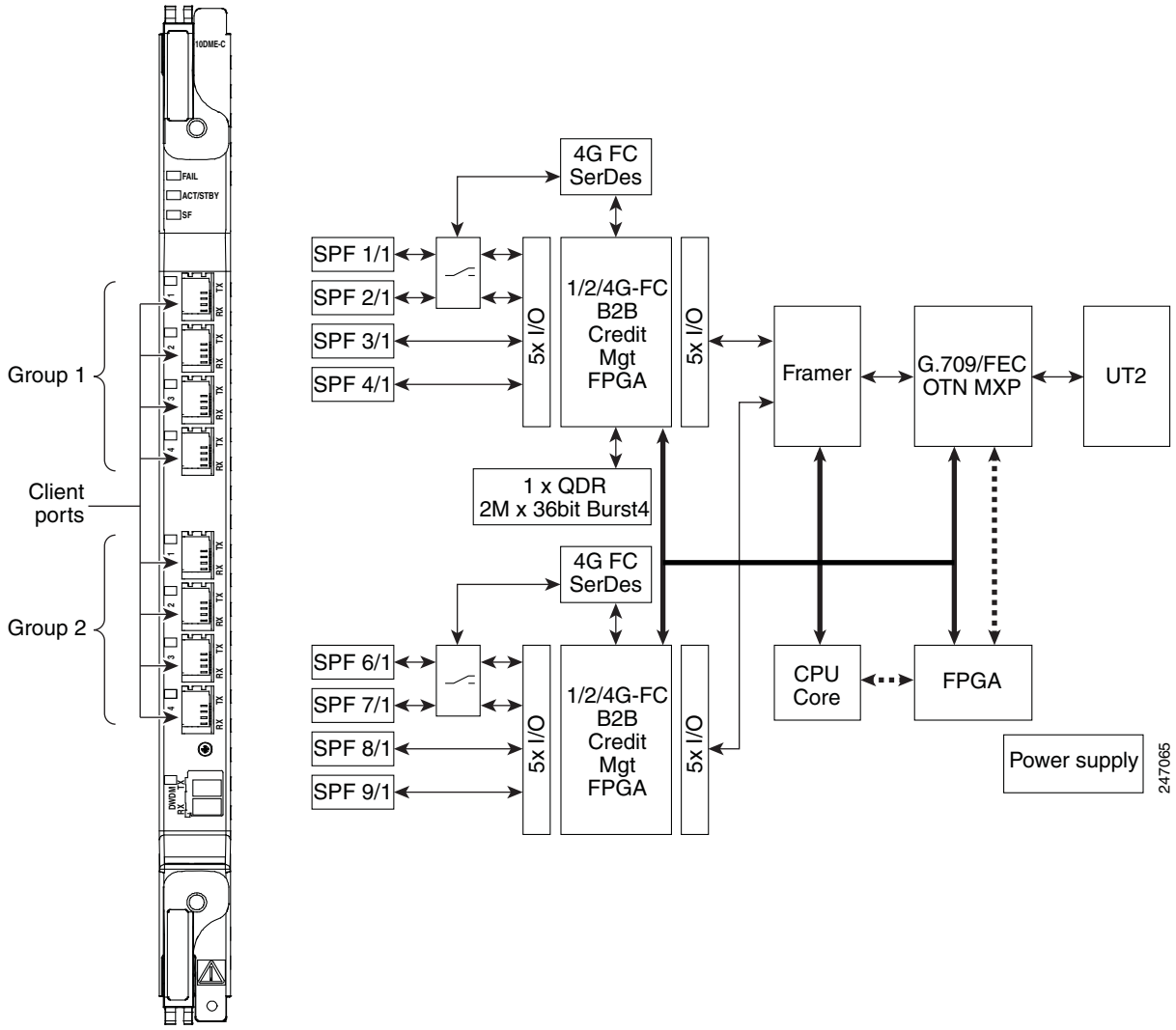
Note MXP_MR_10DMEX_C card cannot be used for line timing.

- Configurable squelching policy: The card can be configured to squelch the client-interface output if LOS occurs at the DWDM receiver or if a remote fault occurs. In the event of a remote fault, the card manages MS-AIS insertion.
- The card is tunable across the full C-band, thus eliminating the need to use different versions of each card to provide tunability across specific wavelengths in a band.
- You can provision a string (port name) for each fiber channel/FICON interface on the MXP_MR_10DMEX_C card, which allows the MDS Fabric Manager to create a link association between that SAN port and a SAN port on a Cisco MDS 9000 switch.

10.18.2 Faceplate

Figure 10-36 shows the MXP_MR_10DMEX_C faceplate and block diagram.

Figure 10-36 MXP_MR_10DMEX_C Faceplate and Block Diagram



For information on safety labels for the card, see the "10.2.2 Class 1M Laser Product Cards" section on page 10-10.

Caution You must use a 20-dB fiber attenuator (15 to 25 dB) when working with the card in a loopback on the trunk port. Do not use direct fiber loopbacks with the card, because they can cause irreparable damage to the MXP_MR_10DMEX_C card.

10.18.3 Wavelength Identification

The card uses trunk lasers that are wavelocked, which allows the trunk transmitter to operate on the ITU grid effectively. The MXP_MR_10DMEX_C card uses a C-band version of the MLSE-based UT module.

Table 10-61 describes the required trunk transmit laser wavelengths for the MXP_MR_10DMEX_C card. The laser is tunable over 82 wavelengths in the C-band at 50-GHz spacing on the ITU grid.

Table 10-61 MXP_MR_10DMEX_C Trunk Wavelengths

Channel Number	Frequency (THz)	Wavelength (nm)	Channel Number	Frequency (THz)	Wavelength (nm)
1	196.00	1529.55	42	193.95	1545.72
2	195.95	1529.94	43	193.90	1546.119
3	195.90	1530.334	44	193.85	1546.518
4	195.85	1530.725	45	193.80	1546.917
5	195.80	1531.116	46	193.75	1547.316
6	195.75	1531.507	47	193.70	1547.715
7	195.70	1531.898	48	193.65	1548.115
8	195.65	1532.290	49	193.60	1548.515
9	195.60	1532.681	50	193.55	1548.915
10	195.55	1533.073	51	193.50	1549.32
11	195.50	1533.47	52	193.45	1549.71
12	195.45	1533.86	53	193.40	1550.116
13	195.40	1534.250	54	193.35	1550.517
14	195.35	1534.643	55	193.30	1550.918
15	195.30	1535.036	56	193.25	1551.319
16	195.25	1535.429	57	193.20	1551.721
17	195.20	1535.822	58	193.15	1552.122
18	195.15	1536.216	59	193.10	1552.524
19	195.10	1536.609	60	193.05	1552.926
20	195.05	1537.003	61	193.00	1553.33
21	195.00	1537.40	62	192.95	1553.73
22	194.95	1537.79	63	192.90	1554.134
23	194.90	1538.186	64	192.85	1554.537
24	194.85	1538.581	65	192.80	1554.940
25	194.80	1538.976	66	192.75	1555.343
26	194.75	1539.371	67	192.70	1555.747
27	194.70	1539.766	68	192.65	1556.151
28	194.65	1540.162	69	192.60	1556.555
29	194.60	1540.557	70	192.55	1556.959
30	194.55	1540.953	71	192.50	1557.36
31	194.50	1541.35	72	192.45	1557.77
32	194.45	1541.75	73	192.40	1558.173
33	194.40	1542.142	74	192.35	1558.578

Table 10-61 MXP_MR_10DMEX_C Trunk Wavelengths (continued)

Channel Number	Frequency (THz)	Wavelength (nm)	Channel Number	Frequency (THz)	Wavelength (nm)
34	194.35	1542.539	75	192.30	1558.983
35	194.30	1542.936	76	192.25	1559.389
36	194.25	1543.333	77	192.20	1559.794
37	194.20	1543.730	78	192.15	1560.200
38	194.15	1544.128	79	192.10	1560.606
39	194.10	1544.526	80	192.05	1561.013
40	194.05	1544.924	81	192.00	1561.42
41	194.00	1545.32	82	191.95	1561.83

10.18.4 MXP_MR_10DMEX_C Card-Level Indicators

Table 10-62 describes the card-level LEDs on the MXP_MR_10DMEX_C card.

Table 10-62 MXP_MR_10DMEX_C Card-Level Indicators

Card-Level LED	Description
Red FAIL LED	The red FAIL LED indicates that the card's processor is not ready. This LED is on during reset. The FAIL LED flashes during the boot process. Replace the card if the red FAIL LED persists.
ACT/STBY LED Green (Active) Amber (Standby)	If the ACT/STBY LED is green, the card is operational (one or more ports active) and ready to carry traffic. If the ACT/STBY LED is amber, the card is operational and in standby (protect) mode.
Amber SF LED	The amber SF LED indicates a signal failure or condition such as LOS, LOF, or high BERs on one or more of the card's ports. The amber SF LED is also on if the transmit and receive fibers are incorrectly connected. If the fibers are properly connected and the link is working, the light turns off.

10.18.5 MXP_MR_10DMEX_C Port-Level Indicators

Table 10-63 describes the port-level LEDs on the MXP_MR_10DMEX_C card.

Table 10-63 MXP_MR_10DMEX_C Port-Level Indicators

Port-Level LED	Description
Port LED (eight LEDs, four for each group, one for each SFP)	When green, the port LED indicates that the client port is either in service and receiving a recognized signal (that is, no signal fail), or the port is in Out of Service and Maintenance (OOS,MT or locked, maintenance) state and the signal fail and alarms are being ignored.
Green/Red/Amber/Off	When red, the port LED indicates that the client port is in service but is receiving a signal fail (LOS). When amber, the port LED indicates that the port is provisioned and in a standby state. When off, the port LED indicates that the SFP is either not provisioned, out of service, not properly inserted, or the SFP hardware has failed.
Green DWDM LED	The green DWDM LED indicates that the DWDM port is in service and that it is receiving a recognized signal.

10.19 Y-Cable and Splitter Protection

Y-cable and splitter protection are two main forms of card protection that are available for TXP, MXP, and Xponder (GE_XP, 10GE_XP, GE_XPE, 10GE_XPE, and OTU2_XP) cards when they are provisioned in TXP or MXP mode. Y-cable protection is provided at the client port level. Splitter protection is provided at the trunk port level.

Note GE_XP, 10GE_XP, GE_XPE, and 10GE_XPE cards use VLAN protection when they are provisioned in L2-over-DWDM mode. For information, see the "10.12.10.3 Layer 2 Over DWDM Protection" section on page 10-81. The ADM-10G card uses path protection and 1+1 protection. For more information, see the "10.13.10 Protection" section on page 10-103.

10.19.1 Y-Cable Protection

Y-cable protection is available for the following ONS 15454 TXP, MXP, and Xponder cards:

- TXP_MR_10G
- TXP_MR_10E
- TXP_MR_2.5G
- 40G-TXP-C
- MXP_2.5G_10G
- MXP_2.5G_10E
- MXP_2.5G_10E_C
- MXP_2.5G_10E_L
- MXP_MR_2.5G
- MXP_MR_10DME_C
- MXP_MR_10DME_L

- 40G-MXP-C
- GE_XP and GE_XPE (when in 10GE or 20GE MXP card mode)
- 10GE_XP and 10GE_XPE (when in 10GE TXP card mode)
- OTU2_XP (when in Transponder card configuration)

To create Y-cable protection, you create a Y-cable protection group for two TXP, MXP, or Xponder cards using the CTC software, then connect the client ports of the two cards physically with a Y-cable. The single client signal is sent into the RX Y-cable and is split between the two TXP, MXP, or Xponder cards. The two TX signals from the client side of the TXP, MXP, or Xponder cards are combined in the TX Y-cable into a single client signal. Only the active card signal passes through as the single TX client signal. The other card must have its laser turned off to avoid signal degradation where the Y-cable joins.

When an MXP_MR_2.5G, MXP_MR_10DME_C, or MXP_MR_10DME_L card that is provisioned with Y-cable protection is used on a storage ISL link (FC1G, FC2G, FC4G, FICON1G, FICON2G, or FICON4G), a protection switchover resets the standby port to active. This reset reinitialises the end-to-end link to avoid any link degradation caused due to loss of buffer credits during switchover and results in an end-to-end traffic hit of 15 to 20 seconds.

When using the MXP_MR_10DME_C or MXP_MR_10DME_L card, enable the fast switch feature and use it with a Cisco MDS storage switch to avoid this 15 to 20 second traffic hit. When enabling fast switch on the MXP_MR_10DME_C or MXP_MR_10DME_L card, ensure that the attached MDS switches have the buffer-to-buffer credit recovery feature enabled.

You can also use the TXP_MR_2.5G card to avoid this 15 to 20 second traffic hit. When a Y-cable protection switchover occurs, the storage ISL link does not reinitialize and results in an end-to-end traffic hit of less than 50ms.

Note Y-cable connectors will not work with copper SFPs because Y-cables are made up of optical connectors and there is no way to physically connect them to a copper SFP. Y-cable protection is not supported on IB_5G.

Note There is a traffic hit of upto a couple hundred milliseconds on the MXP_MR_2.5G and MXP_MR_10DME cards in Y-cable configuration when a fiber cut or SFP failure occurs on one of the client ports.

Note The OTU2_XP and 40E-MXP-C card cannot implement Y-cable protection for the client ports in 10 GE LAN PHY mode. Hence, a pair of OTU2_XP cards is used at each end in pass-through mode (Transponder mode with G.709 disabled) to implement Y-cable protection. The 40E-MXP-CE card can implement Y-cable protection without the OTU2_XP card for the client ports in LAN PHY GFP mode. However, the 40E-MXP-CE card cannot implement Y-cable protection without the OTU2_XP card for the client ports in LAN PHY WIS mode.

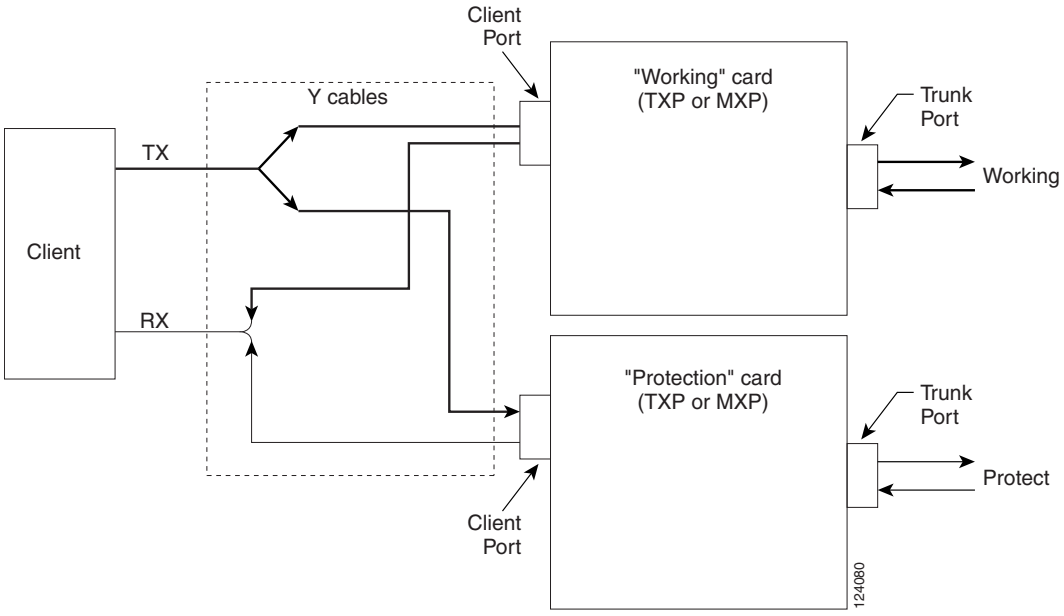
Note If you create a GCC on either card of the protect group, the trunk port stays permanently active, regardless of the switch state. When you provision a GCC, you are provisioning unprotected overhead bytes. The GCC is not protected by the protect group.

Figure 10-37 on page 10-141 shows the Y-cable signal flow.

Note Loss of Signal–Payload (LOS-P) alarms, also called Incoming Payload Signal Absent alarms, can occur on a split signal if the ports are not in a Y-cable protection group.

Note Removing an SFP from the client ports of a card in a Y-cable protection group card causes an IMPROPRMVL (PPM) alarm. The working port raises the IMPROPRMVL alarm and the protected port raises the IMPROPRMVL alarm. The severity on the client ports is changed according to the protection switch state.

Figure 10-37 Y-Cable Protection

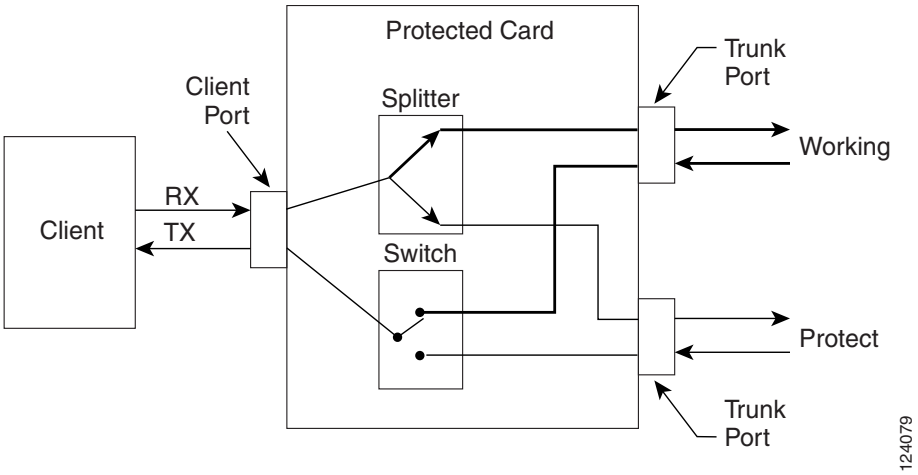


10.19.2 Splitter Protection

Splitter protection, shown in Figure 10-38, is provided with TXPP cards, MXPP cards., and OTU2_XP cards (on trunk ports that are not part of a regenerator group). You can create and delete splitter protection groups in OTU2_XP card.

To implement splitter protection, a client injects a single signal into the client RX port. An optical splitter internal to the card then splits the signal into two separate signals and routes them to the two trunk TX ports. The two signals are transmitted over diverse optical paths. The far-end MXPP or TXPP card uses an optical switch to choose one of the two trunk RX port signals and injects it into the TX client port. When using splitter protection with two MXPP or TXPP cards, there are two different optical signals that flow over diverse paths in each direction. In case of failure, the far-end switch must choose the appropriate signal using its built-in optical switch. The triggers for a protection switch are LOS, LOF, SF, or SD.

Figure 10-38 Splitter Protection



10.20 Far-End Laser Control

The 15454 DWDM cards provide a transparent mode that accurately conveys the client input signal to the far-end client output signal. The client signal is normally carried as payload over the DWDM signals. Certain client signals, however, cannot be conveyed as payload. In particular, client LOS or LOF cannot be carried. Far-end laser control (FELC) is the ability to convey an LOS or LOF from the near-end client input to the far-end client output.

If an LOS is detected on the near-end client input, the near-end trunk sets the appropriate bytes in the OTN overhead of the DWDM line. These bytes are received by the far-end trunk, and cause the far-end client laser to be turned off. When the laser is turned off, it is said to be squelched. If the near-end LOS clears, the near-end trunk clears the appropriate bytes in the OTN overhead, the far-end detects the changed bytes, and the far-end client squelch is removed.

FELC also covers the situation in which the trunk port detects that it has an invalid signal; the client is squelched so as not to propagate the invalid signal.

Payload types with the 2R mode preclude the use of OTN overhead bytes. In 2R mode, an LOS on the client port causes the trunk laser to turn off. The far end detects the LOS on its trunk receiver and squelches the client.

FELC is not provisionable. It is always enabled when the DWDM card is in transparent termination mode. However, FELC signaling to the far-end is only possible when ITU-T G.709 is enabled on both ends of the trunk span.

10.21 Jitter Considerations

Jitter introduced by the SFPs used in the transponders and muxponders must be considered when cascading several cards. With TXP_MR_2.5G, TXPP_MR_2.5G, MXP_MR_2.5G, MXPP_MR_2.5G, and TXP_MR_10E cards, several transponders can be cascaded before the cumulative jitter violates the jitter specification. The recommended limit is 20 cards. With TXP_MR_10G cards, you can also cascade several cards, although the recommended limit is 12 cards. With MXP_2.5G_10G and MXP_2.5G_10E

cards, any number of cards can be cascaded as long as the maximum reach between any two is not exceeded. This is because any time the signal is demultiplexed, the jitter is eliminated as a limiting factor.

The maximum reach between one transponder and the other must be halved if a Y cable is used. For more information on Y-cable operation, see the "10.19.1 Y-Cable Protection" section on page 10-139.

10.22 Termination Modes

Transponder and muxponder cards have various SONET and SDH termination modes that can be configured using CTC (see the "Provision Transponder and Muxponder Cards" chapter in the *Cisco ONS 15454 DWDM Procedure Guide*). The termination modes are summarized in Table 10-64.

Table 10-64 Termination Modes

Cards	Termination Mode	Description
All TXP, MXP, and OTU2_XP cards, with the exception of the MXP_2.5G_10G card (see next section of this table)	Transparent Termination	All the bytes of the payload pass transparently through the cards.
	Section Termination	The SONET transport overhead (TOH) section bytes and the SDH regenerator section overhead (SOH) bytes are terminated. None of these SOH bytes are passed through. They are all regenerated, including the SONET TOH section DCC (SDCC) bytes and the SDH regenerator section DCC (RS-DCC) bytes. In the section termination mode, the SONET TOH line and SDH multiplex section overhead bytes are passed transparently.
	Line Termination	In line termination mode, the section and line overhead bytes for SONET and the overhead bytes for the SDH multiplex and regenerator sections are terminated. None of the overhead bytes are passed through. They are all regenerated, including the SONET SDCC and line DCC (LDCC) bytes and the SDH RS-DCC and multiplexer section DCC (MS-DCC) bytes.
MXP_2.5G_10G[1]	Transparent Termination	All client bytes pass transparently except the following: B1 is rebuilt, S1 is rewritten, A1 to A2 are regenerated, and H1 to H3 are regenerated.
	Section Termination	The SONET TOH section bytes and the SDH regenerator section overhead bytes are terminated. None of these section overhead bytes are passed through. They are all regenerated, including the SONET TOH section DCC bytes and the SDH RS-DCC bytes. In the section termination mode, the SONET TOH line and SDH multiplex section overhead bytes are passed transparently.
	Line Termination	In the line termination mode, the section and line overhead bytes for SONET and the overhead bytes for the SDH multiplex and regenerators sections are terminated. None of the overhead bytes are passed through. They are all regenerated, including the SONET SDCC and LDCC bytes and the SDH RS-DCC and MS-DCC bytes.

1. Clients operating at the OC48/STM16 rate are multiplexed into an OC192/STM64 frame before going to OTN or DWDM.

For TXP and MXP cards, adhere to the following conditions while DCC termination provisioning:

- For SDCC/RS-DCC provisioning, the card should be in the Section/RS-DCC or Line/MS-DCC termination mode.
- For LDCC/MS-DCC provisioning, the card should be in the Line/MS-DCC termination mode.

For more information on enabling termination modes, see the procedures for changing card setting in the "Provision Transponder and Muxponder Cards" chapter of the *Cisco ONS 15454 DWDM Procedure Guide*.

10.23 SFP and XFP Modules

SFPs and 10-Gbps SFPs (XFPs) are integrated fiber optic transceivers that provide high-speed serial links from a port or slot to the network. For more information on SFPs/XFPs and for a list of SFPs/XFPs supported by the transponder and muxponder cards, see the Installing the GBIC, SFP, and XFP Optics Modules in Cisco ONS Platforms.

In CTC, SFPs/XFPs are called pluggable port modules (PPMs). To provision SFPs/XFPs and change the line rate for multirate PPMs, see the *Cisco ONS 15454 DWDM Procedure Guide*.

CHAPTER 11

Node Reference

This chapter explains the ONS 15454 dense wavelength division multiplexing (DWDM) node types that are available for the ONS 15454. The DWDM node type is determined by the type of amplifier and filter cards that are installed in an ONS 15454. The chapter also explains the DWDM automatic power control (APC), reconfigurable optical add/drop multiplexing (ROADM) power equalization, span loss verification, and automatic node setup (ANS) functions.

Note Unless otherwise specified, "ONS 15454" refers to both ANSI and ETSI shelf assemblies.

Note In this chapter, "OPT-BST" refers to the OPT-BST, OPT-BST-E, OPT-BST-L cards, and to the OPT-AMP-L and OPT-AMP-17-C cards when they are provisioned in OPT-LINE (optical booster) mode. "OPT-PRE" refers to the OPT-PRE card and to the OPT-AMP-L and OPT-AMP-17-C cards provisioned in OPT-PRE (preamplifier) mode.

Chapter topics include:

- 11.1 DWDM Node Configurations, page 11-1
- 11.2 Supported Node Configurations for OPT-RAMP-C and OPT-RAMP-CE Cards, page 11-34
- 11.3 Supported Node Configurations for PSM Card, page 11-38
- 11.4 Multishelf Node, page 11-42
- 11.5 Optical Sides, page 11-44
- 11.6 Configuring Mesh DWDM Networks, page 11-53
- 11.7 DWDM Node Cabling, page 11-74
- 11.8 Automatic Node Setup, page 11-90
- 11.9 DWDM Functional View, page 11-96
- 11.10 DWDM Network Functional View, page 11-106

11.1 DWDM Node Configurations

The ONS 15454 supports the following DWDM node configurations: hub, terminal, optical add/drop multiplexing (OADM), reconfigurable OADM (ROADM), anti-amplified spontaneous emission (anti-ASE), line amplifier, optical service channel (OSC) regeneration line, multishelf nodes, and node

configurations for mesh networks. All node configurations can be provisioned with C-band or L-band cards except the OADM and anti-ASE nodes. These nodes require AD-xB-xx.x or AD-xC-xx.x cards, which are C-band only. All node configurations can be single-shelf or multishelf.

Note The Cisco TransportPlanner tool creates a plan for amplifier placement and proper node equipment.

Note To support multiple optical sides in mesh DWDM networks, east and west are no longer used to reference the left and right sides of the ONS 15454 shelf. If a network running a previous software release is upgraded to this release, west will be mapped to A and east to B. In two-sided nodes, such as a hub or ROADM node, Side A refers to Slots 1 through 6 and Side B refers to Slots 12 through 17. Terminal nodes have one side labeled "A," regardless of which slots have cards installed. For more information about configuring the ONS 15454 in mesh DWDM networks, see the "11.6 Configuring Mesh DWDM Networks" section on page 11-53.

11.1.1 Terminal Node

A terminal node is a single ONS 15454 node equipped with two TCC2/TCC2P/TCC3/TNC/TSC cards and one of the following combinations:

- One 32MUX-O card and one 32DMX-O card
- One 32WSS card and either a 32DMX or a 32DMX-O card
- One 40-WSS-C or 40-WSS-CE card and one 40-DMX-C or 40-DMX-CE card
- One 40-MUX-C and one 40-DMX-C or 40-DMX-CE card
- One 80-WXC-C card, one 15216-MD-40-ODD, 15216-EF-40-ODD, or 15216-MD-48-ODD patch panel, and one 15216-MD-40-EVEN, 15216-EF-40-EVEN, or 15216-MD-48-EVEN (ONS 15216 40 or 48-channel mux/demux patch panel), and 15216-MD-ID-50 or 15216-MD-48-CM
- One 40-SMR1-C and one 15216-MD-40-ODD, 15216-EF-40-ODD, or 15216-MD-48-ODD patch panel
- One 40-SMR2-C and one 15216-MD-40-ODD, 15216-EF-40-ODD, or 15216-MD-48-ODD patch panel

Note Although it is recommended that you use the 15216-MD-40-ODD, 15216-EF-40-ODD, or 15216-MD-48-ODD patch panel along with the 40-SMR1-C and 40-SMR2-C cards, you can alternatively use the 40-MUX-C and 40-DMX-C cards instead of the 15216-EF-40-ODD, or 15216-MD-48-ODD patch panel.

Cards in the terminal nodes can be installed in Slots 1 through 6 or Slots 12 through 17. The side where cards are installed is always assigned as Side A.

Figure 11-1 shows an example of a terminal configuration with a 2MUX-O card installed. The channel flow for a terminal node is the same as the hub node (Figure 11-28).

Figure 11-1 Terminal Node Configuration With 32MUX-O Cards Installed

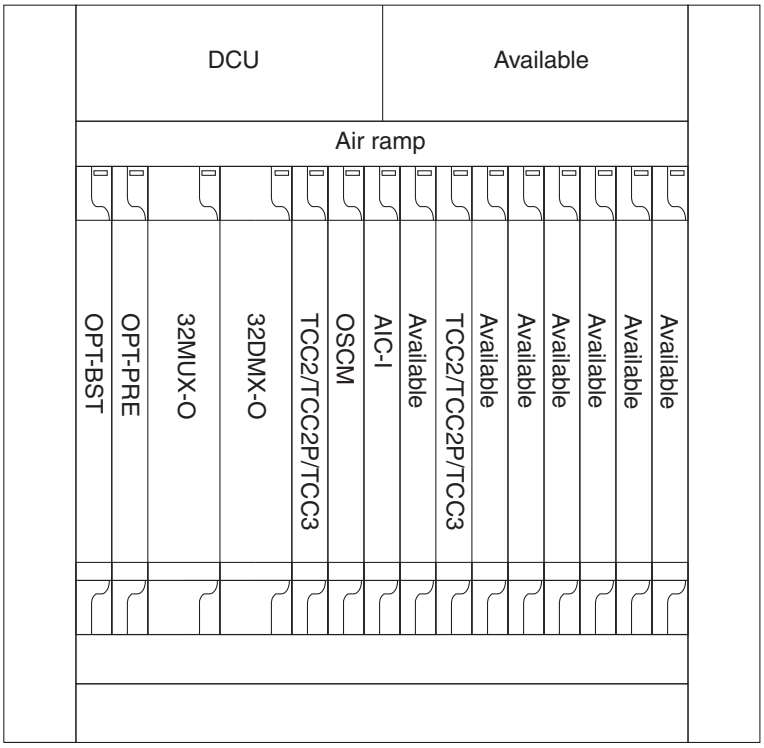


Figure 11-2 shows an example of a terminal configuration with a 40-WSS-C card installed.

Figure 11-2 Terminal Node Configuration with 40-WSS-C Cards Installed

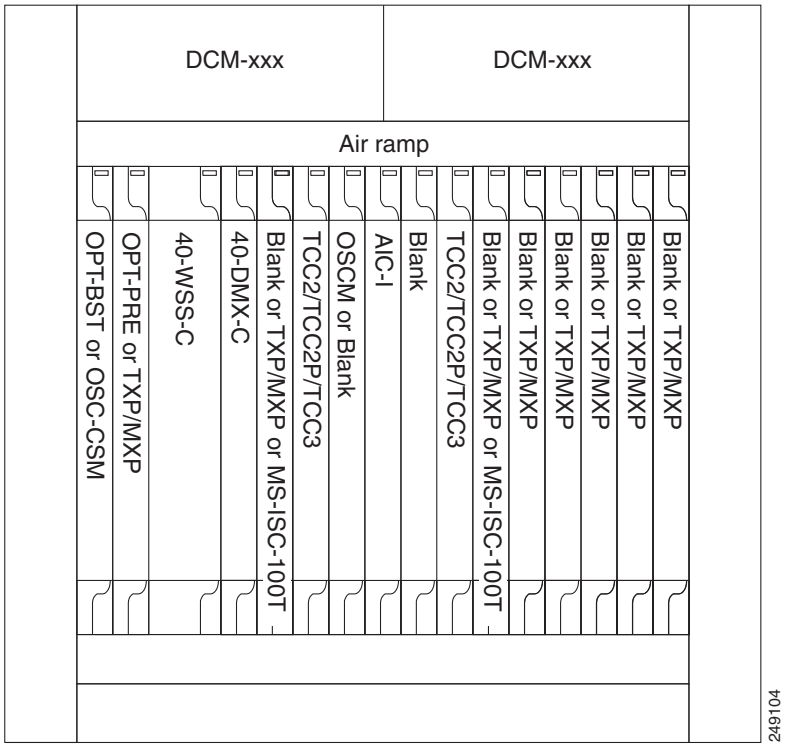


Figure 11-3 shows an example of a terminal configuration with a 40-MUX-C card installed.

Figure 11-3 Terminal Node with 40-MUX-C Cards Installed

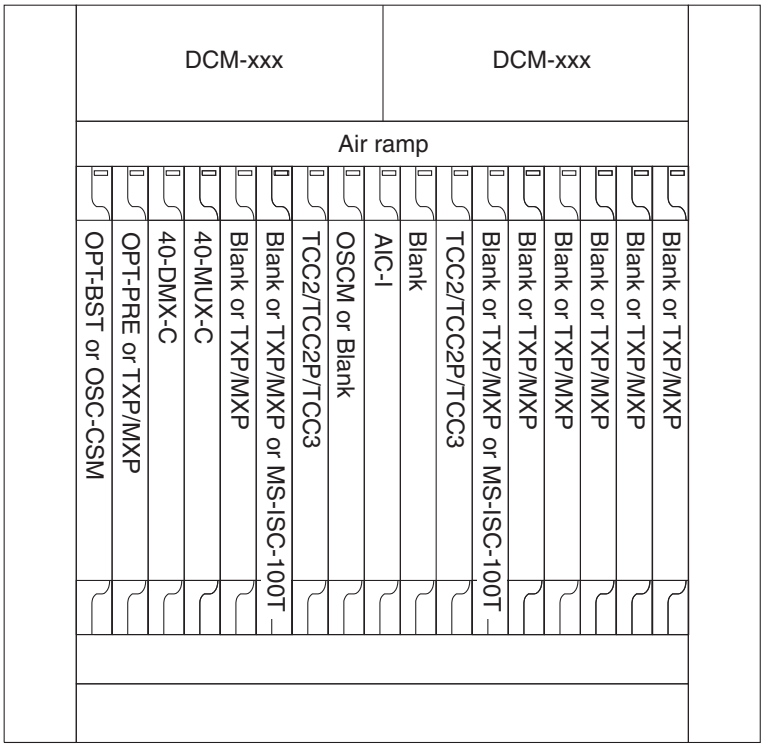
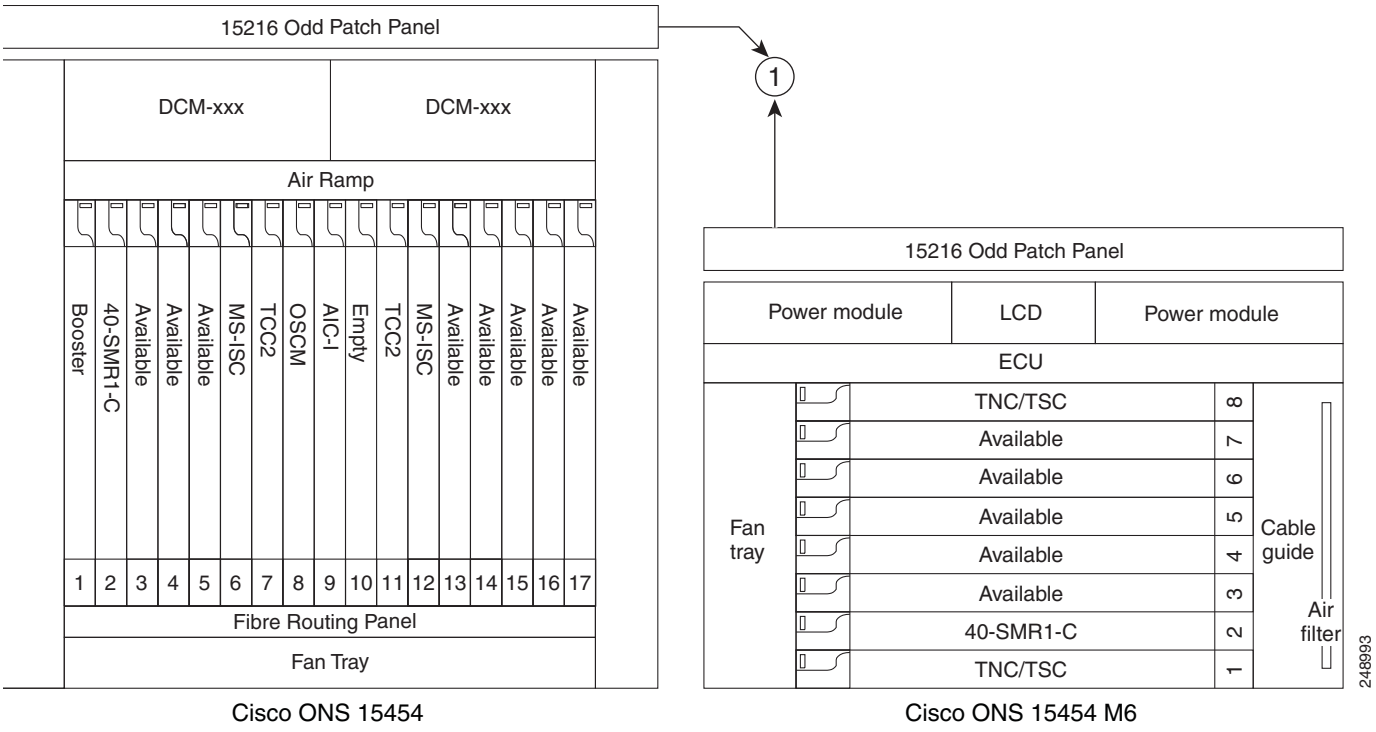


Figure 11-4 shows an example of a terminal configuration with a 40-SMR1-C card installed.

Figure 11-4 Terminal Node with 40-SMR1-C Card Installed - Cisco ONS 15454 and Cisco ONS 15454 M6

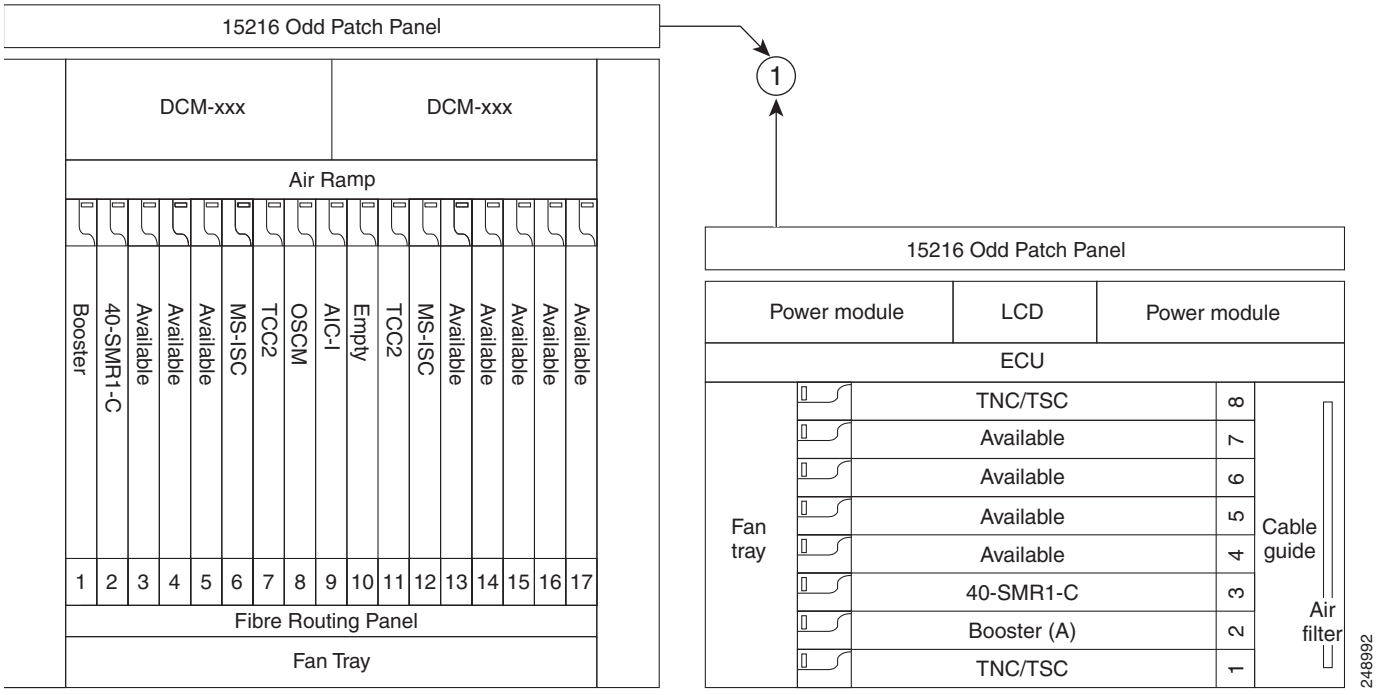


Cisco ONS 15454 Cisco ONS 15454 M6

1	**15216-MD-40-ODD, 15216-EF-40-ODD, or 15216-MD-48-ODD patch panel**

Figure 11-5 shows an example of a terminal configuration with 40-SMR1-C and booster amplifier cards installed.

Figure 11-5 Terminal Node with 40-SMR1-C and Booster Amplifier Cards Installed - Cisco ONS 15454 and Cisco ONS 15454 M6



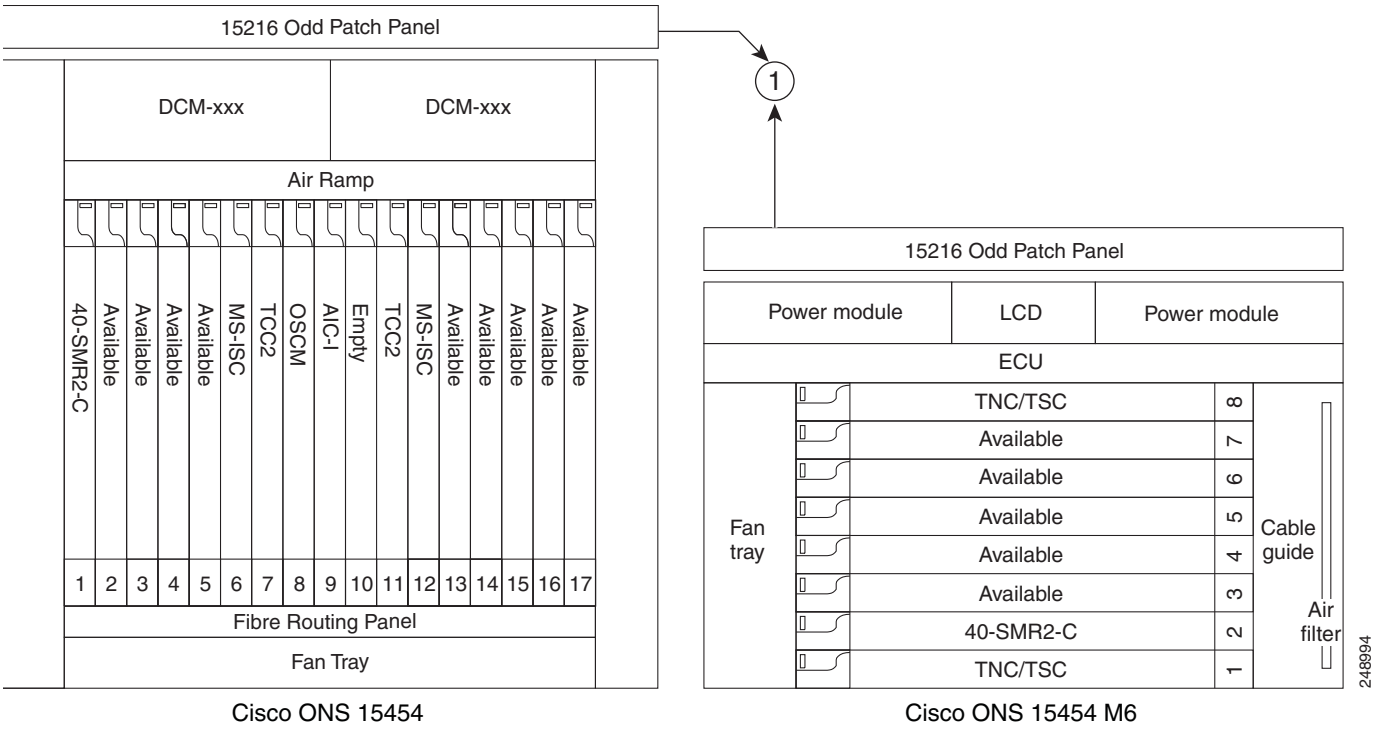
Cisco ONS 15454 Cisco ONS 15454 M6

1	15216-MD-40-ODD, 15216-EF-40-ODD, or 15216-MD-48-ODD patch panel

Note When you use the 40-SMR1-C card along with a booster amplifier, the OSCM card must be connected to the booster amplifier.

Figure 11-6 shows an example of a terminal configuration with a 40-SMR2-C card installed.

Figure 11-6 Terminal Node with 40-SMR2-C Card Installed - Cisco ONS 15454 and Cisco ONS 15454 M6



Cisco ONS 15454 Cisco ONS 15454 M6

1	**15216-MD-40-ODD, 15216-EF-40-ODD, or 15216-MD-48-ODD patch panel**

11.1.2 OADM Node

An OADM node is a single ONS 15454 node equipped with cards installed on both sides and at least one AD-xC-xx.x card or one AD-xB-xx.x card and two TCC2/TCC2P/TCC3/TNC/TSC cards. This configuration supports 32 channels. In an OADM node, channels can be added or dropped independently from each direction and then passed through the reflected bands of all OADMs in the DWDM node (called express path). They can also be passed through one OADM card to another OADM card without using a TDM ITU-T line card (called optical pass-through) if an external patchcord is installed.

Unlike express path, an optical pass-through channel can be converted later to an add/drop channel in an altered ring without affecting another channel. OADM amplifier placement and required card placement is determined by the Cisco TransportPlanner tool or your site plan.

OADM nodes can be amplified or passive. In amplified OADMs, booster and preamplifier cards are installed on bode sides of the node. Figure 11-7 shows an example of an amplified OADM node configuration. In addition, OADM nodes can be asymmetric. Amplifiers may be installed in one side, but not the other. Or preamplifiers may be installed in one side, and a booster in the other.

Figure 11-7 Amplified OADM Node Configuration Example

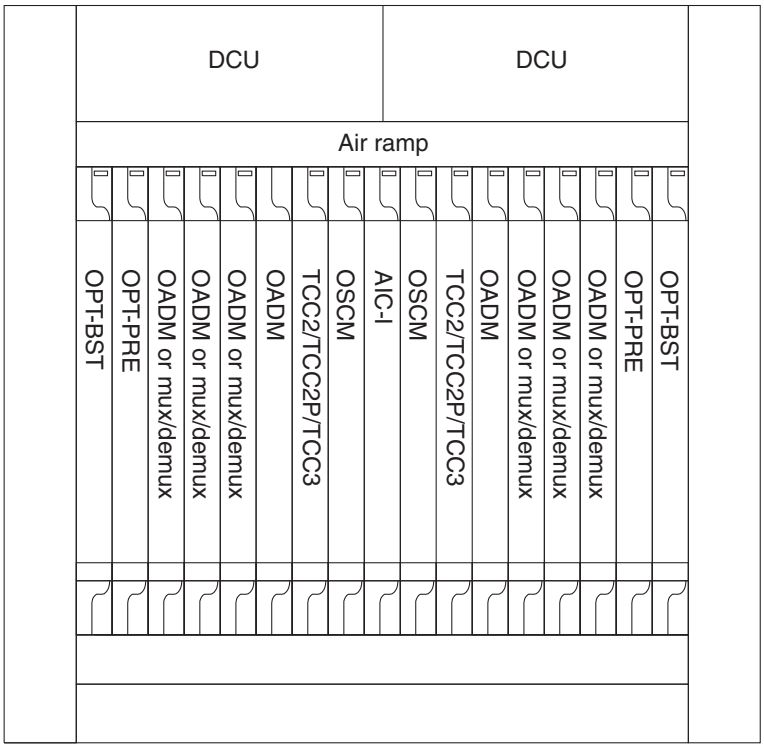
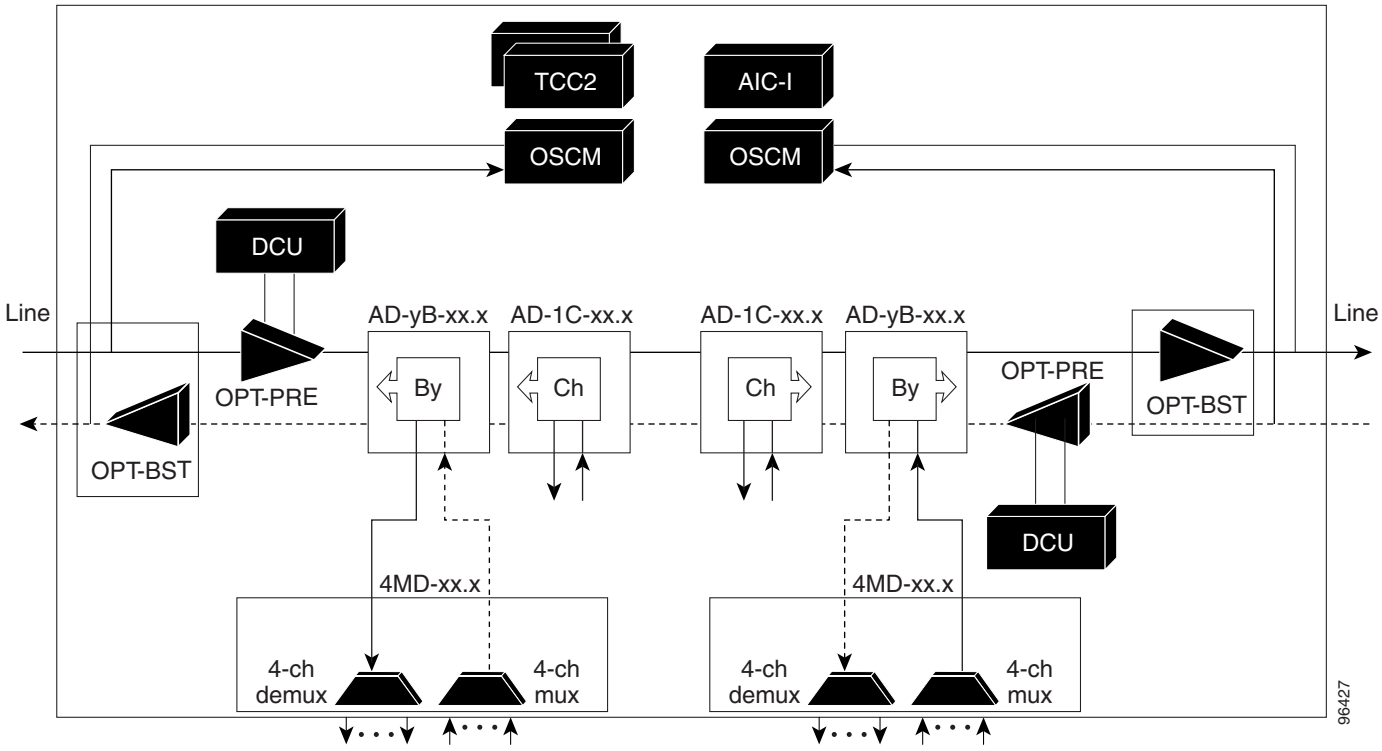


Figure 11-8 shows an example of the channel flow on the amplified OADM node. Since the 32-wavelength plan is based on eight bands (each band contains four channels), optical adding and dropping can be performed at the band level and/or at the channel level (meaning individual channels can be dropped).

Figure 11-8 Amplified OADM Node Channel Flow Example



11.1.3 ROADM Node

A ROADM node adds and drops wavelengths without changing the physical fiber connections. A ROADM node is equipped with two TCC2/TCC2P/TCC3/TNC/TSC cards and one of the following combinations:

- Two 32WSS cards and optionally, two 32DMX or 32DMX-O cards
- Two 40-WSS-C or 40-WSS-CE cards and optionally, two 40-DMX-C or 40-DMX-CE cards
- Two 40-SMR1-C cards and two 15216-MD-40-ODD, 15216-EF-40-ODD, or 15216-MD-48-ODD (ONS 15216 40 or 48-channel mux/demux) patch panels
- Two 40-SMR2-C cards and two 15216-MD-40-ODD, 15216-EF-40-ODD, or 15216-MD-48-ODD (ONS 15216 40 or 48-channel mux/demux) patch panels
- Two 80-WXC-C cards and two 15216-MD-40-ODD, 15216-EF-40-ODD, 15216-MD-48-ODD, 15216-MD-40-EVEN, 15216-EF-40-EVEN, or 15216-MD-48-EVEN patch panels

Note Although it is recommended that you use the 15216-MD-40-ODD, 15216-EF-40-ODD, or 15216-MD-48-ODD patch panel along with the 40-SMR1-C and 40-SMR2-C cards, you can alternatively use the 40-MUX-C and 40-DMX-C cards instead of the 15216-MD-40-ODD, 15216-EF-40-ODD, or 15216-MD-48-ODD patch panel.

Transponders (TXPs) and muxponders (MXPs) can be installed in Slots 6 and 12 and, if amplification is not used, in any open slot.

Note Although not required, 32DMX-O can be used in a ROADM node. Cisco TransportPlanner automatically chooses the demultiplexer card that is best for the ROADM node based on the network requirements.

Figure 11-9 shows an example of an amplified ROADM node configuration with 32DMX cards installed.

Figure 11-9 ROADM Node with 32DMX Cards Installed

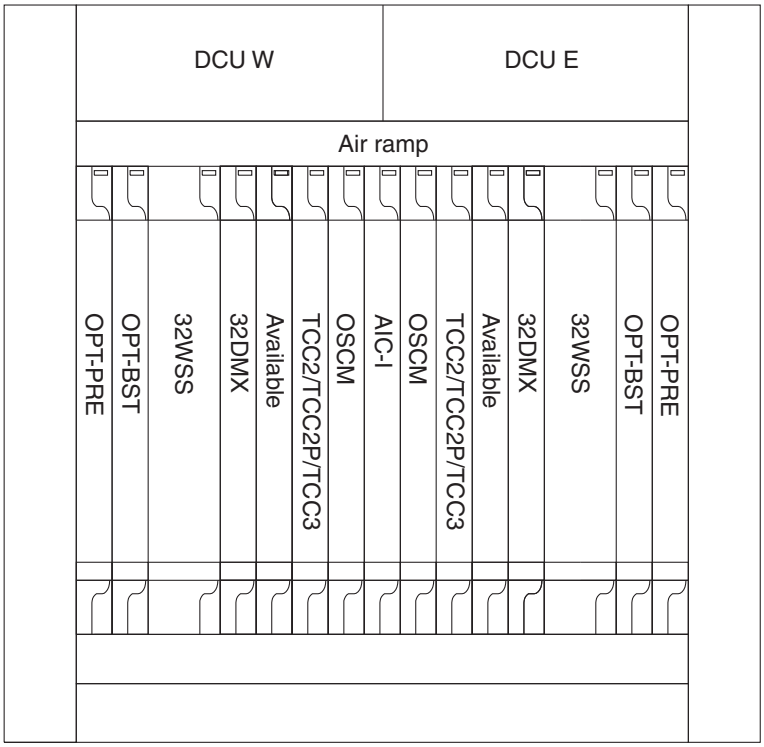


Figure 11-10 shows an example of an amplified ROADM node configuration with 40-WSS-C cards installed.

Figure 11-10 ROADM Node with 40-WSS-C Cards Installed

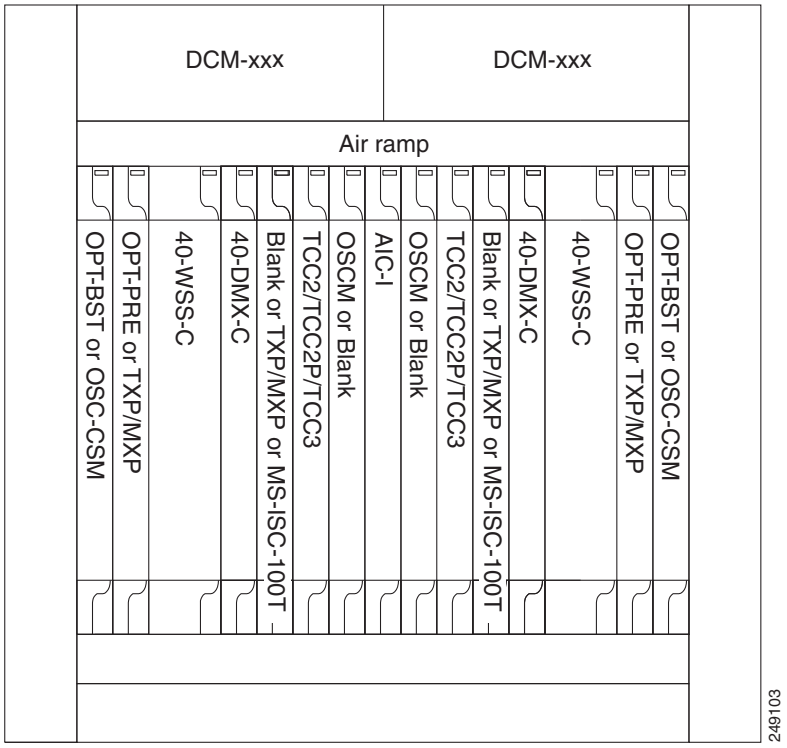
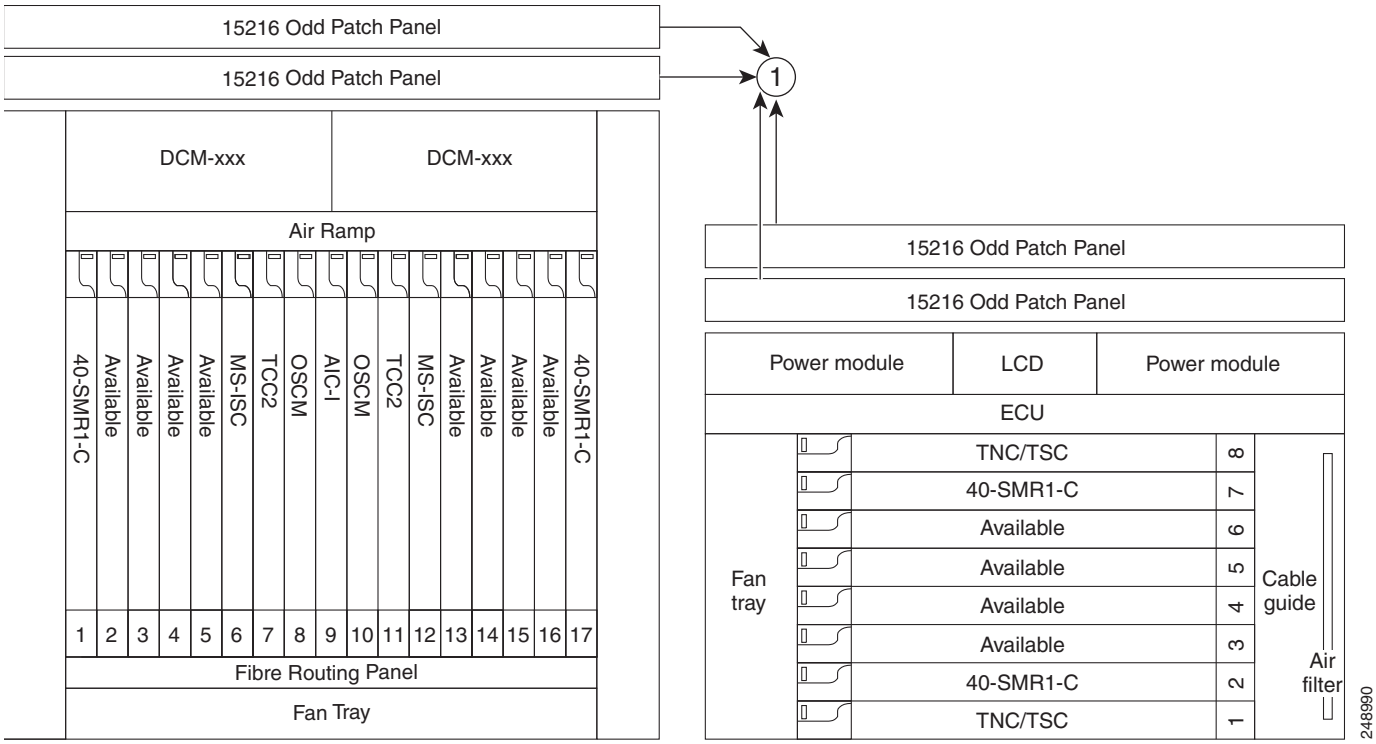


Figure 11-11 shows an example of a ROADM node with 40-SMR1-C cards installed.

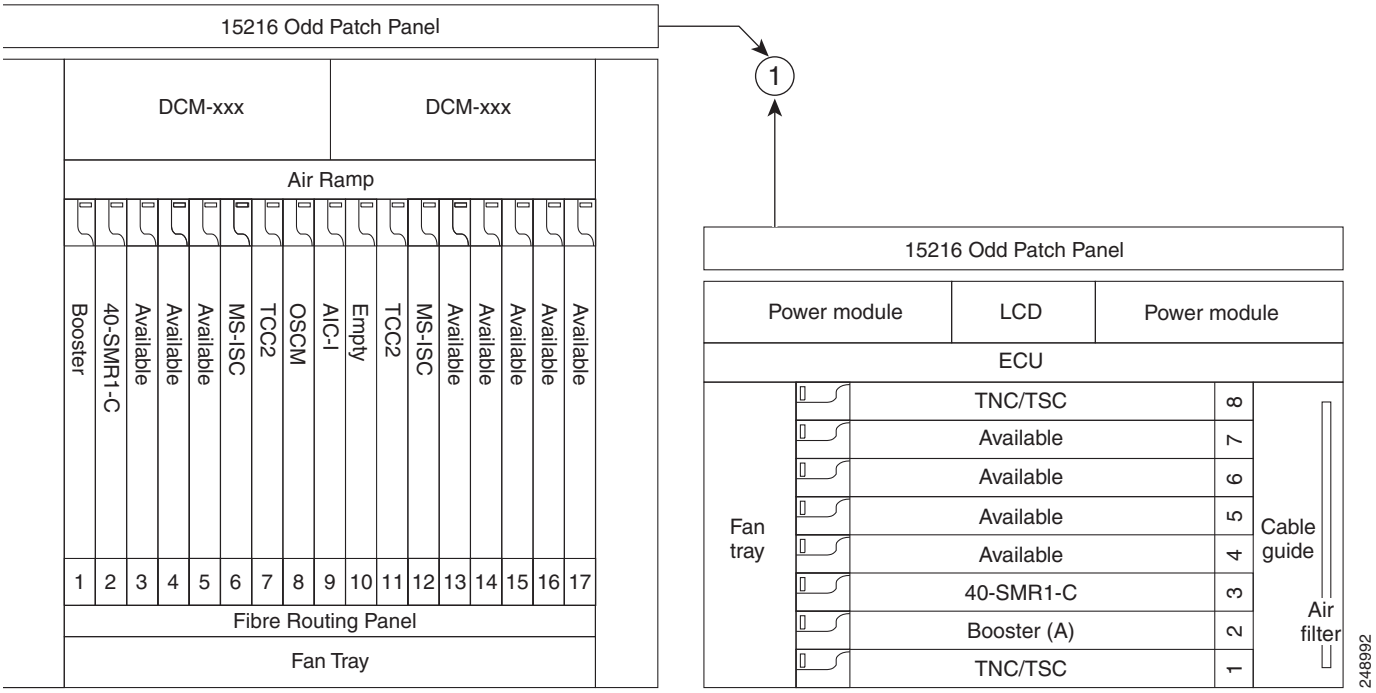
Figure 11-11 ROADM Node with 40-SMR1-C Cards Installed - Cisco ONS 15454 and Cisco ONS 15454 M6



1	**15216-MD-40-ODD, 15216-EF-40-ODD, or 15216-MD-48-ODD patch panel**

Figure 11-12 shows an example of a ROADM node with 40-SMR1-C and booster amplifier cards installed.

Figure 11-12 ROADM Node with 40-SMR1-C and Booster Amplifier Cards Installed - Cisco ONS 15454 and Cisco ONS 15454 M6



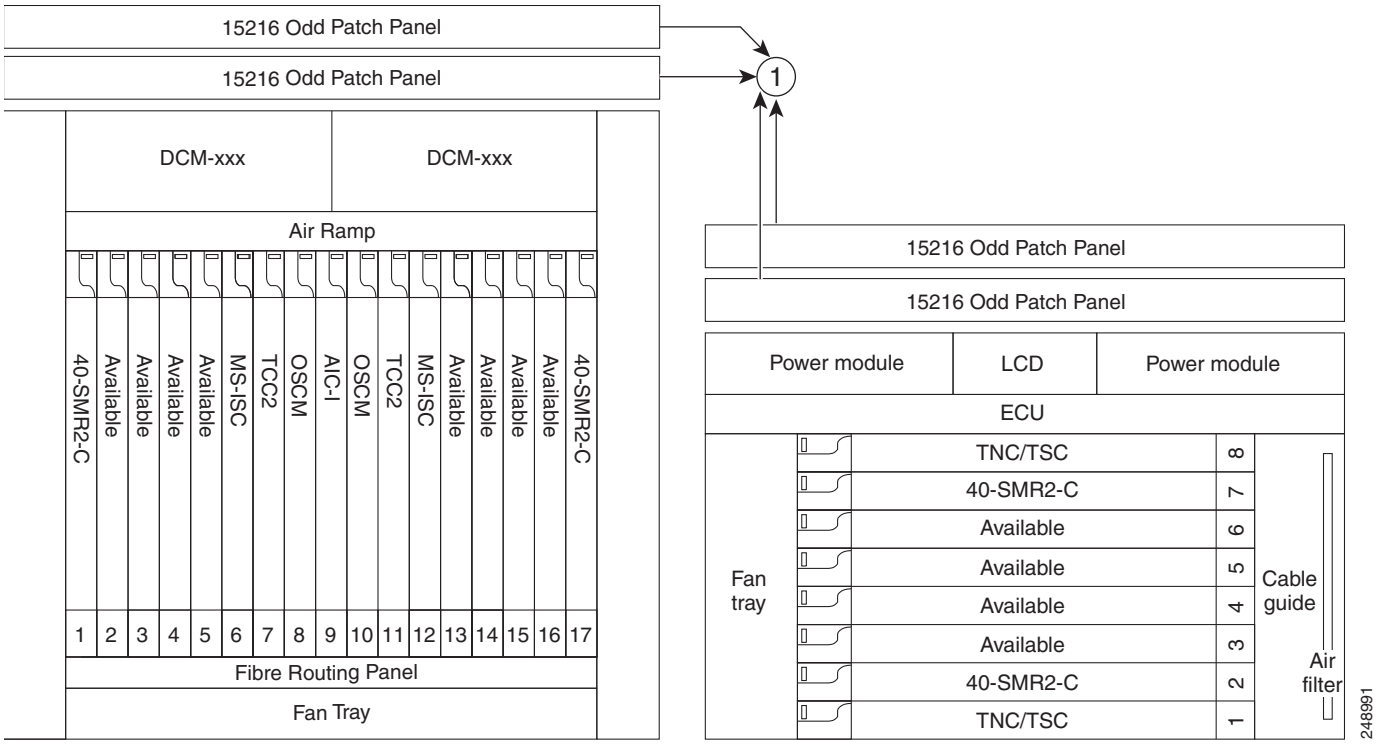
Cisco ONS 15454 Cisco ONS 15454 M6

1	**15216-MD-40-ODD, 15216-EF-40-ODD, or 15216-MD-48-ODD patch panel**

Note When you use the 40-SMR1-C card along with a booster amplifier, the OSCM card must be connected to the booster amplifier.

Figure 11-13 shows an example of a ROADM node with 40-SMR2-C cards installed.

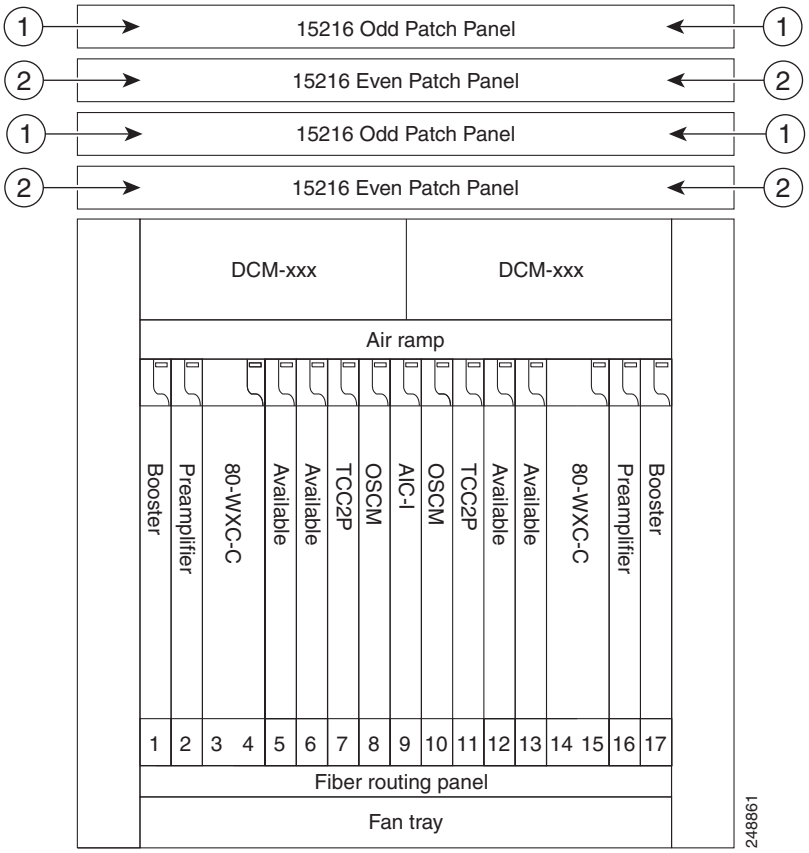
Figure 11-13 ROADM Node with 40-SMR2-C Cards Installed - 15454 - Cisco ONS 15454 and Cisco ONS 15454 M6



1	**15216-MD-40-ODD, 15216-EF-40-ODD, or 15216-MD-48-ODD patch panel**

Figure 11-14 shows the layout of a 80-channel colored two-degree ROADM node.

Figure 11-14 80-Channel Colored Two-Degree ROADM Node

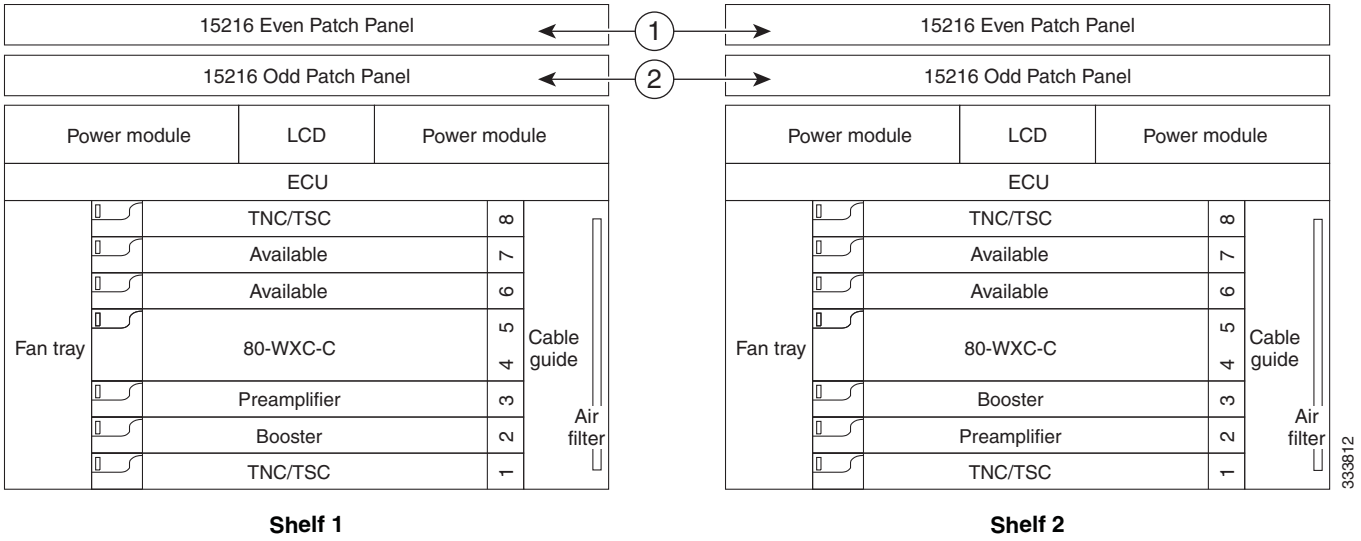


1	15216-MD-40-ODD, 15216-EF-40-ODD, or 15216-MD-48-ODD patch panel
2	15216-MD-40-EVEN, 15216-EF-40-EVEN, or 15216-MD-48-EVEN patch panel

The 80-WXC-C cards are inserted in Slots 3 and 14, and function in the bidirectional mode.

Figure 11-15 shows the layout of an ONS 15454 M6 80-channel colored two-degree ROADM node.

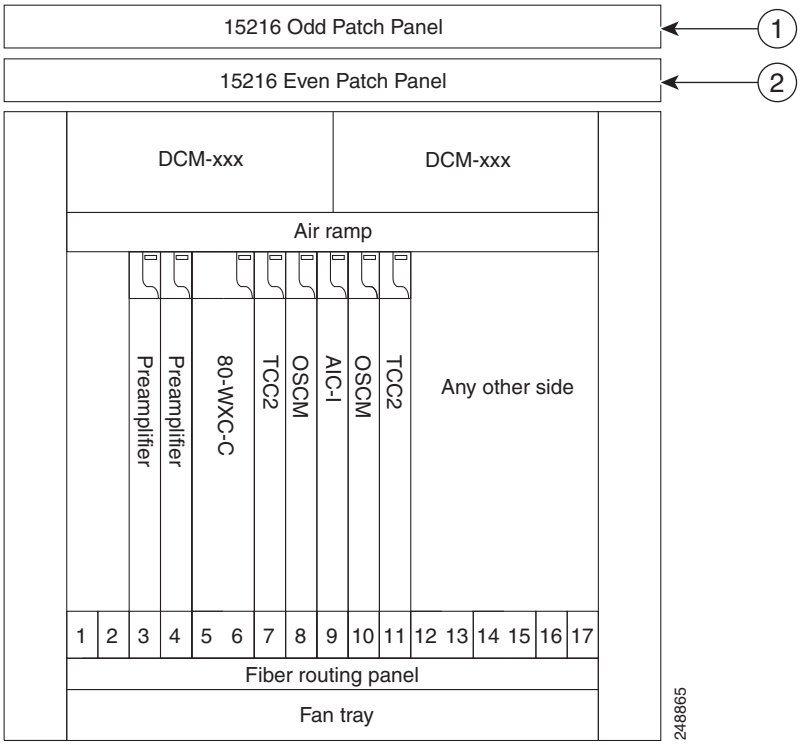
Figure 11-15 ONS 15454 M6 80-Channel Colored Two-degree ROADM Node



1	15216-MD-40-EVEN, 15216-EF-40-EVEN, or 15216-MD-48-EVEN patch panel
2	15216-MD-40-ODD, 15216-EF-40-ODD, or 15216-MD-48-ODD patch panel

Figure 11-16 shows the layout of an 80-channel n-degree ROADM node with omni-directional side.

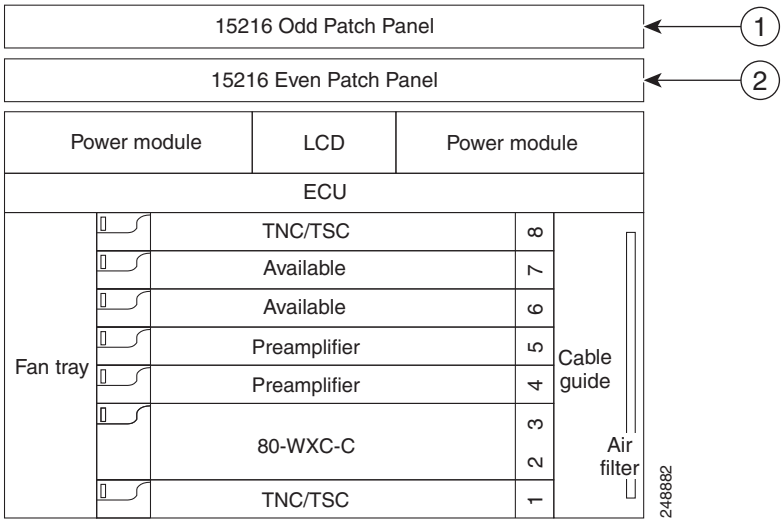
Figure 11-16 80-Channel n-degree ROADM node with Omni-directional Side



1	15216-MD-40-ODD, 15216-EF-40-ODD, or 15216-MD-48-ODD patch panel
2	15216-MD-40-EVEN, 15216-EF-40-EVEN, or 15216-MD-48-EVEN patch panel

Figure 11-17 shows the layout of an ONS 15454 M6 80-channel n-degree ROADM node with omni-directional side.

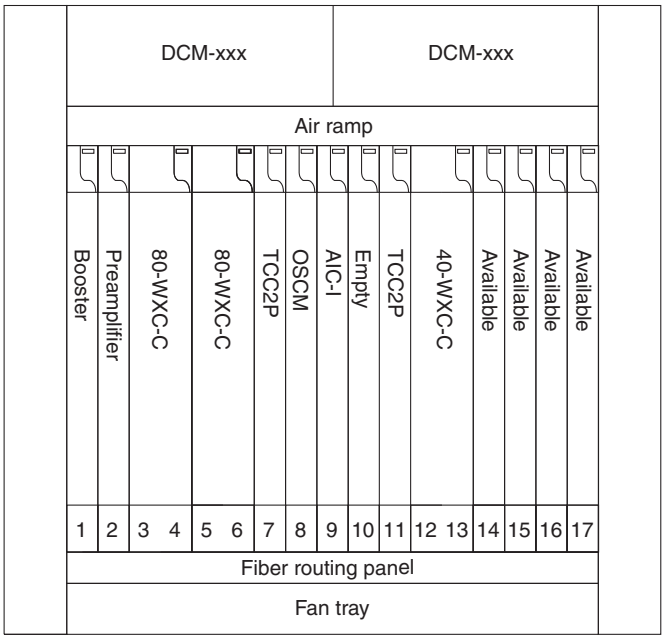
Figure 11-17 ONS 15454 M6 80-Channel n-degree ROADM node with Omni-directional Side



1	**15216-MD-40-ODD, 15216-EF-40-ODD, or 15216-MD-48-ODD patch panel**
2	**15216-MD-40-EVEN, 15216-EF-40-EVEN, or 15216-MD-48-EVEN patch panel**

Figure 11-18 shows the layout of a 40-channel n-degree ROADM node with a 40-WXC-C based colorless side.

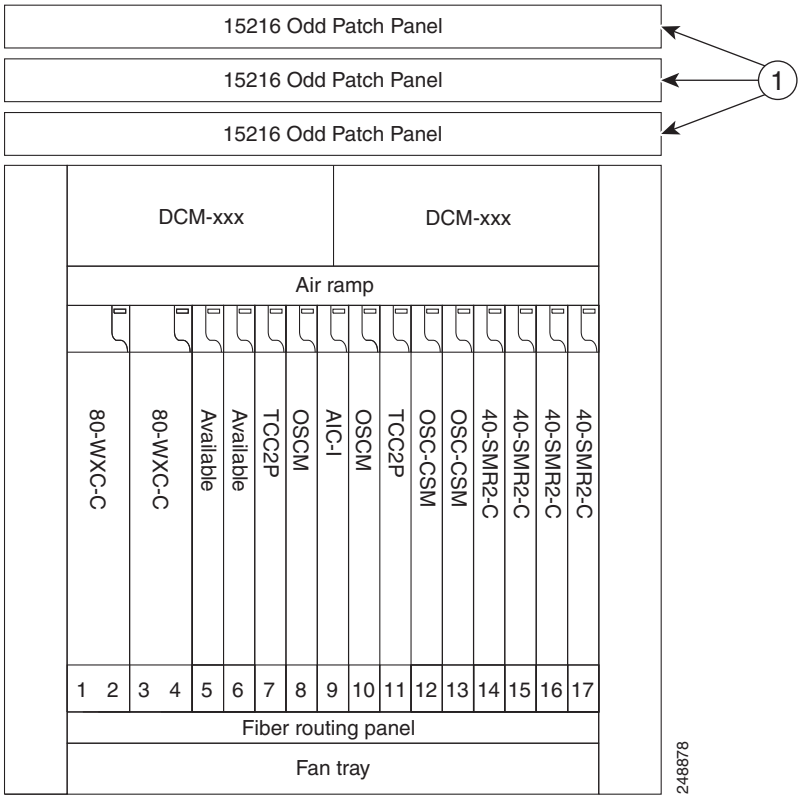
Figure 11-18 40-Channel n-degree ROADM Node with 40-WXC-C Based Colorless Side



The 80-WXC-C cards are connected to the ADD/DROP ports of the 40-WXC-C card and function as colorless multiplexer and demultiplexer units.

Figure 11-19 shows the layout of a 40-channel four-degree ROADM node with a 40-SMR2-C based colorless side.

Figure 11-19 40-Channel Four-degree ROADM Node with 40-SMR2-C Based Colorless Side

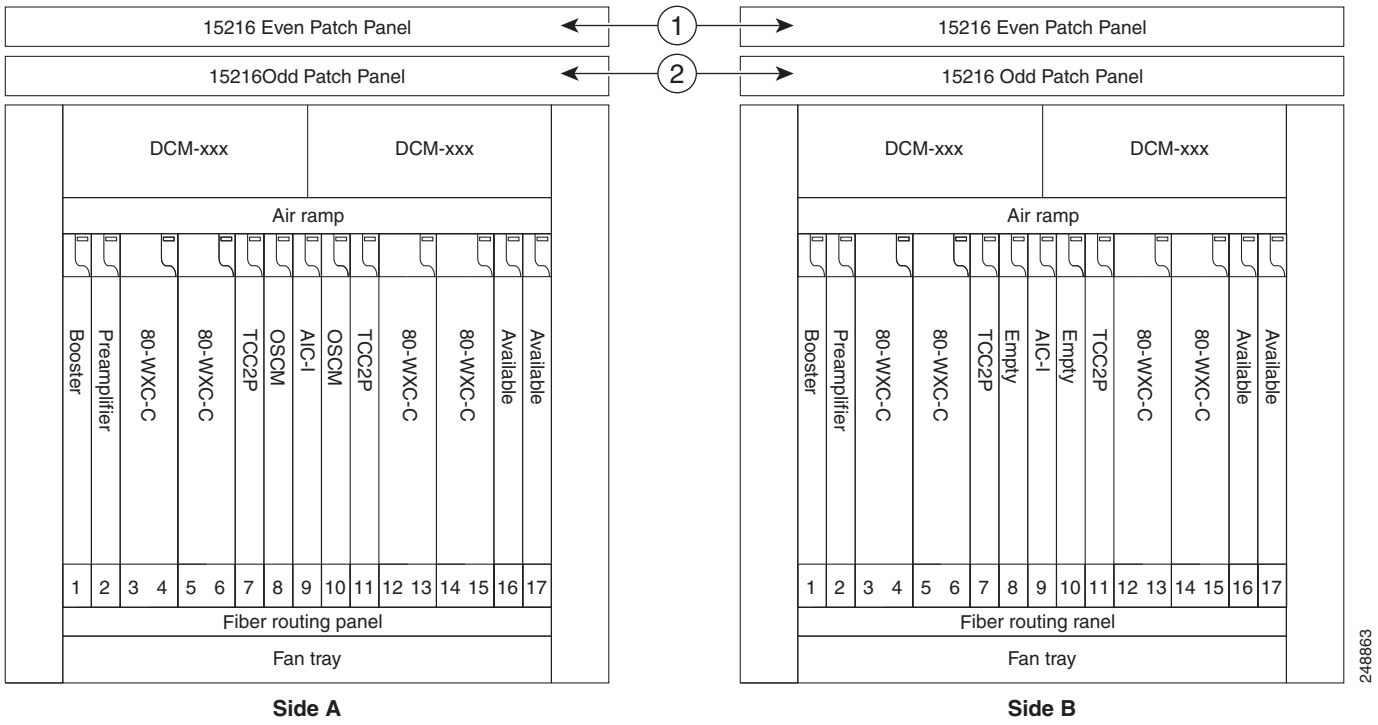


1	15216-MD-40-ODD, 15216-EF-40-ODD, or 15216-MD-48-ODD patch panel

The 80WXC-C (multiplexer) card is inserted in Slot 3 and the 80-WXC-C (demultiplexer) card is inserted in Slot 5. The 80-WXC-C cards are connected to the ADD/DROP ports of the 40-SMR2-C card and function as the colorless multiplexer and demultiplexer units.

Figure 11-20 shows the layout for an 80-channel colorless ROADM node.

Figure 11-20 80-Channel Colorless ROADM Node



1	**15216-MD-40-EVEN, 15216-EF-40-EVEN, or 15216-MD-48-EVEN patch panel**
2	**15216-MD-40-ODD, 15216-EF-40-ODD, or 15216-MD-48-ODD patch panel**

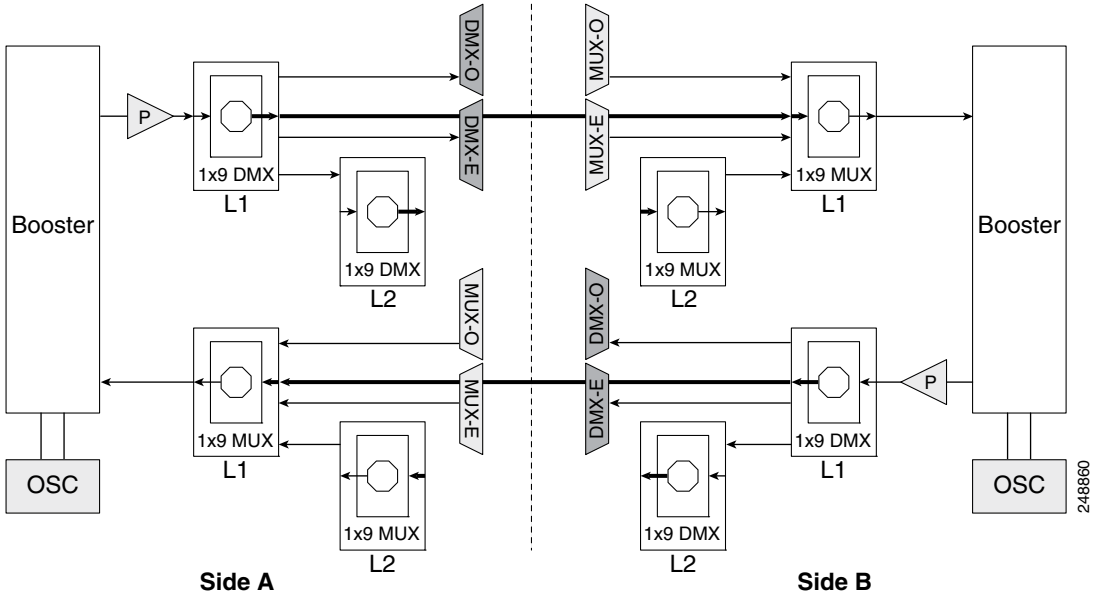
An 80 channel colorless two-degree ROADM node requires the following cards: 80-WXC-C, 15216-MD-40-ODD, 15216-EF-40-ODD, 15216-MD-48-ODD, 15216-MD-40-EVEN, 15216-EF-40-EVEN, 15216-MD-48-EVEN, preamplifiers, and boosters.

The 80-WXC-C cards can be used at two levels; level1 (L1) and level2 (L2).

The L1 80WXC-C (multiplexer) card is inserted in Slot 3 and the L1 80-WXC-C (demultiplexer) card is inserted in Slot 5. The L2 80WXC-C (multiplexer) card is inserted in Slot 12 and the L2 80-WXC-C (demultiplexer) card is inserted in Slot 14.

Figure 11-21 shows an example of the optical signal flow in an 80-channel colorless two-degree ROADM node from Side A to Side B using 80-WXC-C cards. The optical signal flow from Side B to Side A follows an identical path.

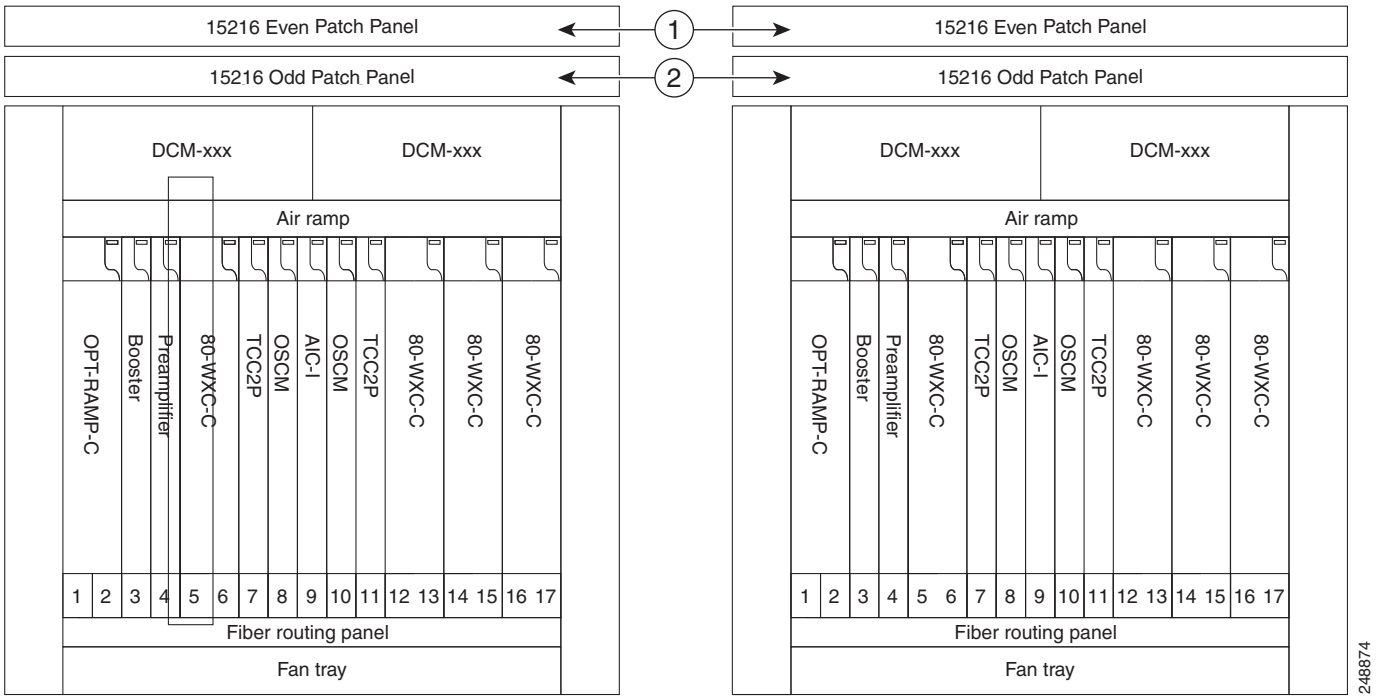
Figure 11-21 80-Channel Colorless Two-degree ROADM Node



1	The booster on Side A receives the composite optical signal. It separates the optical service channel from the optical payload and sends the payload to the preamplifier on Side A.
2	The preamplifier compensates for chromatic dispersion, amplifies the optical payload and sends it to the L1 80-WXC-C card (demultiplexer).
3	Up to eight colorless ports are available on the L1 80-WXC-C card if no colored wavelength is terminated. In Figure 11-21, two EAD ports are connected to 40-DMX-C or 40-DMX-CE cards, 15216-MD-40-ODD, 15216-EF-40-ODD, 15216-MD-48-ODD, 15216-MD-40-EVEN, 15216-EF-40-EVEN, or 15216-MD-48-EVEN units where the colored odd and even wavelengths are dropped. The express wavelengths are sent to the L1 80-WXC-C card (multiplexer) on Side B where the wavelengths are multiplexed with other colored or colorless wavelengths.
4	The L1-80-WXC-C card on Side B sends the composite signal to the booster on Side B.
5	The booster on Side B receives the composite optical signal, adds the optical service channel to the optical payload and sends it to the transmission line.
6	It is possible to configure more colorless ports by cascading the 80-WXC-C cards at two levels. For example, to get 14 colorless ports connect one of the EAD ports of the L1 80-WXC-C card to another 80-WXC-C cards at level 2. There are five colorless ports on the L1 80-WXC-C card and nine colorless ports on the L2 80-WXC-C card. To achieve an 80 channel colorless configuration, connect nine L2 80-WXC-C cards to the nine EAD ports of the L1 80-WXC-C card.

Figure 11-22 shows the layout for an 80-channel colorless ROADM node with OPT-RAMP-C cards.

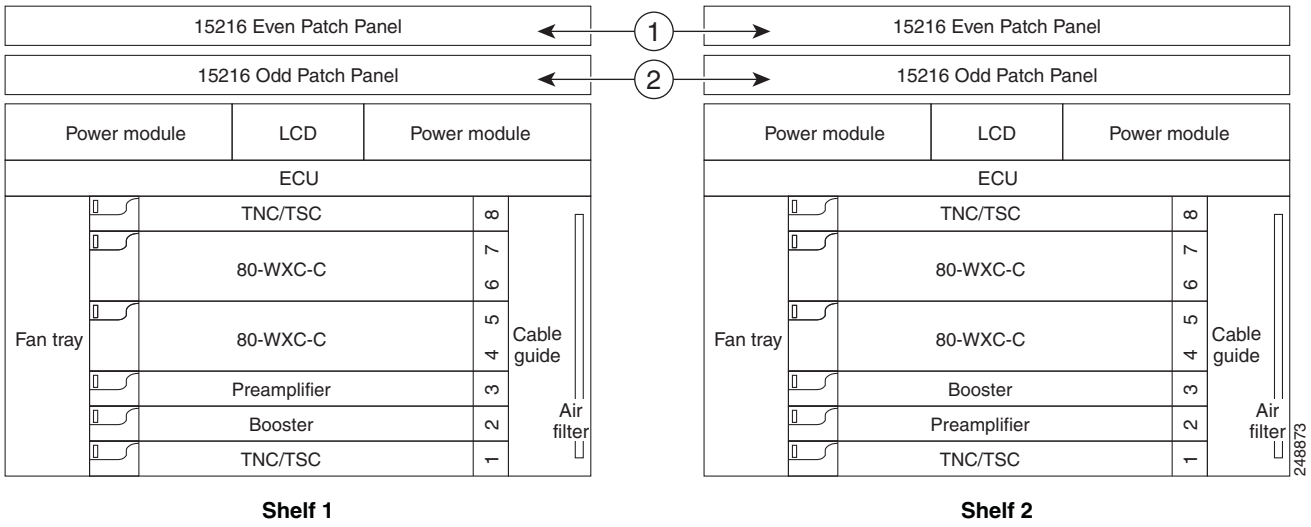
Figure 11-22 80-Channel Colorless ROADM Node with OPT-RAMP-C Card



1	15216-MD-40-EVEN, 15216-EF-40-EVEN, or 15216-MD-48-EVEN patch panel
2	15216-MD-40-ODD, 15216-EF-40-ODD, or 15216-MD-48-ODD patch panel

Figure 11-23 shows an example of an ONS 15454 M6 80-channel two degree colorless ROADM node.

Figure 11-23 ONS 15454 M6 80-Channel Two-degree Colorless ROADM Node

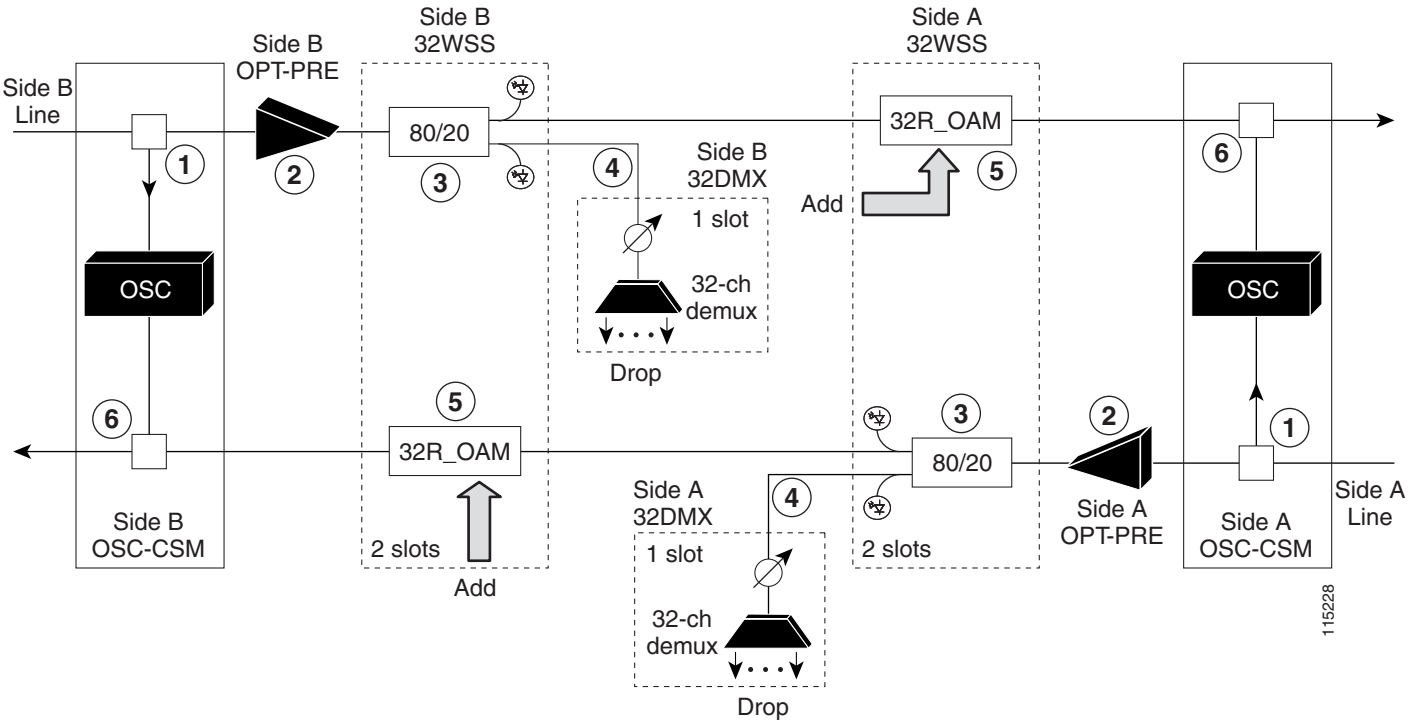


1	15216-MD-40-EVEN, 15216-EF-40-EVEN, or 15216-MD-48-EVEN patch panel
2	15216-MD-40-ODD, 15216-EF-40-ODD, or 15216-MD-48-ODD patch panel

The L1 80WXC-C (multiplexer) card is inserted in Slot 4 and the L1 80-WXC-C (demultiplexer) is inserted in Slot 6. The L2 80WXC-C (multiplexer) card is inserted in Slot 2 and the L2 80-WXC-C (demultiplexer) is inserted in Slot 4.

Figure 11-24 shows an example of a ROADM optical signal flow from Side A to Side B using the 32WSS or 40-WSS-C cards. The optical signal flow from Side B to Side A follows an identical path through the Side B OSC-CSM and 32WSS or 40-WSS-C cards. In this example, OSC-CSM cards are installed, hence OPT-BSTs are not needed.

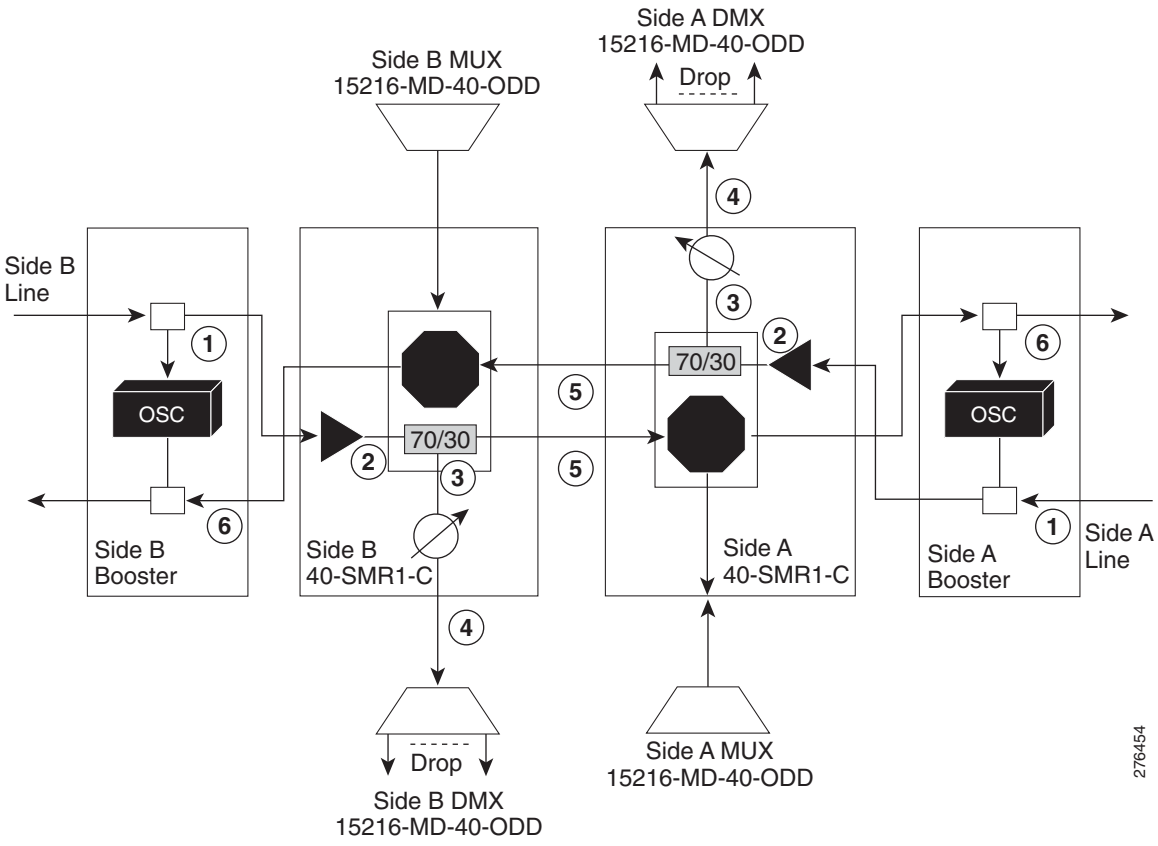
Figure 11-24 ROADM Optical Signal Flow Example Using 32WSS or 40-WSS-C Card



1	The OSC-CSM receives the optical signal. It separates the optical service channel from the optical payload and sends the payload to the OPT-PRE module.
2	The OPT-PRE compensates for chromatic dispersion, amplifies the optical payload, and sends it to the 32WSS or 40-WSS-C/40-WSS-CE.
3	The 32WSS or 40-WSS-C/40-WSS-CE splits the signal into two components. The 80 percent component is sent to the DROP-TX port and the 20 percent component is sent to the EXP-TX port.
4	The drop component goes to the 32DMX card or 40-DMX-C/40-DMX-CE card where it is demultiplexed and dropped.
5	The express wavelength aggregate signal goes to the 32WSS or 40-WSS-C/40-WSS-CE on the other side where it is demultiplexed. Channels are stopped or forwarded based upon their switch states. Forwarded wavelengths are merged with those coming from the ADD path and sent to the OSC-CSM module.
6	The OSC-CSM combines the multiplexed payload with the OSC and sends the signal out the transmission line.

Figure 11-25 shows an example of an ROADM optical signal flow from Side A to Side B using the 40-SMR1-C card. The optical signal flow from Side B to Side A follows an identical path through the Side B booster and 40-SMR1-C card.

Figure 11-25 ROADM Optical Signal Flow Example Using 40-SMR1-C Card



1	The booster receives the optical signal. It separates the optical service channel from the optical payload and sends the payload to the preamplifier module within the 40-SMR1-C card.
2	The preamplifier module compensates for chromatic dispersion, amplifies the optical payload, and sends it to the 70/30 splitter within the 40-SMR1-C card.
3	The 70/30 splitter splits the signal into two components. The 70 percent component is sent to the DROP-TX port and the 30 percent component is sent to the EXP-TX port.
4	The drop component goes to the 15216-MD-40-ODD, 15216-EF-40-ODD, or 15216-MD-48-ODD card where it is demultiplexed and dropped.
5	The express wavelength aggregate signal goes to the 40-SMR1-C card on the other side where it is demultiplexed. Channels are stopped or forwarded based upon their switch states. Forwarded wavelengths are merged with those coming from the ADD path and sent to the booster module.
6	The booster combines the multiplexed payload with the OSC, amplifies it, and sends the signal out the transmission line.

11.1.4 Hub Node

A hub node is a single ONS 15454 node equipped with two TCC2/TCC2P/TCC3/TNC/TSC cards and one of the following combinations:

- Two 32MUX-O cards and two 32DMX-O or 32DMX cards
- Two 32WSS cards and two 32DMX or 32DMX-O cards

- Two 40-WSS-C or 40-WSS-CE cards and two 40-DMX-C or 40DMX-CE cards
- Two 40-SMR1-C and two 15216-MD-40-ODD, 15216-EF-40-ODD, or 15216-MD-48-ODD (ONS 15216 40 or 48-channel mux/demux patch panel)
- Two 40-SMR2-C and two 15216-MD-40-ODD, 15216-EF-40-ODD, or 15216-MD-48-ODD

Note Although it is recommended that you use the 15216-MD-40-ODD, 15216-EF-40-ODD, or 15216-MD-48-ODD card along with the 40-SMR1-C and 40-SMR2-C cards, you can alternatively use the 40-MUX-C and 40-DMX-C cards instead of the 15216-MD-40-ODD, 15216-EF-40-ODD, or 15216-MD-48-ODD card.

Note The configuration for a hub node using 40-SMR1-C or 40-SMR2-C cards is identical to the ROADM node, except that there is no patchcord connecting the two 40-SMR1-C or 40-SMR2-C cards. For more details on the ROADM node configuration, see the "11.1.3 ROADM Node" section on page 11-10.

Note The 32WSS/40-WSS-C/40-WSS-CE and 32DMX/32DMX-L/40-DMX-C/ 40-DMX-CE cards are normally installed in ROADM nodes, but they can also be installed in hub and terminal nodes. If the cards are installed in a hub node, the 32WSS/32WSS-L/ 40-WSS-C/40-WSS-CE express ports (EXP RX and EXP TX) are not cabled.

A dispersion compensation unit (DCU) can also be added, if necessary. Figure 11-26 shows a hub node configuration with 32MUX-O and 32DMX-O cards installed.

Figure 11-26 Hub Node Configuration Example with 32-Channel C-Band Cards

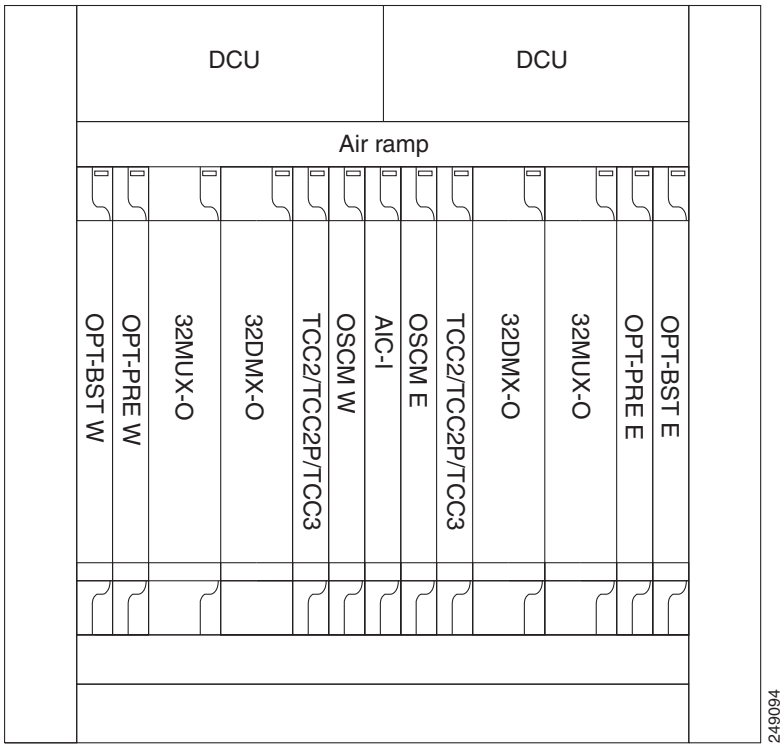


Figure 11-27 shows a 40-channel hub node configuration with 40-WSS-C cards installed.

Figure 11-27 Hub Node Configuration Example with 40-WSS-C Cards

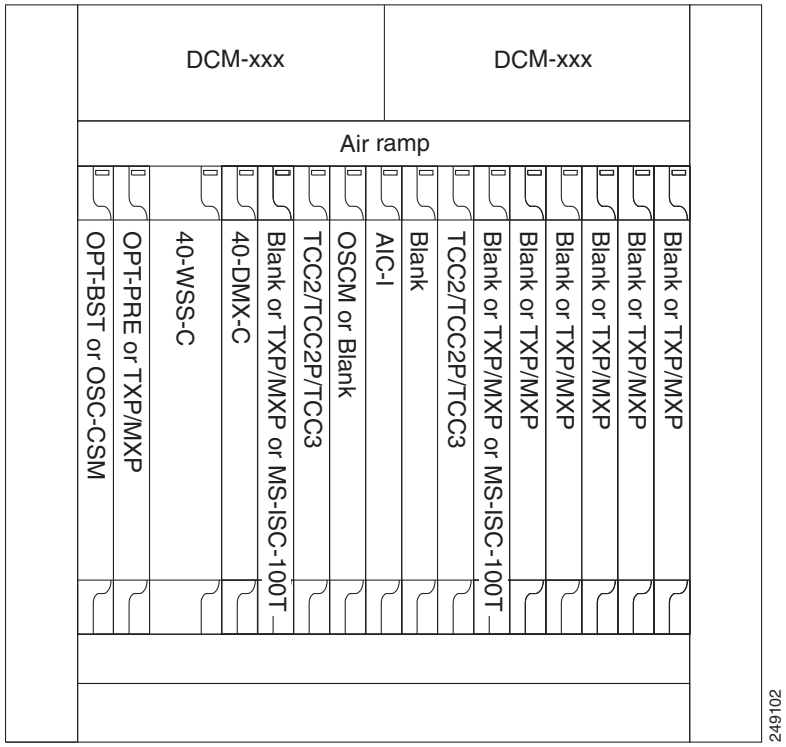
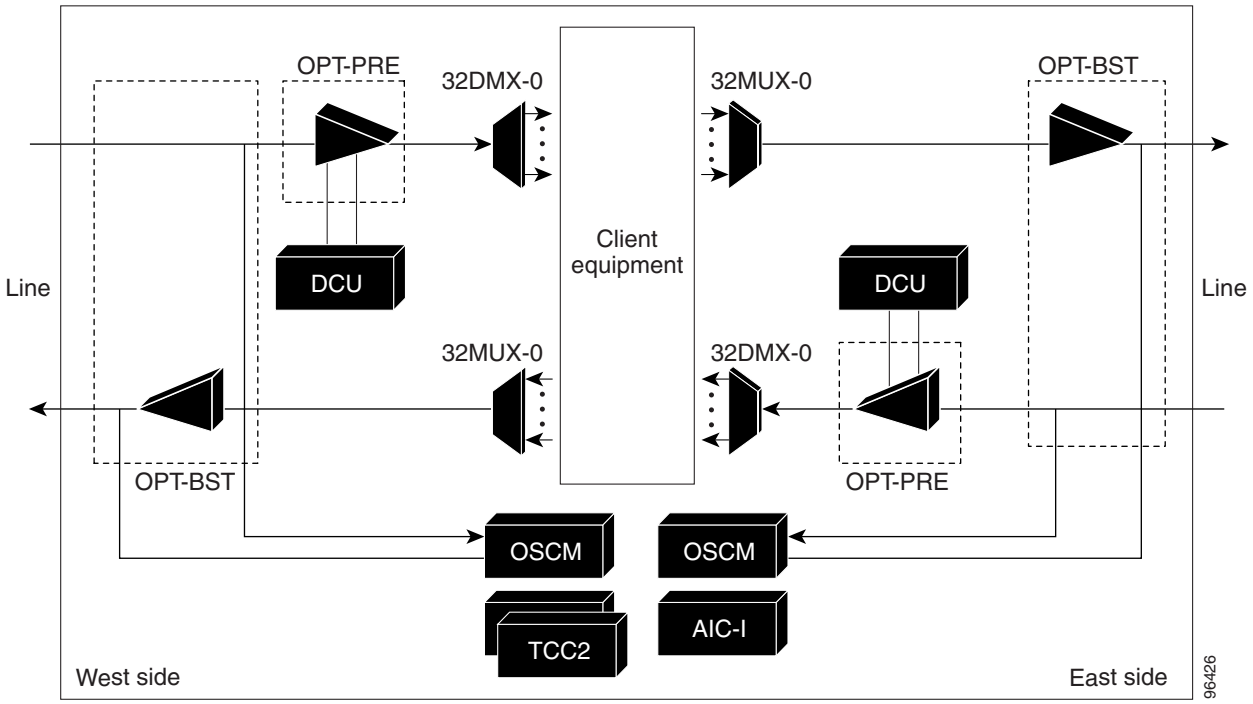


Figure 11-28 shows the channel flow for a hub node. Up to 32 channels from the client ports are multiplexed and equalized onto one fiber. Then, multiplexed channels are transmitted to the OPT-BST amplifier. The OPT-BST output is combined with an output signal from the OSCM card and transmitted to the other side.

Received signals are divided between the OSCM card and an OPT-PRE card. Dispersion compensation is applied to the signal received by the OPT-PRE amplifier, and it is then sent to the 32DMX-O card, which demultiplexes and attenuates the input signal.

Figure 11-28 Hub Node Channel Flow Example



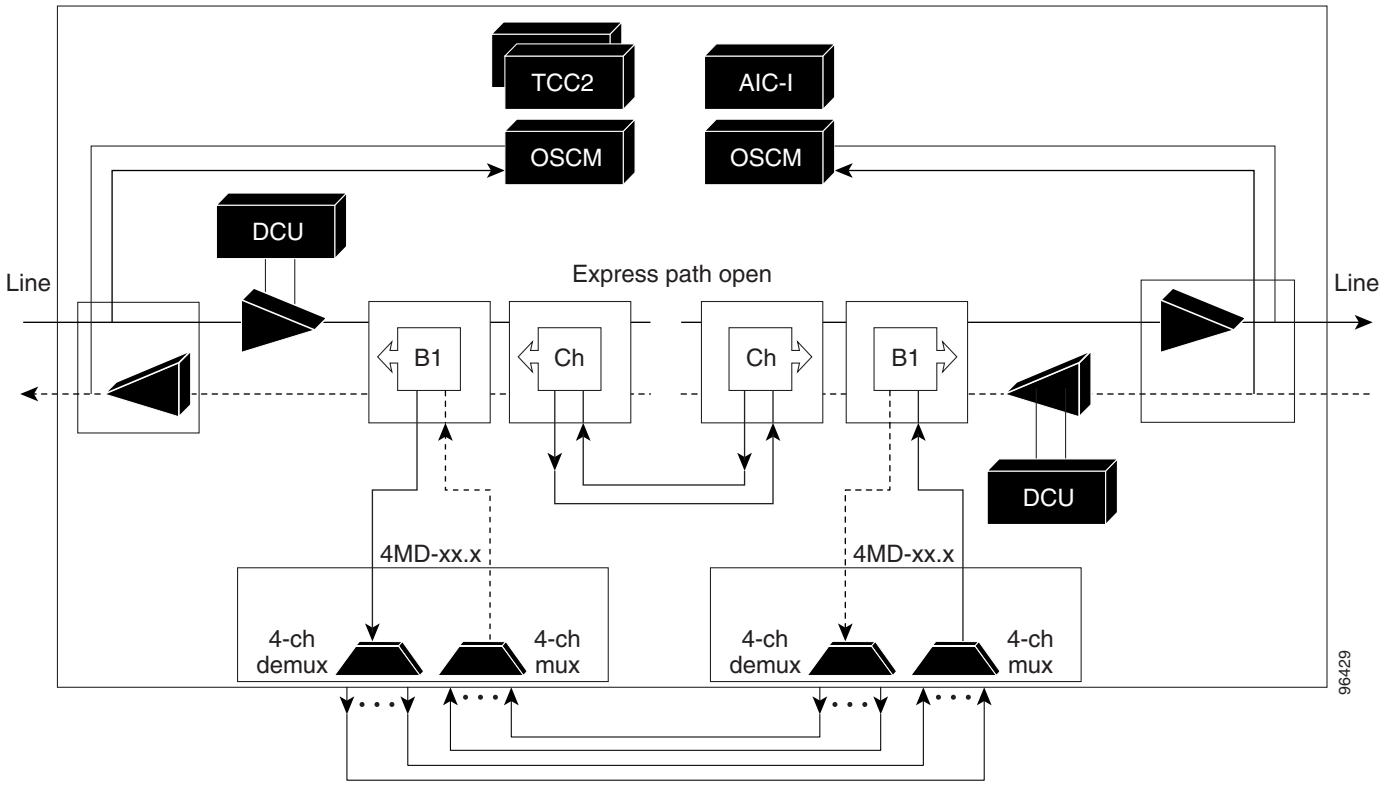
11.1.5 Anti-ASE Node

In a mesh ring network, the ONS 15454 requires a node configuration that prevents ASE accumulation and lasing. An anti-ASE node can be created by configuring a hub node or an OADM node with some modifications. No channels can travel through the express path, but they can be demultiplexed and dropped at the channel level on one side and added and multiplexed on the other side.

The hub node is the preferred node configuration when some channels are connected in pass-through mode. For rings that require a limited number of channels, combine AD-xB-xx.x and 4MD-xx.x cards, or cascade AD-xC-xx.x cards. See Figure 11-8 on page 11-10.

Figure 11-29 shows an anti-ASE node that uses all wavelengths in the pass-through mode. Use Cisco TransportPlanner to determine the best configuration for anti-ASE nodes.

Figure 11-29 Anti-ASE Node Channel Flow Example



11.1.6 Line Amplifier Node

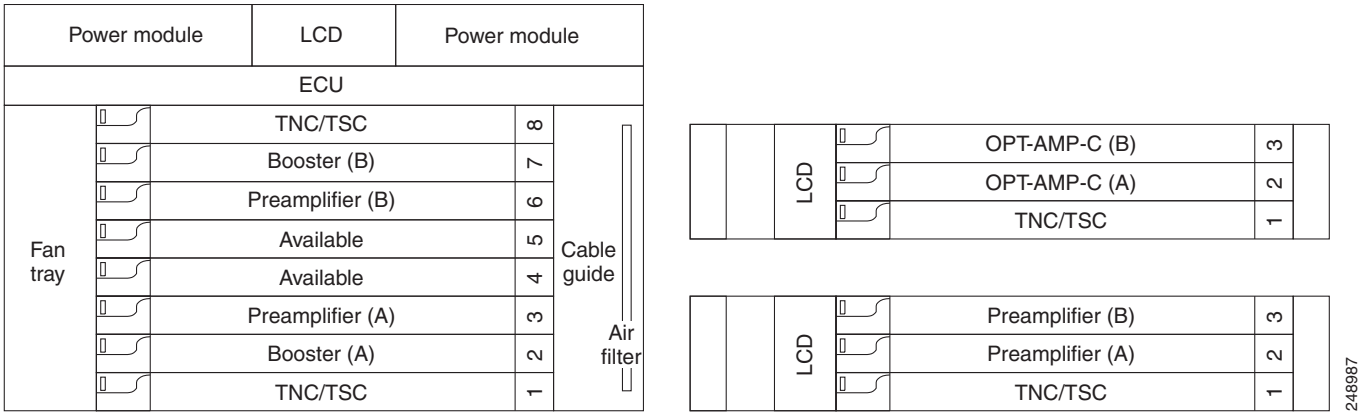
A line amplifier node is a single ONS 15454 node that is used to amplify the optical signal in long spans. The line amplifier node can be equipped with one of the following sets of cards:

- Two OPT-PRE cards, two OPT-BST cards, and two OSCM cards
- Two OPT-PRE cards and two OSC-CSM cards
- Two OPT-AMP-17-C cards and two OSCM cards
- Two OPT-AMP-C cards and two OSCM cards

Attenuators might also be required between each preamplifier and OPT-BST amplifier to match the optical input power value and to maintain the amplifier gain tilt value.

Two OSCM cards are connected to the OPT-BST cards to multiplex the OSC signal with the pass-though channels. If the node does not contain a booster card, OSC-CSM cards must be installed instead of OSCM cards. Figure 11-30 shows an example of a line amplifier node configuration using OPT-BST, OPT-PRE, and OSCM cards.

Figure 11-30 Line Amplifier Node Configuration Example - Cisco ONS 15454 M6 and Cisco ONS 15454 M2



Cisco ONS 15454 M6 Cisco ONS 15454 M2

11.1.7 OSC Regeneration Node

The OSC regeneration node is added to the DWDM networks for two purposes:

- To electrically regenerate the OSC channel whenever the span links are 37 dB or longer and payload amplification and add/drop capabilities are not present. Cisco TransportPlanner places an OSC regeneration node in spans longer than 37 dB. The span between the OSC regeneration node and the next DWDM network site cannot be longer than 31 dB.
- To add data communications network (DCN) capability wherever needed within the network.

OSC regeneration nodes require two OSC-CSM cards, as shown in Figure 11-31. The cards are installed in each side of the shelf.

Figure 11-31 OSC Regeneration Line Node Configuration Example - Cisco ONS 15454, Cisco ONS 15454 M6, and Cisco ONS 15454 M2

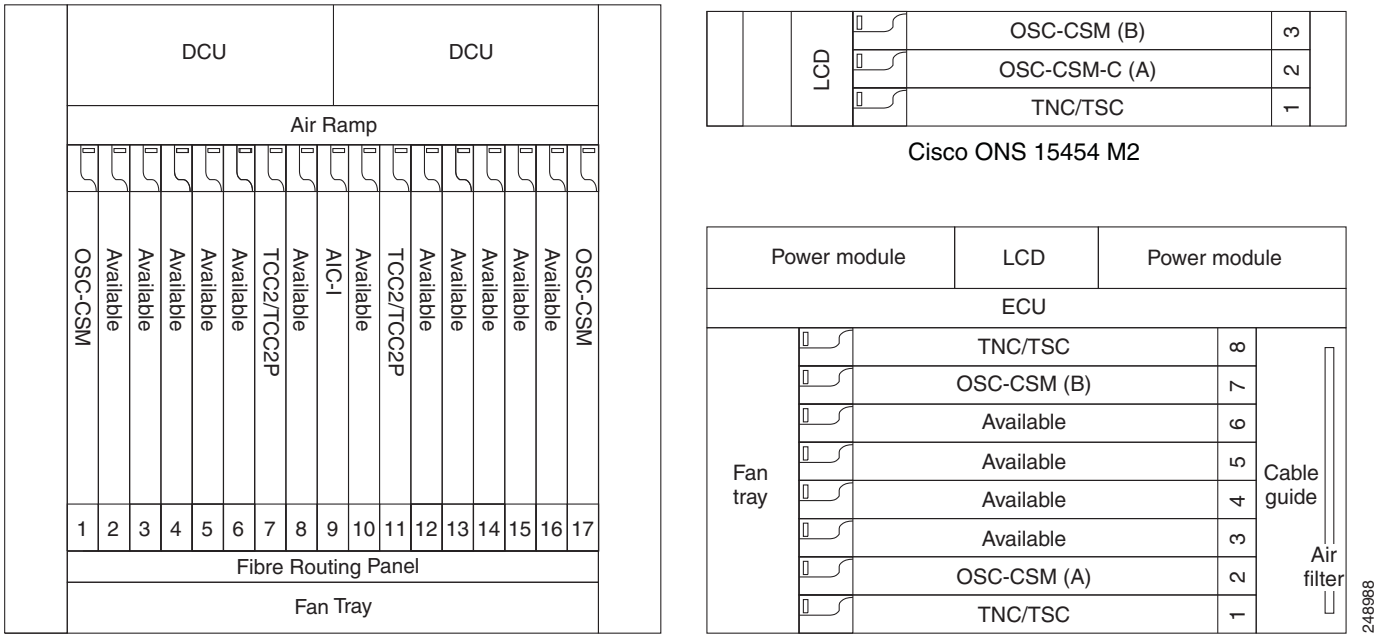
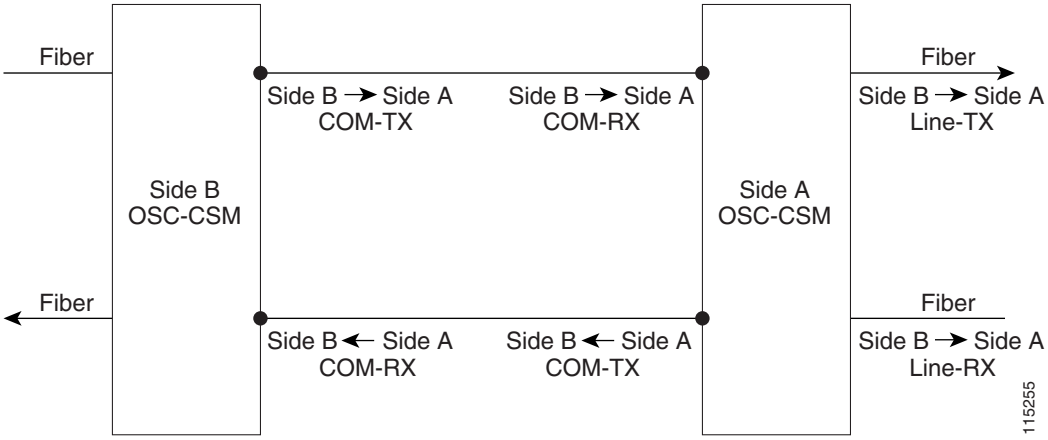


Figure 11-32 shows the OSC regeneration line node signal flow.

Figure 11-32 OSC Regeneration Line Node Flow



11.2 Supported Node Configurations for OPT-RAMP-C and OPT-RAMP-CE Cards

The OPT-RAMP-C and OPT-RAMP-CE cards can be equipped in the following network element type configurations:

- C-band odd systems:

  - C-band terminal site with 32-MUX-O and 32-DMX-O cards
  - C-band hub node with 32-MUX-O and 32-DMX-O cards
  - C-band fixed OADM node
  - C-band line site
  - C-band 32-channel reconfigurable OADM (ROADM)
  - C-band terminal site using a 32-WSS and 32-DMX cards
  - C-band flexible terminal site using AD-xC cards
  - C-band hub node using a 32-WSS and 32-DMX cards
  - C-band 40-channel ROADM
  - C-band terminal site using a 40-WSS-C and 40-DMX-C cards
  - C-band terminal site using 40-MUX-C and 40-DMX-C cards
  - C-band hub node using a 40-WSS-C and 40-DMX-C cards
  - C-band up to 4 degree mesh node
  - C-band up to 8 degree mesh node
  - C-band multiring/mesh with MMU node
  - C-band 4 degree multiring/mesh node (MMU based)
- C-band odd and even systems:
  - C-band 64-channel terminal site
  - C-band 72-channel terminal site
  - C-band 80-channel terminal site
  - C-band 64-channel hub site
  - C-band 72-channel hub site
  - C-band 80-channel hub site
  - C-band 64-channel ROADM site
  - C-band 72-channel ROADM site
  - C-band 80-channel ROADM site

The following amplifier cards are defined as booster or preamplifiers:

- Booster:
  - OPT-BST
  - OPT-BST-E
  - OPT-AMP-17-C
  - OPT-AMP-C
- Preamplifier:
  - OPT-PRE
  - OPT-AMP-C
  - OPT-BST
  - OPT-BST-E

Note When the booster is not needed, it must be replaced with an OSC-CSM card.

The maximum number of shelves that can be aggregated in a multishelf node are:

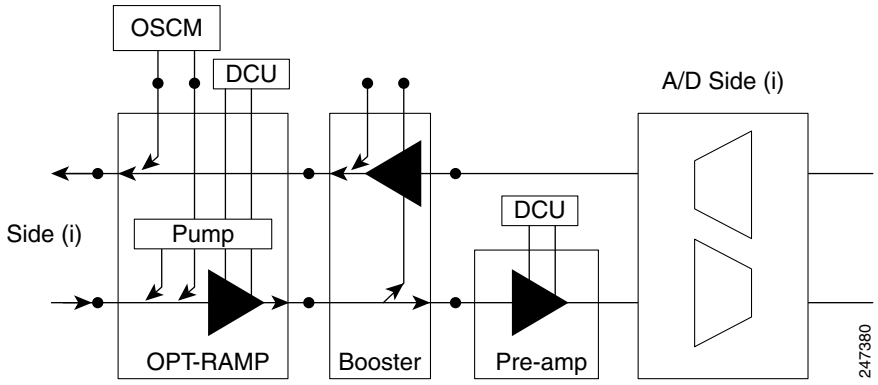
- Eight, if the MS-ISC-100T switch card is used.
- Twelve, if an external Catalyst 2950 switch is used.

11.2.1 OPT-RAMP-C or OPT-RAMP-CE Card in an Add/Drop Node

When the OPT-RAMP-C or OPT-RAMP-CE card is equipped in an add/drop node, the booster amplifier is mandatory and cannot be replaced by an OSC-CSM card. The preamplifier is an OPT-BST, OPT-BST-E, or OPT-AMP-C card, and must be cabled as an unidirectional card. Note that the COM-TX and LINE-RX ports must not be used for any other connections. If a single module ROADM 40-SMR-1-C is used as an add/drop card, a preamplifier is not required. If a single module ROADM 40-SMR-2-C is used as an add/drop card, both the preamplifier and booster are not required.

Figure 11-33 shows the OPT-RAMP-C or OPT-RAMP-CE card in an add/drop node.

Figure 11-33 OPT-RAMP-C or OPT-RAMP-CE Card in an Add/Drop Node



When required, a DCN extension can be used on A/D Side (i) in Figure 11-33.

Side (i) in Figure 11-33 can be equipped with the following cards:

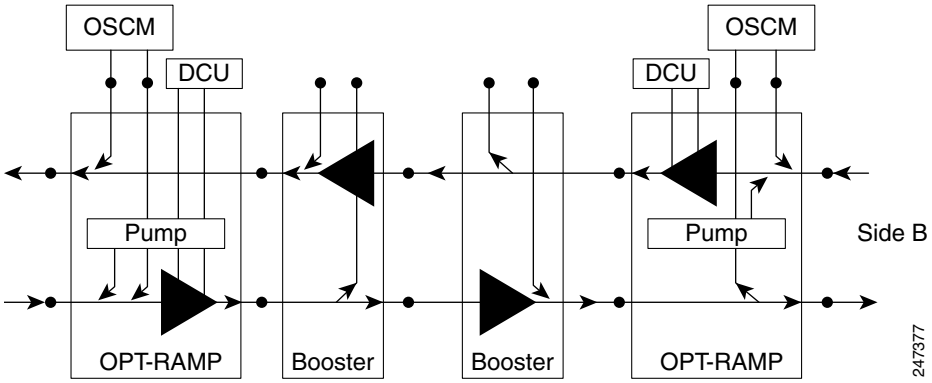
- WSS + DMX
- AD-xC
- 40-WXC-C or 80-WXC-C + MUX + DMX
- Single module ROADM

11.2.2 OPT-RAMP-C or OPT-RAMP-CE Card in a Line Site Node with Booster Amplification

The OPT-RAMP-C or OPT-RAMP-CE card can be equipped in a line site node with a booster amplifier in the following configurations:

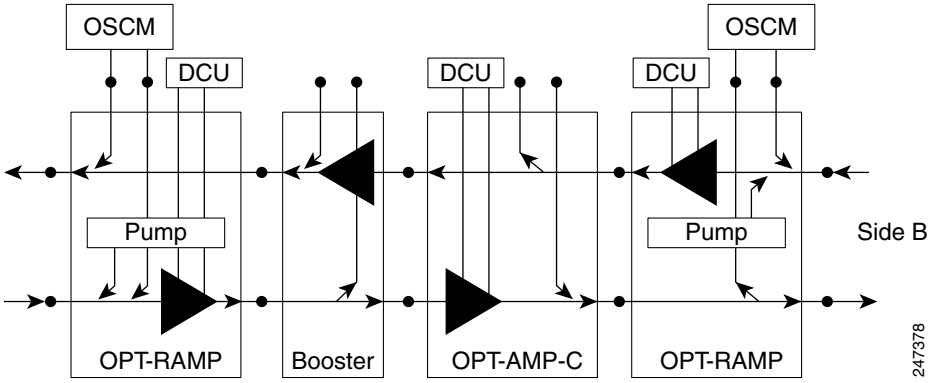
- OPT-BST and OPT-BST-E can be used as booster in a line site node with OPT-RAMP-C or OPT-RAMP-CE. The booster cards need to be cabled as bidirectional units. Figure 11-34 shows the OPT-RAMP-C or OPT-RAMP-CE card in a line site configuration.

Figure 11-34 OPT-RAMP-C Card or OPT-RAMP-CE Card in a Line Site Configuration



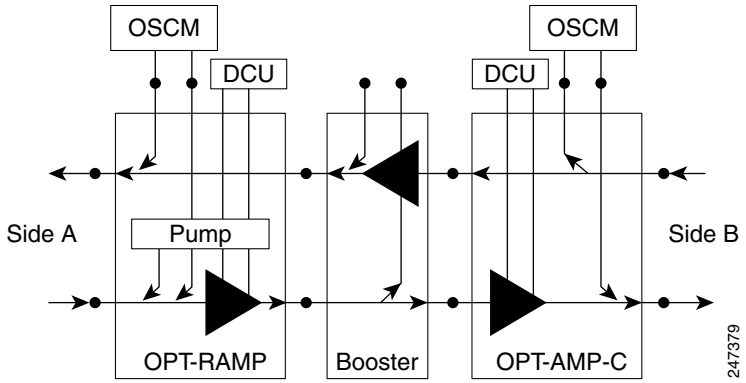
- The OPT-AMP-C can be used as a booster in a line site node with OPT-RAMP-C or OPT-RAMP-CE and needs to be cabled as a bidirectional unit. An additional DCU unit can be equipped between the OPT-AMP-C DC ports. Figure 11-35 shows a line site configured with OPT-AMP-C card and an additional DCU unit.

Figure 11-35 Line Site Configured with OPT-AMP-C



- A line site can be configured with OPT-RAMP-C or OPT-RAMP-CE card on one side only. Figure 11-36 shows the line site configured with OPT-RAMP-C or OPT-RAMP-CE on side A only. The booster is configured on side B.

Figure 11-36 Line Site with OPT-RAMP-C or OPT-RAMP-CE On One Side



In all configurations, the booster amplifier facing the OPT-RAMP-C or OPT-RAMP-CE card is mandatory for safety reasons.

11.3 Supported Node Configurations for PSM Card

The PSM card supports the following node configurations:

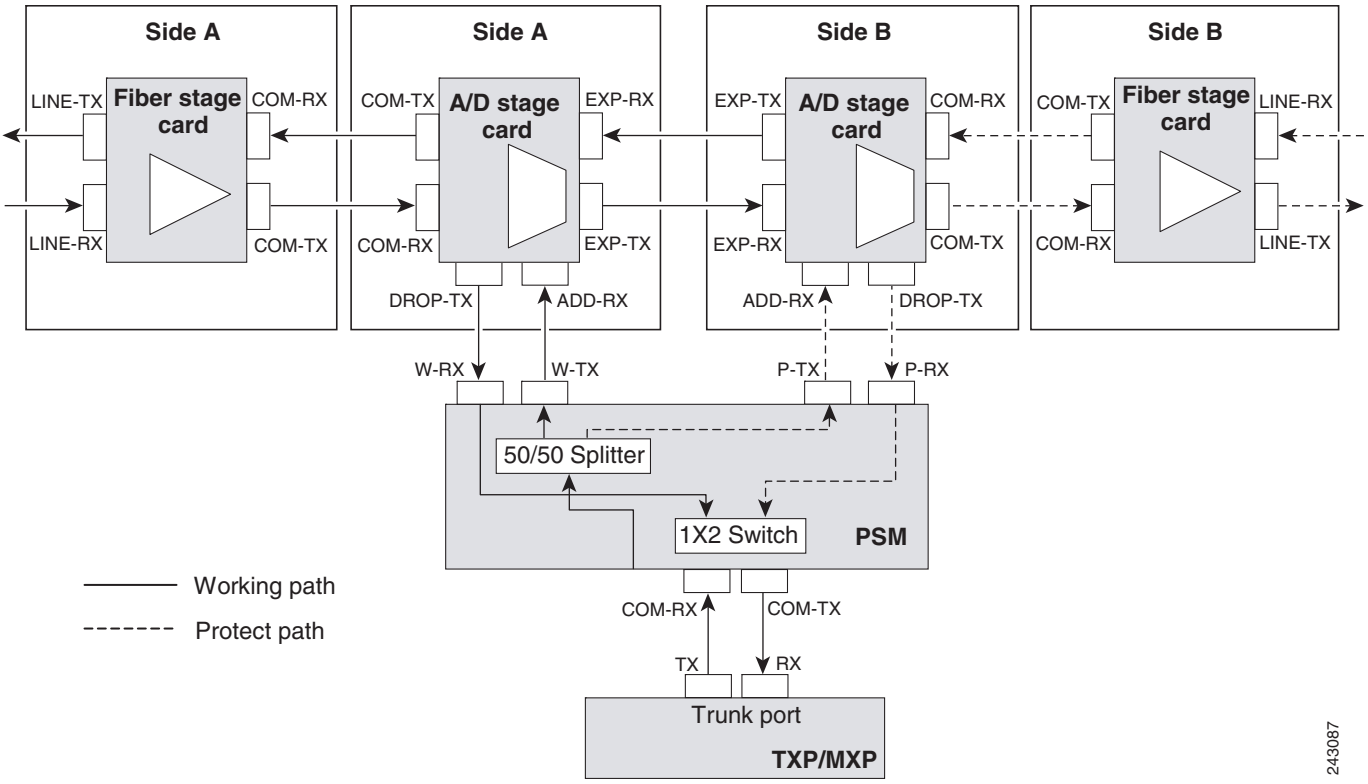
- 11.3.1 Channel Protection
- 11.3.2 Multiplex Section Protection
- 11.3.3 Line Protection
- 11.3.4 Standalone

11.3.1 Channel Protection

In a channel protection configuration, the PSM card is used in conjunction with a TXP/MXP card. The PSM card in a channel protection configuration can be used in any site apart from a terminal site.

Figure 11-37 shows the DWDM functional view of a PSM card in channel protection configuration.

Figure 11-37 PSM Channel Protection Configuration



In this configuration, the COM-RX and COM-TX ports of the PSM card are connected to the TXP/MXP trunk ports. This configuration is applicable to an *n*-degree MSTP node, for example, a two-degree ROADM, an *n*-degree ROADM, or an OADM node. The example block diagram shows a two-degree node with Side A and Side B as the two sides. The Side A and Side B fiber-stage block can be DWDM cards that are used to amplify transmitted or received signal (see the "11.5.1.1 Fiber Stage" section on page 11-45 for the list of cards). The Side A and Side B add/drop stage block can be DWDM cards that can add and drop traffic (see the "11.5.1.2 A/D Stage" section on page 11-47 for the list of cards).

In the transmit direction, the traffic originating from a TXP/MXP trunk port is split by the PSM card on to the W-TX and P-TX ports. The W-TX and P-TX ports are connected to the ADD-RX ports of the add/drop stage cards in Side A and Side B respectively. The add/drop stage cards multiplex traffic on Side A and Side B line ports that become the working and protect paths respectively.

In the receive direction, the W-RX and P-RX ports of the PSM card are connected to the DROP-TX ports of the add/drop stage cards on Side A and Side B respectively. The add/drop stage cards demultiplex traffic received from Side A and Side B line ports that are the working and protect paths respectively. The PSM card selects one of the two input signals on the W-RX and P-RX ports to be transmitted to the COM-RX port of the PSM card.

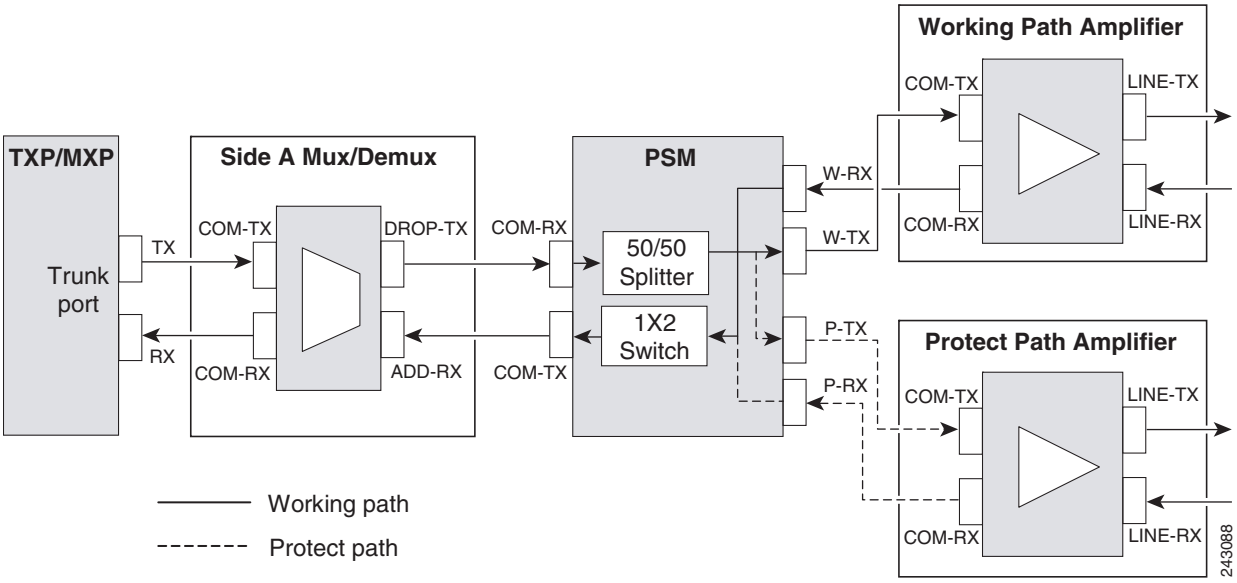
Note All traffic multiplexed or demultiplexed by the two add/drop stage cards is not protected.

11.3.2 Multiplex Section Protection

The PSM card performs multiplex section protection when connected between a multiplexer/demultiplexer card in a terminal site. The multiplexer/demultiplexer stage can be built using WSS and DMX or 40MUX and 40DMX cards. The terminal sites can be 50/100 Ghz band. The number of supported channels can therefore be 32/40 or 72/80.

Figure 11-38 shows the block diagram of a PSM card in multiplex section protection configuration.

Figure 11-38 PSM Multiplex Section Protection Configuration



In the transmit direction, the traffic originating from a TXP trunk port is multiplexed by the Side A multiplexer. The PSM card splits traffic on to the W-TX and P-TX ports, which are independently amplified by two separated booster amplifiers.

In the receive direction, the signal on the line ports is preamplified by two separate preamplifiers and the PSM card selects one of the two input signals on the W-RX and P-RX ports to be transmitted to the COM-RX port of the PSM card. The received signal is then demultiplexed to a TXP card.

The presence of a booster amplifier is not mandatory. However, if a DCN extension is used, the W-TX and P-TX ports of the PSM card can be connected directly to the line. The presence of a preamplifier is also not mandatory.

Note The PSM card cannot be used with Raman amplification in a line protection or section protection configuration.

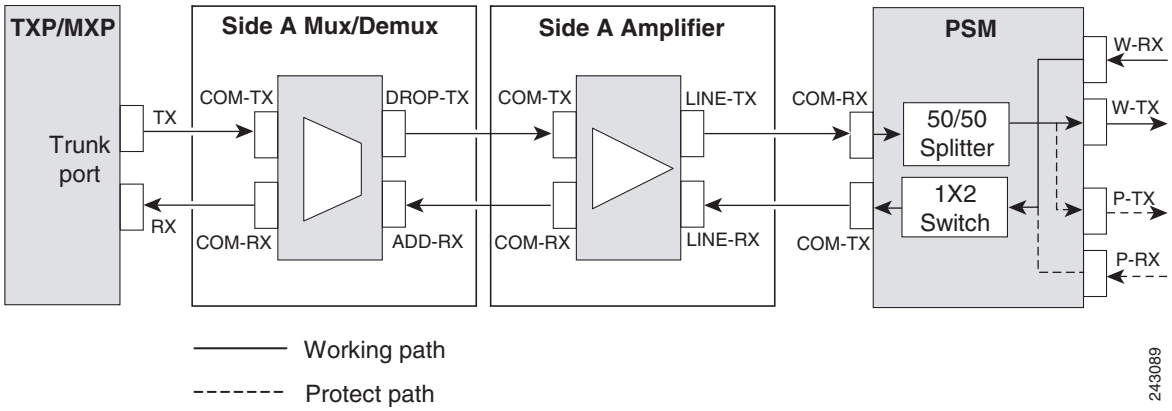
11.3.3 Line Protection

In a line protection configuration, the working and protect ports of the PSM card are connected directly to the external line. This configuration is applicable to any MSTP node that is configured as a terminal site. The multiplexer/demultiplexer stage can be built using WSS and DMX, 40MUX and 40DMX,

40-SMR1-C and 15216-MD-40-ODD, 15216-EF-40-ODD, or 15216-MD-48-ODD, or 40-SMR2-C and 15216-MD-40-ODD, 15216-EF-40-ODD, or 15216-MD-48-ODD units. The terminal sites can be 50/100 Ghz band. The number of supported channels can therefore be 32/40 or 72/80.

Figure 11-39 shows the block diagram of a PSM card in line protection configuration.

Figure 11-39 PSM Line Protection Configuration



In the transmit direction, the traffic originating from a transponder trunk port is multiplexed by the Side A multiplexer and amplified by a booster amplifier. The Line-TX port of the amplifier is connected to the COM-RX port of the PSM card. The PSM card splits traffic received on the COM-RX port on to the W-TX and P-TX ports, which form the working and protect paths.

In the receive direction, the PSM card selects one of the two input signals on the W-RX and P-RX ports to be transmitted to the COM-RX port of the PSM card. The received signal is then preamplified and demultiplexed to the TXP card.

The presence of a booster amplifier is not mandatory. However, if a DCN extension is used, the COM-RX port of the PSM card is connected to the multiplex section. The presence of a preamplifier is also not mandatory; the COM-TX port of the PSM card can be connected to the demultiplexer.

Note The PSM card cannot be used with Raman amplification in a line protection or section protection configuration.

11.3.4 Standalone

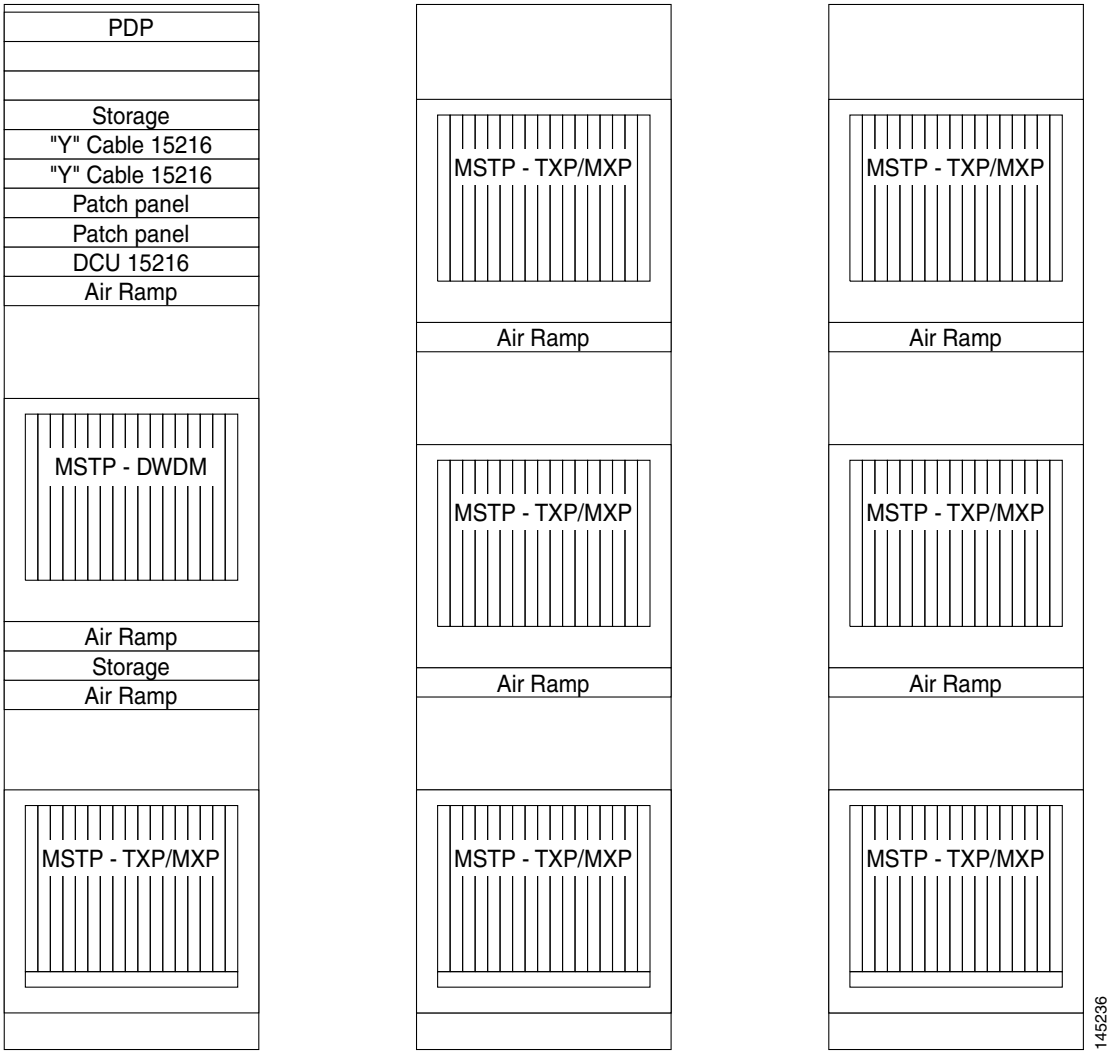
In a standalone configuration, the PSM card can be equipped in any slot and supports all node configurations. In this configuration, the PSM card provides only basic functionality, such as, protection against a fiber cut, optical safety, and automatic laser shutdown (ALS). It does not provide other functionalities such as, automatic power control (APC), automatic node setup (ANS), network and node alarm correlation, circuit management, and so on.

11.4 Multishelf Node

In a multishelf configuration, the ONS 15454-M6 node or the ONS 15454-DWDM node with TCC3 card as the node controller can manage up to 29 subtending shelves as a single entity. The subtending shelves can be 15454-M6 or 15454-DWDM.

The node controller is the main shelf with the TCC2/TCC2P/TCC3/TNC/TNCE/TSC/TSCE cards running the multishelf functions. Each subtending shelf must be equipped with TCC2/TCC2P/TCC3/TNC/TNCE/TSC/TSCE cards, which run the shelf functions. For internal data exchange between the node controller shelf and subtending shelves, the node controller shelf must be equipped with redundant MS-ISC-100T cards or, as an alternative, the Catalyst 2950 switch. We recommend that you use the MS-ISC-100T cards. If using the Catalyst 2950, it is installed on one of the multishelf racks. All subtending shelves must be located in the same site at a maximum distance of 100 meters or 328 feet from the Ethernet switches used to support the communication LAN. Figure 11-40 shows an example of a multishelf node configuration.

Figure 11-40 Multishelf Node Configuration



A multishelf node has a single public IP address for all client interfaces (Cisco Transport Controller [CTC], Transaction Language One [TL1], Simple Network Management Protocol [SNMP], and HTTP); a client can only connect to the node controller shelf, not to the subtending shelves. The user interface and subtending shelves are connected to a patch panel using straight-through (CAT-5) LAN cables.

The node controller shelf has the following functions:

- IP packet routing and network topology discovery at the node controller level.
- Open Shortest Path First (OSPF) centralized on the node controller shelf.

The subtending shelves have the following functions:

- Overhead circuits are not routed within a multishelf node but are managed at the subtending controller shelf only. To use overhead bytes, the AIC-I must be installed on the subtending shelf where it is terminated.
- Each subtending shelf will act as a single shelf node that can be used as a timing source line, TCC/TCC2P/TCC3/TNC/TSC clock, or building integrated timing supply (BITS) source line.

11.4.1 Multishelf Node Layout

Multishelf configurations are configured by Cisco TransportPlanner and are automatically discovered by the CTC software. In a typical multishelf installation, all optical units are equipped on the node controller shelf and TXP/MXP cards are equipped in the aggregated subtended shelves. In addition, all empty slots in the node controller shelf can be equipped with TXP/MXP cards. In a DWDM mesh network, up to eight optical sides can be configured with client and optical cards installed in different shelves to support mesh and ring-protected signal output.

Note When a DWDM ring or network has to be managed through a Telcordia operations support system (OSS), every node in the network must be set up as multi-shelf. OLA sites and nodes with one shelf must be set up as "multi-shelf stand-alone" to avoid the use of LAN switches.

11.4.2 DCC/GCC/OSC Terminations

A multishelf node provides the same communication channels as a single-shelf node:

- OSC links terminate on OSCM/OSC-CSM cards. Two links are required between each ONS 15454 node. An OSC link between two nodes cannot be substituted by an equivalent generic communications channel/data communications channel (GCC/DCC) link terminated on the same pair of nodes. OSC links are mandatory and they can be used to connect a node to a gateway network element (GNE).
- GCC/DCC links terminate on TXP/MXP cards.

The maximum number of DCC/GCC/OSC terminations that are supported in a multishelf node is 48.

Note Optical Service Channel can be created on the OC3 port of the TNC card.

11.5 Optical Sides

From a topological point of view, all DWDM units equipped in an MSTP node belongs to a side. A side can be identified by a letter (A, B, C, D, E, F, G, or H), or by the ports (called as side line ports, see 11.5.2 Side Line Ports, page 11-47) that are physically connected to the spans. An MSTP node can be connected to a maximum of 8 different spans. Each side identifies one of the spans the MSTP node is connected to.

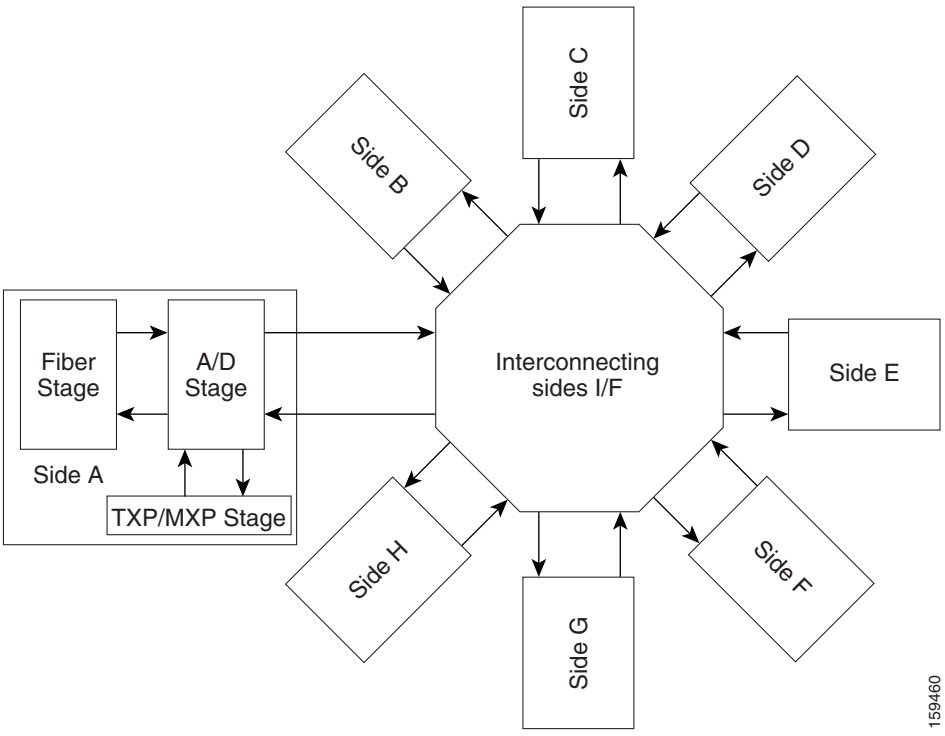
Note Side A and Side B replace "west" and "east" when referring to the two sides of the ONS 15454 shelf. Side A refers to Slots 1 through 6 (formerly "west"), and Side B refers to Slots 12 through 17 (formerly "east"). The line direction port parameter, East-to-West and West-to-East, has been removed.

Sides are viewed and managed from the Provisioning > WDM-ANS > Optical Sides tab in CTC.

11.5.1 Optical Side Stages

All MSTP nodes can be modelled according to Figure 11-41.

Figure 11-41 Interconnecting Sides Conceptual View



According to Figure 11-41, each MSTP node side includes DWDM units that can be conceptually divided into three stages.

- Fiber stage—The set of DWDM cards with ports that directly or indirectly face the span.
- A/D stage—The add/drop stage.

- TXP/MXP stage—The virtual grouping of all TXP or MXP cards with signals multiplexed or demultiplexed to and from the physical fiber stage.

11.5.1.1 Fiber Stage

The fiber stage includes DWDM cards that are used to amplify transmitted or received signals and cards that are used to add optical supervision channels. The fiber stage cards are:

- Booster amplifier cards that directly connect to the span, such as:
  - OPT-BST
  - OPT-BST-E
  - OPT-BST-L
  - OPT-AMP-C, when provisioned in OPT-LINE (booster amplifier) mode
  - OPT-AMP-L, when provisioned in OPT-LINE (booster amplifier) mode
  - OPT-AMP-17-C, when provisioned in OPT-LINE (booster amplifier) mode
- Preamplifier cards, such as:
  - OPT-PRE
  - OPT-AMP-C, when provisioned in OPT-PRE (preamplifier) mode
  - OPT-AMP-L, when provisioned in OPT-PRE (preamplifier) mode
  - OPT-AMP-17-C, when provisioned in OPT-PRE (preamplifier) mode
- OSC cards, such as:
  - OSCM
  - OSC-CSM
- OPT-RAMP-C card

Table 11-1 shows the commonly deployed fiber stage layouts supported by DWDM mesh nodes. In the table, OPT-BST includes the OPT-BST, OPT-BST-E, and OPT-BST-L cards. OPT-AMP includes the OPT-AMP-L and OPT-AMP-17-C cards configured in either OPT-PRE or OPT-LINE mode.

Note In the table, L and C suffix is not reported because C-band and L-band amplifiers cannot be mixed in the same layout.

Table 11-1 Supported Fiber Stage Configurations

Layout	Cards	Configurations
A	OPT-BST <-> OPT-PRE/OPT-AMP (OPT-PRE mode)	• OPT-BST OSC ports connected to OSCM OSC ports or OSC-CSM LINE ports • OPT-BST LINE ports connected to the span • OPT-BST COM-TX ports connected to OPT-AMP (OPT-PRE mode) or OPT-PRE COM-RX ports • OPT-AMP (OPT-PRE mode) or OPT-PRE LINE-TX or COM-TX ports connected to the next stage (for example, a 40-WSS-C/40-WSS-CE COM-RX port in a ROADM node) • OPT-BST COM-RX ports connected to the next stage (for example, a 40-WSS-C/40-WSS-CE COM-TX port in a ROADM node)
B	OPT-AMP (OPT-BST mode) <-> OPT-PRE/OPT-AMP (OPT-PRE mode)	• OPT-AMP (BST) OSC ports connected to OSCM OSC ports or OSC-CSM LINE ports • OPT-AMP (BST) LINE ports connected to the span • OPT-AMP (BST) COM-TX ports connected to OPT-AMP (PRE)/OPT-PRE COM-RX ports • OPT-AMP (PRE)/OPT-PRE LINE-TX/COM-TX port connected to the next stage (for example, a 40-WSS-C/40-WSS-CE COM-RX port in a ROADM node) • OPT-AMP (BST) COM-RX port connected to the next stage (for example, a 40-WSS-C/40-WSS-CE COM-TX port in a ROADM node)
C	OSC-CSM <-> OPT-PRE/OPT-AMP(OPT-PRE mode)	• OSC-CSM LINE ports connected to the span • OSC-CSM COM-TX ports connected to OPT-AMP COM-RX ports • OPT-AMP(PRE)/OPT-PRE LINE-TX/COM-TX port connected to the next stage (for example, 40-WSS-C/40-WSS-CE COM-RX ports in ROADM) • OSC-CSM COM-RX port connected to the next stage (for example, a 40-WSS-C/40-WSS-CE COM-TX port in a ROADM node)
D	OPT-BST	• OPT-BST OSC ports connected to OSCM OSC ports or OSC-CSM LINE ports • OPT-BST LINE ports connected to the span • OPT-BST COM ports connected to the next stage (for example, a 40-WSS-C/40-WSS-CE COM port in a ROADM node)

Table 11-1 Supported Fiber Stage Configurations (continued)

Layout	Cards	Configurations
E	OPT-AMP (OPT-BST mode)	• OPT-AMP OSC ports connected to OSCM OSC ports or OSC-CSM LINE ports • OPT-AMP LINE ports connected to the span • OPT-AMP COM ports connected to the next stage (for example, a 40-WSS-C/40-WSS-CE COM port in a ROADM node)
F	OSC-CSM	• OSC-CSM LINE ports connected to the span • OSC-CSM COM ports connected to the next stage (for example, a 40-WSS-C/40-WSS-CE COM port in a ROADM node)

11.5.1.2 A/D Stage

The A/D stage includes DWDM cards that can add and drop traffic. The A/D stage is divided into three node types:

- Mesh nodes—ONS 15454 nodes configured in multishelf mode can connect to eight different sides. For more detail on mesh node, see 11.6 Configuring Mesh DWDM Networks, page 11-53.
- Legacy—Half of a ROADM node or an OADM node with cascaded AD-xB-xx-x or AD-xC-xx.x cards
- Non-A/D—A line node or a side that does not have A/D capability is included in the A/D stage

Stages are built by active cards and patchcords. However, the interconnecting sides are completed by the mesh patch panels (four-degree patch panel or eight-degree patch panel) in mesh nodes, or by patchcords connected to EXP-RX/EXP-TX ports in legacy nodes.

11.5.2 Side Line Ports

Side line ports are ports that are physically connected to the spans. Side line ports can be:

- All ports terminating the fiber stage and physically labeled as LINE, such as ports on the following cards:
  - Booster amplifier (OPT-BST, OPT-BST-E, or OPT-BST-L cards, and the OPT-AMP-C, OPT-AMP-L, or OPT-AMP-17-C cards when provisioned in OPT-LINE mode)
  - OSC-CSM
  - OPT-RAMP-C
- All ports that can be physically connected to the external span using DCN terminations, such as:
  - Booster amplifier LINE-RX and LINE-TX ports
  - OSC-CSM LINE-RX and LINE-TX ports
  - 40-WXC-C COM-RX and COM-TX ports
  - MMU EXP-A-RX and EXP-A-TX ports
- All ports that can be physically connected to the external span using DCN terminations in a line node, such as:

  - Preamplifier (OPT-PRE card and the OPT-AMP-C, OPT-AMP-L, or OPT-AMP-17-C cards when provisioned in OPT-PRE mode) COM-RX and COM-TX ports
  - Booster amplifier COM-TX port
  - OSC-CSM COM-TX port
- All ports that can be physically connected to the external span using DCN terminations in a 40-channel MUX/DMX terminal node, such as:
  - 40-MUX-C COM-TX port
  - 40-DMX-C COM-RX port
- All ports that can be physically connected to the external span when PSM cards implement line protection:
  - PSM W-TX and W-RX ports
  - PSM P-TX and P-RX ports

Note PSM card will support two sides A(w) and A(p).

11.5.3 Optical Side Configurations

You can use the following Side IDs depending on the type of node layout:

- In legacy nodes (that is, a node with no provisioned or installed 40-WXC-C cards), the permissible Side IDs are only A and B.
- In four-degree mesh nodes with four or less 40-WXC-C cards installed, the permissible Side IDs are A, B, C, and D.
- In eight-degree mesh nodes with eight or less 40-WXC-C cards installed, the allowed Side IDs are A, B, C, D, E, F, G, and H.

The system automatically assigns Side IDs when you import the CTP XML configuration file into CTC. You can create a side manually using CTC or TL1 if the following conditions are met:

- You use a permissible side identifier, A through H.
- The shelf contains a TX and an RX side line port (see the "11.5.2 Side Line Ports" section on page 11-47).
- The side line ports are not connected to an internal patchcord.

Note We do not recommend that you manually create or modify ONS 15454 optical sides.

The following tables show examples of how the system automatically assigns Side IDs for common DWDM layouts.

Table 11-2 shows a standard ROADM shelf with Sides A and B provisioned. The shelf is connected to seven shelves containing TXP, MXP, ADM-10G, GE_XP, 10GE_XP, GE_XPE, and 10GE_XPE cards.

Table 11-2 Multishelf ROADM Layout Example

Shelf	Slots 1–6	Side	Slots 12–17	Side
1	WSS+DMX	A	WSS+DMX	B
2	TXP/MXP	—	TXP/MXP	—
3	TXP/MXP	—	TXP/MXP	—
4	TXP/MXP	—	TXP/MXP	—
5	TXP/MXP	—	TXP/MXP	—
6	TXP/MXP	—	TXP/MXP	—
7	TXP/MXP	—	TXP/MXP	—
8	TXP/MXP	—	TXP/MXP	—

Table 11-3 shows a protected ROADM shelf. In this example, Side A and B are Slots 1 through 6 in Shelves 1 and 2. 40-WSS-C/40-WSS-CE/40-DMX-C or 40-WSS-CE/40-DMX-CE cards are installed in Sides A and B. Slots 12 through 17 in Shelves 1 and 2 contain TXP, MXP, ADM-10G, GE_XP, 10GE_XP, GE_XPE, or 10GE_XPE cards.

Table 11-3 Multishelf Protected ROADM Layout Example

Shelf	Slots 1–6	Side	Slots 12–17	Side
1	WSS+DMX	A	TXP/MXP	—
2	WSS+DMX	B	TXP/MXP	—
3	TXP/MXP	n/a	TXP/MXP	—
4	TXP/MXP	n/a	TXP/MXP	—
5	TXP/MXP	n/a	TXP/MXP	—
6	TXP/MXP	n/a	TXP/MXP	—
7	TXP/MXP	n/a	TXP/MXP	—
8	TXP/MXP	n/a	TXP/MXP	—

Table 11-4 shows a four-degree mesh node. Side A is Shelf 1, Slots 1 through 6. Side B and C are Shelf 2, Slots 1 through 6 and 12 through 17, and Side D is Shelf 3, Slots 1 through 6. 40-WXC-C cards in line termination mode are installed in Sides A through D.

Table 11-4 Multishelf Four-Degree Mesh Node Layout Example

Shelf	Slots 1–6	Side	Slots 12–17	Side
1	WXC Line Termination	A	TXP/MXP	—
2	WXC Line Termination	B	WXC Line Termination	C
3	WXC Line Termination	D	TXP/MXP	—
4	TXP/MXP	n/a	TXP/MXP	—

Table 11-4 Multishelf Four-Degree Mesh Node Layout Example (continued)

Shelf	Slots 1–6	Side	Slots 12–17	Side
5	TXP/MXP	n/a	TXP/MXP	—
6	TXP/MXP	n/a	TXP/MXP	—
7	TXP/MXP	n/a	TXP/MXP	—
8	TXP/MXP	n/a	TXP/MXP	—

Table 11-5 shows a protected four-degree mesh node example. In the example, Sides A through D are assigned to Slots 1 through 6 in Shelves 1 through 4.

Table 11-5 Multishelf Four-Degree Protected Mesh Node Layout Example

Shelf	Slots 1–6	Side	Slots 12–17	Side
1	WXC Line Termination	A	TXP/MXP	—
2	WXC Line Termination	B	TXP/MXP	—
3	WXC Line Termination	C	TXP/MXP	—
4	WXC Line Termination	D	TXP/MXP	—
5	TXP/MXP	—	TXP/MXP	—
6	TXP/MXP	—	TXP/MXP	—
7	TXP/MXP	—	TXP/MXP	—
8	TXP/MXP	—	TXP/MXP	—

Table 11-6 shows a protected four-degree mesh node example. In the example, Sides A through D are assigned to Slots 1 through 4 in Shelves 1 through 4, and TXP, MXP, ADM-10G, GE_XP, 10GE_XP, GE_XPE, or 10GE_XPE cards are installed in Shelves 1 through 4, Slots 12-17, and Shelves 5 through 8, Slots 1 through 6 and 12 through 17.

Table 11-6 Multishelf Four-Degree Protected Mesh Node Layout Example

Shelf	Slots 1–6	Side	Slots 12–17	Side
1	WXC Line Termination	A	TXP/MXP	—
2	WXC Line Termination	B	TXP/MXP	—
3	WXC Line Termination	C	TXP/MXP	—
4	WXC Line Termination	D	TXP/MXP	—
5	TXP/MXP	—	TXP/MXP	—
6	TXP/MXP	—	TXP/MXP	—

Table 11-6 Multishelf Four-Degree Protected Mesh Node Layout Example (continued)

Shelf	Slots 1–6	Side	Slots 12–17	Side
7	TXP/MXP	—	TXP/MXP	—
8	TXP/MXP	—	TXP/MXP	—

Table 11-7 shows a four-degree mesh node provisioned as an upgrade. In the example, Sides A through D are assigned to Slots 1 through 4. and 12 through 17 in Shelves 1and 2. 40-WXC-C cards in XC termination mode are installed in Sides A and B, and 40-WXC-C cards in line termination mode are installed in Sides C and D.

Table 11-7 Multishelf Four-Degree Mesh Node Upgrade Layout Example

Shelf	Slots 1–6	Side	Slots 12–17	Side
1	WXC XC Termination	A	WXC XC Termination	B
2	WXC Line Termination	C	WXC Line Termination	D
3	TXP/MXP	—	TXP/MXP	—
4	TXP/MXP	—	TXP/MXP	—
5	TXP/MXP	—	TXP/MXP	—
6	TXP/MXP	—	TXP/MXP	—
7	TXP/MXP	—	TXP/MXP	—
8	TXP/MXP	—	TXP/MXP	—

Table 11-8 shows an eight-degree mesh node. In the example, Sides A through H are assigned to Slots 1 through 6 in Shelf 1, Slots 1 through 6 and 12 through 17 in Shelves 2 through 4, and Slots 1 through 6 in Shelf 5. 40-WXC-C cards in line termination mode are installed in Sides A through H.

Table 11-8 Multishelf Eight-Degree Mesh Node Layout Example

Shelf	Slots 1–6	Side	Slots 12–17	Side
1	WXC Line Termination	A	TXP/MXP	—
2	WXC Line Termination	B	WXC Line Termination	C
3	WXC Line Termination	D	WXC Line Termination	E
4	WXC Line Termination	F	WXC Line Termination	G
5	WXC Line Termination	H	TXP/MXP	—
6	TXP/MXP	—	TXP/MXP	—
7	TXP/MXP	—	TXP/MXP	—
8	TXP/MXP	—	TXP/MXP	—

Table 11-9 shows another eight-degree mesh node. In the example, Sides A through H are assigned to Slots 1 through 6 in all shelves (Shelves 1 through 8). 40-WXC-C cards in line termination mode are installed in Sides A through H.

Table 11-9 Multishelf Four-Degree Mesh Node Upgrade Layout Example

Shelf	Slots 1–6	Side	Slots 12–17	Side
1	WXC Line Termination	A	TXP/MXP	—
2	WXC Line Termination	B	TXP/MXP	—
3	WXC Line Termination	C	TXP/MXP	—
4	WXC Line Termination	D	TXP/MXP	—
5	WXC Line Termination	E	TXP/MXP	—
6	WXC Line Termination	F	TXP/MXP	—
7	WXC Line Termination	G	TXP/MXP	—
8	WXC Line Termination	H	TXP/MXP	—

Table 11-10 shows a four-degree mesh node with a user-defined side. Because the software assigns sides consecutively, and because the mesh node is four-degrees, the side assigned to Shelf 5, Slots 1 through 6 is “Unknown.”

Table 11-10 Multishelf Four-Degree Mesh Node User-Defined Layout Example

Shelf	Slots 1–6	Side	Slots 12–17	Side
1	WXC Line Termination	A	TXP/MXP	—
2	TXP/MXP	—	WXC Line Termination	C[1]
3	WXC Line Termination	D	TXP/MXP	—
4	TXP/MXP	—	TXP/MXP	—
5	WXC Line Termination	U[2]	TXP/MXP	—
6	TXP/MXP	—	TXP/MXP	—
7	TXP/MXP	—	TXP/MXP	—
8	TXP/MXP	—	TXP/MXP	—

1. User-defined
2. Unknown

11.6 Configuring Mesh DWDM Networks

ONS 15454 shelves can be configured in mesh DWDM networks using the 40-WXC-C or 80-WXC-C wavelength cross-connect cards and four-degree patch panel or eight-degree patch panels. Mesh DWDM networks can also be configured using the 40-SMR2-C cards and the four-degree patch panel.

ONS 15454 DWDM mesh configurations can be up to four degrees (four optical directions) when the four-degree patch panel is installed, and up to eight degrees (eight optical directions) when the eight-degree patch panel is installed. Two mesh node types are available, the line termination mesh node and the cross-connect (XC) termination mesh node.

Note Mesh nodes using the 40-WXC-C or 80-WXC-C card requires multishelf management.

11.6.1 Line Termination Mesh Node Using 40-WXC-C Cards

The line termination mesh node is installed in native Software Release 9.2 mesh networks. Line termination mesh nodes can support between one and eight line terminations. Each line direction requires the following cards: 40-WXC-C, 40-MUX-C, 40-DMX-C or 40-DMX-CE, a preamplifier and a booster. Within this configuration, the following substitutions can be used:

- The 40-MUX-C cards can be replaced with 40-WSS-C/40-WSS-CE cards.
- The OPT-BST cards can be replaced with OPT-AMP-17-C (in OPT-BST mode) and/or OPT-BST-E cards.
- The OPT-PRE can be replaced with an OPT-AMP-17-C (in OPT-LINE mode) card.

Each side of the line termination mesh node is connected as follows:

- The 40-WXC-C COM-RX port is connected to the preamplifier output port.
- The 40-WXC-C COM-TX port is connected to the booster amplifier COM-RX port.
- The 40-WXC-C DROP TX port is connected to the 40-DMX-C or 40-DMX-CE COM-RX port.
- The 40-WXC-C ADD-RX port is connected to the 40-MUX-C COM-TX port.
- The 40-WXC-C EXP-TX port is connected to the mesh patch panel.
- The 40-WXC-C EXP-RX port is connected to the mesh patch panel.

Figure 11-42 shows one shelf from a line termination node.

Figure 11-42 Line Termination Mesh Node Shelf

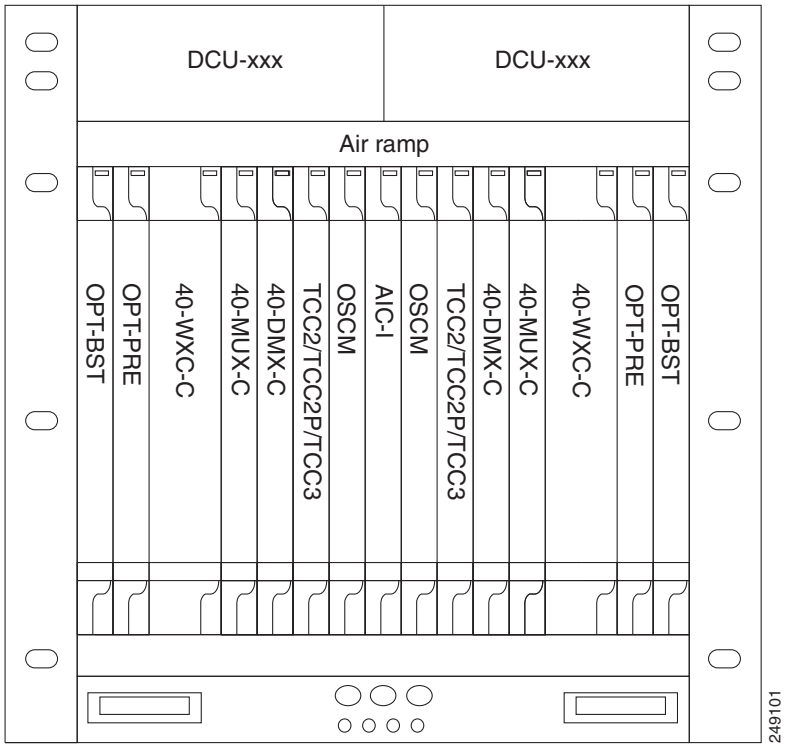


Figure 11-43 shows a functional block diagram of one line termination side using 40-WXC-C and 40-MUX-C cards.

Figure 11-43 Line Termination Mesh Node Side—40-MUX-C Cards

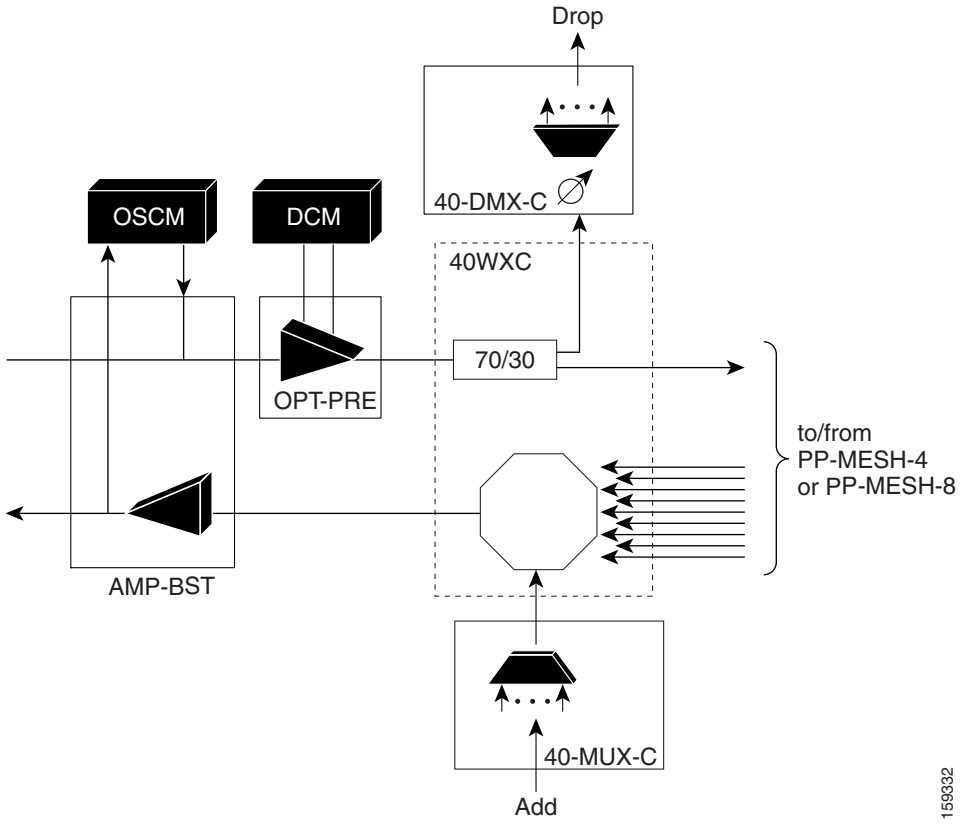


Figure 11-44 shows a functional block diagram line termination side using 40-WXC-C and 40-WSS-C cards.

Figure 11-44 Line Termination Mesh Node Side—40-WSS-C Cards

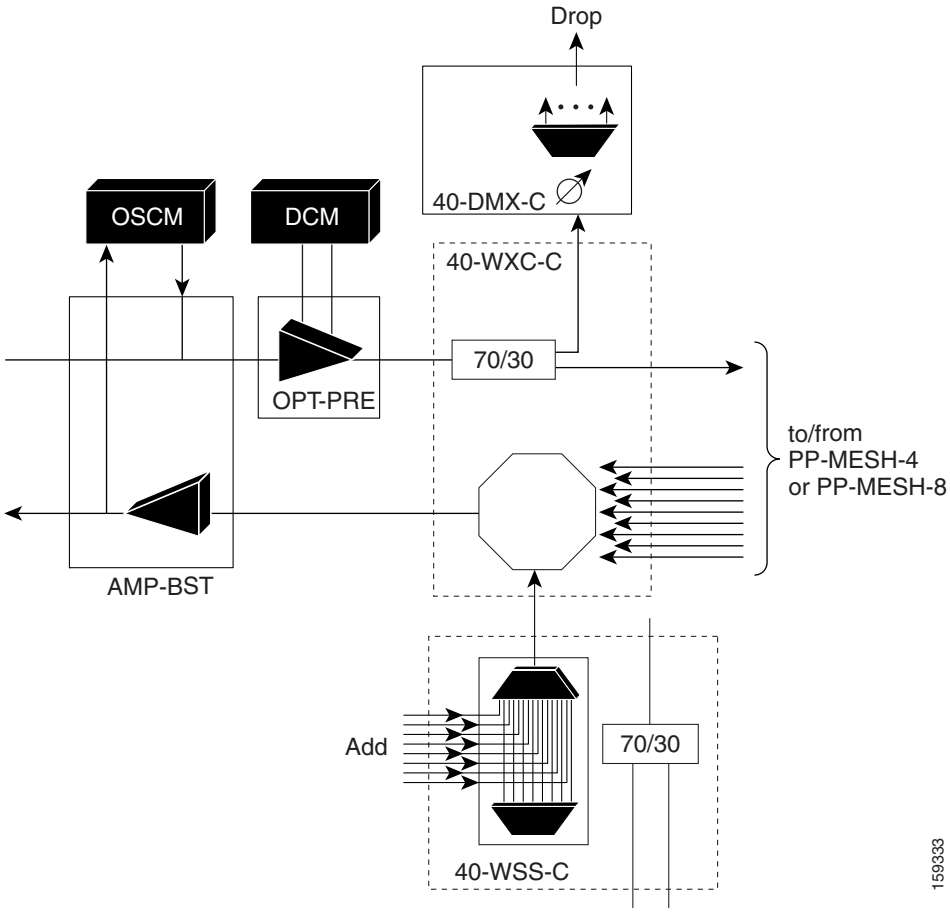
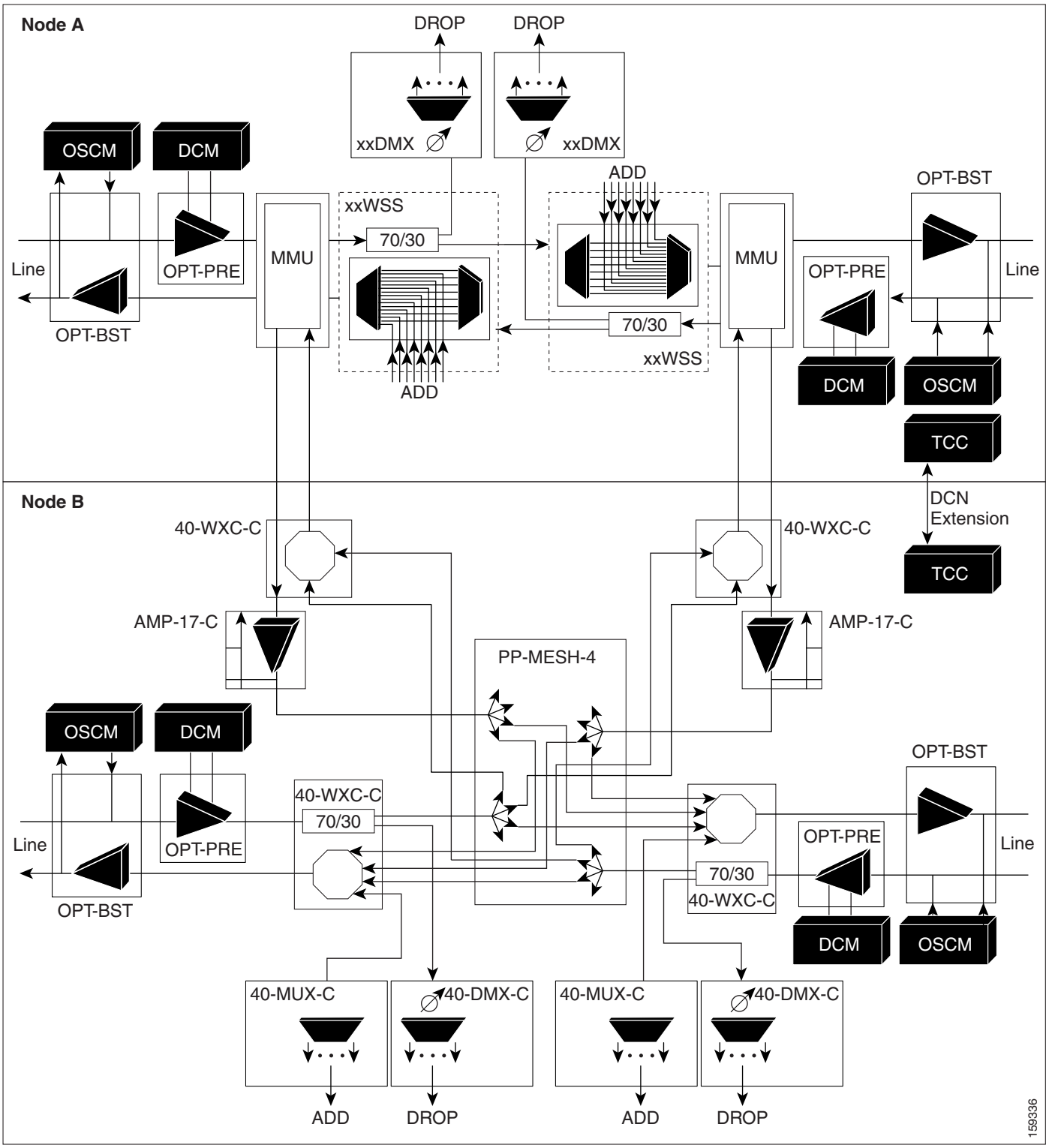


Figure 11-45 shows a functional block diagram of a node that interconnects a ROADM with MMU cards with two native line termination mesh sides.

Figure 11-45 Line Termination Mesh Nodes—ROADM With MMU Cards

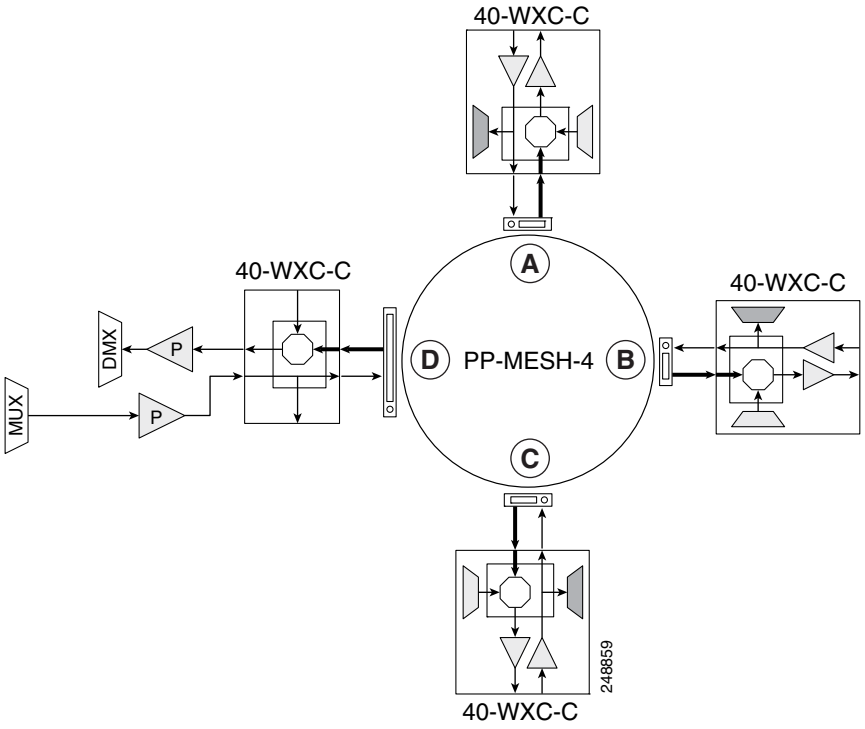


11.6.1.1 40-Channel Omni-directional n-degree ROADM Node

Any side in the line termination mesh node can be configured as an omni-directional side. The side that is configured as the omni-directional side is connected to a local multiplexer and demultiplexer that can add or drop traffic to or from any of the node directions.

In Figure 11-46 side D is configured as the omni-directional side. Wavelengths from the local multiplexer on side D is routed to sides A, B, or C by the patch panel. Wavelengths from sides A, B, or C can be dropped on side D. The maximum number of omni-directional channels is 40.

Figure 11-46 40-Channel Omni-directional Four-Degree ROADM Node

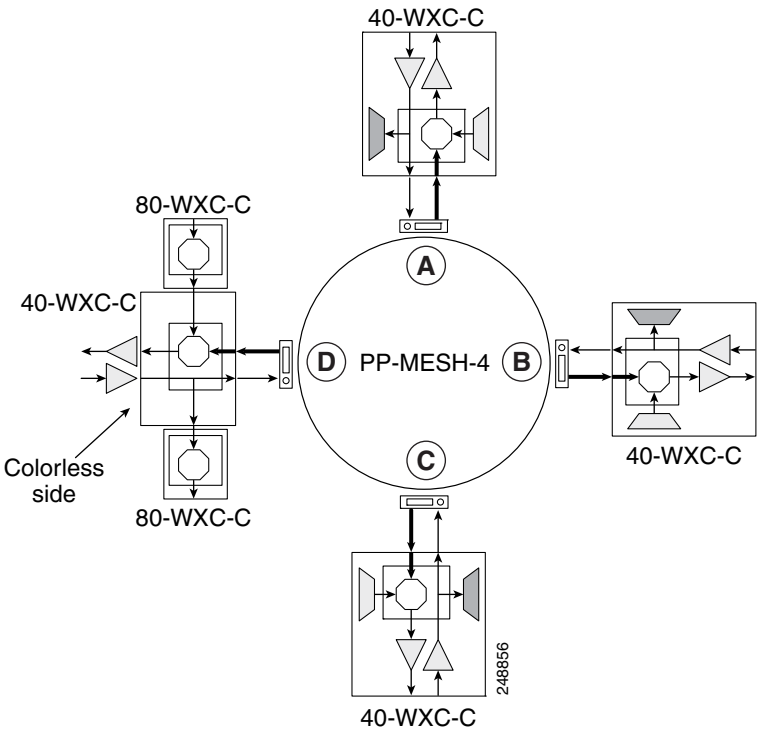


11.6.1.2 40-Channel Colorless n-Degree ROADM Node

Any side in the line termination mesh node can be configured as a colorless side where any wavelength can be added or dropped. The side that is configured as the colorless side is connected to two 80-WXC-C cards configured as a multiplexer and demultiplexer respectively. In Figure 11-47 side D is configured as the colorless side. The 80-WXC-C cards are connected to the add and drop ports of the 40-WXC-C cards and function as a colorless multiplexer and demultiplexer.

A combination of wavelengths from any of the nine ports is sent to the common output port of the 80-WXC-C card (multiplexer) that is connected to the 40-WXC-C card. The wavelengths entering the 40-WXC-C card are sent to the common input port of the 80-WXC-C card (demultiplexer) and dropped at any of the nine output ports.

Figure 11-47 40-Channel Colorless Four-Degree ROADM Node

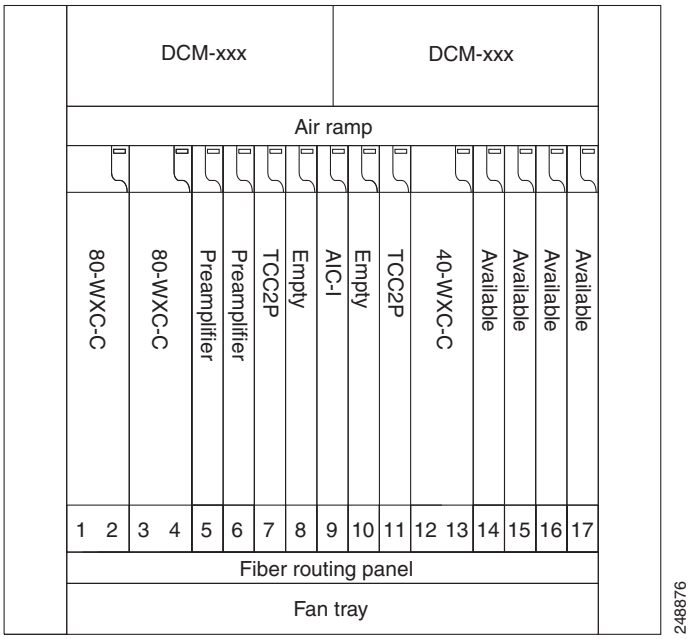


11.6.1.3 40-Channel Colorless and Omni-directional n-Degree ROADM Node

Any side in the line termination mesh node can be configured as a colorless and omni-directional side. The side that is configured as the colorless and omni-directional side is connected to a multiplexer (80-WXC-C) and demultiplexer (80-WXC-C) that can add or drop traffic to or from any of the node directions.

Figure 11-48 shows the layout of a 40-channel n-degree ROADM node with colorless and omni-directional side.

Figure 11-48 40-Channel n-Degree ROADM Node with Colorless and Omni-directional Side

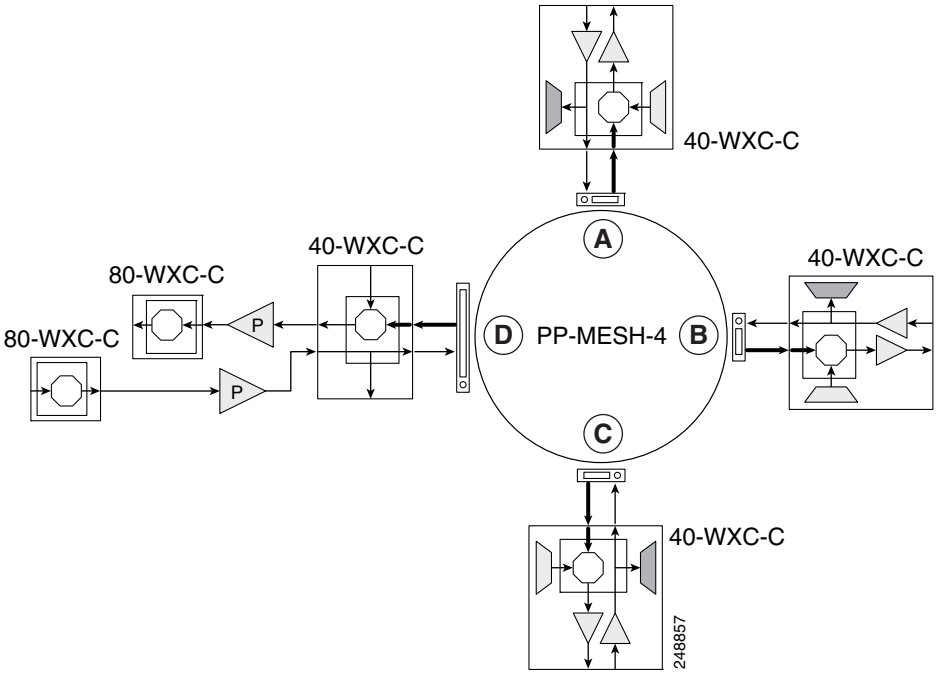


In Figure 11-49 side D is configured as the colorless and omni-directional side.

A combination of wavelengths from any of the nine ports is sent to the common output port of the 80-WXC-C card (multiplexer) and then routed to the preamplifier. The preamplifier sends the wavelengths to the 40-WXC-C card that is connected to the patch panel. The patch panel routes the wavelengths to sides A, B, or C.

Wavelengths from sides A, B, or C are dropped on side D. The incoming wavelengths from the 40-WXC-C card are sent to the preamplifier. The preamplifer amplifies the signal and sends it to the common input port of the 80-WXC-C card (demultiplexer). The wavelengths are then dropped at any of the nine output ports.

Figure 11-49 40-Channel Colorless and Omni-directional Four-Degree ROADM Node



11.6.2 Line Termination Mesh Node Using 80-WXC-C Cards

Line termination mesh nodes using 80- WXC-C cards can support between one and eight line terminations. Each line direction requires the following units: 80-WXC-C, 15216-MD-40-ODD, 15216-EF-40-ODD, or 15216-MD-48-ODD, and 15216-MD-40-EVEN, 15216-EF-40-EVEN, or 15216-MD-48-EVEN, 15216-MD-ID-50 or 15216-MD-48-CM, a preamplifier, and a booster.

- The OPT-BST cards can be replaced with OPT-AMP-17-C (in OPT-BST mode) or OPT-BST-E cards.
- The OPT-PRE can be replaced with an OPT-AMP-17-C (in OPT-LINE mode) card.

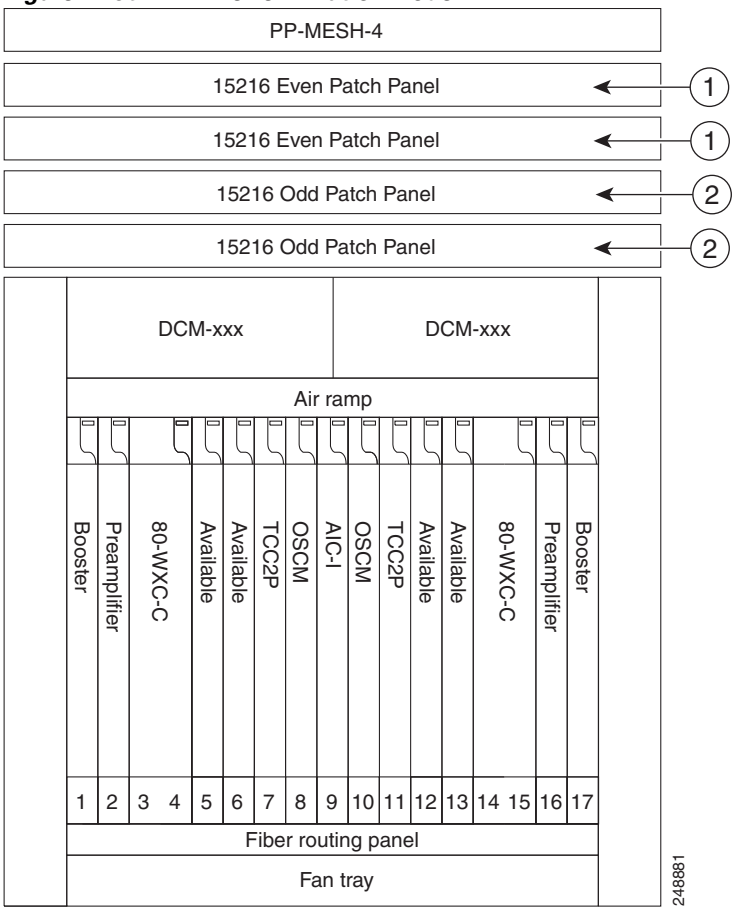
Each side of the line termination mesh node is connected as follows:

- The 80-WXC-C COM-RX port is connected to the preamplifier output port.
- The 80-WXC-C COM port is connected to the booster amplifier COM-RX port.
- The 80-WXC-C DROP TX port is connected to the COM-RX (ODD+EVEN-RX) port of 15216-MD-ID-50 or 15216-MD-48-CM. The ODD-TX port of the 15216-MD-ID-50 or 15216-MD-48-CM is connected to the COM-RX port of 15216-MD-40-ODD, 15216-EF-40-ODD, or 15216-MD-48-ODD; and the EVEN-TX port of the 15216-MD-ID-50 or 15216-MD-48-CM is connected to the COM-RX port of 15216-MD-40-EVEN, 15216-EF-40-EVEN, or 15216-MD-48-EVEN.
- The 80-WXC-C AD port is connected to the COM-TX (ODD+EVEN-TX) port of 15216-MD-ID-50 or 15216-MD-48-CM. The ODD-RX port of the 15216-MD-ID-50 or 15216-MD-48-CM is connected to the COM-TX port of 15216-MD-40-ODD, 15216-EF-40-ODD, or 15216-MD-48-ODD; and the EVEN-RX port of the 15216-MD-ID-50 or 15216-MD-48-CM is connected to the COM-TX port of 15216-MD-40-EVEN, 15216-EF-40-EVEN, or 15216-MD-48-EVEN.

- The 80-WXC-C EXP-TX port is connected to the mesh patch panel.

Figure 11-50 shows the layout for a line termination node.

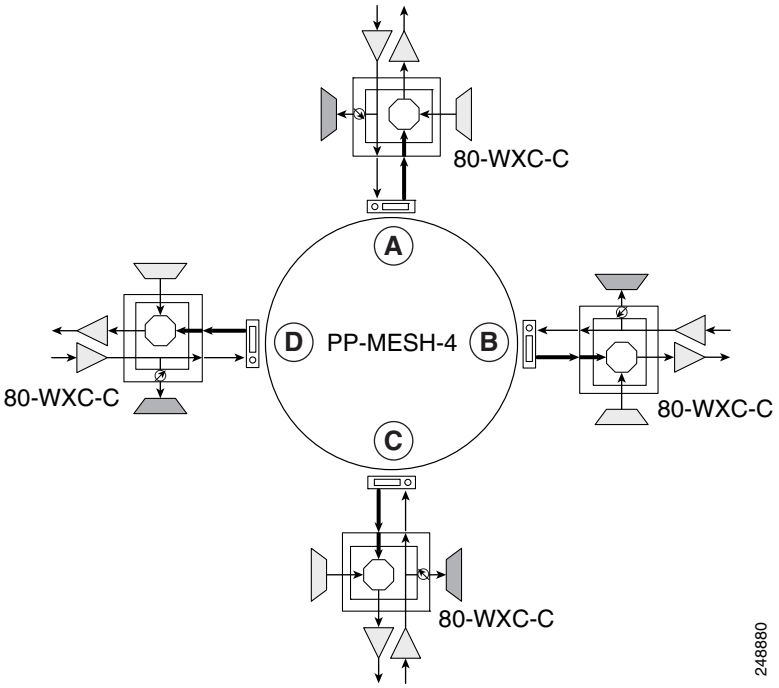
Figure 11-50 Line Termination Node



1	15216-MD-40-EVEN, 15216-EF-40-EVEN, or 15216-MD-48-EVEN patch panel
2	15216-MD-40-ODD, 15216-EF-40-ODD, or 15216-MD-48-ODD patch panel

Figure 11-51 shows the functional block diagram of a four-degree line termination mesh node using 80-WXC-C, 15216-MD-40-ODD, 15216-EF-40-ODD, 15216-MD-48-ODD, 15216-MD-40-EVEN, 15216-EF-40-EVEN, or 15216-MD-48-EVEN. All the 80-WXC-C cards are in bidirectional mode. Wavelengths entering from side(i) can be routed to any of the other n-1 sides where n is defined by the PP MESH type.

Figure 11-51 Four-Degree Line Termination Mesh Node Functional Diagram

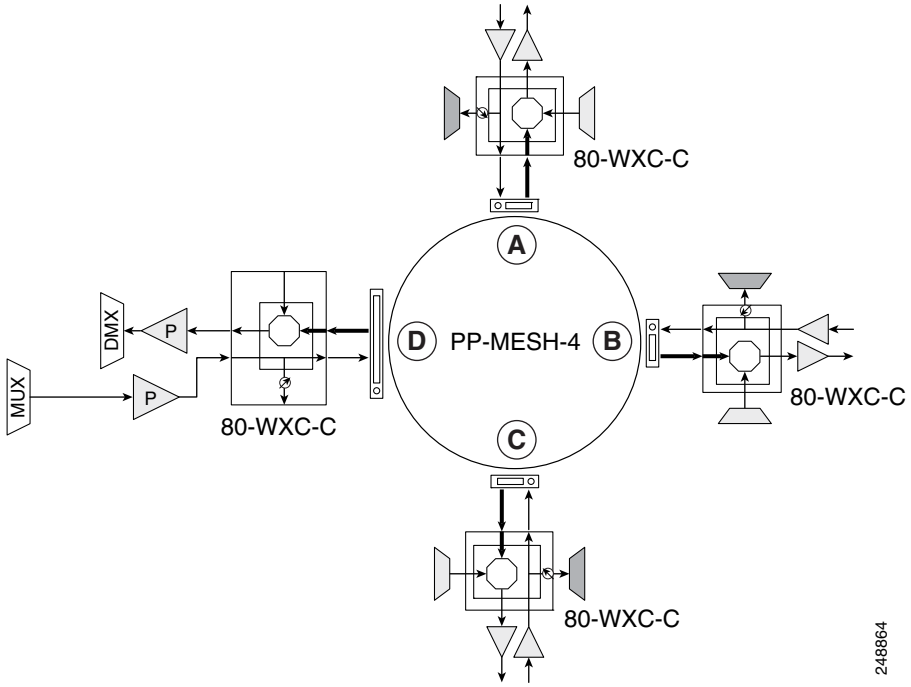


11.6.2.1 80-Channel Omni-directional n-degree ROADM Node

Any side in the line termination mesh node can be configured as a omni-directional side. The side that is configured as the omni-directional side is connected to a local multiplexer and demultiplexer that can add or drop traffic to or from any of the node directions.

In Figure 11-52, side D is configured as the omni-directional side. Wavelengths from the local multiplexer on side D are routed to sides A, B, or C by the patch panel. Wavelengths from sides A, B, or C are dropped on side D.

Figure 11-52 80-Channel Omni-directional Four-Degree ROADM Node

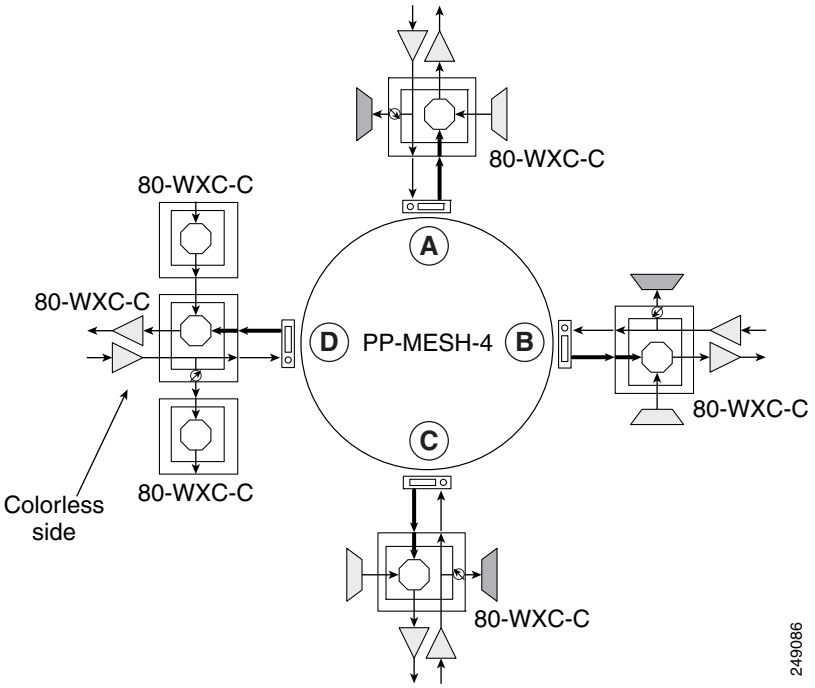


11.6.2.2 80-Channel Colorless n-degree ROADM Node

Any side in the line termination mesh node can be configured as a colorless side where any wavelength can be added or dropped. The side that is configured as the colorless side is connected to two 80-WXC-C cards configured as a multiplexer and demultiplexer respectively. In Figure 11-53, side D is configured as the colorless side. The 80-WXC-C cards are connected to the add and drop ports of the 80-WXC-C cards as a colorless multiplexer and demultiplexer.

A combination of wavelengths from any of the nine ports is sent to the common output port of the 80-WXC-C card (multiplexer) that is connected to the 80-WXC-C card. The wavelengths entering the 80-WXC-C card is passed to the common input port of the 80-WXC-C card (demultiplexer) and dropped at any of the nine output ports.

Figure 11-53 80-Channel Colorless Four-Degree ROADM Node

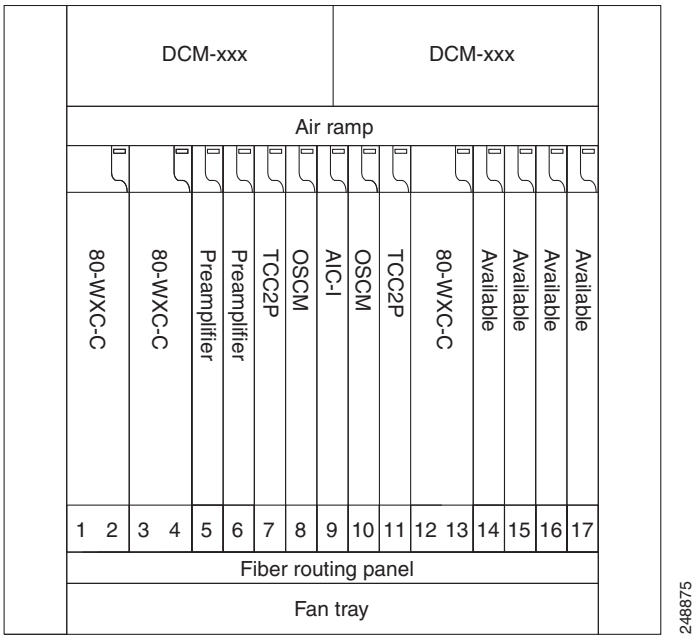


11.6.2.3 80-Channel Colorless and Omni-directional n-Degree ROADM Node

Any side in the line termination mesh node can be configured as a colorless and omni-directional side. The side that is configured as the colorless and omni-directional side is connected to a multiplexer (80-WXC-C) and demultiplexer (80-WXC-C) that can add or drop traffic to or from any of the node directions.

Figure 11-54 shows the layout of a 80-channel n-degree ROADM node with colorless and omnidirectional side.

Figure 11-54 80-Channel n-degree ROADM Node with Colorless and Omnidirectional Side

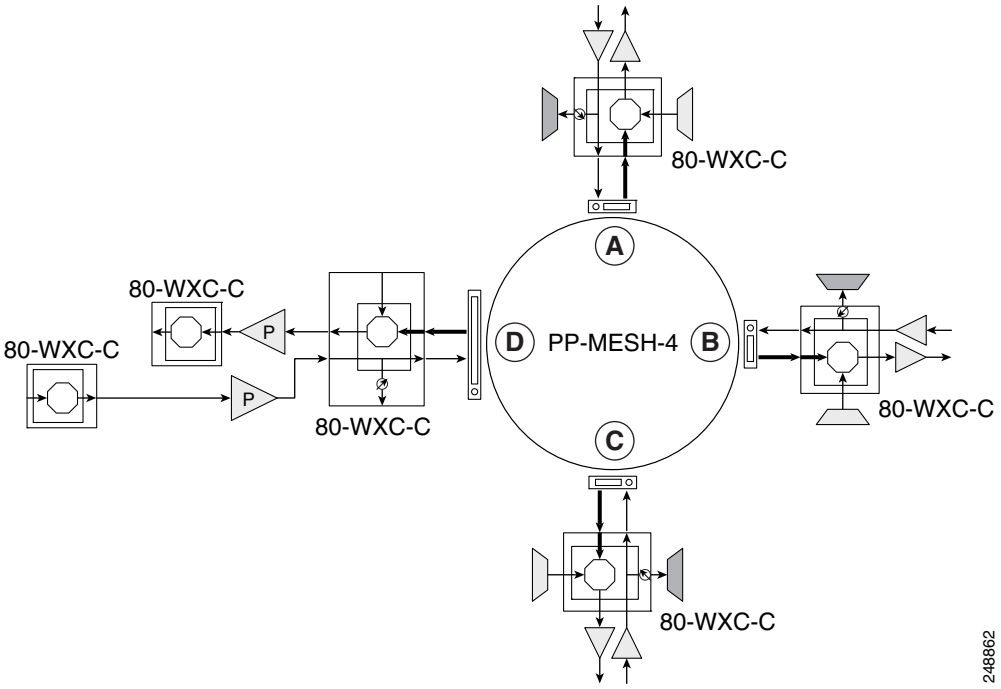


In Figure 11-55 side D is configured as the colorless and omni-directional side.

A combination of wavelengths from any of the nine ports is sent to the common output port of the 80-WXC-C card (multiplexer) and is then routed to the preamplifier. The preamplifier sends the wavelengths to the 80-WXC-C card that is connected to the patch panel. The patch panel routes the wavelengths to sides A, B, or C.

Wavelengths from sides A, B, or C can be dropped on side D. The incoming wavelengths from the 80-WXC-C card are sent to the preamplifier. The preamplifer amplifies the signal and sends it to the common input port of the 80-WXC-C card (demultiplexer). The wavelengths are then dropped at any of the nine output ports.

Figure 11-55 80-Channel Colorless and Omni-directional Four-Degree ROADM Node



11.6.3 Line Termination Mesh Node Using 40-SMR2-C Cards

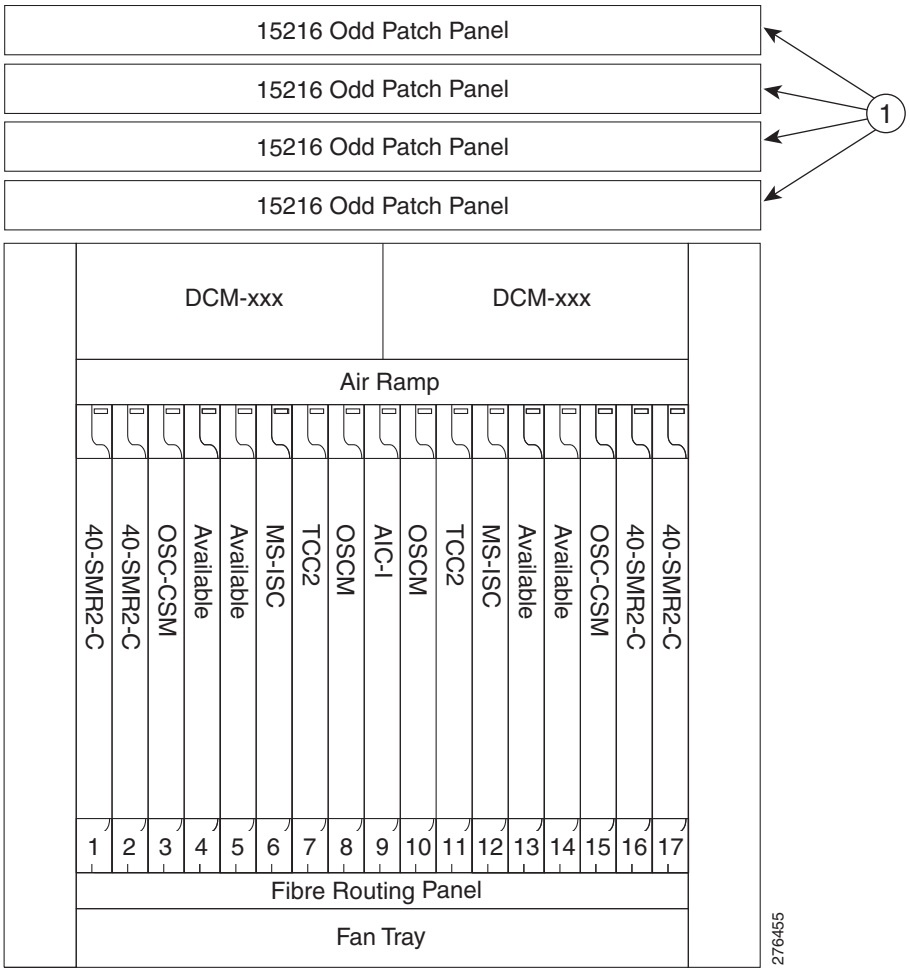
Line termination mesh nodes using the 40-SMR2-C cards can support between one and four line terminations. Each line direction requires the 40-SMR2-C and 15216-MD-40-ODD, 15216-EF-40-ODD, or 15216-MD-48-ODD cards. Although it is recommended that you use the 15216-MD-40-ODD, 15216-EF-40-ODD, or 15216-MD-48-ODD card along with the 40-SMR2-C card, you can alternatively use the 40-MUX-C and 40-DMX-C cards instead of the 15216-MD-40-ODD, 15216-EF-40-ODD, or 15216-MD-48-ODD card.

Each side of the line termination mesh node is connected as follows:

- The 40-SMR2-C LINE-RX port is connected to the external line.
- The 40-SMR2-C LINE-TX port is connected to the external line.
- The 40-SMR2-C DROP TX port is connected to the 15216-MD-40-ODD, 15216-EF-40-ODD, or 15216-MD-48-ODD (or 40-DMX-C) COM-RX port.
- The 40-SMR2-C ADD-RX port is connected to the 15216-MD-40-ODD, 15216-EF-40-ODD, or 15216-MD-48-ODD (or 40-DMX-C) COM-TX port.
- The 40-SMR2-C EXP-TX port is connected to the mesh patch panel.
- The 40-SMR2-C EXP*i*-RX (where *i* = 1, 2, 3) port is connected to the mesh patch panel.

Figure 11-56 shows the layout for a line termination node.

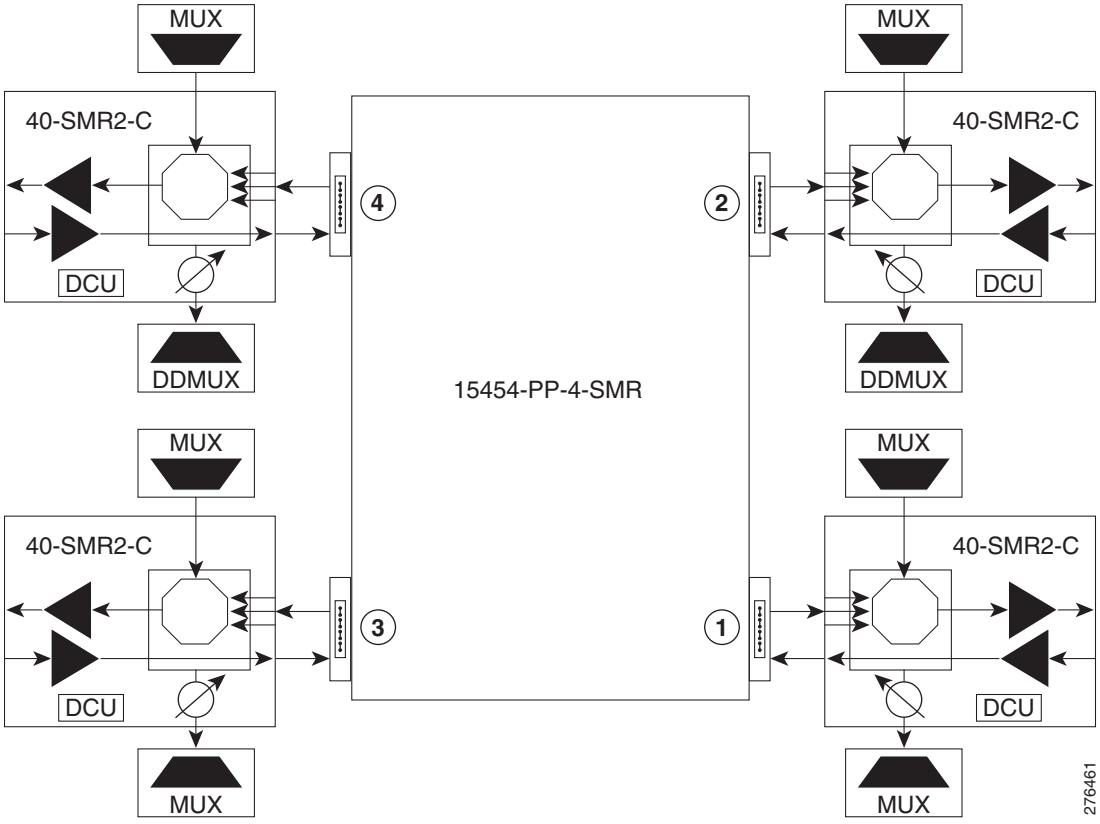
Figure 11-56 Line Termination Mesh Node Shelf



1	15216-MD-40-ODD, 15216-EF-40-ODD, or 15216-MD-48-ODD patch panel

Figure 11-57 shows the functional block diagram of a four-degree line termination mesh node using 40-SMR2-C, 15216-MD-40-ODD, 15216-EF-40-ODD, or 15216-MD-48-ODD, and 15454-PP-4-SMR patch panel.

Figure 11-57 Four-Degree Line Termination Mesh Node Functional Diagram



11.6.4 XC Termination Mesh Node

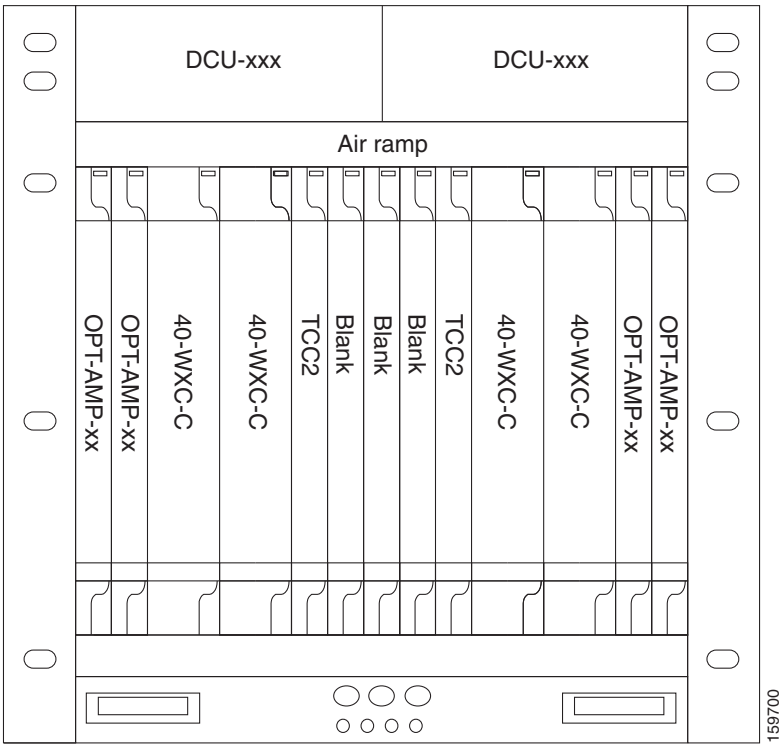
The XC termination mesh node, shown in Figure 11-58, is the second mesh node type. It is used to upgrade a non-mesh node to a mesh node or to interconnect two non-mesh nodes. The XC termination mesh nodes contain the following cards:

- 40-WXC-C cards
- OPT-AMP-17-C cards configured in OPT-PRE mode

The XC termination mesh node is connected as follows:

- The 40-WXC-C COM-RX port is connected to the MMU EXP-A-TX port.
- The 40-WXC-C COM-TX port is connected to the MMU EXP-A-RX port.
- The 40-WXC-C EXP-TX port is connected to the OPT-AMP-17-C COM-RX port.
- The 40-WXC-C EXP-RX port is connected to the OPT-AMP-17-C COM-TX port.
- The 40-WXC-C EXP-TX port is connected to the mesh patch panel.
- The 40-WXC-C EXP-RX port is connected to the mesh patch panel.

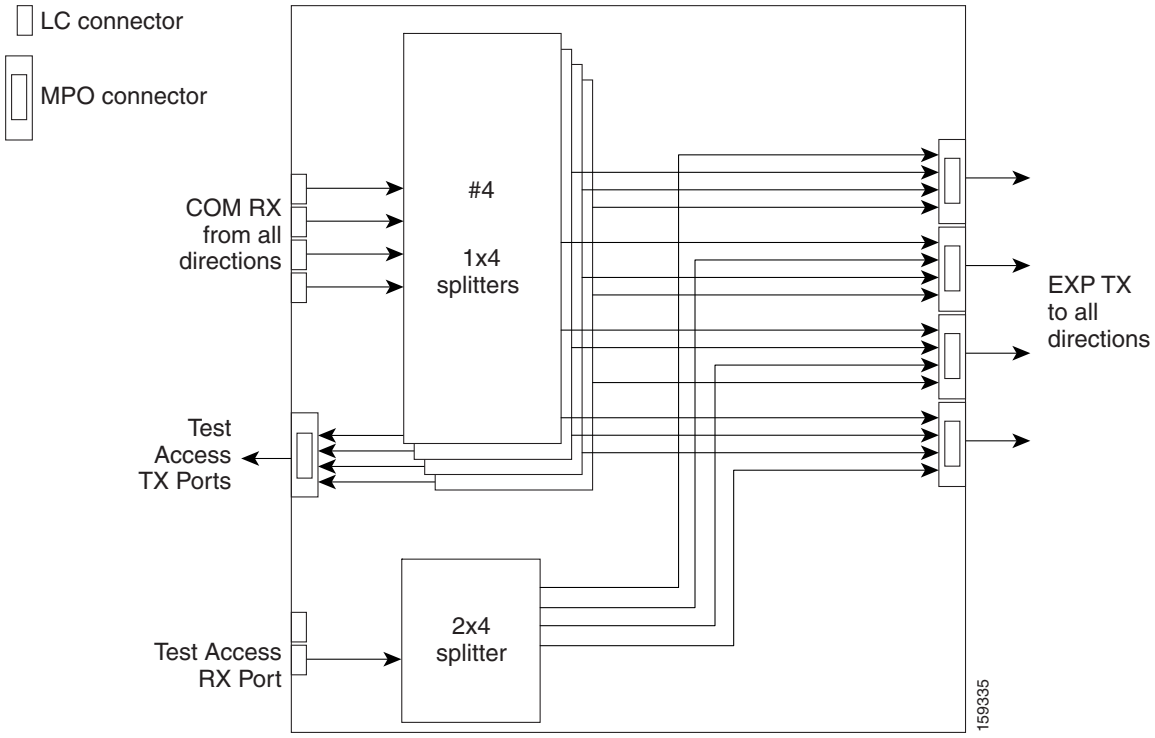
Figure 11-58 XC Termination Mesh Node Shelf



11.6.5 Mesh Patch Panels and Shelf Layouts

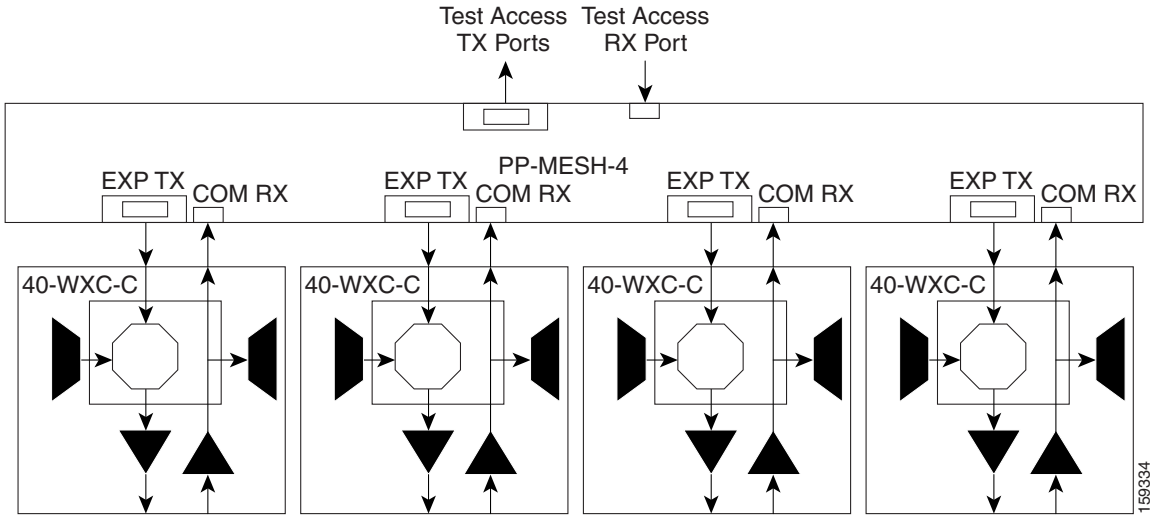
ONS 15454 mesh topologies require the installation of a four-degree patch panel, PP-MESH-4 (for 40-WXC-C cards) or 15454-PP-4-SMR (for 40-SMR2-C cards) or an eight-degree patch panel, PP-MESH-8 (for 40-WXC-C cards). If the four-degree patch panel is installed, mesh topologies of up to four degrees can be created. If the eight-degree patch panel is installed, mesh topologies of up to eight degrees can be created. The four-degree patch panel contains four 1x4 optical splitters, and the eight-degree patch panel contains eight 1x8 splitters. Each mesh patch panel contains a 2x8 splitter that is used for the test access transmit and receive ports. Figure 11-59 shows a block diagram for the PP-MESH-4 patch panel.

Figure 11-59 PP-MESH-4 Patch Panel Block Diagram



At the mesh patch panel, the signal is split into four signals (if a four-degree patch panel is used) or eight signals (if an eight-degree patch panel is used). Figure 11-60 shows the signal flow at the four-degree PP-MESH-4 patch panel. 40-WXC-C cards connect to the four-degree patch panel at the EXP TX and COM RX ports.

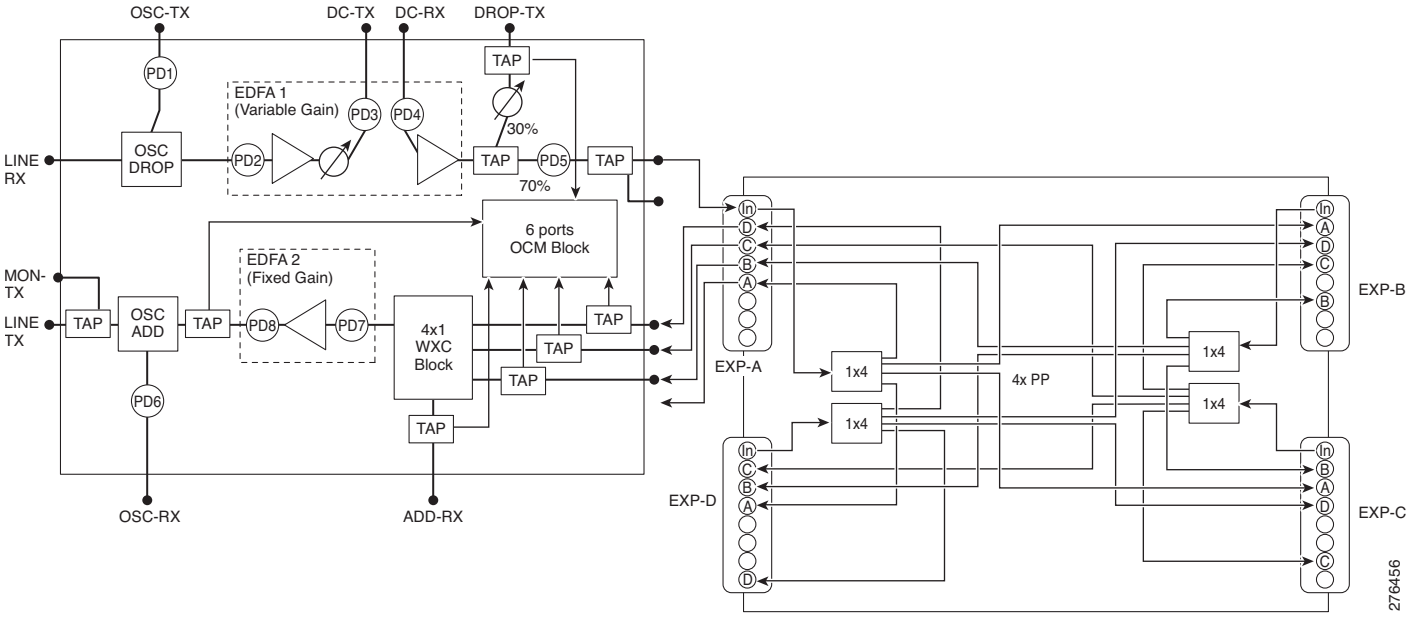
Figure 11-60 PP-MESH-4 Patch Panel Signal Flow



The mesh patch panels interconnect 40-WXC-C cards to create mesh networks, including four-degree and eight-degree mesh topologies. In addition, shelves with 40-WXC-C cards can be configured with mesh patch panels to create multiring, MMU-based mesh nodes. 40-WXC-C cards can be installed in ROADM nodes with MMU cards to upgrade a two-degree MMU-based ROADM node into four-degree or eight-degree mesh nodes.

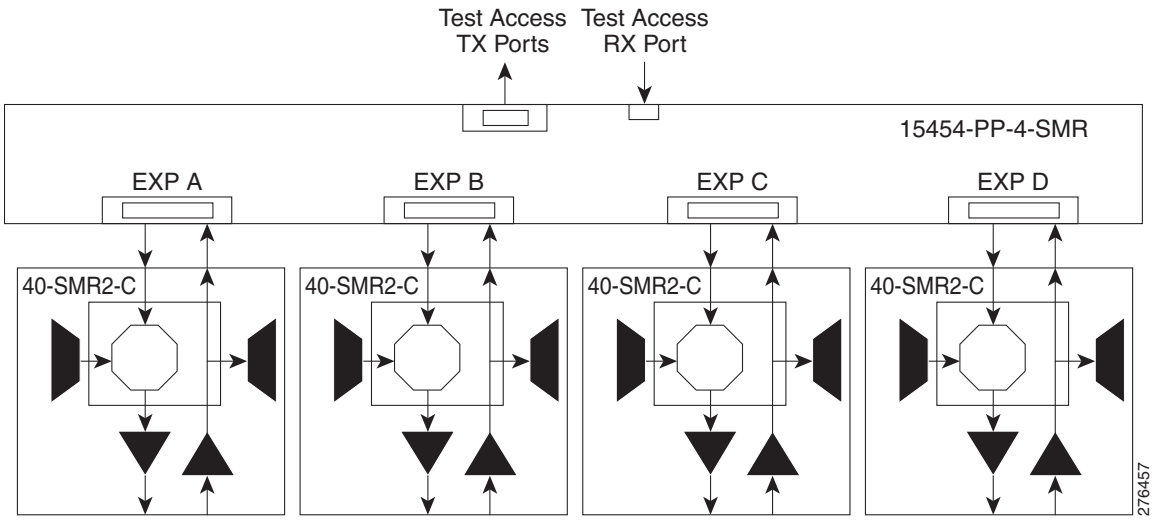
Figure 11-61 shows the block diagram of the four-degree 15454-PP-4-SMR patch panel connected to one 40-SMR2-C card. The 40-SMR2-C cards connect to the 15454-PP-4-SMR patch panel at the EXP RX ports.

Figure 11-61 15454-PP-4-SMR Patch Panel Block Diagram



You can use the 15454-PP-4-SMR patch panel to connect upto four 40-SMR2-C cards in a four-degree mesh node. The optical splitters inside the patch panel forward the output signal (EXP-TX port) of the 40-SMR2-C card on each side of the mesh node to the input port of the 40-SMR2-C cards on the other three sides of the mesh node. The 4x1 WXC block inside the 40-SMR2-C card selects which wavelength from which side must be propagated at the output of each side. Figure 11-60 shows the signal flow at the four-degree 15454-PP-4-SMR patch panel. 40-SMR2-C cards connect to the four-degree patch panel at the EXP-TX and EXP-RX ports.

Figure 11-62 15454-PP-4-SMR Patch Panel Signal Flow



11.6.6 Using a Mesh Node With Omni-Directional Add/Drop Section

Normally, multidegree mesh node use four or eight 40-WXC-C cards and a four-degree or eight-degree patch panel. Each of the 40-WXC-C cards uses a 40-MUX-C card to add wavelengths going to the span and a 40-DMX-C card to drop wavelengths coming in from the span. The 40-MUX-C and 40-DMX-C cards are connected to only one of the node directions. These cards can add/drop traffic only to/from the side that is associated to the 40-WXC-C card. The omni-directional configuration allows you to install a local multiplexer/demultiplexer that can add/drop traffic to/from any of the node directions. Figure 11-63 shows an example of how to set up a omni-directional add/drop configuration.

By setting up a NE as shown in the figure, it is possible to connect the transmit ports of TXP or MXP cards to a 40-MUX-C card and then connect the output of the 40-MUX-C card to an OPT-BST card. The OPT-BST card then connects to a preferred 40-WXC-C card in the four-degree or eight-degree ROADM node (40-WXC-C connected to port 4 of PP-MESH-4, as shown in the figure).

The patch panel splits the traffic coming from the OPT-BST card in all the node directions, through the software configuration. The wavelengths entering the 40-WXC-C cards (ports 1, 2, and 3) can be selectively sent out in any desired outbound direction. In the inbound direction, the patch panel on the preferred 40-WXC-C card, splits any of the wavelengths entering the NE through the 40-WXC-C cards (ports 1, 2, and 3). Through the software configuration, the wavelength can be passed to an OPT-PRE card or stopped. This whole configuration can be managed using a single IP address

An example of using a mesh node for omni-directional add/drop section is shown in Figure 11-63.

Figure 11-63 Mesh Node With Omni-Directional Add/Drop Section

11.7 DWDM Node Cabling

DWDM node cabling is specified by the Cisco TransportPlanner Internal Connections table. The following sections provide examples of the cabling that you will typically install for common DWDM node types.

Note The cabling illustrations shown in the following sections are examples. Always install fiber-optic cables based on the Cisco TransportPlanner Internal Connections table for your site.

11.7.1 OSC Link Termination Fiber-Optic Cabling

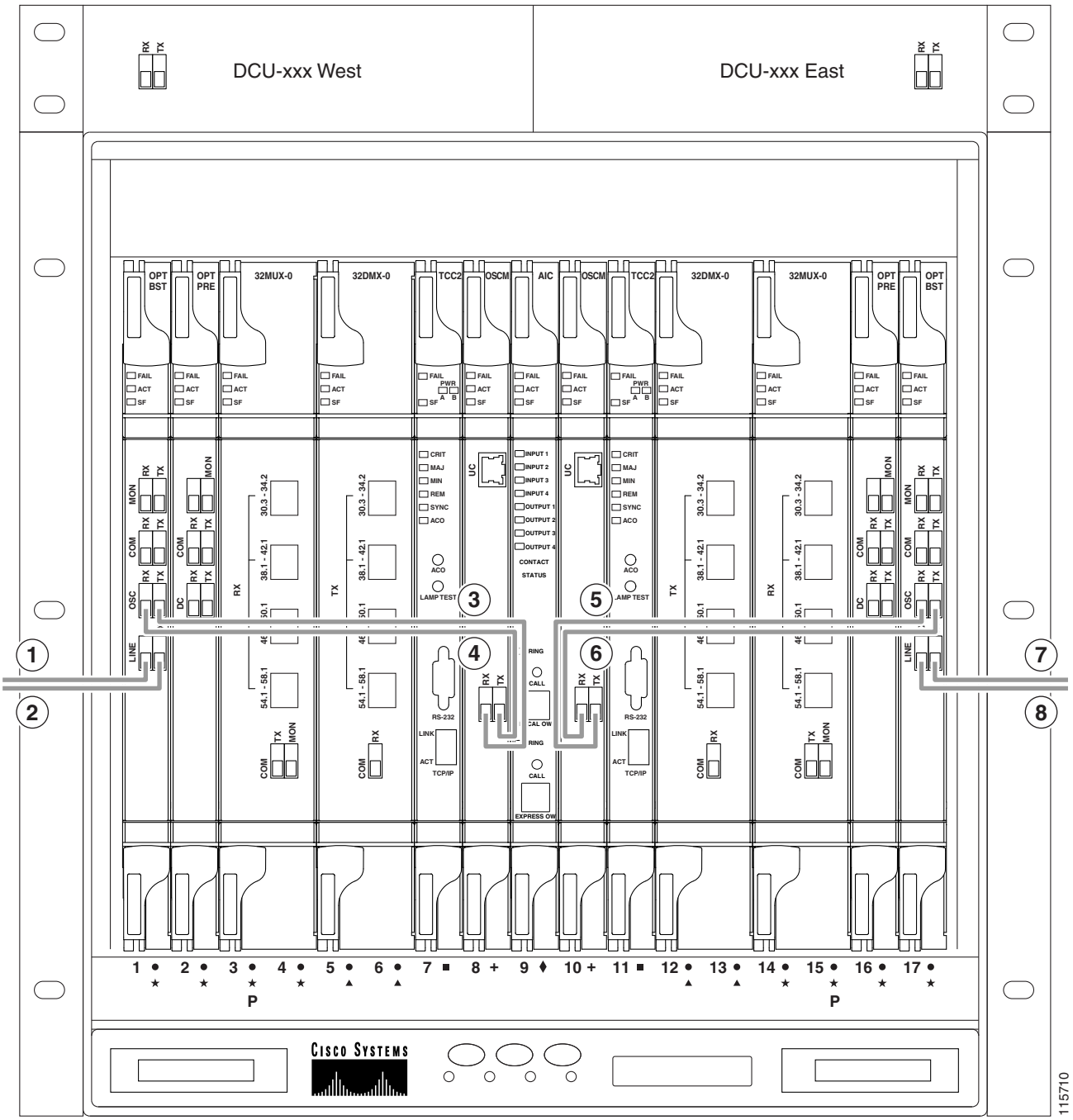
OSC link termination cabling include the following characteristics:

- The OPT-BST and OSC-CSM cards are the only cards that directly interface with the line (span) fiber.
- The OSCM card only carries optical service channels, not DWDM channels.
- The OSCM and OSC-CSM cards cannot both be installed on the same side of the shelf (Side B or Side A). You can have different cards on each side, for example an OSCM card on Side A and an OSC-CSM card on Side B.

- When an OPT-BST card and an OSC-CSM card are both used on the same side of the node, the OPT-BST card combines the supervision channel with the DWDM channels and the OSC-CSM card acts as an OSCM card; it does not carry DWDM traffic.
- If an OPT-BST and an OSCM card are installed on Side B, the Side B OPT-BST OSC RX port is connected to the Side B OSCM TX port, and the Side B OPT-BST OSC TX port is connected to the Side B OSCM RX port.
- If an OPT-BST and an OSC-CSM card are installed on Side B, the Side B OPT-BST OSC RX port is connected to the Side B OSC-CSM LINE TX port, and the Side B OPT-BST OSC TX port is connected to the Side B OSC-CSM LINE RX port.
- If an OPT-BST and an OSCM card are installed on Side A, the Side A OPT-BST OSC TX port is connected to the Side A OSCM RX port, and the Side A OPT-BST OSC RX port is connected to the Side A OSCM TX port.
- If an OPT-BST and an OSC-CSM card are installed on Side A, the Side A OPT-BST OSC TX port is connected to the Side A OSC-CSM LINE RX port, and the Side A OPT-BST OSC RX port is connected to the Side A OSC-CSM LINE TX port.

Figure 11-64 shows an example of OSC fibering for a hub node with OSCM cards installed.

Figure 11-64 Fibering OSC Terminations—Hub Node with OSCM Cards



1	Side A OPT-BST LINE RX to Side B OPT-BST or OSC-CSM LINE TX on adjacent node	**5**	Side B OSCM TX to Side B OPT-BST OSC RX

2	Side A OPT-BST LINE TX to Side B OPT-BST or OSC-CSM LINE RX on adjacent node	**6**	Side B OSCM RX to Side B OPT-BST OSC TX
3	Side A OPT-BST OSC TX to Side A OSCM RX	**7**	Side B OPT-BST LINE TX to Side A OPT-BST or OSC-CSM LINE RX on adjacent node
4	Side A OPT-BST OSC RX to Side A OSCM TX	**8**	Side B OPT-BST LINE RX to Side A OPT-BST or OSC-CSM LINE TX on adjacent node

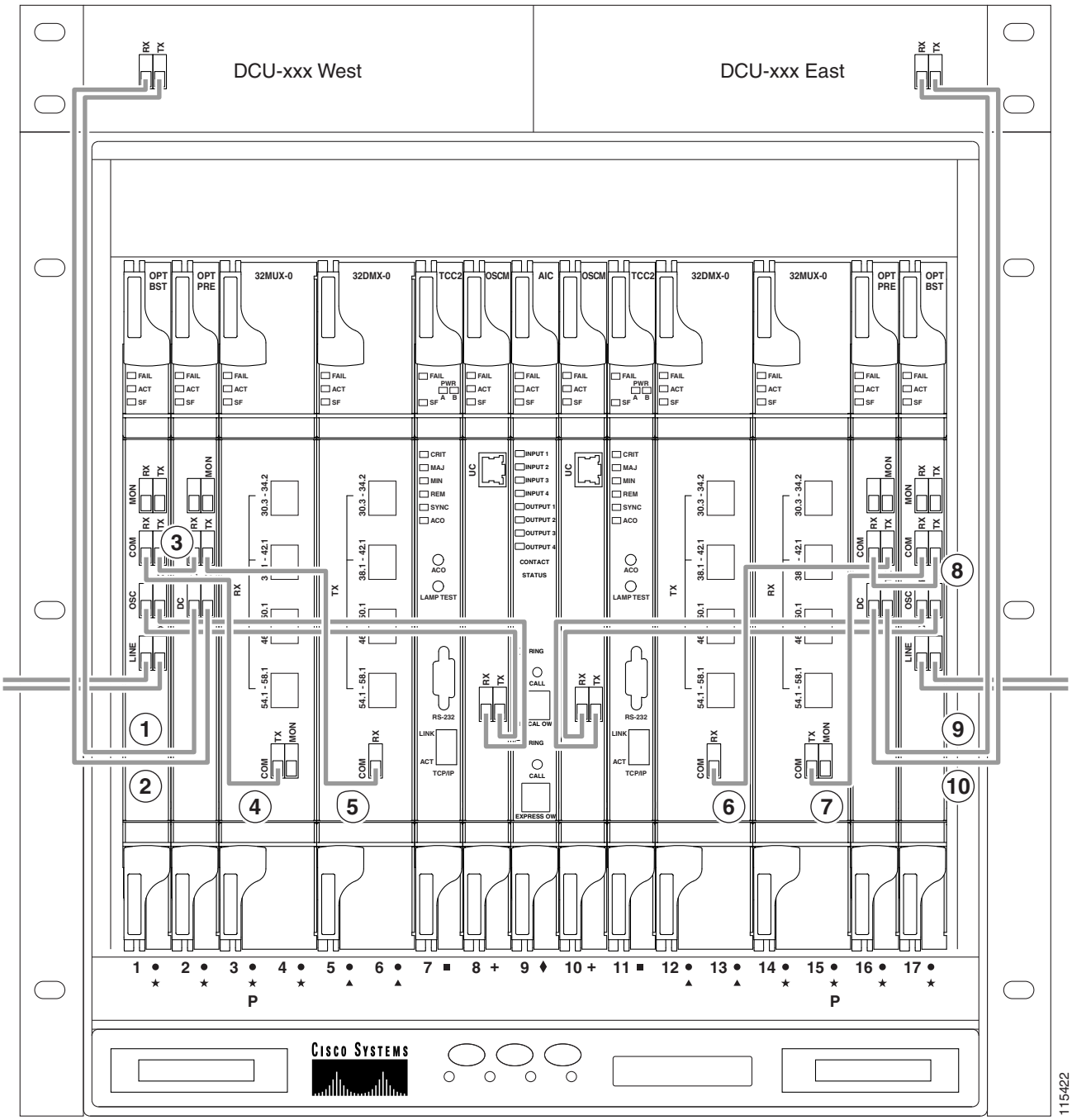
11.7.2 Hub Node Fiber-Optic Cabling

The following rules generally apply to hub node cabling:

- The Side A OPT-BST or OSC-CSM card common (COM) TX port is connected to the Side A OPT-PRE COM RX port or the Side A 32DMX-O/40-DMX-C/40-DMX-CE COM RX port.
- The Side A OPT-PRE COM TX port is connected to the Side A 32DMX-O/40-DMX-C/40-DMX-CE COM RX port.
- The Side A 32MUX-O/32WSS/32WSS-L COM TX port is connected to the Side A OPT-BST or Side A OSC-CSM COM RX port.
- The Side B 32MUX-O/32WSS/32WSS-L COM TX port is connected to the Side B OPT-BST or Side B OSC-CSM COM RX port.
- The Side B OPT-BST or Side B OSC-CSM COM TX port is connected to the Side B OPT-PRE COM RX port or the Side B 32DMX-O/32DMX COM RX port.
- The Side B OPT-PRE COM TX port is connected to the Side B 32DMX-O/32DMX COM RX port.

Figure 11-65 shows an example of a hub node with cabling. In the example, OSCM cards are installed. If OSC-CSM cards are installed, they are usually installed in Slots 1 and 17.

Figure 11-65 Fibering a Hub Node



1	Side A DCU TX to Side A OPT-PRE DC RX[1]	**6**	Side B 32DMX-O COM RX to Side B OPT-PRE COM TX
2	Side A DCU RX to Side A OPT-PRE DC TX[1]	**7**	Side B 32MUX-O COM TX to Side B OPT-BST COM RX

3	Side A OPT-BST COM TX to Side A OPT-PRE COM RX	**8**	Side B OPT-PRE COM RX to Side B OPT-BST COM TX
4	Side A OPT-BST COM RX to Side A 32MUX-O COM TX	**9**	Side B DCU TX to Side B OPT-PRE DC RX[1]
5	Side A OPT-PRE COM TX to Side A 32DMX-O COM RX	**10**	Side B DCU RX to Side B OPT-PRE DC TX[1]

1. If a DCU is not installed, a 4-dB attenuator loop, +/– 1 dB must be installed between the OPT-PRE DC ports.

11.7.3 Terminal Node Fiber-Optic Cabling

The following rules generally apply to terminal node cabling:

- A terminal site has only one side (as compared to a hub node, which has two sides). The terminal side can be either Side B or Side A.
- The terminal side OPT-BST or OSC-CSM card COM TX port is connected to the terminal side OPT-PRE COM RX port or the 32DMX-O/40-DMX-C/40-DMX-CE COM RX port.
- The terminal side OPT-PRE COM TX port is connected to the terminal side 32DMX-O/40-DMX-C/40-DMX-CE COM RX port.
- The terminal side 32MUX-O/40-MUX-C COM TX port is connected to the terminal side OPT-BST or OSC-CSM COM RX port.

11.7.4 Line Amplifier Node Fiber-Optic Cabling

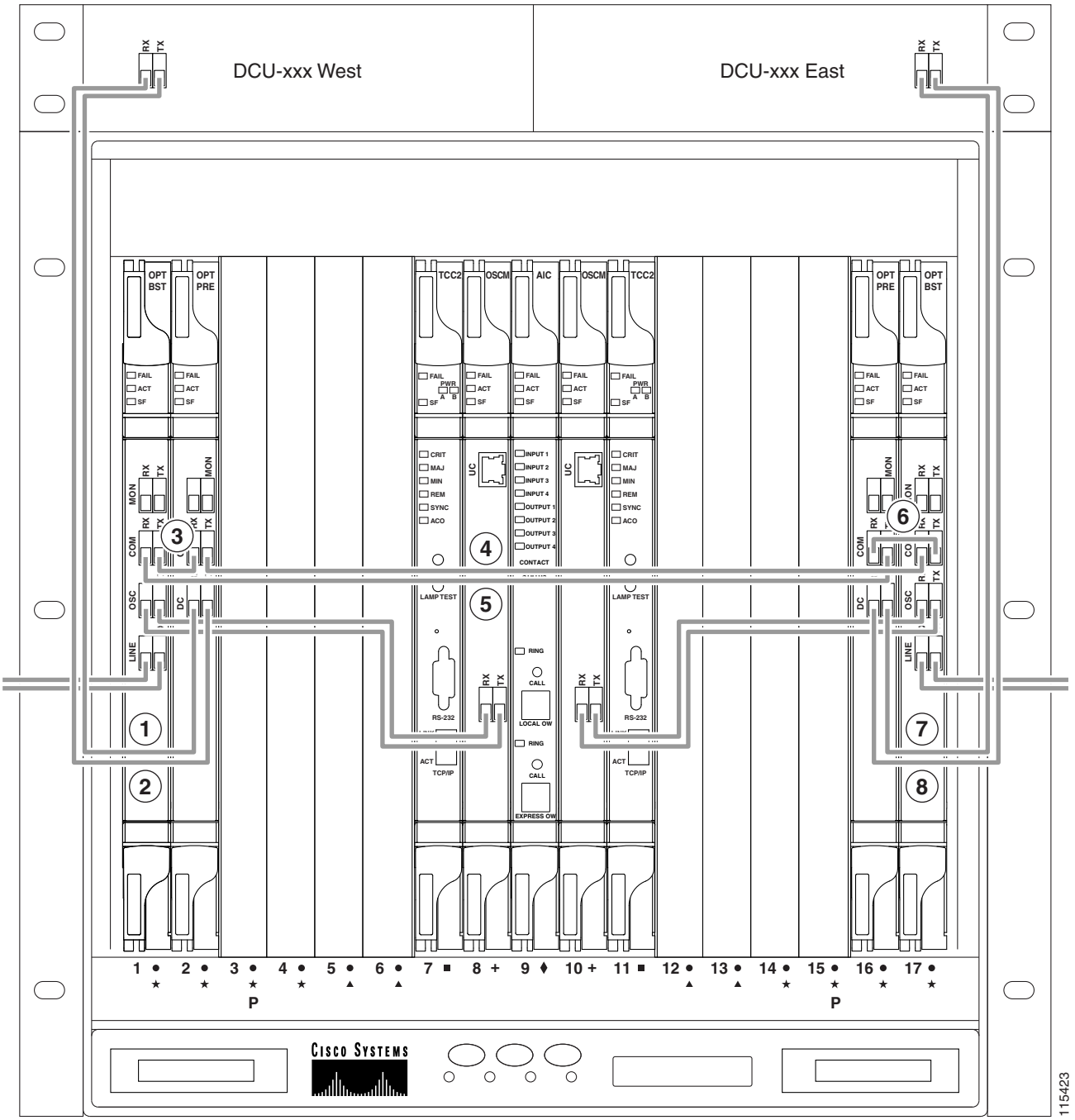
The following rules generally apply to line amplifier node cabling:

- The line amplifier node layout allows all combinations of OPT-PRE and OPT-BST cards and allows you to use asymmetrical card choices in Side A-to-Side B and Side B-to-Side A configurations. For a given line direction, you can configure the four following possibilities:
  - Only preamplification (OPT-PRE)
  - Only booster amplification (OPT-BST)
  - Both preamplification and booster amplification (where a line amplifier node has amplification in at least one direction)
  - Neither preamplification nor booster amplification
- If a Side A OPT-PRE card is installed:
  - The Side A OSC-CSM or OPT-BST COM TX is connected to the Side A OPT-PRE COM RX port.
  - The Side A OPT-PRE COM TX port is connected to the Side B OSC-CSM or OPT-BST COM RX port.
- If a Side A OPT-PRE card is not installed, the Side A OSC-CSM or OPT-BST COM TX port is connected to the Side B OSC-CSM or OPT-BST COM RX port.
- If a Side B OPT-PRE card is installed:
  - The Side B OSC-CSM or OPT-BST COM TX port is connected to the Side B OPT-PRE COM RX port.

  - The Side B OPT-PRE COM TX port is connected to the Side A OSC-CSM or OPT-BST COM RX port.
- If an Side B OPT-PRE card is not installed, the Side B OSC-CSM or OPT-BST COM TX port is connected to the Side A OSC-CSM or OPT-BST COM RX port.

Figure 11-66 shows an example of a line amplifier node with cabling.

Figure 11-66 Fibering a Line Amplifier Node



1	Side A DCU TX to Side A OPT-PRE DC RX[1]	**5**	Side A OPT-BST COM RX to Side B OPT-PRE COM TX
2	Side A DCU RX to Side A OPT-PRE DC TX[1]	**6**	Side A OPT-BST COM RX to Side B OPT-PRE COM TX
3	Side A OPT-BST COM TX to Side A OPT-PRE COM RX	**7**	Side B DCU TX to Side B OPT-PRE DC RX[1]
4	Side A OPT-PRE COM TX to Side B OPT-BST COM RX	**8**	Side B DCU RX to Side B OPT-PRE DC TX[1]

1. If a DCU is not installed, a 4-dB attenuator loop, +/– 1 dB, must be installed between the OPT-PRE DC ports.

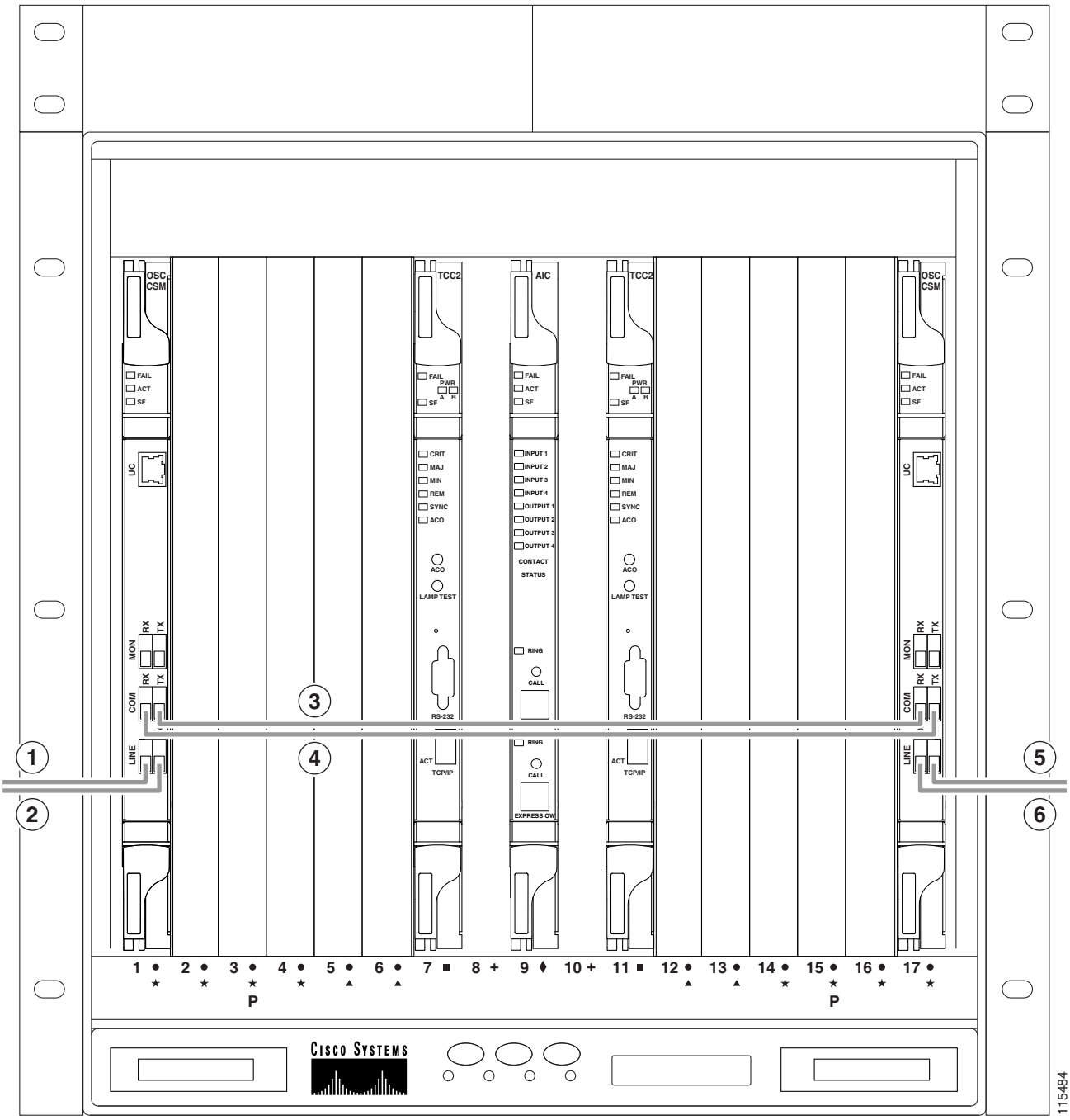
11.7.5 OSC Regeneration Node Fiber-Optic Cabling

The following rules generally apply to OSC regeneration node cabling:

- The Side A OSC-CSM COM TX port connects to the Side B OSC-CSM COM RX port.
- The Side A OSC-CSM COM RX port connects to the Side B OSC-CSM COM TX port.
- Slots 2 through 5 and 12 through 16 can be used for TXP and MXP cards.

Figure 11-67 shows an example of an OSC regeneration node with cabling.

Figure 11-67 Fibering an OSC Regeneration Node



1	Side A OSC-CSM LINE RX to Side B OSC-CSM or OPT-BST LINE TX on adjacent node	**4**	Side A OSC-CSM COM RX to Side B OSC-CSM COM TX
2	Side A OSC-CSM LINE TX to Side B OSC-CSM or OPT-BST LINE RX on adjacent node	**5**	Side B OSC-CSM LINE RX to Side A OSC-CSM or OPT-BST LINE TX on adjacent node
3	Side A OSC-CSM COM TX to Side B OSC-CSM COM RX	**6**	Side B OSC-CSM LINE TX to Side A OSC-CSM or OPT-BST LINE RX on adjacent node

11.7.6 Amplified or Passive OADM Node Fiber-Optic Cabling

The two sides of the OADM node do not need to be symmetrical. On each side, Cisco TransportPlanner can create one of the following four configurations:

- OPT-BST and OPT-PRE
- OSC-CSM and OPT-PRE
- Only OSC-CSM
- Only OPT-BST

Note Amplified OADM nodes contain OPT-PRE cards and/or OPT-BST cards. Passive OADM nodes do not. Both contain add/drop channel or band cards.

The following rules generally apply for OADM node express path cabled connections:

- TX ports should only be connected to RX ports.
- EXP ports are connected only to COM ports in between AD-xC-xx.x or AD-xB-xx.x cards that all belong to Side B (that is, they are daisy-chained).
- EXP ports are connected only to COM ports in between AD-xC-xx.x or AD-xB-xx.x cards that all belong to Side A (that is, they are daisy-chained).
- The EXP port of the last AD-xC-xx.x or AD-xB-xx.x card on Side A is connected to the EXP port of the first AD-xC-xx.x or AD-xB-xx.x card on Side B.
- The OPT-BST COM RX port is connected to the nearest (in slot position) AD-xC-xx.x or AD-xB-xx.x COM TX port.
- The OPT-PRE COM TX port is connected to the nearest (in slot position) AD-xC-xx.x or AD-xB-xx.x COM RX port.
- If OADM cards are located in adjacent slots, the TCC2/TCC2P/TCC3/TNC/TSC card assumes that they are connected in a daisy-chain between the EXP ports and COM ports as noted previously.
- The first Side A AD-xC-xx.x or AD-xB-xx.x card COM RX port is connected to the Side A OPT-PRE or OSC-CSM COM TX port.
- The first Side A AD-xC-xx.x or AD-xB-xx.x card COM TX port is connected to the Side A OPT-BST or OSC-CSM COM RX port.
- The first Side B AD-xC-xx.x or AD-xB-xx.x card COM RX port is connected to the Side B OPT-PRE or OSC-CSM COM TX port.

- The first Side B AD-xC-xx.x or AD-xB-xx.x card COM TX port is connected to the Side B OPT-BST or OSC-CSM RX port.
- If a Side A OPT-PRE is present, the Side A OPT-BST or OSC-CSM COM TX port is connected to the Side A OPT-PRE COM RX port.
- If a Side B OPT-PRE is present, the Side B OPT-BST or OSC-CSM COM TX port is connected to the Side B OPT-PRE COM RX port.

The following rules generally apply for OADM node add/drop path cabled connections:

- AD-xB-xx.x add/drop (RX or TX) ports are only connected to the following ports:
  - 4MD-xx.x COM TX or 4MD-xx.x COM RX ports
  - Another AD-xB-xx.x add/drop port (a pass-through configuration)
- An AD-xB-xx.x add/drop band port is only connected to a 4MD-xx.x card belonging to the same band.
- For each specific AD-xB-xx.x card, the add and drop ports for that band card are connected to the COM TX and COM RX ports of the same 4MD-xx.x card.
- The AD-xB-xx.x and 4MD-xx.x cards are located in the same side (the connected ports all have the same line direction).

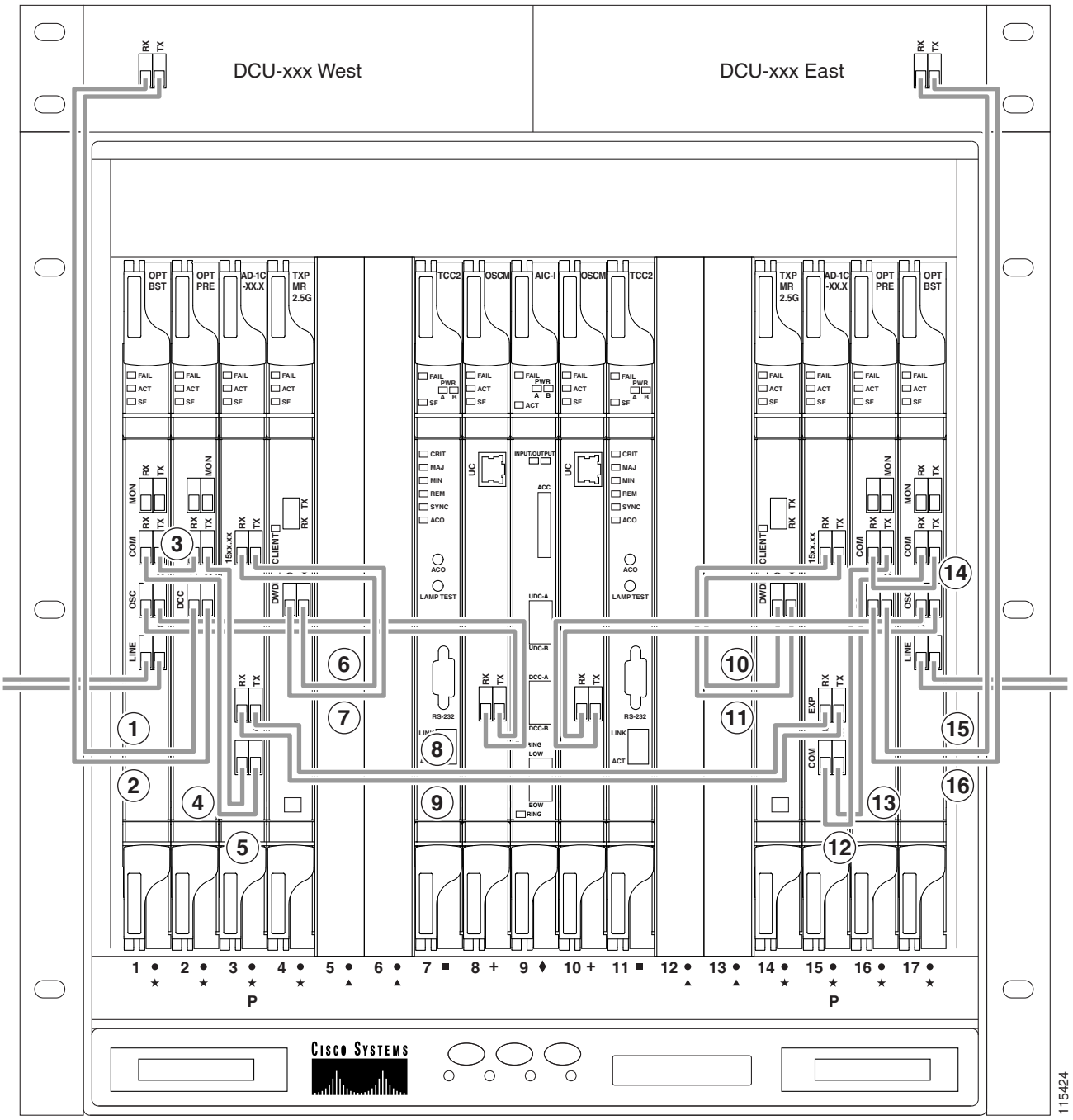
The following rules generally apply for OADM node pass-through path cabled connections:

- Pass-through connections are only established between add and drop ports on the same band or channel and in the same line direction.
- AD-xC-xx.x or AD-xB-xx.x add/drop ports must be connected to other AD-xC-xx.x or AD-xB-xx.x add/drop ports (as pass-through configurations).
- Add (RX) ports must be connected to drop (TX) ports.
- 4MD-xx.x client input/output ports must be connected to other 4MD-xx.x client input/output ports.
- A Side A AD-xB-xx.x drop (TX) port is connected to the corresponding Side A 4MD-xx.x COM RX port.
- A Side A AD-xB-xx.x add (RX) port is connected to the corresponding Side A 4MD-xx.x COM TX port.
- An Side B AD-xB-xx.x drop (TX) port is connected to the corresponding Side B 4MD-xx.x COM RX port.
- An Side B AD-xB-xx.x add (RX) port is connected to the corresponding Side B 4MD-xx.x COM TX port.

Figure 11-68 shows an example of an amplified OADM node with AD-1C-xx.x cards installed.

Note Figure 11-68 is an example. Always install fiber-optic cables based on the Cisco TransportPlanner Internal Connections table for your site.

Figure 11-68 Fibering an Amplified OADM Node



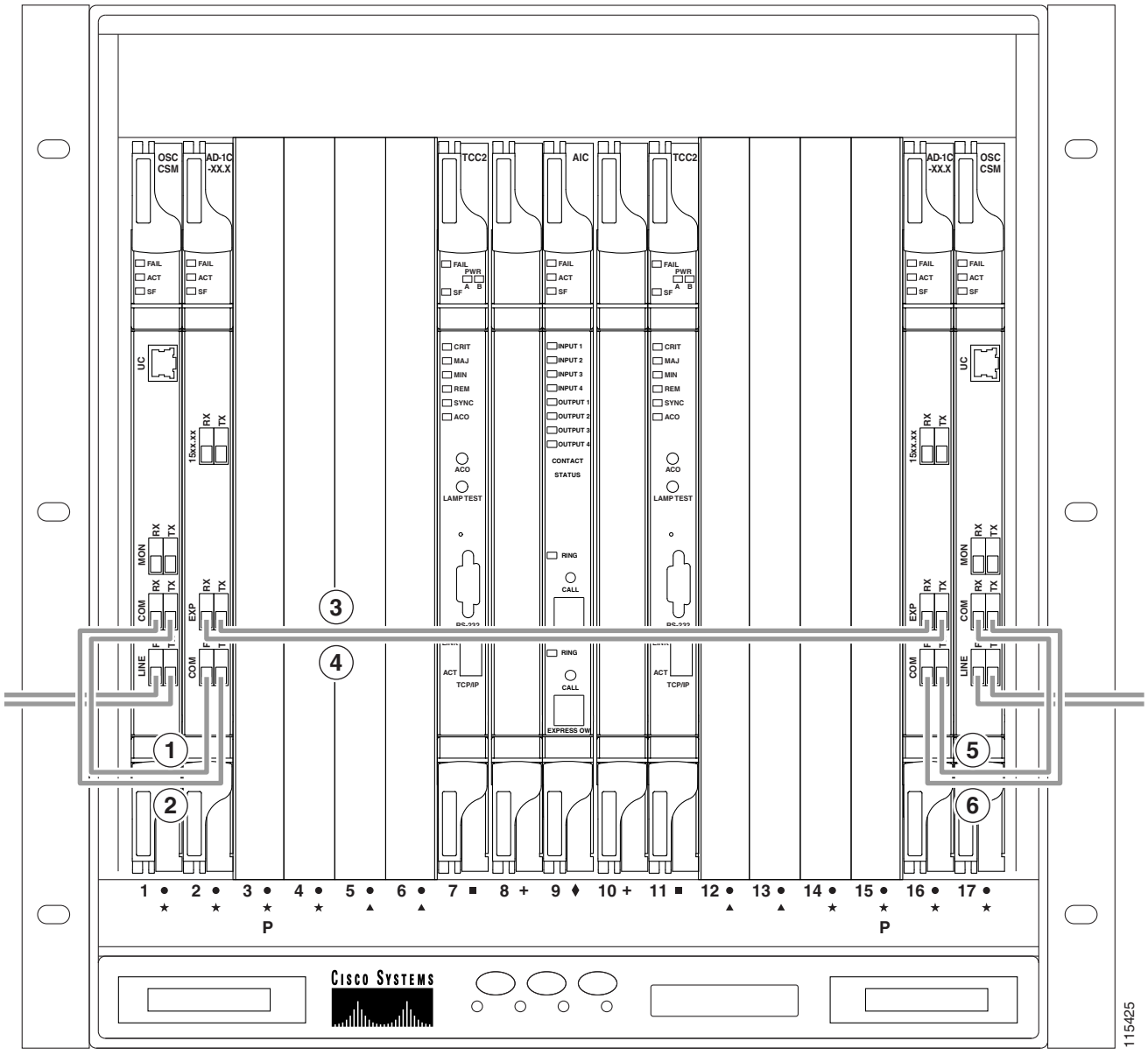
1	Side A DCU TX to Side A OPT-PRE DC RX[1]	**9**	Side A AD-1C-xx.x EXP RX to Side B AD-1C-xx.x EXP TX
2	Side A DCU RX to Side A OPT-PRE DC TX[1]	**10**	Side B TXP_MR_2.5G DWDM RX to Side B AD-1C-xx.x (15xx.xx) TX
3	Side A OPT-BST COM TX to Side A OPT-PRE COM RX	**11**	Side B TXP_MR_2.5G DWDM TX to Side B AD-1C-xx.x (15xx.xx) RX

4	Side A OPT-BST COM RX to Side A AD-1C-xx.x COM TX	**12**	Side B AD-1C-xx.x COM RX to OPT-PRE COM TX
5	Side A OPT-PRE COM TX to Side A AD-1C-xx.x COM RX	**13**	Side B AD-1C-xx.x COM TX to OPT-BST COM RX
6	Side A AD-1C-xx.x (15xx.xx) RX to Side A TXP_MR_2.5G DWDM TX	**14**	Side B OPT-PRE COM RX to Side B OPT-BST COM TX
7	Side A AD-1C-xx.x (15xx.xx) TX to Side A TXP_MR_2.5G DWDM RX	**15**	Side B DCU TX to Side B OPT-PRE DC RX[1]
8	Side A AD-1C-xx.x EXP TX to Side B AD-1C-xx.x EXP RX	**16**	Side B DCU RX to Side B OPT-PRE DC TX[1]

1. If a DCU is not installed, a 4-dB attenuator loop, +/ 1 dB, must be installed between the OPT-PRE DC ports.

Figure 11-69 shows an example of a passive OADM node with two AD-1C-xx.x cards installed.

Figure 11-69 Fibering a Passive OADM Node



1	Side A OSC-CSM COM TX to Side A AD-1C-xx.x COM RX	**4**	Side A OSC-CSM EXP RX to Side B AD-1C-xx.x EXP TX
2	Side A OSC-CSM COM RX to Side A AD-1C-xx.x COM TX	**5**	Side B AD-1C-xx.x COM TX to Side B OSC-CSM COM RX
3	Side A OSC-CSM EXP TX to Side B AD-1C-xx.x EXP RX	**6**	Side B AD-1C-xx.x COM RX to Side B OSC-CSM COM TX

11.7.7 ROADM Node Fiber-Optic Cabling

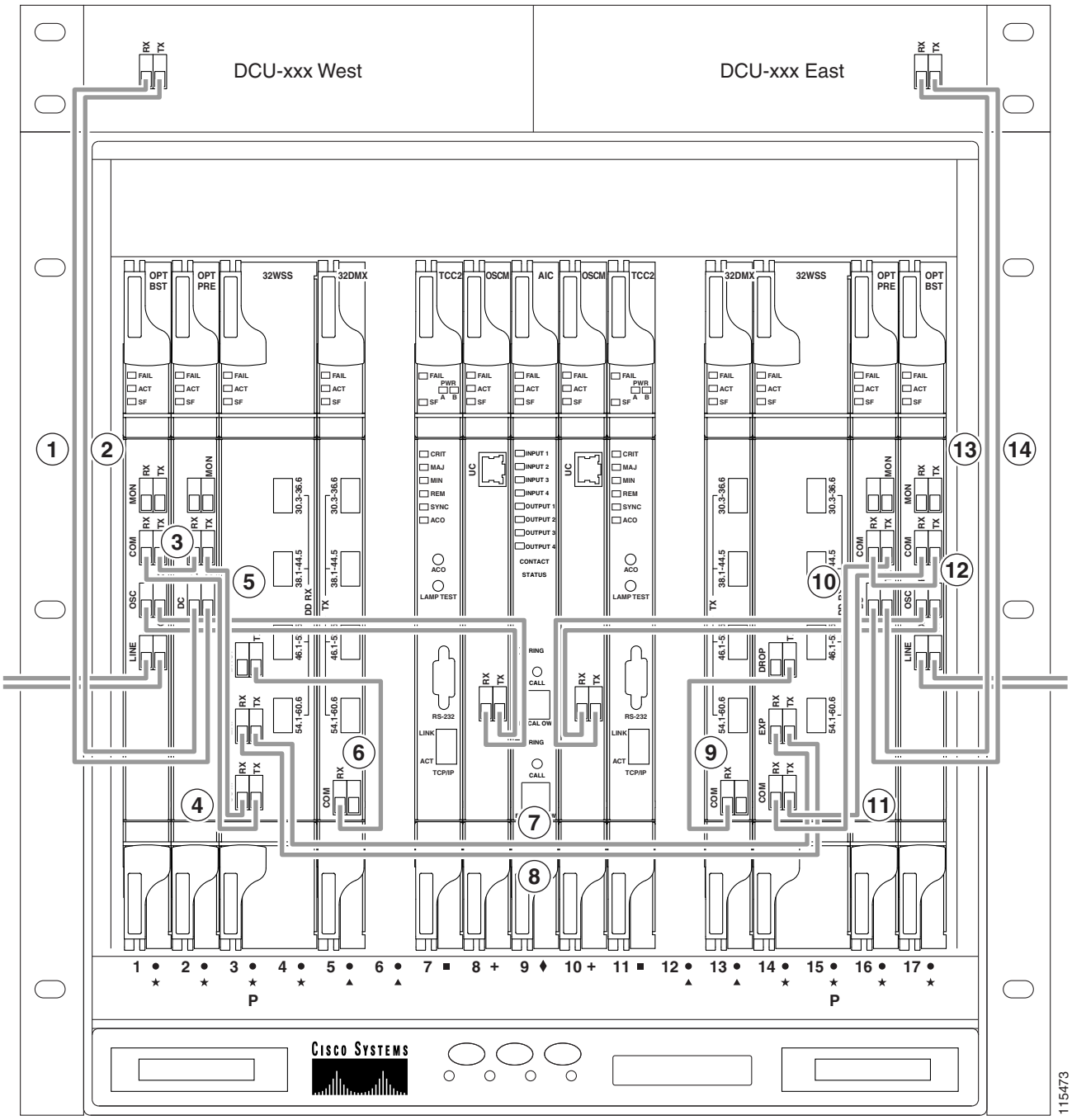
The following rules generally apply to ROADM node cabling:

- The Side A OPT-BST or OSC-CSM COM TX port is connected to the Side A OPT-PRE COM RX port.
- The Side A OPT-PRE COM TX port is connected to the Side A 32WSS COM RX port.
- The Side A OPT-BST or OSC-CSM COM RX port is connected to the Side A 32WSS COM TX port.
- The Side A OPT-BST (if installed) OSC TX port is connected to the Side A OSCM RX port.
- The Side A OPT-BST (if installed) OSC RX port is connected to the Side A OSCM TX port.
- The Side A 32WSS EXP TX port is connected to the Side B 32WSS EXP RX port.
- The Side A 32WSS EXP RX port is connected to the Side B 32WSS EXP TX port.
- The Side A 32WSS DROP TX port is connected to the Side A 32DMX COM RX port.
- The Side A 40-WSS-C/40-WSS-CE DROP TX port is connected to the Side A 40-DMX-C or 40-DMX-CE COM RX port.
- The Side B OPT-BST or OSC-CSM COM TX port is connected to the Side B OPT-PRE COM RX port.
- The Side B OPT-PRE COM TX port is connected to the Side B 32WSS COM RX port.
- The Side B OPT-BST or OSC-CSM COM RX port is connected to the Side B 32WSS COM TX port.
- The Side B OPT-BST (if installed) OSC TX port is connected to the Side B OSCM RX port.
- The Side B OPT-BST (if installed) OSC RX port is connected to the Side B OSCM TX port.
- The Side B 32WSS DROP TX port is connected to the Side B 32DMX COM RX port.
- The Side B 40-WSS-C/40-WSS-CE DROP TX port is connected to the Side B 40-DMX-C or 40-DMX-CE COM RX port.

Figure 11-70 shows an example of an amplified ROADM node with cabling.

Note Figure 11-70 is an example. Always install fiber-optic cables based on the Cisco TransportPlanner Internal Connections table for your site.

Figure 11-70 Fibering a ROADM Node



1	Side A DCU TX to Side A OPT-PRE DC RX[1]	**8**	Side A 32WSS EXP RX to Side B 32WSS EXP TX
2	Side A DCU RX to Side A OPT-PRE DC TX[1]	**9**	Side B 32DMX COM RX to Side B 32WSS DROP TX
3	Side A OPT-BST COM TX to Side A OPT-PRE COM RX	**10**	Side B 32WSS COM RX to Side B OPT-PRE COM TX

4	Side A 32WSS COM TX to Side A OPT-BST COM RX	**11**	Side B 32WSS COM TX to Side B OPT-BST COM RX
5	Side A 32WSS COM RX to Side A OPT-PRE COM TX	**12**	Side B OPT-BST COM TX to Side B OPT-PRE COM RX
6	Side A 32DMX COM RX to Side A 32WSS DROP TX	**13**	Side B DCU RX to Side B OPT-PRE DC TX[1]
7	Side A 32WSS EXP TX to Side B 32WSS EXP RX	**14**	Side B DCU TX to Side B OPT-PRE DC RX[1]

1. If a DCU is not installed, a 4-dB attenuator loop, +/–1 dB must be installed between the OPT-PRE DC ports.

11.8 Automatic Node Setup

Automatic node setup (ANS) is a TCC2/TCC2P/TCC3/TNC/TSC function that adjusts values of the variable optical attenuators (VOAs) on the DWDM channel paths to equalize the per channel power at the amplifier input. This power equalization means that at launch, all channels have the same amplifier power, independent of the input signal on the client interface and independent of the path crossed by the signal inside the node. This equalization is needed for two reasons:

- Every path introduces a different penalty on the signal that crosses it.
- Client interfaces add their signal to the ONS 15454 DWDM ring with different power levels.

To support ANS, integrated VOAs and photodiodes are provided in the following cards:

- AD-xB-xx.x card express and drop paths
- AD-xC-xx.x card express and add paths
- 4MD-xx.x card add paths
- 32MUX-O card add paths
- 32WSS/40-WSS-C/40-WSS-CE/40-WXC-C/80-WXC-C add, drop, and pass through paths
- 32DMX-O card drop paths
- 32DMX, 40-DMX-C, 40-DMX-CE card input port
- 40-MUX-C card output port
- 40-SMR1-C/40-SMR2-C add, drop, and pass through ports
- PSM card input and output ports (both working and protect path)

Optical power is equalized by regulating the VOAs. Based on the expected per channel power, ANS automatically calculates the VOA values by:

- Reconstructing the different channel paths.
- Retrieving the path insertion loss (stored in each DWDM transmission element).

VOAs operate in one of three working modes:

- Automatic VOA Shutdown—In this mode, the VOA is set at maximum attenuation value. Automatic VOA shutdown mode is set when the channel is not provisioned to ensure system reliability in the event that power is accidentally inserted.
- Constant Attenuation Value—In this mode, the VOA is regulated to a constant attenuation independent from the value of the input signal. Constant attenuation value mode is set on VOAs associated to aggregated paths.

- Constant Power Value—In this mode, the VOA values are automatically regulated to keep a constant output power when changes occur to the input power signal. This working condition is set on VOAs associated to a single channel path.

ANS calculates the following VOA provisioning parameters:

- Target attenuation
- Target power

Optical patchcords are passive devices that are modeled by the two termination points, each with an assigned slot and port. If user-provisioned optical patchcords exist, ANS checks if the new connection is feasible according to internal connection rules. If the user connection violates one of the rules, ANS returns a denied message. ANS requires the expected wavelength to be provisioned. When provisioning the expected wavelength, the following rules apply:

- The card family generically characterizes the card name, and not the particular wavelengths supported (for example, AD-2C-xx.x for all two-channel OADMs).
- At the provisioning layer, you can provision a generic card for a specific slot using CTC or TL1.
- Wavelength assignment is done at the port level.
- An equipment mismatch alarm is raised when a mismatch between the identified and provisioned value occurs. The default value for the provisioned attribute is AUTO.

ONS 15454 ANS parameters set the values required for the node to operate successfully. Cisco TransportPlanner calculates the ANS parameters based on the requirements for a planned network. Cisco TransportPlanner exports the parameters to an ASCII, NE update file. When the NE update file is imported in CTC, the Provisioning > WDM-ANS > Provisioning tab is populated with the ANS parameters to provision the node for the network. These ANS parameters can be modified. All the ANS parameters are mapped to the physical ports of the cards. ANS parameters can also be manually added or deleted in the Provisioning tab. The ranges for the values of the ANS parameters is shown in Table 11-11. For more information on how to add an ANS parameter, refer to the “Turn Up a Node” chapter in the *Cisco ONS 15454 DWDM Procedure Guide*.

Note The Provisioning > WDM-ANS > Provisioning tab in CTC is empty if the NE update file is not imported.

Note It is recommended that you use the Cisco TransportPlanner NE Update file to provision the ANS parameters instead of manually adding all the parameters in CTC. ANS provisioning parameters must be manually changed by Cisco qualified personnel only. Setting incorrect ANS provisioning (either as preamplifier or booster input power thresholds) may impact traffic.

Table 11-11 Ranges and Values for the ANS Parameters

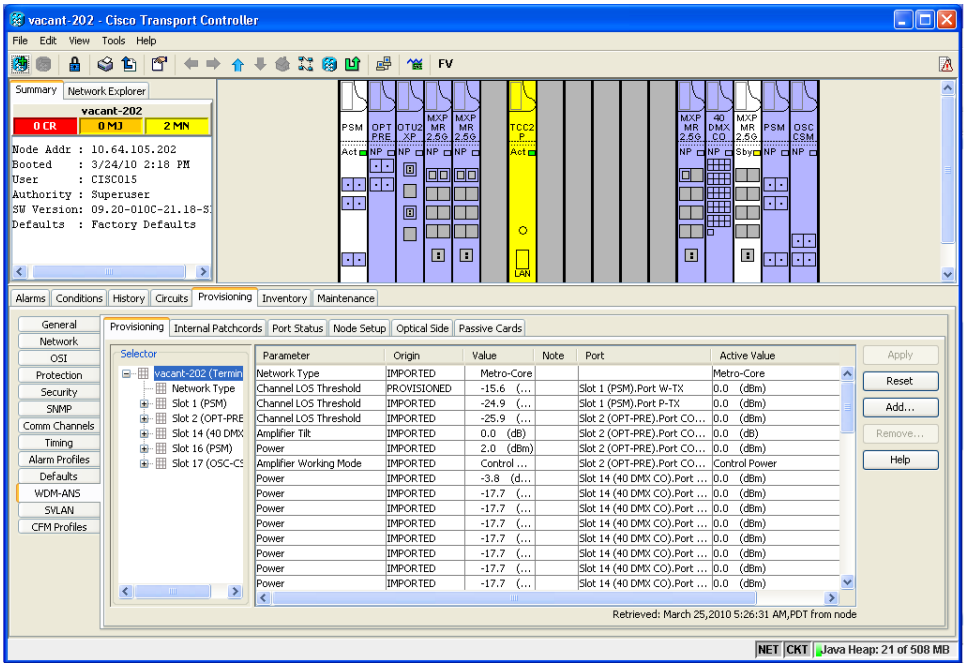
ANS Parameter	Range/Value
OSC LOS Threshold	-50.0 to +30.0 dBm
Channel LOS Threshold	-50.0 to +30.0 dBm
Amplifier Working Mode	Control Power, Control Gain, Fixed Gain
Amplifier Gain	0.0 to 40.0 dB
Amplifier Tilt	-15.0 to +15.0 dB
OSC Power	-24.0 to 0.0 dBm

Table 11-11 Ranges and Values for the ANS Parameters

ANS Parameter	Range/Value
Raman Ratio	0.0 to 100.0%
Raman Total Power	100 to 450 mW
Power	-30.0 to +50 dBm
WXC Dithering	0 to 33
Min Expected Span Loss	0.0 to 60.0 dB
Max Expected Span Loss	0.0 to 60.0 dB
VOA Attenuation	0 to 30 dB

ANS parameters can be viewed in the node view Provisioning > WDM-ANS > Provisioning tab, as shown in Figure 11-71.

Figure 11-71 WDM-ANS Provisioning



The Provisioning > WDM-ANS > Provisioning tab presents the following information:

- Selector—Presents the ANS parameters in a tree view based on physical position. Clicking the + or – expands or collapses individual tree elements. Clicking a tree element displays the element parameters in the table on the right. For example, clicking the node name at the top displays all the node ANS parameters or clicking Slot 1 (PSM) displays the PSM amplifier parameters only. The ANS parameters can be sorted according to physical position.
- Parameter—Displays the ANS parameter name.
- Origin—Indicates how the parameter was calculated:
  - Imported—The value was set by importing the CTP XML file.

  - Provisioned—The value was manually provisioned.
  - Automatic—The value is automatically calculated by the system using the Raman provisioning wizard. For more information on how to provision using a wizard, see the "DLP-G468 Configure the Raman Pump Using an Installation Wizard" task in the *Cisco ONS 15454 DWDM Procedure Guide*.
- Value—Displays the ANS parameter value. The values can be modified manually, although manually modifying the ANS parameters is not recommended.
- Note—Displays information for parameters that could not be calculated, that is, parameters with Unknown appearing in the Value column.
- Port —Displays the port value. Port is represented as Slot.Port.
- Active Value —Displays the active parameter value. The active value cannot be modified manually. When you modify the parameter value in the Value field, the active value is updated with the modified value after you run ANS.

The Provisioning > WDM-ANS > Port Status tab presents the following information:

- Port—Displays the port value. The port is represented as Slot.Port.
- Parameter—Displays the ANS parameter name.
- Result—After you run ANS, one of the following statuses is provided for each ANS parameter in the Result column:
  - Success - Changed—The parameter setpoint was recalculated successfully.
  - Success - Unchanged—The parameter setpoint did not need recalculation.
  - Unchanged - Port in IS state—ANS could not modify the setpoint because the port is in IS state.
  - Fail - Out of Range—The calculated setpoint is outside the expected range.
  - Fail - Missing Input Parameter—The parameter could not be calculated because the required provisioning data is unknown or unavailable.
  - Not Applicable State—Ports are not in use.
- Value—Displays the parameter value.
- Set By—Displays the application that sets this parameter. This field can take the following values:
  - ANS
  - APC
  - Circuit Creation
  - Raman Wizard.

A parameter could be set by more than one application. For example, VOA Attenuation parameter could be set by both ANS and APC. In this case, individual entries will be displayed for ANS and APC.

- Last Change—Displays the date and time when the parameter was last modified.

11.8.1 Raman Setup and Tuning

Raman amplification occurs in the optical fiber and the consequent Raman gain depends on the characteristics of the span (attenuator presence, fiber type, junctions, etc.). As two Raman pumps at two different wavelengths are used to stimulate the Raman effect, not only is the total signal power

calculation significant, but the right mix of power to ensure gain flatness is crucial. These setpoints of the total Raman power and Raman ratio can be configured on the OPT-RAMP-C or OPT-RAMP-CE card in three ways:

- Raman installation wizard
- CTP XML file
- CTC/TL1 interface

For information on how to configure the setpoints on the OPT-RAMP-C or OPT-RAMP-CE card, see the *Cisco ONS 15454 DWDM Procedure Guide*.

Raman amplification on OPT-RAMP-C or OPT-RAMP-CE cards depends on the optical fiber installed. Therefore, Raman total power and Raman ratio values calculated using the Raman installation wizard via CTC is more accurate than the values provisioned by loading the CTP XML file. For this reason, the value provisioned using the wizard cannot be overridden by the CTP XML file. However, the values provisioned using the wizard or the CTP XML file can be overriden by manually provisioning the parameters.

When the Raman installation is completed, a report of the status of Raman configuration on a node in the OPT-RAMP-C or OPT-RAMP-CE card can be viewed in the Maintenance > Installation tab when you are in card view.

The Installation tab displays the following fields:

- User—Name of user who configured the Raman pump.
- Date—Date when the Raman pump was configured.
- Status
  - Raman Not Tuned—The OPT-RAMP-C or OPT-RAMP-CE card was provisioned but ANS was not launched.
  - Tuned by ANS—ANS was run successfully and the basic ANS parameters were applied.
  - Tuned by Wizard—The Raman installation wizard was run successfully without errors.
  - Tuned by User Acceptance—The Raman installation wizard was completed with errors and the user accepted the values that the wizard calculated.
  - Raman is Tuning—The Raman installation wizard is running.
- S1Low (dBm)—See Table 11-12.
- S1High (dBm)—See Table 11-12.
- S2Low (dBm)—See Table 11-12.
- S2High (dBm)—See Table 11-12.
- Power (mW)—Total Raman power setpoints.
- Ratio—Raman pump ratio setpoint.
- Gain—Expected Raman gain that the wizard calculated.
- Actual Tilt—Expected Raman tilt that the wizard calculated.
- Fiber Cut Recovery—Status of the fiber cut restoration.
  - Executed—The restore procedure was completed successfully.
  - Pending—The restore procedure is not complete.
  - Failed—The system failed to execute the procedure.
- Fiber Cut Date—Date when the fiber cut occured.

The Raman pump is equipped with two different Raman pumps transmitting powers (P1 and P2) at two different wavelengths λ 1 and λ 2. During installation, the two pumps alternatively turn ON and OFF at two different power values. λ1 and λ2 signals are used as probes at the end of spans to measure Raman gain efficiency of the two Raman pumps separately.

The example in Figure 11-72 shows the Raman gain on an OPT-RAMP-C or OPT-RAMP-CE card in Node B that was measured by setting the wavelength and power measurements as follows:

λ 1=1530.33 nm signal probe at Node A

λ 2=1560.61 nm signal probe at Node A

P1 = 1425 nm power at Node B

P2 = 1452 nm power at Node B

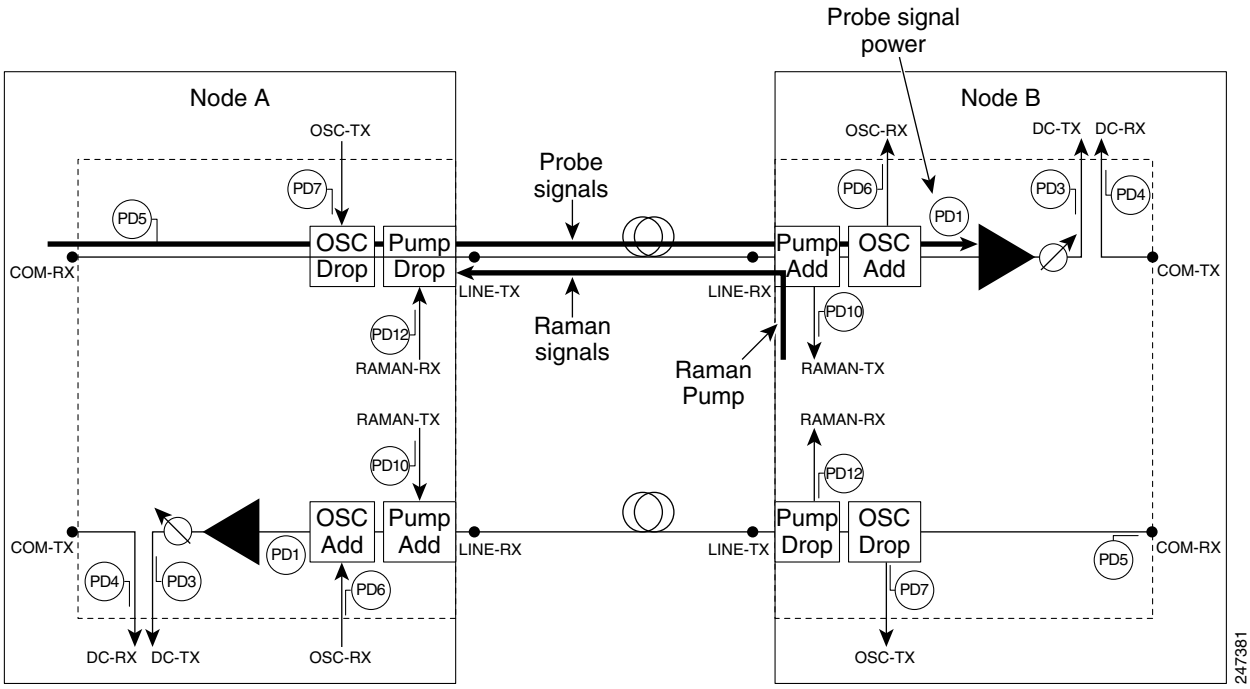
Plow = 100 mW

Phigh = 280 mW

Pmin = 8 mW

Pmax = 450 mW

Figure 11-72 Raman Gain on Node B



The S1low, S1high, S2low, and S2low values in the Maintenance > Installation tab are based on the power values read on the LINE-RX port of Node B.

Table 11-12 Example of Raman Power Measurements

Input	P1	P2	Raman Power at Node B
λ 1=1530.33 nm at Node A	Plow = 100 mW	Pmin = 8 mW	S1low
	Phigh = 250 mW	Pmin = 8 mW	S1high
λ 2=1560.61 nm at Node A	Pmin = 8 mW	Plow = 100 mW	S2low
	Pmin = 8 mW	Phigh = 250 mW	S2low

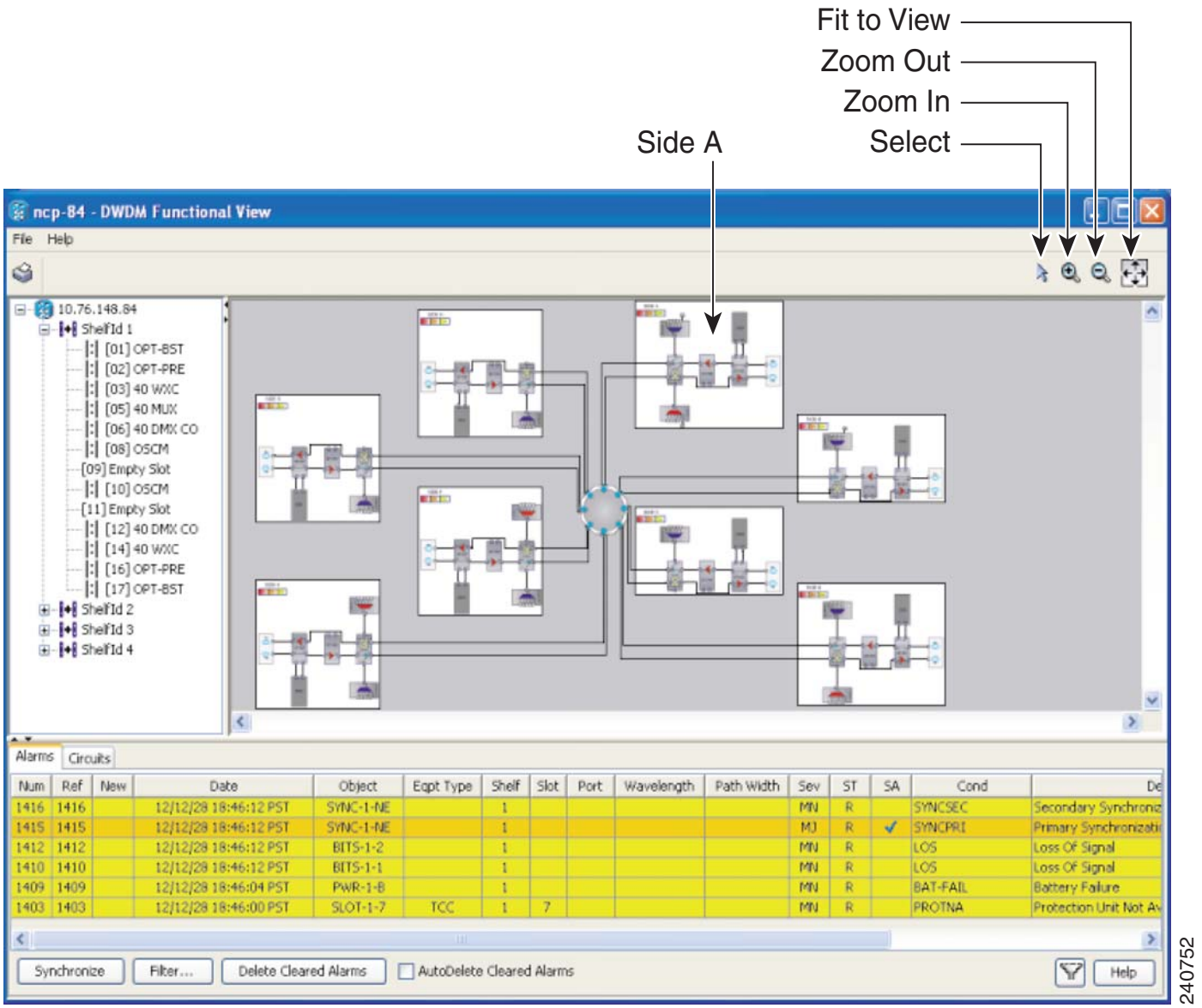
11.9 DWDM Functional View

DWDM functional view offers a graphical view of the DWDM cards and the internal connections between them in an MSTP node. The functional view also shows cards and connections for multidegree MSTP nodes (up to eight sides). To navigate to the functional view of a DWDM node, use the following navigational path in CTC when you are in node view:

Provisioning > WDM-ANS > Internal Patchcords > Functional View

An example of the functional view for an eight-sided node is shown in Figure 11-73.

Figure 11-73 Functional View for an Eight-Sided Node



11.9.1 Navigating Functional View

The functional view has two main panes. The upper pane contains a tree view of the shelves and a graphical view of the shelf equipment. The lower pane describes alarms and circuits in a tabular format.

The upper pane in Figure 11-73 is divided into a left pane and a right pane. The left pane shows a tree structure view of the shelf or shelves in the MSTP system. You can expand the tree view of a shelf to show the slot usage in that shelf. The right pane is a graphical view of the sides in the shelf. In the case of Figure 11-73, there are eight sides (A through H). Side A is located as shown in the figure. All of the cards in each side are grouped together.

The meanings of the icons in the upper right corner are as follows:

- Select—use this icon to select a graphical element in the graphical view pane.
- Patchcord—Use this icon to create an internal patchcord between cards.

Note The Patchcord icon is not functional for Software Release 8.5.

- Zoom In/Zoom Out—Use these icons to zoom in or zoom out in the graphical display pane.
- Fit to View—Use this icon to have the graphical view fit the space available on your screen.

The bottom pane can be used to display alarms (using the Alarms tab) or Circuits (using the Circuits tab). Clicking the Alarms tab displays the same information as the Alarms tab in the network, node, or card view. Clicking the Circuits tab displays the same information as the Alarms tab in the network, node, or card view.

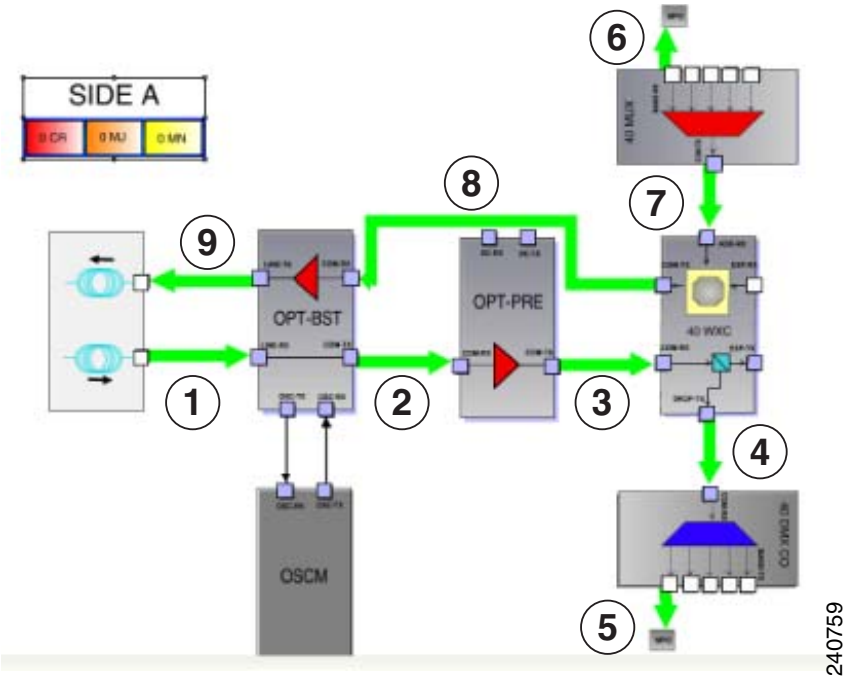
11.9.2 Using the Graphical Display

This section explains how to use the graphical portion of the display to gather information about the cards and ports.

11.9.2.1 Displaying a Side

Double-click a side to show the details of that side. For example, if you double-click Side A in Figure 11-73, the result is as shown in Figure 11-74.

Figure 11-74 Side A Details



The green arrows in the diagram represent the DWDM optical path within the selected side. The optical path in this instance is summarized as follows:

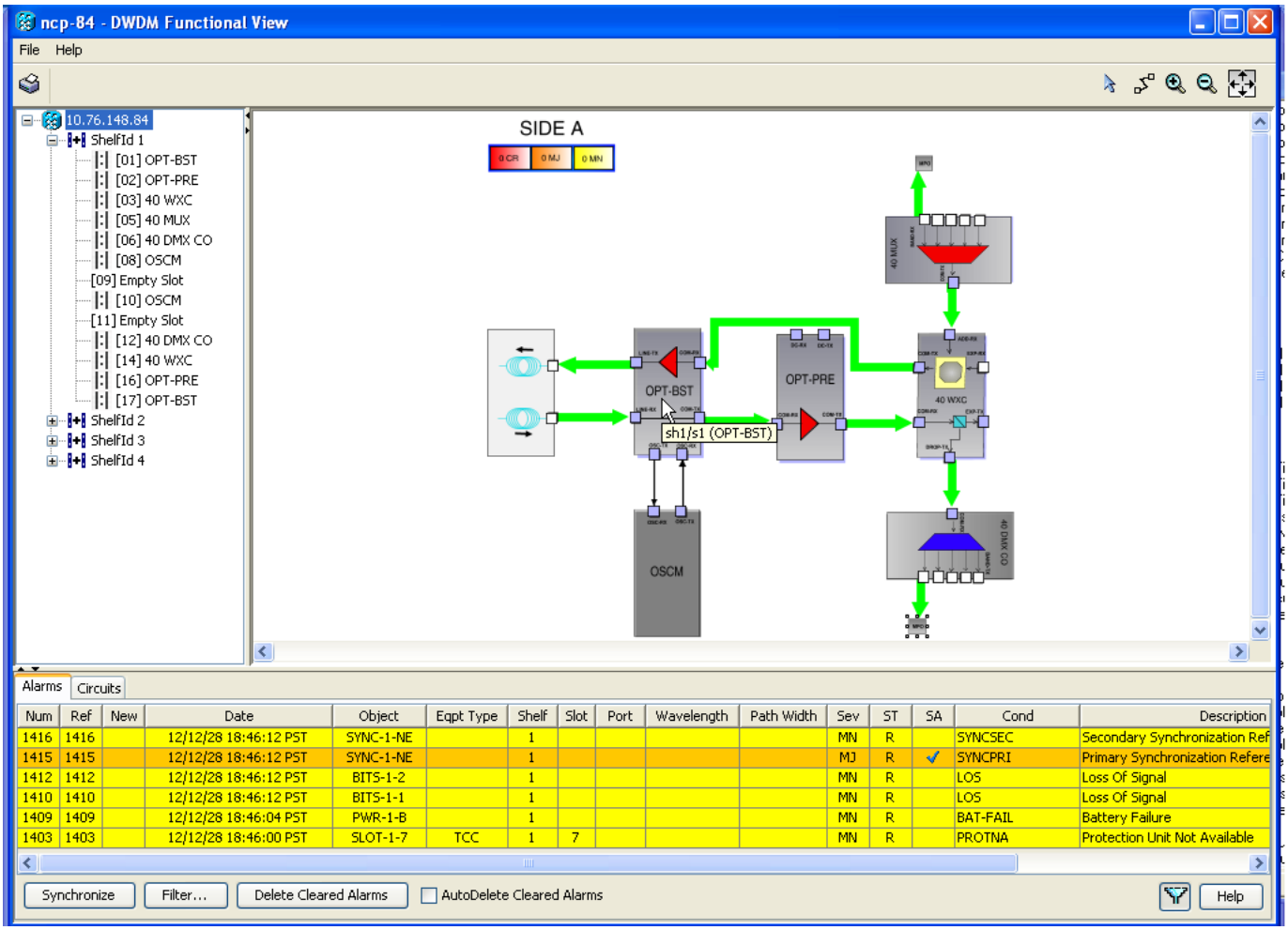
1. The light enters the OPT-BST card LINE-RX port from the optical span.
2. The path continues out of the OPT-BST card COM-TX port to the COM-RX port of the OPT-PRE card.
3. The OPT-PRE card sends the optical signal out of its COM-TX port to the 40-WXC COM-RX input port.
4. The 40-WXC card sends the signal to be locally dropped out of its DROP-TX port to the 40-DMX/40-DMX-CE card COM-RX port.
5. The 40-DMX/40-DMX-CE card sends the dropped signal out on one of its multifiber push on (MPO) connectors to the block labeled MPO. When you expand the MPO block (double-click it or right-click it and select **Down**), you will see a muxponder (MUX) card inside the MPO block. One of the eight optical fibers in the MPO cable is connected to the MUX trunk port.
6. The optical signal from the trunk port of the MXP card inside the MPO block enters the 40-MUX card at one of its five MPO connectors.
7. The 40-MUX card sends the optical signal out of its COM-TX port to the ADD-RX port of the 40-WXC card.
8. The added signal from the MXP gets sent out on the COM-TX port of the 40-WXC card to the COM-RX port of the OPT-BST card.
9. Finally, the OPT-BST card sends the optical signal out onto the span from its LINE-TX port.

11.9.2.2 Displaying Card Information

In the functional view graphical pane, you can double-click a card to bring up the usual CTC card view.

You can also move the mouse over a card to display information about the card. For example, when the mouse is placed over the OPT-BST card in Side A, the tooltip text displays sh1/s1 (OPT-BST), indicating that the OPT-BST card for Side A is located in Shelf 1, Slot 1. See Figure 11-75.

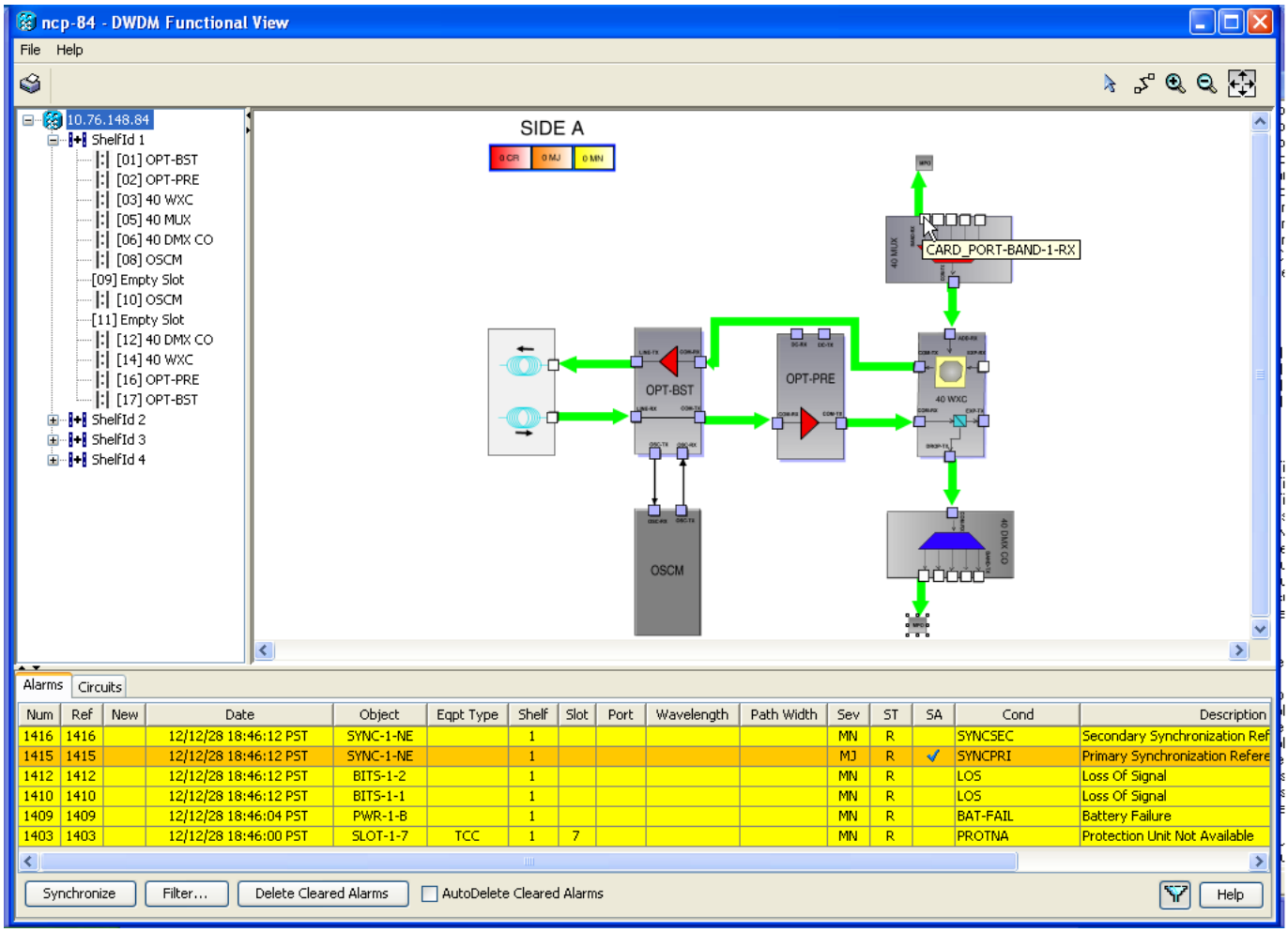
Figure 11-75 Side A OPT-BST Card Shelf and Slot Information



11.9.2.3 Displaying Port Information

Move the mouse over a port on a card to display information about the port. For example, when the mouse is placed over the top left port of the 40-MUX card in Side A, the tooltip text displays CARD_PORT-BAND-1-RX, indicating that the 40-MUX port being pointed to is for the first band of wavelengths (wavelengths 1 to 8) to be added into the optical path at the 40-MUX card. These wavelengths come into the 40-MUX card from a transponder (TXP) or muxponder (MXP) on an MPO connector, which contains eight integrated optical fibers. See Figure 11-76.

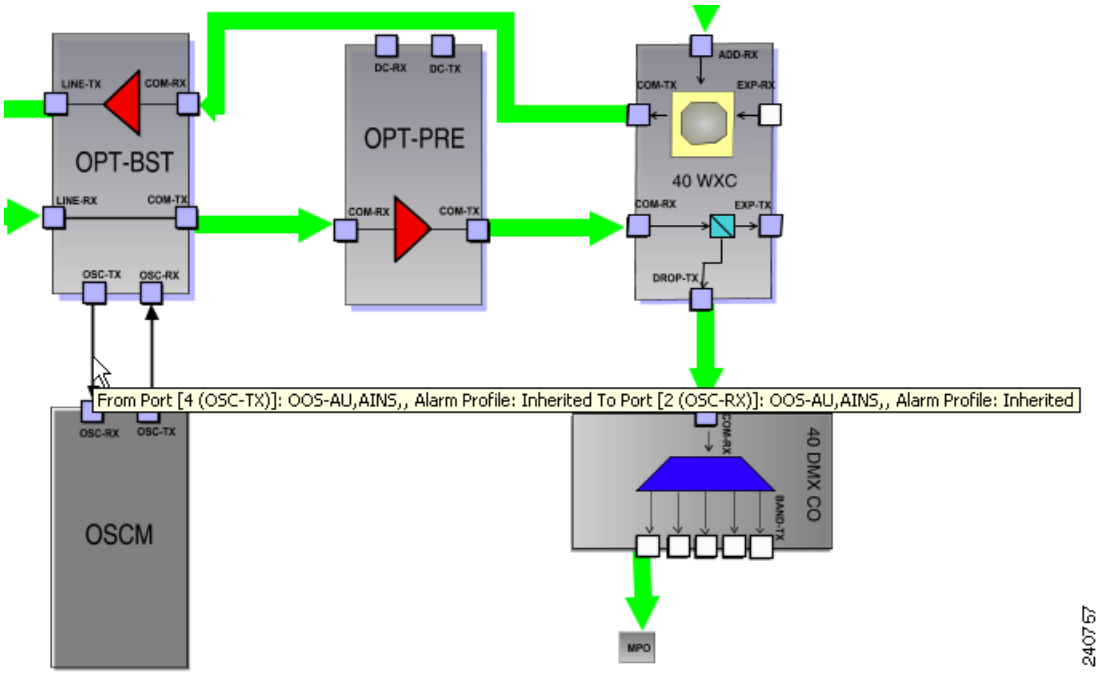
Figure 11-76 Side A 40-MUX Port Information



11.9.2.4 Displaying Patchcord Information

Move the mouse over a patchcord to see the state of the output and input port associated with that patchcord. See Figure 11-77.

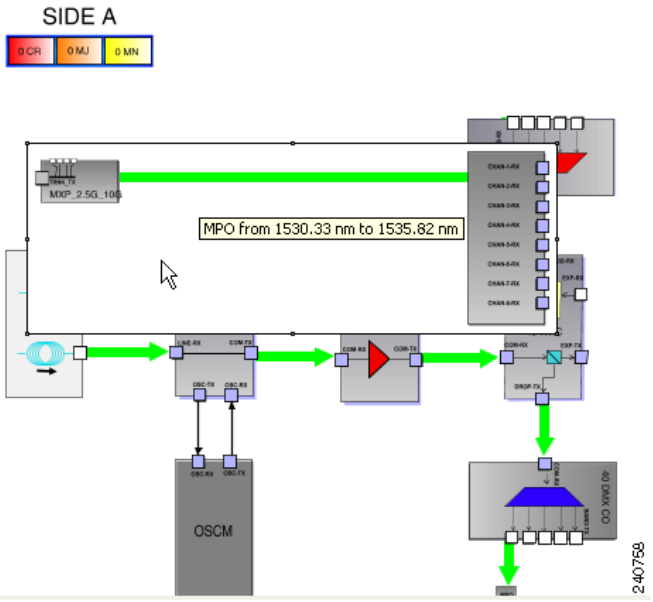
Figure 11-77 Patchcord Input and Output Port State Information



11.9.2.5 Displaying MPO Information

To show the details inside an MPO block, double-click it or right-click it and select **Down**. When the detailed view is visible, right-click inside the MPO block and select **Upper View** to collapse the block. When you move the mouse over the MPO block, the associated wavelengths are displayed as a tool tip (see Figure 11-78).

Figure 11-78 MPO Information



11.9.2.6 Alarm Box Information

Within the side display, an alarm box is shown that gives the alarm count for the Critical, Major, and Minor alarms that affect that side. This alarm summary is only for the side, and is different from the alarms under the Alarms tab, where all of the alarms for the system are summarized. If an alarm under the Alarms tab appears that has to do with Side A, for example, only the appropriate alarm count in the Alarm box for Side A is incremented. The alarm counts in the Alarm boxes for the other nodes (B through H) are not incremented. In the graphical view of a side, the card icon or port icon changes color to reflect the severity of an alarm associated with the card (red, orange, or yellow). The color of the MPO block reflects the color of highest alarm severity for the elements in the MPO block.

11.9.2.7 Transponder and Muxponder Information

All of the TXP and MXP cards connected with patchcords are grouped together under the MPO icon. In the node shown in Figure 11-73, there is an MXP card in Side A that is connected to the 40-MUX card and to the 40-DMX/40-DMX-CE card. The MXP card is connected through the 40-MUX card to the add port on the 40-WXC card and it is also connected through the 40-DMX/40-DMX-CE card to the drop port on the 40-WXC card. To view the connections to the MXP card from the 40-MUX card, double-click the MPO icon. Figure 11-79 shows the MPO icon before double-clicking it and Figure 11-80 shows the result after double-clicking it.

Note In the case of a protected TXP (TXPP) or MXP (MXPP) card, the card icon has a label indicating the active trunk and the protected trunk.

Figure 11-79 Side A MPO Connection to an MXP Before Double-Clicking

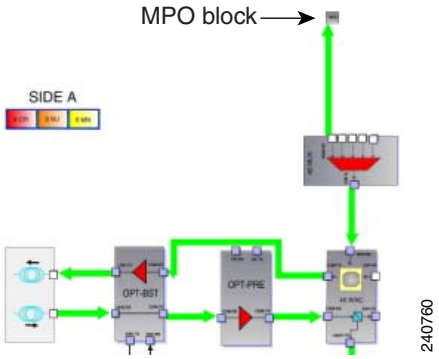
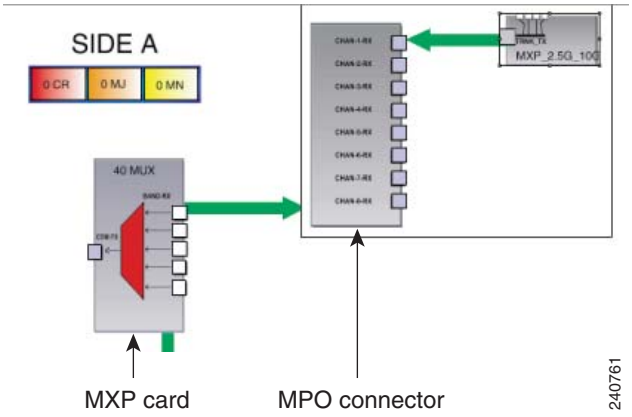


Figure 11-80 Side A MPO Connection to an MXP After Double-Clicking



11.9.2.8 Changing the Views

When you right-click inside of a side view, a shortcut menu allows you to do the following (see Figure 11-81):

- Fit to View—Fits the side view into the available display space.
- Delete Side—Deletes the selected side.
- Rotate Left—Rotates the side 90 degrees counterclockwise (all connections are maintained).
- Rotate Right—Rotates the side 90 degrees clockwise (all connections are maintained).
- Horizontal Flip—Flips the side horizontally (all connections are maintained).
- Vertical Flip—Flips the side vertically (all connections are maintained).

After you have selected Fit to View for a side, you can right-click in the side view to bring up a new menu with the following selections (see Figure 11-82):

- Go to Upper View—Returns to the previous view.

- Perform AutoLayout—Optimizes the placement of the cards and the connections between them.

Figure 11-81 Side A View Options

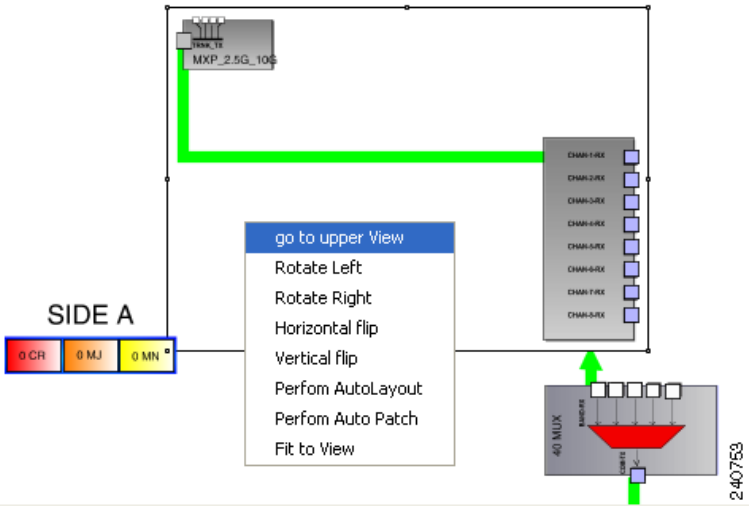
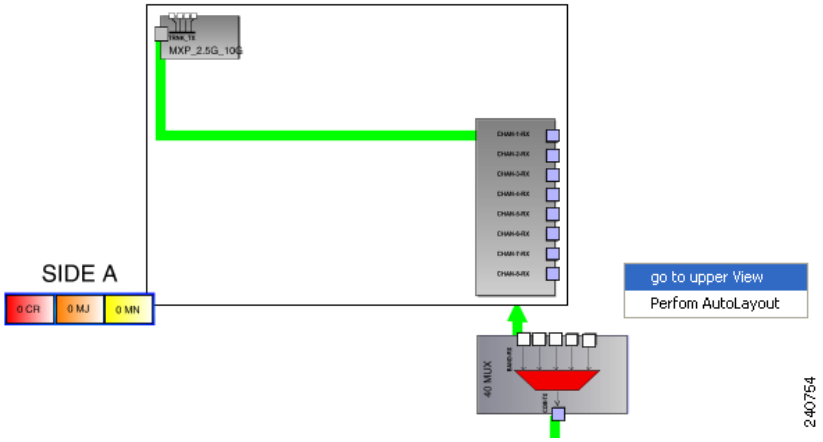


Figure 11-82 Side A View Options (after Selecting Fit to View)



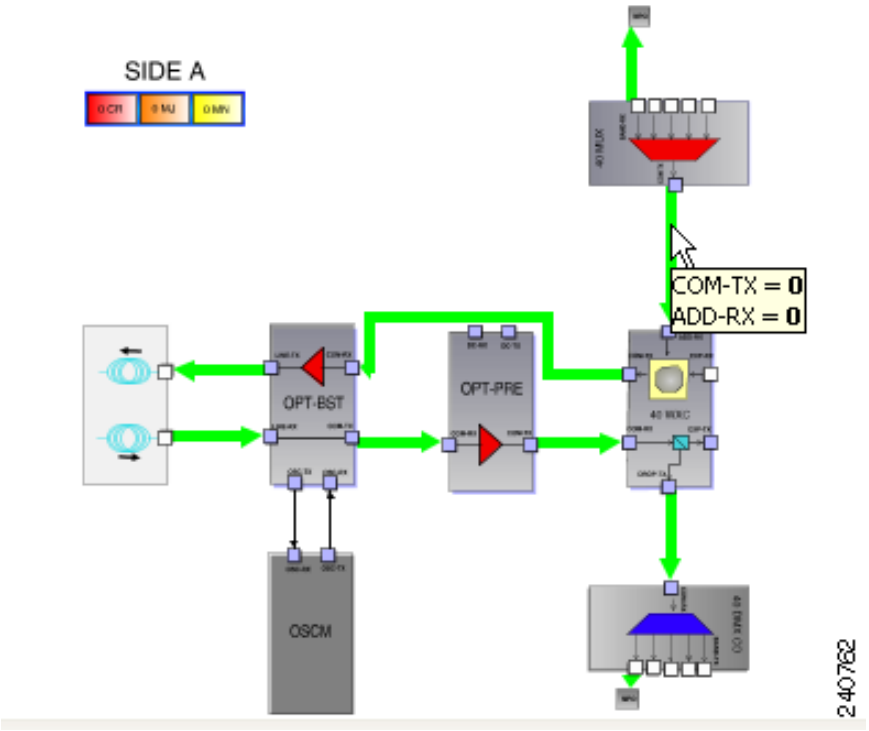
11.9.2.9 Selecting Circuits

When the Circuits tab is selected, the circuits for the functional view are shown. The patchcord lines in the graphical display are normally black in color. A patchcord line becomes green only when you select a circuit associated with the patchcord that carries the selected circuit.

11.9.2.10 Displaying Optical Path Power

To show the optical power present in an optical path, move the mouse over the desired optical path (green line). A tooltip shows the power along the optical path in dBm (see Figure 11-83).

Figure 11-83 Optical Path Power



11.10 DWDM Network Functional View

The DWDM Network Functional View (NFV) displays a graphical representation of the circuit connections, optical power, and alarms in the DWDM network. The NFV allows you to view the circuit connections and flow of data at the network level. The NFV also helps to find an alternate network path if there is a loss of signal in the network.

The NFV offers dual options to view the network:

- Graphical view—Displays the circuit connections, optical power, and alarms of a circuit through a graphical representation. To view the graphical display of the circuit connections, select the circuit listed in the upper left pane. Click **dB**, **SL**, and **PV** button on the toolbar to view the optical power of the selected circuit, span loss of the desired span, and insertion loss of the patchchord respectively. For more information refer to 11.10.2 Using the Graphical Display, page 11-108.
- Viewing the circuit details in tabular format—The circuit connections, optical power, and alarms of a circuit are displayed in a tabular format (seen in the left pane of the Network Functional View). For more information refer to 11.10.2.2 Selecting the Circuit, page 11-109.

  For information on how to view optical power values and alarms of the circuit selected in the Network Functional View, see the “View Optical Power Values and Alarms Using the Network Functional View” task in the *Cisco ONS 15454 DWDM Procedure Guide*.

11.10.1 Navigating Network Functional View

This section explains how to navigate to the network functional view (NFV). To navigate to the NFV, go to the network view in the CTC and click the **FV** button on the toolbar. The DWDM Network Functional View window opens.

The NFV is similar to the DWDM functional view in its graphical layout and behavior at the node level. For additional information, see "11.9 DWDM Functional View" section on page 11-96.

The network functional view has two main panes (Figure 11-84):

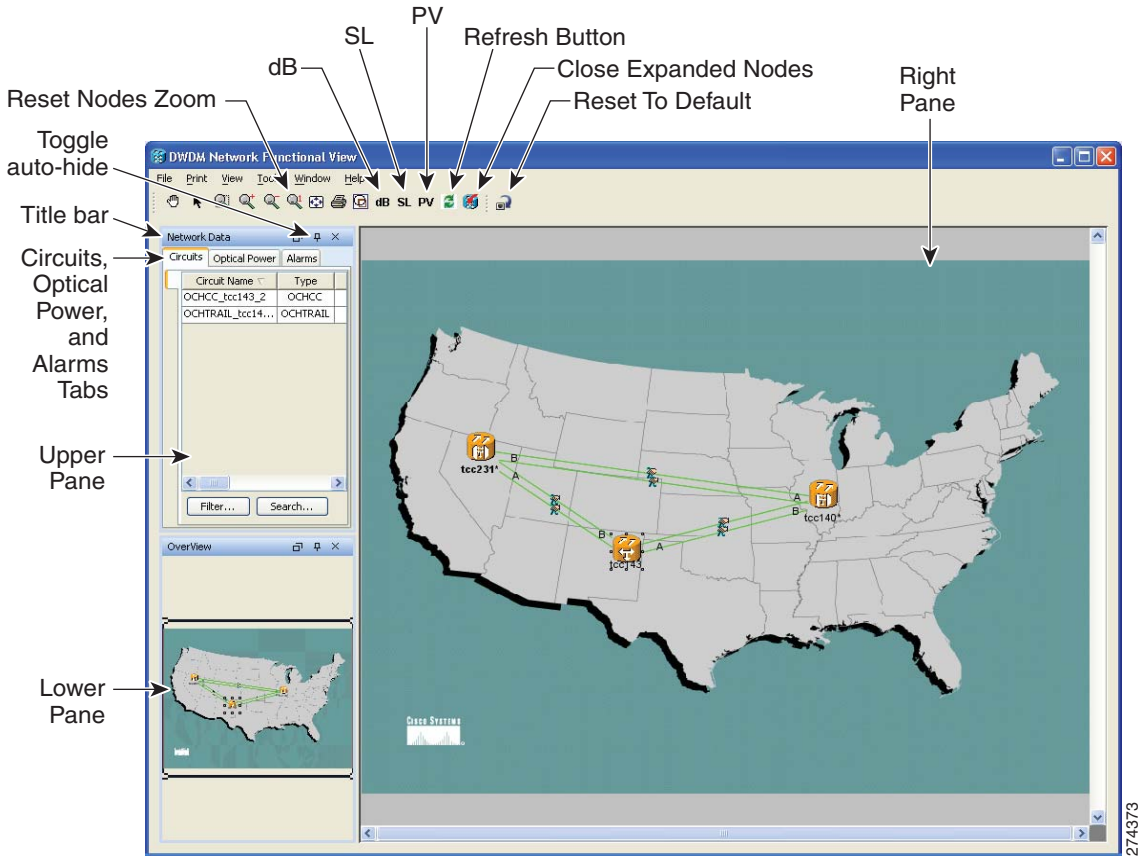
- **Left pane**—Is divided into an upper pane and a lower pane. The upper pane has three tabs that are listed in Table 11-13, and the lower pane displays the graphical overview of the network.
- **Right pane**—Displays the graphical view of all the nodes and devices in the network.

Table 11-13 Circuits, Optical Power, and Alarms tab

Tab	Description
Circuits	Displays the lists of circuits for the nodes present in the network.
Optical Power	Displays the optical link and span loss of the circuits. This tab lists the aggregated power-in and power-out of all the internal patchcords for the nodes that have the functional view open.
Alarms	Displays the alarms of all the circuits for the nodes present in the network.

You can hide or close the upper and lower panes, and view only the network map in the NFV. Click the **Close** button on the title bar to close the pane or click the **Toggle auto-hide** button on the title bar to hide the pane. Click the **Reset To Default** button on the toolbar to restore (or view) all the panes.

Figure 11-84 DWDM Network Functional View



11.10.2 Using the Graphical Display

This section explains how to use the graphical display to gather information on circuits, optical power, and alarms for the nodes.

To expand a node, click on the network functional view graph and Press **F2**. The node opens in a double zoom mode and you can read the power information in the zoom out view. Click **F2** again to zoom-in or return to the normal view. Additionally, to zoom-in and zoom-out the graph on the network functional view, press the **Ctrl** key and scroll up and down with the scroll wheel on your mouse. Click **Reset Nodes Zoom** button on the toolbar to reset the graphical view to the default zoom size.

The keystroke commands provide the keyboard shortcuts for graphical control of the NFV. To access the keystroke commands, click **Help > Keystroke commands**.

Note To open and view the nodes in the network functional view, right-click the node and choose **Open Node FV**. Or double-click on the **Node** to open the node FV. To navigate to the node level, right-click **FV > Node FV**. To close all the opened nodes in the FV, click **Close Expanded Nodes** button on the toolbar. To zoom-in and zoom-out of the open node, press the **Ctrl** key and scroll up and down with the scroll wheel on your mouse.

When you have multiple node FVs opened, you cannot view the graphical details of the individual node due to overlapping of the map. To avoid overlapping of the map, do the following:

1. Select the entire expanded node (all sides), and move it out of the map (to the desired location). To select the entire node, click on the title bar of the node and Press **Ctrl A**.
2. Move the individual sides of the node one-by-one back to the proper position inside the network map. To move the individual sides of the node, select the side and move it to the desired location.

11.10.2.1 Displaying Optical Power

The NFV toolbar has the following buttons that displays the optical power information of the circuits:

- **dB** (Power)—Click the **dB** button on the toolbar to view the optical power information of the circuits. The optical power in the optical path in dBm is displayed in the power balloon.
  You can view the aggregated power only for those nodes that have the FV open. To open the node FV, right-click the node and choose **Open Node FV**. It also shows the per channel estimated power of the ports of the selected circuit.

  Right-click the internal patchcord link and select **Flip Power Balloons** to view the power balloon of the selected patchcord. The power balloon is flipped and you can see the power details of the selected patchcord without overlapping.
- **SL** (Span Loss)—Click the **SL** button to see the loss of signal of the desired span.
- **PV** (Patchcord Verification)—Click the **PV** button to display the insertion loss of the patchcord. The PV calculates the input and output power of the patchcord. You can view the insertion loss of the patchchord only for those nodes that have the FV open. To open the node FV, right-click the node and choose **Open Node FV**. The insertion loss should not exceed 2dBm. The patchcord lines are colored to indicate the insertion loss:
  - Red—Indicates that the insertion loss of the patchcords exceeded 2dBm.
  - White—Indicates that the system was not able to calculate the insertion loss of the patchcord.
  - Black—Indicates that the insertion loss of the patchcords is within the limit and not more than 2dBm.

Note Click **Refresh** on the toolbar, to refresh the optical power and span loss information. The optical power and span loss information is calculated and is refreshed in the graphical display and optical power table.

11.10.2.2 Selecting the Circuit

The Circuit tab in the NFV allows you to view the available circuits in the network. Click the **Circuit** tab to view the list of circuits in the selected network. Choose the circuit from the list to view the circuit level information. A graphical display of the selected circuit and the impacted span is visible in the map. Additionally, you can view the general information (type, source, and destination), status (IS,OOS [ANSI] or unlocked, locked [ETSI]), and physical connection details (wavelength, direction, and span) of the selected circuit.

The circuit can be in any of the following states:

- DISCOVERED
- PARTIAL
- DISCOVERED_TL1
- PARTIAL_TL1

When you switch the selection between the circuits, and if both the circuits are in DISCOVERED_TL1 state, the circuit details of the new selection is not displayed (it may still show the previously selected circuit details).

If you find that the current selection is not refreshed, do either of the following:

- Deselect the selected circuit before selecting the another circuit.

Or

- Update all the selected circuits using the Reconfigure Circuit option. Go to CTC Tools > Circuits > Reconfigure Circuits menu to reconfigure the selected circuits. During reconfiguration, CTC reassembles all connections of the selected circuits and VCAT members into circuits based on path size, direction, and alignment.

Note If the information does not refresh when you switch the selection between the circuits in OCH_CC and its OCH_TRAIL (and vice-versa), follow the suggestion provided on how to view the current selection if the screen is not refreshed.

To view the optical power and alarm details of a circuit, click **Circuit** and select the circuit name from the list to view the following details:

- **Optical Power**—To view the optical power of the selected circuit, click the **Optical Power** tab. You can view the optical link status and the span loss of the selected circuit.
- **Alarms**—To view the alarms of the selected circuit, click the **Alarms** tab. If a card has one or more alarms (that is part of the selected circuit), the node turns either yellow or red, depending on the severity of the alarm. The alarm in red indicates a major alarm and yellow indicates a minor alarm. If there is an alarm present in the card that is not part of the selected circuit, then the node appears gray.

  If a node has alarms that is not part of the selected circuits, then the alarms are not listed in the table, but the node is colored in the graphical view (right pane).

Note At the circuit level, you can view both the node and network level information.

11.10.2.3 Exporting Reports

You can also export the NFV reports of circuit level information in HTML or JPEG format. The export operation creates two files, an HTML and a JPEG format of the NFV information. The .jpg file provides a graphical representation of the site layout. For more information on exporting the reports, see the "Export Network Functional View Reports" task in the *Cisco ONS 15454 DWDM Procedure Guide.*

11.11 Non-DWDM (TDM) Networks

Non-DWDM (TDM) Networks take synchronous and asynchronous signals and multiplexes them to a single higher bit rate for transmission at a single wavelength over fiber. When the node is configured as a Non-DWDM Network, the supported MSTP cards — amplifiers, transponders, and muxponders, are used in the standalone mode. MSTP applications like Circuit Provisioning, NLAC and APC are not supported in amplified TDM networks. For more information on how to configure a node as a Non-DWDM network, see the "NTP-G320 Configure the Node as a Non-DWDM Network" section in "Turn Up a Node" chapter in the *Cisco ONS 15454 DWDM Procedure Guide*.

When the node is configured as a Not-DWDM network, all the amplifiers are configured by default with the following values:

- Working mode = Control Gain
- Channel Power Ref. = +1dBm.

Booster(LINE) amplifiers enable optical safety when used in Non-DWDM. ALS configuration is set to "Auto Restart" by default. A manual restart request is therefore needed to turn up the bidirectional link, in addition with an appropriated cabling (bi-directional) of LINE TX/RX ports.

In NOT-DWDM mode, you must configure significant optical parameters and thresholds before launching the ANS application. For information on how to configure the amplifier, see the "DLP-G693 Configure the Amplifier" section in "Turn Up a Node" chapter in the *Cisco ONS 15454 DWDM Procedure Guide*. For information on how to configure the PSM behavior, see the "DLP-G694 Configure the PSM" section in "Turn Up a Node" chapter in the *Cisco ONS 15454 DWDM Procedure Guide*.

When the ANS application is launched, amplifier ports move into IS state and Gain Setpoint is automatically calculated by the card, after initial APR cycle. Gain Setpoint must be equal to MAX [Min Gain Setpoint of the card ; (Power Ref-Pinput)]; where Pinput is the optical power value at the ingress port (COM-RX) of the amplification stage.

CHAPTER 12

Network Reference

This chapter explains the Cisco ONS 15454 dense wavelength division multiplexing (DWDM) network applications and topologies. The chapter also provides network-level optical performance references.

Note Unless otherwise specified, “ONS 15454” refers to both ANSI and ETSI shelf assemblies.

Note In this chapter, “OPT-BST” refers to the OPT-BST, OPT-BST-E, OPT-BST-L cards, and to the OPT-AMP-L, OPT-AMP-C, and OPT-AMP-17-C cards when they are provisioned in OPT-LINE (optical booster) mode. “OPT-PRE” refers to the OPT-PRE card and to the OPT-AMP-L, OPT-AMP-C, and OPT-AMP-17-C cards provisioned in OPT-PRE (preamplifier) mode.

Note OPT-BST-L, 32WSS-L, 32DMX-L, and OPT-AMP-L cards can be installed only in L-band compatible nodes and networks. OPT-BST, OPT-BST-E, 32WSS, 32DMX, 40-DMX-C, 40-DMX-CE, 40-MUX-C, 40-WSS-C, 40-WSS-CE, 40-WXC-C, 80-WXC-C, 40-SMR1-C, 40-SMR2-C, OPT-AMP-C, OPT-AMP-17-C, OPT-RAMP-C and OPT-RAMP-CE cards can be installed only in C-band compatible nodes and networks.

Chapter topics include:

- 12.1 Network Applications, page 12-2
- 12.2 Network Topologies, page 12-2
- 12.5 Network Topologies for the OPT-RAMP-C and OPT-RAMP-CE Cards, page 12-18
- 12.6 Network Topologies for the PSM Card, page 12-19
- 12.7 Optical Performance, page 12-19
- 12.8 Automatic Power Control, page 12-20
- 12.9 Power Side Monitoring, page 12-24
- 12.10 Span Loss Verification, page 12-25
- 12.11 Network Optical Safety, page 12-27
- 12.12 Network-Level Gain—Tilt Management of Optical Amplifiers, page 12-40
- 12.13 Optical Data Rate Derivations, page 12-46
- 12.14 Even Band Management, page 12-48

12.1 Network Applications

Cisco ONS 15454 nodes can be provisioned for metro core DWDM network applications. Metro core networks often include multiple spans and amplifiers, so the optical signal-to-noise ratio (OSNR) is the limiting factor for channel performance.

Within DWDM networks, the ONS 15454 uses a communications protocol, called Node Services Protocol (NSP), to communicate with other nodes. NSP automatically updates nodes whenever a change in the network occurs. Each ONS 15454 DWDM node can:

- Identify other ONS 15454 DWDM nodes in the network.
- Identify the different types of DWDM networks.
- Identify when the DWDM network is complete and when it is incomplete.

12.2 Network Topologies

The ONS 15454 DWDM network topologies include ring networks, linear networks, mesh networks, interconnected rings and spurs.

12.2.1 Ring Networks

Ring networks support hubbed, multi-hubbed, any-to-any, and mesh traffic topologies.

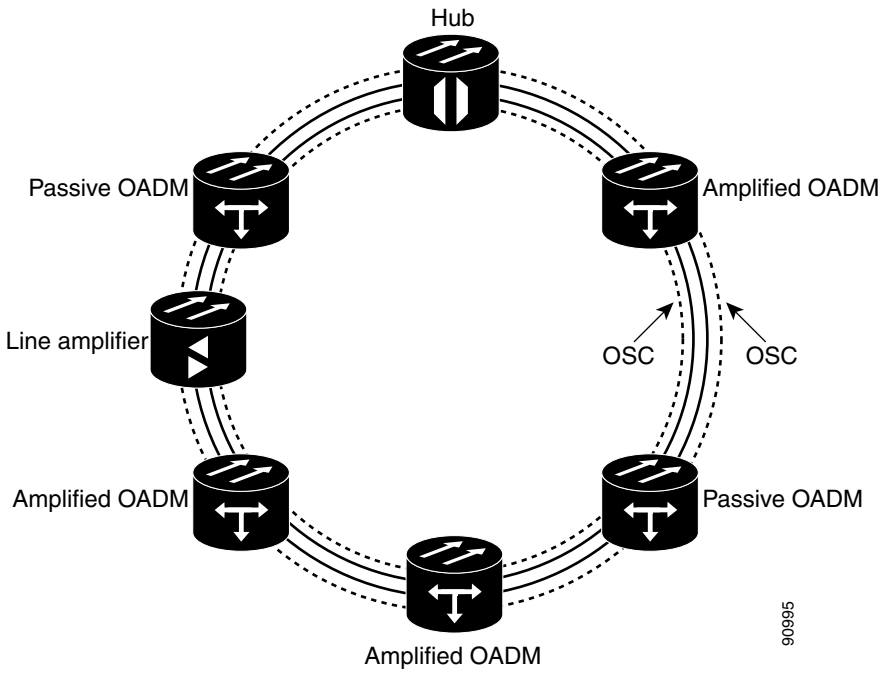
12.2.1.1 Hubbed Traffic Topology

In the hubbed traffic topology (Figure 12-1), a hub node terminates all the DWDM channels. A channel can be provisioned to support protected traffic between the hub node and any node in the ring. Both working and protected traffic use the same wavelength on both sides of the ring. Protected traffic can also be provisioned between any pair of optical add/drop multiplexing (OADM) nodes, except that either the working or the protected path must be regenerated in the hub node.

Protected traffic saturates a channel in a hubbed topology, that is, no channel reuse is possible. However, the same channel can be reused in different sections of the ring by provisioning unprotected multihop traffic. From a transmission point of view, this network topology is similar to two bidirectional point-to-point links with OADM nodes.

For more information about hub nodes, see the "11.1.4 Hub Node" section on page 11-27.

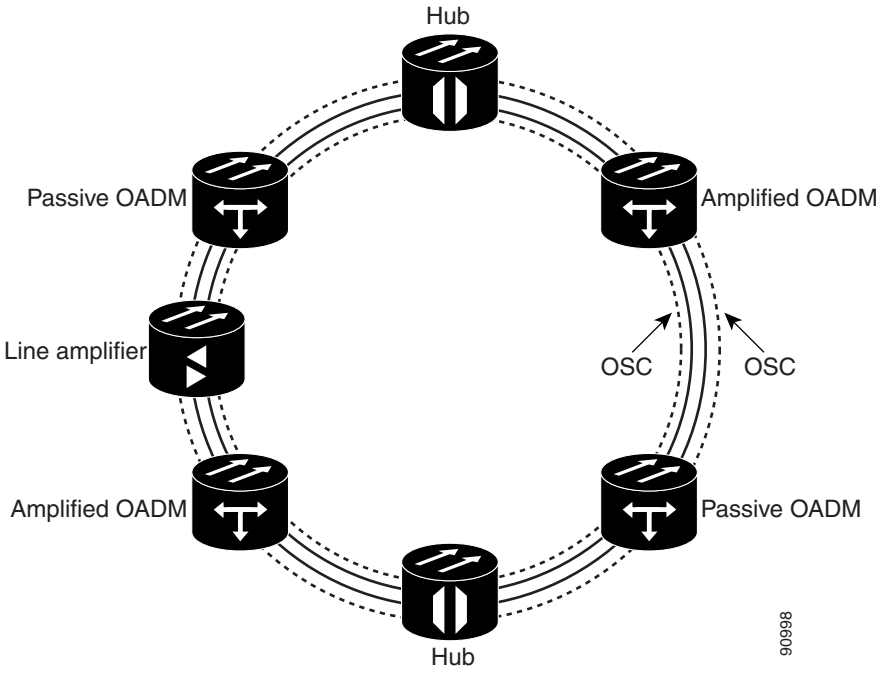
Figure 12-1 Hubbed Traffic Topology



12.2.1.2 Multihubbed Traffic Topology

A multihubbed traffic topology (Figure 12-2) is based on the hubbed traffic topology, except that two or more hub nodes are added. Protected traffic can only be established between the two hub nodes. Protected traffic can be provisioned between a hub node and any OADM node only if the allocated wavelength channel is regenerated through the other hub node. Multihop traffic can be provisioned on this ring. From a transmission point of view, this network topology is similar to two or more point-to-point links with OADM nodes.

Figure 12-2 Multihubbed Traffic Topology

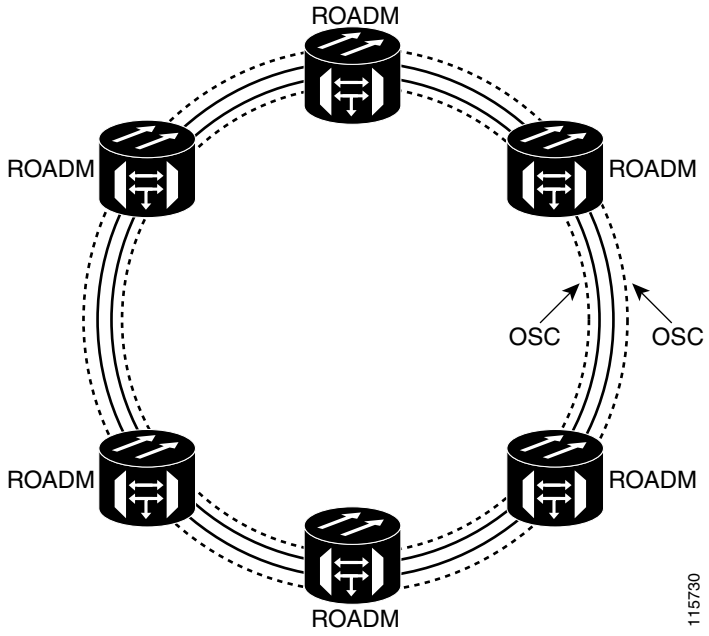


12.2.1.3 Any-to-Any Traffic Topology

The any-to-any traffic topology (Figure 12-3) contains only reconfigurable OADM (ROADM) nodes (with or without optical service channel [OSC] regeneration) or optical amplifier nodes. This topology potentially allows you to route every wavelength from any source to any destination node inside the network.

See the "11.1.3 ROADM Node" section on page 11-10 for more information.

Figure 12-3 Any-to-Any Traffic Topology



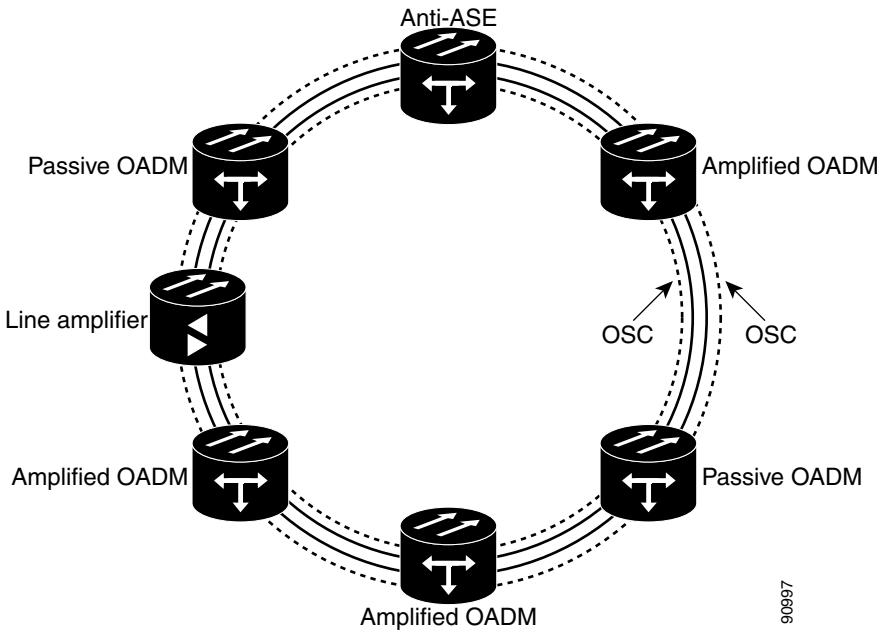
12.2.1.4 Meshed Traffic Topology

The meshed traffic topology (Figure 12-4) does not use hubbed nodes; only amplified and passive OADM nodes are present. Protected traffic can be provisioned between any two nodes; however, the selected channel cannot be reused in the ring. Unprotected multihop traffic can be provisioned in the ring. A meshed ring must be designed to prevent amplified spontaneous emission (ASE) lasing. This is done by configuring a particular node as an anti-ASE node. An anti-ASE node can be created in two ways:

- Equip an OADM node with 32MUX-O cards and 32DMX-O cards. This solution is adopted when the total number of wavelengths deployed in the ring is higher than ten. OADM nodes equipped with 32MUX-O cards and 32DMX-O cards are called full OADM nodes.
- When the total number of wavelengths deployed in the ring is lower than ten, the anti-ASE node is configured by using an OADM node where all the channels that are not terminated in the node are configured as “optical pass-through.” In other words, no channels in the anti-ASE node can travel through the express path of the OADM node.

For more information about OADM nodes, see the “11.1.2 OADM Node” section on page 11-8. For more information about anti-ASE nodes, see the “11.1.5 Anti-ASE Node” section on page 11-31.

Figure 12-4 Meshed Traffic Topology



12.2.2 Linear Networks

Linear configurations are characterized by the use of two terminal nodes, east and west. The 32-channel terminal nodes can be equipped with a 32MUX-O card and a 32DMX-O card, or with a 32WSS card and a 32DMX or 32DMX-O card. The 40-channel terminal nodes can be equipped with a 40-MUX-C card and a 40-DMX-C/40-DMX-CE card, a 40-WSS-C/40-WSS-CE card with a 40-DMX-C/40-DMX-CE card, or a 40-SMR1-C/40-SMR2-C card with a 15216-MD-40-ODD card. OADM or line amplifier nodes can be installed between the two terminal nodes. Only unprotected traffic can be provisioned in a linear configuration. Figure 12-5 shows five ONS 15454 nodes in a linear configuration with an amplified and a passive OADM node.

Figure 12-5 Linear Configuration with an OADM Node

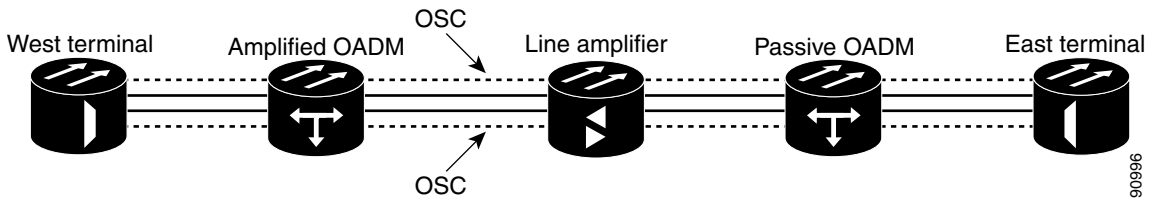
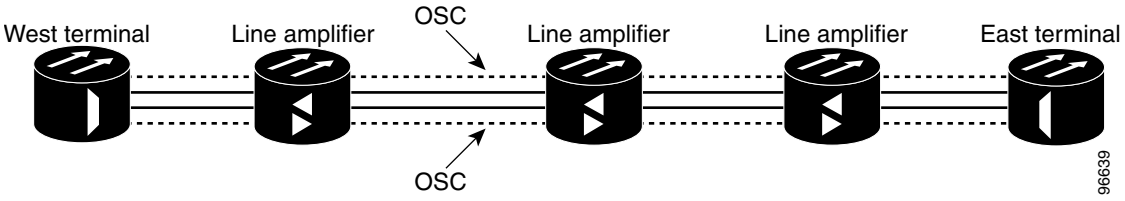


Figure 12-6 shows five ONS 15454 nodes in a linear configuration without an OADM node. See the "11.1.1 Terminal Node" section on page 11-2 for more information.

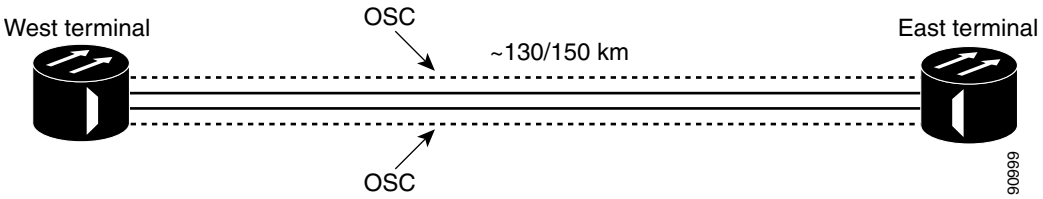
Figure 12-6 Linear Configuration without an OADM Node



A single-span link is a type of linear configuration characterized by a single-span link with preamplification and post-amplification. A single-span link is also characterized by the use of two terminal nodes, east and west. Only unprotected traffic can be provisioned on a single-span link.

Figure 12-7 shows two ONS 15454s in a single-span link. Eight channels are carried on one span. Single-span link losses apply to OC-192/STM-64 LR ITU cards. The optical performance values are valid assuming that the sum of the OADM passive node insertion losses and the span losses does not exceed 35 dB.

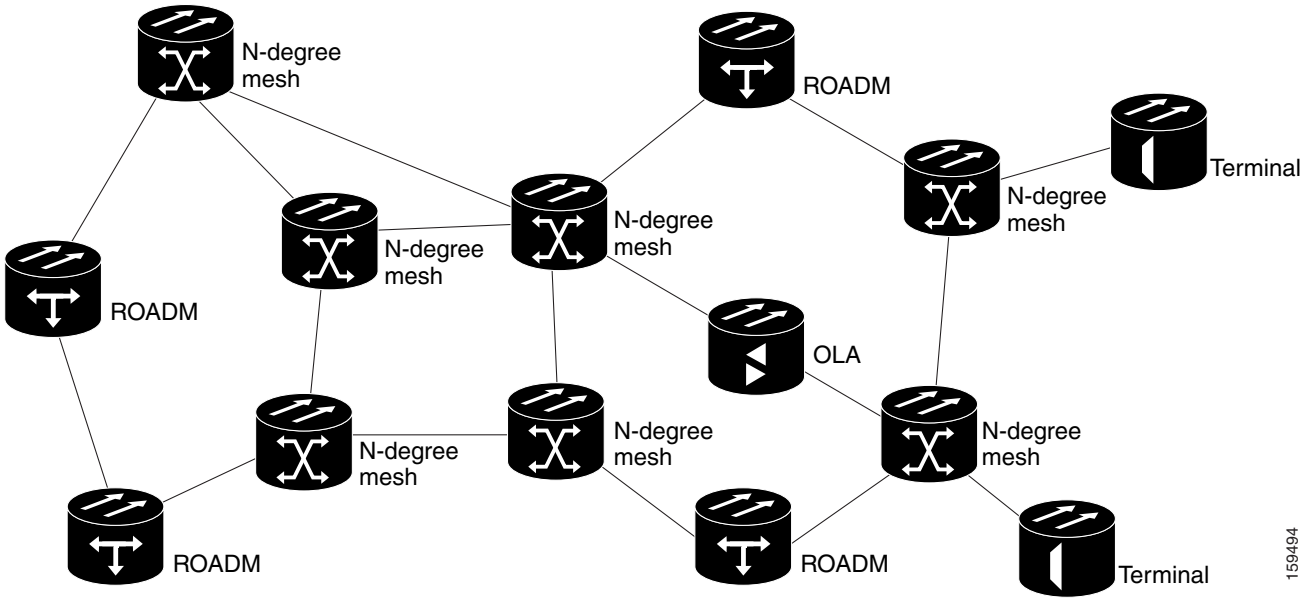
Figure 12-7 Single-Span Link



12.2.3 Mesh Networks

A mesh network can be native or multiring. In a native mesh network (Figure 12-8), any combination of four-degree and eight-degree mesh nodes can work together. Four-degree mesh nodes transmit an optical signal in four directions, while an eight-degree mesh node transmits an optical signal in eight directions. For additional information about mesh nodes, see the "11.6 Configuring Mesh DWDM Networks" section on page 11-53. The intermediate nodes are ROADM nodes. In a mesh node, all wavelengths can be routed through four (four-degree mesh node) to eight (eight-degree mesh node) different optical line termination ports using a 40-WXC-C, 80-WXC-C, or 40-SMR2-C card without any optical-electrical-optical (OEO) regeneration. It is possible to combine 40-WSS-C/40-WSS-CE, 40-WXC-C, 40-SMR2-C, and 32WSS cards in the same mesh network without impacting system performance. For nodes equipped with 32WSS cards, the maximum system capacity is 32 channels. Terminal sites are connected to the mesh network as a spur.

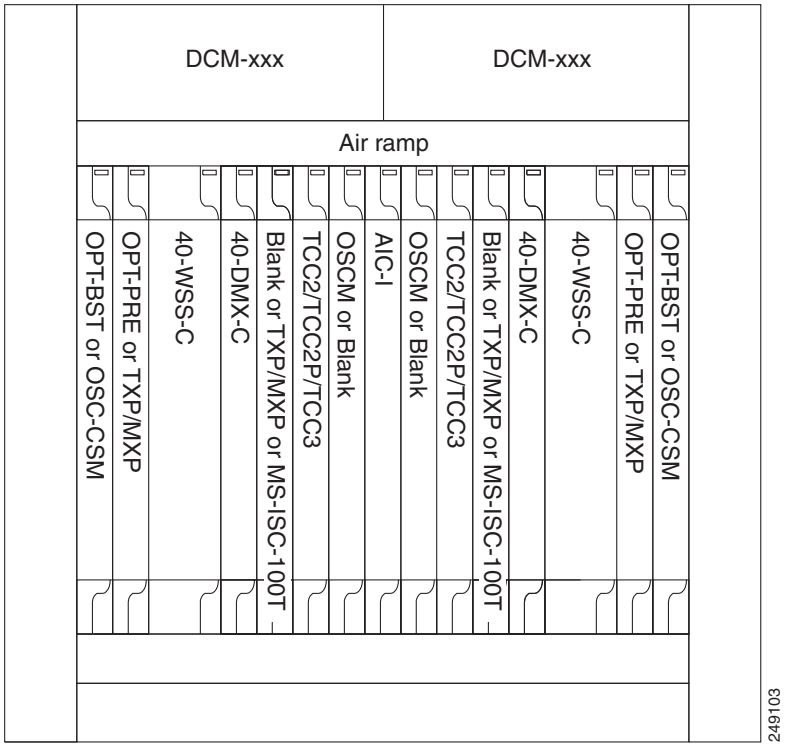
Figure 12-8 Mesh Network



In a multiring mesh network (Figure 12-9), several rings are connected with four-degree or eight-degree mesh nodes. The intermediate ROADM nodes are equipped with MMU cards. All wavelengths can be routed among two or more rings using a 40-WXC-C or 40-SMR2-C card without any optical-electrical-optical (OEO) regeneration. As in a native mesh network, it is possible to combine 40-WSS-C/40-WSS-CE, 40-WXC-C, 40-SMR2-C, and 32WSS cards in the same multiring network without impacting system performance. For nodes equipped with 32WSS cards, maximum system capacity is limited to 32 channels. A terminal node is connected to a multiring node as a spur.

For information on node configurations for both native mesh and multiring networks, see the "11.6 Configuring Mesh DWDM Networks" section on page 11-53.

Figure 12-9 Multiring Network



12.3 Interconnected Rings

The interconnected ring configuration allows you to connect two different nodes using external ports to allow traffic flow between different subnets. In Figure 12-10, the main ring consists of nodes R, R1, and R2 and the tributary ring consists of nodes r, r1, and r2. It is possible to connect more than one tributary ring to the main ring at the same point. Node R of the main ring can forward wavelengths to the node r of the tributary ring and vice-versa.

Node R is either a colorless and omni-directional n-degree ROADM node (Figure 12-11) or a two-degree colorless ROADM node (Figure 12-12) equipped with 80-WXC-C cards. See the "11.6 Configuring Mesh DWDM Networks" section on page 11-53 for more information about colorless and omni-directional n-degree ROADM nodes and two-degree colorless ROADM nodes.

Node r of the tributary ring is a two-degree ROADM node equipped with 40-SMR1-C, 40-SMR2-C, 40-WSS-C, or 40-WSS-CE cards. OTS PPCs are provisioned between the EAD ports of the 80-WXC-C card on node R and the EXP or ADD/DROP ports of the 40-SMR1-C, 40-SMR2-C, 40-WSS-C, or 40-WSS-CE cards on node r. All the nodes are managed by different IP addresses.

Figure 12-10 Interconnected Rings

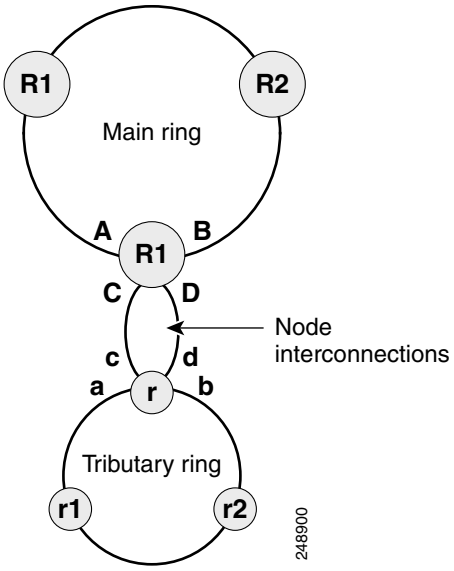


Figure 12-11 Colorless and Omni-directional n- Degree ROADM Node

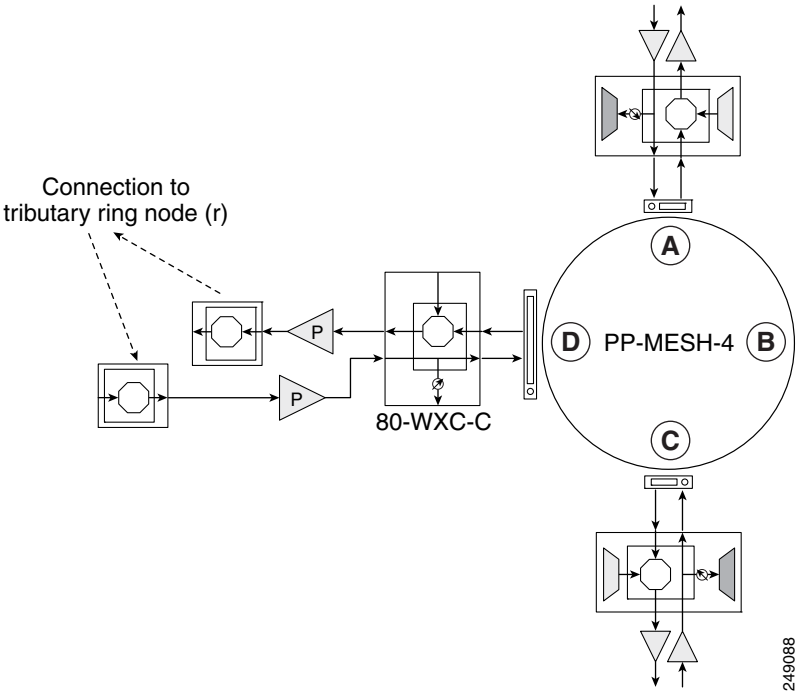
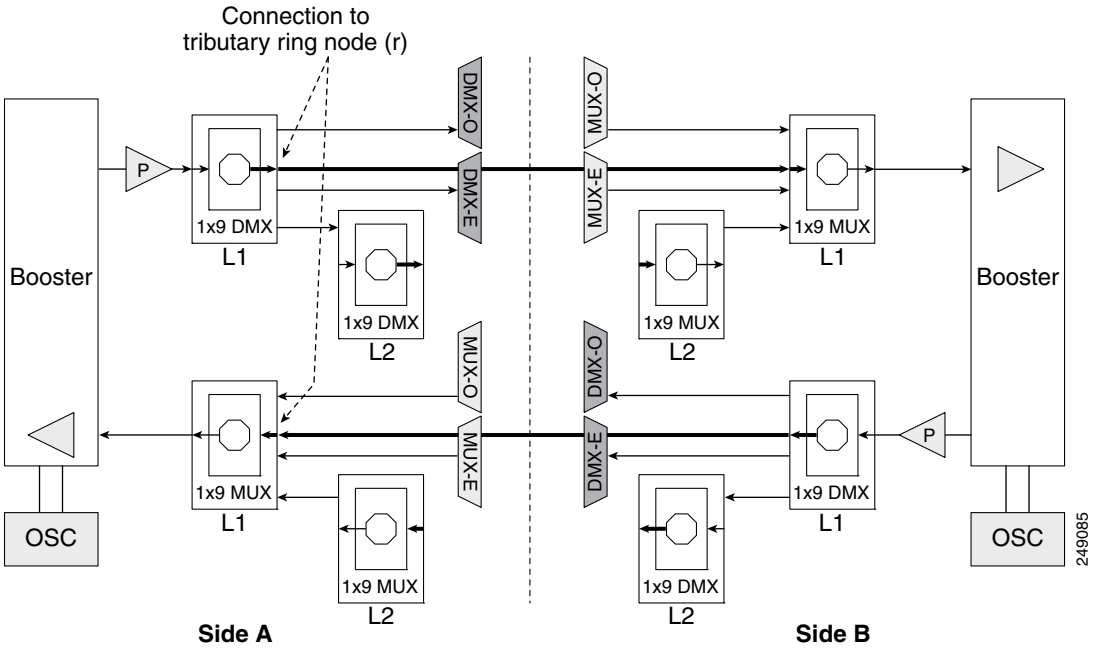


Figure 12-12 Colorless Two-Degree ROADM Node



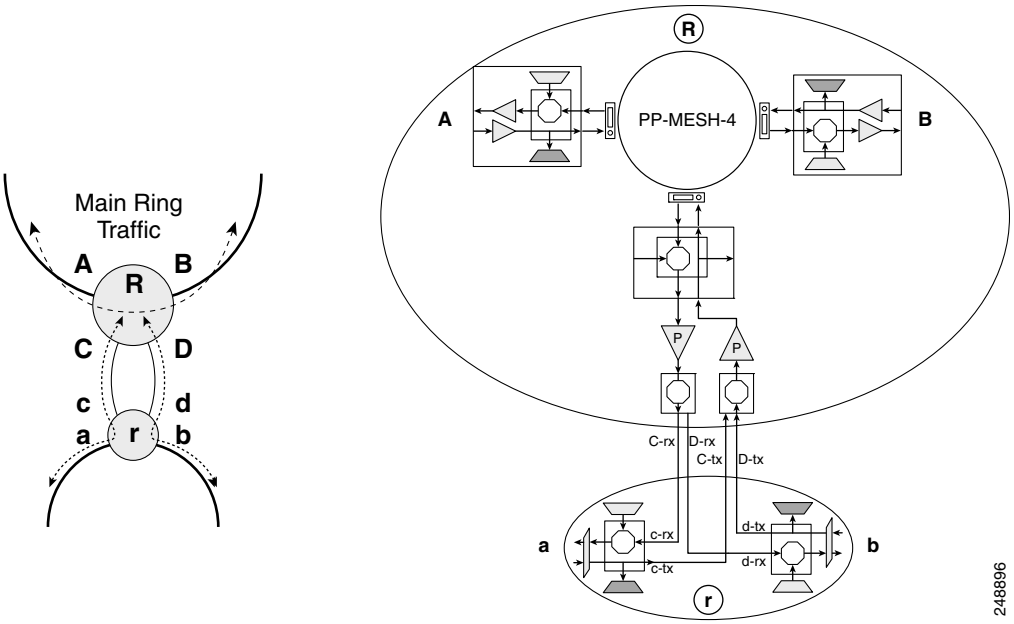
12.3.1 Interconnected Ring Scenarios

In the following sections, three interconnected ring scenarios are given:

12.3.1.1 Scenario A: Interconnect Traffic from Tributary Ring to Main Ring without Local Add/Drop in the Tributary Ring

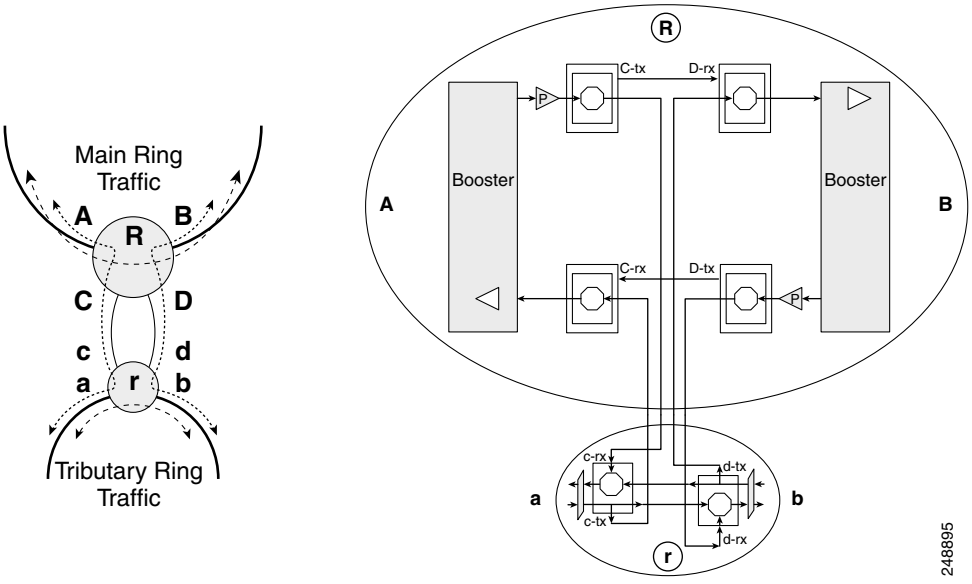
In scenario A-1(Figure 12-13), node R is a three-degree colorless and omni-directional ROADM node and node r is a two-degree 40-SMR1-c based ROADM node. The EAD ports of the 80-WXC-C cards on node R are connected to the ADD/DROP ports of the 40-SMR1-C card on node r. Traffic from node r can be routed to side A or B of node R. Traffic from side a cannot be added or dropped at node r but can be routed to side b using the express path.

Figure 12-13 Interconnected Ring - Scenario A-1



In scenario A-2 (Figure 12-14), node R is a two-degree colorless ROADM node and node r is a two-degree 40-SMR1-C based ROADM node. The EAD ports of the 80-WXC-C cards on node R are connected to the ADD/DROP ports of the 40-SMR1-C card on node r. Traffic from node r can be routed to one side of node R. For example, traffic can be routed from side a to side A or from side b to side B. Traffic from side a cannot be added or dropped at node r but can be routed to side b using the express path.

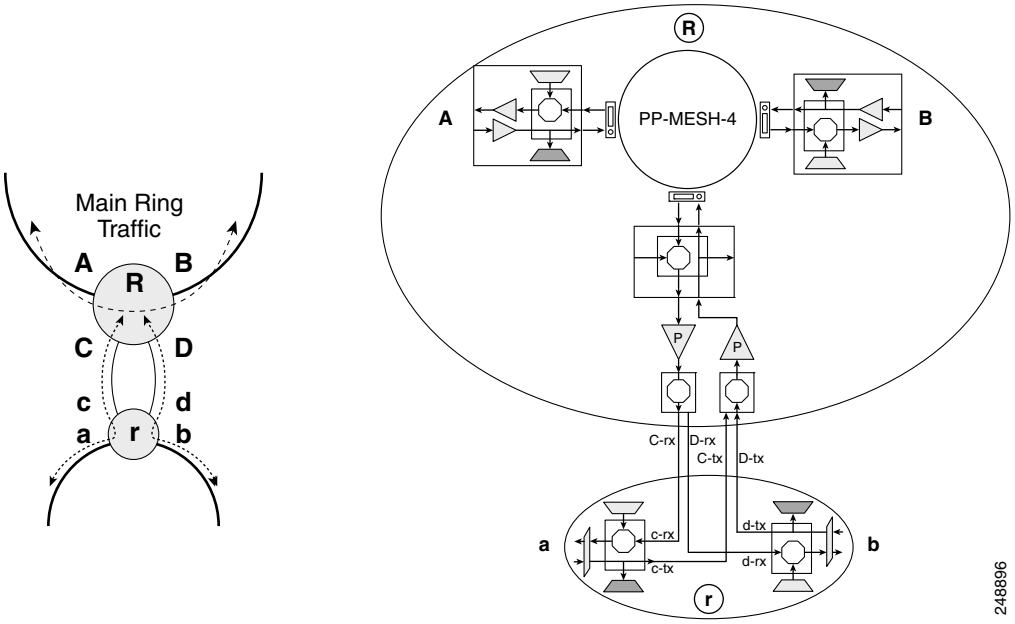
Figure 12-14 Interconnected Ring - Scenario A-2



12.3.1.2 Scenario B: Interconnect Traffic from Tributary Ring to Main Ring with Local Add/Drop in the Tributary Ring

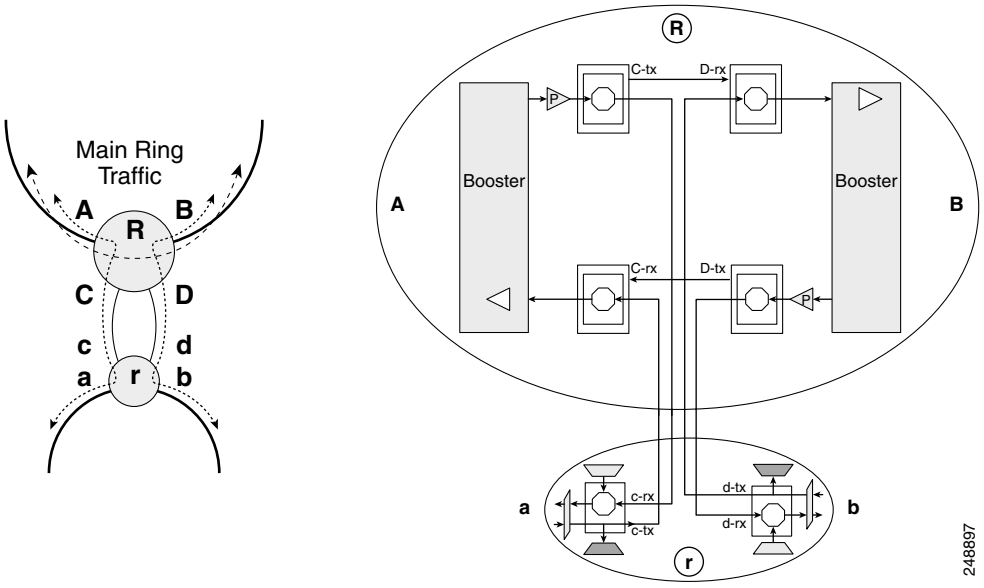
In scenario B-1(Figure 12-15), node R is a three-degree colorless and omni-directional ROADM node and node r is a hub node with two terminal sides equipped with 40-SMR1-C or 40-WSS-C cards. The EAD ports of the 80-WXC-C cards on node R are connected to the EXP ports of the 40-SMR1-C or40-WSS-C card on node r. Traffic from node r can be routed to side A or B of node R. Traffic local to the tributary ring can be added or dropped at node r. For example, traffic from side a can be dropped at node r but cannot be routed to side b since the EXP ports are not available.

Figure 12-15 Interconnected Ring - Scenario B-1



In scenario B-2 (Figure 12-16), node R is a two-degree colorless ROADM node and node r is a hub node with two terminal sides equipped with 40-SMR1-C or 40-WSS-C cards. The EAD ports of the 80-WXC-C cards on node R are connected to the EXP ports of the 40-WSS-C card on node r. Traffic from node r can be routed to one side of node R. For example, traffic can be routed from side a to side A or from side b to side B. Traffic local to the tributary ring can be added or dropped at node r. For example, traffic from side a can be dropped at node r but cannot be routed to side b since the EXP ports are not available.

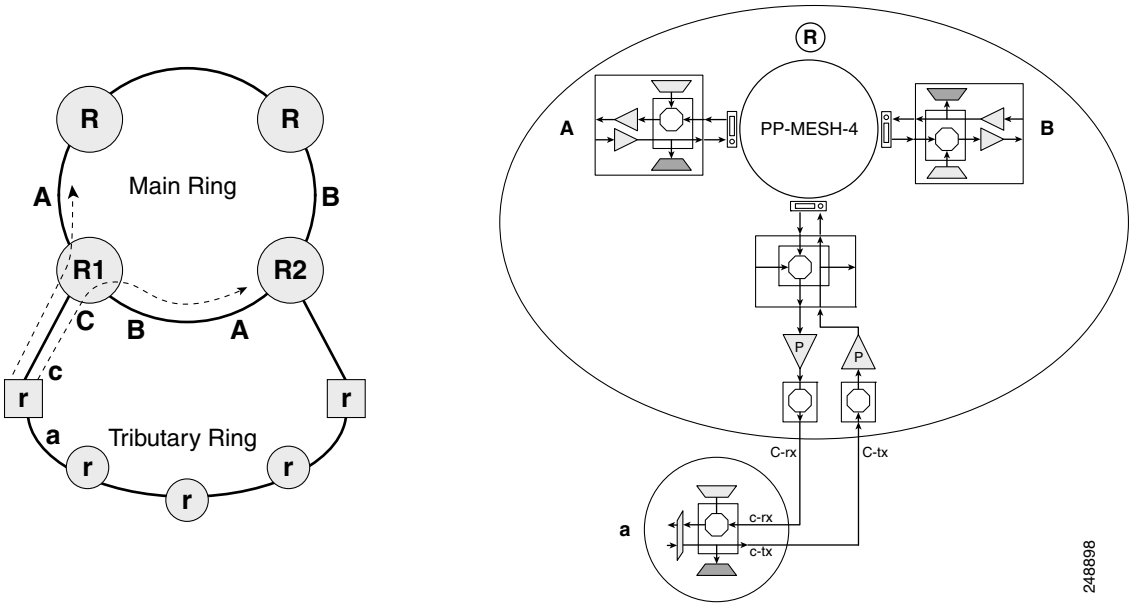
Figure 12-16 Interconnected Ring - Scenario B-2



12.3.1.3 Scenario C: Interconnect Traffic Between Tributary Rings Using the Main Ring

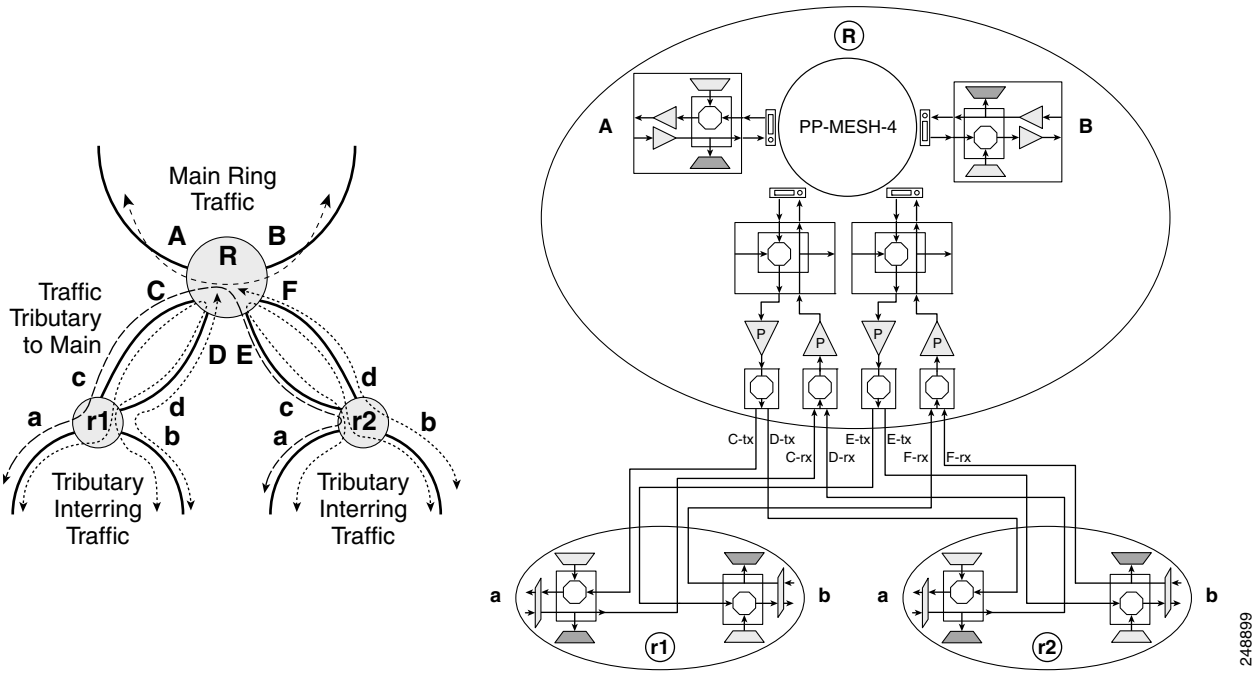
In scenario C-1(Figure 12-17), nodes R1 and R2 are n-degree colorless and omni-directional ROADM nodes. Node r is a terminal site. The EXP ports of the 40-SMR-1C card in node r are connected to the EAD ports of the 80-WXC-C card in nodes R1 and R2. Traffic from node r is routed to side A and B of nodes R1 and R2. Traffic local to the tributary ring can be added or dropped at node r.

Figure 12-17 Interconnected Ring - Scenario C-1



In scenario C-2(Figure 12-18), node R is an n-degree colorless and omni-directional ROADM node with 2 omni-directional sides. Nodes r1 and r2 are hub sites. The ADD/DROP ports of 40-SMR-1-C cards in node r1 and r2 are connected to the EAD ports of 80-WXC-C cards in node R. Traffic can be routed from node r1 to node r2 through node R. Traffic local to the tributary ring can be added or dropped at node r1 and r2.

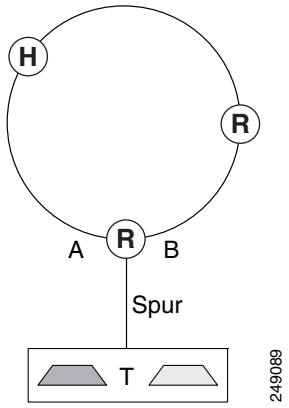
Figure 12-18 Interconnected Ring - Scenario C-2



12.4 Spur Configuration

Remote terminal sites can be connected to the main network using a spur. In a spur configuration, the multiplexer (MUX) and demultiplexer (DMX) units associated with one of the sides of node R in the main network (Figure 12-19) are moved to the remote terminal site T. This helps to aggregate traffic from the terminal site. The MUX and DMX units in terminal site T are connected to node R with a single fibre couple. Node R is a n-degree ROADM node equipped with 40-SMR1-C, 40-SMR2-C, or 80-WXC-C cards. Traffic from terminal site T can be routed to side A or side B on node R. Amplification on the spur link is not allowed. PSM is not supported on terminal site T.

Figure 12-19 Spur



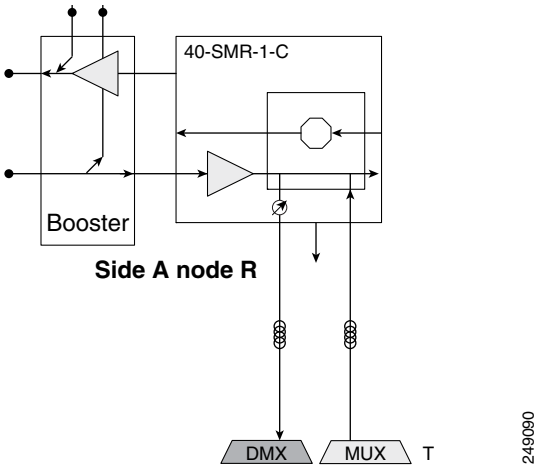
12.4.1 Spur Configuration Scenarios

In the following sections, three spur scenarios are provided:

12.4.1.1 Scenario A: Spur Configuration without 15454 Chassis in RemoteTerminal T

In Figure 12-20, node R is a two-degree ROADM node equipped with 40-SMR1-C card. The remote terminal site T does not have a 15454 chassis and is not shown in the network map in CTC. The terminal site is built using passive MUX and DMX units. All OCHNC circuits originating from 40-SMR1-C on Side A of node R to the remote terminal site are terminated on 40-SMR1-C ADD/DROP ports.

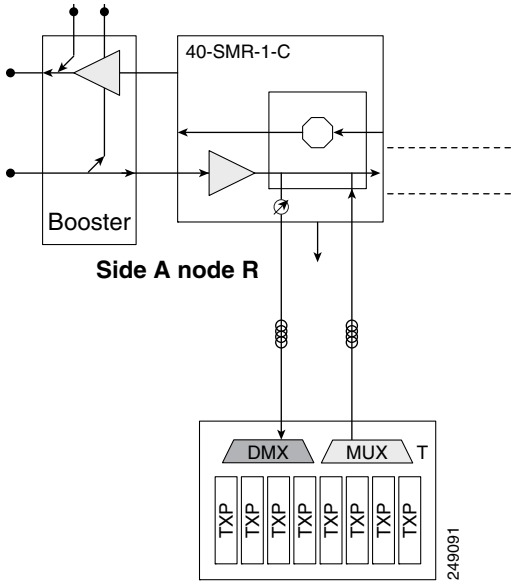
Figure 12-20 Scenario A: Spur Without 15454 Chassis in RemoteTerminal T



12.4.1.2 Scenario B: Spur Configuration with Passive MUX and DMX Units in Remote Terminal T

In Figure 12-21, node R is a two-degree ROADM node equipped with 40-SMR1-C card. The terminal site T is built with a 15454 chassis equipped with TXP units and passive MUX and DMX units. Terminal site T is connected to node R on the network map in CTC. All OCHNC circuits originating from 40-SMR1-C on Side A of node R to the remote site are terminated on 40-SMR1-C ADD/DROP ports. OCHCC and OCHTRAIL circuits are supported on the TXP units in terminal site T.

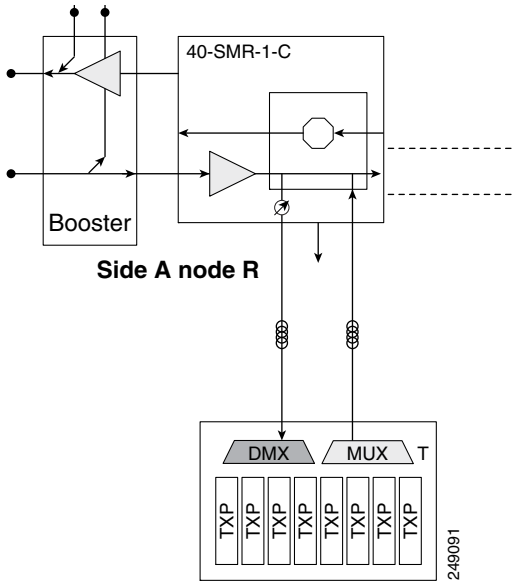
Figure 12-21 Scenario B: Spur With Passive MUX and DMX Units in Remote Terminal T



12.4.1.3 Scenario C: Spur Configuration with Active MUX and DMX Units in Remote Terminal T

In Figure 12-22, node R is a two-degree ROADM node equipped with 40-SMR1-C card. The terminal site T is built with a 15454 chassis equipped with TXP units and active MUX and DMX units. Terminal site T is connected to node R on the network map in CTC. DCN extension is supported between the ADD/DROP ports of 40-SMR1-C and the COM ports of the active MUX and DMX units. OCHNC circuits are terminated on the CHAN ports of the MUX and DMX units of terminal site T. OCHCC and OCHTRAIL circuits are supported on the TXP units in terminal site T.

Figure 12-22 Scenario C: Spur with Active MUX and DMX Units in Remote Terminal T



12.5 Network Topologies for the OPT-RAMP-C and OPT-RAMP-CE Cards

The OPT-RAMP-C or OPT-RAMP-CE card can be equipped in any of the following network topologies:

- Open (hubbed) ring network
- Multi-hubbed ring network
- Closed (meshed) ring network
- Any-to-any ring network
- Linear network topology
- Point-to-point linear network topology
- Multi-ring network
- Mesh network
- Hybrid network

For more information about the OPT-RAMP-C or OPT-RAMP-CE card, see Chapter 4, “Optical Amplifier Cards.”.

12.6 Network Topologies for the PSM Card

The PSM card is supported in the following network topologies:

- The PSM card in a channel protection configuration is supported in all network topologies except linear networks as it is not possible to configure a working and protect path.
- The PSM card in a multiplex section protection configuration is supported in linear point-to-point network topologies.
- The PSM card in a line protection configuration is supported in the following network topologies:
  - Linear point-to-point in a single span network (if the OSC card is used).
  - Linear point-to-point multispan network when a DCN extension is used (on all spans). In this case, the maximum number of span links can be divided into three according to the DCN extension optical safety requirements.
- The PSM card in a standalone configuration is supported in all network topologies.

12.7 Optical Performance

This section provides optical performance information for ONS 15454 DWDM networks. The performance data is a general guideline based upon the network topology, node type, client cards, fiber type, number of spans, and number of channels. The maximum number of nodes that can be in an ONS 15454 DWDM network is 16. The DWDM topologies and node types that are supported are shown in Table 12-1.

Table 12-1 Supported Topologies and Node Types

Number of Channels	Fiber	Topologies	Node Types
32 channels	SMF-28[1]	Ring	Hub
	E-LEAF[2]	Linear	Active OADM
	TW-RS[3]	Linear without OADM	Passive OADM
			Terminal
			Line
			OSC regeneration
16 channels	SMF-28	Ring	Hub
		Linear	Active OADM
		Linear without OADM	Passive OADM
			Terminal
			Line
			OSC regeneration
8 channels	SMF-28	Linear without OADM	Terminal
			Line

1. SMF-28 = single-mode fiber 28.
2. E-LEAF = enhanced large effective area fiber.
3. TW-RS = TrueWave reduced slope fiber.

12.8 Automatic Power Control

The ONS 15454 automatic power control (APC) feature performs the following functions:

- Maintains constant per channel power when desired or accidental changes to the number of channels occur. Constant per channel power increases optical network resilience.
- Compensates for optical network degradation (aging effects).
- Simplifies the installation and upgrade of DWDM optical networks by automatically calculating the amplifier setpoints.

Note APC algorithms manage the optical parameters of the OPT-BST, OPT-PRE, OPT-AMP-17-C, 32DMX, 40-DMX-C, 40-DMX-CE, 40-SMR1-C, 40-SMR2-C, OPT-BST-L, OPT-AMP-L, OPT-AMP-C, and 32DMX-L cards.

Amplifier software uses a control gain loop with fast transient suppression to keep the channel power constant regardless of any changes in the number of channels. Amplifiers monitor the changes to the input power and change the output power proportionately according to the calculated gain setpoint. The shelf controller software emulates the control output power loop to adjust for fiber degradation. To perform this function, the TCC2/TCC2P/TCC3/TNC/TSC needs to know the channel distribution, which is provided by a signaling protocol, and the expected per channel power, which you can provision. The TCC2/TCC2P/TCC3/TNC/TSC card compares the actual amplifier output power with the expected amplifier output power and modifies the setpoints if any discrepancies occur.

12.8.1 APC at the Amplifier Card Level

In constant gain mode, the amplifier power out control loop performs the following input and output power calculations, where G represents the gain and t represents time.

Pout (t) = G * Pin (t) (mW)

Pout (t) = G + Pin (t) (dB)

In a power-equalized optical system, the total input power is proportional to the number of channels. The amplifier software compensates for any variation of the input power due to changes in the number of channels carried by the incoming signal.

Amplifier software identifies changes in the read input power in two different instances, t1 and t2, as a change in the traffic being carried. The letters m and n in the following formula represent two different channel numbers. Pin/ch represents the input power per channel.

Pin (t1)= nPin/ch

Pin (t2) = mPin/ch

Amplifier software applies the variation in the input power to the output power with a reaction time that is a fraction of a millisecond. This keeps the power constant on each channel at the output amplifier, even during a channel upgrade or a fiber cut.

The per channel power and working mode (gain or power) are set by automatic node setup (ANS). The provisioning is conducted on a per-side basis. A preamplifier or a booster amplifier facing Side *i* is provisioned using the Side *i* parameters present in the node database, where *i* - A, B, C, D, E, F, G, or H.

Starting from the expected per channel power, the amplifiers automatically calculate the gain setpoint after the first channel is provisioned. An amplifier gain setpoint is calculated in order to make it equal to the loss of the span preceding the amplifier itself. After the gain is calculated, the setpoint is no longer

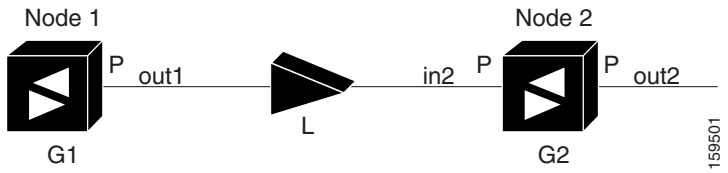
changed by the amplifier. Amplifier gain is recalculated every time the number of provisioned channels returns to zero. If you need to force a recalculation of the gain, move the number of channels back to zero.

12.8.2 APC at the Shelf Controller Layer

Amplifiers are managed through software to control changes in the input power caused by changes in the number of channels. The software adjusts the output total power to maintain a constant per channel power value when the number of input channel changes.

Changes in the network characteristics have an impact on the amplifier input power. Changes in the input power are compensated for only by modifying the original calculated gain, because input power changes imply changes in the span loss. As a consequence, the gain to span loss established at amplifier start-up is no longer satisfied, as shown in Figure 12-23.

Figure 12-23 Using Amplifier Gain Adjustment to Compensate for System Degradation



In Figure 12-23, Node 1 and Node 2 are equipped with booster amplifiers and preamplifiers. The input power received at the preamplifier on Node 2 (Pin2) depends on the total power launched by the booster amplifier on Node1, Pout1(n) (where n is the number of channels), and the effect of the span attenuation (L) between the two nodes. Span loss changes due to aging fiber and components or changes in operating conditions. The power into Node 2 is given by the following formula:

Pin2 = LPout1(n)

The phase gain of the preamplifier on Node 2 (GPre-2) is set during provisioning in order to compensate for the span loss so that the Node 2 preamplifier output power (Pout-Pre-2) is equal to the original transmitted power, as represented in the following formula:

Pout-Pre-2 = L x GPre-2 x Pout1(n)

In cases of system degradation, the power received at Node 2 decreases due to the change of span insertion loss (from L to L'). As a consequence of the preamplifier gain control working mode, the Node 2 preamplifier output power (Pout-Pre-2) also decreases. The goal of APC at the shelf controller layer is simply to detect if an amplifier output change is needed because of changes in the number of channels or to other factors. If factors other than changes in the number of channels occur, APC provisions a new gain at the Node 2 preamplifier (GPre-2') to compensate for the new span loss, as shown in the formula:

GPre-2' = GPre-2 (L/ L') = GPre-2 + [Pout-Pre-2 –Exp(Pout-Pre-2)]

Generalizing on the above relationship, APC is able to compensate for system degradation by adjusting working amplifier gain or variable optical attenuation (VOA) and to eliminate the difference between the power value read by the photodiodes and the expected power value. The expected power values are calculated using:

- Provisioned per channel power value
- Channel distribution (the number of express, add, and drop channels in the node)
- ASE estimation

Channel distribution is determined by the sum of the provisioned and failed channels. Information about provisioned wavelengths is sent to APC on the applicable nodes during circuit creation. Information about failed channels is collected through a signaling protocol that monitors alarms on ports in the applicable nodes and distributes that information to all the other nodes in the network.

ASE calculations purify the noise from the power level reported from the photodiode. Each amplifier can compensate for its own noise, but cascaded amplifiers cannot compensate for ASE generated by preceding nodes. The ASE effect increases when the number of channels decreases; therefore, a correction factor must be calculated in each amplifier of the ring to compensate for ASE build-up.

APC is a network-level feature that is distributed among different nodes. An APC domain is a set of nodes that is controlled by the same instance of APC at the network level. An APC domain optically identifies a portion of the network that can be independently regulated. An optical network can be divided into several different domains, with the following characteristics:

- Every domain is terminated by two node sides. The node sides terminating domains are:
  - Terminal node (any type)
  - ROADM node
  - Hub node
  - Cross-connect (XC) termination mesh node
  - Line termination mesh node
- APC domains are shown in both Cisco Transport Controller (CTC) and Transaction Language One (TL1).
- In CTC, domains are shown in the network view and reported as a list of spans. Each span is identified by a node/side pair, for example:

  APC Domain Node_1 Side A, Node_4 Side B
  + Span 1: Node_1 Side A, Node_2 Side B
  + Span 2: Node_2 Side A, Node_3 Side B
  + Span 3: Node_3 Side A, Node_4 Side B
- APC domains are not refreshed automatically; instead, they are refreshed using a Refresh button.

Inside a domain, the APC algorithm designates a master node that is responsible for starting APC hourly or every time a new circuit is provisioned or removed. Every time the master node signals APC to start, gain and VOA setpoints are evaluated on all nodes in the network. If corrections are needed in different nodes, they are always performed sequentially following the optical paths starting from the master node.

APC corrects the power level only if the variation exceeds the hysteresis thresholds of +/– 0.5 dB. Any power level fluctuation within the threshold range is skipped since it is considered negligible. Because APC is designed to follow slow time events, it skips corrections greater than 3 dB. This is the typical total aging margin that is provisioned during the network design phase. After you provision the first channel or the amplifiers are turned up for the first time, APC does not apply the 3 dB rule. In this case, APC corrects all the power differences to turn up the node.

To avoid large power fluctuations, APC adjusts power levels incrementally. The maximum power correction is +/– 0.5 dB. This is applied to each iteration until the optimal power level is reached. For example, a gain deviation of 2 dB is corrected in four steps. Each of the four steps requires a complete APC check on every node in the network. APC can correct up to a maximum of 3 dB on an hourly basis. If degradation occurs over a longer time period, APC compensates for it by using all margins that you provision during installation.

If no margin is available, adjustments cannot be made because setpoints exceed the ranges. APC communicates the event to CTC, Cisco Transport Manager (CTM), and TL1 through an APC Fail condition. APC clears the APC fail condition when the setpoints return to the allowed ranges.

APC can be manually disabled. In addition, APC automatically disables itself when:

- An Hardware Fail (HF) alarm is raised by any card in any of the domain nodes.
- A Mismatch Equipment Alarm (MEA) is raised by any card in any of the domain nodes.
- An Improper Removal (IMPROPRMVL) alarm is raised by any card in any of the domain nodes.
- Gain Degrade (GAIN-HDEG), Power Degrade (OPWR-HDEG), and Power Fail (PWR-FAIL) alarms are raised by the output port of any amplifier card in any of the domain nodes.
- A VOA degrade or fail alarm is raised by any of the cards in any of the domain nodes.
- The signaling protocol detects that one of the APC instances in any of the domain nodes is no longer reachable.

The APC state (Enable/Disable) is located on every node and can be retrieved by the CTC or TL1 interface. If an event that disables APC occurs in one of the network nodes, APC is disabled on all the other nodes and the APC state changes to DISABLE - INTERNAL. The disabled state is raised only by the node where the problem occurred to simplify troubleshooting.

APC raises the following minor, non-service-affecting alarms at the port level in CTC, TL1, and Simple Network Management Protocol (SNMP):

- APC Out of Range—APC cannot assign a new setpoint for a parameter that is allocated to a port because the new setpoint exceeds the parameter range.
- APC Correction Skipped—APC skipped a correction to one parameter allocated to a port because the difference between the expected and current values exceeds the +/– 3 dB security range.
- APC Disabled—APC is disabled, either by a user or internal action.

After the error condition is cleared, the signaling protocol enables APC on the network and the APC DISABLE - INTERNAL condition is cleared. Because APC is required after channel provisioning to compensate for ASE effects, all optical channel network connection (OCHNC) and optical channel client connection (OCHCC) circuits that you provision during the disabled APC state are kept in the Out-of-Service and Autonomous, Automatic In-Service (OOS-AU,AINS) (ANSI) or Unlocked-disabled,automaticInService (ETSI) service state until APC is enabled. OCHNCs and OCHCCs automatically go into the In-Service and Normal (IS-NR) (ANSI) or Unlocked-enabled (ETSI) service state only after APC is enabled.

12.8.3 Managing APC

The APC status is indicated by four APC states shown in the node view status area:

- Enabled—APC is enabled.
- Disabled—APC was disabled manually by a user.
- Disable - Internal—APC has been automatically disabled for an internal cause.
- Not Applicable—The node is provisioned to Not DWDM, which does not support APC.

You can view the APC information and disable and enable APC manually on the Maintenance > DWDM > APC tab.

Caution When APC is disabled, aging compensation is not applied and circuits cannot be activated. Do not disable APC unless it is required for specific maintenance or troubleshooting tasks. Always enable APC as soon as the tasks are completed.

The APC subtab provides the following information:

- Position—The slot number, card, and port for which APC information is shown.
- Last Modification—Date and time APC parameter setpoints were last modified.
- Parameter—The parameter that APC last modified.
- Last Check—Date and time APC parameter setpoints were last verified.
- Side—The side where the APC information for the card and port is shown.
- State—The APC state.

A wrong use of maintenance procedures (for example, the procedures to be applied in case of fiber cut repair) can lead the system to raise the APC Correction Skipped alarm. The APC Correction Skipped alarm strongly limits network management (for example, a new circuit cannot be turned into IS). The Force APC Correction button helps to restore normal conditions by clearing the APC Correction Skipped alarm.

The Force APC Correction button must be used under the Cisco TAC surveillance since its misuse can lead to traffic loss.

The Force APC Correction button is available in the **Card View > Maintenance > APC** tab pane in CTC for the following cards:

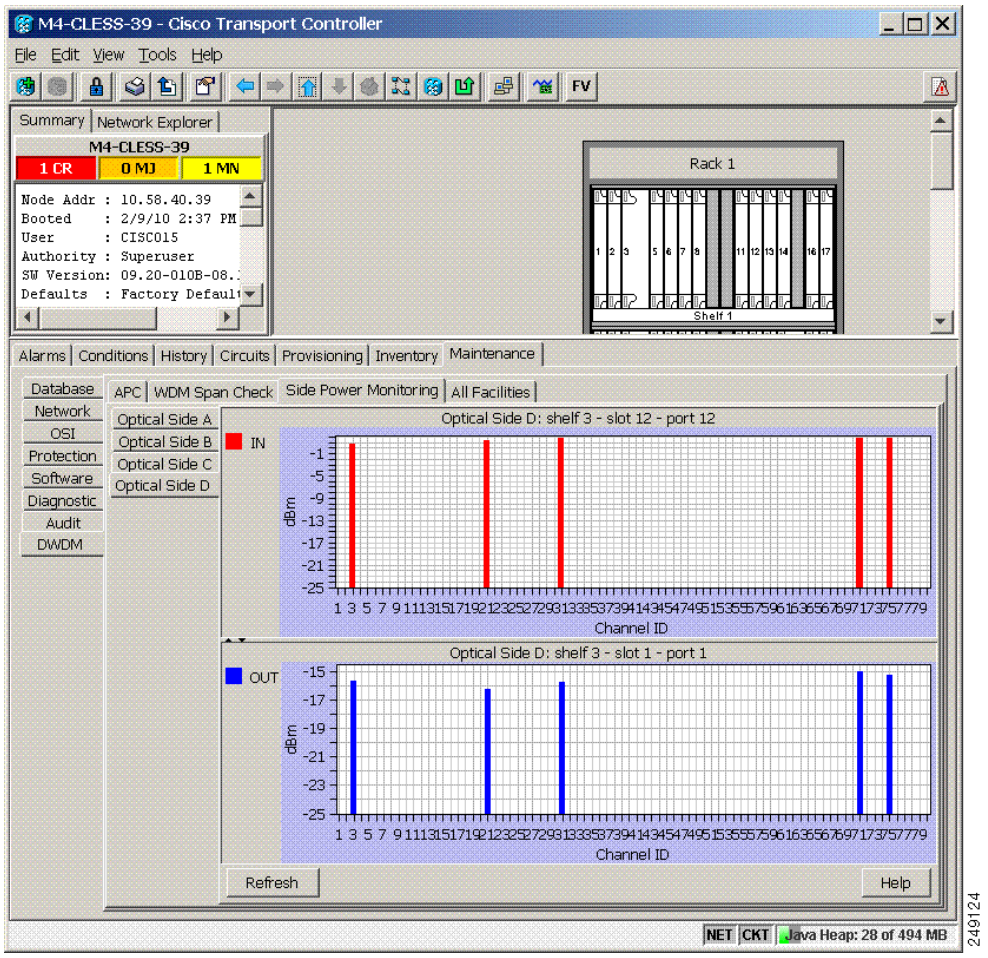
- OPT-PRE
- OPT-BST-E
- OPT-BST
- OPT-AMP-C
- OPT-AMP-17C
- AD-xB
- AD-xC
- 40-SMR1-C
- 40-SMR2-C

This feature is not available for the TL1 interface.

12.9 Power Side Monitoring

DWDM nodes allow you to view the side power levels on the Maintenance > DWDM > Side Power Monitoring > Optical Side *n* tab, where *n* is A, B, C, D(Figure 12-24). Each existing channel will have an IN and OUT power on each node side in the case of bidirectional circuits. OUT indicates the power on the output port with respect to the side to which it is referred to. It is the last port of the side before the first amplified port in the direction going from the node to the span or the output port of the side itself if there are no amplified ports. IN indicates the power on the input port with respect to the side to which is referred to. It is the first port of the side after the last amplified port in the direction going from the span to the node or the input port of the side itself if there are no amplified ports.

Figure 12-24 ROADM Power Monitoring Subtab



12.10 Span Loss Verification

Span loss measurements can be performed from the Maintenance > DWDM > WDM Span Check tab. The CTC span check compares the far-end OSC power with the near-end OSC power. A Span Loss Out of Range condition is raised when the measured span loss is higher than the maximum expected span loss. It is also raised when the measured span loss is lower than the minimum expected span loss and the difference between the minimum and maximum span loss values is greater than 1 dB. The minimum and maximum expected span loss values are calculated by Cisco TransportPlanner for the network and imported into CTC. However, you can manually change the minimum and expected span loss values.

CTC span loss measurements provide a quick span loss check and are useful whenever changes to the network occur, for example after you install equipment or repair a broken fiber. CTC span loss measurement resolutions are:

- +/– 1.5 dB for measured span losses between 0 and 25 dB
- +/– 2.5 dB for measured span losses between 25 and 38 dB

For ONS 15454 span loss measurements with higher resolutions, an optical time domain reflectometer (OTDR) must be used.

Note From Software Release 9.0 onwards, span loss measurement is performed using C-band channels (whenever available), instead of OSC signals. Software Release 9.0 is not interoperable with earlier releases that are only OSC-based. Therefore, span loss measurement cannot be done on a span if the adjacent nodes are running different software releases; for example one node running Software Release 8.0 or an earlier release and the second node running Software Release 9.0 or a later release.

12.10.1 Span Loss Measurements on Raman Links

Span loss measurement when Raman amplification is active is less accurate than a standard link as it is based on a mathematical formula that uses the Raman noise and Raman gain.

Span loss on a Raman link is measured in the following states:

- Automatically during Raman link setup (without Raman amplification)
- Automatically during fiber cut restore (without Raman amplification)
- Periodically or upon request (with Raman amplification)

CTC reports three values in the Maintenance > DWDM > WDM Span Check tab:

- Current Span Measure with Raman—Estimated span loss with Raman pump turned ON.
- Wizard Span Measure with Raman Off—Span loss with Raman pump turned OFF, during Raman installation.
- Last Span Measure with Raman—Span loss after a fiber cut restoration procedure.

Measurements are performed automatically on an hourly basis.

A Span Loss Out of Range condition is raised under the following conditions:

- Span loss is greater than the maximum expected span loss + resolution
- Span loss is less than the minimum expected span loss – resolution

The minimum and maximum expected span loss values are calculated by Cisco Transport Planner for the network and imported into CTC. However, you can manually change the minimum and maximum expected span loss values.

Note During Raman installation using a wizard, the Span Loss Out of Range alarm is not raised when the out of range condition is raised. In such a case, the wizard fails and an error message is displayed, and the span is not tuned.

CTC span loss measurements provide a quick span loss check and are useful whenever changes to the network occur, for example after you install equipment or repair a broken fiber. CTC span loss measurement resolutions are:

- +/– 1.5 dB for span loss measurements between 0 and 26 dB
- +/– 2.0 dB for span loss measurements between 26 and 31 dB
- +/– 3.0 dB for span loss measurements between 31 and 34 dB
- +/– 4.0 dB for span loss measurements between 34 and 36 dB

12.11 Network Optical Safety

If a fiber break occurs on the network, automatic laser shutdown (ALS) automatically shuts down the OSCM and OSC-CSM OSC laser output power and the optical amplifiers contained in the OPT-BST, OPT-BST-E, OPT-BST-L, OPT-AMP-L, OPT-AMP-C, OPT-AMP-17-C, OPT-RAMP-C, OPT-RAMP-CE, 40-SMR1-C, and 40-SMR2-C cards, and the TX VOA in the protect path of the PSM card (in line protection configuration only). (Instead, the PSM active path will use optical safety mechanism implemented by the booster amplifier or OSC-CSM card that are mandatory in the line protection configuration.)

The Maintenance > ALS tab in CTC card view provide the following ALS management options for OSCM, OSC-CSM, OPT-BST, OPT-BST-E, OPT-BST-L, OPT-AMP-L, OPT-AMP-C, OPT-AMP-17-C, OPT-RAMP-C, OPT-RAMP-CE, 40-SMR1-C, 40-SMR2-C, and PSM (on the protect path, only in line protection configuration) cards:

- Disable—ALS is off. The OSC laser transmitter and optical amplifiers are not automatically shut down when a traffic outage loss of signal (LOS) occurs.
- Auto Restart—ALS is on. The OSC laser transmitter and optical amplifiers automatically shut down when traffic outages (LOS) occur. It automatically restarts when the conditions that caused the outage are resolved. Auto Restart is the default ALS provisioning for OSCM, OSC-CSM, OPT-BST, OPT-BST-E, OPT-BST-L, OPT-AMP-L, OPT-AMP-C, OPT-AMP-17-C, OPT-RAMP-C, OPT-RAMP-CE, 40-SMR1-C, 40-SMR2-C, and PSM (on the protect path, only in line protection configuration) cards.
- Manual Restart—ALS is on. The OSC laser transmitter and optical amplifiers automatically shut down when traffic outages (LOS) occur. However, the laser must be manually restarted when conditions that caused the outage are resolved.
- Manual Restart for Test—Manually restarts the OSC laser transmitter and optical amplifiers for testing.

12.11.1 Automatic Laser Shutdown

When ALS is enabled on OPT-BST, OPT-BST-E, OPT-BST-L, OPT-AMP-L, OPT-AMP-C, OPT-AMP-17-C, OPT-RAMP-C, OPT-RAMP-CE, 40-SMR1-C, 40-SMR2-C, PSM (on the protect path, only in line protection configuration), OSCM, OSC-CSM, and TNC cards, a network safety mechanism will occur in the event of a system failure. ALS provisioning is also provided on the transponder (TXP) and muxponder (MXP) cards. However, if a network uses ALS-enabled OPT-BST, OPT-BST-E, OPT-BST-L, OPT-AMP-L, OPT-AMP-C, OPT-AMP-17-C, OPT-RAMP-C, OPT-RAMP-CE, 40-SMR1-C, 40-SMR2-C, PSM (on the protect path, only in line protection configuration), OSCM, and OSC-CSM cards, ALS does not need to be enabled on the TXP cards or MXP cards. ALS is disabled on TXP and MXP cards by default and the network optical safety is not impacted.

If TXP and MXP cards are connected directly to each other without passing through a DWDM layer, ALS should be enabled on them. The ALS protocol goes into effect when a fiber is cut, enabling some degree of network point-to-point bidirectional traffic management between the cards.

If ALS is disabled on the OPT-BST, OPT-BST-E, OPT-BST-L, OPT-AMP-L, OPT-AMP-C, OPT-AMP-17-C, OPT-RAMP-C, OPT-RAMP-CE, 40-SMR1-C, 40-SMR2-C, PSM (on the protect path, only in line protection configuration), OSCM, and OSC-CSM cards (the DWDM network), ALS can be enabled on the TXP and MXP cards to provide laser management in the event of a fiber break in the network between the cards.

12.11.2 Automatic Power Reduction

Automatic power reduction (APR) is controlled by the software and is not user configurable. During amplifier restart after a system failure, the amplifier (OPT-BST, for example) operates in pulse mode and an APR level is activated so that the Hazard Level 1 power limit is not exceeded. This is done to ensure personnel safety.

When a system failure occurs (cut fiber or equipment failure, for example) and ALS Auto Restart is enabled, a sequence of events is placed in motion to shut down the amplifier laser power, then automatically restart the amplifier after the system problem is corrected. As soon as a loss of optical payload and OSC is detected at the far end, the far-end amplifier shuts down. The near-end amplifier then shuts down because it detects a loss of payload and the OSC shuts down due to the far-end amplifier shutdown. At this point, the near end attempts to establish communication to the far end using the OSC laser transmitter. To do this, the OSC emits a two-second pulse at very low power (maximum of 0 dBm) and waits for a similar two-second pulse in response from the far-end OSC laser transmitter. If no response is received within 100 seconds, the near end tries again. This process continues until the near end receives a two-second response pulse from the far end, indicating the system failure is corrected and full continuity in the fiber between the two ends exists.

After the OSC communication is established, the near-end amplifier is configured by the software to operate in pulse mode at a reduced power level. It emits a nine-second laser pulse with an automatic power reduction to +8 dBm. (For 40-SMR1-C and 40-SMR2-C cards, the pulse is not +8 dBm but it is the per channel power setpoint.) This level assures that Hazard Level 1 is not exceeded, for personnel safety, even though the establishment of successful OSC communication is assurance that any broken fiber is fixed. If the far-end amplifier responds with a nine-second pulse within 100 seconds, both amplifiers are changed from pulse mode at reduced power to normal operating power mode.

For a direct connection between TXP or MXP cards, when ALS Auto Restart is enabled and the connections do not pass through a DWDM layer, a similar process takes place. However, because the connections do not go through any amplifier or OSC cards, the TXP or MXP cards attempt to establish communication directly between themselves after a system failure. This is done using a two-second restart pulse, in a manner similar to that previously described between OSCs at the DWDM layer. The power emitted during the pulse is below Hazard Level 1.

APR is also implemented on the PSM card (on the protect path, only in line protection configuration). In the PSM line protection configuration, when a system failure occurs on the working path (cut fiber or equipment failure, for example), the ALS and APR mechanisms are implemented by the booster amplifier or the OSC-CSM card. Alternately, when a system failure occurs on the protect path, and ALS Auto Restart is enabled on the PSM card, a sequence of events is placed in motion to shut down the TX VOA on the protect path, and then automatically restart it after the system failure is corrected. During protect path restart, the TX VOA on the protect path operates in pulse mode and limits the power to maximum +8 dBm so that the Hazard Level 1 power limit is not exceeded on protect TX path.

When ALS is disabled, the warning Statement 1056 is applicable.

Warning **Invisible laser radiation may be emitted from the end of the unterminated fiber cable or connector. Do not view directly with optical instruments. Viewing the laser output with certain optical instruments (for example, eye loupes, magnifiers, and microscopes) within a distance of 100 mm may pose an eye hazard.** Statement 1056

Note If you must disable ALS, verify that all fibers are installed in a restricted location. Enable ALS immediately after finishing the maintenance or installation process.

Note For the line amplifier to start up automatically, disable the ALS on the terminal node that is unidirectional.

12.11.3 Network Optical Safety on OPT-RAMP-C and OPT-RAMP-CE Cards

Optical safety on the OPT-RAMP-C and OPT-RAMP-CE cards is implemented in the RAMAN-TX and COM-TX ports. RAMAN-TX will report safety settings associated to the Raman pump while the COM-TX port will report safety settings associated with the embedded EDFA.

12.11.3.1 RAMAN-TX Settings on Raman Pump

The Raman pump is automatically turned off as soon as the LOS alarm is detected on the LINE-RX port. The Raman pump is automatically turned on at APR power every 100 secs for a duration of 9 seconds at a pulse power of at 8 dBm, as soon as the LINE-RX port is set to IS-NR/unlocked-enabled.

Note Optical safety cannot be disabled on the OPT-RAMP-C and OPT-RAMP-CE cards and cannot be disabled on OSCM cards when connected to a OPT-RAMP-C or OPT-RAMP-CE card.

The system periodically verifies if the signal power is present on the LINE-RX port. If signal power is present, the following occurs:

- Pulse duration is extended.
- Raman pumps are turned on at APR power, if the laser was shut down.

The Raman power is then moved to setpoint if power is detected for more than 10 seconds. During Automatic Laser Restart (ALR) the safety is enabled. The laser is automatically shut down if LOS is detected on the receiving fiber. In general Raman pump turns on only when Raman signals are detected. However, the Raman pump can be configured to turn on to full power even when OSC power is detected for more than 9 seconds on OSC-RX port.

12.11.3.2 COM-TX Safety Setting on EDFA

EDFA is shutdown automatically under the following conditions:

- The Raman pumps shut down.
- An LOS-P alarm is detected on the COM-RX port.

If EDFA was shut down because of Raman pump shut down, the EDFA restarts by automatically turning on the EDFA lasers as soon as the Raman loop is closed.

- Pulse duration: 9 seconds
- Pulse power: 8 dB (maximum APR power foreseen by safety regulation)
- Exit condition: Received power detected on the DC-RX port at the end of APR pulse. If power is detected on DC-RX (so DCU is connected) EDFA moves to set-point; otherwise, it keeps 9 dB as the output power at restart
- EDFA moves to the power set point when power is detected on the DC-RX port.

If EDFA was shutdown because of an LOS-P alarm. The EDFA restarts by automatically turning on the EDFA laser as soon as an LOS-P alarm on the COM-RX port is cleared, and the Raman loop is closed.

- Pulse duration: 9 seconds
- Pulse power: 8 dB (maximum APR power foreseen by safety regulation)
- Exit condition: Received power detected on the LINE-RX port at the end of the APR pulse

Warning **All ONS 15454 users must be properly trained on laser safety hazards in accordance with IEC 60825-2, or ANSI Z136.1.**

12.11.4 Fiber Cut Scenarios

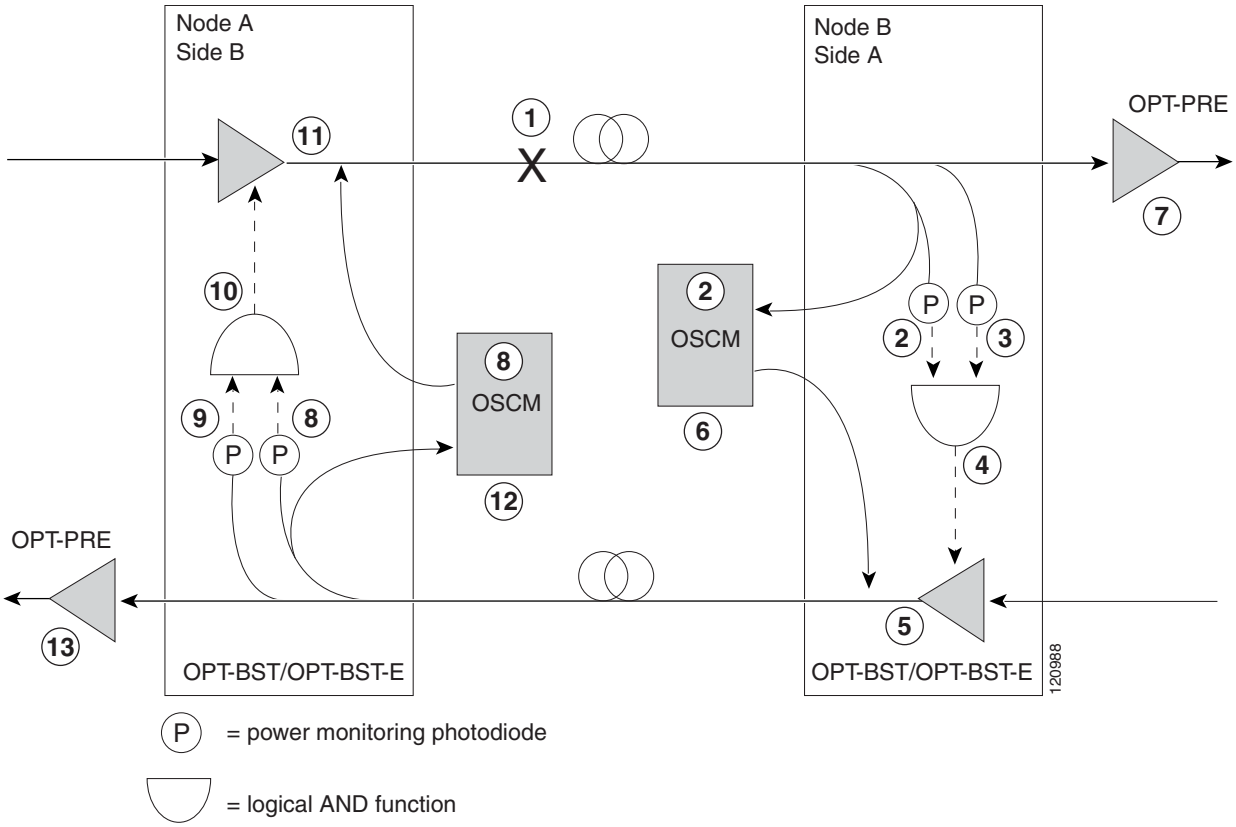
In the following paragraphs, four ALS scenarios are given:

- 12.11.4.1 Scenario 1: Fiber Cut in Nodes Using OPT-BST/OPT-BST-E Cards, page 12-30
- 12.11.4.2 Scenario 2: Fiber Cut in Nodes Using OSC-CSM Cards, page 12-32
- 12.11.4.3 Scenario 3: Fiber Cut in Nodes Using OPT-BST-L Cards, page 12-34
- 12.11.4.4 Scenario 4: Fiber Cut in Nodes Using OPT-AMP-L, OPT-AMP-C, OPT-AMP-17-C (OPT-LINE Mode), 40-SMR1-C, or 40-SMR2-C Cards, page 12-35
- 12.11.4.5 Scenario 5: Fiber Cut in Nodes Using DCN Extension, page 12-37
- 12.11.4.6 Scenario 6: Fiber Cut in Nodes Using OPT-RAMP-C or OPT-RAMP-CE Cards, page 12-39

12.11.4.1 Scenario 1: Fiber Cut in Nodes Using OPT-BST/OPT-BST-E Cards

Figure 12-25 shows nodes using OPT-BST/OPT-BST-E cards with a fiber cut between them.

Figure 12-25 Nodes Using OPT-BST/OPT-BST-E Cards



Two photodiodes at Node B monitor the received signal strength for the optical payload and OSC signals. When the fiber is cut, an LOS is detected at both of the photodiodes. The AND function then indicates an overall LOS condition, which causes the OPT-BST/OPT-BST-E transmitter, OPT-PRE transmitter, and OSCM lasers to shut down. This in turn leads to an LOS for both the optical payload and OSC at Node A, which causes Node A to turn off the OSCM, OPT-PRE transmitter, and OPT-BST/OPT-BST-E transmitter lasers. The sequence of events after a fiber cut is as follows (refer to the numbered circles in Figure 12-25):

1. Fiber is cut.
2. The Node B power monitoring photodiode detects a Loss of Incoming Payload (LOS-P) on the OPT-BST/OPT-BST-E card. Refer to the *Cisco ONS 15454 DWDM Troubleshooting Guide*.
3. On the OPT-BST/OPT-BST-E card, the simultaneous LOS-O and LOS-P detection triggers a command to shut down the amplifier. CTC reports an LOS alarm (loss of continuity), while LOS-O and LOS-P are demoted. Refer to the *Cisco ONS 15454 DWDM Troubleshooting Guide*.
4. The OPT-BST/OPT-BST-E card amplifier is shut down within one second.
5. The OSCM laser is shut down.
6. The OPT-PRE card automatically shuts down due to a loss of incoming optical power.
7. The Node A power monitoring photodiode detects a LOS-O on the OPT-BST/OPT-BST-E card and the OSCM card detects a LOS (OC3) at the SONET layer. Refer to the *Cisco ONS 15454 DWDM Troubleshooting Guide*.
8. The Node A power monitoring photodiode detects a LOS-P on the OPT-BST/OPT-BST-E card. Refer to the *Cisco ONS 15454 DWDM Troubleshooting Guide*.

9. On the OPT-BST/OPT-BST-E, the simultaneous LOS-O and LOS-P detection triggers a command to shut down the amplifier. CTC reports an LOS alarm (loss of continuity), while LOS-O and LOS-P are demoted. Refer to the *Cisco ONS 15454 DWDM Troubleshooting Guide*.
10. The OPT-BST/OPT-BST-E card amplifier is shut down within one second.
11. The OSCM laser is shut down.
12. The Node A OPT-PRE card automatically shuts down due to a loss of incoming optical power.

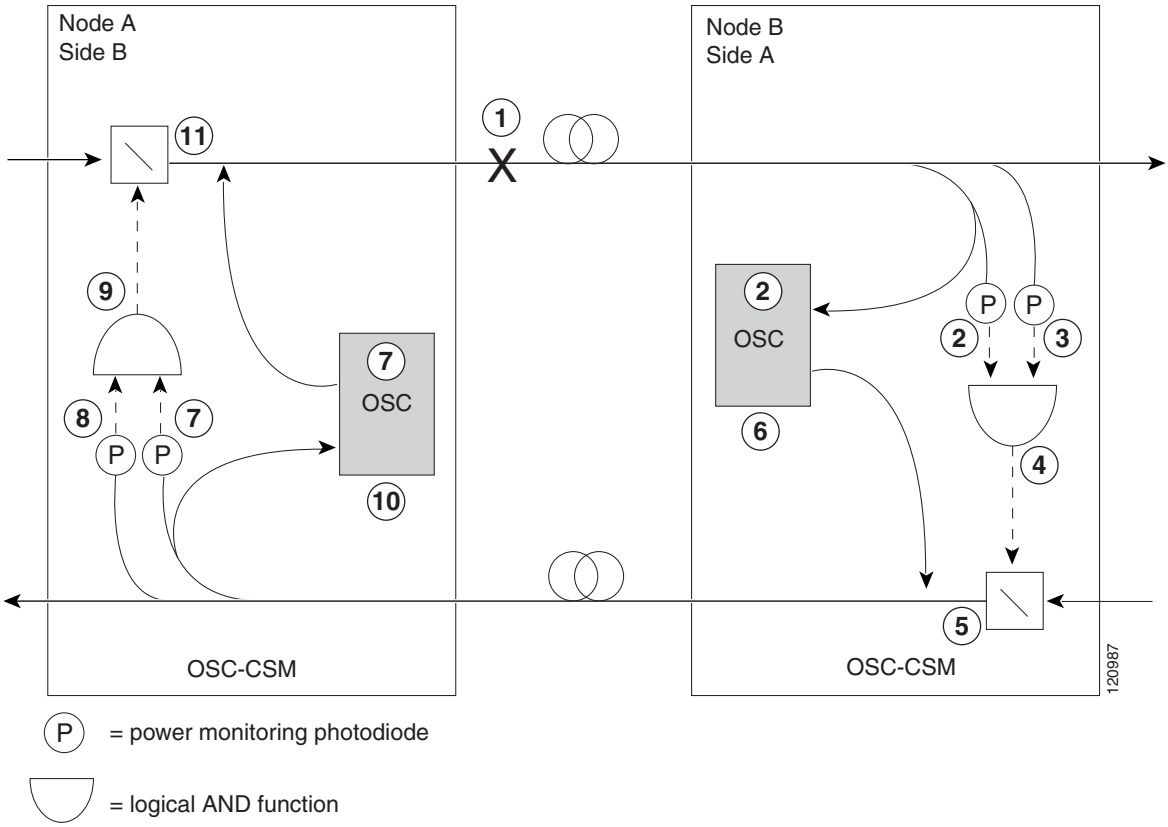
When the fiber is repaired, either an automatic or manual restart at the Node A OPT-BST/OPT-BST-E transmitter or at the Node B OPT-BST/OPT-BST-E transmitter is required. A system that has been shut down is reactivated through the use of a restart pulse. The pulse is used to signal that the optical path has been restored and transmission can begin. For example, when the far end, Node B, receives a pulse, it signals to the Node B OPT-BST/OPT-BST-E transmitter to begin transmitting an optical signal. The OPT-BST/OPT-BST-E receiver at Node A receives that signal and signals the Node A OPT-BST/OPT-BST-E transmitter to resume transmitting.

Note During a laser restart pulse, APR ensures that the laser power does not exceed Class 1 limits. See the "12.11.2 Automatic Power Reduction" section on page 12-28 for more information about APR.

12.11.4.2 Scenario 2: Fiber Cut in Nodes Using OSC-CSM Cards

Figure 12-26 shows nodes using OSC-CSM cards with a fiber cut between them.

Figure 12-26 Nodes Using OSC-CSM Cards



Two photodiodes at the Node B OSC-CSM card monitor the received signal strength for the received optical payload and OSC signals. When the fiber is cut, LOS is detected at both of the photodiodes. The AND function then indicates an overall LOS condition, which causes the Node B OSC laser to shut down and the optical switch to block traffic. This in turn leads to LOS for both the optical payload and OSC signals at Node A, which causes Node A to turn off the OSC laser and the optical switch to block outgoing traffic. The sequence of events after a fiber cut is as follows (refer to the numbered circles in Figure 12-26):

1. Fiber is cut.
2. The Node B power monitoring photodiode detects a LOS-P on the OSC-CSM card. Refer to the *Cisco ONS 15454 DWDM Troubleshooting Guide*.
3. On the OSC-CSM, the simultaneous LOS-O and LOS-P detection triggers a change in the position of the optical switch. CTC reports a LOS alarm (loss of continuity), while LOS-O and LOS-P are demoted. Refer to the *Cisco ONS 15454 DWDM Troubleshooting Guide*.
4. The optical switch blocks outgoing traffic.
5. The OSC laser is shut down.
6. The Node A power monitoring photodiode detects a LOS-O on the OSC-CSM card. Refer to the *Cisco ONS 15454 DWDM Troubleshooting Guide*.
7. The Node A power monitoring photodiode detects a LOS-P on the OSC-CSM card. Refer to the *Cisco ONS 15454 DWDM Troubleshooting Guide*.

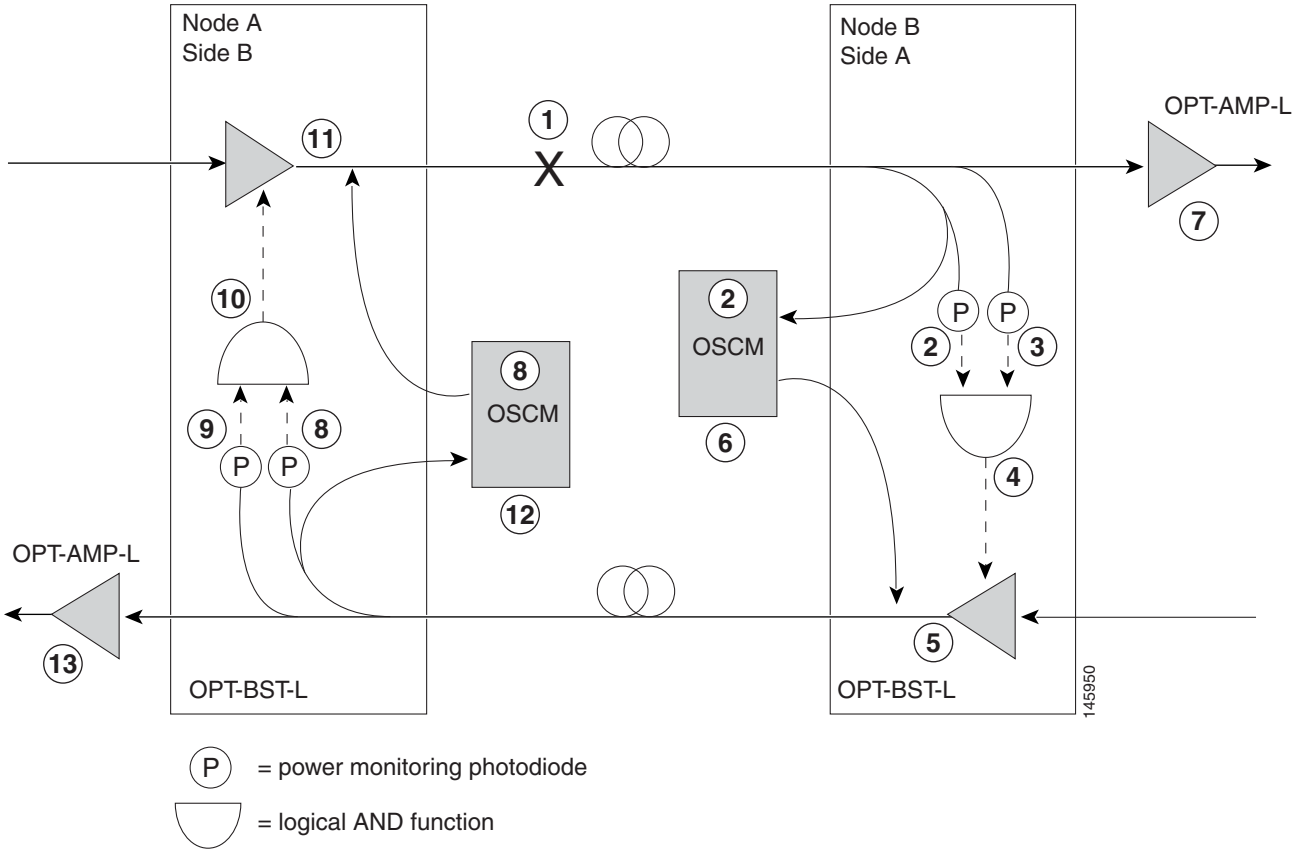
8. On the OSC-CSM, the simultaneous LOS-O and LOS-P detection triggers a change in the position of the optical switch. CTC reports a LOS alarm (loss of continuity), while LOS-O and LOS-P are demoted. Refer to the *Cisco ONS 15454 DWDM Troubleshooting Guide*.
9. The OSC laser is shut down.
10. The optical switch blocks outgoing traffic.

When the fiber is repaired, either an automatic or manual restart at the Node A OSC-CSM card OSC or at the Node B OSC-CSM card OSC is required. A system that has been shut down is reactivated through the use of a restart pulse. The pulse indicates the optical path is restored and transmission can begin. For example, when the far-end Node B receives a pulse, it signals to the Node B OSC to begin transmitting its optical signal and for the optical switch to pass incoming traffic. The OSC-CSM at Node A then receives the signal and tells the Node A OSC to resume transmitting and for the optical switch to pass incoming traffic.

12.11.4.3 Scenario 3: Fiber Cut in Nodes Using OPT-BST-L Cards

Figure 12-27 shows nodes using OPT-BST-L cards with a fiber cut between them.

Figure 12-27 Nodes Using OPT-BST-L Cards



Two photodiodes at Node B monitor the received signal strength for the optical payload and OSC signals. When the fiber is cut, an LOS is detected at both of the photodiodes. The AND function then indicates an overall LOS condition, which causes the OPT-BST-L transmitter and OSCM lasers to shut down. This

in turn leads to an LOS for both the optical payload and the OSC at Node A, which causes Node A to turn off the OSCM OSC transmitter and OPT-BST-L amplifier lasers. The sequence of events after a fiber cut is as follows (refer to the numbered circles in Figure 12-27):

1. Fiber is cut.
2. The Node B power monitoring photodiode detects an LOS-P on the OPT-BST-L card. For more information on alarms, refer to the *Cisco ONS 15454 DWDM Troubleshooting Guide*.
3. On the OPT-BST-L card, the simultaneous LOS-O and LOS-P detection triggers a command to shut down the amplifier. CTC reports an LOS alarm (loss of continuity), while LOS-O and LOS-P are demoted. For more information on alarms, refer to the *Cisco ONS 15454 DWDM Troubleshooting Guide*.
4. The OPT-BST-L card amplifier is shut down within one second.
5. The OSCM laser is shut down.
6. The OPT-AMP-L, OPT-AMP-C, or OPT-AMP-17-C card automatically shuts down due to a loss of incoming optical power.
7. The Node A power monitoring photodiode detects an LOS-O on the OPT-BST-L card and the OSCM card detects an LOS (OC3) at the SONET layer. For more information on alarms, refer to the *Cisco ONS 15454 DWDM Troubleshooting Guide*.
8. The Node A power monitoring photodiode detects an LOS-P on the OPT-BST-L card. For more information on alarms, refer to the *Cisco ONS 15454 DWDM Troubleshooting Guide*.
9. On the OPT-BST-L, the simultaneous LOS-O and LOS-P detection triggers a command to shut down the amplifier. CTC reports an LOS alarm (loss of continuity), while the LOS-O and LOS-P are demoted. For more information on alarms, refer to the *Cisco ONS 15454 DWDM Troubleshooting Guide*.
10. The OPT-BST-L card amplifier is shut down within one second.
11. The OSCM laser is shut down.
12. The Node A OPT-AMP-L, OPT-AMP-C, or OPT-AMP-17-C card automatically shuts down due to an LOS for the incoming optical power.

When the fiber is repaired, either an automatic or manual restart at the Node A OPT-BST-L transmitter or at the Node B OPT-BST-L transmitter is required. A system that has been shut down is reactivated through the use of a restart pulse. The pulse indicates the optical path is restored and transmission can begin. For example, when the far end, Node B, receives a pulse, it signals to the Node B OPT-BST-L transmitter to begin transmitting an optical signal. The OPT-BST-L receiver at Node A receives that signal and signals the Node A OPT-BST-L transmitter to resume transmitting.

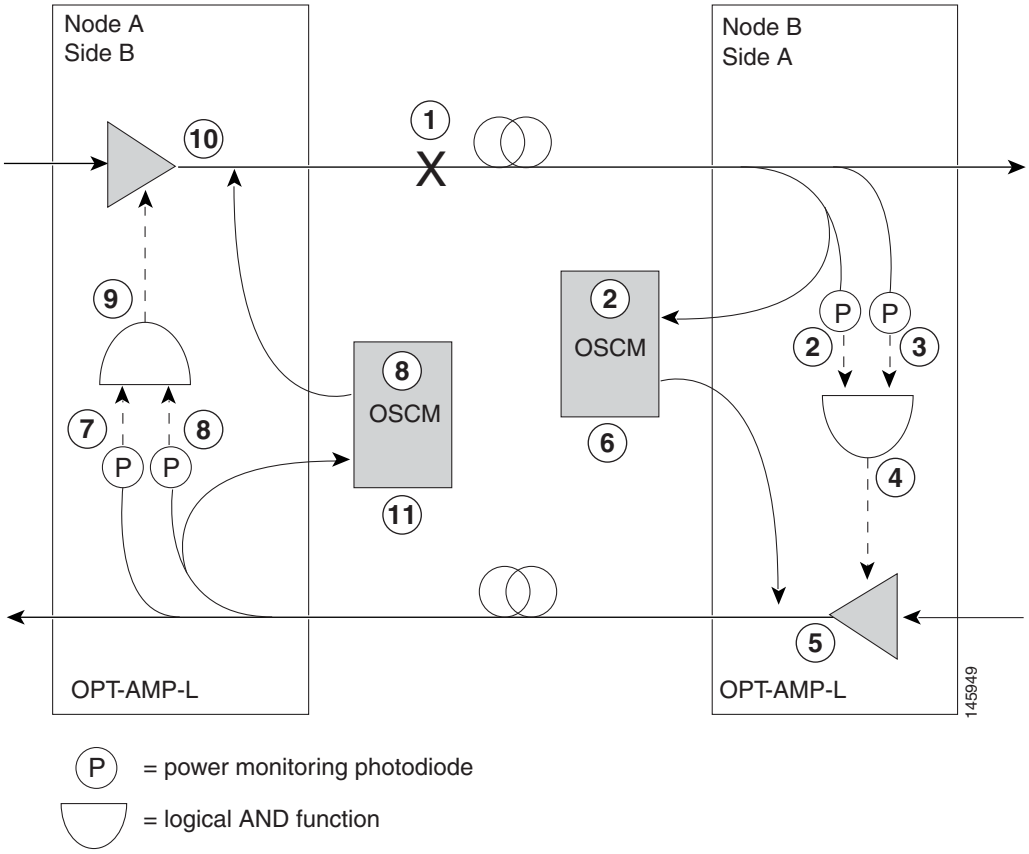
Note During a laser restart pulse, APR ensures that the laser power does not exceed Class 1 limits. See the "12.11.2 Automatic Power Reduction" section on page 12-28 for more information about APR.

12.11.4.4 Scenario 4: Fiber Cut in Nodes Using OPT-AMP-L, OPT-AMP-C, OPT-AMP-17-C (OPT-LINE Mode), 40-SMR1-C, or 40-SMR2-C Cards

Figure 12-28 shows nodes using OPT-AMP-L, OPT-AMP-C, OPT-AMP-17-C (in OPT-LINE mode), 40-SMR1-C, or 40-SMR2-C cards with a fiber cut between them.

Note A generic reference to the OPT-AMP card refers to the OPT-AMP-L, OPT-AMP-17-C, OPT-AMP-C, 40-SMR1-C, or 40-SMR2-C cards.

Figure 12-28 Nodes Using OPT-AMP Cards



Two photodiodes at Node B monitor the received signal strength for the optical payload and OSC signals. When the fiber is cut, an LOS is detected at both of the photodiodes. The AND function then indicates an overall LOS condition, which causes the OPT-AMP card amplifier transmitter and OSCM card OSC lasers to shut down. This in turn leads to an LOS for both the optical payload and OSC at Node A, which causes Node A to turn off the OSCM card OSC and OPT-AMP card amplifier lasers. The sequence of events after a fiber cut is as follows (refer to the numbered circles in Figure 12-28):

1. Fiber is cut.
2. The Node B power monitoring photodiode detects an LOS-P on the OPT-AMP card. For more information on alarms, refer to the *Cisco ONS 15454 DWDM Troubleshooting Guide*.
3. On the OPT-AMP card, the simultaneous LOS-O and LOS-P detection triggers a command to shut down the amplifier. CTC reports an LOS alarm (loss of continuity), while LOS-O and LOS-P are demoted. For more information on alarms, refer to the *Cisco ONS 15454 DWDM Troubleshooting Guide*.
4. The OPT-AMP card amplifier is shut down within one second.
5. The OSCM card laser is shut down.

6. The Node A power monitoring photodiode detects an LOS-O on the OPT-AMP card and the OSCM card detects an LOS (OC3) at the SONET layer. For more information on alarms, refer to the *Cisco ONS 15454 DWDM Troubleshooting Guide*.
7. The Node A power monitoring photodiode detects an LOS-P on the OPT-AMP card. For more information on alarms, refer to the *Cisco ONS 15454 DWDM Troubleshooting Guide*.
8. On the OPT-AMP card, the simultaneous LOS-O and LOS-P detection triggers a command to shut down the amplifier. CTC reports an LOS alarm (loss of continuity), while LOS-O and LOS-P are demoted. For more information on alarms, refer to the *Cisco ONS 15454 DWDM Troubleshooting Guide*.
9. The OPT-AMP card amplifier is shut down within one second.
10. The OSCM card laser is shut down.

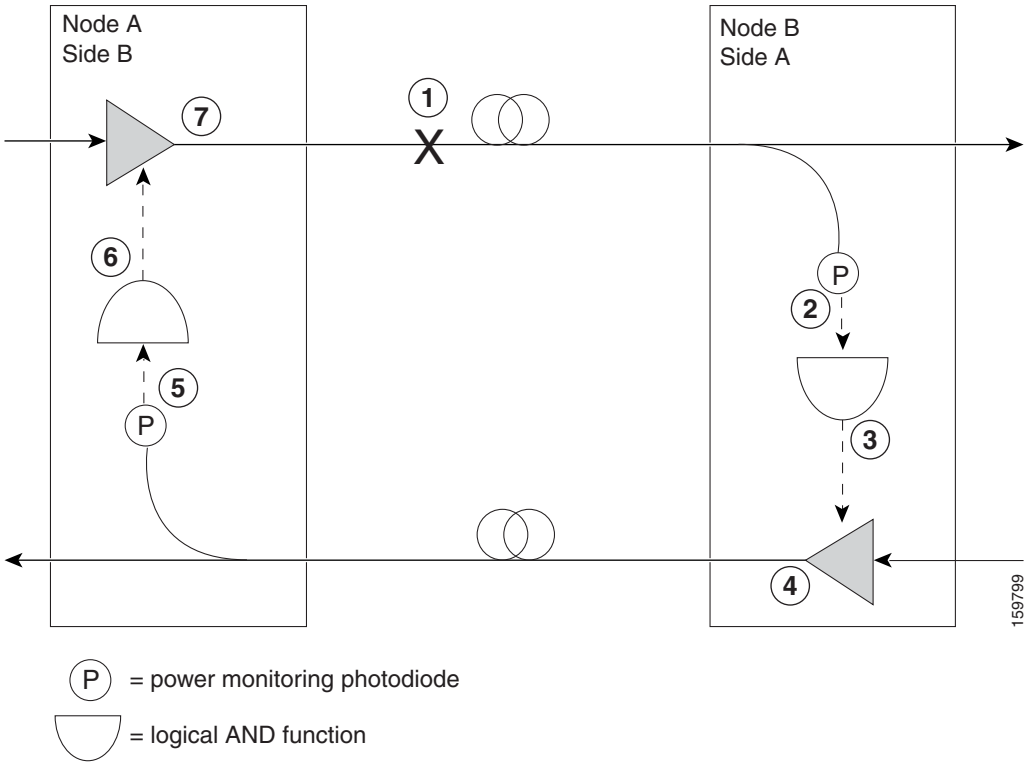
When the fiber is repaired, either an automatic or manual restart at the Node A OPT-AMP card transmitter or at the Node B OPT-AMP card transmitter is required. A system that has been shut down is reactivated through the use of a restart pulse. The pulse indicates that the optical path is restored and transmission can begin. For example, when the far end, Node B, receives a pulse, it signals to the Node B OPT-AMP card transmitter to begin transmitting an optical signal. The OPT-AMP card receiver at Node A receives that signal and signals the Node A OPT-AMP card transmitter to resume transmitting.

Note During a laser restart pulse, APR ensures that the laser power does not exceed Class 1 limits. See the "12.11.2 Automatic Power Reduction" section on page 12-28 for more information about APR.

12.11.4.5 Scenario 5: Fiber Cut in Nodes Using DCN Extension

Figure 12-29 shows a fiber cut scenario for nodes that do not have OSC connectivity. In the scenario, references to the OPT-BST cards refers to the OPT-BST, OPT-BST-L, OPT-BST-E, OPT-AMP-L, OPT-AMP-C, OPT-AMP-17-C, 40-SMR1-C, and 40-SMR2-C cards when provisioned in OPT-LINE mode.

Figure 12-29 Fiber Cut With DCN Extension



Two photodiodes at Node B monitor the received signal strength for the optical payload. When the fiber is cut, an LOS is detected on the channel photodiode while the other one never gets a signal because the OSC is not present. The AND function then indicates an overall LOS condition, which causes the OPT-BST amplifier transmitter to shut down. This in turn leads to a LOS for the optical payload at Node A, which causes Node A to turn off the OPT-BST amplifier lasers.

The sequence of events after a fiber cut is as follows (refer to the numbered circles in Figure 12-29):

1. Fiber is cut.
2. The Node B power monitoring photodiode detects an LOS on the OPT-BST card. Refer to the *Cisco ONS 15454 DWDM Troubleshooting Guide* for LOS troubleshooting procedures.
3. On the OPT-BST card, the LOS detection triggers a command to shut down the amplifier. Refer to the *Cisco ONS 15454 DWDM Troubleshooting Guide* for alarm troubleshooting procedures.
4. The OPT-BST card amplifier is shut down within one second.
5. The Node A power monitoring photodiode detects a LOS on the OPT-BST card. Refer to the *Cisco ONS 15454 DWDM Troubleshooting Guide* for alarm troubleshooting procedures.
6. On the OPT-BST, the LOS detection triggers a command to shut down the amplifier. Refer to the *Cisco ONS 15454 DWDM Troubleshooting Guide*.
7. The OPT-BST card amplifier is shut down within one second.

When the fiber is repaired, a manual restart with 9 sec restart pulse time (MANUAL RESTART) is required at the Node A OPT-BST transmitter and at the Node B OPT-BST transmitter. A system that has been shut down is reactivated through the use of a 9 sec restart pulse. The pulse indicates that the optical path is restored and transmission can begin.

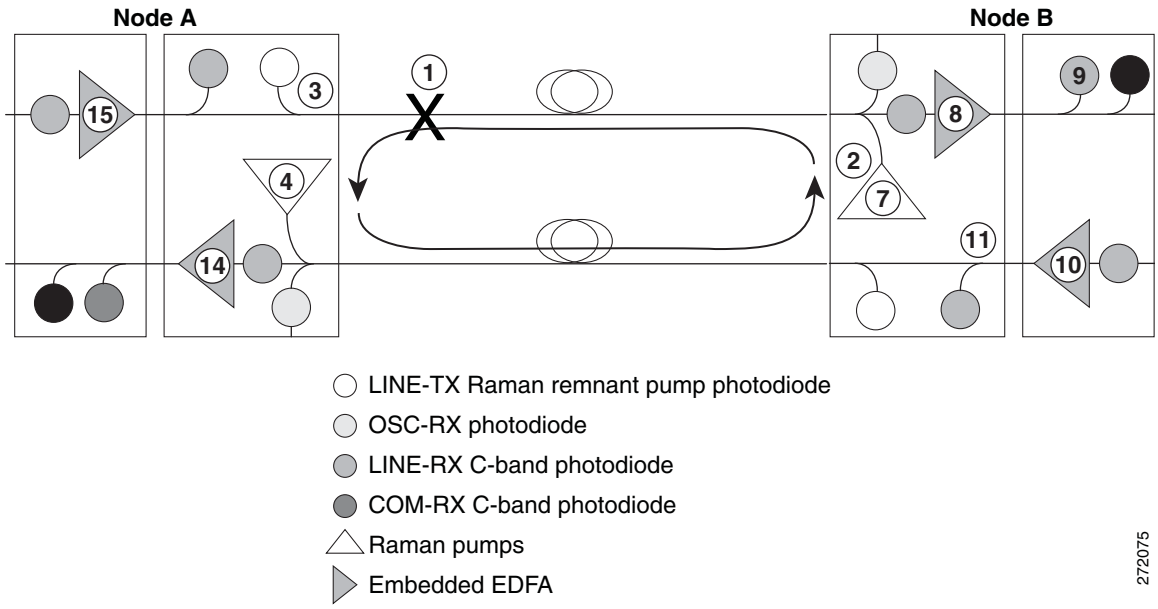
For example, when the far end, Node B, receives a pulse, it signals to the Node B OPT-BST transmitter to begin transmitting an optical signal. The OPT-BST receiver at Node A receives that signal and signals the Node A OPT-BST transmitter to resume transmitting.

Note During a laser restart pulse, APR ensures that the laser power does not exceed Class 1 limits. See the "12.11.2 Automatic Power Reduction" section on page 12-28 for more information about APR.

12.11.4.6 Scenario 6: Fiber Cut in Nodes Using OPT-RAMP-C or OPT-RAMP-CE Cards

Figure 12-30 shows a fiber cut scenario for nodes that do not have OSC connectivity. In this scenario, OPT-RAMP-C or OPT-RAMP-CE cards are provisioned in OPT-LINE mode.

Figure 12-30 Nodes Using OPT-RAMP-C or OPT-RAMP-CE Cards



The following types of photodiodes monitor the received signal strength for the optical payload:

- OSC-RX photodiodes
- LINE-RX C-band photodiode
- Line-TX Raman pump photodiode
- COM-RX C-band photodiode

The sequence of events after a fiber cut is as follows (refer to the numbered circles in Figure 12-30):

1. Fiber is cut in the direction of Node B to Node A.
2. On Node A, the RAMAN-RX port detects an LOS-R alarm on the OPT-RAMP-C or OPT-RAMP-CE card. Refer to the *Cisco ONS 15454 DWDM Troubleshooting Guide* for LOS-R troubleshooting procedures.
3. On the OPT-RAMP-C or OPT-RAMP-CE card, the LOS-R alarm triggers a command to shut down the Raman pump on Node A.

4. On Node B, the RAMAN-RX port detects an LOS-R alarm.
5. The LOS-R alarm triggers a command to shut down the Raman pump on Node B.
6. Simultaneously, an LOS alarm is detected on Node B, LINE-RX port.
7. The LOS alarm triggers a command to shut down the embedded EDFA.
8. The LINE-RX port detects a LOS alarm and causes the booster amplifier to shut down.
9. On Node A, the LINE-RX port detects a LOS alarm and triggers a command to shut down the embedded EDFA and then the Booster amplifier.

Automatic Laser Restart (ALR) on the Raman pump is detected as soon as the fiber is restored. This turns both the Raman pumps to ON state, on both nodes. When power on the Raman pump is restored, it turns on the embedded EDFA also. The booster amplifiers on both Node A and Node B detects power on LINE-RX port. This restarts the booster amplifier. Once the APR cycle is completed, all the lasers move to full power.

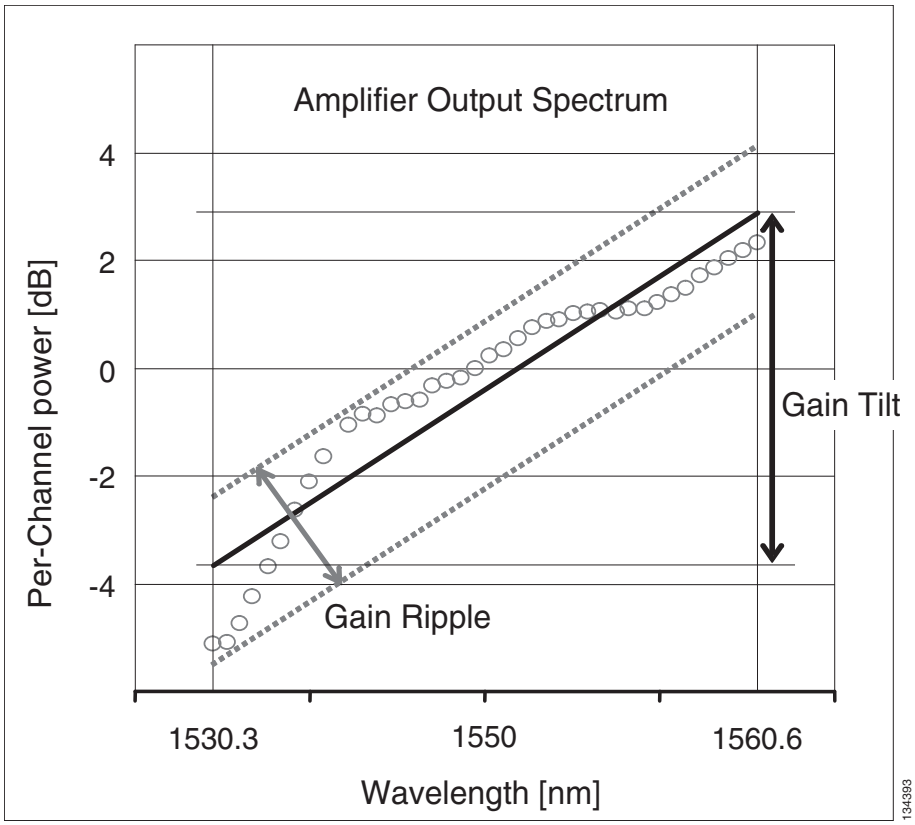
Note During a laser restart pulse, APR ensures that the laser power does not exceed Class 1 limits. See the "12.11.2 Automatic Power Reduction" section on page 12-28 for more information about APR.

12.12 Network-Level Gain—Tilt Management of Optical Amplifiers

The ability to control and adjust per channel optical power equalization is a principal feature of ONS 15454 DWDM metro core network applications. A critical parameter to assure optical spectrum equalization throughout the DWDM system is the gain flatness of erbium-doped fiber amplifiers (EDFAs).

Two items, gain tilt and gain ripple, are factors in the power equalization of optical amplifier cards such as the OPT-BST and OPT-PRE. Figure 12-31 shows a graph of the amplifier output power spectrum and how it is affected by gain tilt and gain ripple.

Figure 12-31 Effect of Gain Ripple and Gain Tilt on Amplifier Output Power



Gain ripple and gain tilt are defined as follows:

- Gain ripple is random and depends on the spectral shape of the amplifier optical components.
- Gain tilt is systematic and depends on the gain setpoint (Gstp) of the optical amplifier, which is a mathematical function F(Gstp) that relates to the internal amplifier design.

Gain tilt is the only contribution to the power spectrum disequalization that can be compensated at the card level. A VOA internal to the amplifier can be used to compensate for gain tilt.

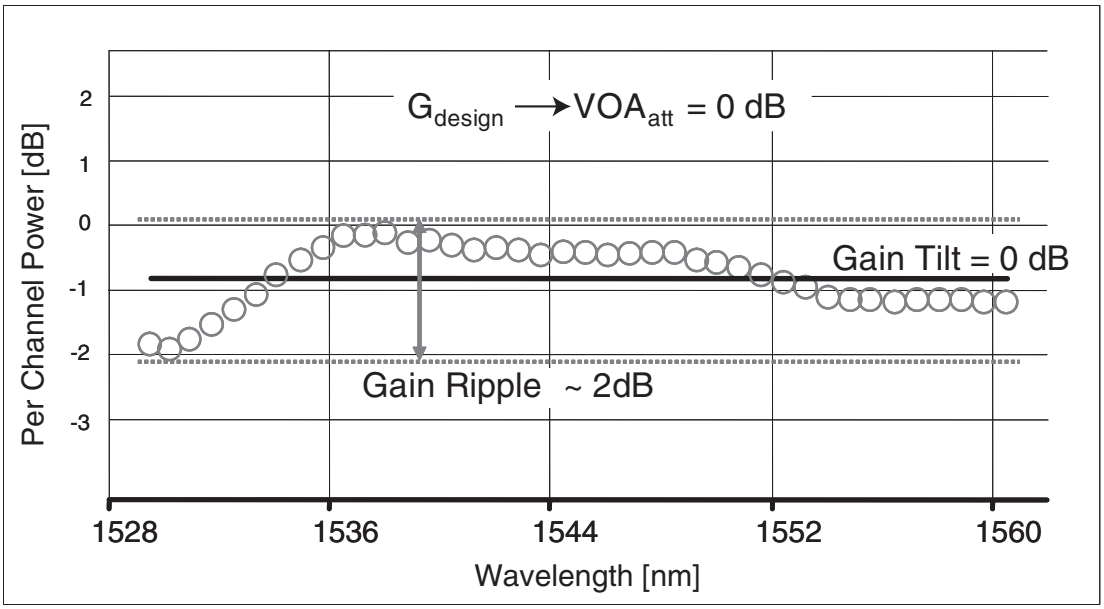
An optical spectrum analyzer (OSA) is used to acquire the output power spectrum of an amplifier. The OSA shows the peak-to-peak difference between the maximum and minimum power levels, and takes into account the contributions of both gain tilt and gain ripple.

Note Peak-to-peak power acquisition using an OSA cannot be used to measure the gain tilt, because gain ripple itself is a component of the actual measurement.

12.12.1 Gain Tilt Control at the Card Level

The OPT-BST and OPT-PRE amplifier cards have a flat output (gain tilt = 0 dB) for only a specific gain value (Gdesign), based on the internal optical design (see Figure 12-32).

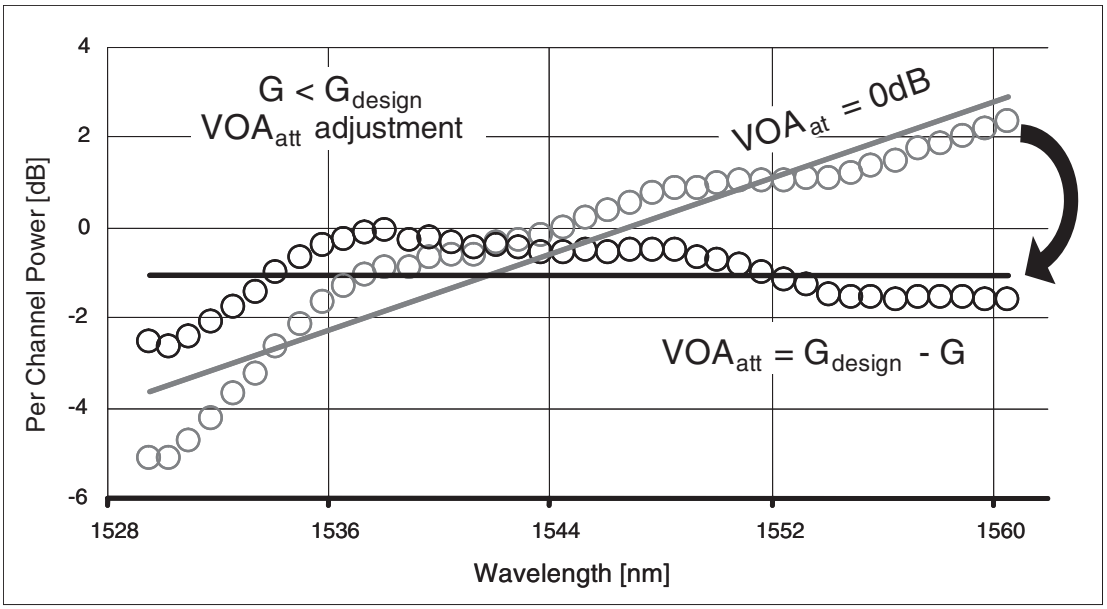
Figure 12-32 Flat Gain (Gain Tilt = 0 dB)



If the working gain setpoint of the amplifier is different from Gdesign, the output spectrum begins to suffer a gain tilt variation.

In order to compensate for the absolute value of the increase of the spectrum tilt, the OPT-BST and OPT-PRE cards automatically adjust the attenuation of the VOA to maintain a flat power profile at the output, as shown in Figure 12-33.

Figure 12-33 Effect of VOA Attenuation on Gain Tilt



The VOA attenuator automatic regulation guarantees (within limits) a zero tilt condition in the EDFA for a wide range of possible gain setpoint values.

Table 12-2 shows the flat output gain range limits for the OPT-BST and OPT-PRE cards, as well as the maximum (worst case) values of gain tilt and gain ripple expected in the specific gain range.

Table 12-2 Flat Output Gain Range Limits

Amplifier Card Type	Flat Output Gain Range	Gain Tilt (Maximum)	Gain Ripple (Maximum)
OPT-BST	G < 20 dB	0.5 dB	1.5 dB
OPT-PRE	G < 21 dB	0.5 dB	1.5 dB

If the operating gain value is outside of the range shown in Table 12-2, the EDFA introduces a tilt contribution for which the card itself cannot directly compensate. This condition is managed in different ways, depending the amplifier card type:

- OPT-BST—The OPT-BST amplifier is, by design, not allowed to work outside the zero tilt range. Cisco TransportPlanner network designs use the OPT-BST amplifier card only when the gain is less than or equal to 20 dB.
- OPT-PRE—Cisco TransportPlanner allows network designs even if the operating gain value is equal to or greater than 21 dB. In this case, a system-level tilt compensation strategy is adopted by the DWDM system. A more detailed explanation is given in 12.12.2 System Level Gain Tilt Control, page 12-43.

12.12.2 System Level Gain Tilt Control

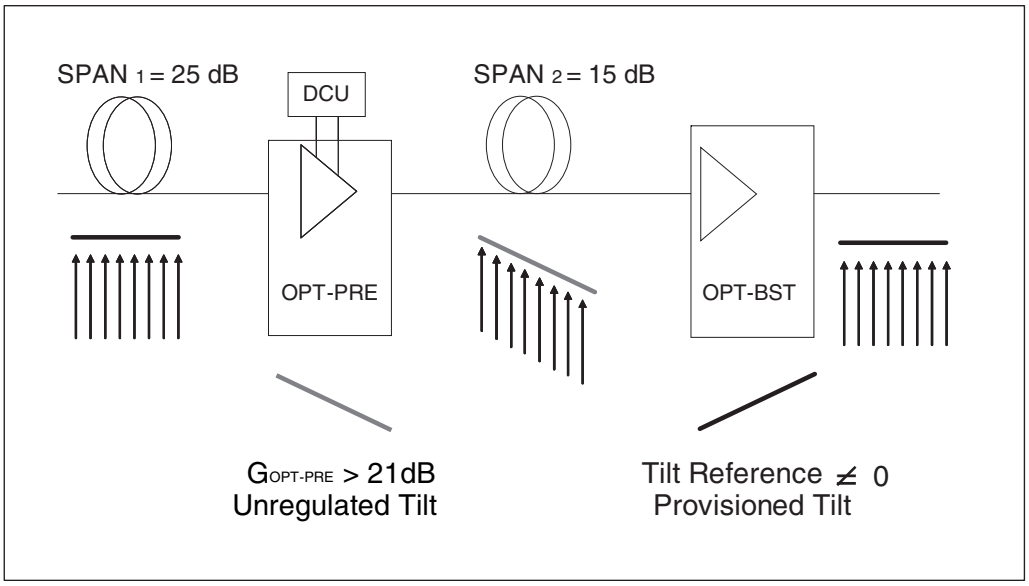
System level gain tilt control for OPT-PRE cards is achievable with two main scenarios:

- Without an ROADM node
- With an ROADM node

12.12.2.1 System Gain Tilt Compensation Without ROADM Nodes

When an OPT-PRE card along a specific line direction (Side A-to-Side B or Side B-to-Side A) is working outside the flat output gain range (G > 21 dB), the unregulated tilt is compensated for in spans that are not connected to ROADM nodes by configuring an equal but opposite tilt on one or more of the amplifiers in the downstream direction. The number of downstream amplifiers involved depends on the amount of tilt compensation needed and the gain setpoint of the amplifiers that are involved. See Figure 12-34.

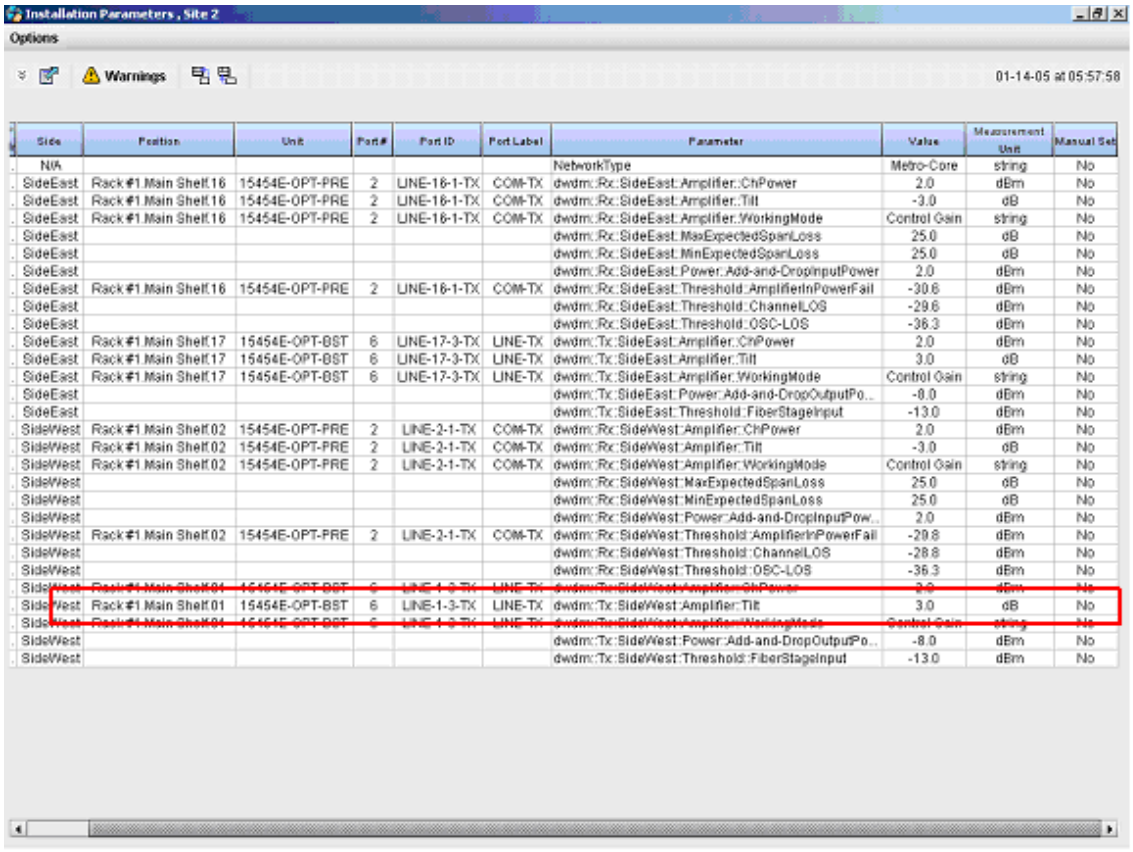
Figure 12-34 System Tilt Compensation Without an ROADM Node



The proper Tilt Reference value is calculated by Cisco TransportPlanner and inserted in the Installation Parameter List imported during the node turn-up process (see the "Turn Up a Node" chapter in the *Cisco ONS 15454 DWDM Procedure Guide*). For both OPT-PRE and OPT-BST cards, the provisionable Gain Tilt Reference range is between –3 dB and +3 dB.

During the ANS procedure, the Tilt value for the OPT-BST or OPT-PRE card is provisioned by the TCC2/TCC2P/TCC3/TNC/TSC card (see Figure 12-35). The provisioned Tilt Reference Value is reported in the CTC OPT-PRE or OPT-BST card view (in the Provisioning > Opt. Ampli. Line > Parameters > Tilt Reference tab).

Figure 12-35 Cisco TransportPlanner Installation Parameters



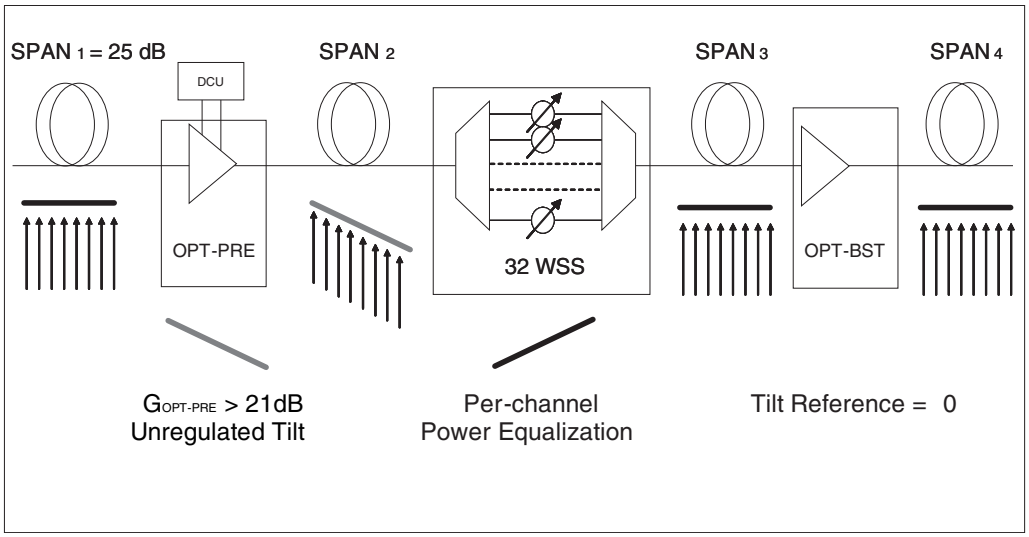
Side	Position	Unit	Port#	Port ID	Port Label	Parameter	Value	Measurement Unit	Manual Set
N/A						NetworkType	Metro-Core	string	No
SideEast	Rack #1 Main Shelf.16	15454E-OPT-PRE	2	LINE-16-1-TX	COM-TX	dwdm::Rx::SideEast::Amplifier::ChPower	2.0	dBm	No
SideEast	Rack #1 Main Shelf.16	15454E-OPT-PRE	2	LINE-16-1-TX	COM-TX	dwdm::Rx::SideEast::Amplifier::Tilt	-3.0	dB	No
SideEast	Rack #1 Main Shelf.16	15454E-OPT-PRE	2	LINE-16-1-TX	COM-TX	dwdm::Rx::SideEast::Amplifier::WorkingMode	Control Gain	string	No
SideEast						dwdm::Rx::SideEast::MaxExpectedSpanLoss	25.0	dB	No
SideEast						dwdm::Rx::SideEast::MinExpectedSpanLoss	25.0	dB	No
SideEast						dwdm::Rx::SideEast::Power::Add-and-DropInputPower	2.0	dBm	No
SideEast	Rack #1 Main Shelf.16	15454E-OPT-PRE	2	LINE-16-1-TX	COM-TX	dwdm::Rx::SideEast::Threshold::AmplifierInPowerFail	-30.6	dBm	No
SideEast						dwdm::Rx::SideEast::Threshold::ChannelLOS	-29.6	dBm	No
SideEast						dwdm::Rx::SideEast::Threshold::OSC-LOS	-36.3	dBm	No
SideEast	Rack #1 Main Shelf.17	15454E-OPT-BST	6	LINE-17-3-TX	LINE-TX	dwdm::Tx::SideEast::Amplifier::ChPower	2.0	dBm	No
SideEast	Rack #1 Main Shelf.17	15454E-OPT-BST	6	LINE-17-3-TX	LINE-TX	dwdm::Tx::SideEast::Amplifier::Tilt	3.0	dB	No
SideEast	Rack #1 Main Shelf.17	15454E-OPT-BST	6	LINE-17-3-TX	LINE-TX	dwdm::Tx::SideEast::Amplifier::WorkingMode	Control Gain	string	No
SideEast						dwdm::Tx::SideEast::Power::Add-and-DropOutputPo...	-8.0	dBm	No
SideEast						dwdm::Tx::SideEast::Threshold::FiberStageInput	-13.0	dBm	No
SideWest	Rack #1 Main Shelf.02	15454E-OPT-PRE	2	LINE-2-1-TX	COM-TX	dwdm::Rx::SideWest::Amplifier::ChPower	2.0	dBm	No
SideWest	Rack #1 Main Shelf.02	15454E-OPT-PRE	2	LINE-2-1-TX	COM-TX	dwdm::Rx::SideWest::Amplifier::Tilt	-3.0	dB	No
SideWest	Rack #1 Main Shelf.02	15454E-OPT-PRE	2	LINE-2-1-TX	COM-TX	dwdm::Rx::SideWest::Amplifier::WorkingMode	Control Gain	string	No
SideWest						dwdm::Rx::SideWest::MaxExpectedSpanLoss	25.0	dB	No
SideWest						dwdm::Rx::SideWest::MinExpectedSpanLoss	25.0	dB	No
SideWest						dwdm::Rx::SideWest::Power::Add-and-DropInputPow...	2.0	dBm	No
SideWest	Rack #1 Main Shelf.02	15454E-OPT-PRE	2	LINE-2-1-TX	COM-TX	dwdm::Rx::SideWest::Threshold::AmplifierInPowerFail	-29.8	dBm	No
SideWest						dwdm::Rx::SideWest::Threshold::ChannelLOS	-28.8	dBm	No
SideWest						dwdm::Rx::SideWest::Threshold::OSC-LOS	-36.3	dBm	No
SideWest	Rack #1 Main Shelf.01	15454E-OPT-BST	6	LINE-1-3-TX	LINE-TX	dwdm::Tx::SideWest::Amplifier::ChPower	2.0	dBm	No
SideWest	Rack #1 Main Shelf.01	15454E-OPT-BST	6	LINE-1-3-TX	LINE-TX	dwdm::Tx::SideWest::Amplifier::Tilt	3.0	dB	No
SideWest	Rack #1 Main Shelf.01	15454E-OPT-BST	6	LINE-1-3-TX	LINE-TX	dwdm::Tx::SideWest::Amplifier::WorkingMode	Control Gain	string	No
SideWest						dwdm::Tx::SideWest::Power::Add-and-DropOutputPo...	-8.0	dBm	No
SideWest						dwdm::Tx::SideWest::Threshold::FiberStageInput	-13.0	dBm	No

12.12.2.2 System Gain Tilt Compensation With ROADM Nodes

When a ROADM node is present in the network, as shown in Figure 12-36, a per channel dynamic gain equalization can be performed. Both gain tilt and gain ripple are completely compensated using the following techniques:

- Implementing the per channel VOAs present inside the 32WSS card
- Operating in Power Control Mode with the specific power setpoint designed by Cisco TransportPlanner

Figure 12-36 System Tilt Compensation With an ROADM Node



12.13 Optical Data Rate Derivations

This section discusses the derivation of several data rates commonly used in optical networking.

12.13.1 OC-192/STM-64 Data Rate (9.95328 Gbps)

The SONET OC-1 rate is 51.84 Mbps. This rate results from a standard SONET frame, which consists of 9 rows of 90 columns of 8-bit bytes (810 bytes total). The transmission rate is 8000 frames per second (125 microseconds per frame). This works out to 51.84 Mbps, as follows:

(9) x (90 bytes/frame) x (8 bits/byte) x (8000 frames/sec) = 51.84 Mbps

OC-192 is 192 x 51.84 Mbps = 9953.28 Mbps = 9.95328 Gbps

STM-64 is an SDH rate that is equivalent to the SONET OC-192 data rate.

12.13.2 10GE Data Rate (10.3125 Gbps)

10.3125 Gbps is the standard 10 Gbps Ethernet LAN rate. The reason the rate is higher than 10.000 Gbps is due to the 64-bit to 66-bit data encoding. The result is 10 Gbps x 66/64 = 10.3125 Gbps. The reason for 64-bit to 66-bit encoding is to ensure that there are adequate data transitions to ensure proper operation of a clock and data recovery circuit at the far end. Additionally, the encoding assures a data stream that is DC balanced.

12.13.3 10G FC Data Rate (10.51875 Gbps)

The Fibre Channel rate is based on the OC-192 rate of 9.95328 Gbps, with the addition of 64-bit to 66-bit encoding and WAN Interconnect Sublayer (WIS) overhead bytes.

The rate is derived from the basic 9.95328 Gbps OC-192 rate. First, it has the 64-bit to 66-bit encoding added, which brings it to the 10.3125 Gbps rate (10 Gbps x 66/64 = 10.3125 Gbps). Beyond that, the WIS overhead is added, which is an additional two percent on top of the 10.3125 Gbps. This yields:

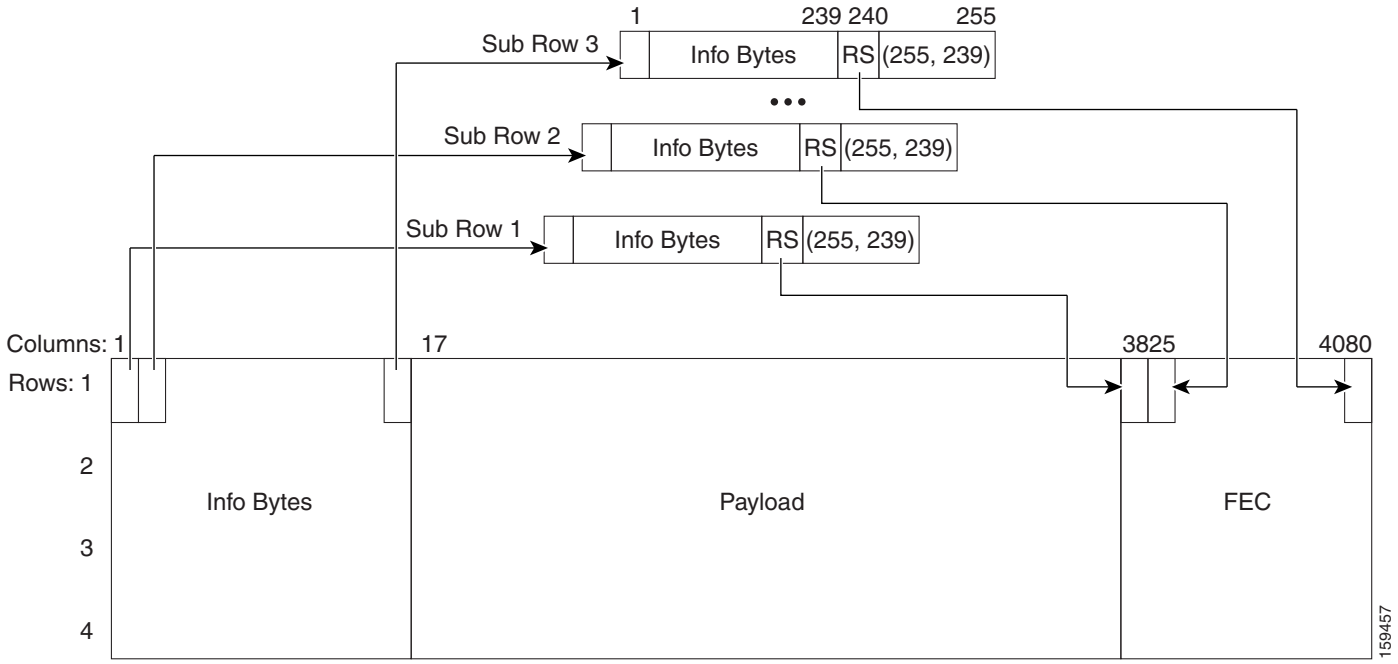
10.3125 Gbps x .02 = 0.20625 Gbps

10.3125 Gbps + 0.20625 Gbps = 10.51875 Gbps

12.13.4 ITU-T G.709 Optical Data Rates

To understand optical networking data rates, an understanding of the ITU-T G.709 frame structure, shown in Figure 12-37, is needed.

Figure 12-37 ITU-T G.709 Frame Structure



Each of the sub-rows in Figure 12-37 contains 255 bytes. Sixteen are interleaved horizontally (16 x 255 = 4080). This is repeated four times to make up the complete ITU-T G.709 frame.

The Reed Solomon (RS) (255,239) designation indicates the forward error correction (FEC) bytes. There are 16 FEC, or parity, bytes. The ITU-T G.709 protocol uses one overhead byte and 238 data bytes to compute 16 parity bytes to form 255 byte blocks—the RS (255,239) algorithm. Interleaving the information provides two key advantages. First, the encoding rate of each stream is reduced relative to the line transmission rate and, second, it reduces the sensitivity to bursts of error. The interleaving combined with the inherent correction strength of the RS (255,239) algorithm enables the correction of transmission bursts of up to 128 consecutive errored bytes. As a result, the ITU-T G.709 contiguous burst error correcting capability is enhanced 16 times above the capacity of the RS(255,239) algorithm by itself.

ITU-T G.709 defines the Optical Transport Unit 2 (OTU2) rate as 10.70923 Gbps. ITU-T G.709 defines three line rates:

1. 2,666,057.143 kbps—Optical Transport Unit 1 (OTU1)

2. 10,709,225.316 kbps—Optical Transport Unit 2 (OTU2)
3. 43,018,413.559 kbps—Optical Transport Unit 3 (OTU3)

The OTU2 rate is higher than OC-192 because the OTU2 has to carry overhead and FEC bytes in its frame; the bits must be sent faster to carry the payload information at the OC-192 rate.

The ITU-T G.709 frame has two parts. Two are similar to a SDH/SONET frame:

1. Overhead area for operation, administration, and maintenance functions
2. Payload area for customer data

In addition, the ITU-T G.709 frame also includes FEC bytes.

12.13.4.1 OC-192 Packaged Into OTU2 G.709 Frame Data Rate (10.70923 Gbps)

In this case, an OC-192 frame is being transported over a OTU2 G.709 frame, which adds the benefit of FEC. The OC-192 data rate (9.95328 Gbps) must increase in order to transport more bytes (OC-192 plus ITU-T G.709 overhead plus ITU-T G.709 FEC bytes) in the same amount of time. In an OTU2 transmission, 237 of the 255 bytes are OC-192 payload. This means the resultant data rate is:

9.95328 x 255/237 = 10.70923 Gbps

12.13.4.2 10GE Packaged Into OTU2 G.709 Frame Data Rate (Nonstandard 11.0957 Gbps)

Encapsulating Ethernet data into an OTU2 G.709 frame is considered nonstandard. The goal is to add the benefit of ITU-T G.709 encapsulation to achieve better burst error performance. However, this means adding overhead and FEC bytes, so more bytes must be transmitted in the same amount of time, so the data rate must increase. The new date rate is:

10.3215 x 255/237 = 11.0957 Gbps

12.13.4.3 10G FC Packaged Into OTU2 G.709 Frame Data Rate (Nonstandard 11.31764 Gbps)

Encapsulating Fibre Channel in an OTU2 frame is considered nonstandard. The rate is higher than the 10.51875 rate because OTU2 includes FEC bytes. The bits must run at a faster rate so that the payload is provided at the standard Fibre Channel rate. The rate is:

10.51875 x 255/237 = 11.31764 Gbps

12.14 Even Band Management

With the introduction of the following cards, it is now possible to transport 72, 80, 104, or 112 wavelength channels in the same network:

- 40-WSS-CE (40-channel Wavelength Selective Switch, C-band, even channels)
- 40-DMX-CE (40-channel Demultiplexer, C-band, even channels)

By using these new cards along with the 40-WSS-C and 40-DMX-C cards (which handle 40 C-band odd channels), the 32WSS and 32DMX cards (which handle 32 C-band odd channels), and the 32WSS-L and 32DMX-L (which handle 32 L-band odd channels), it is possible to cover 80 C-band channels (40 even and 40 odd channels) and 32 L-band odd channels, for a maximum of 112 channels. The following channel coverage combinations are possible:

- 72 C-band channels, using the 32WSS, 32DMX, 40-WSS-CE, and 40-DMX-CE cards

- 80 C-band channels, using the 40-WSS-C, 40-DMX-C, 40-WSS-CE, and 40-DMX-CE cards
- 104 channels (32 L-band odd channels and 72 C-band channels), using the 32WSS-L and 32DMX-L cards as a set to cover 32 L-band odd channels and the 32WSS, 32DMX, 40-WSS-CE, and 40-DMX-CE cards as a set to cover 72 C-band odd and even channels
- 112 channels (32 L-band odd channels and 80 C-band even channels), using the 32WSS-L and 32DMX-L cards as a set to cover 32 L-band odd channels and the 40-WSS-C, 40-DMX-C, 40-WSS-CE, and 40-DMX-CE, cards as a set to cover 80 C-band odd and even channels

The following node topologies are available for even channel management or odd-plus-even channel management:

- Terminal node
- Hub node
- ROADM node
- OSC regeneration and optical line amplification node

The external ONS 15216-ID-50 module is a 50 GHz/100GHz optical interleaver/deinterleaver that is required to combine or separate odd and even C-band channels. This module increases capacity by combining two optical data streams into a single, more densely spaced stream. The module can be used in multiplexer mode to combine two 100-GHz optical signal streams into one 50-GHz stream, and in demultiplexer mode to separate the 50-GHz stream into two 100-GHz streams.

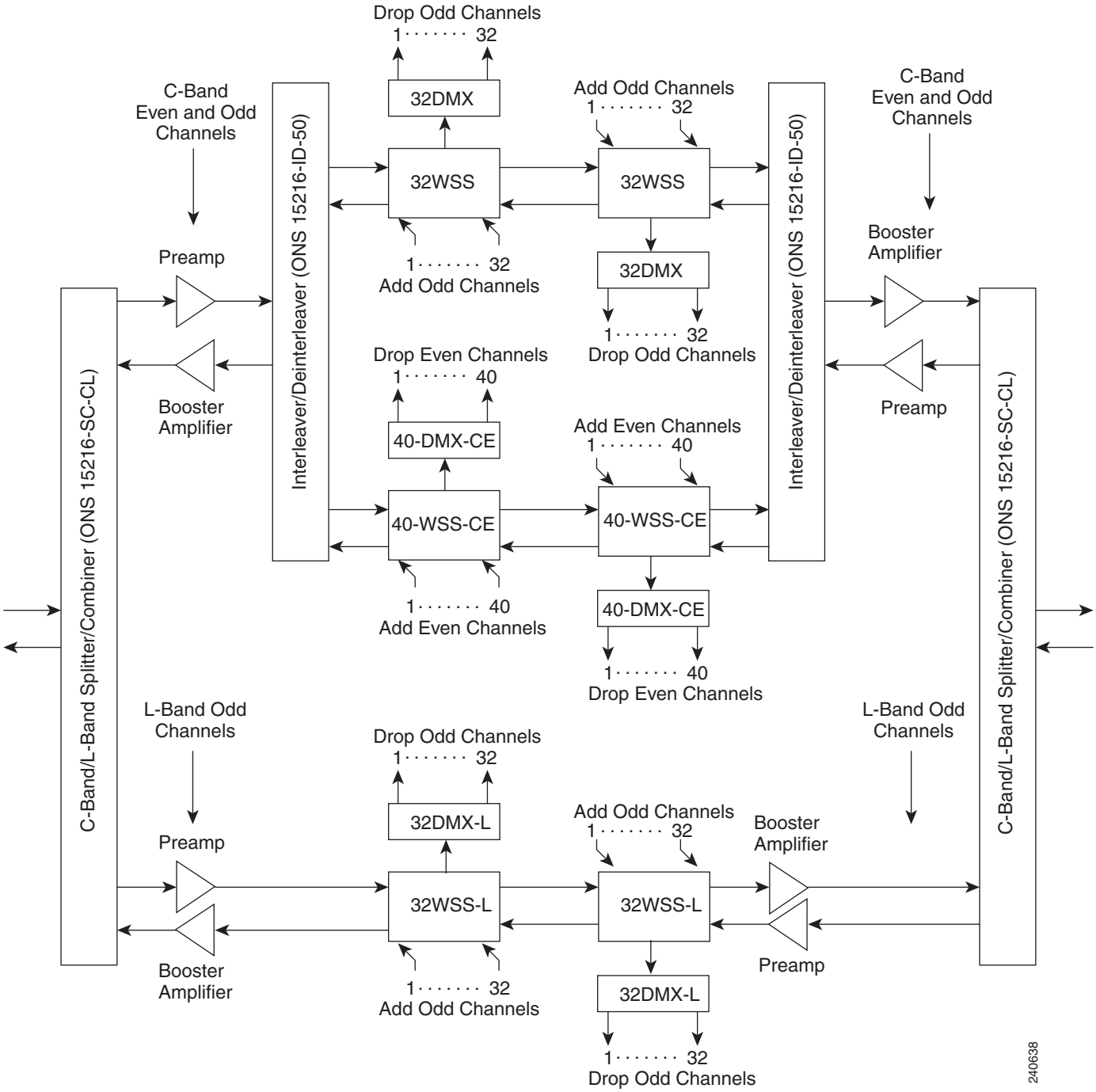
The ONS 15216-SC-CL module is an external C-band and L-band splitter/combiner module that combines and separates the C-band odd/even channels and the L-band odd channels.

An example of a 104-channel C-band plus L-band ROADM node is shown in Figure 12-38 on page 12-50. There are 72 C-band even channels and 32 L-band odd channels. The signal flow from the left side of the diagram to the right side is given in the following steps. The signal flow from the right side to the left is identical.

1. All the C-band and L-band signals enter the ONS 15216-SC-CL.
2. When the signals exit the ONS 15216-SC-CL, the 72 C-band even and odd channel signals are sent to the upper set of blocks and the 32 L-band odd channel signals are sent to the lower set of blocks.
3. The 72 C-band even and odd channel signals pass through a preamplifier, then through an ONS 15261-ID-50 and wavelength selective switch (WSS). Only the channels to be dropped are sent to the demultiplexer (DMX) block. There are two such sets of blocks, one set for the 32 odd C-band channels, and one set for the 40 even C-band channels.
4. The 32 L-band odd channel signals pass through a preamplifier, then through two 32-channel wavelength selective switch (32WSS-L) cards. Only the channels to be dropped are sent to the 32-channel demultiplexer (32DMX-L) card.
5. At the upper set of blocks, the ONS 15261-ID-50 deinterleaves the 32 C-band odd channels from the 40 C-band even channels. The 32 C-band odd channels are routed through the top blocks (two 32WSS cards and one 32DMX card), while the 40 C-band even channels are routed through the lower blocks (two 40-WSS-CE cards and one 40-DMX-CE card).
6. When a signal enters a 32WSS-L or 40-WSS-CE card, it is split. Part of the signal (the channels that are to be dropped) goes to the32 DMX-L card or 40-DMX-CE card so that channels can be dropped for use by the client equipment. The other part of the signal goes to the next 32WSS-L card or 40_DMX-CE card, where the channels can be passed through or blocked, and channels can be added to the stream from the client equipment.

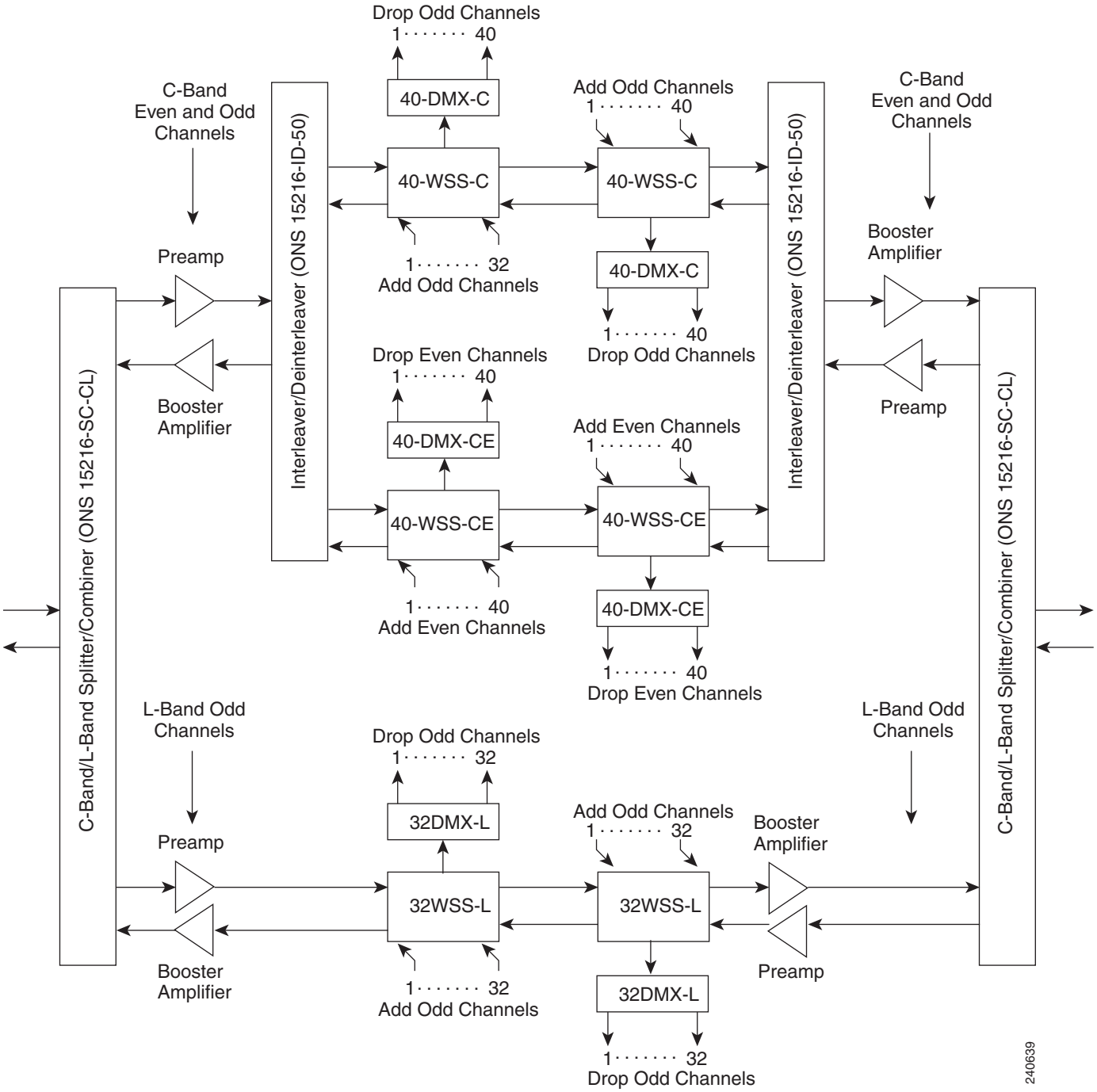
7. After the channels leave the last 32WSS-L card or 40-WSS-CE card, the C-band even and odd channels are interleaved back into a single stream by the ONS 15216-ID-50 module, sent through a booster amplifier, and then they enter the ONS 15216-SC-CL module, where they are combined with the L-band signals from the lower set of blocks and sent out onto the optical fiber.

Figure 12-38 104-Channel C-Band plus L-Band ROADM Node



An example of a 112-channel C-band plus L-band ROADM node is shown in Figure 12-39. It operates in a similar manner to the 104-channel ROADM node shown in Figure 12-38 on page 12-50, except that there are 40 odd C-band channels instead of 32.

Figure 12-39 112-Channel C-Band plus L-Band ROADM Node



12.15 Wavelength Drifted Channel Automatic Shutdown

The wavelength drifted channel automatic shutdown feature detects wavelength instability or wavelength drift in the Trunk-TX port of the card connected to an MSTP multiplexer. The channel photodiode or optical channel monitor (OCM) associated with a variable optical attenuator (VOA) is used to detect the power fluctuation.

The wavelength drifted channel automatic shutdown feature is supported on 40-SMR1-C, 40-SMR2-C, 80-WXC-C, 40-WXC-C, and 40-WSS-C cards. The 40-WSS and 40-WXC cards do not detect the power fluctuation on their ADD ports because the Add Photodiode is located before the filtering stage. The 40-SMR1-C, 40-SMR2-C, and 80-WXC-C cards have the OCM devices installed on the ADD port. The OCM device detects the wavelength sensitive signal so that an alarm is raised on the ADD port at the source node. The power fluctuation is detected on different ports for each card. Table 12-3 lists the ports on which the power fluctuation is detected:

Table 12-3 Detection of Power Fluctuation

Card	Port	Circuit
40-SMR1-C 40-SMR2-C	LINE-TX	ADD/DROP EXP/PT
80-WXC-C	COM-TX	ADD/DROP EXP/PT
40-WXC-C	COM-TX	ADD/DROP EXP/PT
40-WSS-C	CHAN-RX	ADD/DROP
	PT	PT

The detection mechanism leverages on the repeated crossing of the embedded OPT-PWR-DEG-LOW threshold value associated to the port. When the card exceeds the OPT-PWR-DEG-LOW threshold value 16 times in 24 hours, the WVL-DRIFT-CHAN-OFF alarm is raised.

For more information on severity level of the conditions and procedure to clear the alarms, refer to the *Cisco ONS 15454 DWDM Troubleshooting Guide*.

Note The automatic shutdown of a channel when the WVL-DRIFT-CHAN-OFF is raised will be implemented in later releases.

CHAPTER 13

Optical Channel Circuits and Virtual Patchcords Reference

This chapter explains the Cisco ONS 15454 dense wavelength division multiplexing (DWDM) optical channel (OCH) circuit types and virtual patchcords that can be provisioned on the ONS 15454. Circuit types include the OCH client connection (OCHCC), the OCH trail, and the OCH network connection (OCHNC). Virtual patchcords include internal patchcords and provisionable (external) patchcords (PPCs). This chapter also describes 13.3 End-to-End SVLAN Circuit that can be created between GE_XP, 10GE_XP, GE_XPE, or 10GE_XPE cards.

Note Unless otherwise specified, “ONS 15454" refers to both ANSI and ETSI shelf assemblies.

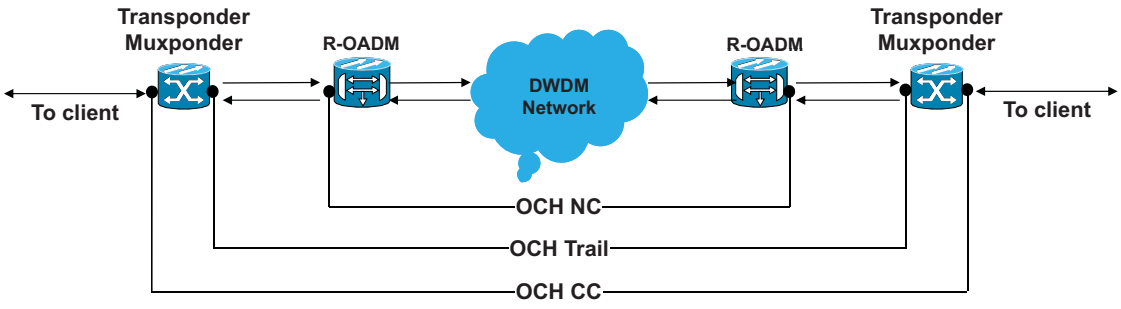
13.1 Optical Channel Circuits

The ONS 15454 DWDM optical circuits provide end-to-end connectivity using three OCH circuit types:

- Optical Channel Network Connections (OCHNC)
- Optical Channel Client Connections (OCHCC)
- Optical Channel Trails (OCH Trails)

A graphical representation of OCH circuits is shown in Figure 13-1.

Figure 13-1 Optical Channel Circuits



13.1.1 OCHNC Circuits

OCHNC circuits establish connectivity between two optical nodes on a specified C-band wavelength. The connection is made through the ports present on the wavelength selective switches, multiplexers, demultiplexer, and add/drop cards. In an OCHNC circuit, the wavelength from a source OCH port ingresses to a DWDM system and then egresses from the DWDM system to the destination OCH port. The source and destination OCH port details are listed in Table 13-1.

Table 13-1 OCHNC Ports

Card	Source Ports	Destination Ports
32WSS 32WSS-L 40-WSS-C 40-WSS-CE	ADD-RX	—
32MUX-O 40-MUX-C	CHAN-RX	—
32DMX-O 32DMX 32DMX-L 40-DMX-C 40-DMX-CE	—	CHAN-TX
4MD AD-1C-xx.x AD-4C-xx.x	CHAN-RX	CHAN-TX
40-SMR1-C 40-SMR2-C	ADD-RX	DROP-TX
15216-MD-40-ODD 15216-MD-40-EVEN	CHAN-RX	CHAN-TX
15216-EF-40-ODD 15216-EF-40-EVEN	CHAN-RX	CHAN-TX
15216-MD-48-ODD 15216-MD-48-EVEN	CHAN-RX	CHAN-TX

Note When the 40-SMR1-C or 40-SMR2-C card operates along with the 15216-MD-40-ODD, 15216-EF-40-ODD, or 15216-MD-48-ODD (ONS 15216 40 or 48-channel mux/demux), the OCH ports on the patch panel are the endpoints of the OCHNC circuit.

When the 40-SMR1-C or 40-SMR2-C card operates along with the 40-MUX-C and 40-DMX-C cards, the endpoints of the OCHNC circuit are on the MUX/DMX cards.

13.1.2 OCHCC Circuits

OCHCC circuits extend the OCHNC to create an optical connection from the source client port to the destination client port of the TXP/MXP cards. An OCHCC circuit represents the actual end-to-end client service passing through the DWDM system.

Each OCHCC circuit is associated to a pair of client or trunk ports on the transponder (TXP), muxponder (MXP), GE_XP (in layer-1 DWDM mode), 10GE_XP (in layer-1 DWDM mode), or ITU-T line card.

The OCHCCs can manage splitter protection as a single protected circuit. However, for the Y-Cable protection, two OCHCC circuits and two protection groups are required.

13.1.3 OCH Trail Circuits

OCH trail circuits transport the OCHCCs. The OCH trail circuit creates an optical connection from the source trunk port to the destination trunk port of the Transponder (TXP), Muxponder (MXP), GE_XP, 10GE_XP, or ITU-T line card. The OCH trail represents the common connection between the two cards, over which all the client OCHCC circuits, SVLAN circuits or STS circuits are carried.

Once an OCHCC is created, a corresponding OCH Trail is automatically created. If the OCHCC is created between two TXP, MXP, GE_XP, or 10GE_XP cards, two circuits are created in the CTC. These are:

One OCHCC (at client port endpoints)

One OCH trail (at trunk port endpoints)

If the OCHCC is created between two TXPP or two MXPP cards, three circuits are created in the CTC. These are:

- One OCHCC (at client port endpoints)
- Two OCH Trails (at trunk port endpoints)
  One for the working and other for the protect trunk.

Note On a TXP, MXP, and GE_XP card (in layer 1 DWDM mode), additional OCHCC circuits are created over the same OCH trail.

Note On a TXP, MXP, GE_XP (in layer 1 DWDM mode), and 10GE_XP (in layer 1 DWDM mode) card, the OCH trail cannot be created independently, and is created along with the first OCHCC creation on the card. However, on a GE_XP card (in layer-2 DWDM mode), 10GE_XP card (in layer-2 DWDM mode), and ADM_10G card, an OCH trail can be created between the trunk ports for the upper layer circuits (SVLAN in GE_XP/10GE_XP and STS in ADM_10G). No OCHCC is supported in these cases.

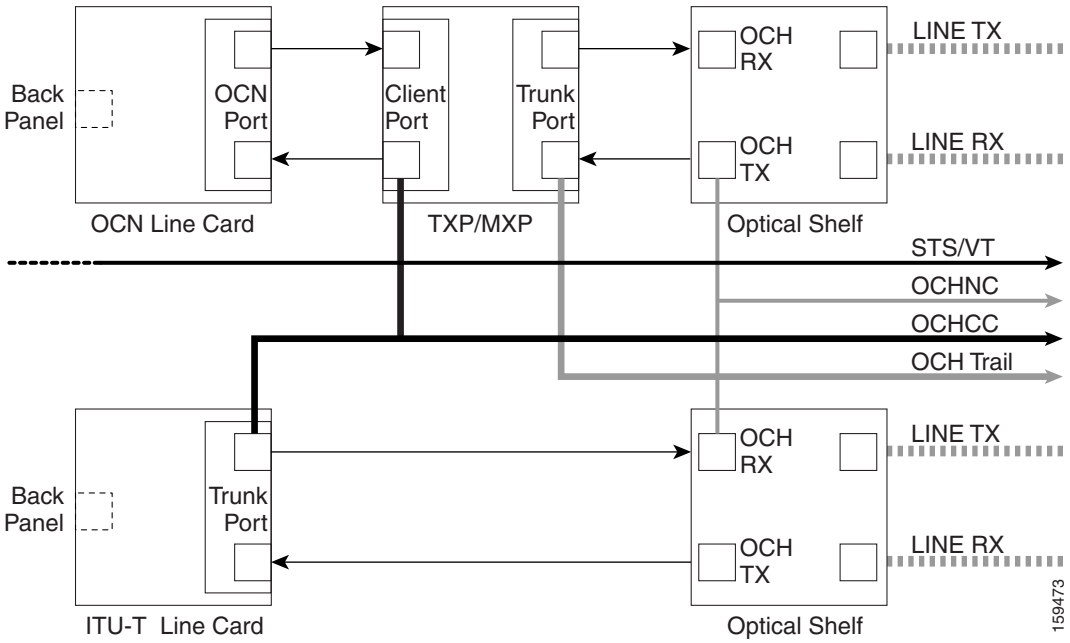
If the OCHCC is created between two ITU-T line cards, only one trunk port belongs to the OCHCC at each end of the circuit. Table 13-2 lists the ports that can be OCHCC and OCH trail endpoints.

Table 13-2 OCHCC and OCH Trail Ports

Card	OCHCC	OCH Trail
TXPs MXPs GE_XP 10GE_XP ADM-10G	Any client port	Any trunk port
ITU-T line cards: • OC48/STM64 EH • OC192 SR/STM64 • MRC-12 • MRC-2.5-12 • MRC-2.5G-4	Any trunk port	Any trunk port

Figure 13-2 shows the relationships and optical flow between the OCHCC, OCH trail, and OCHNC circuits.

Figure 13-2 Optical Channel Management



13.1.4 Administrative and Service States

OCHCCs, OCH trails, and OCHNCs occupy three different optical layers. Each OCH circuit has its own administrative and service states. The OCHCCs impose additional restrictions on changes that can be made to client card port administrative state.

The OCHCC service state is the sum of the OCHCC service state and the OCH trail service state. When creating an OCHCC circuit, you can specify an initial state for both the OCHCC and the OCH trail layers, including the source and destination port states. The ANSI/ETSI administrative states for the OCHCC circuits and connections are:

- IS/Unlocked
- IS,AINS/Unlocked,AutomaticInService
- OOS,DSBLD/Locked,disabled

OCHCC service states and source and destination port states can be changed independently. You can manually modify client card port states in all traffic conditions. Setting an OCHCC circuit to OOS,DSBLD/Locked,disabled state has no effect on OCHCC client card ports.

An OCH trail is created automatically when you create an OCHCC. OCH trails can be created independently between OCH-10G cards and GE_XP and 10GE_XP when they are provisioned in Layer 2 Over DWDM mode. The OCH trail ANSI/ETSI administrative states include:

- IS/Unlocked
- IS,AINS/Unlocked,automaticInService
- OOS,DSBLD/Locked,disabled

You can modify OCH trail circuit states from the Edit Circuit window. Placing an OCH trail OOS,DSBLD/Locked,disabled causes the following state changes:

- The state of the OCH trail ports changes to OOS,DSBLD/Locked,disabled.
- The OCHNC state changes to OOS,DSBLD/Locked,disabled.

Changing the OCH trail state to IS,AINS/Unlocked,automaticInService causes the following state changes:

- The state of the OCH trail trunk ports changes to IS/Unlocked.
- The OCHNC state changes to IS,AINS/Unlocked,automaticInService.

The OCH trail service state is the sum of the OCHCC trunk port state and the OCHNC (if applicable) state. Changing the client card trunk ports to OOS,DSBLD/Locked,disabled when the OCH trail state IS/Unlocked will cause the OCH trail state to change to OOS,DSBLD/Locked,disabled and its status to change to Partial.

The OCHNC circuit states are not linked to the OCHCC circuit states. The administrative states for the OCHNC circuit layer are:

- IS,AINS/Unlocked,AutomaticInService
- OOS,DSBLD/Locked,disabled

When you create an OCHNC, you can set the target OCHNC circuit state to IS/Unlocked or OOS,DSBLD/Locked,disabled. You can create an OCHNC even if OCHNC source and destination ports are OOS,MT/Locked,maintenance. The OCHNC circuit state will remain OOS-AU,AINS/Unlocked-disabled,automaticInService until the port maintenance state is removed. During maintenance or laser shutdown, the following behavior occurs:

- If OCHNCs or their end ports move into an AINS/AutomaticInService state because of user maintenance activity on an OCHCC circuit (for example, you change an optical transport section (OTS) port to OOS,DSBLD/Locked,disabled), Cisco Transport Controller (CTC) suppresses the loss of service (LOS) alarms on the TXP, MXP, GE_XP, 10GE_XP, or ITU-T line card trunk ports and raises a Trail Signal Fail condition. Line card trunk port alarms are not changed, however.
- If TXP client or trunk port are set to OOS,DSBLD/Locked,disabled state (for example, a laser is turned off) and the OCH trunk and OCH filter ports are located in the same node, the OCH filter LOS alarm is demoted by a Trail Signal Fail condition.

OCHCCs are associated with the client card end ports. Therefore, the following port parameters cannot be changed when they carry an OCHCC:

- Wavelength
- Service (or payload type)
- Splitter protection
- ITU-T G.709
- Forward error correction (FEC)
- Mapping

Certain OCHCC parameters, such as service type, service size, and OCHNC wavelength can only be modified by deleting and recreating the OCHCC. If the OCHCC has MXP end ports, you can modify services and parameters on client ports that are not allocated to the OCHCC. Some client port parameters, such as Ethernet frame size and distance extension, are not part of an OCHCC so they can be modified if not restricted by the port state. For addition information about administrative and service states, see Appendix B, “Administrative and Service States.”

13.1.5 Creating and Deleting OCHCCs

To create an OCHCC, you must know the client port states and their parameters. If the client port state is IS/Unlocked, OCHCC creation will fail if the OTN line parameters (ITU-T G.709, FEC, signal fail bit error rate (SF BER), and signal degrade bit error rate (SD BER) on the OCHCC differ from what is provisioned on the trunk port. The port state must be changed to OOS-DSLB/Locked,disabled in order to complete the OCHCC.

If you delete an OCHCC, you can specify the administrative state to apply to the client card ports. For example, you can have the ports placed in OOS,DSBLD/Locked,disabled state after an OCHCC is deleted. If you delete an OCHCC that originates and terminates on MXP cards, the MXP trunk port states can only be changed if the trunk ports do not carry other OCHCCs.

13.1.6 OCHCCs and Service and Communications Channels

Although optical service channels (OSCs), generic communications channels (GCCs), and data communications channels (DCCs) are not managed by OCHCCs, the following restrictions must be considered when creating or deleting OCHCCs on ports with service or communication channels:

- Creating an OCHCC when the port has a service or a communications channel is present—OCHCC creation will fail if the OCHCC parameters are incompatible with the GCC/DCC/GCC. For example, you cannot disable ITU-T G.709 on the OCHCC if a GCC carried by the port requires the parameter to be enabled.

- Creating a service or communications channel on ports with OCHCCs—OCHCC creation will fail if the GCC/DCC/GCC parameters are incompatible with the OCHCC.
- Deleting an OCHCC on ports with service or communications channels—If an OSC/GCC/DCC is present on a TXP, MXP, GE_XP, 20GE_XP, or ITU-T line card client or trunk port, you cannot set these ports to the OOS,DSBLD/Locked,disabled state after the OCHCC circuit is deleted.

13.2 Virtual Patchcords

The TXP, MXP, TXPP, MXPP, GE_XP, 10GE_XP, and ADM-10G client ports and DWDM filter ports can be located in different nodes or in the same single-shelf or multishelf node. ITU-T line card trunk ports and the corresponding DWDM filter ports are usually located in different nodes.

OCHCC provisioning requires a virtual patchcord between the client card trunk ports and the DWDM filter ports. Depending on the physical layout, this can be an internal patchcord or a provisionable (external) patchcord (PPC). Both patchcord types are bidirectional. However, each direction is managed as a separate patchcord.

Internal patchcords provide virtual links between the two sides of a DWDM shelf, either in single-shelf or multishelf mode. They are viewed and managed in the Provisioning > WDM-ANS > Internal Patchcords tab.

When the NE update file is imported in CTC, the Provisioning > WDM-ANS > Internal Patchcord tab is populated with the internal patchcords. When you create an internal patchcord manually, the Internal Patchcord Creation wizard prompts you to choose one of the following internal patchcord types:

- Trunk to Trunk (L2)—Creates an internal patchcord between two trunk ports (in NNI mode) of a GE_XP, 10GE_XP, GE_XPE, or 10GE_XPE card provisioned in the L2-over-DWDM mode.
- OCH-Trunk to OCH-Filter—Creates an internal patchcord between the trunk port of a TXP, MXP, GE_XP, 10GE_XP, or ITU-T line card, and an OCH filter card (wavelength selective switch, multiplexer, or demultiplexer).
- OCH-Filter to OCH-Filter—Creates an internal patchcord between a MUX input port and a DMX output port.
- OTS to OTS—Creates an internal patchcord between two OTS ports.
- Optical Path—Creates an internal patchcord between two optical cards, or between an optical card and a passive card.

Note If a Side-to-Side PPC is created between nodes, it will no longer function if the node Security Mode mode is enabled (see the "DLP-G264 Enable Node Security Mode" task in the *Cisco ONS 15454 DWDM Procedure Guide*). When the Secure mode is enabled, it is no longer possible for the DCN extension feature to use the LAN interface to extend the internal network (due to the network isolation in this configuration mode). The result is that the topology discovery on the Side-to-Side PPC no longer operates.

Table 13-3 shows the internal patchcord Trunk (L2), OCH trunk, OCH filter, and OTS/OCH ports.

Table 13-3 Internal Patchcord Ports

Card	Trunk (L2) Port	OCH Trunk Ports	OCH Filter Ports	OTS/OCH Ports
GE_XP 10GE_XP GE_XPE 10GE_XPE	Trunk port in NNI mode	Any trunk port	—	—
TXPs MXPs ADM-10G ITU-T line cards	—	Any trunk port	—	—
OPT-BST OPT-BST-E OPT-BST-L	—	—	—	COM-TX COM-RX OSC-TX OSC-RX
OPT-AMP-17-C OPT-AMP-L	—	—	—	COM-TX COM-RX OSC-TX[1] OSC-RX[1] DC-TX[1] DC-RX[1]
OPT-PRE	—	—	—	COM-TX COM-RX DC-TX DC-RX
OSCM OSC-CSM	—	—	—	COM-TX COM-RX OSC-TX OSC-RX
32MUX 32MUX-O 40-MUX-C	—	—	Any CHAN RX port	COM-TX
32DMX 32DMX-L 32DMX-O 40-DMX-C 40-DMX-CE	—	—	Any CHAN TX port	COM-RX

Table 13-3 Internal Patchcord Ports (continued)

Card	Trunk (L2) Port	OCH Trunk Ports	OCH Filter Ports	OTS/OCH Ports
32WSS 32WSS-L 40-WSS-C 40-WSS-CE	—	—	Any ADD port	COM-TX COM-RX EXP-TX EXP-RX DROP-TX
40-WXC-C	—	—	—	ADD-RX DROP-TX COM TX COM RX
80-WXC-C	—	—	—	EAD *i*, *i*=1 to 8 AD COM COM-RX DROP-TX EXP-TX
MMU	—	—	—	EXP A TX EXP A RX
40-SMR2-C	—	—	—	ADD-RX DROP-RX EXP-TX EXPi-RX
40-SMR1-C	—	—	—	ADD-RX DROP-RX EXP-TX EXP-RX LINE-RX LINE-TX
TDC-CC TDC-FC	—	—	—	DC-RX DC-TX
XT-40G XM-40G	—	Any trunk port	—	—
PASSIVE-MD-40-ODD PASSIVE-MD-40-EVEN	—	—	Any CHAN TX port	COM-RX COM-TX
PASSIVE-MD-ID-50 PASSIVE-15216-ID-50	—	—	—	COM-RX COM-TX

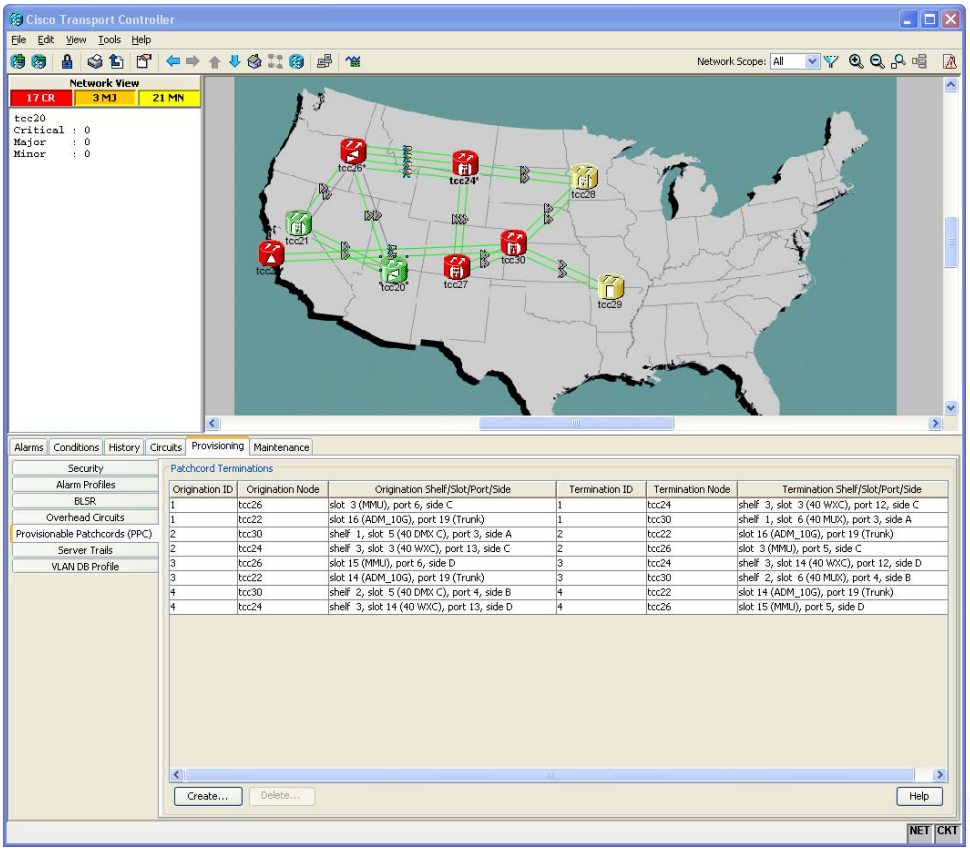
Table 13-3 Internal Patchcord Ports (continued)

Card	Trunk (L2) Port	OCH Trunk Ports	OCH Filter Ports	OTS/OCH Ports
PASSIVE-PP-4-SMR PASSIVE-PP-MESH-4 PASSIVE-PP-MESH-8	—	—	—	EXP-RX EXP-TX
PASSIVE_DCU	—	—	—	DC-RX DC-TX

1. When provisioned in OPT-PRE mode.

PPCs are created and managed from the network view Provisioning > Provisionable Patchcord (PPC) tab (Figure 13-3), or from the node view (single-shelf mode) or multiself view (multishelf mode) Provisioning > Comm Channel > PPC tab.

Figure 13-3 Network View Provisionable Patchcords Tab



PPCs are required when the TXP, MXP, GE_XP, 10GE_XP, ADM-10G, or ITU-T line card is installed in a different node than the OCH filter ports. They can also be used to create OTS-to-OTS links between shelves that do not have OSC connectivity. PPCs are routable and can be used to discover network topologies using Open Shortest Path First (OSPF). GCCs and DCCs are not required for PPC creation. When you create a PPC, the PPC Creation wizard asks you to choose one of the following PPC types:

- Client/Trunk to Client/Trunk (L2)—Creates a PPC between two client or trunk ports (in NNI mode) on GE_XP, 10GE_XP, GE_XPE, or 10GE_XPE cards provisioned in the L2-over-DWDM mode.
- Client/Trunk to Client/Trunk—Creates a PPC between two client or trunk ports on TXP, MXP, GE_XP, 10GE_XP, ADM_10G, or ITU-T line cards.
- Side to Side (OTS)—Creates a PPC between two OTS ports that belong to a Side. This option establishes data communications network (DCN) connectivity between nodes that do not have OSCM or OSC-CSM cards installed and therefore do not have OSC connectivity. CTC selects the OTS ports after you choose the origination and termination sides.
- OCH Trunk to OCH Filter—Creates a PPC between a OCH trunk port on a TXP, MXP, GE_XP, 10GE_XP, ADM-10G, or ITU-T line card and an OCH filter port on a multiplexer, demultiplexer, or wavelength selective switch card.

Table 13-4 shows the PPC Client/Trunk (L2), Client/Trunk, OTS, and OCH Filter ports.

Table 13-4 Provisionable Patchcord Ports

Card	Client/Trunk (L2) Port	Client/Trunk Port	OTS Port	OCH Filter Port
GE_XP 10GE_XP GE_XPE 10GE_XPE	Client or trunk port in NNI mode	Any trunk port	—	—
TXPs MXPs ADM-10G ITU-T line cards	—	Any trunk port	—	—
OPT-BST OPT-BST-E OPT-BST-L	—	—	COM RX[1] LINE RX LINE TX	—
OPT-AMP-17-C OPT-AMP-L	—	—	COM RX[2] COM TX[3] LINE RX[3] LINE TX[3]	—
OPT-PRE	—	—	COM RX[4] COM TX[4]	—
OSC-CSM	—	—	COM RX[1] LINE RX LINE TX	—
32MUX 32MUX-O 40-MUX-C	—	—	—	Any CHAN RX port

Table 13-4 Provisionable Patchcord Ports (continued)

Card	Client/Trunk (L2) Port	Client/Trunk Port	OTS Port	OCH Filter Port
32DMX 32DMX-L 32DMX-O 40-DMX-C 40-DMX-CE	—	—	—	Any CHAN TX port
32WSS 32WSS-L 40-WSS-C 40-WSS-CE	—	—	—	Any ADD port
40-WXC-C	—	—	COM RX COM TX	—
80-WXC-C	—	—	EAD *i*, *i*=1 to 8 AD COM COM-RX DROP-TX EXP-TX	—
40-SMR1-C 40-SMR2-C	—	—	LINE RX LINE TX	—
MMU	—	—	EXP A RX EXP A TX	—

1. Line nodes only.
2. When card mode is OPT-PRE.
3. When card mode is OPT-LINE.
4. Line nodes with two OPT-PRE cards and no BST cards installed.

13.2.1 PPC Provisioning Rules

For Client/Trunk to Client/Trunk (L2) PPCs, the following provisioning rules and conditions apply:

- The card must be provisioned in the L2-over-DWDM mode.
- The client or trunk ports must be in the NNI mode.
- PPCs can be created only between NNI ports of the same size (1GE-1GE or 10GE-10GE).

For Client/Trunk to Client/Trunk PPCs, the following provisioning rules and conditions apply:

- Patchcords can be created on preprovisioned or physically installed cards.
- Trunk-to-trunk connections require compatible wavelengths if the port is equipped. A check is automatically performed during patchcord provisioning to ensure wavelength compatibility of ports.

- For connections involving one or more preprovisioned ports, no compatibility check is performed.

For OCH Trunk to OCH Filter PPCs, the following provisioning rules and conditions apply:

- GCC and DCC links are not required to create a PPC.
- PPCs can be created for preprovisioned or physically installed cards.
- OCH trunk and OCH filter ports must be on the same wavelength. CTC checks the ports for wavelength compatibility automatically during PPC provisioning.
- For OC-48/STM-16 and OC-192/STM-64 ITU-T line cards, the wavelength compatibility check is performed only when the cards are installed. The check is not performed for preprovisioned cards.
- For all other preprovisioned cards, a wavelength compatibility check is not performed if card is set to first tunable wavelength. The wavelength is automatically provisioned on the port, according to the add/drop port that you chose when you created the PPC.

13.3 End-to-End SVLAN Circuit

An end-to-end SVLAN circuit can be created between GE_XP, 10GE_XP, GE_XPE, or 10GE_XPE cards through a wizard in CTC. SVLAN circuits created this way are only a snapshot of the SVLAN settings (NNI and QinQ) of each card in the network. If an end-to-end SVLAN circuit is created via CTC and the SVLAN settings of the cards are changed manually, CTC does not update the SVLAN circuit created with the new settings. To update the SVLAN circuit in CTC, the circuit must be refreshed.

However, any changes made to subtended OCH trail circuits are reflected in the SVLAN circuit in CTC. If an OCH trail becomes incomplete and the current SVLAN circuit snapshot has some SVLAN circuits that are using it, they remain incomplete. If the snapshot contains incomplete SVLAN circuits and an OCH trail circuit becomes available, the incomplete SVLAN circuit snapshot in CTC appears to be complete.

When the destination port of the SVLAN circuit facing the router is configured as a NNI client port, the outgoing ethernet packets do not drop the SVLAN tag when they exit the MSTP network allowing the router to determine the origin of the ethernet packet.

SVLAN circuits are stateless circuits; an administrative or service state need not be set.

Note During SVLAN provisioning, if a SVLAN circuit span using UNI ports in transparent mode is over subscribed, a warning message is displayed. However, the circuit is created. This is supported on channel groups on GE_XP, 10GE_XP, GE_XPE, or 10GE_XPE cards.

13.3.1 End-to-End SVLAN Provisioning Rules

The following provisioning rules and conditions apply to end-to-end SVLAN circuits:

- GE_XP, 10GE_XP, GE_XPE, and 10GE_XPE cards must be provisioned in L2-over-DWDM mode.
- SVLAN database must be loaded with the SVLAN.
- SVLAN circuits are routed through OCH trail circuits or PPC; Client/Trunk to Client/Trunk (L2). Therefore, before creating an SVLAN circuit, make sure that the subtended OCH trail circuits between GE_XP, 10GE_XP, GE_XPE, and 10GE_XPE cards or PPC links are created.
- For protected SVLAN circuits, create a ring (through OCH trail circuits), define a master node, and enable the protection role.

For information on how to create end-to-end SVLAN circuit, see the “NTP-G203 Create End to End SVLAN Circuits” procedure in the *Cisco ONS 15454 DWDM Procedure Guide.*

CHAPTER 14

Cisco Transport Controller Operation

This chapter describes operations of the Cisco Transport Controller (CTC), the software interface for Cisco ONS 15454, Cisco ONS 15454 M2, and Cisco ONS 15454 M6 shelf assemblies. For CTC setup and login information, refer to the *Cisco ONS 15454 DWDM Procedure Guide*.

Note Unless otherwise specified, ONS 15454, ONS 15454 M2, and ONS 15454 M6 refers to both ANSI and ETSI shelf assemblies.

Chapter topics include:

- 14.1 CTC Software Delivery Methods, page 14-1
- 14.2 CTC Installation Overview, page 14-2
- 14.3 PC and UNIX Workstation Requirements, page 14-3
- 14.4 ONS 15454 Connections, page 14-5
- 14.5 CTC Window, page 14-8
- 14.6 Using the CTC Launcher Application to Manage Multiple ONS Nodes, page 14-19
- 14.7 TCC2/TCC2P/TCC3/TNC/TSC Card Reset, page 14-22
- 14.8 TCC2/TCC2P/TCC3/TNC/TSC Card Database, page 14-23
- 14.9 Software Revert, page 14-23

14.1 CTC Software Delivery Methods

ONS 15454, ONS 15454 M2, and ONS 15454 M6 provisioning and administration is performed using the CTC software. CTC is a Java application that resides on the control cards: TCC2/TCC2P/TCC3/TNC/TSC. CTC is downloaded to your workstation the first time you log into 15454-DWDM, 15454-M2, or 15454-M6 shelf assemblies with a new software release using the web interface. You can also log into CTC using the CTC launcher application (StartCTC.exe). Refer to the "14.6 Using the CTC Launcher Application to Manage Multiple ONS Nodes" section on page 14-19 for more information.

14.1.1 CTC Software Installed on the TCC2/TCC2P/TCC3/TNC/TSC Card

The CTC software is preloaded on the TCC2/TCC2P/TCC3/TNC/TSC cards; therefore, you do not need to install software on these cards. When a new CTC software version is released, use the release-specific software upgrade document to upgrade the ONS 15454, 15454-M2, or 15454-M6 software on the TCC2/TCC2P/TCC3/TNC/TSC cards.

When you upgrade the CTC software, the control cards store the new CTC version as the protect CTC version. When you activate the new CTC software, the control cards store the older CTC version as the protect CTC version, and the newer CTC release becomes the working version. You can view the software versions that are installed on an ONS 15454, 15454-M2, or 15454-M6 shelf assemblies by selecting the Maintenance > Software tabs in node view (single-shelf mode) or multishelf view (multishelf mode).

Select the Maintenance > Software tabs in network view to display the software versions installed on all the network nodes.

14.1.2 CTC Software Installed on the PC or UNIX Workstation

CTC software is downloaded from the TCC2/TCC2P/TCC3/TNC/TSC cards and installed on your computer automatically after you connect to the ONS 15454, 15454-M2, or 15454-M6 with a new software release for the first time. Downloading the CTC software files automatically ensures that your computer is running the same CTC software version as the TCC2/TCC2P/TCC3/TNC/TSC cards you are accessing. The CTC files are stored in the temporary directory designated by your computer operating system. Click the **Delete CTC Cache** button to remove files stored in the temporary directory. If the files are deleted, they download the next time you connect to ONS 15454, 15454-M2, or 15454-M6. Downloading the Java archive (JAR) files for CTC takes several minutes depending on the bandwidth of the connection between your workstation and ONS 15454, 15454-M2, or 15454-M6. For example, JAR files downloaded from a modem or a data communications channel (DCC) network link require more time than JAR files downloaded over a LAN connection.

During network topology discovery, CTC polls each node in the network to determine which one contains the most recent version of the CTC software. If CTC discovers a node in the network that has a more recent version of the CTC software than the version you are currently running, CTC generates a message stating that a later version of the CTC has been found in the network and offers to install the CTC software upgrade. After the node view appears, you can upgrade CTC by using the **Tools > Update CTC** menu option. If you have network discovery disabled, CTC will not seek more recent versions of the software. Unreachable nodes are not included in the upgrade discovery.

Note Upgrading the CTC software will overwrite your existing software. You must restart CTC after the upgrade is complete.

14.2 CTC Installation Overview

To connect to ONS 15454, 15454-M2, or 15454-M6 using CTC, you enter the IP address in the URL field of Microsoft Internet Explorer. After connecting to ONS 15454, 15454-M2, or 15454-M6, the following occurs automatically:

1. A CTC launcher applet is downloaded from the TCC2/TCC2P/TCC3/TNC/TSC card to your computer.

2. The launcher determines whether your computer has a CTC release matching the release on the TCC2/TCC2P/TCC3/TNC/TSC card.
3. If the computer does not have CTC installed, or if the installed release is older than the TCC2/TCC2P/TCC3/TNC/TSC card's version, the launcher downloads the CTC program files from the TCC2/TCC2P/TCC3/TNC/TSC card.
4. The launcher starts CTC. The CTC session is separate from the web browser session, so the web browser is no longer needed. Always log into nodes having the latest software release. If you log into an ONS 15454, 15454-M2, or 15454-M6 that is connected with older versions of CTC, or to Cisco ONS 15327s or Cisco ONS 15600s, CTC files are downloaded automatically to enable you to interact with those nodes. The CTC file download occurs only when necessary, such as during your first login. You cannot interact with nodes on the network that have a software version later than the node that you used to launch CTC.

Each ONS 15454, 15454-M2, or 15454-M6 can handle up to five concurrent CTC sessions. CTC performance can vary, depending upon the volume of activity in each session, network bandwidth, and TCC2/TCC2P/TCC3/TNC/TSC card load.

Note You can also use TL1 commands to communicate with ONS 15454, 15454-M2, or 15454-M6 through VT100 terminals and VT100 emulation software, or you can telnet to ONS 15454, 15454-M2, or 15454-M6 using TL1 ports 2361 and 3083. Refer to the *Cisco ONS SONET TL1 Command Guide* or *Cisco ONS 15454 SDH and Cisco ONS 15600 SDH TL1 Command Guide* for a comprehensive list of TL1 commands.

14.3 PC and UNIX Workstation Requirements

To use CTC for ONS 15454, 15454-M2, or 15454-M6, your computer must have a web browser with the correct Java Runtime Environment (JRE) installed. The correct JRE for each CTC software release is included on the ONS 15454, 15454-M2, or 15454-M6 software CD. If you are running multiple CTC software releases on a network, the JRE installed on the computer must be compatible with the different software releases.

When you change the JRE version on the JRE tab, you must exit and restart CTC for the new JRE version to take effect. Table 14-1 shows JRE compatibility with ONS 15454 software releases.

Table 14-1 JRE Compatibility

ONS Software Release	JRE 1.2.2 Compatible	JRE 1.3 Compatible	JRE 1.4 Compatible	JRE 5.0 Compatible	JRE 1.6 Compatible
ONS 15454 Release 4.5	No	Yes	No	No	No
ONS 15454 Release 4.6	No	Yes	Yes	No	No
ONS 15454 Release 4.7	No	No	Yes	No	No
ONS 15454 Release 5.0	No	No	Yes	No	No
ONS 15454 Release 6.0	No	No	Yes	No	No
ONS 15454 Release 7.0	No	No	Yes	Yes	No
ONS 15454 Release 7.2	No	No	Yes	Yes	No
ONS 15454 Release 8.0	No	No	No	Yes	No
ONS 15454 Release 8.5	No	No	No	Yes	No

Table 14-1 JRE Compatibility (continued)

ONS Software Release	JRE 1.2.2 Compatible	JRE 1.3 Compatible	JRE 1.4 Compatible	JRE 5.0 Compatible	JRE 1.6 Compatible
ONS 15454 Release 9.0	No	No	No	Yes	No
ONS 15454 Release 9.1	No	No	No	Yes	No
ONS 15454 Release 9.2	No	No	No	No	Yes

Note To avoid network performance issues, Cisco recommends managing a maximum of 50 nodes concurrently with CTC. The 50 nodes can be on a single DCC or split across multiple DCCs. Cisco does not recommend running multiple CTC sessions when managing two or more large networks. To manage more than 50 nodes, Cisco recommends using Cisco Transport Manager (CTM). If you do use CTC to manage more than 50 nodes, you can improve performance by adjusting the heap size; see the "General Troubleshooting" chapter of the *Cisco ONS 15454 DWDM Troubleshooting Guide*. You can also create login node groups; see the "Connect the PC and Log Into the GUI" chapter of the *Cisco ONS 15454 DWDM Procedure Guide.*

Table 14-2 lists the requirements for PCs and UNIX workstations. In addition to the JRE, the Java plug-in is also included on the ONS 15454 software CD.

Table 14-2 Computer Requirements for CTC

Area	Requirements	Notes
Processor (PC only)	Pentium 4 processor or equivalent	A faster CPU is recommended if your workstation runs multiple applications or if CTC manages a network with a large number of nodes and circuits.
RAM	1 GB RAM or more	A minimum of 1 GB is recommended if your workstation runs multiple applications or if CTC manages a network with a large number of nodes and circuits.
Hard drive	20 GB hard drive with 250 MB of free space required	CTC application files are downloaded from the TCC2/TCC2P/TCC3/TNC/TSC to your computer. These files occupy around 100MB (250MB to be safer) or more space depending on the number of versions in the network.

Table 14-2 Computer Requirements for CTC (continued)

Area	Requirements	Notes
Operating System	• PC: Windows 2000, Windows XP, Windows Vista, Windows 7, Windows Server 2003, Windows Server 2008 • Workstation: Solaris Version 9 or 10 on an UltraSPARC-III or faster processor, with a minimum of 1 GB RAM and 250 MB of available hard drive space • Apple Mac OS X. CTC needs to be installed using the CacheInstaller available on the CCO or the ONS CD	Use the latest Patch/Service Pack released by the OS vendor. Check with the vendor for the information about the latest Patch/Service Pack.
Java Runtime Environment	JRE 1.6	JRE 1.6 is installed by the CTC Installation Wizard included on the ONS 15454, 15454-M2, or 15454-M6 software CD. JRE 1.6 provides enhancements to the CTC's performance, especially for large networks with numerous circuits. We recommend that you use JRE 1.6 for networks with Software R9.2 nodes. If CTC must be launched directly from nodes running software R7.0 or R7.2, we recommend JRE 1.4.2 or JRE 5.0. If CTC must be launched directly from nodes running software R5.0 or R6.0, we recommend JRE 1.4.2. If CTC must be launched directly from nodes running software earlier than R5.0, we recommend JRE 1.3.1_02.
Web browser	• PC: Internet Explorer 6.x, 7.x, 8.x • UNIX Workstation: Mozilla 1.7 • MacOS-X PC: Safari	For the PC, use JRE 1.6 with any supported web browser. The supported browser can be downloaded from the Web.
Cable	User-supplied CAT-5 straight-through cable with RJ-45 connectors on each end to connect the computer to ONS 15454, 15454-M2, or 15454-M6 directly or through a LAN. User-supplied cross-over CAT-5 cable to the DCN port on the ONS 15454 patch panel or to the Catalyst 2950 (multishelf mode).	—

14.4 ONS 15454 Connections

You can connect to the ONS 15454, 15454-M2, or 15454-M6 shelf assemblies in multiple ways.

(ONS 15454) You can connect your PC directly to the ONS 15454 shelf using the RJ-45(LAN) port on the faceplate of TCC2/TCC2P/TCC3 card or using the backplane RJ-45 LAN port.

(ONS 15454 M6) You can connect your PC directly to the ONS 15454 M6 shelf using the RJ-45(LAN) port on the faceplate of TNC/TSC card or using the EMS RJ-45 port or using the RJ-45 Craft port. The EMS RJ-45 port and RJ-45 Craft port are present on the external connection unit (ECU).

(ONS 15454 M2) You can connect your PC directly to the ONS 15454 M2 shelf using the RJ-45(LAN) port on the faceplate of TNC/TSC card or using the EMS RJ-45 port on the power module.

For the ANSI shelf, you can connect using the LAN pins on the backplane (the ETSI shelf provides a LAN connection through the RJ-45 jack on the MIC-T/C/P Front Mount Electrical Connection [FMEC]). Alternatively, you can connect your PC to a hub or switch that is connected to the ONS 15454, connect to the ONS 15454 through a LAN or modem, or establish TL1 connections from a PC or TL1 terminal. Table 14-3 lists the connection methods and requirements for ONS 15454, 15454-M2, or 15454-M6 shelves.

Note The TNC/TSC card supports multi-shelf connections through three FE RJ45 connections on the ECU. The TNC card supports one GE connection for CRS-1 router through the SFP port on the card. This SFP port can act as a secondary OSC supporting only FE and GE interfaces.
The TNC/TSC card in ONS 15454 M6 shelf can connect to CTC through the EMS RJ-45 port or Craft port on the ECU. The TNC/TSC card in ONS 15454 M2 shelf can connect to CTC through the EMS RJ-45 port on the power module.

Table 14-3 Connection Methods for ONS 15454, ONS 15454 M2, and ONS 15454 M6

Method	Description	Requirements
Local craft	Refers to onsite network connections between the CTC computer and the ONS 15454, 15454-M2, or 15454-M6 using one of the following: • The RJ-45 (LAN) port on the TCC2/TCC2P/TCC3/TNC/TSC card • The RJ-45 (LAN) port on the patch panel (multishelf mode) • Port 23 or 24 of the Catalyst 3560-V2-24TS-SD and 2950 (multishelf mode) • The LAN pins on the 15454-DWDM backplane (ANSI) • The RJ-45 jack on the MIC-T/C/P FMEC (ETSI) • (ONS 15454 M6) EMS RJ-45 port on the ECU • (ONS 15454 M6) RJ-45 Craft port on the ECU • (ONS 15454 M2) EMS RJ-45 port on the power module • A hub or switch to which the ONS 15454 is connected	If you do not use Dynamic Host Configuration Protocol (DHCP), you must change the computer IP address, subnet mask, and default router, or use automatic host detection.
Corporate LAN	Refers to a connection to the ONS 15454, 15454-M2, or 15454-M6 through a corporate or network operations center (NOC) LAN.	• The ONS 15454, 15454-M2, or 15454-M6 must be provisioned for LAN connectivity, including IP address, subnet mask, and default gateway. • The ONS 15454, 15454-M2, or 15454-M6 must be physically connected to the corporate LAN. • The CTC computer must be connected to the corporate LAN that has connectivity to ONS 15454, 15454-M2, or 15454-M6.

Table 14-3 Connection Methods for ONS 15454, ONS 15454 M2, and ONS 15454 M6

Method	Description	Requirements
TL1	Refers to a connection to the ONS 15454, 15454-M2, or 15454-M6 using TL1 rather than CTC. TL1 sessions can be started from CTC, or you can use a TL1 terminal. The physical connection can be a craft connection, corporate LAN, or a TL1 terminal.	Refer to the *Cisco ONS SONET TL1 Reference Guide* or the *Cisco ONS 15454 SDH and Cisco ONS 15600 SDH TL1 Reference Guide.*
Remote	Refers to a connection made to the ONS 15454, 15454-M2, or 15454-M6 using a modem.	• A modem must be connected to the ONS 15454, 15454-M2, or 15454-M6. • The modem must be provisioned for the ONS 15454, 15454-M2, or 15454-M6. To run CTC, the modem must be provisioned for Ethernet access.

14.5 CTC Window

When you log into a single-shelf ONS 15454, 15454-M2, or 15454-M6, the CTC window appears in node view (Figure 14-1). When you log into a multishelf ONS 15454 or 15454-M6, meaning that two or more ONS 15454 or 15454-M6 shelves are configured to operate as one node, the multishelf view (Figure 14-2) appears in the CTC window. The window includes a menu bar, a toolbar, and a top and bottom pane. The top pane provides status information about the selected objects and a graphic of the current view. The bottom pane provides tabs and subtabs to view ONS 15454 information and perform ONS 15454 provisioning and maintenance tasks. From the CTC window, you can display the other ONS 15454 views. In single-shelf mode, these are the network, node, and card views. In multishelf mode, these are the network, multishelf, shelf, and card views.

Figure 14-1 Node View (Default Login View for Single-Shelf Mode)

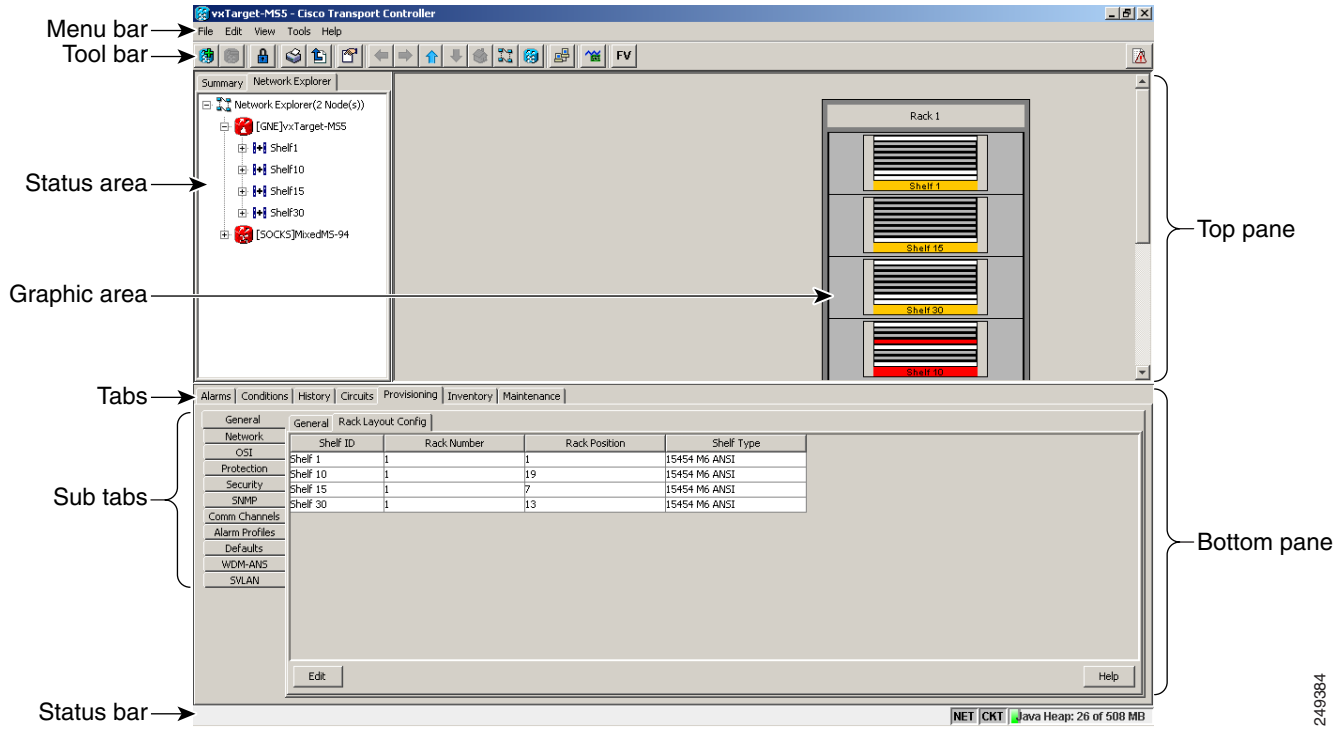
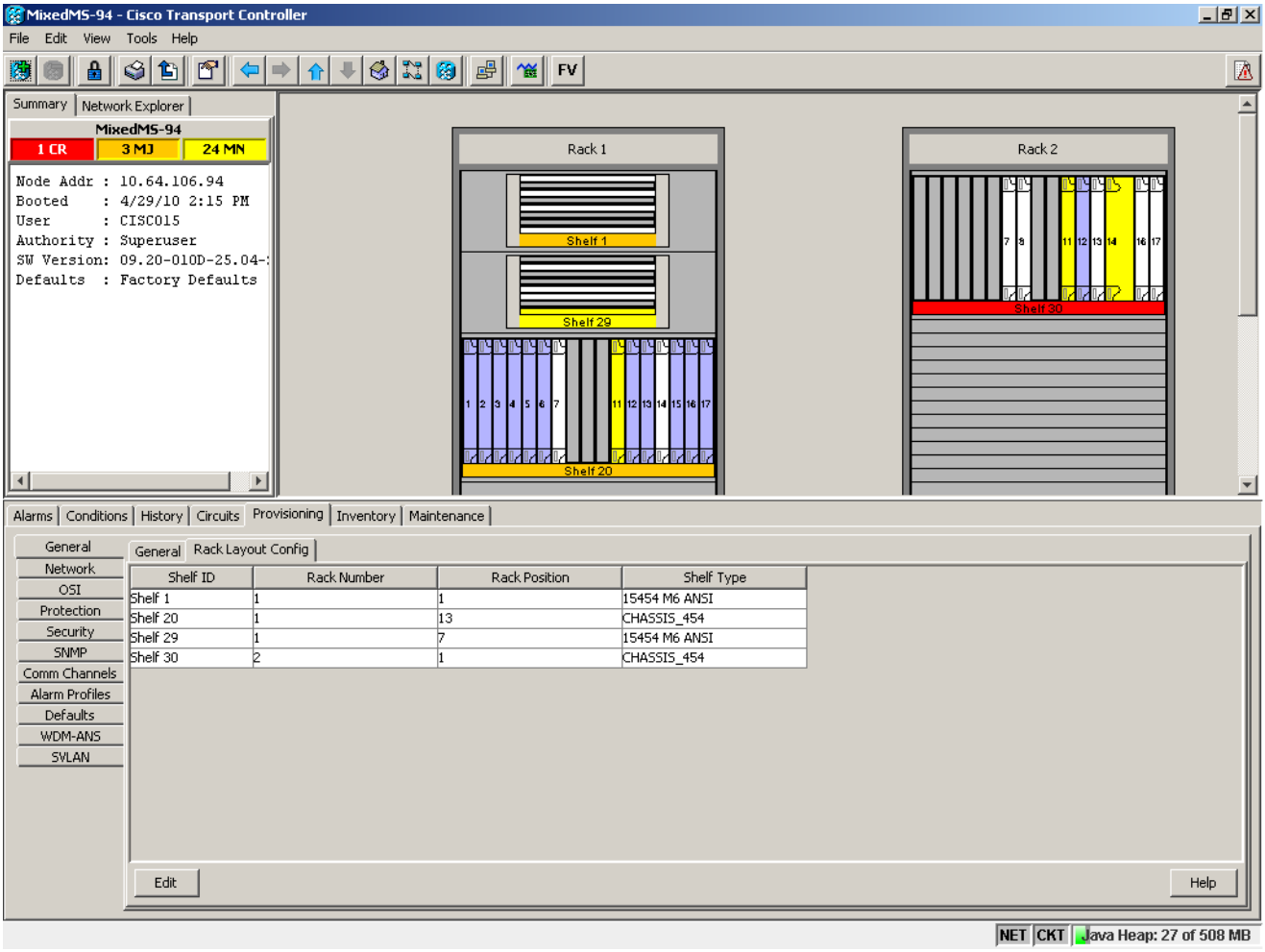


Figure 14-2 Multishelf View (Default Login View for Multishelf Mode)



14.5.1 Summary Pane

The Summary pane on the left has the following fields:

- Node Addr—IP address of the node.
- Booted—The Booted field indicates one of the following:
  - Date and time of the node reboot. The node reboot is caused by complete power cycle, software upgrade, or software downgrade.
  - Date and time of reset of the control cards one after the other.
- User—Login user name.
- Authority—Security level of users. The possible security levels are Retrieve, Maintanence, Provisioning, and Superuser.
- SW Version—CTC software version.
- Defaults—Name provided to identify the defaults list.

14.5.2 Node View (Multishelf Mode), Node View (Single-Shelf Mode), and Shelf View (Multishelf Mode)

Node view, shown in Figure 14-1, is the first view that appears after you log into a single-shelf ONS 15454. Multishelf view, shown in Figure 14-2, is the first view that appears after you log into a multishelf ONS 15454. The login node is the first node shown, and it is the "home view" for the session. Multishelf view and node view allow you to manage one ONS 15454 node. The status area shows the node name; IP address; session boot date and time; number of Critical (CR), Major (MJ), and Minor (MN) alarms; name and security level of the current logged-in user; software version; and network element default setup.

(On ONS 15454 and 15454-M6) In a multishelf mode, up to 30 shelves operate as a single node.

Note The reason for extending the number of subtending shelves to 30 is to accommodate and manage the new optical and DWDM cards that operate in the even band frequency grid.

When you open a shelf from multishelf view, shelf view appears, which looks similar to node view but does not contain the tabs and subtabs that are used for node-level operations.

14.5.2.1 CTC Card Colors

The graphic area of the CTC window depicts the ONS 15454 shelf assembly. The colors of the cards in the graphic reflect the real-time status of the physical card and slot (Table 14-4).

Table 14-4 Multishelf View (Multishelf Mode), Node View (Single-Shelf Mode), and Shelf View (Multishelf Mode) Card Colors

Card Color	Status
Gray	Slot is not provisioned; no card is installed.
Violet	Slot is provisioned; no card is installed.
White	Slot is provisioned; a functioning card is installed.
Yellow	Slot is provisioned; a Minor alarm condition exists.
Orange	Slot is provisioned; a Major alarm condition exists.
Red	Slot is provisioned; a Critical alarm exists.

On the ONS 15454 ETSI, the colors of the FMEC cards reflect the real-time status of the physical FMEC cards. Table 14-5 lists the FMEC card colors. The FMEC ports shown in CTC do not change color.

Note You cannot preprovision FMECs.

Table 14-5 Multishelf View (Multishelf Mode) and Node View (Single-Shelf Mode) FMEC Color

Upper Shelf FMEC Color	Status
White	Functioning card is installed.
Yellow	Minor alarm condition exists.
Orange (Amber)	Major alarm condition exists.
Red	Critical alarm exists.

The wording on a card in node view (single-shelf mode) or shelf view (multishelf mode) shows the status of a card (Active, Standby, Loading, or Not Provisioned). Table 14-6 lists the card statuses.

Table 14-6 Node View (Single-Shelf Mode) or Shelf View (Multishelf Mode) Card Statuses

Card Status	Description
Act	Card is active.
Sty	Card is in standby mode.
Ldg	Card is resetting.
NP	Card is not present.

Port color in card view, node view (single-shelf mode), and shelf view (multishelf mode) indicates the port service state. Table 14-7 lists the port colors and their service states. For more information about port service states, see Appendix B, "Administrative and Service States."

Table 14-7 Node View (Single-Shelf Mode) or Shelf View (Multishelf Mode) Card Port Colors and Service States

Port Color	Service State	Description
Cyan (blue)	Out-of-Service and Management, Loopback (OOS-MA,LPBK) (ANSI) Locked-enabled,loopback (ETSI)	Port is in a loopback state. On the card in node or shelf view, a line between ports indicates that the port is in terminal or facility loopback (see Figure 14-3 and Figure 14-4). Traffic is carried and alarm reporting is suppressed. Raised fault conditions, whether or not their alarms are reported, can be retrieved on the CTC Conditions tab or by using the TL1 RTRV-COND command.
Cyan (blue)	Out-of-Service and Management, Maintenance (OOS-MA,MT) (ANSI) Locked-enabled,maintenance (ETSI)	Port is out-of-service for maintenance. Traffic is carried and loopbacks are allowed. Alarm reporting is suppressed. Raised fault conditions, whether or not their alarms are reported, can be retrieved on the CTC Conditions tab or by using the TL1 RTRV-COND command. Use this service state for testing or to suppress alarms temporarily. Change the state to IS-NR/Unlocked-enabled; OOS-MA,DSBLD/Locked-enabled,disabled; or OOS-AU,AINS/Unlocked-disabled,automaticInService when testing is complete.

Table 14-7 Node View (Single-Shelf Mode) or Shelf View (Multishelf Mode) Card Port Colors and Service States

Port Color	Service State	Description
Gray	Out-of-Service and Management, Disabled (OOS-MA,DSBLD) (ANSI) Locked-enabled,disabled (ETSI)	The port is out-of-service and unable to carry traffic. Loopbacks are not allowed in this service state.
Green	In-Service and Normal (IS-NR) (ANSI) Unlocked-enabled (ETSI)	The port is fully operational and performing as provisioned. The port transmits a signal and displays alarms; loopbacks are not allowed.
Violet	Out-of-Service and Autonomous, Automatic In-Service (OOS-AU,AINS) (ANSI) Unlocked-disabled,automaticInService (ETSI)	The port is out-of-service, but traffic is carried. Alarm reporting is suppressed. The node monitors the ports for an error-free signal. After an error-free signal is detected, the port stays in this service state for the duration of the soak period. After the soak period ends, the port service state changes to IS-NR/Unlocked-enabled. Raised fault conditions, whether or not their alarms are reported, can be retrieved on the CTC Conditions tab or by using the TL1 RTRV-COND command. The AINS port will automatically transition to IS-NR/Unlocked-enabled when a signal is received for the length of time provisioned in the soak field.

Figure 14-3 Terminal Loopback Indicator

Figure 14-4 Facility Loopback Indicator

14.5.2.2 Multishelf View Card Shortcuts

If you move your mouse over cards in the multishelf view graphic, popups display additional information about the card including the card type; the card status (active or standby); the type of alarm, such as Critical, Major, or Minor (if any); the alarm profile used by the card; and for transponder (TXP) or muxponder (MXP) cards, the wavelength of the dense wavelength division multiplexing (DWDM) port.

14.5.2.3 Node View (Single-Shelf Mode) or Shelf View (Multishelf Mode) Card Shortcuts

If you move your mouse over cards in the node view (single-shelf mode) or shelf view (multishelf mode) graphic, popups display additional information about the card including the card type; the card status (active or standby); the type of alarm, such as Critical, Major, or Minor (if any); the alarm profile used by the card; and for TXP or MXP cards, the wavelength of the DWDM port. Right-click a card to reveal a shortcut menu, which you can use to open, reset, delete, or change a card. Right-click a slot to preprovision a card (that is, provision a slot before installing the card).

14.5.2.4 Node View (Single-Shelf Mode) or Shelf View (Multishelf Mode) Port Shortcuts

If you move your mouse over the ports in the node view (single-shelf mode) or shelf view (multishelf mode), the popup message displays information about the port type, service state, and the alarm profile used by the port. For example, the popup message displays "((EXP-RX-1-4) Service State: IS-NR, Alarm Profile: Inherited)".

14.5.2.5 Card View (Single-Shelf Mode) or Shelf View (Multishelf Mode) Port Shortcuts

If you right-click the ports in the card view (single-shelf mode or multishelf mode), the popup message displays the side information along with shelf, slot, and port information. For example, the popup message displays "Shelf 1, Slot 3 (40 SMR2 C), Port EXP-TX 1-1, Side C".

14.5.2.6 Multishelf View Tabs

Table 14-8 lists the tabs and subtabs available in the multishelf view. The actions on these tabs apply to the multishelf node and its subtending shelves.

Table 14-8 Multishelf View Tabs and Subtabs

Tab	Description	Subtabs
Alarms	Lists current alarms (CR, MJ, MN) for the multishelf node and updates them in real time.	—
Conditions	Displays a list of standing conditions on the multishelf node.	—
History	Provides a history of multishelf node alarms including the date, type, and severity of each alarm. The Session subtab displays alarms and events for the current session. The Node subtab displays alarms and events retrieved from a fixed-size log on the node.	Session, Node
Circuits	Creates, deletes, edits, and maps circuits.	Circuits, Rolls
Provisioning	Provisions the ONS 15454 multishelf node.	General, Network, OSI, Security, SNMP, Comm Channels, Alarm Profiles, Defaults, WDM-ANS
Inventory	Provides inventory information (part number, serial number, and Common Language Equipment Identification [CLEI] codes) for cards installed on all shelves in the multishelf node. Allows you to delete and reset cards and change the card service state.	—
Maintenance	Performs maintenance tasks for the multishelf node.	Database, Network, OSI, Software, Diagnostic, Audit, DWDM

14.5.2.7 Node View (Single-Shelf Mode) or Shelf View (Multishelf Mode) Tabs

Table 14-9 lists the tabs and subtabs available in node view (single-shelf mode) or shelf view (multishelf mode).

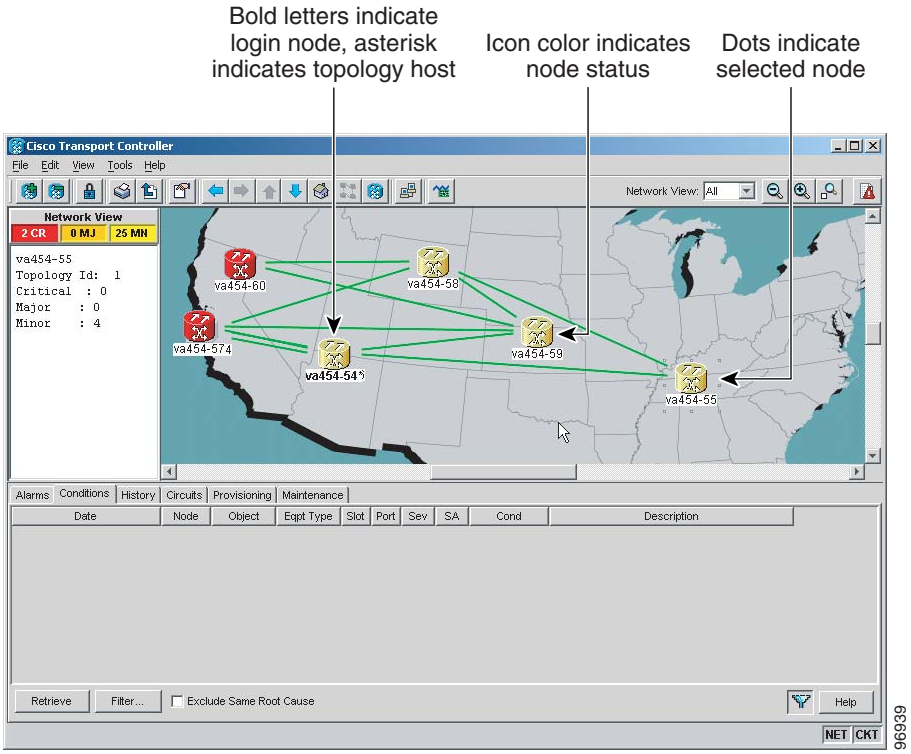
Table 14-9 Node View (Single-Shelf Mode) or Shelf View (Multishelf Mode) Tabs and Subtabs

Tab	Description	Subtabs
Alarms	Lists current alarms (CR, MJ, MN) for the node or shelf and updates them in real time.	—
Conditions	Displays a list of standing conditions on the node or shelf.	—
History	Provides a history of node or shelf alarms including the date, type, and severity of each alarm. The Session subtab displays alarms and events for the current session. The Node subtab displays alarms and events retrieved from a fixed-size log on the node.	Session, Node
Circuits	Creates, deletes, edits, and maps circuits.	Circuits, Rolls
Provisioning	Provisions the ONS 15454 single-shelf or multishelf node.	Single-shelf mode: General, Network, OSI, Security, SNMP, Comm Channels, Alarm Profiles, Defaults, WDM-ANS Multishelf mode: General, Protection, Timing, Alarm Profiles
Inventory	Provides inventory information (part number, serial number, and CLEI codes) for cards installed in the single-shelf or multishelf node. Allows you to delete and reset cards and change the card service state. **Note** Each card has bootstrap and boot code. After the card is upgraded using the boot code upgrade procedure, the bootstrap version is displayed in the Inventory tab in CTC; However, the boot code version is not displayed in the Inventory tab.	—
Maintenance	Performs maintenance tasks for the single-shelf or multishelf node.	Single-shelf mode: Database, Network, OSI, Software, Diagnostic, Audit, DWDM Multishelf mode: Protection, Overhead XConnect, Diagnostic, Timing

14.5.3 Network View

Network view allows you to view and manage ONS 15454, 15454-M2, or 15454-M6 that have DCC connections to the node that you logged into and any login node groups you have selected (Figure 14-5).

Figure 14-5 Network in CTC Network View



Note Nodes with DCC connections to the login node do not appear if you checked the Disable Network Discovery check box in the Login dialog box.

The graphic area displays a background image with colored ONS 15454 icons. A Superuser can set up the logical network view feature, which enables each user to see the same network view.

14.5.3.1 Network View Tabs

Table 14-10 lists the tabs and subtabs available in network view.

Table 14-10 Network View Tabs and Subtabs

Tab	Description	Subtabs
Alarms	Lists current alarms (CR, MJ, MN) for the network and updates them in real time.	—
Conditions	Displays a list of standing conditions on the network.	—
History	Provides a history of network alarms including date, type, and severity of each alarm.	—
Circuits	Creates, deletes, edits, filters, and searches for network circuits.	—

Table 14-10 Network View Tabs and Subtabs (continued)

Tab	Description	Subtabs
Provisioning	Provisions security, alarm profiles, bidirectional line switched rings (BLSRs) (ANSI), multiplex section-shared protection rings (MS-SPRing) (ETSI), and overhead circuits.	Security, Alarm Profiles, BLSR (ANSI), MS-SPRing (ETSI), Overhead Circuits, Provisionable Patchcords
Maintenance	Displays the type of equipment and the status of each node in the network; displays working and protect software versions; and allows software to be downloaded.	Software

14.5.3.2 CTC Node Colors

The color of a node in network view, shown in Table 14-11, indicates the node alarm status.

Table 14-11 Node Status Shown in Network View

Color	Alarm Status
Green	No alarms
Yellow	Minor alarms
Orange	Major alarms
Red	Critical alarms
Gray with Unknown#	Node initializing for the first time (CTC displays Unknown# because CTC has not discovered the name of the node yet)

14.5.3.3 DCC Links

The lines show DCC connections between the nodes (Table 14-12). DCC connections can be green (active) or gray (fail). The lines can also be solid (circuits can be routed through this link) or dashed (circuits cannot be routed through this link). Circuit provisioning uses active/routable links. Selecting a node or span in the graphic area displays information about the node and span in the status area.

Table 14-12 DCC Colors Indicating State in Network View

Color and Line Style	State
Green and solid	Active/Routable
Green and dashed	Active/Nonroutable
Gray and solid	Failed/Routable
Gray and dashed	Failed/Nonroutable

14.5.3.4 Link Consolidation

CTC provides the ability to consolidate the DCC, generic communications channel (GCC), optical transmission section (OTS), and PPC links shown in the network view into a more streamlined view. Link consolidation allows you to condense multiple inter-nodal links into a single link. The link

consolidation sorts links by class, meaning that all DCC links are consolidated together, for example.You can access individual links within consolidated links using the right-click shortcut menu.Each link has an associated icon (Table 14-13).

Table 14-13 Link Icons

Icon	Description
	DCC icon
	GCC icon
	OTS icon
	PPC icon

Note Link consolidation is only available on non-detailed maps. Non-detailed maps display nodes in icon form instead of detailed form, meaning that the nodes appear as rectangles with ports on the sides. Refer to the *Cisco ONS 15454 DWDM Procedure Guide* for more information about consolidated links.

14.5.4 Card View

The card view provides information about individual ONS 15454 cards. Use this window to perform card-specific maintenance and provisioning. A graphic showing the ports on the card is shown in the graphic area. The status area displays the node name, slot, number of alarms, card type, equipment type, card status (active or standby), card service state if the card is present, and port service state (described in Table 14-7 on page 14-12). The information that appears and the actions that you can perform depend on the card. For more information about card service states, refer to Appendix B, "Administrative and Service States."

Note CTC provides a card view for all cards except the TCC2/TCC2P/TCC3/TSC cards.

Use the card view tabs and subtabs shown in Table 14-14 to provision and manage the ONS 15454. The subtabs, fields, and information shown under each tab depend on the card type selected.

Table 14-14 Card View Tabs and Subtabs

Tab	Description	Subtabs
Alarms	Lists current alarms (CR, MJ, MN) for the card and updates them in real time.	—
Conditions	Displays a list of standing conditions on the card.	—

Table 14-14 Card View Tabs and Subtabs (continued)

Tab	Description	Subtabs
History	Provides a history of card alarms including date, object, port, and severity of each alarm.	Session (displays alarms and events for the current session), Card (displays alarms and events retrieved from a fixed-size log on the card)
Circuits	Creates, deletes, edits, and search circuits.	—
Provisioning	Provisions an ONS 15454 card.	DS-N and OC-N cards: Line, Line Thresholds (different threshold options are available for DS-N and OC-N cards), Elect Path Thresholds, SONET Thresholds, SONET STS, Alarm Profiles TXP and MXP cards: Card, Line, Line Thresholds, Optics Thresholds, OTN, Alarm Profiles DWDM cards (subtabs depend on card type): Optical Line, Optical Chn, Optical Amplifier, Parameters, Optics Thresholds, Alarm Profiles
Maintenance	Performs maintenance tasks for the card.	Loopback, Info, Protection, J1 Path Trace, AINS Soak (options depend on the card type), Automatic Laser Shutdown
Performance (Not available for the AIC-I cards)	Performs performance monitoring for the card.	DS-N and OC-N cards: no subtabs TXP and MXP cards: Optics PM, Payload PM, OTN PM DWDM cards (subtabs depend on card type): Optical Line, Optical Chn, Optical Amplifier Line, OC3 Line, Parameters, Optics Thresholds
Inventory	(40-WSS, 40-WXC, OPT-PRE and OPT-BST cards) Displays an Inventory screen of the ports.	—

14.6 Using the CTC Launcher Application to Manage Multiple ONS Nodes

The CTC Launcher application is an executable file, StartCTC.exe, that is provided on Software Release 9.2 CDs for Cisco ONS products. You can use CTC Launcher to log into multiple ONS nodes that are running CTC Software Release 3.3 or higher, without using a web browser. The CTC launcher application provides an advantage particularly when you have more than one NE version on the network, because it allows you to pick from all available CTC software versions. It also starts more quickly than the browser version of CTC and has a dedicated node history list.

CTC Launcher provides two connection options. The first option is used to connect to ONS NEs that have an IP connection to the CTC computer. The second option is used to connect to ONS NEs that reside behind third party, OSI-based GNEs. For this option, CTC Launcher creates a TL1 tunnel to transport the TCP traffic through the OSI-based GNE.

The TL1 tunnel transports the TCP traffic to and from ONS ENEs through the OSI-based GNE. TL1 tunnels are similar to the existing static IP-over-CLNS tunnels, GRE, and Cisco IP, that can be created at ONS NEs using CTC. (Refer to the Cisco ONS product documentation for information about static IP-over-CLNS tunnels.) However, unlike the static IP-over-CLNS tunnels, TL1 tunnels require no provisioning at the ONS ENE, the third-party GNE, or DCN routers. All provisioning occurs at the CTC computer when the CTC Launcher is started.

Figure 14-6 shows examples of two static IP-over-CLNS tunnels. A static Cisco IP tunnel is created from ENE 1 through other vendor GNE 1 to a DCN router, and a static GRE tunnel is created from ONS ENE 2 to the other vender, GNE 2. For both static tunnels, provisioning is required on the ONS ENEs. In addition, a Cisco IP tunnel must be provisioned on the DCN router and a GRE tunnel provisioned on GNE 2.

Figure 14-6 Static IP-Over-CLNS Tunnels

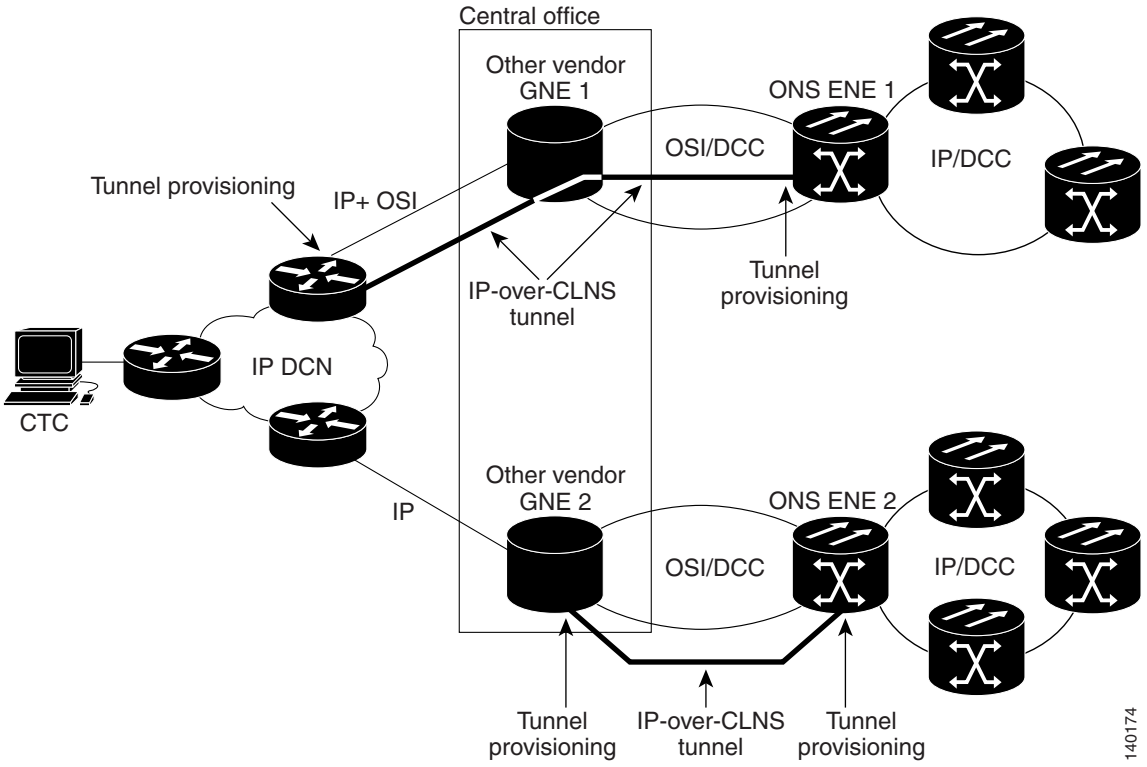
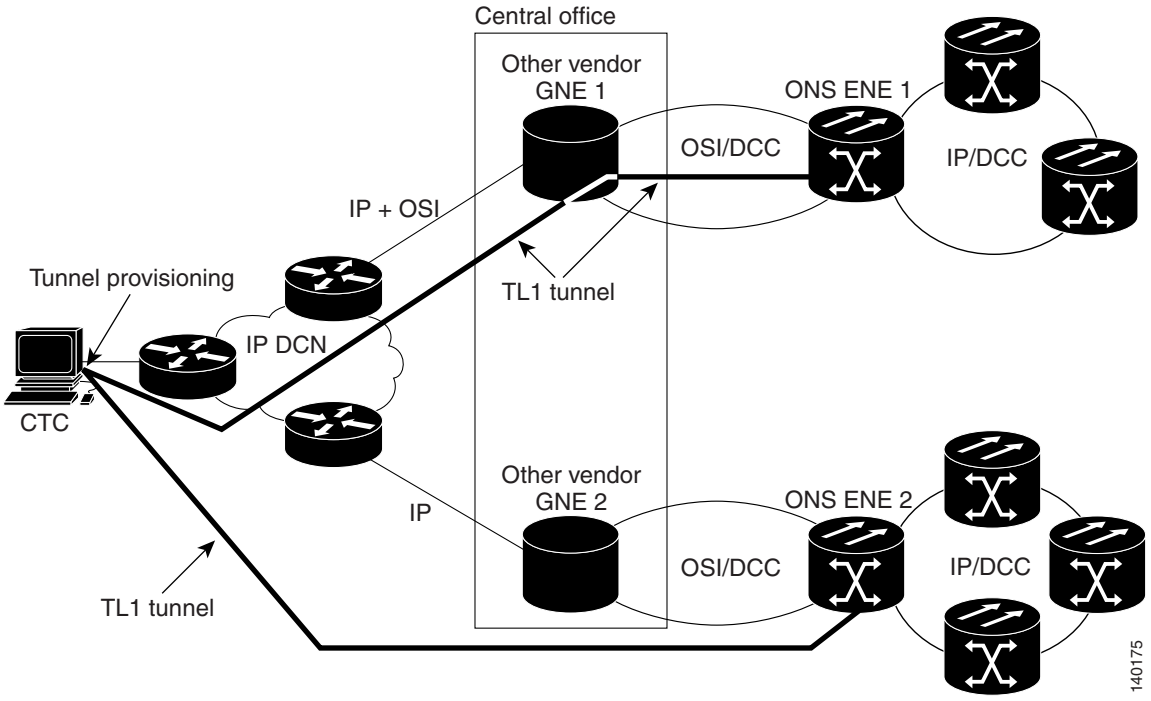


Figure 14-7 shows the same network using TL1 tunnels. Tunnel provisioning occurs at the CTC computer when the tunnel is created with the CTC Launcher. No provisioning is needed at ONS NEs, GNEs, or routers.

Figure 14-7 TL1 Tunnels



TL1 tunnels provide several advantages over static IP-over-CLNS tunnels. Because tunnel provisioning is needed only at the CTC computer, they are faster to set up. Because they use TL1 for TCP transport, they are more secure. TL1 tunnels also provide better flow control. On the other hand, IP over CLNS tunnels require less overhead and usually provide a slight performance edge over TL1 Tunnels (depending on network conditions). TL1 tunnels do not support all IP applications such as SNMP and RADIUS Authentication. Table 14-15 shows a comparison between the two types of tunnels.

Table 14-15 TL1 and Static IP-Over-CLNS Tunnels Comparison

Category	Static IP-Over-CLNS	TL1 Tunnel	Comments
Setup	Complex	Simple	Requires provisioning at ONS NE, GNE, and DCN routers. For TL1 tunnels, provisioning is needed at CTC computer.
Performance	Best	Average to good	Static tunnels generally provide better performance than TL1 tunnels, depending on TL1 encoding used. LV+Binary provides the best performance. Other encoding will produce slightly slower TL1 tunnel performance.
Support all IP applications	Yes	No	TL1 tunnels do not support SNMP or RADIUS Server IP applications.
ITU Standard	Yes	No	Only the static IP-over-CLNS tunnels meet ITU standards. TL1 tunnels are new.
Tunnel traffic control	Good	Very good	Both tunnel types provide good traffic control
Security setup	Complex	No setup needed	Static IP-over-CLNS tunnels require careful planning. Because TL1 tunnels are carried by TL1, no security provisioning is needed.

Table 14-15 TL1 and Static IP-Over-CLNS Tunnels Comparison (continued)

Category	Static IP-Over-CLNS	TL1 Tunnel	Comments
Potential to breach DCN from DCC using IP.	Possible	Not possible	A potential exists to breach a DCN from a DCC using IP. This potential does not exist for TL1 tunnels.
IP route management	Expensive	Automatic	For static IP-over-CLNS tunnels, route changes require manual provisioning at network routers, GNEs, and ENEs. For TL1 tunnels, route changes are automatic.
Flow control	Weak	Strong	TL1 tunnels provide the best flow control.
Bandwidth sharing among multiple applications	Weak	Best	—
Tunnel lifecycle	Fixed	CTC session	TL1 tunnels are terminated when the CTC session ends. Static IP-over-CLNS tunnels exist until they are deleted in CTC.

TL1 tunnel specifications and general capabilities include:

- Each tunnel generally supports between six to eight ENEs, depending on the number of tunnels at the ENE.
- Each CTC session can support up to 32 tunnels.
- The TL1 tunnel database is stored locally in the CTC Preferences file.
- Automatic tunnel reconnection when the tunnel goes down.
- Each ONS NE can support at least 16 concurrent tunnels.

14.7 TCC2/TCC2P/TCC3/TNC/TSC Card Reset

You can soft reset the TCC2/TCC2P/TCC3/TNC/TSC card by using CTC or by physically resetting the card (a hard reset). A soft reset reboots the TCC2/TCC2P/TCC3/TNC/TSC card and reloads the operating system and the application software. Additionally, a hard reset temporarily removes power from the TCC2/TCC2P/TCC3/TNC/TSC card and clears all the buffer memory.

You can apply a soft reset from CTC to either an active or standby TCC2/TCC2P/TCC3/TNC/TSC card without affecting traffic. If you need to perform a hard reset on an active TCC2/TCC2P/TCC3/TNC/TSC card, put the TCC2/TCC2P/TCC3/TNC/TSC card into standby mode first by performing a soft reset.

Note Hard reset can also be performed on the TNC/TSC card through CTC and TL1 interface. Before performing the hard reset, bring the TNC/TSC card to maintenance mode.

When you reset the standby TCC2/TCC2P/TCC3/TNC/TSC card, the system traffic is not affected. When you reset the active TCC2/TCC2P/TCC3/TNC/TSC card, traffic switches to the standby card if the standby card is present and in the ready standby state. If the standby card is not in the ready standby state, traffic does not switch, and results in loss of system traffic and management connectivity until the card reboots completely.

Caution When you reset the TNC/TSC card on the ONS 15454 or 15454-M6 shelves in simplex control mode, loss of management connectivity happens until the card reboots. The system traffic loss may occur depending on the line card and traffic type.

Note (Cisco ONS 15454 shelf) When a CTC reset is performed on an active TCC2/TCC2P/TCC3 card, the AIC-I card goes through an initialization process and also resets because it is controlled by the active TCC2/TCC2P/TCC3 card.

14.8 TCC2/TCC2P/TCC3/TNC/TSC Card Database

When dual TCC2/TCC2P/TCC3/TNC/TSC cards are installed in the ONS 15454, 15454-M2, or 15454-M6 shelves, each TCC2/TCC2P/TCC3/TNC/TSC card hosts a separate database; therefore, the protect card database is available if the database on the working TCC2/TCC2P/TCC3/TNC/TSC card fails. You can also store a backup version of the database on the workstation running CTC. This operation should be part of a regular ONS 15454, 15454-M2, or 15454-M6 maintenance program at approximately weekly intervals, and should also be completed when preparing ONS 15454, 15454-M2, or 15454-M6 for a pending natural disaster, such as a flood or fire.

The TNC card provides 4GB of nonvolatile database storage for communication, provisioning, and system control. This allows full database recovery during power failure.

The configuration details are stored in the database of the TCC2/TCC2P/TCC3/TNC/TSC card. The database restore from a TNC card to a TSC card or vice versa is not supported.

Note The following parameters are not backed up and restored: node name, IP address, mask and gateway, and Internet Inter-ORB Protocol (IIOP) port. If you change the node name and then restore a backed up database with a different node name, the circuits map to the new node name. We recommend keeping a record of the old and new node names.

14.9 Software Revert

When you click the **Activate** button after a software upgrade, the TCC2/TCC2P/TCC3/TNC/TSC card copies the current working database and saves it in a reserved location in the TCC2/TCC2P/TCC3/TNC/TSC card flash memory. If later during the upgrade you need to revert to the original working software load from the protect software load, the saved database installs automatically. You do not need to restore the database manually or recreate circuits.

The revert feature is useful if the maintenance window in which you were performing an upgrade closes while you are still upgrading CTC software. You can revert to the protect software load without losing traffic. During the next maintenance window, you can complete the upgrade and activate the new software load.

Circuits created or provisioning done after you activate a new software load (upgrade to a higher release) will be lost with a revert. The database configuration at the time of activation is reinstated after a revert. (This does not apply to maintenance reverts, such as Software R5.0.1 to Software R5.0.2, because maintenance releases retain the database during activation.)

Caution Cisco does not recommend reverting after changing provisioning on the node. Depending upon the particular provisioning, reverting in this case can be traffic affecting.

To perform a supported (non-service-affecting) revert from a software release that you have just activated, the release you revert to must have been working at the time you first activated the new software on that node. Because a supported revert automatically restores the node configuration at the time of the previous activation, any configuration changes made after activation will be lost when you revert the software. Downloading the software release that you are upgrading to a second time after you have activated the new load ensures that no actual revert to a previous load can take place (the TCC2/TCC2P/TCC3/TNC/TSC resets, but it does not affect the traffic and does not change your database).

Note To perform a supported software upgrade or revert, you must consult the specific upgrade document and release notes for the release you are upgrading to (or reverting from).

CHAPTER 15

Security Reference

This chapter provides information about Cisco ONS 15454 users and security.

Note Unless otherwise specified, “ONS 15454” refers to both ANSI and ETSI shelf assemblies.

Chapter topics include:

- 15.1 User IDs and Security Levels, page 15-1
- 15.2 User Privileges and Policies, page 15-2
- 15.3 Audit Trail, page 15-8
- 15.4 RADIUS Security, page 15-9

15.1 User IDs and Security Levels

The Cisco Transport Controller (CTC) ID is provided with the ONS 15454 system, but the system does not display the user ID when you sign into CTC. This ID can be used to set up other ONS 15454 users.

You can have up to 500 user IDs on one ONS 15454. Each CTC or TL1 user can be assigned one of the following security levels:

- Retrieve—Users can retrieve and view CTC information but cannot set or modify parameters.
- Maintenance—Users can access only the ONS 15454 maintenance options.
- Provisioning—Users can access provisioning and maintenance options.
- Superusers—Users can perform all of the functions of the other security levels as well as set names, passwords, and security levels for other users.

See Table 15-3 on page 15-7 for idle user timeout information for each security level.

By default, multiple concurrent user ID sessions are permitted on the node, that is, multiple users can log into a node using the same user ID. However, you can provision the node to allow only a single login per user and prevent concurrent logins for all users.

Note You must add the same user name and password to each node the user accesses.

Note Maintenance, Provisioning, and Superusers must be properly trained on the hazards of laser safety and be aware of safety-related instructions, labels, and warnings. Refer to the *Cisco Optical Products Safety and Compliance Information* document for a current list of safety labels and warnings, including laser warnings. Refer to IEC 60825-2 for international laser safety standards, or to ANSI Z136.1 for U.S. laser safety standards. The *Cisco ONS 15454 DWDM Procedure Guide* explains how users can disable laser safety during maintenance or installation; when following these procedures, adhere to all posted warnings and cautions to avoid unsafe conditions or abnormal exposure to optical radiation.

15.2 User Privileges and Policies

This section lists user privileges for each CTC task and describes the security policies available to Superusers for provisioning.

15.2.1 User Privileges by CTC Task

Table 15-1 shows the actions that each user privilege level can perform in node view.

Table 15-1 ONS 15454 Security Levels—Node View

CTC Tab	Subtab	[Subtab]:Actions	Retrieve	Maintenance	Provisioning	Superuser
Alarms	—	Synchronize/Filter/Delete Cleared Alarms	X	X	X	X
Conditions	—	Retrieve/Filter	X	X	X	X
History	Session	Filter	X	X	X	X
	Node	Retrieve/Filter	X	X	X	X
Circuits	Circuits	Create/Edit/Delete	—	—	X	X
		Filter/Search	X	X	X	X
	Rolls	Complete/ Force Valid Signal/ Finish	—	—	X	X

Table 15-1 ONS 15454 Security Levels—Node View (continued)

CTC Tab	Subtab	[Subtab]:Actions	Retrieve	Maintenance	Provisioning	Superuser
Provisioning	General	General: Edit	—	—	Partial[1]	X
		Multishelf Config: Edit	—	—	—	X
	Network	General: Edit	—	—	—	X
		Static Routing: Create/Edit/ Delete	—	—	X	X
		OSPF: Create/Edit/Delete	—	—	X	X
		RIP: Create/Edit/Delete	—	—	X	X
		Proxy: Create/Edit/Delete	—	—	—	X
		Firewall: Create/Edit/Delete	—	—	—	X
	OSI	Main Setup:Edit	—	—	—	X
		TARP: Config: Edit	—	—	—	X
		TARP: Static TDC: Add/Edit/Delete	—	—	X	X
		TARP: MAT: Add/Edit/Remove	—	—	X	X
		Routers: Setup: Edit	—	—	—	X
		Routers: Subnets: Edit/Enable/Disable	—	—	X	X
		Tunnels: Create/Edit/Delete	—	—	X	X

Table 15-1 ONS 15454 Security Levels—Node View (continued)

CTC Tab	Subtab	[Subtab]:Actions	Retrieve	Maintenance	Provisioning	Superuser
	Security	Users: Create/Delete/Clear Security Intrusion Alarm	—	—	—	X
		Users: Change	Same user	Same user	Same user	All users
		Active Logins: View/Logout/ Retrieve Last Activity Time	—	—	—	X
		Policy: Edit/View	—	—	—	X
		Access: Edit/View	—	—	—	X
		RADIUS Server: Create/Edit/Delete/Move Up/M ove Down/View	—	—	—	X
		Legal Disclaimer: Edit	—	—	—	X
	SNMP	Create/Edit/Delete	—	—	X	X
		Browse trap destinations	X	X	X	X
	Comm Channels	SDCC: Create/Edit/Delete	—	—	X	X
		LDCC: Create/Edit/Delete	—	—	X	X
		GCC: Create/Edit/Delete	—	—	X	X
		OSC: Create/Edit/Delete	—	—	X	X
		PPC: Create/Edit/Delete	—	—	X	X
		LMP: General: Edit	X	X	X	X
		LMP: Control Channels: Create/Edit/Delete	—	—	—	X
		LMP: TE Links: Create/Edit/Delete	—	—	—	X
		LMP: Data Links: Create/Edit/Delete	—	—	—	X
	Alarm Profiles	Load/Store/Delete[2]	—	—	X	X
		New/Compare/Available/Usage	X	X	X	X
	Defaults	Edit/Import	—	—	—	X
		Reset/Export	X	X	X	X
	WDM-ANS	Provisioning: Edit	—	—	—	X
		Provisioning: Reset	X	X	X	X
		Internal Patchcords: Create/Edit/Delete/Commit/ Default Patchcords	—	—	X	X
		Port Status: Launch ANS	—	—	—	X
		Node Setup: Setup/Edit	X	X	X	X
		Optical Side: Create/Edit/Delete	X	X	X	X
Inventory	—	Delete	—	—	X	X
		Reset	—	X	X	X

Table 15-1 ONS 15454 Security Levels—Node View (continued)

CTC Tab	Subtab	[Subtab]:Actions	Retrieve	Maintenance	Provisioning	Superuser
Maintenance	Database	Backup	—	X	X	X
		Restore	—	—	—	X
	Network	Routing Table: Retrieve	X	X	X	X
		RIP Routing Table: Retrieve	X	X	X	X
	OSI	IS-IS RIB: Refresh	X	X	X	X
		ES-IS RIB: Refresh	X	X	X	X
		TDC: TID to NSAP/Flush Dynamic Entries	—	X	X	X
		TDC: Refresh	X	X	X	X
	Software	Download/Cancel	—	X	X	X
		Activate/Revert	—	—	—	X
	Diagnostic	Node Diagnostic Logs	—	—	X	X
	Audit	Retrieve	—	—	—	X
		Archive	—	—	X	X
	DWDM	APC: Run/Disable/Refresh	—	X	X	X
		WDM Span Check: Retrieve Span Loss values/ Edit/Reset	X	X	X	X
		ROADM Power Monitoring: Refresh	X	X	X	X
		PP-MESH Internal Patchcord: Refresh	X	X	X	X
		Install Without Metro Planner: Retrieve Installation values	X	X	X	X
		All Facilities: Mark/Refresh	X	X	X	X

1. A Provisioning user cannot change node name, contact, location and AIS-V insertion on STS-1 signal degrade (SD) parameters.
2. The action buttons in the subtab are active for all users, but the actions can be completely performed only by the users assigned with the required security levels.

Table 15-2 shows the actions that each user privilege level can perform in network view.

Table 15-2 ONS 15454 Security Levels—Network View

CTC Tab	Subtab	[Subtab]: Actions	Retrieve	Maintenance	Provisioning	Superuser
Alarms	—	Synchronize/Filter/Delete cleared alarms	X	X	X	X
Conditions	—	Retrieve/Filter	X	X	X	X
History	—	Filter	X	X	X	X

Table 15-2 ONS 15454 Security Levels—Network View (continued)

CTC Tab	Subtab	[Subtab]: Actions	Retrieve	Maintenance	Provisioning	Superuser
Circuits	Circuits	Create/Edit/Delete	—	—	X	X
		Filter/Search	X	X	X	X
	Rolls	Complete/ Force Valid Signal/ Finish	—	—	X	X
Provisioning	Security	Users: Create/Delete/Clear Security Intrusion Alarm	—	—	—	X
		Users: Change	Same User	Same User	Same User	All Users
		Active logins: Logout/Retrieve Last Activity Time	—	—	—	X
		Policy: Change	—	—	—	X
	Alarm Profiles	New/Load/Store/Delete[1]	—	—	X	X
		Compare/Available/Usage	X	X	X	X
	BLSR (ANSI) MS-SPRing (ETSI)	Create/Edit/Delete/Upgrade	—	—	X	X
	Overhead Circuits	Create/Delete/Edit/Merge	—	—	X	X
		Search	X	X	X	X
	Provisionable Patchcords (PPC)	Create/Edit/Delete	—	—	X	X
	Server Trails	Create/Edit/Delete	—	—	X	X
	VLAN DB Profile	Load/Store/Merge/Circuits	X	X	X	X
		Add/Remove Rows	—	—	X	X
Maintenance	Software	Download/Cancel	—	X	X	X
	Diagnostic	OSPF Node Information: Retrieve/Clear	X	X	X	X
	APC	Run APC/Disable APC	—	—	—	X
		Refresh	X	X	X	X

1. The action buttons in the subtab are active for all users, but the actions can be completely performed only by the users assigned with the required security levels.

15.2.2 Security Policies

Superusers can provision security policies on the ONS 15454. These security policies include idle user timeouts, password changes, password aging, and user lockout parameters. In addition, Superusers can access the ONS 15454 through the TCC2/TCC2P/TCC3 RJ-45 port, the backplane LAN connection, or both.

15.2.2.1 Superuser Privileges for Provisioning Users

Superusers can grant permission to Provisioning users to perform a set of tasks. The tasks include retrieving audit logs, restoring databases, clearing PMs, and activating and reverting software loads. These privileges can be set only through CTC network element (NE) defaults, except the PM clearing privilege, which can be granted to Provisioning users using CTC Provisioning> Security > Access tabs. For more information on setting up Superuser privileges, refer to the *Cisco ONS 15454 DWDM Procedure Guide*.

15.2.2.2 Idle User Timeout

Each ONS 15454 CTC or TL1 user can be idle during his or her login session for a specified amount of time before the CTC window is locked. The lockouts prevent unauthorized users from making changes. Higher-level users have shorter default idle periods and lower-level users have longer or unlimited default idle periods, as shown in Table 15-3.

Table 15-3 ONS 15454 Default User Idle Times

Security Level	Idle Time
Superuser	15 minutes
Provisioning	30 minutes
Maintenance	60 minutes
Retrieve	Unlimited

15.2.2.3 User Password, Login, and Access Policies

Superusers can view real-time lists of users who are logged into CTC or TL1 user logins by node. Superusers can also provision the following password, login, and node access policies:

- Password length, expiration and reuse—Superusers can configure the password length by using NE defaults. The password length, by default, is set to a minimum of six and a maximum of 20 characters. You can configure the default values in CTC node view with the Provisioning > NE Defaults > Node > security > password Complexity tabs. The minimum length can be set to eight, ten or twelve characters, and the maximum length to 80 characters. The password must be a combination of alphanumeric (a-z, A-Z, 0-9) and special (+, #,%) characters, where at least two characters are nonalphabetic and at least one character is a special character. Superusers can specify when users must change their passwords and when they can reuse them.
- Locking out and disabling users—Superusers can provision the number of invalid logins that are allowed before locking out users and the length of time before inactive users are disabled. The number of allowed lockout attempts is set to the number of allowed login attempts.
- Node access and user sessions—Superusers can limit the number of CTC sessions one user can have, and they can prohibit access to the ONS 15454 using the LAN or TCC2/TCC2P/TCC3 RJ-45 connections.

  In addition, a Superuser can select secure shell (SSH) instead of Telnet at the CTC Provisioning > Security > Access tabs. SSH is a terminal-remote host Internet protocol that uses encrypted links. It provides authentication and secure communication over unsecure channels. Port 22 is the default port and cannot be changed.

15.3 Audit Trail

The Cisco ONS 15454 maintains a Telcordia GR-839-CORE-compliant audit trail log that resides on the TCC2/TCC2P/TCC3/TNC/TSC card. Audit trails are useful for maintaining security, recovering lost transactions and enforcing accountability. Accountability refers to tracing user activities; that is, associating a process or action with a specific user. This record shows who has accessed the system and what operations were performed during a given period of time. The log includes authorized Cisco logins and logouts using the operating system command line interface, CTC, and TL1; the log also includes FTP actions, circuit creation/deletion, and user/system generated actions.

Event monitoring is also recorded in the audit log. An event is defined as the change in status of an element within the network. External events, internal events, attribute changes, and software upload/download activities are recorded in the audit trail.

The audit trail is stored in persistent memory and is not corrupted by processor switches, resets or upgrades. However, if a user pulls both TCC2/TCC2P/TCC3/TNC/TSC cards, the audit trail log is lost.

15.3.1 Audit Trail Log Entries

Table 15-4 contains the columns listed in Audit Trail window.

Table 15-4 Audit Trail Window Columns

Heading	Explanation
Date	Date when the action occurred
Num	Incrementing count of actions
User	User ID that initiated the action
P/F	Pass/Fail (whether or not the action was executed)
Operation	Action that was taken

Audit trail records capture the following activities:

- User—Name of the user performing the action
- Host—Host from where the activity is logged
- Device ID—IP address of the device involved in the activity
- Application—Name of the application involved in the activity
- Task—Name of the task involved in the activity (view a dialog box, apply configuration, and so on)
- Connection Mode—Telnet, Console, Simple Network Management Protocol (SNMP)
- Category—Type of change: Hardware, Software, Configuration
- Status—Status of the user action: Read, Initial, Successful, Timeout, Failed
- Time—Time of change
- Message Type—Denotes whether the event is Success/Failure type
- Message Details—Description of the change

15.3.2 Audit Trail Capacities

The system is able to store 640 log entries.When this limit is reached, the oldest entries are overwritten with new events. When the log server is 80 percent full, an AUD-LOG-LOW condition is raised and logged (by way of Common Object Request Broker Architecture [CORBA]/CTC).

When the log server reaches a maximum capacity of 640 entries and begins overwriting records that were not archived, an AUD-LOG-LOSS condition is raised and logged. This event indicates that audit trail records have been lost. Until the user off-loads the file, this event occurs only once regardless of the amount of entries that are overwritten by the system.

15.4 RADIUS Security

Superusers can configure nodes to use Remote Authentication Dial In User Service (RADIUS) authentication. RADIUS uses a strategy known as authentication, authorization, and accounting (AAA) for verifying the identity of, granting access to, and tracking the actions of remote users. To configure RADIUS authentication, refer to the *Cisco ONS 15454 DWDM Procedure Guide*.

RADIUS server supports IPv6 addresses and can process authentication requests from a GNE or an ENE that uses IPv6 addresses.

15.4.1 RADIUS Authentication

RADIUS is a system of distributed security that secures remote access to networks and network services against unauthorized access. RADIUS comprises three components:

- A protocol with a frame format that utilizes User Datagram Protocol (UDP)/IP
- A server
- A client

The server runs on a central computer typically at the customer's site, while the clients reside in the dial-up access servers and can be distributed throughout the network.

An ONS 15454 node operates as a client of RADIUS. The client is responsible for passing user information to designated RADIUS servers, and then acting on the response that is returned. RADIUS servers are responsible for receiving user connection requests, authenticating the user, and returning all configuration information necessary for the client to deliver service to the user. The RADIUS servers can act as proxy clients to other kinds of authentication servers. Transactions between the client and RADIUS server are authenticated through the use of a shared secret, which is never sent over the network. In addition, any user passwords are sent encrypted between the client and RADIUS server. This eliminates the possibility that someone snooping on an unsecured network could determine a user's password.

15.4.2 Shared Secrets

A shared secret is a text string that serves as a password between:

- A RADIUS client and RADIUS server
- A RADIUS client and a RADIUS proxy
- A RADIUS proxy and a RADIUS server

For a configuration that uses a RADIUS client, a RADIUS proxy, and a RADIUS server, the shared secret that is used between the RADIUS client and the RADIUS proxy can be different than the shared secret used between the RADIUS proxy and the RADIUS server.

Shared secrets are used to verify that RADIUS messages, with the exception of the Access-Request message, are sent by a RADIUS-enabled device that is configured with the same shared secret. Shared secrets also verify that the RADIUS message has not been modified in transit (message integrity). The shared secret is also used to encrypt some RADIUS attributes, such as User-Password and Tunnel-Password.

When creating and using a shared secret:

- Use the same case-sensitive shared secret on both RADIUS devices.
- Use a different shared secret for each RADIUS server-RADIUS client pair.
- To ensure a random shared secret, generate a random sequence at least 22 characters long.
- You can use any standard alphanumeric and special characters.
- You can use a shared secret of up to 128 characters in length. To protect your server and your RADIUS clients from brute force attacks, use long shared secrets (more than 22 characters).
- Make the shared secret a random sequence of letters, numbers, and punctuation and change it often to protect your server and your RADIUS clients from dictionary attacks. Shared secrets should contain characters from each of the three groups listed in Table 15-5.

Table 15-5 Shared Secret Character Groups

Group	Examples
Letters (uppercase and lowercase)	A, B, C, D and a, b, c, d
Numerals	0, 1, 2, 3
Symbols (all characters not defined as letters or numerals)	Exclamation point (!), asterisk (*), colon (:)

The stronger your shared secret, the more secure the attributes (for example, those used for passwords and encryption keys) that are encrypted with it. An example of a strong shared secret is 8d#>9fq4bV)H7%a3-zE13sW$hIa32M#m<PqAa72(.

CHAPTER 16

Timing Reference

This chapter provides information about Cisco ONS 15454 users and node timing. To provision timing, refer to the *Cisco ONS 15454 DWDM Procedure Guide*.

Note Unless otherwise specified, "ONS 15454" refers to both ANSI and ETSI shelf assemblies.

Chapter topics include:

- 16.1 Node Timing Parameters, page 16-1
- 16.2 Network Timing, page 16-2
- 16.3 Synchronization Status Messaging, page 16-3

16.1 Node Timing Parameters

SONET timing parameters must be set for each Cisco ONS 15454 shelf. Each ONS 15454 independently accepts its timing reference from one of three sources:

- The building integrated timing supply (BITS) pins on the ONS 15454 backplane (ANSI) or MIC-C/T/P coaxial connectors (ETSI).
- An OC-N/STM-N card installed in the ONS 15454. The card is connected to a node that receives timing through a BITS source.
- The internal ST3 clock on the TCC2/TCC2P/TCC3/TNC/TSC card.

You can set ONS 15454 timing to one of three modes: external, line, or mixed. If timing is received from a BITS source, set ONS 15454 timing to external. If timing is received from an OC-N/STM-N card, set the timing to line. The BITS connection on Cisco ONS 15454 M6 shelf is through the external connection unit (ECU) and is through the power module on Cisco ONS 15454 M2 shelf.

In typical ONS 15454 networks:

- One node is set to external. The external node derives its timing from a BITS source wired to the BITS backplane pins. The BITS source, in turn, derives its timing from a primary reference source (PRS) such as a Stratum 1 clock or global positioning satellite (GPS) signal.
- The other nodes are set to line. The line nodes derive timing from the externally timed node through the OC-N/STM-N trunk (span) cards. The DWDM node normally derives timing from the line using the OSCM or OSC-CSM card that are inside an OC-3/STM-1 channel.

You can set three timing references for each ONS 15454. The first two references are typically two BITS-level sources, or two line-level sources optically connected to a node with a BITS source. The third reference is usually assigned to the internal clock provided on every ONS 15454 TCC2/TCC2P/TCC3/TNC/TSC card. However, if you assign all three references to other timing sources, the internal clock is always available as a backup timing reference. The internal clock is a Stratum 3 (ST3), so if an ONS 15454 node becomes isolated, timing is maintained at the ST3 level.

The CTC Maintenance > Timing > Report tab show current timing information for an ONS 15454, including the timing mode, clock state and status, switch type, and reference data.

Caution Mixed timing allows you to select both external and line timing sources. However, Cisco does not recommend its use because it can create timing loops. Use this mode with caution.

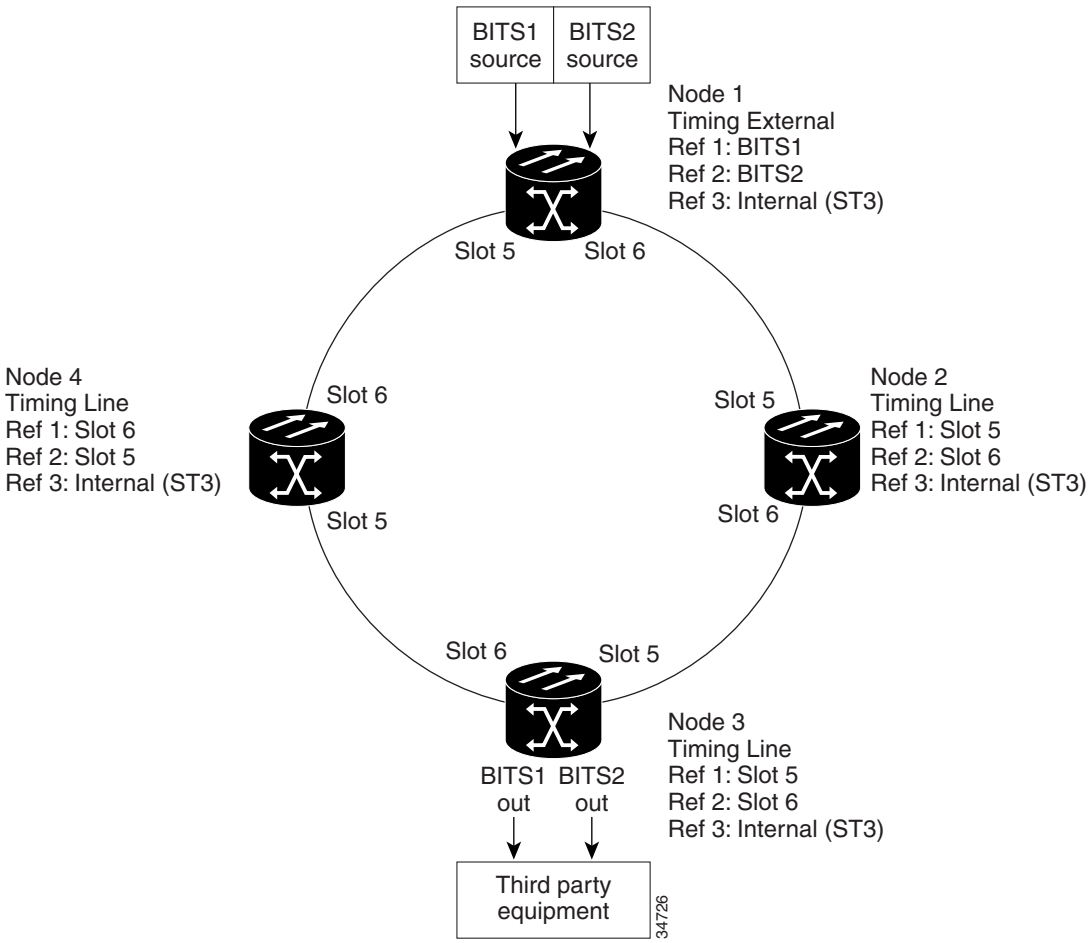
The OC3 port of the TNC/TSC card can be set as the timing reference. In the ONS 15454 M2 shelf, BITS-2 is not supported.

16.2 Network Timing

Figure 16-1 shows an ONS 15454 network timing setup example. Node 1 is set to external timing. Two timing references are set to BITS. These are Stratum 1 timing sources wired to the BITS input pins on the Node 1 backplane. The third reference is set to internal clock. The BITS output pins on the backplane of Node 3 are used to provide timing to outside equipment, such as a digital access line access multiplexer.

In the example, Slots 5 and 6 contain the trunk (span) cards. Timing at Nodes 2, 3, and 4 is set to line, and the timing references are set to the trunk cards based on distance from the BITS source. Reference 1 is set to the trunk card closest to the BITS source. At Node 2, Reference 1 is set to Slot 5 because it is connected to Node 1. At Node 4, Reference 1 is set to Slot 6 because it is connected to Node 1. At Node 3, Reference 1 could be either trunk card because they are at an equal distance from Node 1.

Figure 16-1 ONS 15454 Timing Example



16.3 Synchronization Status Messaging

Synchronization status messaging (SSM) is a SDH and SONET protocol that communicates information about the quality of the timing source. SSM messages are carried on the S1 byte of the SONET Line layer or on S1 byte of the SDH section overhead. They enable SONET or SDH devices to automatically select the highest quality timing reference and to avoid timing loops.

SSM messages are either Generation 1 or Generation 2. Generation 1 is the first and most widely deployed SSM message set. Generation 2 is a newer version. If you enable SSM for the ONS 15454 or the ONS 15454 SDH, consult your timing reference documentation to determine which message set to use.

Table 16-1 shows the SDH message set.

Table 16-1 SDH SSM Message Set

Message	Quality	Description
G811	1	Primary reference clock
STU	2	Sync traceability unknown
G812T	3	Transit node clock traceable
G812L	4	Local node clock traceable
SETS	5	Synchronous equipment
DUS	6	Do not use for timing synchronization

Table 16-2 and Table 16-3 on page 16-4 show the Generation 1 and Generation 2 message sets for SONET.

Table 16-2 SSM Generation 1 Message Set

Message	Quality	Description
PRS	1	Primary reference source—Stratum 1
STU	2	Synchronization traceability unknown
ST2	3	Stratum 2
ST3	4	Stratum 3
SMC	5	SONET minimum clock
ST4	6	Stratum 4
DUS	7	Do not use for timing synchronization
RES	—	Reserved; quality level set by user

Table 16-3 SSM Generation 2 Message Set

Message	Quality	Description
PRS	1	Primary reference source—Stratum 1
STU	2	Synchronization traceability unknown
ST2	3	Stratum 2
TNC	4	Transit node clock
ST3E	5	Stratum 3E
ST3	6	Stratum 3
SMC	7	SONET minimum clock
ST4	8	Stratum 4
DUS	9	Do not use for timing synchronization
RES	—	Reserved; quality level set by user

CHAPTER 17

Management Network Connectivity

This chapter provides an overview of ONS 15454 data communications network (DCN) connectivity. Cisco Optical Networking System (ONS) network communication is based on IP, including communication between Cisco Transport Controller (CTC) computers and ONS 15454 nodes, and communication among networked ONS 15454 nodes. The chapter shows common Cisco ONS 15454 IP network configurations and includes detailed data communications network (DCN) case studies that are based on actual ONS 15454 installations. The chapter provides information about the ONS 15454 IP routing table, external firewalls, and open gateway network element (GNE) networks.

Although ONS 15454 DCN communication is based on IP, ONS 15454 nodes can be networked to equipment that is based on the Open System Interconnection (OSI) protocol suites. This chapter also describes the ONS 15454 OSI implementation and provides scenarios that show how the ONS 15454 can be networked within a mixed IP and OSI environment.

This chapter does not provide a comprehensive explanation of IP networking concepts and procedures, nor does it provide IP addressing examples to meet all networked scenarios. For ONS 15454 networking setup instructions, refer to the "Turn Up a Node" chapter of the *Cisco ONS 15454 DWDM Procedure Guide*.

Note Unless otherwise specified, in this chapter "ONS 15454" refers to both ANSI and ETSI shelf assemblies.

Chapter topics include:

- 17.1 IP Networking Overview, page 17-2
- 17.2 IP Addressing Scenarios, page 17-2
- 17.3 DCN Case Studies, page 17-23
- 17.4 DCN Extension, page 17-37
- 17.5 Routing Table, page 17-39
- 17.6 External Firewalls, page 17-41
- 17.7 Open GNE, page 17-42
- 17.8 TCP/IP and OSI Networking, page 17-45
- 17.9 Link Management Protocol, page 17-49
- 17.10 IPv6 Network Compatibility, page 17-54
- 17.11 IPv6 Native Support, page 17-54
- 17.12 Integration with Cisco CRS-1 Routers, page 17-57
- 17.13 Photonic Path Trace, page 17-61

- 17.14 Shared Risk Link Group, page 17-62
- 17.15 Proactive Protection Regen, page 17-63

Note To connect ONS 15454s to an IP network, you must work with a LAN administrator or other individual at your site who has IP networking training and experience.

17.1 IP Networking Overview

ONS 15454s can be connected in many different ways within an IP environment:

- They can be connected to LANs through direct connections or a router.
- IP subnetting can create ONS 15454 node groups that allow you to provision nodes in a network that are not connected with a data communications channel (DCC).
- Different IP functions and protocols can be used to achieve specific network goals. For example, Proxy Address Resolution Protocol (ARP) enables one LAN-connected ONS 15454 to serve as a gateway for ONS 15454s that are not connected to the LAN.
- Static routes can be created to enable connections among multiple CTC sessions with ONS 15454s that reside on the same subnet with multiple CTC sessions.
- ONS 15454s can be connected to Open Shortest Path First (OSPF) networks so ONS 15454 network information is automatically communicated across multiple LANs and WANs.
- The ONS 15454 proxy server can control the visibility and accessibility between CTC computers and ONS 15454 element nodes.

17.2 IP Addressing Scenarios

ONS 15454 IP addressing generally has nine common scenarios or configurations. Use the scenarios as building blocks for more complex network configurations. Table 17-1 provides a general list of items to check when setting up ONS 15454s in IP networks.

Table 17-1 General ONS 15454 IP Troubleshooting Checklist

Item	What to Check
Link integrity	Verify that link integrity exists between: • CTC computer and network hub/switch • ONS 15454s (backplane [ANSI] or MIC-C/T/P [ETSI] wire-wrap pins or RJ-45 port) and network hub/switch • Router ports and hub/switch ports
ONS 15454 hub/switch ports	If connectivity problems occur, set the hub or switch port that is connected to the ONS 15454 to 10 Mbps half-duplex.
Ping	Ping the node to test connections between computers and ONS 15454s.

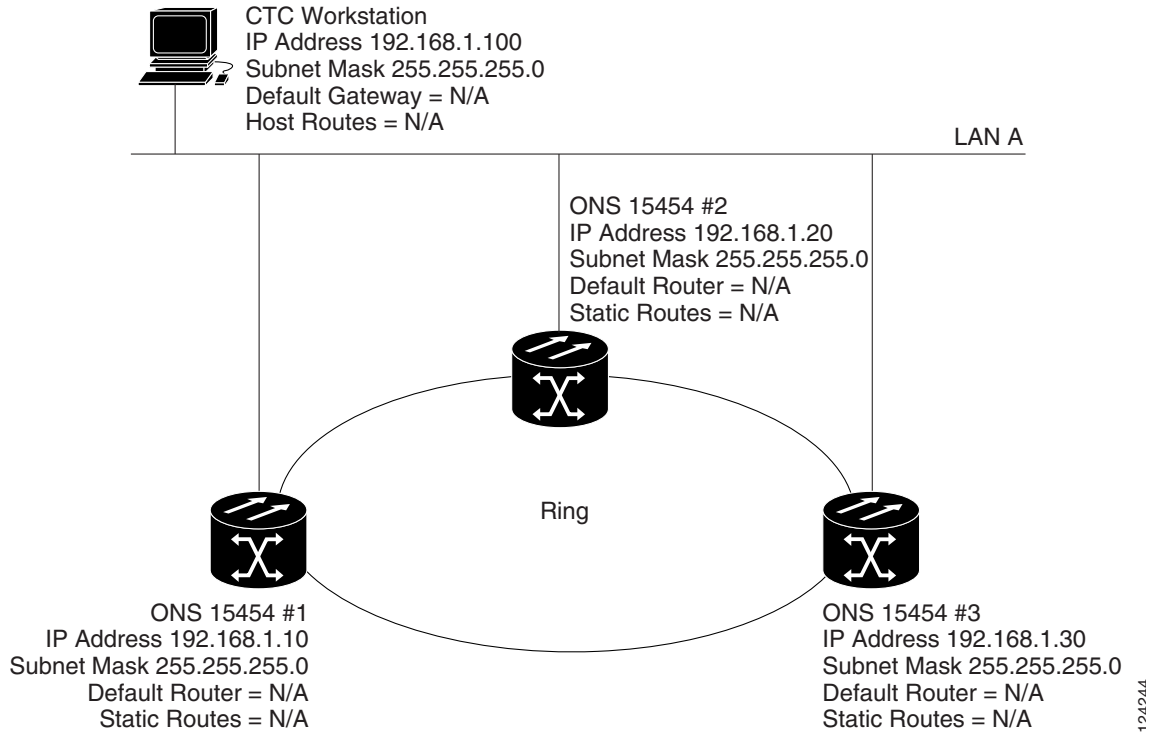
Table 17-1 General ONS 15454 IP Troubleshooting Checklist (continued)

Item	What to Check
IP addresses/subnet masks	Verify that ONS 15454 IP addresses and subnet masks are set up correctly.
Optical connectivity	Verify that ONS 15454 optical trunk ports are in service and that a DCC is enabled on each trunk port.

17.2.1 Scenario 1: CTC and ONS 15454s on Same Subnet

Scenario 1 shows a basic ONS 15454 LAN configuration (Figure 17-1). The ONS 15454s and CTC computer reside on the same subnet. All ONS 15454s connect to LAN A, and all ONS 15454s have DCC connections.

Figure 17-1 Scenario 1: CTC and ONS 15454s on Same Subnet (ANSI and ETSI)

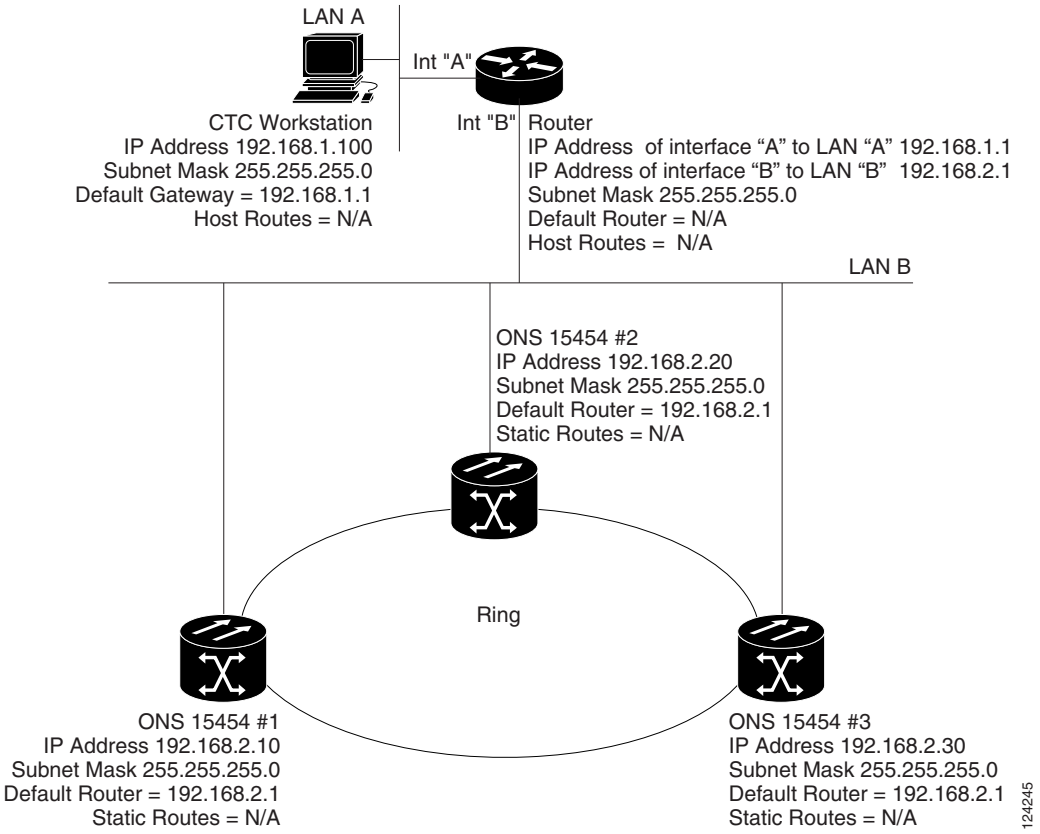


17.2.2 Scenario 2: CTC and ONS 15454s Connected to a Router

In Scenario 2, the CTC computer resides on a subnet (192.168.1.0) and attaches to LAN A (Figure 17-2). The ONS 15454s reside on a different subnet (192.168.2.0) and attach to LAN B. A router connects LAN A to LAN B. The IP address of router interface A is set to LAN A (192.168.1.1), and the IP address of router interface B is set to LAN B (192.168.2.1). The routers each have a subnet mask of 255.255.255.0.

On the CTC computer, the default gateway is set to router interface A. If the LAN uses Dynamic Host Configuration Protocol (DHCP), the default gateway and IP address are assigned automatically. In the Figure 17-2 example, a DHCP server is not available.

Figure 17-2 Scenario 2: CTC and ONS 15454s Connected to Router (ANSI and ETSI)



17.2.3 Scenario 3: Using Proxy ARP to Enable an ONS 15454 Gateway

ARP matches higher-level IP addresses to the physical addresses of the destination host. It uses a lookup table (called ARP cache) to perform the translation. When the address is not found in the ARP cache, a broadcast is sent out on the network with a special format called the ARP request. If one of the machines on the network recognizes its own IP address in the request, it sends an ARP reply back to the requesting host. The reply contains the physical hardware address of the receiving host. The requesting host stores this address in its ARP cache so that all subsequent datagrams (packets) to this destination IP address can be translated to a physical address.

Proxy ARP enables one LAN-connected ONS 15454 to respond to the ARP request for ONS 15454s not connected to the LAN. (ONS 15454 proxy ARP requires no user configuration.) For this to occur, the DCC-connected ONS 15454s must reside on the same subnet as the LAN-connected (gateway)

ONS 15454. When a LAN device sends an ARP request to an ONS 15454 that is not connected to the LAN, the gateway ONS 15454 (the one connected to the LAN) returns its MAC address to the LAN device. The LAN device then sends the datagram for the remote ONS 15454 to the MAC address of the proxy ONS 15454. The proxy ONS 15454 uses its routing table to forward the datagram to the non-LAN ONS 15454.

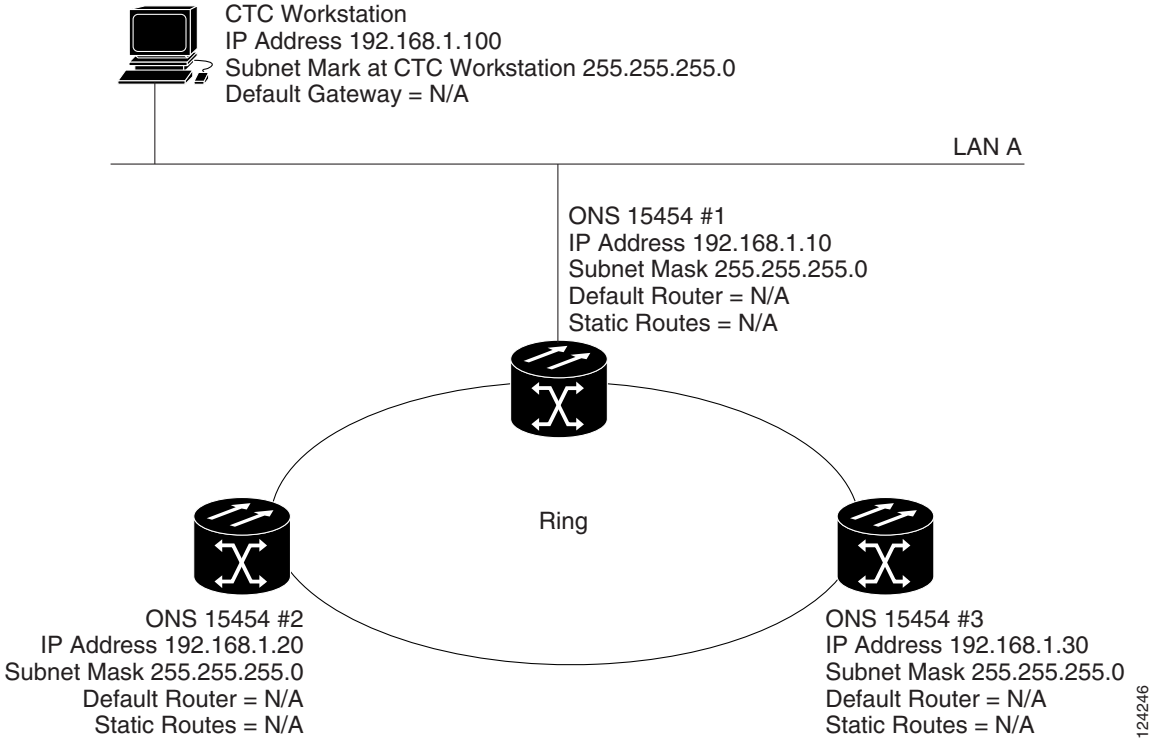
Scenario 3 is similar to Scenario 1, but only one ONS 15454 (Node 1) connects to the LAN (Figure 17-3). Two ONS 15454s (Node 2 and Node 3) connect to ONS 15454 Node 1 through the section DCC. Because all three ONS 15454s are on the same subnet, proxy ARP enables ONS 15454 Node 1 to serve as a gateway for ONS 15345 Node 2 and Node 3.

Note This scenario assumes all CTC connections are to Node 1. If you connect a laptop to either ONS 15454 Node 2 or Node 3, network partitioning occurs; neither the laptop or the CTC computer can see all nodes. If you want laptops to connect directly to end network elements (ENEs), you must create static routes (see the "17.2.5 Scenario 5: Using Static Routes to Connect to LANs" section on page 17-8) or enable the ONS 15454 proxy server (see "17.2.7 Scenario 7: Provisioning the ONS 15454 Proxy Server" section on page 17-12).

Be aware that:

- GNE and ENE 15454 proxy ARP is disabled.
- There is exactly one proxy ARP server on any given Ethernet segment; however, there might be more than one server in an ANSI or ETSI topology.
- The proxy ARP server does not perform the proxy ARP function for any node or host that is on the same Ethernet segment.
- It is important in Figure 17-3 that the CTC workstation be located within the same subnet and on the same Ethernet segment as the proxy ARP server.

Figure 17-3 Scenario 3: Using Proxy ARP (ANSI and ETSI)

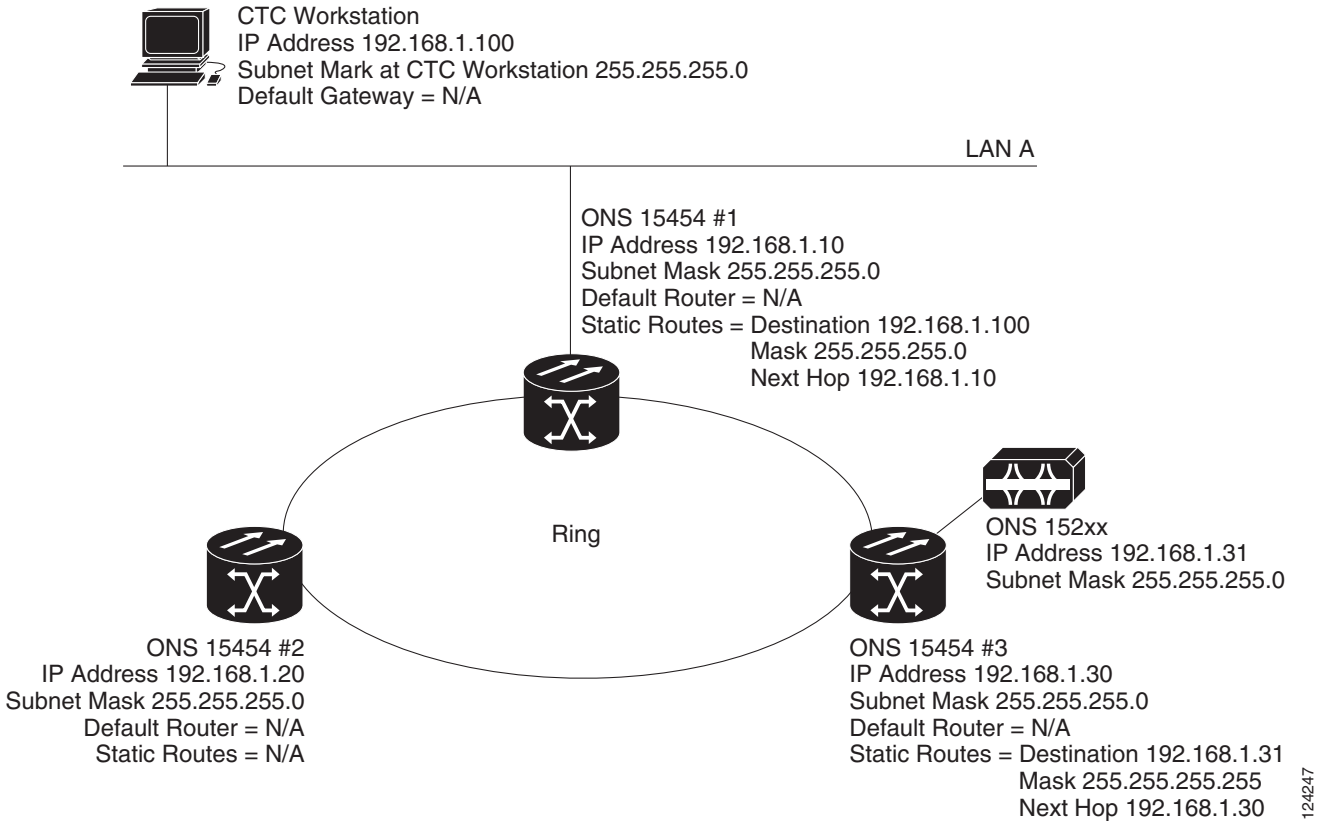


You can also use proxy ARP to communicate with hosts attached to the craft Ethernet ports of DCC-connected nodes (Figure 17-4). The node with an attached host must have a static route to the host. Static routes are propagated to all DCC peers using OSPF. The existing proxy ARP node is the gateway for additional hosts. Each node examines its routing table for routes to hosts that are not connected to the DCC network but are within the subnet. The existing proxy server replies to ARP requests for these additional hosts with the node MAC address. The existence of the host route in the routing table ensures that the IP packets addressed to the additional hosts are routed properly. Other than establishing a static route between a node and an additional host, no provisioning is necessary. The following restrictions apply:

- Only one node acts as the proxy ARP server for any given additional host.
- A node cannot be the proxy ARP server for a host connected to its Ethernet port.

In Figure 17-4, Node 1 announces to Node 2 and 3 that it can reach the CTC host. Similarly, Node 3 announces that it can reach the ONS 152xx. The ONS 152xx is shown as an example; any network element can be set up as an additional host.

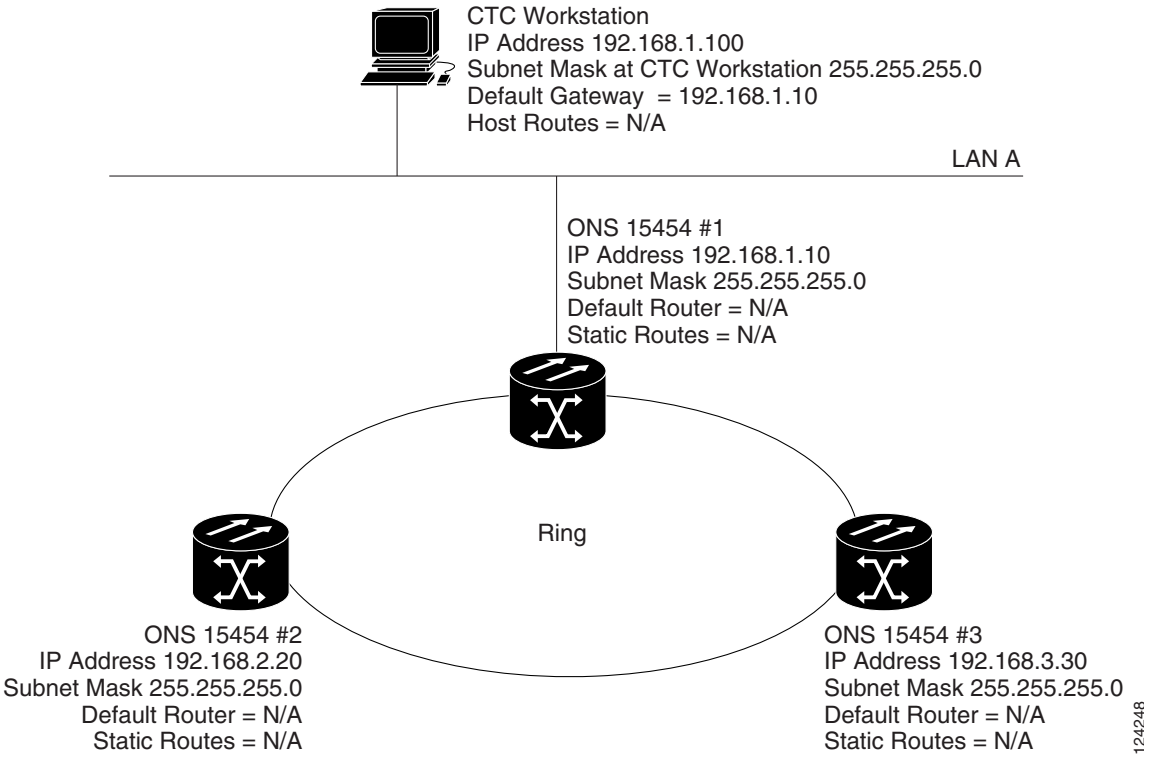
Figure 17-4 Scenario 3: Using Proxy ARP with Static Routing (ANSI and ETSI)



17.2.4 Scenario 4: Default Gateway on CTC Computer

Scenario 4 is similar to Scenario 3, but Nodes 2 and 3 reside on different subnets, 192.168.2.0 and 192.168.3.0, respectively (Figure 17-5). Node 1 and the CTC computer are on subnet 192.168.1.0. Proxy ARP is not used because the network includes different subnets. For the CTC computer to communicate with Nodes 2 and 3, Node 1 is entered as the default gateway on the CTC computer.

Figure 17-5 Scenario 4: Default Gateway on a CTC Computer (ANSI and ETSI)



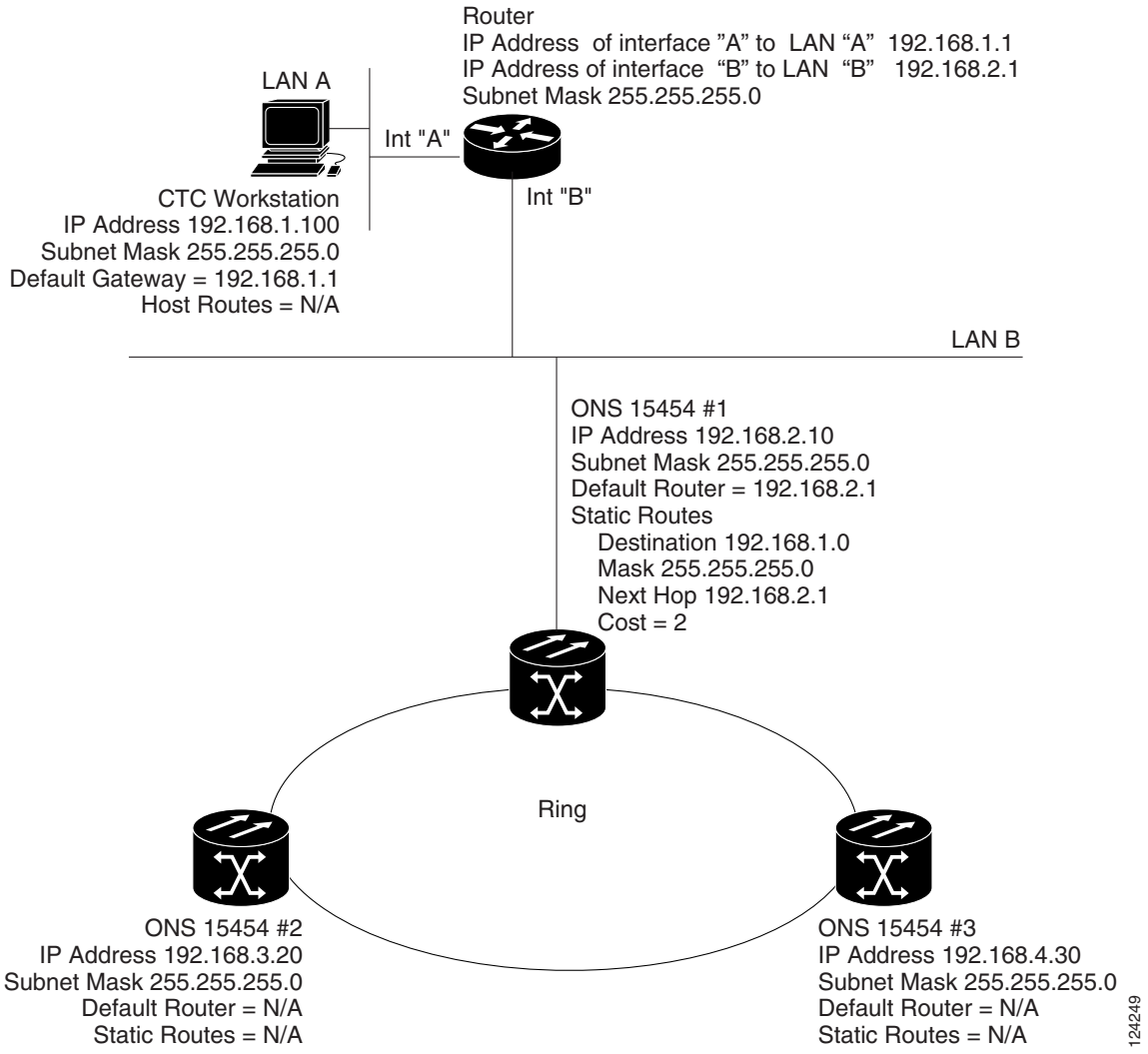
17.2.5 Scenario 5: Using Static Routes to Connect to LANs

Static routes are used for two purposes:

- To connect ONS 15454s to CTC sessions on one subnet connected by a router to ONS 15454s residing on another subnet. (These static routes are not needed if OSPF is enabled. Scenario 6 shows an OSPF example.)
- To enable multiple CTC sessions among ONS 15454s residing on the same subnet.

In Figure 17-6, one CTC residing on subnet 192.168.1.0 connects to a router through interface A (the router is not set up with OSPF). ONS 15454s residing on different subnets are connected through Node 1 to the router through interface B. Because Nodes 2 and 3 are on different subnets, proxy ARP does not enable Node 1 as a gateway. To connect to CTC computers on LAN A, a static route is created on Node 1.

Figure 17-6 Scenario 5: Static Route With One CTC Computer Used as a Destination (ANSI and ETSI)

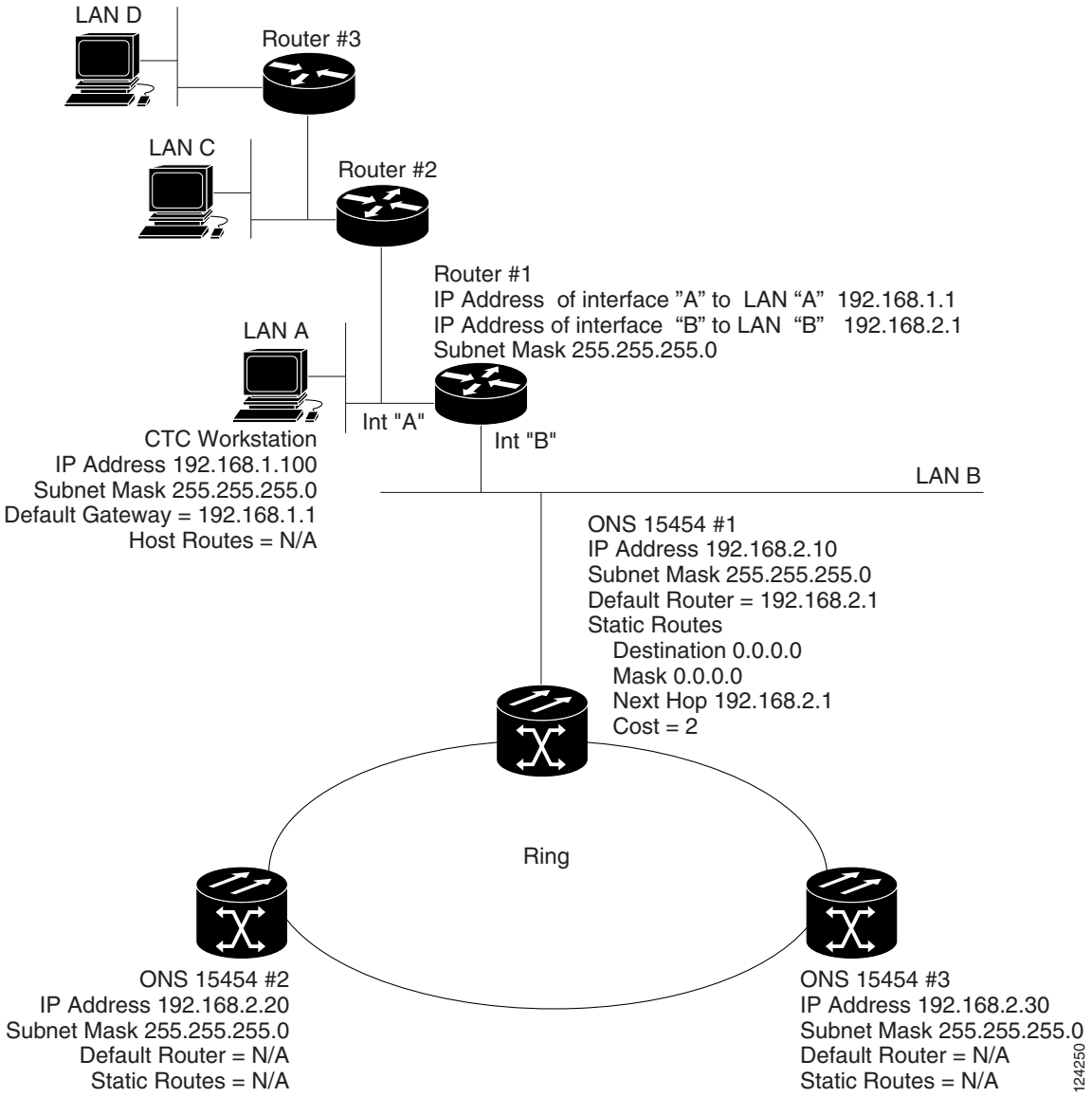


The destination and subnet mask entries control access to the ONS 15454s:

- If a single CTC computer is connected to a router, enter the complete CTC "host route" IP address as the destination with a subnet mask of 255.255.255.255.
- If CTC computers on a subnet are connected to a router, enter the destination subnet (in this example, 192.168.1.0) and a subnet mask of 255.255.255.0.
- If all CTC computers are connected to a router, enter a destination of 0.0.0.0 and a subnet mask of 0.0.0.0. Figure 17-7 shows an example.

The IP address of router interface B is entered as the next hop, and the cost (number of hops from source to destination) is 2.

Figure 17-7 Scenario 5: Static Route With Multiple LAN Destinations (ANSI and ETSI)



17.2.6 Scenario 6: Using OSPF

Open Shortest Path First (OSPF) is a link state Internet routing protocol. Link state protocols use a "hello protocol" to monitor their links with adjacent routers and to test the status of their links to their neighbors. Link state protocols advertise their directly connected networks and their active links. Each link state router captures the link state "advertisements" and puts them together to create a topology of the entire network or area. From this database, the router calculates a routing table by constructing a shortest path tree. Routes are recalculated when topology changes occur.

ONS 15454s use the OSPF protocol in internal ONS 15454 networks for node discovery, circuit routing, and node management. You can enable OSPF on the ONS 15454s so that the ONS 15454 topology is sent to OSPF routers on a LAN. Advertising the ONS 15454 network topology to LAN routers

eliminates the need to manually enter static routes for ONS 15454 subnetworks. Figure 17-8 shows a network enabled for OSPF. Figure 17-9 shows the same network without OSPF. Static routes must be manually added to the router for CTC computers on LAN A to communicate with Nodes 2 and 3 because these nodes reside on different subnets.

OSPF divides networks into smaller regions, called areas. An area is a collection of networked end systems, routers, and transmission facilities organized by traffic patterns. Each OSPF area has a unique ID number, known as the area ID. Every OSPF network has one backbone area called "area 0." All other OSPF areas must connect to area 0.

When you enable an ONS 15454 OSPF topology for advertising to an OSPF network, you must assign an OSPF area ID in decimal format to the ONS 15454 network. An area ID is a "dotted quad" value that appears similar to an IP address. Coordinate the area ID number assignment with your LAN administrator. All DCC-connected ONS 15454s should be assigned the same OSPF area ID.

Note It is recommended that the number of ONS 15454s in an OSPF area be limited, because this allows faster loading into a CTC an is less likely to incur any problems.

Figure 17-8 Scenario 6: OSPF Enabled (ANSI and ETSI)

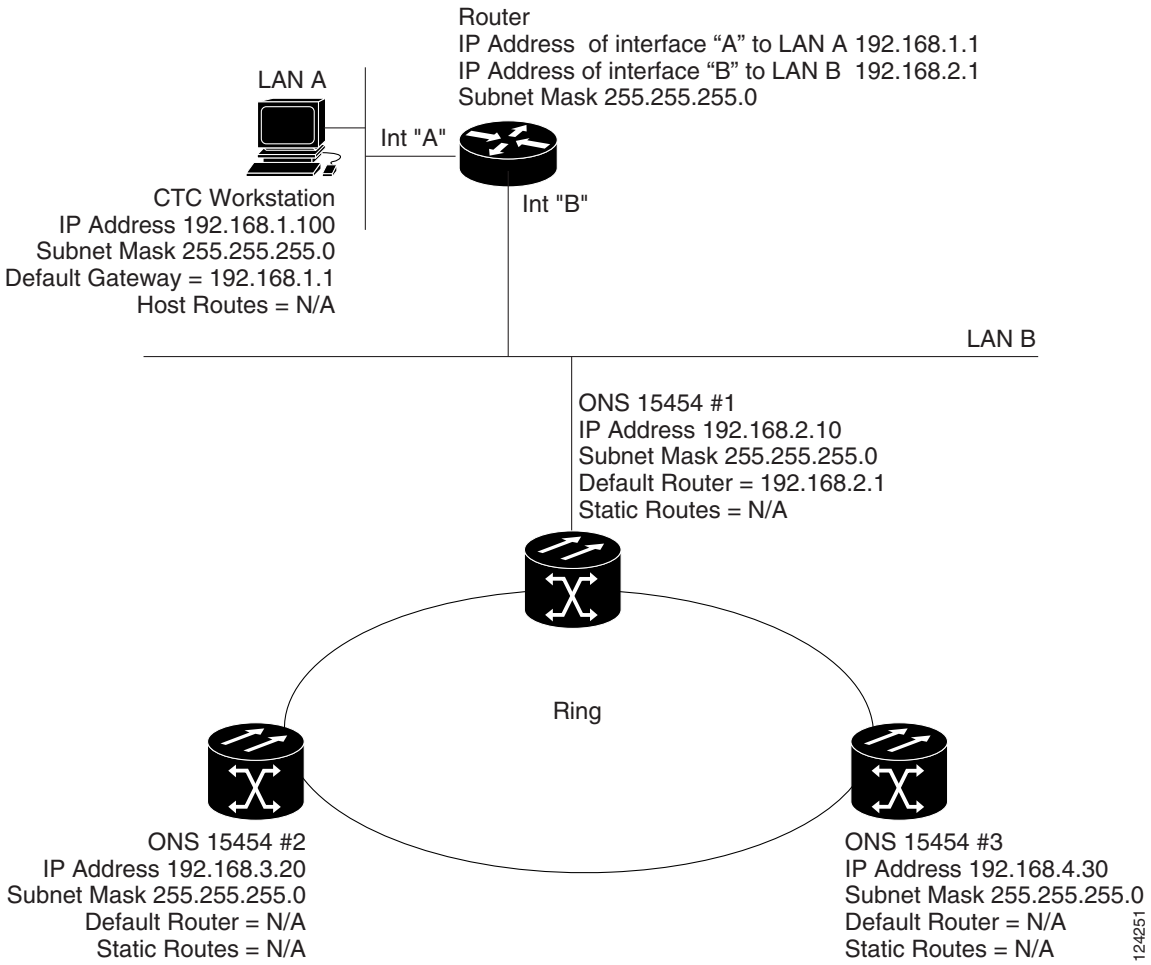
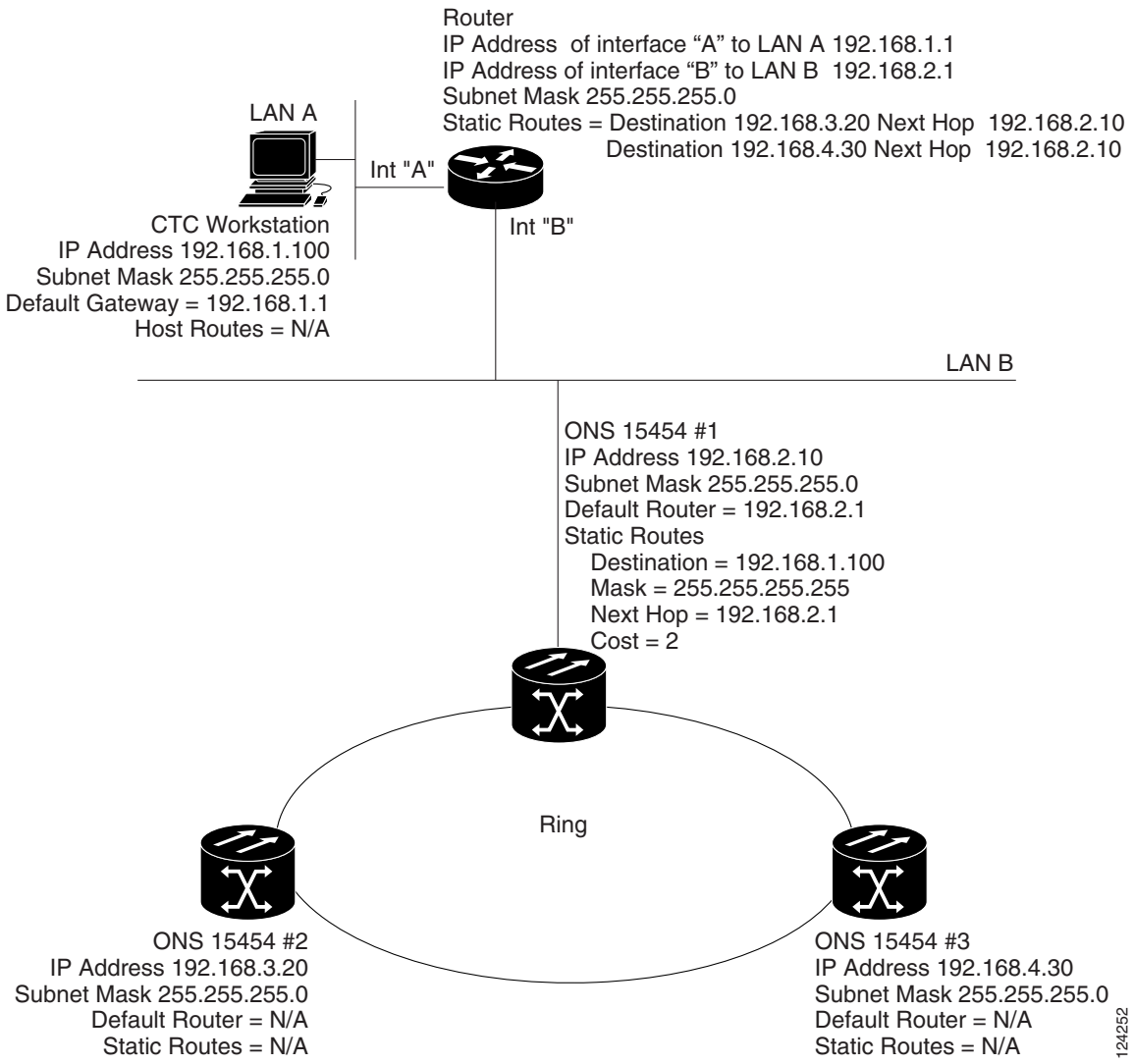


Figure 17-9 Scenario 6: OSPF Not Enabled (ANSI and ETSI)



17.2.7 Scenario 7: Provisioning the ONS 15454 Proxy Server

The ONS 15454 proxy server is a set of functions that allows you to network ONS 15454s in environments where visibility and accessibility between ONS 15454s and CTC computers must be restricted. For example, you can set up a network so that field technicians and network operations center (NOC) personnel can both access the same ONS 15454s while preventing the field technicians from accessing the NOC LAN. To do this, one ONS 15454 is provisioned as a GNE and the other ONS 15454s are provisioned as end ENEs. The GNE ONS 15454 tunnels connections between CTC computers and ENE ONS 15454s, providing management capability while preventing access for non-ONS 15454 management purposes.

The ONS 15454 gateway setting performs the following tasks:

- Isolates DCC IP traffic from Ethernet (craft port) traffic and accepts packets based on filtering rules. The filtering rules (see Table 17-3 on page 17-17 and Table 17-4 on page 17-17) depend on whether the packet arrives at the ONS 15454 DCC or TCC2/TCC2P/TCC3/TNC/TSC Ethernet interface.
- Processes Simple Network Time Protocol (SNTP) and Network Time Protocol (NTP) requests. ONS 15454 ENEs can derive time-of-day from an SNTP/NTP LAN server through the GNE ONS 15454.
- Processes Simple Network Management Protocol version 1 (SNMPv1) traps. The GNE ONS 15454 receives SNMPv1 traps from the ENE ONS 15454s and forwards or relays the traps to SNMPv1 trap destinations or ONS 15454 SNMP relay nodes.

The ONS 15454 proxy server is provisioned using the Enable proxy server on port check box on the Provisioning > Network > General tab. If checked, the ONS 15454 serves as a proxy for connections between CTC clients and ONS 15454s that are DCC-connected to the proxy ONS 15454. The CTC client establishes connections to DCC-connected nodes through the proxy node. The CTC client can connect to nodes that it cannot directly reach from the host on which it runs. If not selected, the node does not proxy for any CTC clients, although any established proxy connections continue until the CTC client exits. In addition, you can set the proxy server as an ENE or a GNE:

- External Network Element (ENE)—If set as an ENE, the ONS 15454 neither installs nor advertises default or static routes that go through its Ethernet port. However, an ENE does install and advertise routes that go through the DCC. CTC computers can communicate with the ONS 15454 using the TCC2/TCC2P/TCC3/TNC/TSC craft port, but they cannot communicate directly with any other DCC-connected ONS 15454.

  In addition, firewall is enabled, which means that the node prevents IP traffic from being routed between the DCC and the LAN port. The ONS 15454 can communicate with machines connected to the LAN port or connected through the DCC. However, the DCC-connected machines cannot communicate with the LAN-connected machines, and the LAN-connected machines cannot communicate with the DCC-connected machines. A CTC client using the LAN to connect to the firewall-enabled node can use the proxy capability to manage the DCC-connected nodes that would otherwise be unreachable. A CTC client connected to a DCC-connected node can only manage other DCC-connected nodes and the firewall itself.
- Gateway Network Element (GNE)—If set as a GNE, the CTC computer is visible to other DCC-connected nodes and firewall is enabled.
- SOCKS Proxy-only—If Proxy-only is selected, firewall is not enabled. CTC can communicate with any other DCC-connected ONS 15454s.

Note If you launch CTC against a node through a Network Address Translation (NAT) or Port Address Translation (PAT) router and that node does not have proxy enabled, your CTC session starts and initially appears to be fine. However CTC never receives alarm updates and disconnects and reconnects every two minutes. If the proxy is accidentally disabled, it is still possible to enable the proxy during a reconnect cycle and recover your ability to manage the node, even through a NAT/PAT firewall.

Note ENEs that belong to different private subnetworks do not need to have unique IP addresses. Two ENEs that are connected to different GNEs can have the same IP address. However, ENEs that connect to the same GNE must always have unique IP addresses.

Figure 17-10 shows an ONS 15454 proxy server implementation. A GNE ONS 15454 is connected to a central office LAN and to ENE ONS 15454s. The central office LAN is connected to a NOC LAN, which has CTC computers. The NOC CTC computer and craft technicians must both be able to access the ONS 15454 ENEs. However, the craft technicians must be prevented from accessing or seeing the NOC or central office LANs.

In the example, the ONS 15454 GNE is assigned an IP address within the central office LAN and is physically connected to the LAN through its LAN port. ONS 15454 ENEs are assigned IP addresses that are outside the central office LAN and given private network IP addresses. If the ONS 15454 ENEs are collocated, the craft LAN ports could be connected to a hub. However, the hub should have no other network connections.

Figure 17-10 Scenario 7: ONS 15454 Proxy Server with GNE and ENEs on the Same Subnet (ANSI and ETSI)

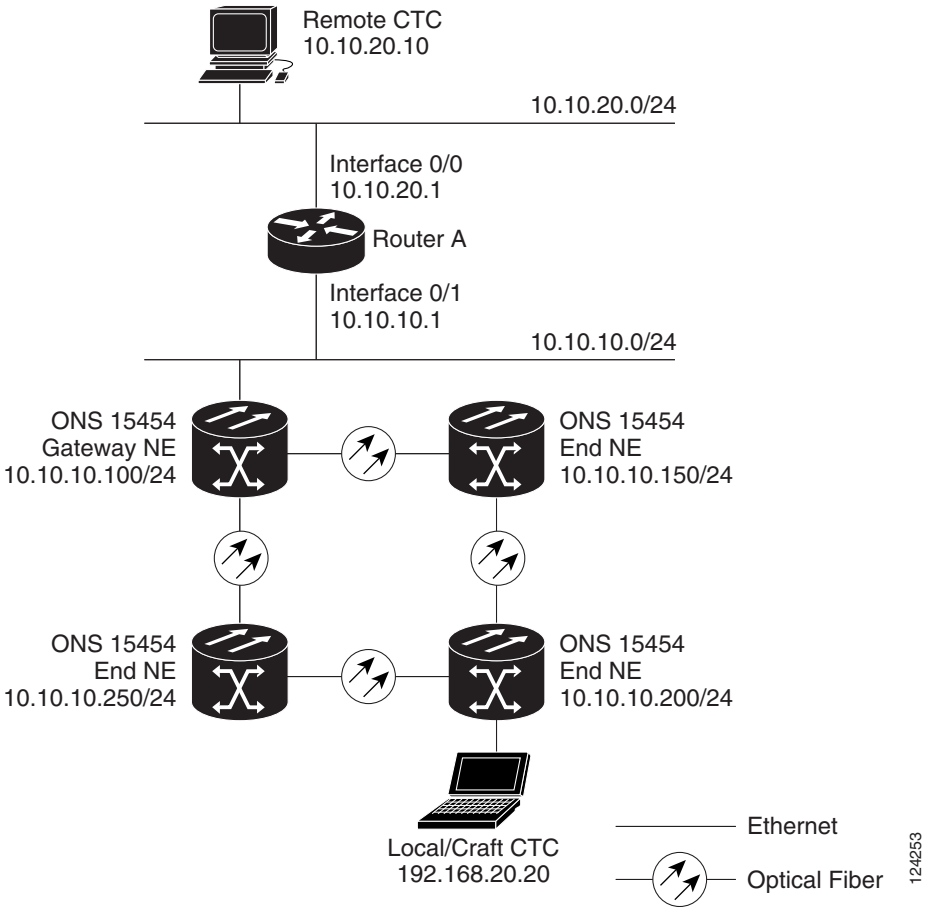


Table 17-2 shows recommended settings for ONS 15454 GNEs and ENEs in the configuration shown in Figure 17-10.

Table 17-2 ONS 15454 Gateway and End NE Settings

Setting	ONS 15454 Gateway NE	ONS 15454 End NE
OSPF	Off	Off

Table 17-2 ONS 15454 Gateway and End NE Settings (continued)

Setting	ONS 15454 Gateway NE	ONS 15454 End NE
SNTP server (if used)	SNTP server IP address	Set to ONS 15454 GNE IP address
SNMP (if used)	SNMPv1 trap destinations	Set SNMPv1 trap destinations to ONS 15454 GNE, port 391

Figure 17-11 shows the same proxy server implementation with ONS 15454 ENEs on different subnets. The ONS 15454 GNEs and ENEs are provisioned with the settings shown in Table 17-2.

Figure 17-11 Scenario 7: ONS 15454 Proxy Server with GNE and ENEs on Different Subnets (ANSI and ETSI)

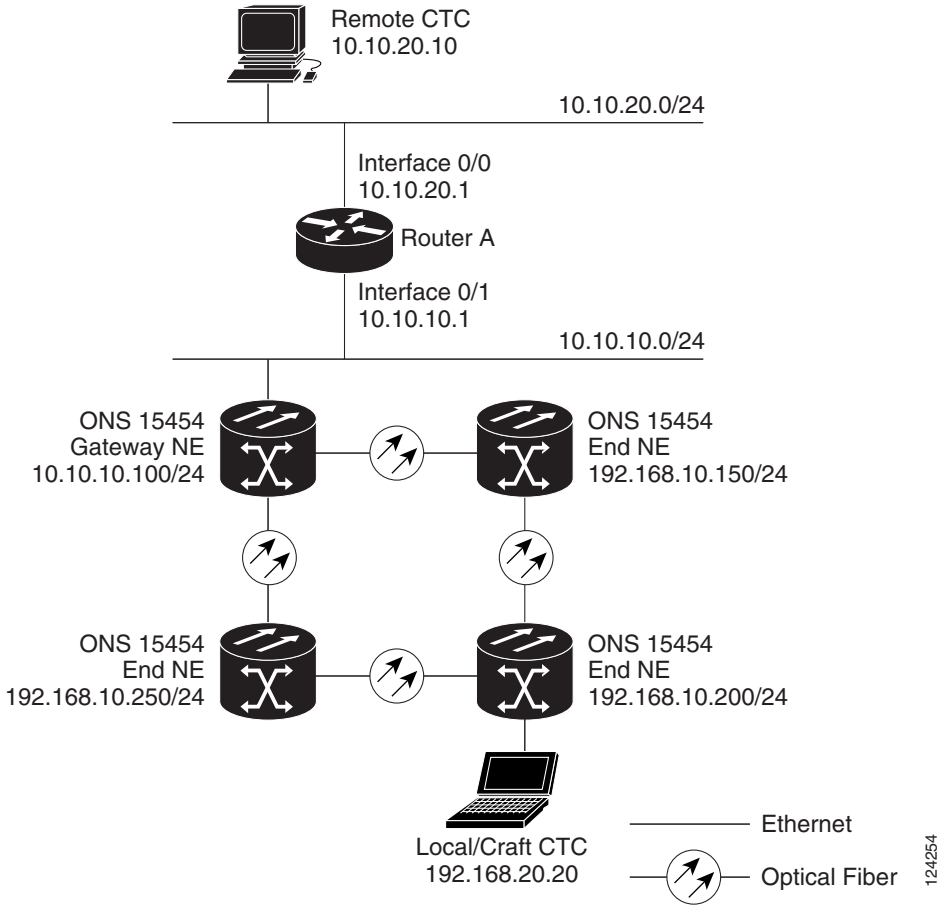


Figure 17-12 shows the same proxy server implementation with ONS 15454 ENEs in multiple rings.

Figure 17-12 Scenario 7: ONS 15454 Proxy Server With ENEs on Multiple Rings (ANSI and ETSI)

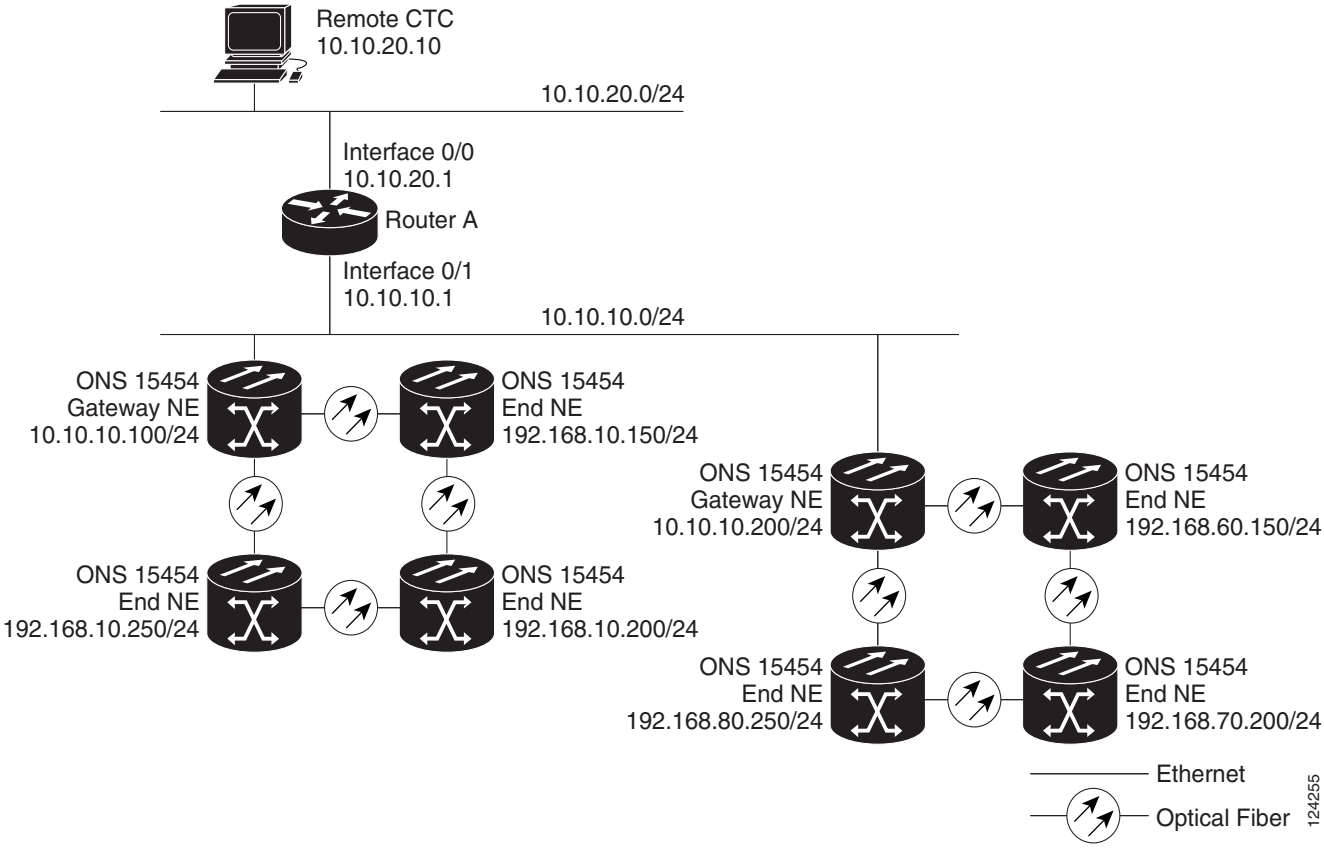


Table 17-3 shows the rules the ONS 15454 follows to filter packets for the firewall when nodes are configured as ENEs and GNEs. If the packet is addressed to the ONS 15454, additional rules (shown in Table 17-4) are applied. Rejected packets are silently discarded.

Table 17-3 Proxy Server Firewall Filtering Rules

Packets Arriving At:	Are Accepted if the Destination IP Address is:
TCC2/TCC2P/TCC3 /TNC/TSC Ethernet interface	• The ONS 15454 itself • The ONS 15454's subnet broadcast address • Within the 224.0.0.0/8 network (reserved network used for standard multicast messages) • Subnet mask = 255.255.255.255
DCC interface	• The ONS 15454 itself • Any destination connected through another DCC interface • Within the 224.0.0.0/8 network

Table 17-4 Proxy Server Firewall Filtering Rules

Packets Arriving At:	Are Rejected If:
TCC2/TCC2P/TCC3 /TNC/TSC Ethernet interface	• User Datagram Protocol (UDP) packets addressed to the SNMP trap relay port (391)
DCC interface	• Transmission Control Protocol (TCP) packets addressed to the proxy server port (1080)

If you implement the proxy server, note that all DCC-connected ONS 15454s on the same Ethernet segment must have the same gateway setting. Mixed values produce unpredictable results, and might leave some nodes unreachable through the shared Ethernet segment.

If nodes become unreachable, correct the setting by performing one of the following:

- Disconnect the craft computer from the unreachable ONS 15454. Connect to the ONS 15454 through another network ONS 15454 that has a DCC connection to the unreachable ONS 15454.
- Disconnect all DCCs to the node by disabling them on neighboring nodes. Connect a CTC computer directly to the ONS 15454 and change its provisioning.

17.2.8 Scenario 8: Dual GNEs on a Subnet

The ONS 15454 provides GNE load balancing, which allows CTC to reach ENEs over multiple GNEs without the ENEs being advertised over OSPF. This feature allows a network to quickly recover from the loss of GNE, even if the GNE is on a different subnet. If a GNE fails, all connections through that GNE fail. CTC disconnects from the failed GNE and from all ENEs for which the GNE was a proxy, and then reconnects through the remaining GNEs. GNE load balancing reduces the dependency on the launch GNE and DCC bandwidth, both of which enhance CTC performance.

Note Dual GNEs do not need special provisioning

Figure 17-13 shows a network with dual GNEs on the same subnet.

Figure 17-13 Scenario 8: Dual GNEs on the Same Subnet (ANSI and ETSI)

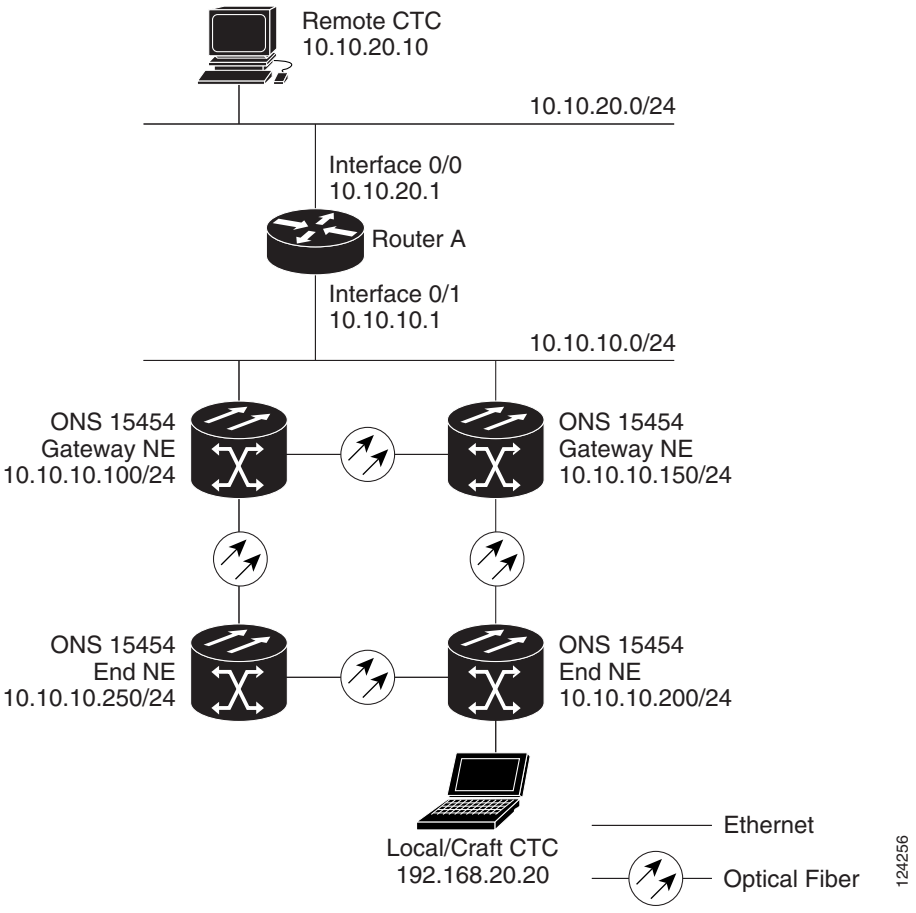
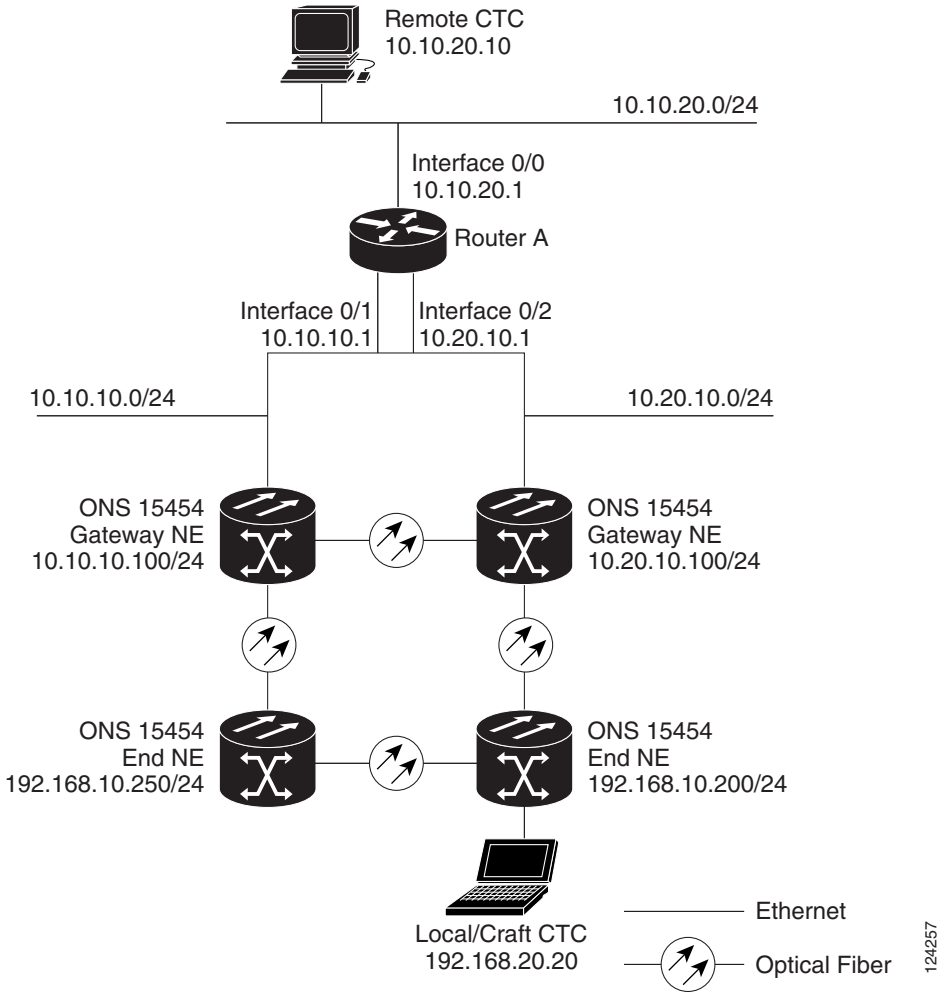


Figure 17-14 shows a network with dual GNEs on different subnets.

Figure 17-14 Scenario 8: Dual GNEs on Different Subnets (ANSI and ETSI)



17.2.9 Scenario 9: IP Addressing with Secure Mode Enabled

The TCC2, TCC2P, TCC3, TNC, and TSC cards default to repeater mode. In this mode, the front and back Ethernet (LAN) ports share a single MAC address and IP address. TCC2P, TCC3, TNC, and TSC cards allow you to place a node in secure mode, which prevents a front-access craft port user from accessing the LAN through the backplane port. Secure mode can be locked, which prevents the mode from being altered. To place a node in secure mode or to lock secure node, refer to the "Manage the Node" chapter in the *Cisco ONS 15454 DWDM Procedure Guide*.

17.2.9.1 Secure Mode Behavior

Changing a TCC2P, TCC3, TNC, or TSC node from repeater mode to secure mode allows you to provision two IP addresses for the ONS 15454 and causes the node to assign the ports different MAC addresses. In secure mode, one IP address is provisioned for the ONS 15454 backplane LAN port, and

the other IP address is provisioned for the card Ethernet port. Both addresses reside on different subnets, providing an additional layer of separation between the craft access port and the ONS 15454 LAN. If secure mode is enabled, the IP addresses provisioned for the backplane LAN port and card Ethernet port must follow general IP addressing guidelines and must reside on different subnets from each other.

In secure mode, the IP address assigned to the backplane LAN port becomes a private address, which connects the node to an operations support system (OSS) through a central office LAN or private enterprise network. A Superuser can configure the node to hide or reveal the backplane's LAN IP address in CTC, the routing table, or TL1 autonomous message reports.

In repeater mode, a node can be a GNE or ENE. Placing the node into secure mode automatically turns on SOCKS proxy and defaults the node to GNE status. However, the node can be changed back to an ENE. In repeater mode, an ENE's SOCKS proxy can be disabled—effectively isolating the node beyond the LAN firewall—but it cannot be disabled in secure mode. To change a node's GNE or ENE status and disable the SOCKS proxy, refer to the "Turn Up a Node" chapter in the *Cisco ONS 15454 DWDM Procedure Guide*.

Caution Enabling secure mode causes the TCC2P, TCC3, TNC, and TSC cards to reboot; the card reboot affects traffic.

Note The secure mode option does not appear in CTC if TCC2 cards are installed. If one TCC2 and one TCC2P card are installed in a node, secure mode will appear in CTC but it cannot be modified.

Note If both front and backplane access ports are disabled in an ENE and the node is isolated from DCC communication (due to user provisioning or network faults), the front and backplane ports are automatically reenabled.

Figure 17-15 shows an example of secure mode ONS 15454 nodes with front-access Ethernet port addresses that reside on the same subnet.

Figure 17-15 Scenario 9: ONS 15454 GNE and ENEs on the Same Subnet with Secure Mode Enabled

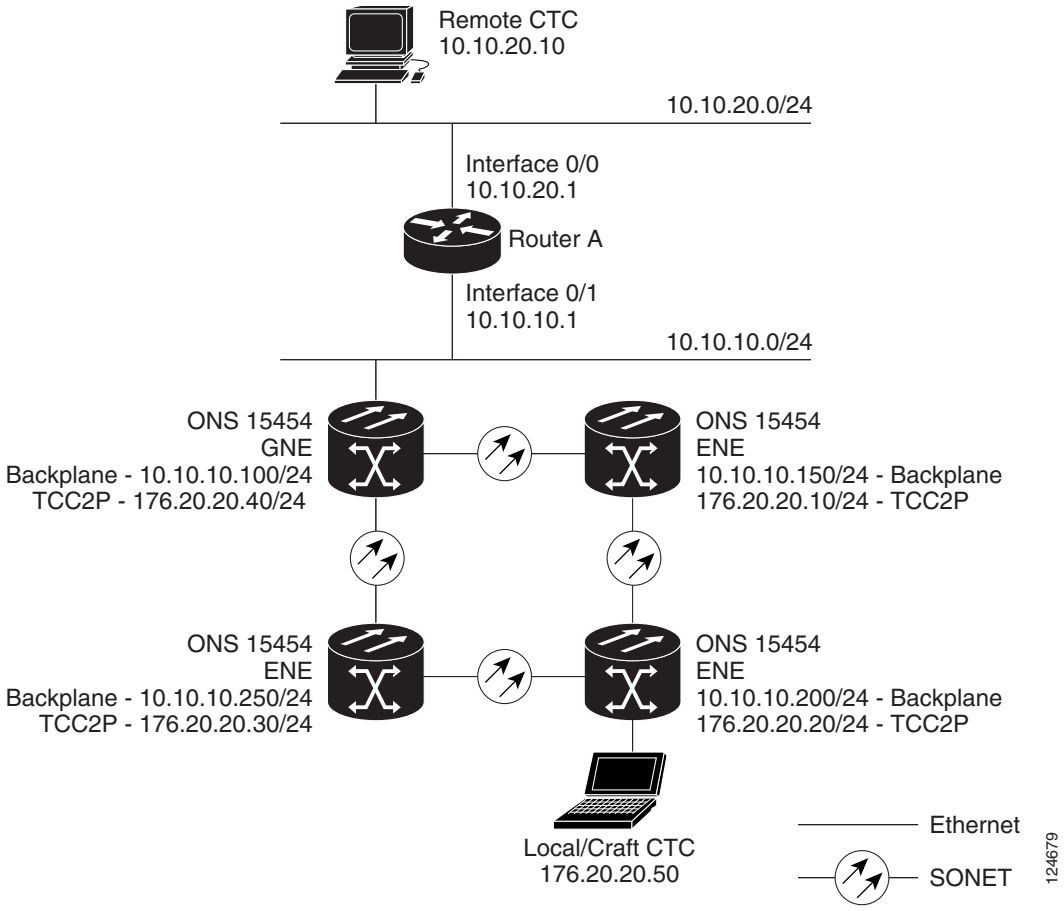
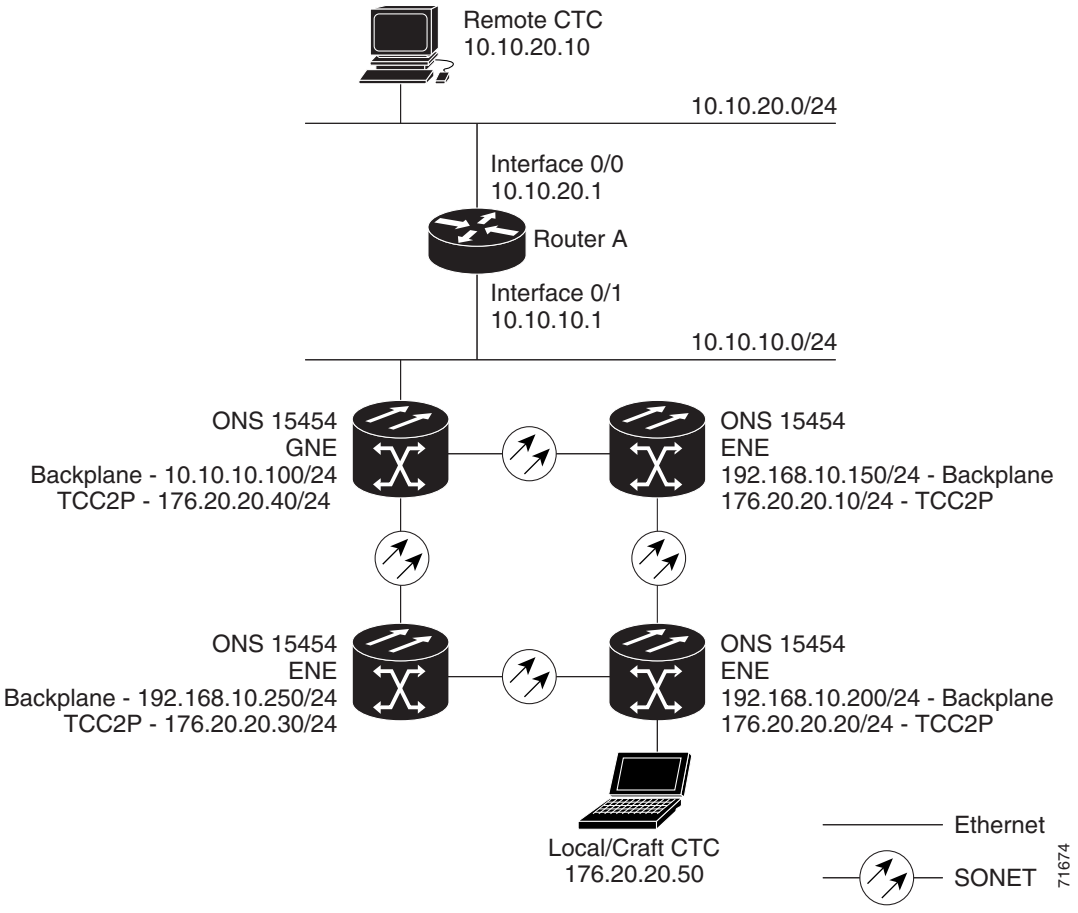


Figure 17-16 shows an example of ONS 15454 nodes connected to a router with secure mode enabled. In each example, the node's port address (node address) resides on a different subnet from the node backplane addresses.

Figure 17-16 Scenario 9: ONS 15454 GNE and ENEs on Different Subnets with Secure Mode Enabled



17.2.9.2 Secure Node Locked and Unlocked Behavior

Secure mode can be locked or unlocked on a node operating in secure mode. The default status is unlocked, and only a Superuser can issue a lock. When secure mode is locked, the node's configuration (including Ethernet port status) and lock status cannot be changed by any network user. To have a secure node's lock removed, contact Cisco Technical Support to arrange a Return Material Authorization (RMA) for the shelf assembly. See the "Obtaining Documentation and Submitting a Service Request" section on page lxx as needed. Enabling a lock makes a permanent change to the shelf's EEPROM.

A node's configuration lock is maintained if the active TCC2P, TCC3, TNC, or TSC card's database is reloaded. For example, if you attempt to load an unlocked node database onto a locked node's standby TCC2P, TCC3, TNC, or TSC card for transfer to the active TCC2P, TCC3, TNC, or TSC card (an action that is not recommended), the unlocked node's status (via the uploaded database) will not override the node's lock status. If you attempt to load a locked database onto the standby TCC2P, TCC3, TNC, or TSC card of an unlocked secure node, the active TCC2P, TCC3, TNC, or TSC card will upload the database. If the uploaded defaults indicate a locked status, this will cause the node to become locked. If a software load has been customized before a lock is enabled, all lockable provisioning features are permanently set to the customized NE defaults provided in the load and cannot be changed by any user.

17.3 DCN Case Studies

The ONS 15454 network is managed over the IP DCN and the optical service channels (OSCs), DCCs, and generic communications channels (GCCs). ONS 15454s perform many of the same functions as Layer 3 routers because they manage traffic between the DCN network management system (NMS) and the dense wavelength division multiplexing (DWDM) optical networks.

This section provides case studies that show different ways an ONS 15454 network can be implemented within the DCN. The case studies are based on actual field installations. They include the network problem, the network topology created to solve it, IP addressing examples, and strengths and weaknesses of the solution. Routing principles followed throughout the case studies include:

- If the ONS 15454 is connected to a DCN router, the default gateway points to the router.
- If the default gateway must advertise to the OSC/DCC/GCC network, a static route is added for the default gateway.
- If the network element (NE) is not connected to a DCN router, the default gateway is set to 0.0.0.0.

17.3.1 SOCKS Proxy Settings

SOCKS proxy (described in the "17.2.7 Scenario 7: Provisioning the ONS 15454 Proxy Server" section on page 17-12) enables the ONS 15454 to serve as a proxy for connections between CTC clients and ONS 15454 nodes connected by OSCs, GCCs, or DCCs. Although SOCKS proxy can make DCN implementations easier, it should not be used when any of the following conditions exist:

- Network management is based on SNMP and SNMP traps. The ONS 15454 can proxy SNMP traps, but if a redundant DCN connection is required, trap duplication on the network management platform will occur.
- Telnet and debug session are required. These are not possible over SOCKS proxy.
- Direct IP connectivity to every node is required.

If these conditions are not present and no requirement to have direct IP connectivity to every node exists (that is, management is performed using CTC and/or Cisco Transport Manager [CTM]), Cisco recommends that you use the SOCKS proxy only option for all nodes that connect to a DCN router.

17.3.2 OSPF

Activating OSPF (described in the "17.2.6 Scenario 6: Using OSPF" section on page 17-10) on the ONS 15454 LAN interface is another option that can be used to create resilient DCN connections. However, this option can only be enabled if every element in the network, from the NEs to the NOC, runs OSPF. This is not always possible, for example, the DCN connections might be on a public network out of the control of the organization using the ONS 15454 network. If you are considering enabling OSPF on the LAN, the following limitations must be considered:

- If OSPF is enabled on the LAN, the internal OSC/DCC/GCC OSPF area cannot be 0.0.0.0.
- The ONS 15454 can act as an OSPF area border gateway and support OSPF virtual links. However, virtual links cannot pass over the OSC/DCC/GCC network.

If all elements in the DCN network are not running OSPF, enabling OSPF on the LAN is very difficult without creating isolated areas and/or segmentation of OSPF area 0. However, if the DCN network is a full OSPF network, enabling OSPF on the LAN might be employed for resilient DCN networks.

17.3.3 Management of Non-LAN Connected Multishelf Node

When using dense wavelength division multiplexing (DWDM) multishelf management feature to subtend shelves from a node controller shelf, the Node Controller must be specially provisioned in case it does not have direct LAN reachability.

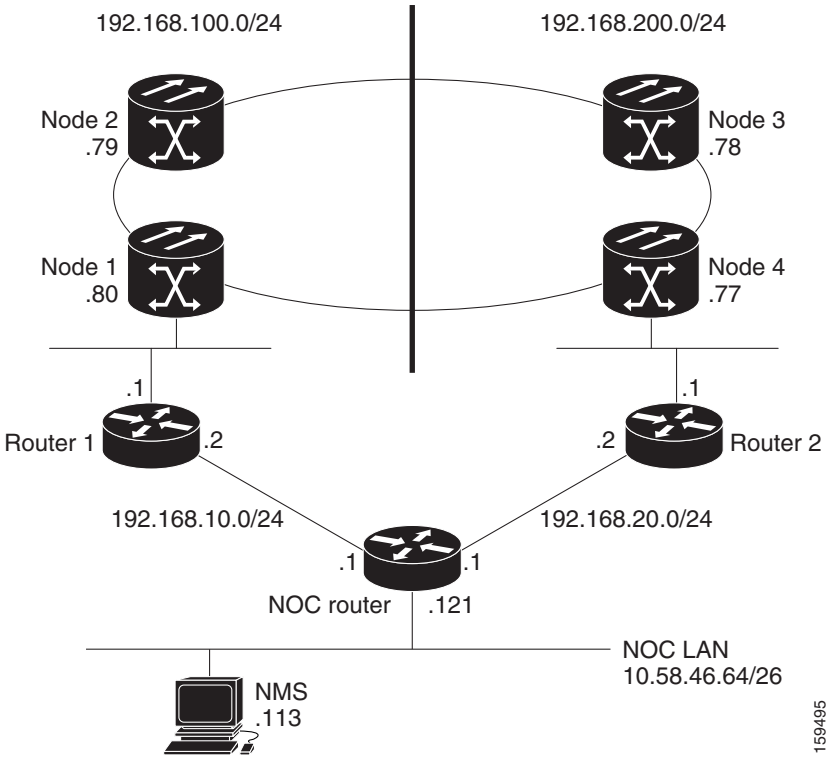
Non-LAN connected Multishelf nodes are not manageable from CTC unless SOCKS Proxy is enabled on the node. In a GNE/ENE firewall configuration, non-LAN connected network elements must be set up as end network elements (ENEs) if Firewall is required. If firewall is not required on the non-LAN connected Multishelf node, then the node must be set up as SOCKS Proxy

LAN-connected network elements (LNEs) can be set up as gateway network elements (GNEs) or as SOCKS proxies, depending upon network security requirements. If the GNE/ENE firewall feature is required, the LNE must be set up as a GNE. If the design does not require the firewall feature but does require all-IP networking, the LNE must be set up as a SOCKS proxy. For procedures to provision a node or shelf as a GNE, ENE or SOCKS proxy, refer to the *Cisco ONS 15454 DWDM Procedure Guide*.

17.3.4 DCN Case Study 1: Ring Topology with Two Subnets and Two DCN Connections

DCN Case Study 1 (Figure 17-17) shows an ONS 15454 ring (DWDM or SONET/SDH). The ring is divided into two subnets and has two DCN connections for resiliency.

Figure 17-17 DCN Case Study 1: ONS 15454 Ring with Two Subnets and Two DCN Connections

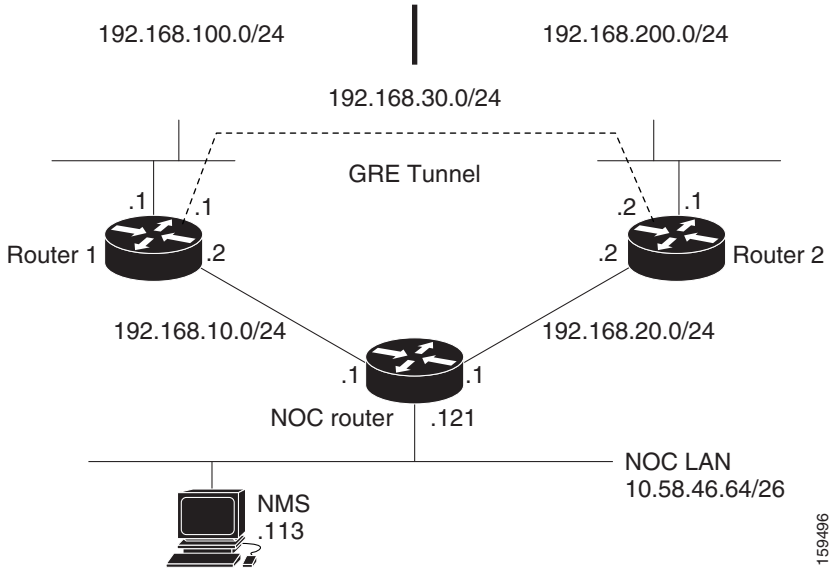


During normal operation, this configuration balances the management traffic load over the two available DCN connections. If one of the two DCN connections fails, the second DCN connection maintains accessibility so NE management can continue. However, if complete IP connectivity is required, for example, for SNMP when SOCKS proxy cannot be used, connection resilience is difficult to achieve because:

- The ONS 15454 does not support route overloading. Configuring different routers with different costs for the same network destination is not possible.
- The ONS 15454 always tries to route traffic on the LAN interface when its link is up, and the link on the NE connected to DCN router is always up.
- If the DCN connection fails, the route is longer available.

One solution is to create a generic routing encapsulation (GRE) tunnel to logically connect the remote Router 1 and remote Router 2 using the OSC/DCC/GCC network (Figure 17-18). With the GRE tunnel, both remote routers have an alternate path to reach the NOC network in case of DCN failure. However, the alternate path might become overloaded on the routing tables, resulting in higher costs.

Figure 17-18 DCN Case Study 1: ONS 15454 Ring with Two Subnets, Two DCN Connections, and GRE Tunnel



17.3.4.1 DCN Case Study 1 IP Configuration

The following sections show sample IP configuration at the routers and ONS 15454 nodes in DCN Case Study 1.

17.3.4.1.1 NOC Router Configuration

Interface configuration:

```
interface Ethernet0/0
 ip address 10.58.46.121 255.255.255.192
 no ip directed-broadcast
!
interface Ethernet1/0
```

```
 ip address 192.168.20.1 255.255.255.0
 no ip directed-broadcast
!
interface Ethernet2/0
 ip address 192.168.10.1 255.255.255.0
 no ip directed-broadcast
!
```

Static routes with alternate paths at different costs:

```
ip classless
ip route 192.168.100.0 255.255.255.0 192.168.10.2
ip route 192.168.100.0 255.255.255.0 192.168.20.2 10
ip route 192.168.200.0 255.255.255.0 192.168.20.2
ip route 192.168.200.0 255.255.255.0 192.168.10.2 10
```

17.3.4.1.2 Router 1 IP Configuration

Interface configuration:

```
interface Ethernet0/0
ip address 192.168.10.2 255.255.255.0
no ip directed-broadcast
!
interface Ethernet1/0
ip address 192.168.100.1 255.255.255.0
no ip directed-broadcast
!
```

GRE tunnel interface configuration:

```
interface Tunnel0
ip address 192.168.30.1 255.255.255.0
tunnel source Ethernet1/0
tunnel destination 192.168.200.1
```

Static routes with alternate paths at different costs:

```
ip classless
ip route 0.0.0.0 0.0.0.0 192.168.10.1
ip route 10.0.0.0 255.0.0.0 192.168.10.1
ip route 10.0.0.0 255.0.0.0 Tunnel0 10
ip route 192.168.200.0 255.255.255.0 Tunnel0 10
ip route 192.168.200.1 255.255.255.255 192.168.100.80
```

Note the host route to the peer Router 2 (192.168.200.1) points to the ONS 15454 network (through 192.168.100.80). This is required to set up the GRE tunnel. In this configuration, only the external route to 10.0.0.0 (that includes the NOC network) is overloaded with the alternate path. However, overloading might occur on this last-resort route.

17.3.4.1.3 Router 2 IP Configuration

Interface configuration:

```
interface Ethernet0/0
ip address 192.168.20.2 255.255.255.0
no ip directed-broadcast
!
interface Ethernet1/0
ip address 192.168.200.1 255.255.255.0
no ip directed-broadcast
```

GRE tunnel interface configuration:

```
interface Tunnel0
ip address 192.168.30.2 255.255.255.0
tunnel source Ethernet1/0
tunnel destination 192.168.100.1
```

Static routes with alternate paths at different costs:

```
ip classless
ip route 0.0.0.0 0.0.0.0 192.168.20.1
ip route 10.0.0.0 255.0.0.0 192.168.20.1
ip route 10.0.0.0 255.0.0.0 Tunnel0 10
ip route 192.168.100.0 255.255.255.0 Tunnel0 10
ip route 192.168.100.1 255.255.255.255 192.168.200.77
```

The host routing path to the Router 1 (192.168.100.1) points to the ONS 15454 network (by 192.168.200.77). This is required to set up the GRE tunnel. In this configuration, only the external route to 10.0.0.0 (that includes the NOC network) is overloaded with the alternate path. However, overloading the last-resort route might occur. Table 17-5 shows network settings on the four ONS 15454 nodes. The static routes are created so the DCN-connected nodes advertise their capability to act as last-resort routers.

Table 17-5 DCN Case Study 1 Node IP Addresses

Node	IP Address/Mask	Default Gateway	Static Routes: Destination/Mask – Next Hop
Node 1	192.168.100.80/24	192.168.100.1	0.0.0.0/0 – 192.168.100.1
Node 2	192.168.100.79/24	0.0.0.0	—
Node 3	192.168.100.78/24	0.0.0.0	—
Node 4	192.168.100.77/24	192.168.100.1	0.0.0.0/0 – 192.168.200.1

17.3.4.2 DCN Case Study 1 Limitations

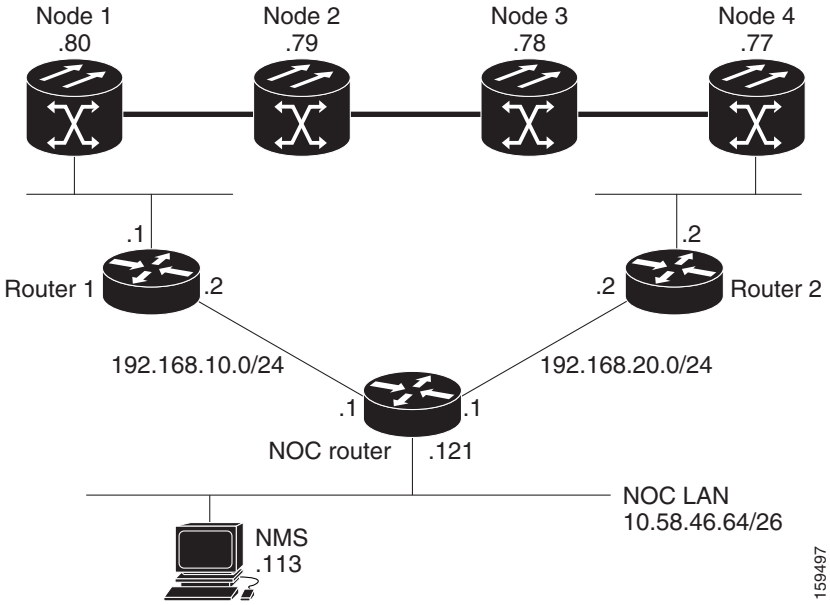
DCN Case Study 1 shows how a GRE tunnel can be created between two routers to create DCN connection resiliency. While the resiliency is a benefit, when a DCN failure forces traffic to the GRE tunnel, the path calculated by the ONS 15454 OSPF algorithm running in the OSC/DCC/GCC network is no longer the shortest one. Subsequently, the round-trip delay time (RTT) might increase significantly because the DCN protection in this configuration is transparent to the ONS 15454 network. The ONS 15454 continues to use the same routing table. In addition, if a DCN failure occurs, the routing path that uses the GRE tunnel adds additional latency because of the number and length of OSC/DCC/GCC spans that the tunnel has to travel over the ONS 15454 network.

This latency makes this DCN Case Study 1 solution difficult to scale to large networks. If this solution is used and the network grows significantly, a larger number of DCN-connected NEs are required. For example, the common rule in ONS 15454 DCN design is that all nodes should be within five section data communications channel (LDCC)/regeneration section DCC (RS-DCC/OSC or eight line DCC (LDCC) /multiplex section DCC (MS-DCC) spans from the network attached node. If Case Study 1 design is implemented, the maximum span numbers should be cut in half. However, if the DCN Case Study 1 design is used in networks that have full IP routing, have connectivity to every NE, and require only CTC/CTM management, the SOCKS proxy feature can be used to provide the same DCN connectivity resilience.

17.3.5 DCN Case Study 2: Linear Topology with DCN Connections on Both Ends

DCN Case Study 2, shown in Figure 17-19, shows a four-node linear topology with DCN connectivity at both ends.

Figure 17-19 DCN Case Study 2: ONS 15454 Linear Topology with DCN Connections at Both Ends



To maintain DCN resilience, static routes are used and a GRE tunnel is created between Router 1 and Router 2 over the DCC/OSC/GCC optical link. In this example, all ONS 15454s are part of the same subnet. Therefore, the Router 1 and Router 2 static route tables have more entries because alternate paths must be configured for every host.

17.3.5.1 DCN Case Study 2 IP Configurations

The following sections provide sample IP configurations at routers and ONS 15454 nodes in DCN Case Study 2.

17.3.5.1.1 NOC Router IP Configuration

Interface configuration:

```
interface Ethernet0/0
 ip address 10.58.46.121 255.255.255.192
 no ip directed-broadcast
!
interface Ethernet1/0
 ip address 192.168.20.1 255.255.255.0
 no ip directed-broadcast
!
interface Ethernet2/0
 ip address 192.168.10.1 255.255.255.0
 no ip directed-broadcast
!
```

Static routes with alternate paths at different costs:

```
ip classless
ip route 192.168.100.0 255.255.255.0 192.168.10.2
ip route 192.168.100.0 255.255.255.0 192.168.20.2 100
ip route 192.168.100.77 255.255.255.255 192.168.20.2
ip route 192.168.100.77 255.255.255.255 192.168.10.2 10
ip route 192.168.100.78 255.255.255.255 192.168.20.2
ip route 192.168.100.78 255.255.255.255 192.168.10.2 10
ip route 192.168.100.79 255.255.255.255 192.168.10.2
ip route 192.168.100.79 255.255.255.255 192.168.20.2 10
ip route 192.168.100.80 255.255.255.255 192.168.10.2
ip route 192.168.100.80 255.255.255.255 192.168.20.2 10
```

17.3.5.1.2 Router 1 IP Configuration

Site 1 router interface:

```
interface Ethernet0/0
ip address 192.168.10.2 255.255.255.0
no ip directed-broadcast
!
interface Ethernet1/0
ip address 192.168.100.1 255.255.255.0
no ip directed-broadcast
```

GRE tunnel interface configuration:

```
interface Tunnel0
ip address 192.168.30.1 255.255.255.0
tunnel source Ethernet1/0
tunnel destination 192.168.100.2
```

Static routes with alternate paths at different costs:

```
ip classless
ip route 0.0.0.0 0.0.0.0 192.168.10.1
ip route 10.0.0.0 255.0.0.0 192.168.10.1
ip route 10.0.0.0 255.0.0.0 Tunnel0 10
ip route 192.168.100.2 255.255.255.255 192.168.100.80
```

Note that the host routing path to the peer DCN router (Site 2, 192.168.100.2) points to the ONS 15454 network (by 192.168.100.80) that is required to set up the GRE tunnel. In this configuration, only the external route to 10.0.0.0 (that include the NOC network) is overloaded with the alternate path, but overloading of the last-resort route might also occur.

17.3.5.1.3 Router 2 IP Configuration

Interface configuration:

```
interface Ethernet0/0
ip address 192.168.20.2 255.255.255.0
no ip directed-broadcast
!
interface Ethernet1/0
ip address 192.168.100.2 255.255.255.0
no ip directed-broadcast
```

GRE tunnel interface configuration:

```
interface Tunnel0
ip address 192.168.30.2 255.255.255.0
tunnel source Ethernet1/0
```

```
tunnel destination 192.168.100.1
```

Static routes with alternate paths at different costs:

```
ip classless
ip route 0.0.0.0 0.0.0.0 192.168.20.1
ip route 10.0.0.0 255.0.0.0 192.168.20.1
ip route 10.0.0.0 255.0.0.0 Tunnel0 10
ip route 192.168.100.1 255.255.255.255 192.168.100.77
```

Note that the host route to the Router 1 (192.168.100.1) points to the ONS 15454 network (by 192.168.200.77). This is required to set up the GRE tunnel. In this configuration, only the external route to 10.0.0.0 (that includes the NOC network) is overloaded with the alternate path. However, overloading the last-resort route might also occur.

Table 17-6 shows network settings on the four ONS 15454 nodes. The static routes are created so the DCN-connected nodes advertise their capability to act as last-resort routers.

Table 17-6 DCN Case Study 2 Node IP Addresses

Node	IP Address/Mask	Default Gateway	Static Routes: Destination/Mask – Next Hop
Node 1	192.168.100.80/24	192.168.100.1	0.0.0.0/0 – 192.168.100.1
Node 2	192.168.100.79/24	0.0.0.0	—
Node 3	192.168.100.78/24	0.0.0.0	—
Node 4	192.168.100.77/24	192.168.100.1	0.0.0.0/0 – 192.168.200.1

17.3.5.2 DCN Case Study 2 Limitations

The linear configuration in DCN Case Study 2 does not effectively protect the management network communication for every fiber failure because the DCN router is not notified of the failures. Therefore, it continues to send packets on the low-cost path. This problem does not occur in ring topologies where the fiber failure is internally protected from the optical ring network. However, the OSPF dynamic routing protocol can be used over the DCN network to provide a solution to this problem. An OSPF configuration is shown in DCN Case Study 3.

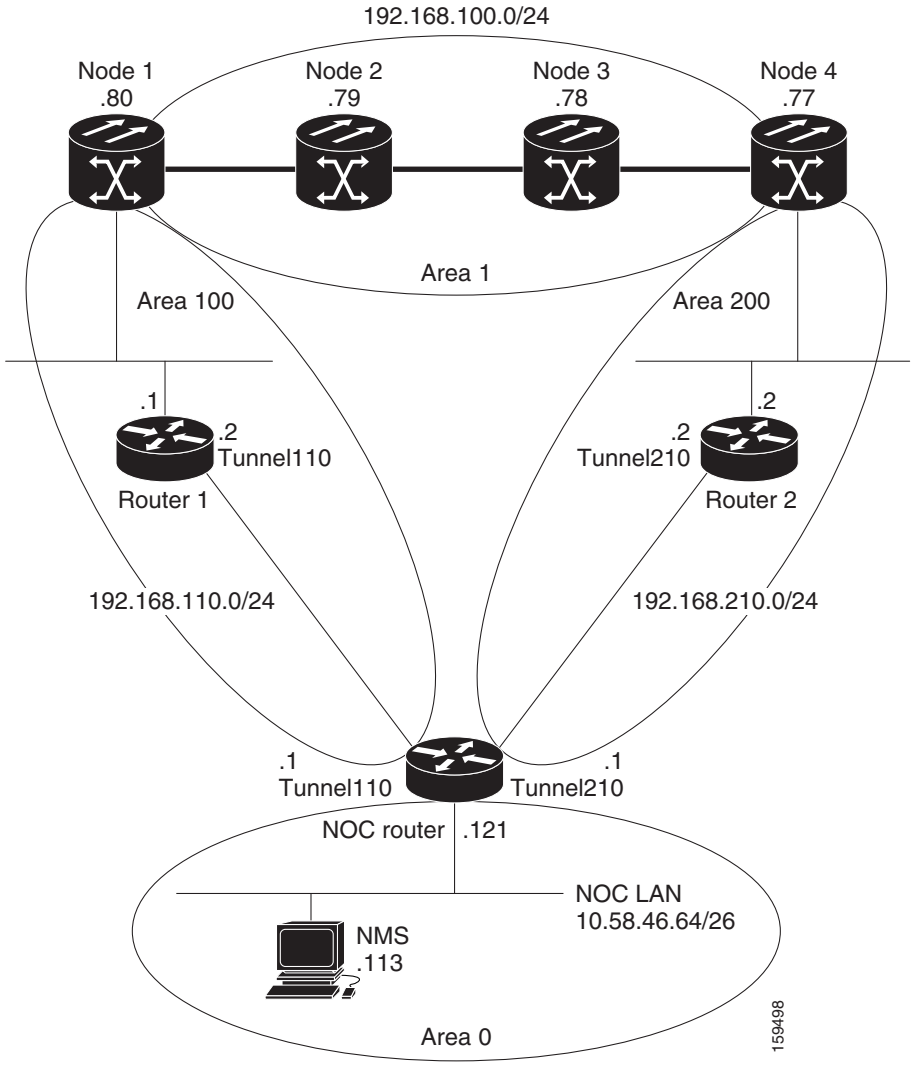
17.3.6 DCN Case Study 3: Linear Topology with DCN Connections on Both Ends Using OSPF Routing

DCN Case Study 3 is the same linear topology as DCN Case Study 2 except OSPF routing is used on the DCN network. This requires the OSPF active on LAN option, located on the node view (single-shelf mode) or multishelf view (multishelf mode) Provisioning > Network > OSPF tab, to be enabled at the end ONS 15454 nodes. In addition, OSPF must be running between Router 1, Router 2, and the NOC router.

Because the DCN connection usually passes over a public network where OSPF is not always an option, the connection between Router 1, Router 2, and the NOC router is configured as a GRE tunnel so OSPF can run on the tunnel itself.

Figure 17-20 shows the linear configuration with the separate OSPF areas, the tunnel connections, and the required OSPF virtual link. (The physical connections where the tunnels are passed are not shown in the figure because they are not directly part of the actual routing path.)

Figure 17-20 DCN Case Study 3: ONS 15454 Linear Topology with DCN Connections at Both Ends Using OSPF



17.3.6.1 DCN Case Study 3 IP Configurations

The following sections provide sample IP configurations at routers and ONS 15454 nodes for DCN Case Study 3.

17.3.6.1.1 NOC Router IP Configuration

Interface configuration:

```
interface Ethernet0/0
 ip address 10.58.46.121 255.255.255.192
 no ip directed-broadcast
!
interface Ethernet1/0
 ip address 192.168.20.1 255.255.255.0
 no ip directed-broadcast
```

```
!
interface Ethernet2/0
 ip address 192.168.10.1 255.255.255.0
 no ip directed-broadcast
!
interface Loopback0
 ip address 1.1.1.1 255.255.255.0
 no ip directed-broadcast
!
```

GRE tunnel interface configuration:

```
interface Tunnel110
 ip address 192.168.110.1 255.255.255.0
 tunnel source Ethernet2/0
 tunnel destination 192.168.10.2
!
interface Tunnel210
 ip address 192.168.210.1 255.255.255.0
 tunnel source Ethernet1/0
 tunnel destination 192.168.20.2
!
```

OSPF routing configuration:

```
router ospf 1
 network 1.1.1.0 0.0.0.255 area 0
 network 10.0.0.0 0.255.255.255 area 0
 network 192.168.110.0 0.0.0.255 area 100
 network 192.168.210.0 0.0.0.255 area 200
 area 100 virtual-link 192.168.100.80
 area 200 virtual-link 192.168.100.77
!
```

Note that the OSPF virtual link to the end ONS 15454s is created to connect the DCC/OSC/GCC OSPF area 1 to the backbone area 0. No static routes are defined on the NOC router.

17.3.6.1.2 Router 1 IP Configuration

Interface configuration:

```
interface Ethernet0/0
ip address 192.168.10.2 255.255.255.0
no ip directed-broadcast
!
interface Ethernet1/0
ip address 192.168.100.1 255.255.255.0
no ip directed-broadcast
```

GRE tunnel interface configuration:

```
interface Tunnel110
 ip address 192.168.110.2 255.255.255.0
 tunnel source Ethernet0/0
 tunnel destination 192.168.10.1
!
```

OSPF and static routing configuration:

```
router ospf 1
 log-adjacency-changes
 network 192.168.100.0 0.0.0.255 area 100
 network 192.168.110.0 0.0.0.255 area 100
!
```

```
ip classless
ip route 0.0.0.0 0.0.0.0 192.168.10.1
```

17.3.6.1.3 Router 2 IP Configuration

Interface configuration:

```
interface Ethernet0/0
ip address 192.168.20.2 255.255.255.0
no ip directed-broadcast
!
interface Ethernet1/0
ip address 192.168.100.2 255.255.255.0
no ip directed-broadcast
```

GRE tunnel interface configuration:

```
interface Tunnel210
 ip address 192.168.210.2 255.255.255.0
 tunnel source Ethernet0/0
 tunnel destination 192.168.20.1
!
```

OSPF and static routing configuration:

```
router ospf 1
 network 192.168.100.0 0.0.0.255 area 200
 network 192.168.210.0 0.0.0.255 area 200
!
ip classless
ip route 0.0.0.0 0.0.0.0 192.168.20.1
```

Table 17-7 shows network settings on the four ONS 15454 nodes. The static routes are created so the DCN-connected nodes can advertise their capability to act as last-resort routers.

Table 17-7 DCN Case Study 3 Node IP Addresses

Node	IP Address/Mask	Default Gateway	OSPF Configuration
Node 1	192.168.100.80/24	192.168.100.1	DCC/OSC/GCC area: 0.0.0.1 LAN area: 0.0.0.100 OSPF Area Range Table: • 192.168.100.79/32 - Area 0.0.0.1 • 192.168.100.78/32 - Area 0.0.0.1 • 192.168.100.77/32 - Area 0.0.0.1 Virtual Link Table: 1.1.1.1
Node 2	192.168.100.79/24	0.0.0.0	DCC/OSC/GCC area: 0.0.0.1 OSPF disabled on LAN

Table 17-7 DCN Case Study 3 Node IP Addresses (continued)

Node	IP Address/Mask	Default Gateway	OSPF Configuration
Node 3	192.168.100.78/24	0.0.0.0	DCC/OSC/GCC area: 0.0.0.1 OSPF disabled on LAN
Node 4	192.168.100.77/24	192.168.100.1	DCC/OSC/GCC area: 0.0.0.1 LAN area: 0.0.0.200 OSPF Area Range Table: • 192.168.100.80/32 - Area 0.0.0.1 • 192.168.100.79/32 - Area 0.0.0.1 • 192.168.100.78/32 - Area 0.0.0.1 Virtual Link Table: 1.1.1.1

The OSPF virtual link requires its neighbor to be indicated with its router ID, not the physical or tunnel interface connected to the network. Using a loopback interface on the NOC router makes the router ID selection independent from real interface IP address.

17.3.6.2 DCN Case Study 3 Limitations

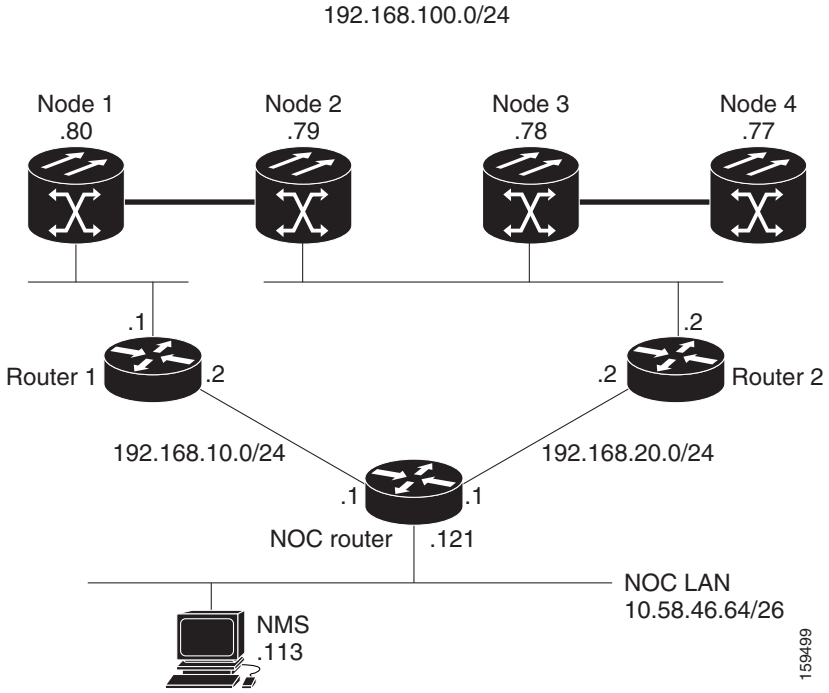
DCN Case Study 3 shows that OSPF can provide better DCN resilience and more efficient routing choices, which results in better performance. OSPF also provides better network scalability. Some limitations of using OSPF include:

- OSPF introduces additional complexity, for example, provisioning the OSPF virtual links and advertisement on the ONS 15454s and routers requires thought and planning.
- OSPF must be enabled on the DCN connection between the NOC and the site routers. This can also be done through GRE tunnels, as shown in this case study.
- Planning and thought must be given to the separation of the OSPF areas. Creation of virtual links to overcome the limitations described in the "17.3.2 OSPF" section on page 17-23 and to avoid isolated areas and segmentation in the backbone area requires planning as well.

17.3.7 DCN Case Study 4: Two Linear Cascaded Topologies With Two DCN Connections

DCN Case Study 4, shown in Figure 17-21, extends the simple linear topology shown in DCN Case Study 3. However in this example, two linear DCN connections go to the same site router and all the ONS 15454s are in the same subnet. A GRE tunnel logically connects the remote Router 1 and Router 2 over the OSC/DCC/GCC network, which is similar to the DCN Case Study 1 configuration (Figure 17-18). The GRE tunnel provides the remote routers with an alternate path to reach the NOC network in case a DCN failure occurs. However, the alternate paths might overload the router routing tables and carry a higher cost because all alternate paths are host-based due to the fact the ONS 15454s reside in the same subnet.

Figure 17-21 DCN Case Study 4: Two Linear Cascaded Topologies with Two DCN Connections



17.3.7.1 DCN Case Study 4 IP Configurations

The following sections provide sample IP configurations at the routers and ONS 15454 nodes for DCN Case Study 4.

17.3.7.1.1 NOC Router IP Configuration

Interface configuration:

```
interface Ethernet0/0
 ip address 10.58.46.121 255.255.255.192
 no ip directed-broadcast
!
interface Ethernet1/0
 ip address 192.168.20.1 255.255.255.0
 no ip directed-broadcast
!
interface Ethernet2/0
 ip address 192.168.10.1 255.255.255.0
 no ip directed-broadcast
!
```

Static routes with alternate paths at different costs:

```
ip classless
ip route 192.168.100.0 255.255.255.0 192.168.10.2
ip route 192.168.100.0 255.255.255.0 192.168.20.2 100
ip route 192.168.100.77 255.255.255.255 192.168.20.2 10
ip route 192.168.100.77 255.255.255.255 192.168.10.2 20
ip route 192.168.100.78 255.255.255.255 192.168.20.2
ip route 192.168.100.78 255.255.255.255 192.168.10.2 10
ip route 192.168.100.79 255.255.255.255 192.168.20.2
```

```
ip route 192.168.100.79 255.255.255.255 192.168.10.2 10
ip route 192.168.100.80 255.255.255.255 192.168.10.2
ip route 192.168.100.80 255.255.255.255 192.168.20.2 10
ip route 192.168.200.0 255.255.255.0 192.168.20.2
ip route 192.168.200.0 255.255.255.0 192.168.10.2 100
```

17.3.7.1.2 Router 1 IP Configuration

Interface configuration:

```
interface Ethernet0/0
ip address 192.168.10.2 255.255.255.0
no ip directed-broadcast
!
interface Ethernet1/0
ip address 192.168.100.1 255.255.255.0
no ip directed-broadcast
```

GRE tunnel interface configuration:

```
interface Tunnel0
ip address 192.168.30.1 255.255.255.0
tunnel source Ethernet1/0
tunnel destination 192.168.100.2
```

Static routes with alternate paths at different costs:

```
ip classless
ip route 0.0.0.0 0.0.0.0 192.168.10.1
ip route 10.0.0.0 255.0.0.0 192.168.10.1
ip route 10.0.0.0 255.0.0.0 Tunnel0 10
ip route 192.168.100.2 255.255.255.255 192.168.100.80
ip route 192.168.100.77 255.255.255.255 Tunnel0 20
ip route 192.168.100.78 255.255.255.255 Tunnel0 10
ip route 192.168.100.79 255.255.255.255 Tunnel0 10
```

Note that the host routing path to the peer DCN router (Router 2, 192.168.100.2) points to the ONS 15454 network (by 192.168.100.80). This is required to set up the GRE tunnel. In this configuration, only the external route to 10.0.0.0 (that includes the NOC network) is overloaded with the alternate path. However, overloading of the last-resort route could also occur.

17.3.7.1.3 Router 2 IP Configuration

Interface configuration:

```
interface Ethernet0/0
ip address 192.168.20.2 255.255.255.0
no ip directed-broadcast
!
interface Ethernet1/0
ip address 192.168.100.2 255.255.255.0
no ip directed-broadcast
```

GRE tunnel interface configuration:

```
interface Tunnel0
ip address 192.168.30.2 255.255.255.0
tunnel source Ethernet1/0
tunnel destination 192.168.100.1
```

Static routes with alternate paths at different costs:

```
ip classless
ip route 0.0.0.0 0.0.0.0 192.168.20.1
```

```
ip route 10.0.0.0 255.0.0.0 192.168.20.1
ip route 10.0.0.0 255.0.0.0 Tunnel0 10
ip route 192.168.100.1 255.255.255.255 192.168.100.79
ip route 192.168.100.80 255.255.255.255 Tunnel0 10
```

Note that the host routing path to the peer DCN router (Router, IP 192.168.100.1) points to the ONS 15454 network (by 192.168.200.79). This is required to set up the GRE tunnel. In this configuration, only the external route to 10.0.0.0 (that include the NOC network) is overloaded with the alternate path. However, overloading the last-resort route is also possible.

Table 17-8 shows network settings on the four ONS 15454 nodes. The static routes are created so the DCN-connected nodes can advertise their capability to act as last-resort routers.

Table 17-8 DCN Case Study 4 Node IP Addresses

Node	IP Address/Mask	Default Gateway	Static Routes: Destination/Mask – Next Hop
Node 1	192.168.100.80/24	192.168.100.1	0.0.0.0/0 – 192.168.100.1 192.168.100.1/32 – 192.168.100.80
Node 2	192.168.100.79/24	192.168.100.2	192.168.100.2/32 – 192.168.100.79
Node 3	192.168.100.78/24	192.168.100.2	0.0.0.0/0 – 192.168.100.2
Node 4	192.168.100.77/24	0.0.0.0	—

17.3.7.2 DCN Case Study 4 Limitations

Many limitations described in the "17.3.4.2 DCN Case Study 1 Limitations" section on page 17-27 also apply to this case study. However, the problems are less acute because of the DCN connection in the middle of the optical network. For DWDM networks, increased latency might became a problem if the linear topology has many spans with intermediate line amplifier or optical add/drop multiplexing (OADM) nodes, which is sometimes done to cover long-distance connections. In this case, when one DCN fails, management packets for nodes near the middle of the span travel 1.5 times the complete point-to-point connection. The normal routing figure is 0.5. The full connection length of a GRE tunnel is used as an alternate routing path.

17.4 DCN Extension

ONS 15454 DWDM networks require a communication channel to exchange data among the different nodes within the network. Until Software Release 7.0, the only usable channel was the optical service channel (OSC) provided by the OSCM and OSC-CSM cards. In a long DWDM metro network, usage of OSC channel adds limitations in terms of cost and performance because the OSC channel maximum loss is 37 dB.

The primary aim of the DCN extension feature is to remove the OSC constraint and leverage on already available external DCN or traffic matrix that allows nodes to be reached without using an OSC channel.

You can connect two nodes in a DWDM network without using an OSC channel in the following two methods:

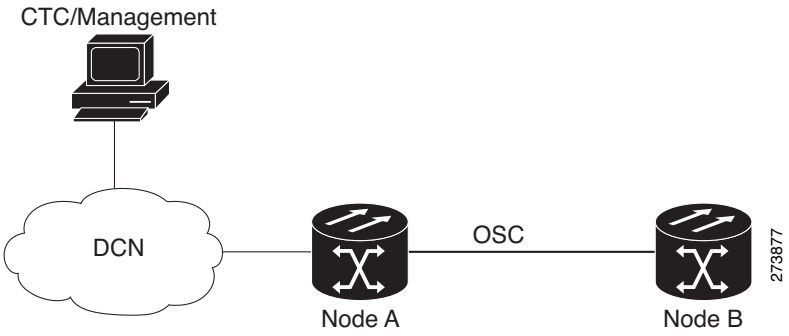
- Using external DCN
- Using GCC/DCC

The following sections describe the different communication methods and the factors to be considered while provisioning the connectivity.

17.4.1 Network Using OSC

Figure 17-22 shows a point-to-point network that uses OSC as the communication channel.

Figure 17-22 Network Using OSC

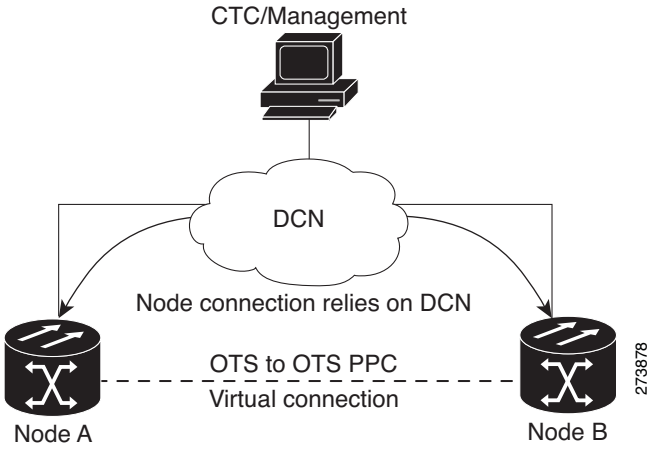


In a network using OSC channel, it is possible to supervise all the nodes from the network operations center (NOC) and all nodes can communicate with each other using the OSC channel. Network topology discovery is automatic when you use an OSC channel.

17.4.2 Network Using External DCN

Figure 17-23 shows a point-to-point network that uses external DCN as the communication channel.

Figure 17-23 Network Using External DCN



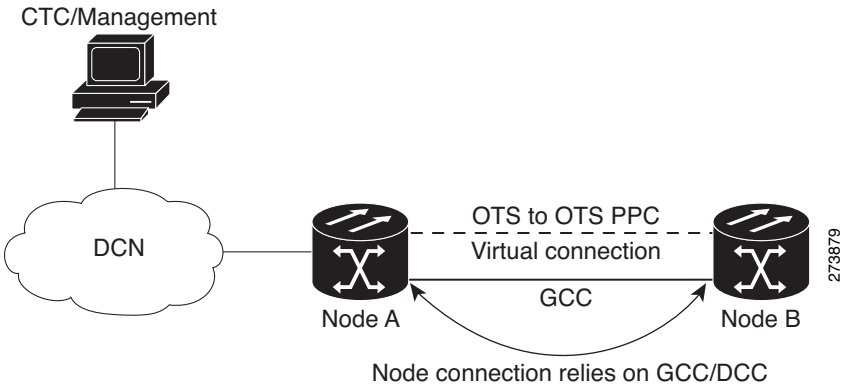
In a network using external DCN, it is possible to supervise all the nodes from the network operations center (NOC) and all nodes can communicate with each other using external DCN. The NOC is connected to each node through the external DCN. Since nodes do not have OSC connectivity, you must

create an OTS-to-OTS PPC between the nodes. The OTS-to-OTS PPC creates a DCN connection between the nodes. Refer to the "Create Circuits and Provisionable Patchcords" chapter in the *Cisco ONS 15454 DWDM Procedure Guide* for instructions on how to provision an OTS-to-OTS PPC.

17.4.3 Network Using GCC/DCC

Figure 17-24 shows a point-to-point network that uses GCC/DCC as the communication channel.

Figure 17-24 Network Using GCC/DCC



In a network using GCC/DCC, one ONS 15454 node (for example, Node A) is provisioned as a gateway network element (GNE). The NOC is connected only to the GNE. It is possible to supervise all the nodes from the network operations center (NOC) and all nodes can communicate with each other using GCC/DCC.

However in such a network, because of the absence of the embedded OSC channel, discovery of the network topology is not automatic. You must manually provision the adjacency of nodes in order to configure the correct topology. Refer to the "Create Circuits and Provisionable Patchcords" chapter in the *Cisco ONS 15454 DWDM Procedure Guide* for instructions on how to provision DCN extension for a network using GCC/DCC.

17.5 Routing Table

ONS 15454 routing information is displayed on the Maintenance > Routing Table tab. The routing table provides the following information:

- Destination—Displays the IP address of the destination network or host.
- Mask—Displays the subnet mask used to reach the destination host or network.
- Gateway—Displays the IP address of the gateway used to reach the destination network or host.
- Usage—Shows the number of times the listed route has been used.
- Interface—Shows the ONS 15454 interface used to access the destination. Values are:
  - motfcc0—The ONS 15454 Ethernet interface, that is, the RJ-45 jack on the TCC2/TCC2P/TCC3 and, for ANSI shelves, the LAN 1 pins on the backplane or, for ETSI shelves, the LAN connection on the MIC-C/T/P.

- pdcc0—An SDCC or RS-DCC interface, that is, an OC-N/STM-N trunk card identified as the SDCC or RS-DCC termination.
- lo0—A loopback interface.

Table 17-9 shows sample routing entries for an ONS 15454.

Table 17-9 Sample Routing Table Entries

Entry	Destination	Mask	Gateway	Usage	Interface
1	0.0.0.0	0.0.0.0	172.20.214.1	265103	motfcc0
2	172.20.214.0	255.255.255.0	172.20.214.92	0	motfcc0
3	172.20.214.92	255.255.255.255	127.0.0.1	54	lo0
4	172.20.214.93	255.255.255.255	0.0.0.0	16853	pdcc0
5	172.20.214.94	255.255.255.255	172.20.214.93	16853	pdcc0

Entry 1 shows the following:

- Destination (0.0.0.0) is the default route entry. All undefined destination network or host entries on this routing table are mapped to the default route entry.
- Mask (0.0.0.0) is always 0 for the default route.
- Gateway (172.20.214.1) is the default gateway address. All outbound traffic that cannot be found in this routing table or is not on the node's local subnet is sent to this gateway.
- Interface (motfcc0) indicates that the ONS 15454 Ethernet interface is used to reach the gateway.

Entry 2 shows the following:

- Destination (172.20.214.0) is the destination network IP address.
- Mask (255.255.255.0) is a 24-bit mask, meaning all addresses within the 172.20.214.0 subnet can be a destination.
- Gateway (172.20.214.92) is the gateway address. All outbound traffic belonging to this network is sent to this gateway.
- Interface (motfcc0) indicates that the ONS 15454 Ethernet interface is used to reach the gateway.

Entry 3 shows the following:

- Destination (172.20.214.92) is the destination host IP address.
- Mask (255.255.255.255) is a 32 bit mask, meaning only the 172.20.214.92 address is a destination.
- Gateway (127.0.0.1) is a loopback address. The host directs network traffic to itself using this address.
- Interface (lo0) indicates that the local loopback interface is used to reach the gateway.

Entry 4 shows the following:

- Destination (172.20.214.93) is the destination host IP address.
- Mask (255.255.255.255) is a 32 bit mask, meaning only the 172.20.214.93 address is a destination.
- Gateway (0.0.0.0) means the destination host is directly attached to the node.
- Interface (pdcc0) indicates that a DCC interface is used to reach the destination host.

Entry 5 shows a DCC-connected node that is accessible through a node that is not directly connected:

- Destination (172.20.214.94) is the destination host IP address.

- Mask (255.255.255.255) is a 32-bit mask, meaning only the 172.20.214.94 address is a destination.
- Gateway (172.20.214.93) indicates that the destination host is accessed through a node with IP address 172.20.214.93.
- Interface (pdcc0) indicates that a DCC interface is used to reach the gateway.

17.6 External Firewalls

This section provides sample access control lists for external firewalls. Table 17-10 lists the ports that are used by the TCC2/TCC2P/TCC3/TNC/TSC.

Table 17-10 Ports Used by the TCC2/TCC2P/TCC3/TNC/TSC

Port	Function	Action[1]
0	Never used	D
20	FTP	D
21	FTP control	D
22	SSH	D
23	Telnet	D
80	HTTP	D
111	SUNRPC	NA
161	SNMP traps destinations	D
162	SNMP traps destinations	D
513	rlogin	D
683	CORBA IIOP	OK
1080	Proxy server (socks)	D
2001-2017	I/O card Telnet	D
2018	DCC processor on active TCC2/TCC2P/TCC3/TNC/TSC	D
2361	TL1	D
3082	Raw TL1	D
3083	TL1	D
5001	BLSR server port	D
5002	BLSR client port	D
7200	SNMP alarm input port	D
9100	EQM port	D
9401	TCC boot port	D
9999	Flash manager	D
10240-12287	Proxy client	D
57790	Default TCC listener port	OK

1. D = deny, NA = not applicable, OK = do not deny

The following access control list (ACL) example shows a firewall configuration when the proxy server gateway setting is not enabled. In the example, the CTC workstation's address is 192.168.10.10. and the ONS 15454 address is 10.10.10.100. The firewall is attached to the GNE, so inbound is CTC to the GNE and outbound is from the GNE to CTC. The CTC Common Object Request Broker Architecture (CORBA) Standard constant is 683 and the TCC CORBA Default is TCC Fixed (57790).

```
access-list 100 remark *** Inbound ACL, CTC -> NE ***
access-list 100 remark
access-list 100 permit tcp host 192.168.10.10 host 10.10.10.100 eq www
access-list 100 remark *** allows initial contact with ONS 15454 using http (port 80) ***
access-list 100 remark
access-list 100 permit tcp host 192.168.10.10 host 10.10.10.100 eq 57790
access-list 100 remark *** allows CTC communication with ONS 15454 GNE (port 57790) ***
access-list 100 remark
access-list 100 permit tcp host 192.168.10.10 host 10.10.10.100 established
access-list 100 remark *** allows ACKs back from CTC to ONS 15454 GNE ***

access-list 101 remark *** Outbound ACL, NE -> CTC ***
access-list 101 remark
access-list 101 permit tcp host 10.10.10.100 host 192.168.10.10 eq 683
access-list 101 remark *** allows alarms etc., from the 15454 (random port) to the CTC
workstation (port 683) ***
access-list 100 remark
access-list 101 permit tcp host 10.10.10.100 host 192.168.10.10 established
access-list 101 remark *** allows ACKs from the 15454 GNE to CTC ***
```

The following ACL example shows a firewall configuration when the proxy server gateway setting is enabled. As with the first example, the CTC workstation address is 192.168.10.10 and the ONS 15454 address is 10.10.10.100. The firewall is attached to the GNE, so inbound is CTC to the GNE and outbound is from the GNE to CTC. CTC CORBA Standard constant is 683 and TCC CORBA Default is TCC Fixed (57790).

```
access-list 100 remark *** Inbound ACL, CTC -> NE ***
access-list 100 remark
access-list 100 permit tcp host 192.168.10.10 host 10.10.10.100 eq www
access-list 100 remark *** allows initial contact with the 15454 using http (port 80) ***
access-list 100 remark
access-list 100 permit tcp host 192.168.10.10 host 10.10.10.100 eq 1080
access-list 100 remark *** allows CTC communication with the 15454 GNE (port 1080) ***
access-list 100 remark

access-list 101 remark *** Outbound ACL, NE -> CTC ***
access-list 101 remark
access-list 101 permit tcp host 10.10.10.100 host 192.168.10.10 established
access-list 101 remark *** allows ACKs from the 15454 GNE to CTC ***
```

17.7 Open GNE

The ONS 15454 can communicate with non-ONS nodes that do not support Point-to-Point Protocol (PPP) vendor extensions or OSPF type 10 opaque link-state advertisements (LSA), both of which are necessary for automatic node and link discovery. An open GNE configuration allows a GCC-based network to function as an IP network for non-ONS nodes.

To configure an open GNE network, you can provision GCC terminations to include a far-end, non-ONS node using either the default IP address of 0.0.0.0 or a specified IP address. You provision a far-end, non-ONS node by checking the Far End is Foreign check box during GCC creation. The default 0.0.0.0 IP address allows the far-end, non-ONS node to identify itself with any IP address; if you set an IP address other than 0.0.0.0, a link is established only if the far-end node identifies itself with that IP address, providing an extra level of security.

By default, the proxy server only allows connections to discovered ONS peers and the firewall blocks all IP traffic between the GCC network and LAN. You can, however, provision proxy tunnels to allow up to 12 additional destinations for SOCKS version 5 connections to non-ONS nodes. You can also provision firewall tunnels to allow up to 12 additional destinations for direct IP connectivity between the GCC network and LAN. Proxy and firewall tunnels include both a source and destination subnet. The connection must originate within the source subnet and terminate within the destination subnet before either the SOCKS connection or IP packet flow is allowed. A proxy connection is allowed if the CTC client is in a source subnet and the requested destination is in the destination subnet. Firewall tunnels allow IP traffic to route between the node Ethernet and pdcc interfaces. An inbound Ethernet packet is allowed through the firewall if its source address matches a tunnel source and its destination matches a tunnel destination. An inbound pdcc packet is allowed through the firewall if its source address matches a tunnel destination and its destination address matches a tunnel source. Tunnels only affect TCP and UDP packets.

The availability of proxy and/or firewall tunnels depends on the network access settings of the node:

- If the node is configured with the proxy server enabled in GNE or ENE mode, you must set up a proxy tunnel and/or a firewall tunnel.
- If the node is configured with the proxy server enabled in proxy-only mode, you can set up proxy tunnels. Firewall tunnels are not allowed.
- If the node is configured with the proxy server disabled, neither proxy tunnels nor firewall tunnels are allowed.

Figure 17-25 shows an example of a foreign node connected to the GCC network. Proxy and firewall tunnels are useful in this example because the GNE would otherwise block IP access between the PC and the foreign node.

Figure 17-25 Proxy and Firewall Tunnels for Foreign Terminations

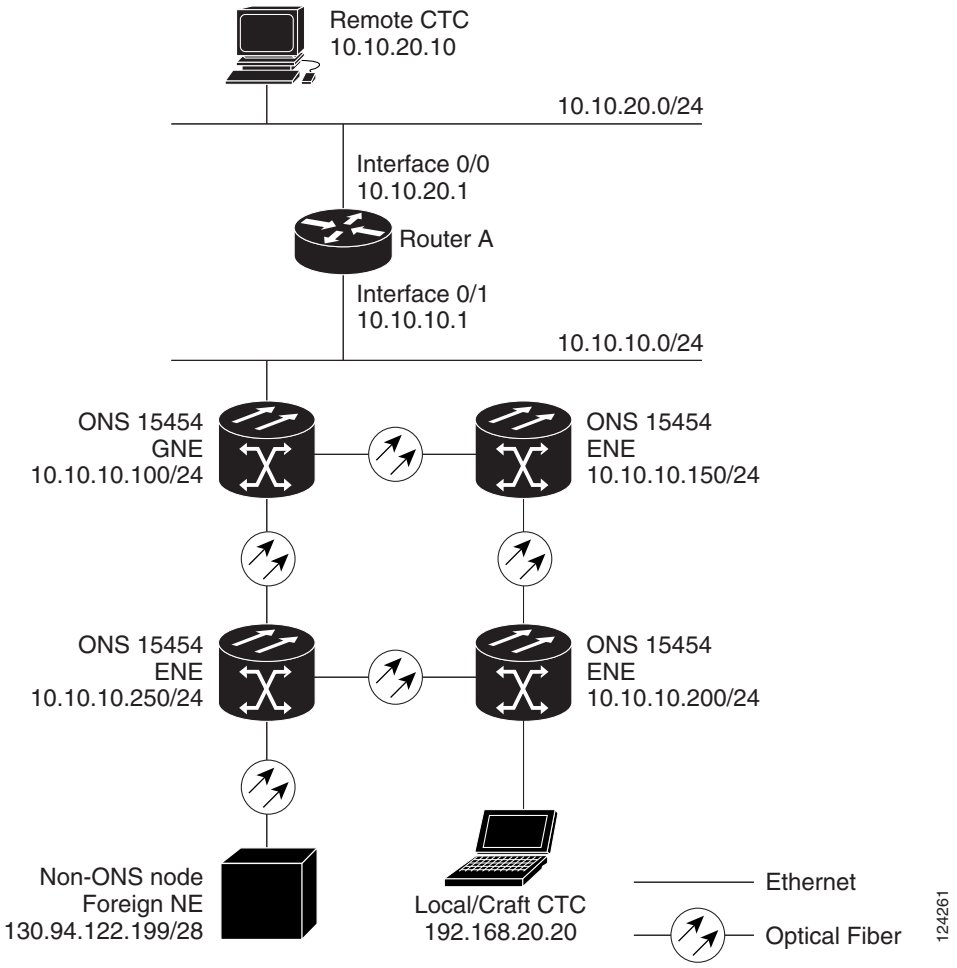
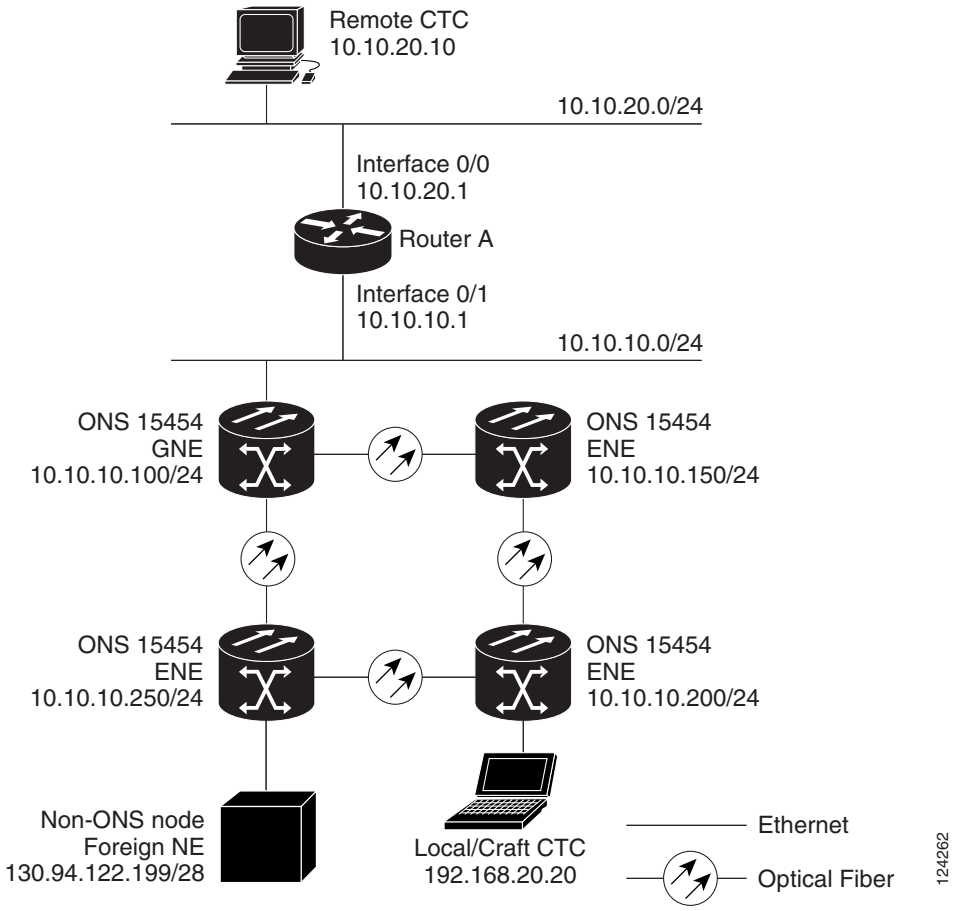


Figure 17-26 shows a remote node connected to an ENE Ethernet port. Proxy and firewall tunnels are useful in this example because the GNE would otherwise block IP access between the PC and foreign node. This configuration also requires a firewall tunnel on the ENE.

Figure 17-26 Foreign Node Connection to an ENE Ethernet Port



17.8 TCP/IP and OSI Networking

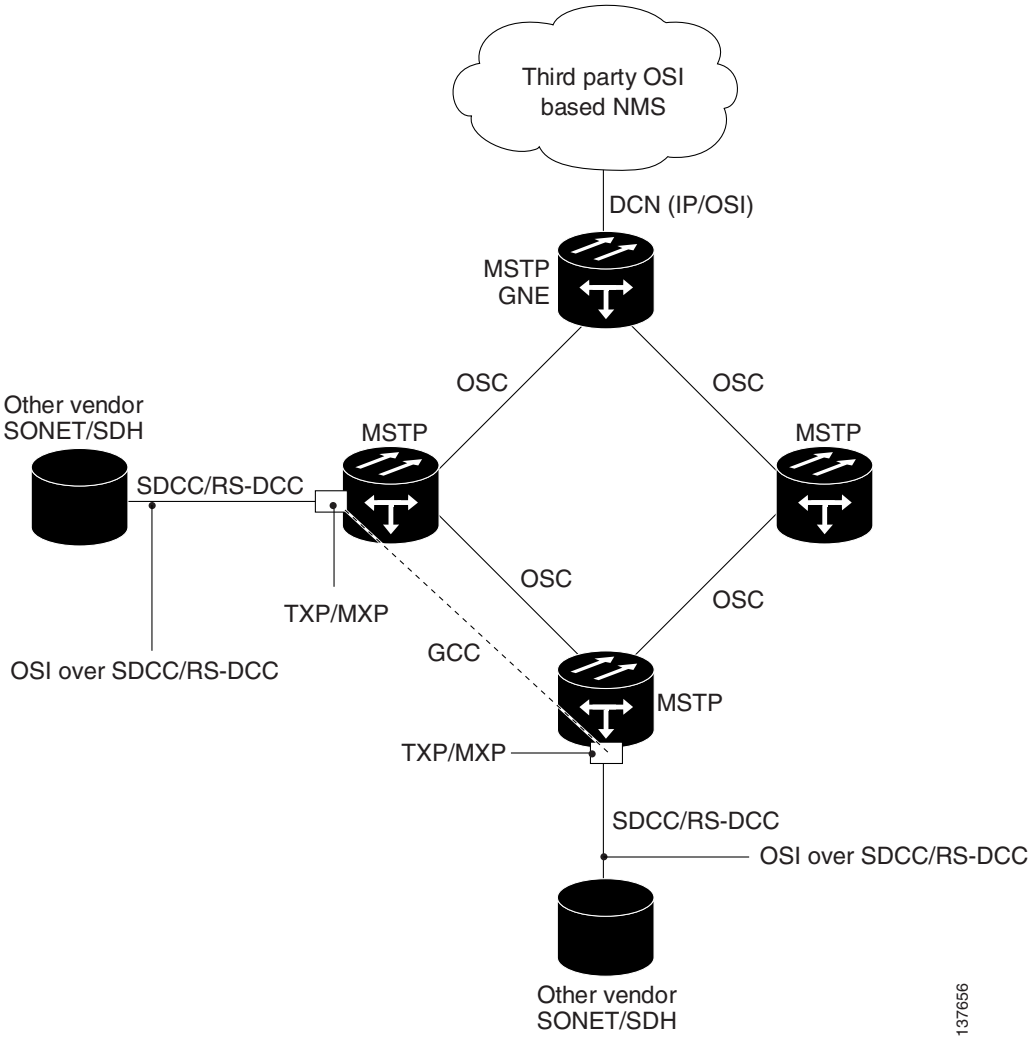
ONS 15454 DCN communication is based on the TCP/IP protocol suite. However, ONS 15454s can also be networked with equipment that uses the OSI protocol suite. While TCP/IP and OSI protocols are not directly compatible, they do have the same objectives and occupy similar layers of the OSI reference model. For detailed information about OSI protocols, processes, and scenarios, refer to the "Management Network Connectivity" chapter in the *ONS 15454 Reference Manual*. OSI/MultiService Transport Platform (MSTP) scenarios are provided in the following sections.

In OSI/MSTP Scenario 1 (Figure 17-27), an SDCC or RS-DCC carries an OC-N/STM-N signal from an OSI-based third-party NE to a transponder (TXP) or muxponder (MXP) card on an ONS NE. It is carried by GCC to a TXP/MXP card on another MSTP NE and then by SDCC or RS-DCC to a second third-party NE. This scenario requires TXPs/MXPs whose client interfaces can be provisioned in section or line termination mode. These include:

- TXP_MR_2.5 and TXPP_MR_2.5 (when equipped with OC-N/STM-N SFPs)
- TXP_MR_10G and TXP_MR_10E (when the client is configured as OC-192/STM-64)
- MXP_2.5_10G and MXP_2.5_10E

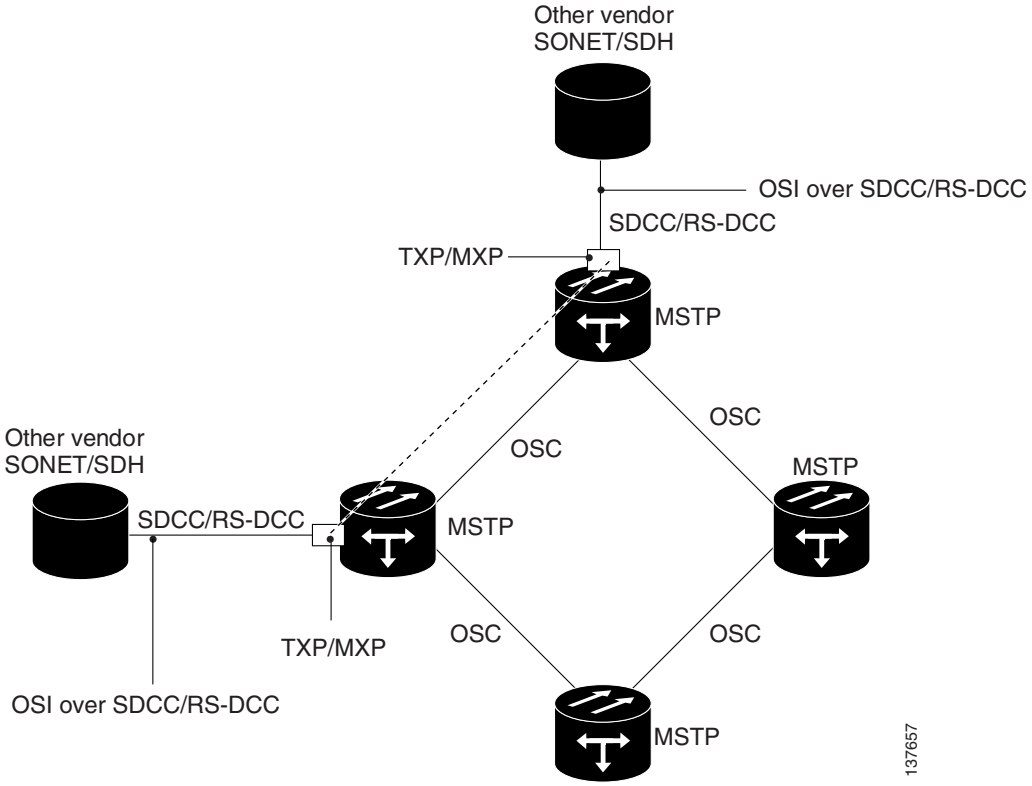
OSI has to be carried or tunneled to the other TXP/MXP card through an OSC termination, GCC termination, or both. The third-party NMS has OSI connectivity to its NEs with the MSTP ONS NE serving as the GNE for third-party vendor, OSI-based SONET equipment.

Figure 17-27 OSI/MSTP Scenario 1



OSI/MSTP Scenario 2 (Figure 17-28) is similar to Scenario 1, except the MSTP NEs do not have connectivity to an OSI NMS.

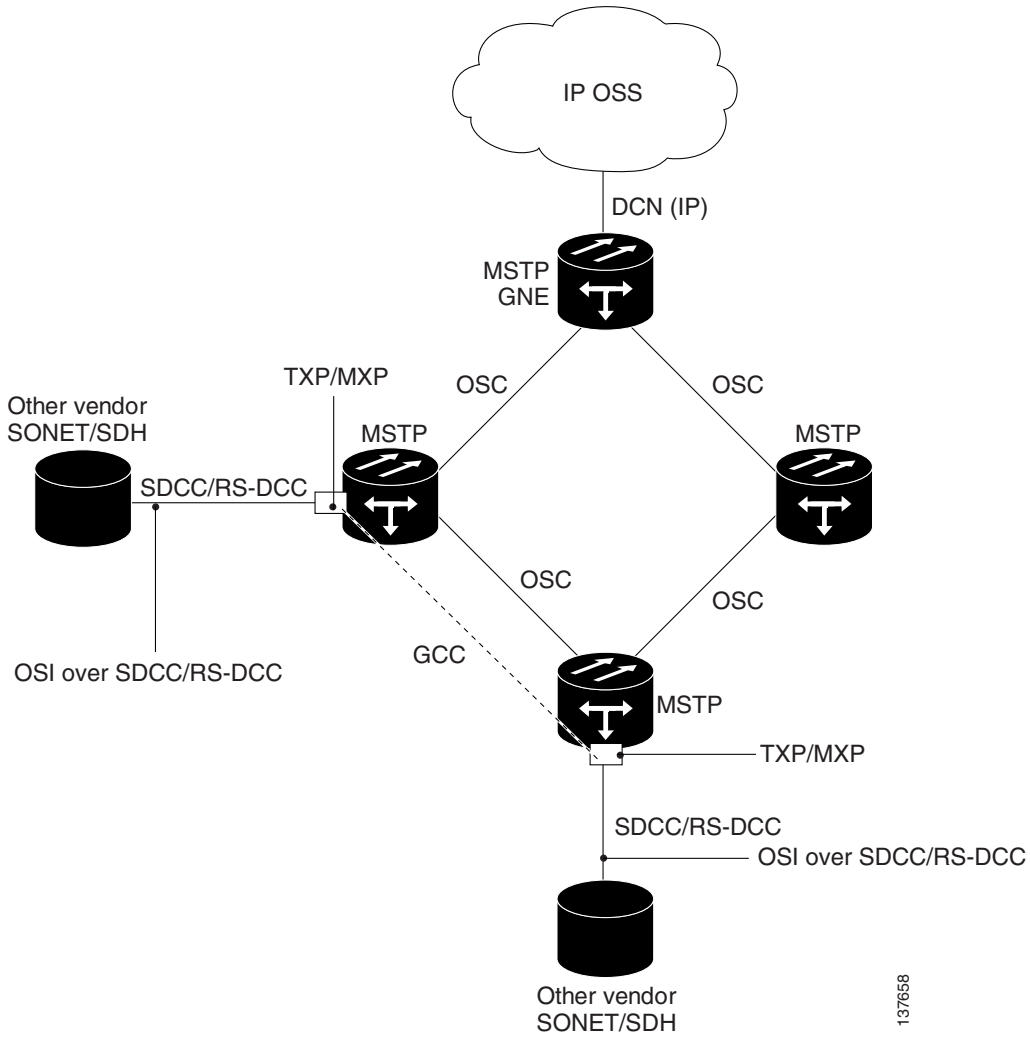
Figure 17-28 OSI/MSTP Scenario 2



OSI/MSTP Scenario 3 (Figure 17-29) shows the following:

- OSI is carried over an SDCC or RS-DCC termination.
- OSI has to be carried or tunneled to the other peer TXP/MXP through an OSC termination, GCC termination, or both.
- An OSS has IP connectivity to all the NEs.
- The MSTP NE is a GNE for the third-party OSI-based SONET NEs. The MSTP NEs perform all mediation functions.

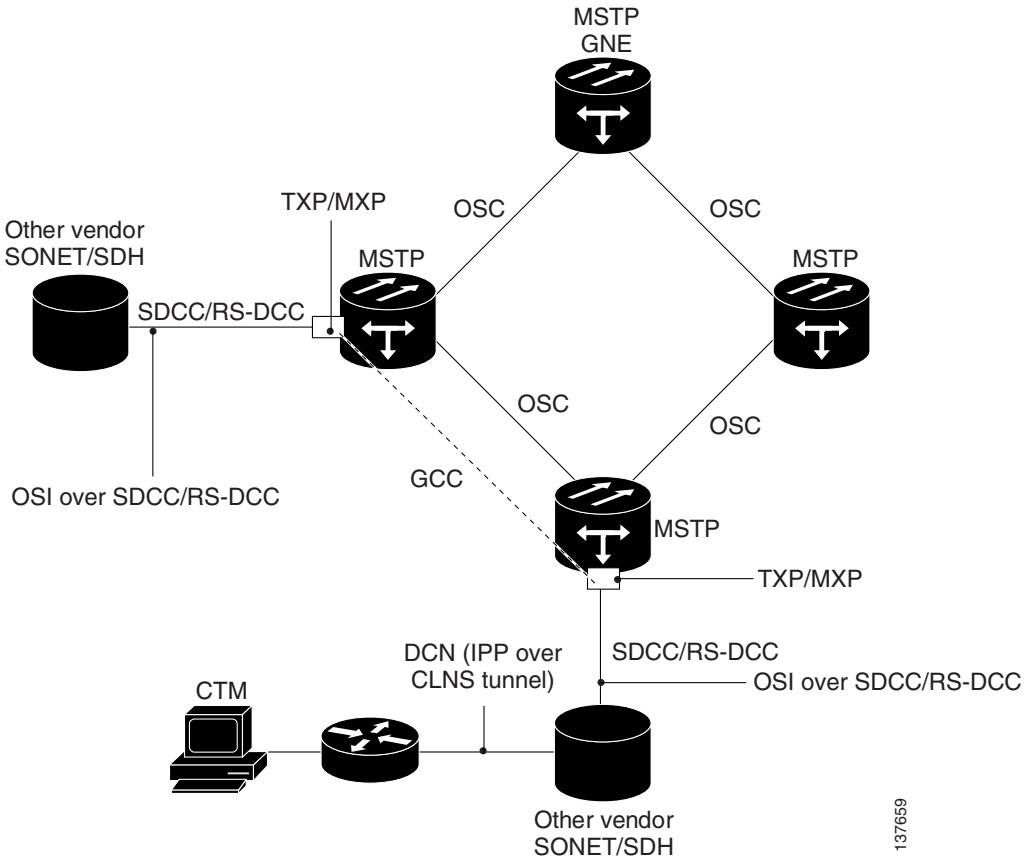
Figure 17-29 OSI/MSTP Scenario 3



OSI/MSTP Scenario 4 (Figure 17-30) shows the following:

- OSI is carried over an SDCC or RS-DCC termination.
- OSI has to be carried or tunneled to the other peer TXP/MXP through an OSC termination, GCC termination, or both
- An OSS has IP connectivity to all the NEs through third-party NE network.
- The MSTP NE is a GNE for the third-party OSI-based SONET NEs. The MSTP NEs perform all mediation functions.
- The third-party vendor NE is a GNE for the Cisco MSTP network.

Figure 17-30 OSI/IP Scenario 4



17.9 Link Management Protocol

This section describes Link Management Protocol[1] (LMP) management and configuration. To troubleshoot specific alarms, refer to the *Cisco ONS 15454 DWDM Troubleshooting Guide*. To configure LMP, refer to the *Cisco ONS 15454 DWDM Procedure Guide.*

Note CTM support is not required for LMP.

LMP is used to establish traffic engineering (TE) links between Cisco ONS 15454 nodes or between Cisco ONS 15454 nodes and selected non-Cisco nodes that use vendor-specific hardware.

17.9.1 Overview

LMP manages TE links between nodes through the use of control channels. TE links are designed to define the most efficient paths possible for traffic to flow over a network and through the Internet. Traffic engineering encompasses traffic management, capacity management, traffic measurement and modeling,

1. The LMP protocol is specified by the IETF in an Internet-Draft, draft-ietf-ccamp-lmp-10.txt, which was published as a Proposed Standard, RFC 4204, (http://www.ietf.org/rfc/rfc4204.txt), on 2005-10-28.

network modeling, and performance analysis. Traffic engineering methods include call routing, connection routing, quality of service (QoS) resource management, routing table management, and capacity management.

LMP manages TE links between peer nodes, such as two optical cross-connect (OXC) nodes. Peer nodes have equivalent signaling and routing. LMP also manages TE links between a node such as an OXC and an adjacent optical line system (OLS) node. An example of an OLS node is an ONS 15454 DWDM node.

Networks with routers, switches, OXC nodes, DWDM OLS nodes, and add/drop multiplexers (ADM) use a common control plane such as Generalized Multiprotocol Label Switching (GMPLS) to provision resources and provide network survivability using protection and restoration techniques. LMP is part of the GMPLS protocol suite.

A single TE link can be formed from several individual links. Management of TE links can be accomplished with in-band messaging, as well as with out-of-band methods. The following material describes the LMP between a pair of nodes that manages TE links. LMP accomplishes the following:

- Maintains control channel connectivity
- Verifies the physical connectivity of the data links
- Correlates the link property information
- Suppresses downstream alarms
- Localizes link failures for protection/restoration purposes in multiple types of networks

DWDM networks often use Multiprotocol Label Switching (MPLS) and GMPLS as common-control planes to control how packets are routed through the network.

LMP manages the control channel that must exist between nodes for routing, signaling, and link management. For a control channel to exist, each node must have an IP interface that is reachable from the other node. Together, the IP interfaces form a control channel. The interface for the control messages does not have to be the same interface as the one for the data.

17.9.1.1 MPLS

MPLS provides a mechanism for engineering network traffic patterns that is independent of routing tables and routing protocols. MPLS assigns short labels to network packets that describe how to forward the packets through the network. The traditional Layer 3 forwarding mechanism requires each hop to analyze the packet header and determine the next hop based on routing table lookup. With MPLS, the analysis of the packet header is performed just once, when a packet enters the MPLS cloud. The packet is then assigned to a stream known as a Label Switch Path (LSP), which is identified with a label. The short, fixed-length label is an index into a forwarding table, which is more efficient than the traditional routing table lookup at each hop. Using MPLS, both the control protocol (used to manage the LSPs) and user data can be carried over the same bearer interfaces.

17.9.1.2 GMPLS

GMPLS is based on MPLS, with protocol extensions to support additional technologies, including time division multiplexing (TDM) slots (such as SONET and SDH), wavelength division multiplexing (WDM) wavelengths at Layer 1, and fiber. For MPLS, the control traffic (signaling and routing) can run over bearer interfaces. This is not the case with GMPLS, where a separate control channel is used. The GMPLS control channel is managed with LMP. With GMPLS, the control channels between two adjacent nodes do not need to use the same physical medium as the data links between those nodes.

17.9.2 Configuring LMP

Configuring LMP consists of the following four topics:

- Control channel management
- TE link management
- Link connectivity verification
- Fault management

17.9.2.1 Control Channel Management

Control channel management establishes and maintains control channels between adjacent nodes. Control channels use a Config message exchange and a fast keep-alive mechanism between the nodes. The latter is required if lower-level mechanisms are not available to detect control-channel failures. A maximum of four LMP control channels can be supported.

The nodes initially exchange configuration messages (Config, ConfigAck, and ConfigNack), which are used to exchange identifiers and negotiate parameters for the keep-alive protocol. The nodes then perform a continuous rapid exchange of Hello messages, which are used to monitor the health on the channel.

Note The identifiers are Local Node Id, Remote Node Id, Local Control Channel Id, and Remote Control Channel Id. The parameters are the HelloInterval and the HelloDeadInterval.

LMP out-of-fiber and LMP out-of-band control channels are supported and terminated on the shelf. An out-of-fiber control channel includes using the control plane network (Ethernet) for the control channel because Ethernet is separate from the fiber used for the data plane. An out-of-band control channel includes using overhead bytes, such as the SDCC and LDCC bytes, for the control channel because overhead bytes are separate from the payload. In-band means that the control messages are in the same channel as the data messages; therefore, out-of-band refers to overhead bytes in the same fiber, separate circuits dedicated to control messages in the same fiber (SONET/SDH circuits), or separate wavelengths in the same fiber (DWDM).

Note Overhead bytes are SDCC or LDCC for SONET networks, RS-DCC or MS-DCC for SDH networks, and GCC or OSC for DWDM networks.

Out-of-band implies in-fiber, but not in-band. In-fiber means that the control messages are in the same fiber as the data messages, and includes both in-band and out-of-band. Out-of-fiber means that the control messages take a path separate from the data plane. This includes separate fiber and Ethernet.

The control channel management for a peer node to OLS link is the same as that for a link between two peer nodes.

Note The software supports gracefully taking a control channel down for administration purposes (refer to Section 3.2.3 of the IETF LMP document). However, there is no provision for a graceful restart (refer to Section 8 of RFC 4204).

- Graceful means that the nodes participating in the control channel agree that the link should go down. To gracefully take down a control channel, the node sets the ControlChannelDown flag in its messages to the other node until either the HelloDeadInterval expires or the other node sends a

message back with the ControlChannelDown flag set. In either case, the node then stops sending messages for this control channel. Before a control channel is taken down, there should be a backup control channel in place that can be used to manage the data links.

- Non-graceful means that one of the nodes just stops sending messages. The other side would declare a failure after the HelloDeadInterval, but would continue to send Hello messages to see if the control channel will come back up.

17.9.2.2 TE Link Management

LMP ensures that links are grouped into TE links and that the properties of those links are the same at both endpoints. This is called TE link management, or link property correlation.

Link property correlation is used to synchronize the TE link properties and verify the TE link configuration. The link property correlation function of LMP aggregates one or more data links into a TE link and synchronizes the properties of the TE link with the neighbor node. The procedure starts by sending a LinkSummary message to the neighbor. The LinkSummary message includes the local and remote Link Identifier, a list of all data links that make up the TE link, and various link properties. It is mandatory that a LinkSummaryAck or LinkSummaryNack message be sent in response to the receipt of a LinkSummary message, indicating agreement or disagreement with the link properties.

Note A maximum of 256 LMP TE links is supported.

17.9.2.3 Link Connectivity Verification

Link connectivity verification is not supported in this release, but might be supported in the future.

17.9.2.4 Fault Management

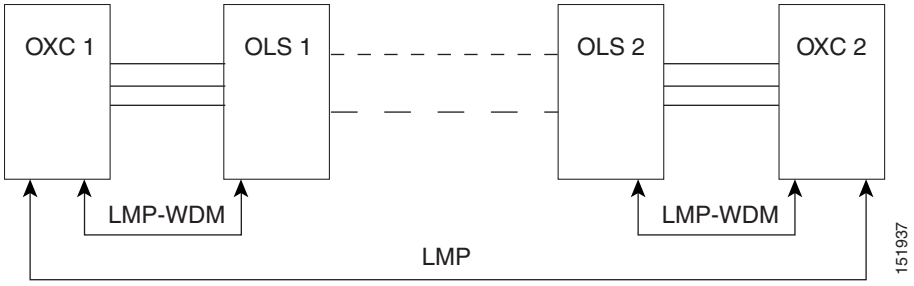
Fault management is particularly useful when the control channels are physically diverse from the data links. It is used for rapid notification regarding the status of one or more TE-link data channels. The use of fault management is negotiated as part of the TE link's LinkSummary exchange. Data links and TE link failures can be rapidly isolated and fault management supports both unidirectional and bidirectional LSPs. Transparent devices are useful because traditional methods for monitoring the health of allocated data links might no longer be appropriate. Instead, fault detection is delegated to the physical layer (for example, loss of light or optical monitoring of the data) instead of Layer 2 or Layer 3. Fault management uses the ChannelStatus, ChannelStatusAck, ChannelStatusRequest, and ChannelStatusResponse messages.

Note The LMP Channel Activation/Deactivation Indication procedures are not supported; they are described in the IETF LMP document, Sections 6.4 and 6.5.

17.9.3 LMP WDM

LMP manages traffic engineering links between peer nodes (nodes that are peers in signaling and/or routing). The purpose of the LMP WDM extensions[2] is to allow LMP to be used between an OXC node and an adjacent DWDM OLS node. Figure 17-31 illustrates the relationship between LMP and LMP-WDM. OXC 1 and OXC 2 are peer nodes whose control channel is managed with LMP. LMP-WDM manages the control channel between an OXC node and an OLS node.

Figure 17-31 LMP and LMP-WDM Relationship



When the two OLS nodes can communicate their configuration and the current state of their optical link to the two peer nodes (OXC 1 and OXC 2) through LMP-WDM, network usability is improved through the reduction of manual configuration and enhanced fault detection and recovery.

17.9.4 LMP Network Implementation

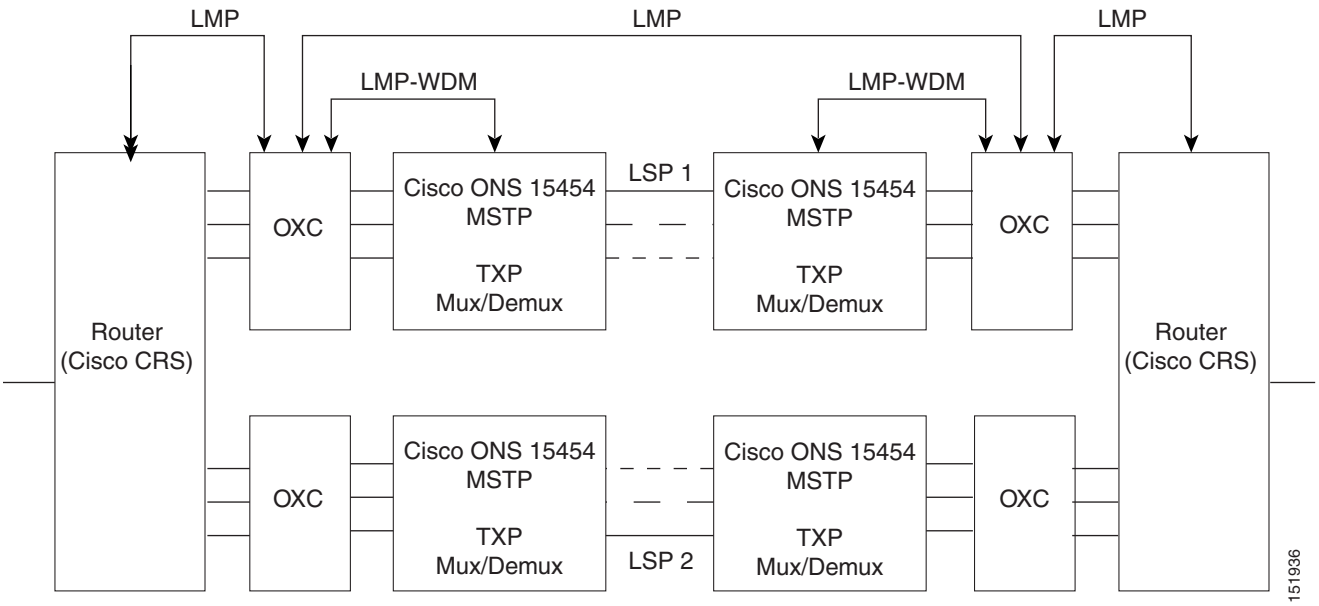
Figure 17-32 shows a network-level LMP implementation. It is an IP-plus-optical network, with end-to-end routing based on MPLS and GMPLS. The primary network components are:

- Routers
  - Cisco Carrier Router System (CSR)
  - Cisco Gigabit Switch Router (GSR)
- An OXC node
- Ultra long-haul (ULH) DWDM equipment

LMP and other features allow the Cisco ONS 15454 DWDM node to fulfill the ULH DWDM role. Figure 17-32 illustrates the relationship between the network components.

2. LMP-WDM extensions that allow management of links between a peer node and an adjacent OLS node are described in the following IETF document: Internet-Draft, draft-ietf-ccamp-lmp-wdm-03.txt, published as a Proposed Standard, RFC 4209 (http://www.ietf.org/rfc/rfc4209.txt), 2005-11-1

Figure 17-32 LMP System Implementation



17.10 IPv6 Network Compatibility

IPv6 simplifies IP configuration and administration and has a larger address space than IPv4 to support the future growth of the Internet and Internet related technologies. It uses 128-bit addresses as against the 32-bit used in IPv4 addresses. Also, IPv6 gives more flexibility in designing newer addressing architectures.

Cisco ONS 15454 DWDM can function in an IPv6 network when an Internet router that supports Network Address Translation-Protocol Translation (NAT-PT) is positioned between the GNE, such as an ONS 15454 DWDM, and the client workstation. NAT-PT is a migration tool that helps users transition from IPv4 networks to IPv6 networks. NAT-PT is defined in RFC-2766. IPv4 and IPv6 nodes communicate with each other using NAT-PT by allowing both IPv6 and IPv4 stacks to interface between the IPv6 DCN and the IPv4 DCC networks.

Note IPv6 is supported on Cisco ONS 15454 DWDM Software R8.0 and later with an external NAT-PT router.

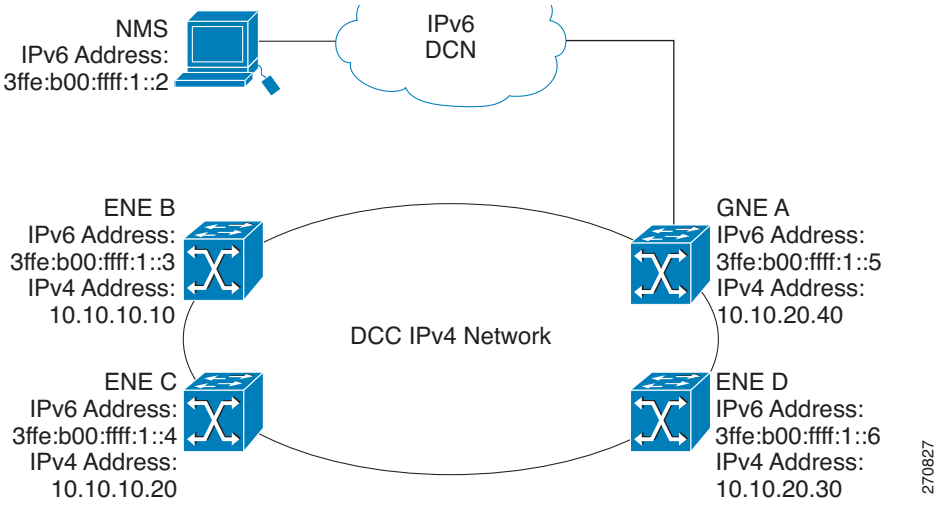
17.11 IPv6 Native Support

Cisco ONS 15454 DWDM Software R9.0 and later supports native IPv6. ONS 15454 DWDM can be managed over IPv6 DCN networks by enabling the IPv6 feature. After you enable IPv6 in addition to IPv4, you can use CTC, TL1, and SNMP over an IPv6 DCN to manage ONS 15454 DWDM. Each NE can be assigned an IPv6 address in addition to the IPv4 address. You can access the NE by entering the IPv4 address, an IPv6 address or the DNS name of the device. The IPv6 address is assigned only on the LAN interface of the NE. DCC/GCC interfaces use the IPv4 address.

By default, when IPv6 is enabled, the node processes both IPv4 and IPv6 packets on the LAN interface. If you want to process only IPv6 packets, you need to disable IPv4 on the node. Before you disable IPv4, ensure that IPv6 is enabled and the node is not in multishelf mode.

Figure 17-33 shows how an IPv6 DCN interacts with and IPv4 DCC.

Figure 17-33 IPv6-IPv4 Interaction



You can manage MSTP multishelf nodes over IPv6 DCN. RADIUS, FTP, SNTP, and other network applications support IPv6 DCN. To enable IPv6 addresses, you need to make the necessary configuration changes from the CTC or TL1 management interface. After you enable IPv6, you can start a CTC or TL1 session using the provisioned IPv6 address. The ports used for all IPv6 connections to the node are the same as the ports used for IPv4.

An NE can either be in IPv6 mode or IPv4 mode. In IPv4 mode, the LAN interface does not have an IPv6 address assigned to it. An NE, whether it is IPv4 or IPv6, has an IPv4 address and subnet mask. TCC2/TCC2P/TCC3/TNC/TSC cards do not reboot automatically when you provision an IPv6 address, but a change in IPv4 address initiates a TCC2/TCC2P/TCC3/TNC/TSC card reset. Table 17-11 describes the differences between an IPv4 node and an IPv6 node.

Table 17-11 Differences Between an IPv6 Node and an IPv4 Node

IPv6 Node	IPv4 Node
Has both IPv6 address and IPv4 address assigned to its craft Ethernet interface.	Does not have an IPv6 address assigned to its craft Ethernet interface.
The default router has an IPv6 address for IPv6 connectivity, and an IPv4 address for IPv4 connectivity.	The default router has an IPv4 address.
Cannot enable OSPF on LAN. Cannot change IPv4 NE to IPv6 NE if OSPF is enabled on the LAN.	Can enable OSPF on the LAN.
Cannot enable RIP on the LAN. Cannot change IPv4 NE to IPv6 NE if RIP is enabled on the LAN.	Can enable static routes/RIP on the LAN.

Table 17-11 Differences Between an IPv6 Node and an IPv4 Node

IPv6 Node	IPv4 Node
Not supported on static routes, proxy tunnels, and firewall tunnels.	Supported on static routes, proxy tunnels, and firewall tunnels.
Routing decisions are based on the default IPv6 router provisioned.	

17.11.1 IPv6 Enabled Mode

The default IP address configured on the node is IPv4. You can use either CTC or the TL1 management interface to enable IPv6. For more information about enabling IPv6 from the CTC interface, see the *Cisco ONS 15454 DWDM Procedure Guide*. For more information about enabling IPv6 using TL1 commands, see the *Cisco ONS 15454 TL1 Command Guide*.

17.11.2 IPv6 Disabled Mode

You can disable IPv6 either from the CTC or from the TL1 management interface. For more information about disabling IPv6 from the CTC interface, see the *Cisco ONS 15454 DWDM Procedure Guide*. For more information about disabling IPv6 using TL1 commands, see the *Cisco ONS 15454 TL1 Command Guide*.

17.11.3 IPv6 in Non-secure Mode

In non-secure mode, IPv6 is supported on the front and the rear Ethernet interfaces. You can start a CTC or TL1 session using the IPv6 address provisioned on the on the front and rear ports of the NE.

17.11.4 IPv6 in Secure Mode

In secure mode, IPv6 is only supported on the rear Ethernet interface. The front port only supports IPv4 even if it is disabled on the rear Ethernet interface. For more information about provisioning IPv6 addresses in secure mode, see the *Cisco ONS 15454 DWDM Procedure Guide*. For more information on secure mode behavior, see section 17.2.9 Scenario 9: IP Addressing with Secure Mode Enabled, page 17-19.

17.11.5 IPv6 Limitations

IPv6 has the following configuration restrictions:

- You can provision an NE as IPv6 enabled only if the node is a SOCKS-enabled or firewall-enabled GNE/ENE.
- IPSec is not supported.
- OSPF/RIP cannot be enabled on the LAN interface if the NE is provisioned as an IPv6 node.
- Static route/firewall/proxy tunnel provisioning is applicable only to IPv4 addresses even if the IPv6 is enabled.

- In secure mode, IPv6 is supported only on the rear Ethernet interface. IPv6 is not supported on the front port.
- ONS platforms use NAT-PT internally for providing IPv6 native support. NAT-PT uses the IPv4 address range 128.x.x.x for packet translation. Do not use the 128.x.x.x address range when you enable IPv6 feature.

17.12 Integration with Cisco CRS-1 Routers

This section describes the integration of a Cisco ONS 15454 DWDM node with a Cisco CRS-1 router. To provision end-to-end circuit connectivity between a DWDM node and a Cisco CRS-1 router, refer to *Cisco ONS 15454 DWDM Procedure Guide*.

This feature provides end-to-end circuit provisioning from one Cisco CRS-1 router to another Cisco CRS-1 router passing through an MSTP network (without using GMPLS). In other words, you can use CTC to create an OCH trail circuit that includes the Cisco CRS-1 nodes involved in the MSTP network. With this feature, circuit provisioning is extended to the physical layer interface module (PLIM) trunk ports of the Cisco CRS-1 router.

Note Cisco ONS Software Release 9.1 supports only Cisco CRS-1 router using Cisco IOS XR Software Release 3.9.0. If you have an earlier version of the Cisco IOS XR software, you cannot configure LMP on the Cisco CRS-1 router, and the router will be visible as an unknown node in the CTC network view.

For more information about the Cisco CRS-1 router, refer to the documentation set available at http://www.cisco.com/en/US/products/ps5763/tsd_products_support_series_home.html.

17.12.1 Card Compatibility

The following Cisco CRS-1 DWDM PLIMs support this feature:

- 4-10GE-ITU/C
- 1OC768-ITU/C
- 1OC768-DSPK

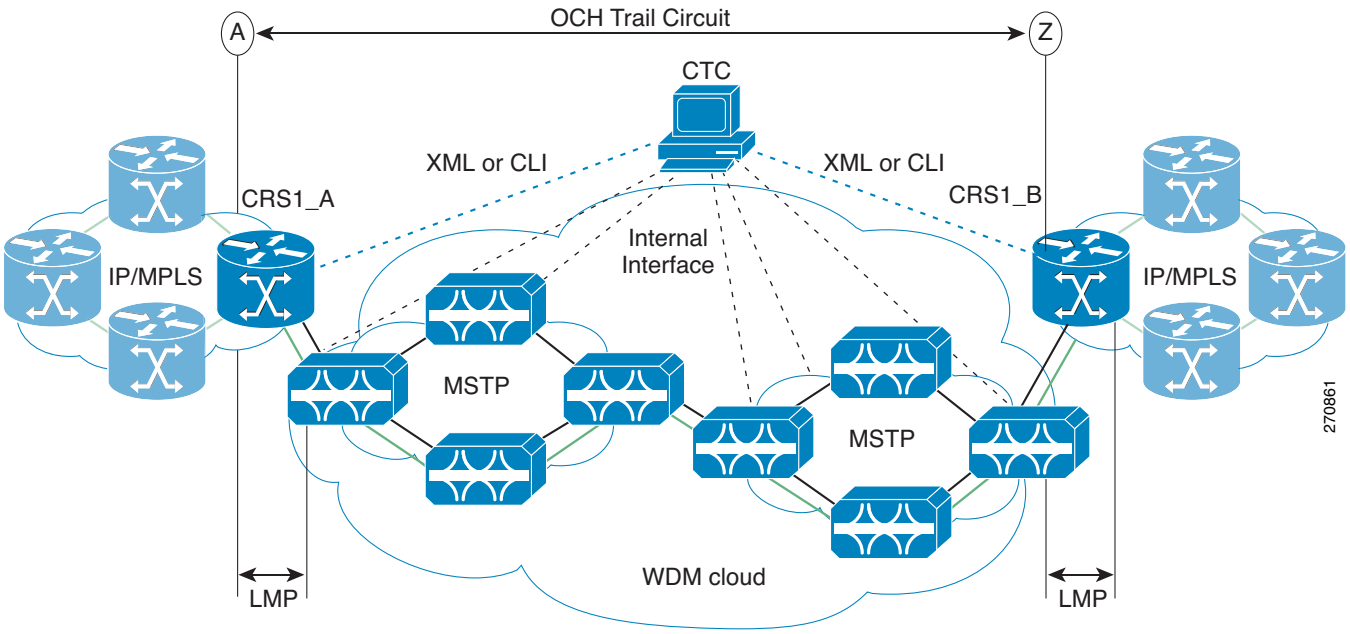
The following ONS 15454 DWDM cards support this feature:

- 32MUX-O
- 32DMX-O
- 32WSS
- 32DMX
- 40-DMX-C
- 40-DMX-CE
- 40-MUX-C
- 40-WSS-C
- 40-WSS-CE

17.12.2 Node Management

Figure 17-34 depicts a typical network that includes DWDM nodes and Cisco CRS-1 routers.

Figure 17-34 Cisco ONS 15454 DWDM Node and Cisco CRS-1 Router Network



17.12.2.1 Physical Connections

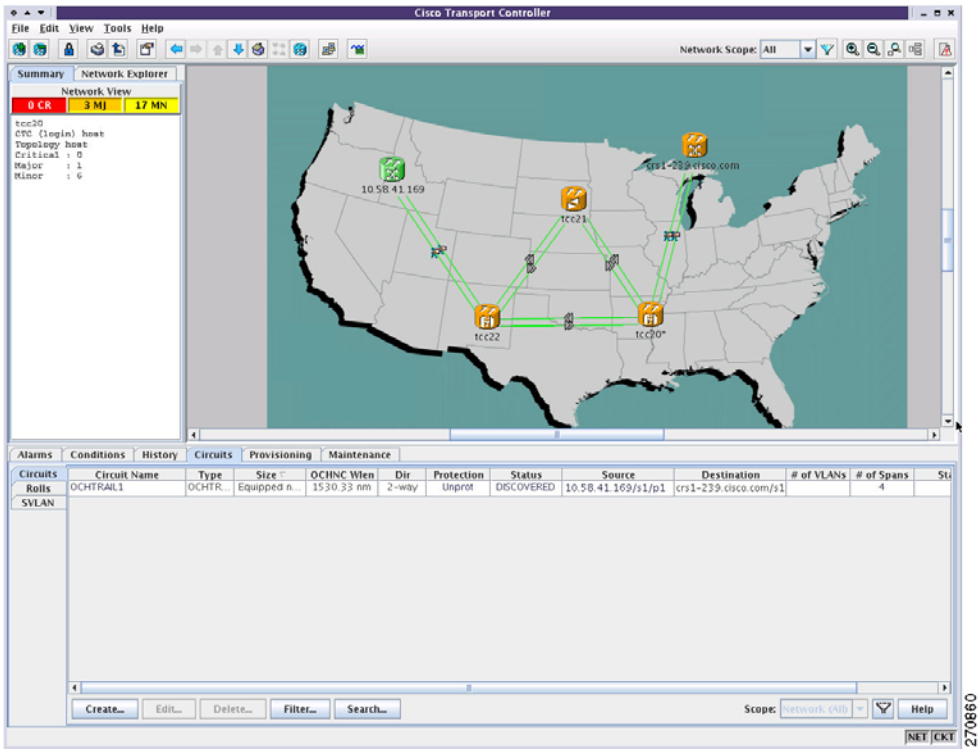
The ONS 15454 DWDM node can be connected to CTC using multiple ways, as described in the "14.4 ONS 15454 Connections" section on page 14-5. The Cisco CRS-1 router must be connected to CTC through TCP/IP, using an Ethernet interface. There must be two physical connections between the DWDM node and the Cisco CRS-1 router for:

- LMP provisioning—through the 10-Mbps Ethernet interface provided by the TCC2P card (on the Cisco ONS 15454 side) and the RP card (on the Cisco CRS-1 router side).
- 10-Gbps and 40-Gbps traffic—through the fiber connection provided from the OCH ports of the multiplexer, demultiplexer, or WSS cards (on the Cisco ONS 15454 side) and from the PLIM trunk ports (on the Cisco CRS-1 router side). You must use LC connectors on both the Cisco ONS 15454 side and the Cisco CRS-1 router side.

17.12.2.2 CTC Display

The CTC network view displays Cisco CRS-1 routers that have LMP control channels to the DWDM node that you logged in to, and to the DWDM nodes with DCC connections to the login node (Figure 17-35). When a data link has been established, the network view also displays the link between the Cisco CRS-1 router and the DWDM node.

Figure 17-35 Cisco CRS-1 Router in CTC Network View



The color of the Cisco CRS-1 router in the network view depends on the Cisco CRS-1 router alarm status. The color of the link between the DWDM node and the Cisco CRS-1 router depends on the link status. For more information on node and link colors, see the "14.5.3.2 CTC Node Colors" section on page 14-17 and the "14.5.3.3 DCC Links" section on page 14-17.

17.12.3 Circuit Management

This section describes LMP provisioning and optical channel (OCH) trail circuit provisioning on the DWDM node and the Cisco CRS-1 router.

17.12.3.1 LMP Provisioning

To provision end-to-end circuit connectivity from one Cisco CRS-1 router to another Cisco CRS-1 router passing through a DWDM network, you must configure LMP on the OCH ports of the first and last DWDM nodes (those adjacent to the Cisco CRS-1 router) and on the PLIM trunk ports of the Cisco CRS-1 router. Configuring LMP involves creating control channels, TE links, and data links. CTC primarily uses data links to discover circuit routes. For each 10-Gbps or 40-Gbps fiber between the Cisco CRS-1 router and the DWDM node, you must create a TE link and a data link. You must have a dedicated TE link for each data link because the Cisco CRS-1 router does not support link bundling (aggregation of one or more data links into a single TE link). When the port association is correct (checked using the LinkSummary message), the operational state of the data link transitions to Up–Free.

During creation of data links between the OCH ports of the DWDM node and the PLIM trunk ports of the Cisco CRS-1 router, CTC performs *lambda tuning*, that is, CTC automatically tunes the PLIM trunk port wavelength to match the supported wavelength on the OCH ports of the DWDM node. For more information on LMP, see the "17.9 Link Management Protocol" section on page 17-49.

You can configure LMP on the DWDM node and the Cisco CRS-1 router through CTC. For details on configuring LMP, refer to *Cisco ONS 15454 DWDM Procedure Guide.*

17.12.3.2 OCH Trail Circuit Provisioning

After you have provisioned LMP on the DWDM nodes and the Cisco CRS-1 routers, you can create an OCH trail circuit from one Cisco CRS-1 router to another Cisco CRS-1 router passing through an MSTP network. The endpoints (source and destination) of the OCH trail circuit must be Cisco CRS-1 routers. CTC does not allow mixed nodes (Cisco CRS-1 router to DWDM node) for OCH trail circuits.

As part of OCH trail circuit creation, you must also define the following optical transport network (OTN) line parameters on both endpoints of the circuit:

- ITU-T G.709
- Forward error correction (FEC)
- Signal fail bit error rate (SF BER)
- Signal degrade bit error rate (SD BER)

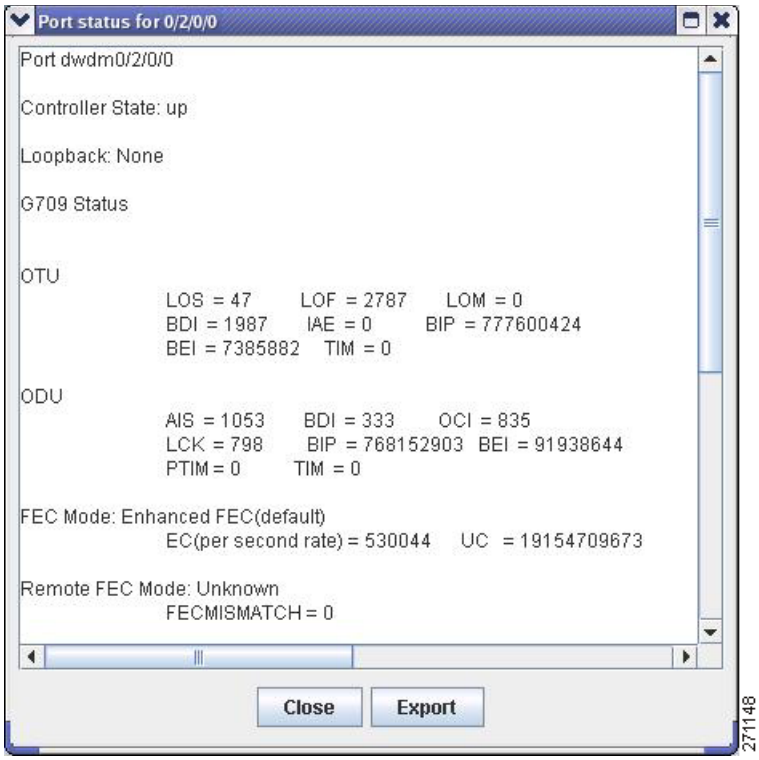
After you define the source and destination nodes for the OCH trail circuit, CTC evaluates the circuit for a valid route between the two endpoints. If a valid route exists, CTC creates the required connections on all the impacted nodes.

17.12.4 Cisco CRS-1 Router Management from CTC

After you have provisioned LMP on the Cisco CRS-1 router and the DWDM node, the Cisco CRS-1 router gets displayed in the CTC network view. You can view active alarms, performance monitoring (PM) parameters, and the software version of the Cisco CRS-1 router from CTC.

To view PM parameters for a specific PLIM port, right-click the Cisco CRS-1 router in CTC network view and choose **Show Router Port Status >** `rack/slot/module/port` (Figure 17-36).

Figure 17-36 Cisco CRS-1 Router PM Parameters



To view all the active alarms, right-click the Cisco CRS-1 router in CTC network view and choose **Show Active Alarms**.

Note The Loss of Signal (LOS) alarm is not reported as critical for the Cisco CRS-1 router, whereas, it is reported as critical for the ONS 15454 node. To avoid this inconsistency, you can use Cisco Craft Works Interface (CWI) to manually change the severity for the LOS alarm of the Cisco CRS-1 router.

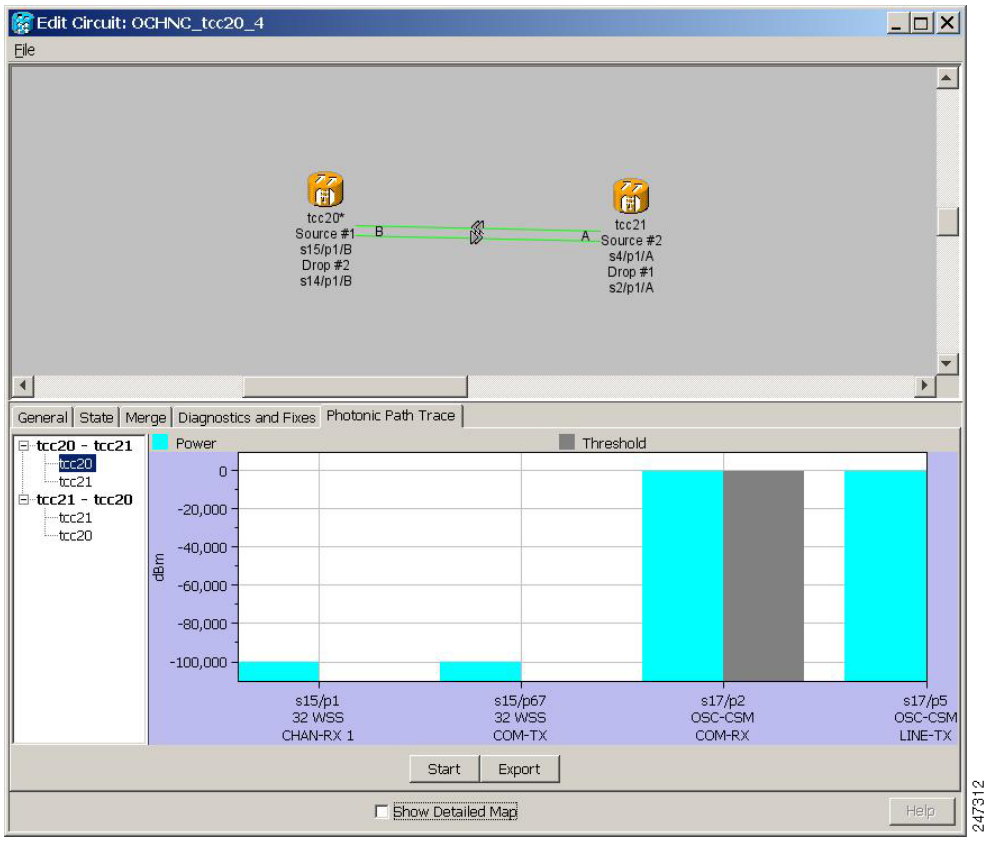
To view the software version, click the **Maintenance > Software** tabs in the CTC network view. The working software version for each node is listed in the Working Version column.

17.13 Photonic Path Trace

Photonic Path Trace (PPT) is a protocol that validates an optical path in an ONS 15454 MSTP network.

PPT performs evidence-based path validation and identifies nodes in case of provisioning failure. PPT uses the power levels on each port to validate the path. For every node in the optical path, PPT reports the power levels against the threshold values in the form of a histogram. The histogram is displayed in the Photonic Path Trace tab of the Edit Circuit window in CTC. For each node, a set of power values collected from all the traversed ports is displayed in the histogram (Figure 17-37).

Figure 17-37 Photonic Path Trace



Note An OCHNC or OCH trail circuit must exist on the optical path on which PPT is started.

For information on how to start PPT on an optical path, see the "Turn Up a Network" chapter in the *Cisco ONS 15454 DWDM Procedure Guide.*

17.14 Shared Risk Link Group

SRLG is a unique 32 bit number that can be assigned to a link or DWDM node. This number can be used as an identifier of a link or a group of resources that may fail. A set of links constitute a SRLG if they share a resource (for example, a common fiber) whose failure causes the other links of the group to fail too. Therefore, the links in the group have a shared risk. A link can belong to multiple SRLGs. SRLG information is an unordered list of SRLGs that the link belongs to that is used by the router layer for making routing decisions. For example, if a router traverses through a diverse path, the path computation ensures that routing does not go through links sharing the same SRLG.

There are two types of SRLGs, unique and additional. Every link or DWDM node must be assigned a unique SRLG attribute. Additional SRLGs for DWDM nodes or links are optional and can be defined in CTC. The additional SRLGs for a link compute the additional risks associated with the link. A list of additional SRLGs for a link can be defined in the Additional Span SRLG information attribute in CTC. This list can contain upto 20 SRLGs.

When the SRLG value of a DWDM node or link is changed, the SRLG attributes are updated for all the relevant router ports. When a new router-based OCH trail is created, the SRLG information of the DWDM nodes and links that are part of the newly created circuit is automatically communicated to the source and destination router. SRLG information can also be synchronized when the SRLG values on the router ports differ from the SRLG values on the DWDM nodes. The SRLG information can be viewed as consolidated or detailed reports in CTC. For more information about provisioning SRLGs on DWDM nodes and links, refer to the "Turn Up a Network" chapter in the *Cisco ONS 15454 DWDM Procedure Guide.*

17.15 Proactive Protection Regen

When an optical signal degrades in a DWDM network, the downstream router is unaware of it. When the FEC limit is reached, there is traffic interruption with significant packet loss and an LOF alarm is raised. The LOF alarm triggers a Fast Reroute (FRR) mechanism in the router layer that switches traffic to a backup path.

The Proactive Protection Regen feature achieves a hitless switchover before the traffic is interrupted by triggering an FRR to backup paths before the LOF alarm is raised.

Proactive protection regen can be enabled on the OTU2_XP card ports when the card is used as a regenerator in Standard regen or Enhanced FEC mode. Proactive protection regen can also be configured during creation of OCH trail circuits between two Cisco CRS-1 routers.

As soon as the BER of the optical signal between the upstream router and the ONS node exceeds the trigger threshold value for the duration set as the trigger window, a PPR-FDI alarm is generated by the ONS node. The PPR-FDI alarm is sent to the downstream router which in turn triggers the switchover to the backup path. The downstream router then sends the PPR-BDI alarm to the upstream router to switch to the backup path.

For more information about configuring proactive protection regen on OTU2_XP cards and OCH trails in CTC, refer to the "Provision Transponder and Muxponder Cards" chapter in the *Cisco ONS 15454 DWDM Procedure Guide.*

CHAPTER 18

Alarm and TCA Monitoring and Management

This chapter describes Cisco Transport Controller (CTC) alarm and threshold crossing alert (TCA) monitoring and management. To troubleshoot specific alarms, refer to the *Cisco ONS 15454 DWDM Troubleshooting Guide*.

Note Unless otherwise specified, "ONS 15454" refers to both ANSI and ETSI shelf assemblies.

Chapter topics include:

- 18.1 Overview, page 18-1
- 18.2 Alarm Counts on the LCD for a Node, Slot, or Port, page 18-2
- 18.3 Alarm Display, page 18-2
- 18.4 Alarm Severities, page 18-8
- 18.5 Alarm Profiles, page 18-9
- 18.6 External Alarms and Controls, page 18-12
- 18.7 Alarm Suppression, page 18-14
- 18.8 Multishelf Configuration Alarming, page 18-15
- 18.9 Threshold Crossing Alert Suppression, page 18-16

18.1 Overview

CTC detects and reports alarms generated by the Cisco ONS 15454 and the larger network. You can use CTC to monitor and manage alarms at the card, node, or network level. Default alarm severities conform to the Telcordia GR-474-CORE standard, but you can set alarm severities in customized alarm profiles or suppress CTC alarm reporting. For a detailed description of the standard Telcordia categories employed by Optical Networking System (ONS) nodes, refer to the *Cisco ONS 15454 DWDM Troubleshooting Guide.*

Note ONS 15454 alarms can also be monitored and managed through Transaction Language One (TL1) or a network management system (NMS).

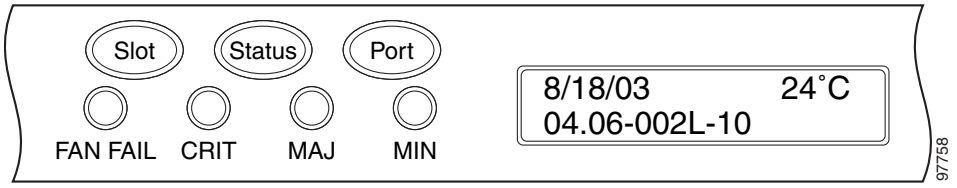
18.2 Alarm Counts on the LCD for a Node, Slot, or Port

You can view node, slot, or port-level alarm counts and summaries using the buttons on the ONS 15454 LCD panel. The Slot and Port buttons toggle between display types; the Slot button toggles between node display and slot display, and the Port button toggles between slot and port views. Pressing the Status button after you choose the display mode changes the display from alarm count to alarm summary.

The ONS 15454 has a one-button update for some commonly viewed alarm counts. If you press the Slot button once and then wait eight seconds, the display automatically changes from a slot alarm count to a slot alarm summary. If you press the Port button to toggle to port-level display, you can use the Port button to toggle to a specific slot and to view each port's port-level alarm count. Figure 18-1 shows the LCD panel layout.

Note In an ONS 15454 M2 shelf assembly, the LCD panel and the Slot, Port, and Status buttons are present on the fan-tray assembly. In an ONS 15454 M6 shelf assembly, the LCD is a separate unit installed above the external connection unit (ECU); the Slot, Port, and Status buttons are present on the LCD unit.

Figure 18-1 ONS 15454 Shelf LCD Panel



18.3 Alarm Display

In the card, node, or network CTC view, click the Alarms tab to display the alarms for that card, node, or network. The Alarms window shows alarms in compliance with Telcordia GR-253-CORE. This means that if a network problem causes two alarms, such as loss of frame (LOF) and loss of signal (LOS), CTC only shows the LOS alarm in this window because it supersedes the LOF and replaces it.

The Path Width column in the Alarms and Conditions tabs expands on the alarmed object information contained in the access identifier (AID) string (such as "STS-4-1-3") by giving the number of STSs contained in the alarmed path. For example, the Path Width tells you whether a critical alarm applies to an STS1 or an STS48c. The column reports the width as a 1, 3, 6, 12, 48, etc. as appropriate, understood to be "STS-*N*."

Table 18-1 lists the column headings and the information recorded in each column.

Table 18-1 Alarm Column Descriptions

Column	Information Recorded
Num	Sequence number of the original alarm. (The column is hidden by default; to view it, right-click a column and choose **Show Column > Num**.)
Ref	Reference number of the original alarm. (The column is hidden by default; to view it, right-click a column and choose **Show Column > Ref**.)

Table 18-1 Alarm Column Descriptions (continued)

Column	Information Recorded
New	Indicates a new alarm; to change this status, click either the Synchronize button or the Delete Cleared Alarms button.
Date	Date and time of the alarm.
Node	Shows the name of the node where the condition or alarm occurred. (Visible in network view.)
Object	TL1 access identifier (AID) for the alarmed object; for an STSmon or VTmon, this is the monitored STS or VT.
Eqpt Type	If an alarm is raised on a card, the card type in this slot.
Slot	If an alarm is raised on a card, the slot where the alarm occurred [appears only in network and node view (single-shelf mode) or shelf view (multishelf mode)].
Port	If an alarm is raised on a card, the port where the alarm is raised; for STSTerm and VTTerm, the port refers to the upstream card it is partnered with.
Path Width	Indicates how many STSs are contained in the alarmed path. This information complements the alarm object notation, which is explained in the *Cisco ONS 15454 DWDM Troubleshooting Guide*
Sev	Severity level: CR (Critical), MJ (Major), MN (minor), NA (Not Alarmed), NR (Not Reported).
ST	Status: R (raised), C (clear), T (transient).
SA	When checked, indicates a service-affecting alarm.
Cond	The error message/alarm name; these names are alphabetically defined in the *Cisco ONS 15454 DWDM Troubleshooting Guide.*
Description	Description of the alarm.

Table 18-2 lists the color codes for alarm and condition severities.

Table 18-2 Color Codes for Alarms and Condition Severities

Color	Description
Red	Raised Critical (CR) alarm
Orange	Raised Major (MJ) alarm
Yellow	Raised Minor (MN) alarm
Magenta (pink)	Raised Not Alarmed (NA) condition
Blue	Raised Not Reported (NR) condition
White	Cleared (C) alarm or condition

18.3.1 Viewing Alarms by Time Zone

By default, alarms and conditions are displayed with the time stamp of the CTC workstation where you are viewing them. However, you can set the node to report alarms (and conditions) using the time zone where the node is located.

18.3.2 Controlling Alarm Display

You can control the display of the alarms shown on the Alarms window. Table 18-3 shows the actions you can perform in the Alarms window.

Table 18-3 Alarm Display

Button/Check Box/Tool	Action
Filter button	Allows you to change the display on the Alarms window to show only alarms that meet a certain severity level, occur in a specified time frame, or reflect specific conditions. For example, you can set the filter so that only critical alarms display in the window. If you enable the Filter feature by clicking the Filter button in one CTC view, such as node view (single-shelf mode) or shelf view (multishelf mode), it is enabled in the others as well (card view and network view).
Synchronize button	Updates the alarm display. Although CTC displays alarms in real time, the Synchronize button allows you to verify the alarm display. This is particularly useful during provisioning or troubleshooting.
Delete Cleared Alarms button	Deletes, from the view, alarms that have been cleared.
AutoDelete Cleared Alarms check box	If checked, CTC automatically deletes cleared alarms.
Filter tool	Enables or disables alarm filtering in the card, node, or network view. When enabled or disabled, this state applies to other views for that node and for all other nodes in the network. For example, if the Filter tool is enabled in the node (default login) view Alarms window, the network view Alarms window and card view Alarms window also show the tool enabled. All other nodes in the network also show the tool enabled.

18.3.3 Filtering Alarms

The alarm display can be filtered to prevent display of alarms with certain severities or alarms that occurred between certain dates and times. You can set the filtering parameters by clicking the Filter button at the bottom-left of the Alarms window. You can turn the filter on or off by clicking the Filter tool at the bottom-right of the window. CTC retains your filter activation setting. For example, if you turn the filter on and then log out, CTC keeps the filter active the next time you log in.

18.3.4 Conditions Tab

The Conditions window displays retrieved fault conditions. A condition is a fault or status detected by ONS 15454 hardware or software. When a condition occurs and continues for a minimum period, CTC raises a condition, which is a flag showing that this particular condition currently exists on the ONS 15454.

The Conditions window shows all conditions that occur, including those that are superseded. For instance, if a network problem causes two alarms, such as LOF and LOS, CTC shows both the LOF and LOS conditions in this window (even though LOS supersedes LOF). Having all conditions visible can

be helpful when troubleshooting the ONS 15454. If you want to retrieve conditions that obey a root-cause hierarchy (that is, LOS supersedes and replaces LOF), you can exclude the same root causes by checking the "Exclude Same Root Cause" check box in the window.

Fault conditions include reported alarms and Not Reported or Not Alarmed conditions. Refer to the trouble notifications information in the *Cisco ONS 15454 DWDM Troubleshooting Guide* for more information about alarm and condition classifications.

18.3.5 Controlling the Conditions Display

You can control the display of the conditions on the Conditions window. Table 18-4 shows the actions you can perform in the window.

Table 18-4 Conditions Display

Button	Action
Retrieve	Retrieves the current set of all existing fault conditions, as maintained by the alarm manager, from the ONS 15454.
Filter	Allows you to change the Conditions window display to only show the conditions that meet a certain severity level or occur in a specified time frame. For example, you can set the filter so that only critical conditions display on the window. There is a Filter button on the lower-right of the window that allows you to enable or disable the filter feature.
Exclude Same Root Cause	Retrieves conditions that obey a root-cause hierarchy (LOS supersedes and replaces LOF).

18.3.5.1 Retrieving and Displaying Conditions

The current set of all existing conditions maintained by the alarm manager can be seen when you click the Retrieve button. The set of conditions retrieved is relative to the CTC view. For example, if you click the button while displaying the node view (single-shelf mode) or shelf view (multishelf mode), node-specific conditions appear. If you click the button while displaying the network view, all conditions for the network (including ONS 15454 nodes and other connected nodes) appear, and the card view shows only card-specific conditions.

You can also set a node to display conditions using the time zone where the node is located, rather than the time zone of the PC where they are being viewed.

18.3.5.2 Conditions Column Descriptions

Table 18-5 lists the Conditions window column headings and the information recorded in each column.

Table 18-5 Conditions Column Description

Column	Information Recorded
Date	Date and time of the condition.
Node	Shows the name of the node where the condition or alarm occurred. (Visible in network view.)

Table 18-5 Conditions Column Description (continued)

Column	Information Recorded
Object	TL1 AID for the condition object. For an STSmon or VTmon, the object.
Eqpt Type	Card type in this slot.
Slot	Slot where the condition occurred (appears only in network and node view).
Port	Port where the condition occurred. For STSTerm and VTTerm, the port refers to the upstream card it is partnered with.
Path Width	Width of the data path.
Sev[1]	Severity level: CR (Critical), MJ (Major), MN (Minor), NA (Not Alarmed), NR (Not Reported).
SA[1]	Indicates a service-affecting alarm (when checked).
Cond	The error message/alarm name; these names are alphabetically defined in the *Cisco ONS 15454 DWDM Troubleshooting Guide.*
Description	Description of the condition.

1. All alarms, their severities, and service-affecting statuses are also displayed in the Condition tab unless you choose to filter the alarm from the display using the Filter button.

18.3.5.3 Filtering Conditions

The condition display can be filtered to prevent display of conditions (including alarms) with certain severities or that occurred between certain dates. You can set the filtering parameters by clicking the Filter button at the bottom-left of the Conditions window. You can turn the filter on or off by clicking the Filter tool at the bottom-right of the window. CTC retains your filter activation setting. For example, if you turn the filter on and then log out, CTC keeps the filter active the next time your user ID is activated.

18.3.6 Viewing History

The History window displays historic alarm or condition data for the node or for your login session. You can chose to display only alarm history, only events, or both by checking check boxes in the History > Shelf window. You can view network-level alarm and condition history, such as for circuits, for all the nodes visible in network view. At the node level, you can see all port (facility), card, STS, and system-level history entries for that node. For example, protection-switching events or performance-monitoring threshold crossings appear here. If you double-click a card, you can view all port, card, and STS alarm or condition history that directly affects the card.

Note In the Preference dialog General tab, the Maximum History Entries value only applies to the Session window.

Different views of CTC display different kinds of history:

- The History > Session window is shown in network view, node view (single-shelf mode) or shelf view (multishelf mode), and card view. It shows alarms and conditions that occurred during the current user CTC session.

- The History > Shelf window is only shown in node view (single-shelf mode) or shelf view (multishelf mode). It shows the alarms and conditions that occurred on the node since CTC software was operated on the node.
- The History > Card window is only shown in card view. It shows the alarms and conditions that occurred on the card since CTC software was installed on the node.

Tip Double-click an alarm in the History window to display the corresponding view. For example, double-clicking a card alarm takes you to card view. In network view, double-clicking a node alarm takes you to node view (single-shelf mode) or shelf view (multishelf mode).

If you check the History window Alarms check box, you display the node history of alarms. If you check the Events check box, you display the node history of Not Alarmed and transient events (conditions). If you check both check boxes, you retrieve node history for both.

18.3.6.1 History Column Descriptions

Table 18-6 lists the History window column headings and the information recorded in each column.

Table 18-6 History Column Description

Column	Information Recorded
Num	Num (number) is the quantity of alarm messages received, and is incremented automatically as alarms occur to display the current total of received error messages. (The column is hidden by default; to view it, right-click a column and choose **Show Column > Num**.)
Ref	Ref (reference) is a unique identification number assigned to each alarm to reference a specific alarm message that is displayed. (The column is hidden by default; to view it, right-click a column and choose **Show Column > Ref**.)
Date	Date and time of the condition.
Node	Shows the name of the node where the condition or alarm occurred. (Visible in network view.)
Object	TL1 AID for the condition object. For an STSmon or VTmon, the object.
Slot	Slot where the condition occurred [only displays in network view and node view (single-shelf mode) or shelf view (multishelf mode)].
Port	Port where the condition occurred. For STSTerm and VTTerm, the port refers to the upstream card it is partnered with.
Path Width	Width of the data path.
Sev	Severity level: Critical (CR), Major (MJ), Minor (MN), Not Alarmed (NA), Not Reported (NR).
ST	Status: raised (R), cleared (C), or transient (T).
SA	Indicates a service-affecting alarm (when checked).
Cond	Condition name.
Description	Description of the condition.
Eqpt Type	Card type in this slot.

18.3.6.2 Retrieving and Displaying Alarm and Condition History

You can retrieve and view the history of alarms and conditions, including transient conditions (passing notifications of processes as they occur) in the CTC History window. The information in this window is specific to the view where it is shown (that is, network history in the network view, node history in the node view (single-shelf mode) or shelf view (multishelf mode), and card history in the card view).

The node and card history views are each divided into two tabs. In node view (single-shelf mode) or shelf view (multishelf mode), when you click the Retrieve button, you can see the history of alarms, conditions, and transients that have occurred on the node in the History > Node window, and the history of alarms, conditions, and transients that have occurred on the node during your login session in the History > Session window. In the card-view history window, after you retrieve the card history, you can see the history of alarms, conditions, and transients on the card in the History > Card window, or a history of alarms, conditions, and transients that have occurred during your login session in the History > Session window. You can also filter the severities and occurrence period in these history windows.

18.3.7 Alarm History and Log Buffer Capacities

The ONS 15454 alarm history log, stored in the TCC2/TCC2P/TCC3/TNC/TSC RSA memory, contains four categories of alarms. These include:

- CR severity alarms
- MJ severity alarms
- MN severity alarms
- the combined group of cleared, Not Alarmed severity, and Not Reported severity alarms

Each category can store between 4 and 640 alarm chunks, or entries. In each category, when the upper limit is reached, the oldest entry in the category is deleted. The capacity is not user-provisionable.

CTC also has a log buffer, separate from the alarm history log, that pertains to the total number of entries displayed in the Alarms, Conditions, and History windows. The total capacity is provisionable up to 5,000 entries. When the upper limit is reached, the oldest entries are deleted.

18.4 Alarm Severities

ONS 15454 alarm severities follow the Telcordia GR-474-CORE standard, so a condition might be Alarmed (at a severity of Critical [CR], Major [MJ], or Minor [MN]), Not Alarmed (NA), or Not Reported (NR). These severities are reported in the CTC software Alarms, Conditions, and History windows at all levels: network, shelf, and card.

ONS equipment provides a standard profile named Default listing all alarms and conditions with severity settings based on Telcordia GR-474-CORE and other standards, but users can create their own profiles with different settings for some or all conditions and apply these wherever desired. (See the "18.5 Alarm Profiles" section on page 18-9.) For example, in a custom alarm profile, the default severity of a carrier loss (CARLOSS) alarm on an Ethernet port could be changed from major to critical. The profile allows setting to Not Reported or Not Alarmed, as well as the three alarmed severities.

Critical and Major severities are only used for service-affecting alarms. If a condition is set as Critical or Major by profile, it will raise as Minor alarm in the following situations:

- In a protection group, if the alarm is on a standby entity (the side not carrying traffic)

- If the alarmed entity has no traffic provisioned on it, no service is lost

Because of this possibility of being raised at two different levels, the alarm profile pane shows Critical as CR / MN and Major as MJ / MN.

18.5 Alarm Profiles

The alarm profiles feature allows you to change default alarm severities by creating unique alarm profiles for individual ONS 15454 ports, cards, or nodes. A created alarm profile can be applied to any node on the network. Alarm profiles can be saved to a file and imported elsewhere in the network, but the profile must be stored locally on a node before it can be applied to the node, its cards, or its cards' ports.

CTC can store up to ten active alarm profiles at any time to apply to the node. Custom profiles can take eight of these active profile positions. Two other profiles, Default profile and Inherited profile, are reserved by the NE, and cannot be edited.The reserved Default profile contains Telcordia GR-474-CORE severities. The reserved Inherited profile allows port alarm severities to be governed by the card-level severities, or card alarm severities to be determined by the node-level severities.

If one or more alarm profiles have been stored as files from elsewhere in the network onto the local PC or server hard drive where CTC resides, you can utilize as many profiles as you can physically store by deleting and replacing them locally in CTC so that only eight are active at any given time.

18.5.1 Creating and Modifying Alarm Profiles

Alarm profiles are created in the network view using the node view (single-shelf mode) or shelf view (multishelf mode) Provisioning > Alarm Profiles tabs. A default alarm severity following Telcordia GR-474-CORE standards is preprovisioned for every alarm. After loading the default profile or another profile on the node, you can clone a profile to create custom profiles. After the new profile is created, the Alarm Profiles window shows the original profile (frequently Default) and the new profile.

Note The alarm profile list contains a master list of alarms that is used for a mixed node network. Some of these alarms might not be used in all ONS nodes.

Note The Default alarm profile list contains alarm and condition severities that correspond when applicable to default values established in Telcordia GR-474-CORE.

Note All default or user-defined severity settings that are Critical (CR) or Major (MJ) are demoted to Minor (MN) in non-service-affecting situations as defined in Telcordia GR-474-CORE.

Tip To see the full list of profiles, including those available for loading or cloning, click the Available button. You must load a profile before you can clone it.

Note Up to 10 profiles, including the two reserved profiles (Inherited and Default) can be stored in CTC.

Wherever it is applied, the Default alarm profile sets severities to standard Telcordia GR-474-CORE settings. In the Inherited profile, alarms inherit, or copy, severity from the next-highest level. For example, a card with an Inherited alarm profile copies the severities used by the node housing the card. If you choose the Inherited profile from the network view, the severities at the lower levels (node and card) are copied from this selection.

You do not have to apply a single severity profile to the node-, card-, and port-level alarms. Different profiles can be applied at different levels. You could use the inherited or default profile on a node and on all cards and ports, but apply a custom profile that downgrades an alarm on one particular card. For example, you might choose to downgrade an OC-N unequipped path alarm (UNEQ-P) from Critical (CR) to Not Alarmed (NA) on an optical card because this alarm raises and then clears every time you create a circuit. UNEQ-P alarms for the card with the custom profile would not display on the Alarms tab (but they would still be recorded on the Conditions and History tabs.)

When you modify severities in an alarm profile:

- All Critical (CR) or Major (MJ) default or user-defined severity settings are demoted to Minor (MN) in Non-Service-Affecting (NSA) situations as defined in Telcordia GR-474.
- Default severities are used for all alarms and conditions until you create a new profile and apply it.

The Load and Store buttons are not available for Retrieve and Maintenance users.

The Delete and Store options will only display nodes to delete profiles from or store profiles to if the user has provisioning permission for those nodes. If the user does not have the proper permissions, CTC greys out the buttons and they are not available to the user.

18.5.2 Alarm Profile Buttons

The Alarm Profiles window displays six buttons at the bottom of the screen. Table 18-7 lists and describes each of the alarm profile buttons and their functions.

Table 18-7 Alarm Profile Buttons

Button	Description
New	Creates a new profile.
Load	Loads a profile to a node or a file.
Store	Saves profiles on a node (or nodes) or in a file.
Delete	Deletes profiles from a node.
Compare	Displays differences between alarm profiles (for example, individual alarms that are not configured equivalently between profiles).
Available	Displays all profiles available on each node.
Usage	Displays all entities (nodes and alarm subjects) present in the network and which profiles contain the alarm. Can be printed.

18.5.3 Alarm Profile Editing

Table 18-8 lists and describes the five profile-editing options available when you right-click an alarm item in the profile column (such as Default).

Table 18-8 Alarm Profile Editing Options

Button	Description
Store	Saves a profile in a node or in a file.
Rename	Changes a profile name.
Clone	Creates a profile that contains the same alarm severity settings as the profile being cloned.
Reset	Restores a profile to its previous state or to the original state (if it has not yet been applied).
Remove	Removes a profile from the table editor.

18.5.4 Alarm Severity Options

To change or assign alarm severity, left-click the alarm severity you want to change in the alarm profile column. Seven severity levels appear for the alarm:

- Not Reported (NR)
- Not Alarmed (NA)
- Minor (MN)
- Major (MJ)
- Critical (CR)
- Use Default
- Inherited

Inherited and Use Default severity levels only appear in alarm profiles. They do not appear when you view alarms, history, or conditions.

18.5.5 Row Display Options

In the network or node view (single-shelf mode) or shelf view (multishelf mode), the Alarm Profiles window (Alarm Profile Editor for node view) displays three check boxes at the bottom of the window:

- Only show service-affecting severities—If unchecked, the editor shows severities in the format *sev1*/*sev2* where *sev1* is a service-affecting severity and *sev2* is not service-affecting. If checked, the editor only shows *sev1* alarms.
- Hide reference values—Highlights alarms with nondefault severities by clearing alarm cells with default severities.
- Hide identical rows—Hides rows of alarms that contain the same severity for each profile.

18.5.6 Applying Alarm Profiles

In CTC node view (single-shelf mode) or shelf view (multishelf mode), the Alarm Behavior window displays alarm profiles for the node. In card view, the Alarm Behavior window displays the alarm profiles for the selected card. Alarm profiles form a hierarchy. A node-level alarm profile applies to all cards in the node except cards that have their own profiles. A card-level alarm profile applies to all ports on the card except ports that have their own profiles.

At the node level, you can apply profile changes on a card-by-card basis or set a profile for the entire node. At the card-level view, you can apply profile changes on a port-by-port basis or set alarm profiles for all ports on that card.

18.6 External Alarms and Controls

External alarm inputs can be provisioned on the Alarm Interface Controller–International (AIC-I) card for external sensors such as an open door and flood sensors, temperature sensors, and other environmental conditions. External control outputs on these two cards allow you to drive external visual or audible devices such as bells and lights. They can control other devices such as generators, heaters, and fans.

Up to 12 external alarm inputs and four external controls are available with the AIC-I card. If you also provision the alarm extension panel (AEP), there are 32 inputs and 16 outputs. The AEP is compatible with the ONS 15454 ANSI shelf only. It is not compatible with the ONS 15454 ETSI shelf.

18.6.1 External Alarms

You can provision each alarm input separately. Provisionable characteristics of external alarm inputs include:

- Alarm Type—List of alarm types.
- Severity—CR, MJ, MN, NA, and NR.
- Virtual Wire—The virtual wire associated with the alarm.
- Raised When—Open means that the normal condition is no current flowing through the contact, and the alarm is generated when current does flow; closed means that normal condition is to have current flowing through the contact, and the alarm is generated when current stops flowing.
- Description—CTC alarm log description (up to 63 characters).

Note If you provision an external alarm to raise when a contact is open, and you have not attached the alarm cable, the alarm will remain raised until the alarm cable is connected.

Note When you provision an external alarm, the alarm object is ENV-IN-*nn*. The variable *nn* refers to the external alarm's number, regardless of the name you assign.

18.6.2 External Controls

You can provision each alarm output separately. Provisionable characteristics of alarm outputs include:

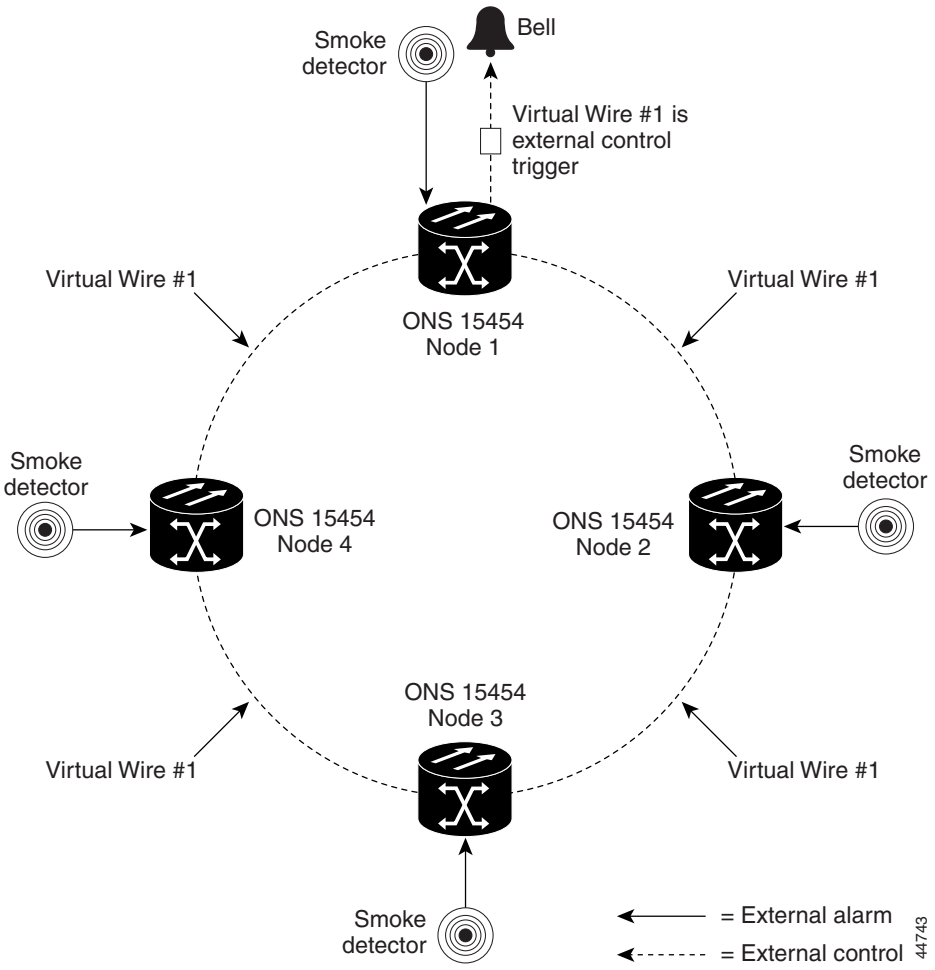
- Control type.
- Trigger type (alarm or virtual wire).
- Description for CTC display.
- Closure setting (manually or by trigger). If you provision the output closure to be triggered, the following characteristics can be used as triggers:

- Local NE alarm severity—A chosen alarm severity (for example, major) and any higher-severity alarm (in this case, critical) causes output closure.
- Remote NE alarm severity—Similar to local NE alarm severity trigger setting, but applies to remote alarms.
- Virtual wire entities—You can provision an alarm that is input to a virtual wire to trigger an external control output.

18.6.3 Virtual Wires

Provisioning the AIC and AIC-I card provides a "virtual wires" option used to route external alarms and controls from different nodes to one or more alarm collection centers. In Figure 18-2, smoke detectors at Nodes 1, 2, 3, and 4 are assigned to Virtual Wire #1, and Virtual Wire #1 is provisioned as the trigger for an external bell at Node 1.

Figure 18-2 External Alarms and Controls Using a Virtual Wire



When using AIC virtual wires, you can:

- Assign different external devices to the same virtual wire.
- Assign virtual wires as the trigger type for different external controls.

18.7 Alarm Suppression

The following sections explain alarm suppression features for the ONS 15454.

18.7.1 Alarms Suppressed for Maintenance

When you place a port in OOS,MT administrative state, this raises the alarm suppressed for maintenance (AS-MT) alarm in the Conditions and History windows and causes subsequently raised alarms for that port to be suppressed.

Note AS-MT can be seen in the Alarms window as well if you have set the Filter dialog box to show NA severity events.

While the facility is in the OOS,MT state, any alarms or conditions that are raised and suppressed on it (for example, a transmit failure [TRMT] alarm) are reported in the Conditions window and show their normal severity in the Sev column. The suppressed alarms are not shown in the Alarms and History windows. (These windows only show AS-MT). When you place the port back into IS,AINS administrative state, the AS-MT alarm is resolved in all three windows. Suppressed alarms remain raised in the Conditions window until they are cleared.

18.7.2 Alarms Suppressed by User Command

In the node view (single-shelf mode) or shelf view (multishelf mode) Provisioning > Alarm Profiles tabs > Alarm Behavior tabs, the ONS 15454 has an alarm suppression option that clears raised alarm messages for the node, chassis, one or more slots (cards), or one or more ports. Using this option raises the alarms suppressed by user command, or AS-CMD alarm. The AS-CMD alarm, like the AS-MT alarm, appears in the Conditions, and History windows. Suppressed conditions (including alarms) appear only in the Conditions window--showing their normal severity in the Sev column. When the Suppress Alarms check box is unchecked, the AS-CMD alarm is cleared from all three windows.

Note AS-MT can be seen in the Alarms window as well if you have set the Filter dialog box to show NA severity events.

A suppression command applied at a higher level does not supersede a command applied at a lower level. For example, applying a node-level alarm suppression command makes all raised alarms for the node appear to be cleared, but it does not cancel out card-level or port-level suppression. Each of these conditions can exist independently and must be cleared independently.

Caution Use alarm suppression with caution. If multiple CTC or TL1 sessions are open, suppressing the alarms in one session suppresses the alarms in all other open sessions.

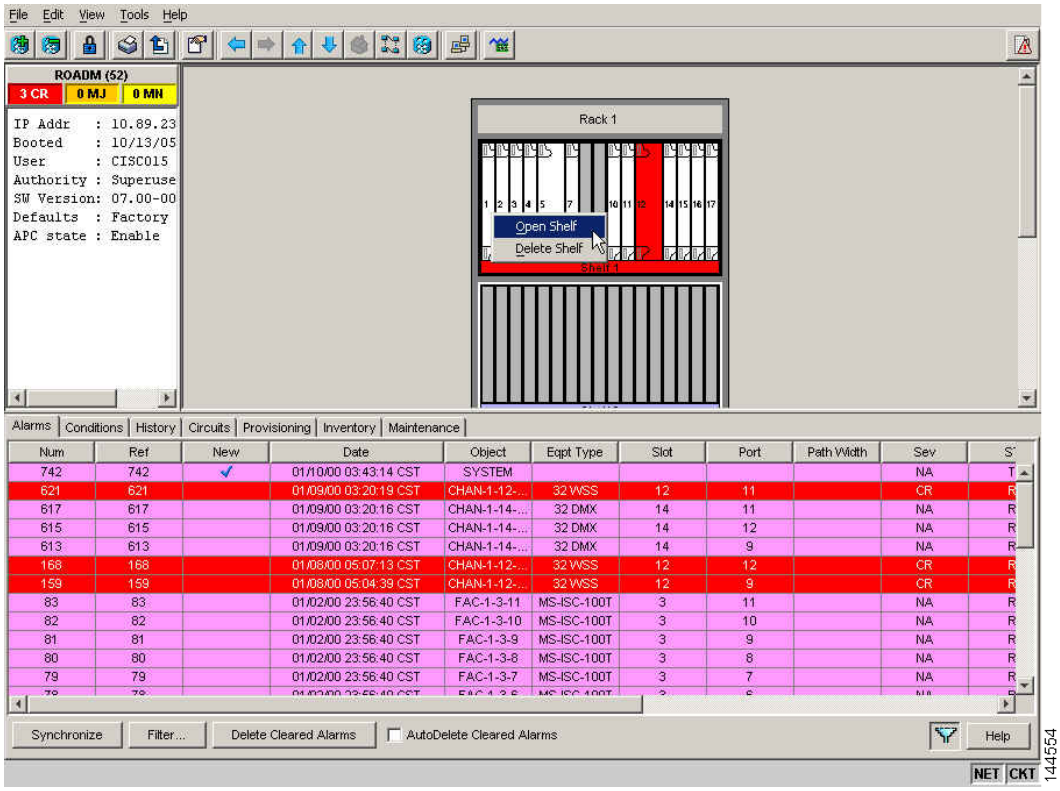
18.8 Multishelf Configuration Alarming

Multishelf systems can share a single IP address among shelves and also correlate optical signal alarms. Ethernet alarm-raising for this configuration also differs from alarm-raising for single-shelf configurations. This section explains how alarms are viewed on a multishelf configuration, how alarm locations are determined, and how multishelf alarming differs from single-shelf alarming.

18.8.1 Viewing Multishelf Alarmed Entities

The multishelf view in CTC shows which slots are occupied in each shelf of the configuration (Figure 18-3).

Figure 18-3 Navigating to Shelf View from Multishelf View



You can determine where an alarm is raised by viewing the Object column. The entry there (for example, FAC-1-3-1) tells you the entity ("fac," or facility), shelf, slot, and port. In shelf view, the Alarms and Conditions tabs also contain a Shelf column that indicates where the alarmed card is located.

18.8.2 Multishelf-Specific Alarming

The following sections explain how Ethernet communication alarms and correlated multishelf alarms are processed in the ONS 15454 DWDM system.

18.8.2.1 Ethernet Communication Alarms

The Ethernet interface card (MS-ISC) that is required for multishelf configurations does not raise traditional Ethernet alarms, such as CARLOSS, that apply to transponder (TXP) or muxponder (MXP) client ports. Instead, MS-ISC card alarms are raised on the shelf as EQPT alarms. These alarms include Duplicate Shelf ID (DUP-SHELF-ID) and Shelf Communication Failure (SHELF-COMM-FAIL).

18.8.2.2 Multishelf Correlated Alarms

ITU-T G.798-based alarm correlation simplifies alarm reporting for DWDM channels. Communication failures including Loss of Signal (LOS), Loss of Signal Payload (LOS-P), and Optical Power Receive Fail-Loss of Light (OPWR-LFAIL) generate multiple conditions at each affected node and channel. Correlation simplifies troubleshooting because a single alarm is reported for each root cause. (The original alarms retain their severity in the Conditions window.)

The Payload Missing Indication (PMI) condition is raised at the far end to correlate optical multiplex section (OMS) and optical transmission section (OTS) communication failures. A single PMI condition is sent when every channel on the aggregated port is lost, that is, when there are no pass-through channels or active added channels in service. If there are added channels on the node, the Forward Defect Indication (FDI) condition is raised at the near end to indicate there are no pass-through optical channels (OCH) in service.

18.9 Threshold Crossing Alert Suppression

This section describes threshold crosssing alert (TCA) suppression on TXP and MXP cards when they are installed in a DWDM node.

18.9.1 Overview

Threshold default settings define the default cumulative values (thresholds) beyond which a TCA will be raised. TCAs make it possible to monitor the network and detect errors early.

The following thresholds are monitored for TXP and MXP cards:

- Optical Thresholds
- ITU-T G.709 Thresholds
- SONET and SDH Thresholds
- FEC Thresholds

Threshold defaults are defined for near end and/or far end and at 15-minute or one-day intervals.

When LOS-P, LOS, or LOF alarms occur on the TXP./MXP cards, different TCAs are suppressed. Which TCAs are suppressed by an alarm depends on how the trunk is configured (ITU-T G.709, SONET, or SDH). The reason for suppressing the TCAs after the alarm occurs is to prevent a flood of TCAs after a system failure.

TCA suppression does not extend to optical thresholds such as OPR (optical power received). Optical threshold TCAs can effectively be suppressed by setting their thresholds to the maximum value.TCA suppression also does not extend to client ports; it only applies to TXP and MXP trunk ports when they are configured as ITU-T G.709, SONET, or SDH. TCA suppression does not extend to 10GE payloads.

Note Suppressed TCAs are not reported as Not Reported (NR) conditions. As a result, suppressed TCAs do not appear in the CTC Conditions tab and they cannot be retrieved with the RTRV-COND TL1 command.

18.9.2 G.709, SONET, and SDH TCA Groups

This section lists the TCAs that are suppressed for each alarm. TCA suppression is determined by how framing is configured for TXP and MXP trunks.

Table 18-9 lists the TCAs for each type of trunk framing and alarm.

Table 18-9 TCA Suppression Groups

Alarm	TXP/MXP Trunk Framing	TCA Suppressed
LOS-P and LOF	G.709	BBE-SM
		ES-SM
		SES-SM
		UAS-SM
		FC-SM
		ESR-SM
		SESR-SM
		BBER-SM
		BBE-PM
		ES-PM
		SES-PM
		UAS-PM
		FC-PM
		ESR-PM
		SESR-PM
		BBER-PM
		BIT-EC
		UNC-WORDS

Table 18-9 TCA Suppression Groups (continued)

Alarm	TXP/MXP Trunk Framing	TCA Suppressed
LOS or LOF	SONET	ES-S
		SES-S
		SEFS-S
		CV-S
		ES-L
		SES-L
		UAS-L
		CV-L
		FC-L
LOS or LOF	SDH	RS-ES
		RS-ESR
		RS-SES
		RS-SESR
		RS-BBR
		RS-BBER
		RS-UAS
		RS-EB
		MS-ES
		MS-ESR
		MS-SES
		MS-SESR
		MS-BBR
		MS-BBER
		MS-UAS
		MS-EB

CHAPTER 19

Performance Monitoring

Performance monitoring (PM) parameters are used by service providers to gather, store, set thresholds for, and report performance data for early detection of problems. In this chapter, PM parameters and concepts are defined for transponder, muxponder, and dense wavelength division multiplexing (DWDM) cards in the Cisco ONS 15454 including optical amplifier, multiplexer, demutiplexer, optical add/drop multiplexer (OADM), and optical service channel (OSC) cards.

Note Unless otherwise specified, "ONS 15454" refers to both ANSI and ETSI shelf assemblies.

For information about enabling and viewing PM values, refer to the *Cisco ONS 15454 DWDM Procedure Guide*.

Chapter topics include:

- 19.1 Threshold Performance Monitoring, page 19-2
- 19.2 TNC Card Performance Monitoring, page 19-2
- 19.3 Transponder, Muxponder, Xponder, and ADM-10G Card Performance Monitoring, page 19-7
- 19.4 DWDM Card Performance Monitoring, page 19-23
- 19.5 Optics and 8b10b PM Parameter Definitions, page 19-27
- 19.6 ITU G.709 and ITU-T G.8021 Trunk-Side PM Parameter Definitions, page 19-28
- 19.7 Full RMON Statistics PM Parameter Definitions, page 19-30
- 19.8 FEC PM Parameter Definitions, page 19-33
- 19.9 SONET PM Parameter Definitions, page 19-34
- 19.10 SDH PM Parameter Definitions, page 19-35
- 19.11 Pointer Justification Count Performance Monitoring, page 19-37

Note For additional information regarding PM parameters, refer to ITU G.826, ITU-T G.8021, ITU G.709, Telcordia documents GR-1230-CORE, GR-820-CORE, GR-499-CORE, and GR-253-CORE, and the ANSI T1.231 document entitled *Digital Hierarchy - Layer 1 In-Service Digital Transmission Performance Monitoring*.

19.1 Threshold Performance Monitoring

Thresholds are used to set error levels for each PM parameter. You can set individual PM threshold values from the Cisco Transport Controller (CTC) card view Provisioning tab. For procedures about provisioning card thresholds, such as line and path thresholds, refer to the *Cisco ONS 15454 DWDM Procedure Guide*.

During the accumulation cycle, if the current value of a PM parameter reaches or exceeds its corresponding threshold value, a threshold crossing alert (TCA) is generated by the node and is displayed by CTC. TCAs provide early detection of performance degradation. When a threshold is crossed, the node continues to count the errors during a given accumulation period. If zero is entered as the threshold value, generation of TCAs is disabled but performance monitoring continues.

Note Due to memory limitations and the number of TCAs generated by different platforms, you can manually add or modify the following two properties to the platform property file (CTC.INI for Windows and .ctcrc for UNIX) to fit the need:

- **ctc.15***xxx***.node.tr.lowater=***yyy* (where *xxx* is platform and *yyy* is the number of the lowater mark. The default lowater mark is 25.)
- **ctc.15***xxx***.node.tr.hiwater=***yyy* (where *xxx* is platform and *yyy* is the number of the hiwater mark. The default hiwater mark is 50.)

If the number of the incoming TCA is greater than the hiwater mark, the node will keep the latest lowater mark and discard older ones.

Change the threshold if the default value does not satisfy your error monitoring needs. For example, customers with a critical OC192/STM64 transponder installed for 911 calls must guarantee the best quality of service on the line; therefore, they lower all thresholds on the client side so that the slightest error raises a TCA.

Note When LOS, LOS-P, or LOF alarms occur on TXP and MXP trunks, ITU-T G.709/SONET/SDH TCAs are suppressed. For details, see Chapter 18, “Alarm and TCA Monitoring and Management.”

19.2 TNC Card Performance Monitoring

(Cisco ONS 15454 M2 and ONS 15454 M6 only)

This section lists the PM parameters and RMONs supported by TNC card.

Note Optics PM and Payload PM are not supported in TSC card.

19.2.1 Optics PM Window

The Optics PM window lists the parameters for the TNC card. The Optics PM window provides buttons to change the statistical values shown. The **Refresh** button manually refreshes statistics. **Auto-Refresh** sets a time interval at which automatic refresh occurs. In the Historical PM subtab, the **Clear** button sets the values on the card to zero. All counters on the card are cleared. The **Help** button activates context sensitive help. Table 19-1 lists the optics PM parameters.

Table 19-1 Optics PM Parameters

Optics PM Parameters	Definition
Laser Bias (Min,%)	Minimum Laser Bias Current (Laser Bias Min) is the minimum percentage of laser bias current during the PM time interval.
Laser Bias (Avg,%)	Average Laser Bias Current (Laser Bias Avg) is the average percentage of laser bias current during the PM time interval.
Laser Bias (Max,%)	Maximum Laser Bias Current (Laser Bias Max) is the maximum percentage of laser bias current during the PM time interval.
Rx Optical Pwr (Min,dBm)	Minimum Receive Optical Power (Rx Optical Pwr Min, dBm) is the minimum received optical power during the PM time interval.
Rx Optical Pwr (Avg,dBm)	Average Receive Optical Power (Rx Optical Pwr Avg, dBm) is the average received optical power during the PM time interval.
Rx Optical Pwr (Max,dBm)	Maximum Receive Optical Power (Rx Optical Pwr Max, dBm) is the maximum received optical power during the PM time interval.
Tx Optical Pwr (Min,dBm)	Minimum Transmit Optical Power (Tx Optical Pwr Min, dBm) is the minimum optical power transmitted during the PM time interval.
Tx Optical Pwr (Avg,dBm)	Average Transmit Optical Power (Tx Optical Pwr Avg, dBm) is the average optical power transmitted during the PM time interval.
Tx Optical Pwr (Max,dBm)	Maximum Transmit Optical Power (Tx Optical Pwr Max, dBm) is the maximum optical power transmitted during the PM time interval.

19.2.2 Payload PM Window

The Payload PM subtabs are: Ethernet, SONET, Statistics, Utilization, and History. The following buttons function the same on all of the tabs. Not all tabs have all of these buttons.

- The **Refresh** button manually refreshes statistics.
- The **Auto-Refresh** button sets a time interval at which automatic refresh occurs.
- The **Baseline** button resets the displayed statistics values to zero.

- (Statistics window only) The **Clear** button allows you to set the values to zero for displayed statistics, all statistics for a port, and all statistics for all optical ports on a card.
- The **Help** button activates context sensitive help.

Table 19-2 lists the payload ethernet PM parameters.

Table 19-2 Payload Ethernet PM Parameters

Payload Ethernet PM Parameters	
IfInOctets	etherStatsUndersizePkts
rxTotalPkts	etherStatsFragments
ifInUcastPkts	etherStatsPkts64Octets
ifInMulticastPkts	etherStatsPkts65to127Octets
ifInBroadcastPkts	etherStatsPkts128to255Octets
ifInErrors	etherStatsPkts256to511Octets
ifOutOctets	etherStatsPkts512to1023Octets
txTotalPkts	etherStatsPkts1024to1518Octets
ifOutUcastPkts	etherStatsBroadcastPkts
ifOutMulticastPkts	etherStatsMulticastPkts
ifOutBroadcastPkts	etherStatsOversizePkts
dot3StatsAlignmentErrors	etherStatsJabbers
dot3StatsFCSErrors	etherStatsOctets
dot3StatsFrameTooLong	

Table 19-3 lists the payload SONET PM parameters.

Table 19-3 Payload SONET PM Parameters

Payload SONET PM Parameters	Definition
CV-S	Section Coding Violation (CV-S) is a count of bit interleaved parity (BIP) errors detected at the section layer (that is, using the B1 byte in the incoming SONET signal). Up to eight section BIP errors can be detected per STS-N frame; each error increments the current CV-S second register.
ES-S	Section Errored Seconds (ES-S) is a count of the number of seconds when at least one section-layer BIP error was detected or an SEF or loss of signal (LOS) defect was present.
SES-S	Section Severely Errored Seconds (SES-S) is a count of the seconds when K (see Telcordia GR-253 for value) or more section-layer BIP errors were detected or an SEF or LOS defect was present.

Table 19-3 Payload SONET PM Parameters

Payload SONET PM Parameters	Definition
SEFS-S	Severely Errored Framing Seconds (SEFS-S) is a count of the seconds when an SEF defect was present. An SEF defect is expected to be present during most seconds when an LOS or loss of frame (LOF) defect is present. However, there can be situations when the SEFS-S parameter is only incremented based on the presence of the SEF defect.
CV-L	Line Coding Violation (CV-L) indicates the number of coding violations occurring on the line. This parameter is a count of bipolar violations (BPVs) and excessive zeros (EXZs) occurring over the accumulation period.
ES-L	Line Errored Seconds (ES-L) is a count of the seconds containing one or more anomalies (BPV + EXZ) and/or defects (that is, loss of signal) on the line.
SES-L	Line Severely Errored Seconds (SES-L) is a count of the seconds containing more than a particular quantity of anomalies (BPV + EXZ > 44) and/or defects on the line.
UAS-L	Line Unavailable Seconds (UAS-L) is a count of the seconds when the line is unavailable. A line becomes unavailable when ten consecutive seconds occur that qualify as SES-Ls, and it continues to be unavailable until ten consecutive seconds occur that do not qualify as SES-Ls.
FC-L	Line Failure Count (FC-L) is a count of the number of near-end line failure events. A failure event begins when an Alarm Indication Signal Line (AIS-L) failure is declared or when a lower-layer, traffic-related, near-end failure is declared. This failure event ends when the failure is cleared. A failure event that begins in one period and ends in another period is counted only in the period where it begins.

Table 19-4 lists the payload SDH PM parameters.

Table 19-4 Payload SDH PM Parameters

Payload SONET PM Parameters	Definition
EB	Errored block indicates that one or more bits are in error within a block.
BBE	Background block error shows the number of background block errors recorded during the PM time interval.
ES	Errored Seconds shows the number of errored seconds recorded during the PM time interval.
SES	Severely Errored Seconds shows the severely errored seconds recorded during the PM time interval.
UAS	Unavailable Seconds shows the unavailable seconds recorded during the PM time interval.
ESR	Errored Seconds Ratio shows the severely errored seconds ratio recorded during the PM time interval.
SESR	Severely Errored Seconds Ratio shows the severely errored seconds ratio recorded during the PM time interval.
BBER	Background Block Errors Ratio shows the background block errors ratio recorded during the PM time interval.

19.2.3 RMONs Supported by TNC Card

Table 19-5 lists the full RMON statistics that are supported by the TNC card.

Table 19-5 Full RMON Statistics on TNC Card

Full RMON Statistics	
ifInOctets	etherStatsPkts65to127Octets
rxTotalPkts	etherStatsPkts128to255Octets
ifInUcastPkts	etherStatsPkts256to511Octets
ifInMulticastPkts	etherStatsPkts512to1023Octets
ifInBroadcastPkts	etherStatsPkts1024to1518Octets
ifInErrors	etherStatsBroadcastPkts
ifOutOctets	etherStatsMulticastPkts
txTotalPkts	etherStatsOversizePkts
ifOutMulticastPkts	etherStatsJabbers
ifOutBroadcastPkts	etherStatsOctets
dot3StatsAlignmentErrors	
dot3StatsFCSErrors	
dot3StatsFrameTooLong	
etherStatsUndersizePkts	
etherStatsFragments	
etherStatsPkts64Octets	

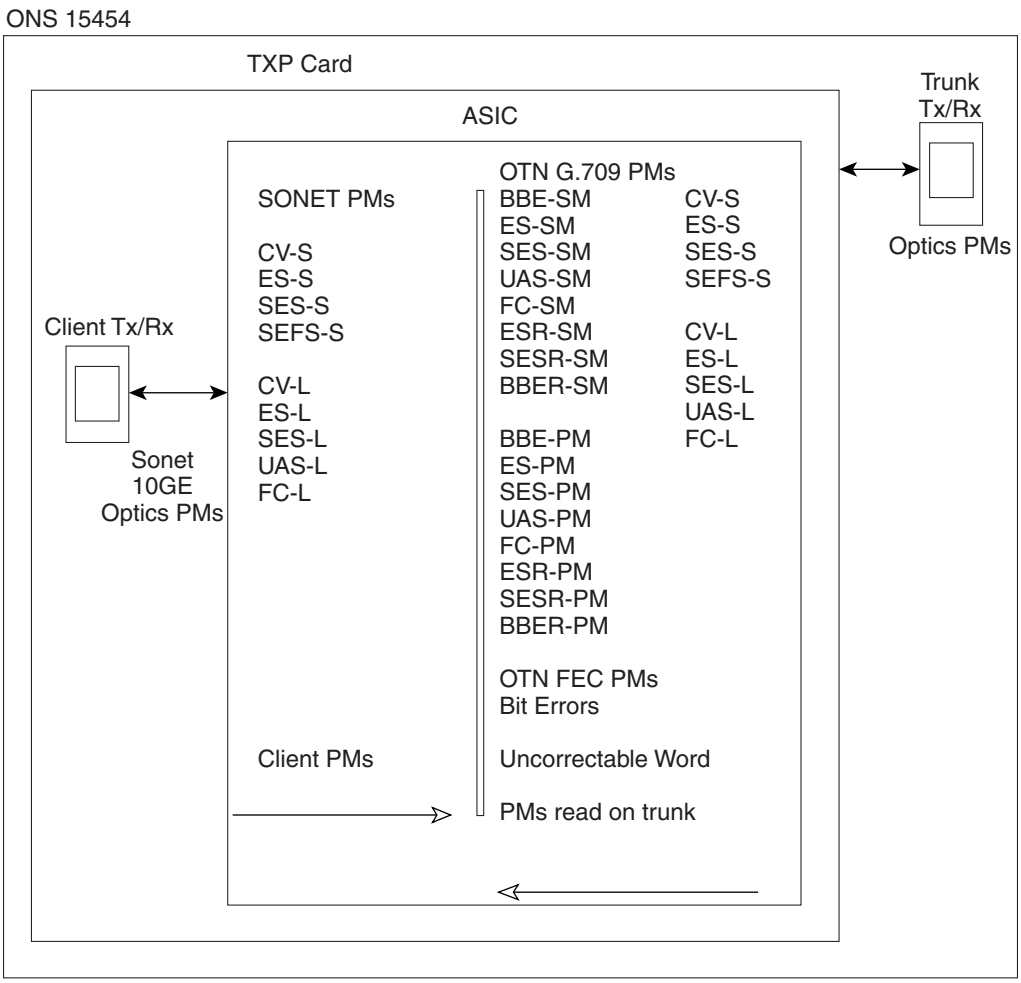
19.3 Transponder, Muxponder, Xponder, and ADM-10G Card Performance Monitoring

This section lists PM parameters for transponder cards (TXP_MR_10G, TXP_MR_2.5G, TXPP_MR_2.5G, TXP_MR_10E, TXP_MR_10E_C, and TXP_MR_10E_L), muxponder cards (MXP_2.5G_10G, MXP_2.5G_10E, MXP_2.5G_10E_C, MXP_2.5G_10E_L, MXP_MR_2.5G, MXPP_MR_2.5G, MXP_MR_10DME-C, MXP_MR_10DME-L, and 40G-MXP-C), Xponder cards (GE_XP, 10GE_XP, GE_XPE, 10GE_XPE, OTU2_XP), and ADM-10G card. The transponder, muxponder, Xponder, and ADM-10G PM parameters are divided into Optics PM, Payload PM, and OTN PM tabs. The tabs displayed vary depending on the card installed. For more information, see the "19.3.1 Optics PM Window" section on page 19-9, the "19.3.2 Payload PM Window" section on page 19-10, or the "19.3.3 OTN PM Window" section on page 19-17.

Note For the OTU2_XP card, if the PPM is not deleted properly from the CTC (but physically removed), the PMs continue to increase (even if the PPM is not present). To ensure the PMs do not increase when the PPM is not present, change the Service State of the PPM port to OOS (ANSI) or locked (ETSI) and move it back to IS (ANSI) or Unlocked (ETSI) state.

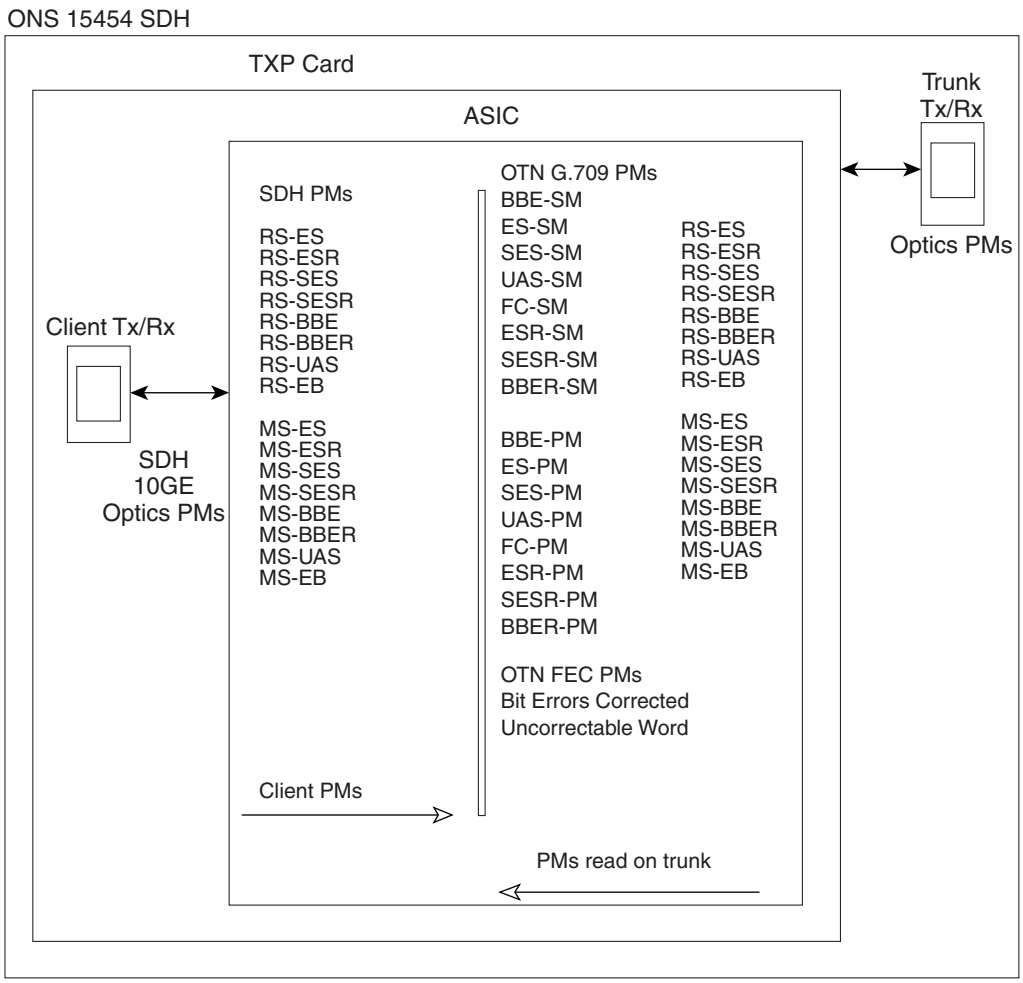
For ONS 15454 ANSI nodes, Figure 19-1 shows where overhead bytes detected on the application-specific integrated circuits (ASICs) produce PM parameters for the TXP_MR_10G card. The remaining transponder, muxponder, Xponder, and ADM-10G cards perform similarly to this illustration.

Figure 19-1 ONS 15454 ANSI Node PM Read Points for TXP_MR_10G Card



For ONS 15454 ETSI nodes, Figure 19-2 shows where overhead bytes detected on the ASICs produce PM parameters for the TXP_MR_10G card. The remaining transponder, muxponder, Xponder, and ADM-10G cards perform similarly to this illustration.

Figure 19-2 ONS 15454 ETSI Node PM Read Points on TXP_MR_10G Cards



19.3.1 Optics PM Window

The Optics PM window lists parameters at the trunk and client side for all transponder, muxponder, Xponder (GE_XP, 10GE_XP, GE_XPE, 10GE_XPE, OTU2_XP), and ADM-10G cards. The Optics PM window provides buttons to change the statistical values shown. The Refresh button manually refreshes statistics. Auto-Refresh sets a time interval at which automatic refresh occurs. In the Historical PM subtab, the Clear button sets the values on the card to zero. All counters on the card are cleared. The Help button activates context sensitive help. Table 19-6 lists the trunk-side and client-side optics PM parameters.

Table 19-6 Trunk-Side and Client-Side Optics PM Parameters

Trunk-Side/Client-Side Optics PM Parameters	Definition
Laser Bias (Avg,%)	Average Laser Bias Current (Laser Bias Avg) is the average percentage of laser bias current during the PM time interval.
Laser Bias (Max,%)	Maximum Laser Bias Current (Laser Bias Max) is the maximum percentage of laser bias current during the PM time interval.
Laser Bias (Min,%)	Minimum Laser Bias Current (Laser Bias Min) is the minimum percentage of laser bias current during the PM time interval.
Link Status	Indicates if the Fibre Channel link is receiving a valid Fibre Channel signal (carrier) from the attached Fibre Channel device. Up means present, and down means not present.
Rx Optical Pwr (Min,dBm)	Minimum Receive Optical Power (Rx Optical Pwr Min, dBm) is the minimum received optical power during the PM time interval.
Rx Optical Pwr (Avg,dBm)	Average Receive Optical Power (Rx Optical Pwr Avg, dBm) is the average received optical power during the PM time interval.
Rx Optical Pwr (Max,dBm)	Maximum Receive Optical Power (Rx Optical Pwr Max, dBm) is the maximum received optical power during the PM time interval.
Tx Optical Pwr (Min,dBm)[1]	Minimum Transmit Optical Power (Tx Optical Pwr Min, dBm) is the minimum optical power transmitted during the PM time interval.
Tx Optical Pwr (Avg,dBm)[1]	Average Transmit Optical Power (Tx Optical Pwr Avg, dBm) is the average optical power transmitted during the PM time interval.
Tx Optical Pwr (Max,dBm)[1]	Maximum Transmit Optical Power (Tx Optical Pwr Max, dBm) is the maximum optical power transmitted during the PM time interval.

1. On the trunk side, this PM is not available for the following cards: TXP_MR_2.5G, TXPP_MR_2.5G, MXP_MR_2.5G, and MXPP_MR_2.5G.

19.3.2 Payload PM Window

The Payload PM window subtabs change depending on the card provisioning. For more information about provisioning TXP, MXP, and Xponder cards, refer to the "Provision Transponder and Muxponder Cards" chapter in the *Cisco ONS 15454 DWDM Procedure Guide*. Possible Payload PM subtabs are: SONET, SDH, Statistics, Utilization, and History. The following buttons function the same on all of the tabs. Not all tabs have all of these buttons.

- The Refresh button manually refreshes statistics.
- Auto-Refresh sets a time interval at which automatic refresh occurs.
- The Baseline button resets the displayed statistics values to zero.
- (Statistics window only) The Clear button allows you to set the values to zero for displayed statistics, all statistics for a port, and all statistics for all optical ports on a card.

- The Help button activates context sensitive help.

For a list of the payload PM provisioning options for all transponder, muxponder, and Xponder cards, refer to the *Cisco ONS 15454 DWDM Procedure Guide*. The options selected in the Provisioning tab can affect the parameters displayed in the Performance > Payload PM tab.

Table 19-7 lists the PM parameter types that appear when a particular port type is provisioned for a transponder or muxponder card.

Table 19-7 Transponder, Muxponder, and Xponder Port Type PM Provisioning Options

If this Port Type is Provisioned[1]	The Following PM Types are Activated[2]
SONET/SDH (including 10G Ethernet WAN Phy) OC3/STM1 OC12/STM4 OC48/STM16 OC192/STM64	SONET or SDH PMs
40G Ethernet LAN Phy 10G Ethernet LAN Phy 10G FiberChannel 8G FiberChannel ONE_GE FC1G FC2G FC1G ISL FC2G ISL FICON1G FICON2G FICON1G ISL FICON2G ISL ISC COMPAT ISC PEER	Full remote monitoring (RMON) statistics
ESCON DV6000 SDI_D1_VIDEO HDTV PASS_THRU ETR_CLO	Payload PMs are not applicable to 2R port types.

1. The port type is provisioned from card view on the Provisioning > Pluggable Port Modules tab. For pluggable port module (PPM) provisioning procedures, refer to the *Cisco ONS 15454 DWDM Procedure Guide*.
2. Performance monitoring parameters are displayed from the card view on the Performance tab.

19.3.2.1 Payload PM SONET/SDH Window

Table 19-8 lists SONET/SDH layer near-end and far-end PM parameters listed in the card view on the Performance > Payload PM > SONET or SDH tab. SONET/SDH layer PMs are available when the client type is set to OC3/STM1, OC12/STM4, or OC48/STM16 on the TXP_MR_2.5G or when OC192/STM64 is set on the TXP_MR_10G, TXP_MR_10E, TXP_MR_10E_C, TXP_MR_10E_L, ADM-10G, or OTU2_XP card on ONS 15454 SONET nodes or ONS 15454 SDH nodes. OC48/STM16 trunk PMs are available on MXP_MR_2.5G and MXPP_MR_2.5G cards on ONS 15454 SONET or ONS 15454 SDH nodes. OC48/STM16 client PMs are available on MXP_2.5G_10G, MXP_2.5G_10E, MXP_2.5G_10E_C, and MXP_2.5G_10E_L cards on ONS 15454 SONET or ONS 15454 SDH nodes.

OC192/STM64 client PMs are available on 40G-MXP-C card on ONS 15454 SONET or ONS 15454 SDH nodes. For PM definitions, see Table 19-36 on page 19-34 and Table 19-37 on page 19-35.

Table 19-8 ONS 15454 SONET/SDH Layer Far-End and Near-End PMs

	Layer Far-End (FE)[1, 2]	Layer Near-End[1, 2]	Note
SONET	CV-LFE ES-LFE FC-LFE SES-LFE UAS-LFE	CV-L CV-S ES-L ES-S FC-L SES-L SES-S SEF-S UAS-L	Applicable standard is Telcordia GR-253.
SDH	MS-BBE MS-BBER MS-EB MS-ES MS-ESR MS-SES MS-SESR MS-UAS	RS-BBE RS-BBER RS-EB RS-ES RS-ESR RS-SES RS-SESR RS-UAS MS-BBE MS-BBER MS-EB MS-ES MS-ESR MS-SES MS-SESR MS-UAS	Applicable standard is Telcordia GR-253.

1. Applicable to optical channel (OCH) and Client (CLNT) facilities.
2. For MXP_MR_2.5G and MXPP_MR_2.5G cards, these parameters are shown in the Performance > Payload PM > SONET PM tabs in the card view.

19.3.2.2 Payload PM Statistics Window

Table 19-8 lists the 10 Gigabit Ethernet (10 GE) payload statistics that are available on the TXP_MR_10G, TXP_MR_10E, TXP_MR_10E_C, TXP_MR_10E_L, ADM-10G, and OTU2_XP cards. PPM provisioning must be completed in card view, on the Provisioning > Pluggable Port Modules tab for 10 GE to be enabled. For PPM provisioning procedures, see the *Cisco ONS 15454 DWDM Procedure Guide*. The parameters are listed in card view on the Performance > Payload PM > Statistics tab. For 10 GE payload definitions, see Table 19-34 on page 19-30.

Note Utilization PMs are also available per port.

Table 19-9 Full RMON Statistics on TXP_MR_10G, TXP_MR_10E, TXP_MR_10E_C, TXP_MR_10E_L, GE_XP, 10GE_XP, GE_XPE, 10GE_XPE, and OTU2_XP Cards

Full RMON Statistics	
dot3StatsFCSErrors	etherStatsBroadcastPkts
dot3StatsFrameTooLong	etherStatsCRCAlignErrors
ifInUcastPkts	etherStatsFragments
ifInBroadcastPkts	etherStatsJabbers
ifInErrors	etherStatsMulticastPkts
ifInErrorsBytePkts	etherStatsOctets
ifInFramingErrorPkts	etherStatsOversizePkts
ifInJunkInterPkts	etherStatsPkts64Octets
ifInMulticastPkts	etherStatsPkts65to127Octets
ifInOctets	etherStatsPkts128to255Octets
ifOutBroadcastPkts	etherStatsPkts256to511Octets
ifOutMulticastPkts	etherStatsPkts512to1023Octets
ifOutOctets	etherStatsPkts1024to1518Octets
rxTotalPkts	etherStatsUndersizePkts
Time Last Cleared	rxControlFrames
txTotalPkts	rxPauseFrames
	rxUnknownOpcodeFrames

Table 19-10 lists the payload statistics that are available on the ADM-10G card. The parameters are listed in card view on the Performance > Payload PM > Statistics tab. For PPM provisioning procedures, refer to the *Cisco ONS 15454 DWDM Procedure Guide*.

Table 19-10 Full RMON Statistics on ADM-10G Card

Full RMON Statistics	
dot3StatsFCSErrors	etherStatsBroadcastPkts
dot3StatsFrameTooLong	etherStatsFragments
dot3StatsInPauseFrames	etherStatsJabbers
dot3StatsOutPauseFrames	etherStatsMulticastPkts
dot3StatsControlInUnknownOpCodes	etherStatsOversizePkts
ifInMulticastPkts	etherStatsPkts64Octets
ifInBroadcastPkts	etherStatsPkts65to127Octets
ifInErrors	etherStatsPkts128to255Octets
ifInErrorsBytePkts	etherStatsPkts256to511Octets
ifInOctets	etherStatsPkts512to1023Octets
ifOutOctets	etherStatsPkts1024to1518Octets
rxTotalPkts	etherStatsUndersizePkts
txTotalPkts	
ifInErrors	
gfpStatsRxCRCErrors	
gfpStatsRxSBitErrors	
ifInPayloadCrcErrors	
gfpStatsLFDRaisedgfpStatsRxFrame	
gfpStatsTxOctets	
gfpStatsRxMBitErrors	
gfpStatsRxTypeInvalid	

Table 19-11 lists the payload PM parameters that are available on the TXP_MR_2.5G and the TXPP_MR_2.5G cards when the ONE_GE or FC1G client type is enabled. For PPM provisioning procedures, refer to the *Cisco ONS 15454 DWDM Procedure Guide*. For payload definitions, see the "19.5 Optics and 8b10b PM Parameter Definitions" section on page 19-27 and the "19.7 Full RMON Statistics PM Parameter Definitions" section on page 19-30.

Note Payload PM is not available for the 2FC client type.

Table 19-11 Gigabit Ethernet (GE) or Fibre Channel (FC) Payload PMs for the TXP_MR_2.5G and TXPP_MR_2.5G Cards

GE or FC Payload Performance Parameters
8b/10bDataOrderedSets
8b/10bIdleOrderedSets
8b/10bNonIdleOrderedSets
8b/10bStatsEncodingDispErrors
ifInErrors
rxTotalPkts

Table 19-12 lists the payload PM parameters that are available on the OTU2_XP card when the 10G FC client type is enabled. For PPM provisioning procedures, refer to the *Cisco ONS 15454 DWDM Procedure Guide*. For payload definitions, see the "19.5 Optics and 8b10b PM Parameter Definitions" section on page 19-27 and the "19.7 Full RMON Statistics PM Parameter Definitions" section on page 19-30.

Table 19-12 10G Fibre Channel (FC) Payload PMs for the OTU2_XP Card

10G FC Payload Performance Parameters
rxTotalPkts
mediaIndStatsRxFramesTruncated
mediaIndStatsRxFramesTooLong
mediaIndStatsRxFrameBadCRC
ifInOctects
ifInErros

For payload definitions, see the "19.5 Optics and 8b10b PM Parameter Definitions" section on page 19-27 and the "19.7 Full RMON Statistics PM Parameter Definitions" section on page 19-30.

Table 19-13 lists the payload PM parameters that are available on the MXP_MR_2.5G and the MXPP_MR_2.5G cards when the ONE_GE or the FC1G client type is enabled. For PPM provisioning procedures, refer to the *Cisco ONS 15454 DWDM Procedure Guide*. For payload definitions, see the "19.5 Optics and 8b10b PM Parameter Definitions" section on page 19-27 and the "19.7 Full RMON Statistics PM Parameter Definitions" section on page 19-30.

Table 19-13 ONE_GE or FC1G Payload PMs for the MXP_MR_2.5G and MXPP_MR_2.5G Cards

ONE_GE or FC1G Payload Performance Parameters
8b10bInvalidOrderedSets
8b10bStatsEncodingDispErrors
ifInDiscards
ifInErrors
ifInOctets
ifOutDiscards
ifOutOctets
mediaIndStatsRxFramesBadCRC
mediaIndStatsRxFramesTooLong
mediaIndStatsRxFramesTruncated
mediaIndStatsTxFramesBadCRC
rxTotalPkts
txTotalPkts

Table 19-14 lists the FC client-side payload PM parameters. FC payload PMs are available on the FC port on both the MXP_MR_2.5G and the MXPP_MR_2.5G cards when the FC1G client type is enabled. For PPM provisioning procedures, refer to the *Cisco ONS 15454 DWDM Procedure Guide*. For payload definitions, see the "19.7 Full RMON Statistics PM Parameter Definitions" section on page 19-30.

Table 19-14 FC1G Payload PMs on the Client Side

FC1G Payload PMs on the Client Port
fcStatsLinkRecoveries
fcStatsRxCredits
fcStatsTxCredits
fcStatsZeroTxCredits
gfpStatsRoundTripLatencyUSec
gfpStatsRxDistanceExtBuffers
gfpStatsTxDistanceExtBuffers

Table 19-15 lists the Transparent Generic Framing Procedure (GFP-T) payload PMs. The GFP-T payload PMs are available on the GFP port on both the MXP_MR_2.5G and the MXPP_MR_2.5G cards when the ONE_GE or the 1 FC client type is enabled. GFP-T payload PMs are also available on the client port on both the MXP_MR_2.5G and the MXPP_MR_2.5G cards when the 1 FC client type is enabled. For PPM provisioning procedures, refer to the *Cisco ONS 15454 DWDM Procedure Guide*. For payload definitions, see the "19.7 Full RMON Statistics PM Parameter Definitions" section on page 19-30.

Table 19-15 GFP-T Payload PMs

GFP-T Payload PMs on the GFP Port
gfpStatsCSFRaised
gfpStatsLFDRaised
gfpStatsRxCRCErrors
gfpStatsRxMBitErrors
gfpStatsRxSBitErrors
gfpStatsRxTypeInvalid
gfpStatsRxFrame
gfpStatsTxFrame
gfpStatsRxSblkCRCErrors
gfpStatsRxOctets
gfpStatsTxOctets
gfpRxCmfFrame
gfpTxCmfFrame

19.3.2.3 MXP_MR_2.5G/MXPP_MR_2.5G Payload Utilization Window

The Payload PM Utilization window in the card view Performance > Payload> Utilization tab shows the percentage of transmit (Tx) and receive (Rx) line bandwidth used by the ports during consecutive time segments. This tab cannot be viewed unless the appropriate PPM port type is provisioned. For PPM provisioning procedures, refer to the *Cisco ONS 15454 DWDM Procedure Guide*. The Utilization window provides an Interval list that enables you to set time intervals of 15 minutes or 1 day. Line utilization is calculated with the following formulas:

Rx = (inOctets + inPkts * 20) * 8 / 100% interval * maxBaseRate

Tx = (outOctets + outPkts * 20) * 8 / 100% interval * maxBaseRate

The interval is defined in seconds. The maxBaseRate is defined by raw bits per second in one direction for the port (that is, 1 Gbps). The maxBaseRate for MXP_MR_2.5G and MXPP_MR_2.5G cards is shown for the ONS 15454 nodes in Table 19-16.

Table 19-16 maxBaseRate for STS and VC Circuits

STS/VC	maxBaseRate
STS-1/VC3	51840000
STS-3c/VC4	155000000
STS-6c/VC4-2c	311000000
STS-12c/VC4-4c	622000000

Note Line utilization numbers express the average of ingress and egress traffic as a percentage of capacity.

19.3.2.4 Payload History Window

The Payload PM History window in the card view Performance > Payload > History tab lists past statistics for the previous time intervals. This tab cannot be viewed unless the appropriate PPM port type is provisioned. For PPM provisioning procedures, refer to the *Cisco ONS 15454 DWDM Procedure Guide*. Depending on the selected time interval, the History window displays the statistics for each port for the number of previous time intervals as shown in Table 19-17.

Table 19-17 History Statistics per Time Interval

Time Interval	Number of Intervals Displayed
15 minutes	32 (current and previous)
1 day (24 hours)	2 (current and previous)

19.3.3 OTN PM Window

The OTN tab has an ITU-T G.709 PM subtab and an FEC PM subtab. Both subtabs provide buttons to change the statistical values shown in the Performance tab. The Refresh button manually refreshes statistics. Auto-Refresh sets a time interval at which automatic refresh occurs. The Baseline button resets the displayed statistics values to zero. The Statistics window also has a Clear button. The Clear button sets the values on the card to zero. All counters on the card are cleared. The Help button activates context sensitive help. For more information about provisioning optical transport network (OTN) settings, refer to the *Cisco ONS 15454 DWDM Procedure Guide*.

Table 19-18 lists the OTN PM provisioning options for all transponder, muxponder, Xponder (GE_XP, 10GE_XP, GE_XPE, 10GE_XPE), and ADM-10G cards. The options selected in the Provisioning tab affects the parameters displayed in the Performance > OTN PM tab.

Table 19-18 Transponder, Muxponder, and Xponder PM Provisioning Options

Card	OTN Provisioning[1]
MXPP_MR_2.5G	—
MXP_2.5G_10E	G.709 FEC FEC Thresholds
MXP_2.5G_10E_C	G.709 FEC FEC Thresholds
MXP_2.5G_10E_L	G.709 FEC FEC Thresholds
MXP_2.5G_10G	G.709 FEC FEC Thresholds
MXP_MR_2.5G	—
MXP_MR_10DME_C	G.709 FEC FEC Thresholds

Table 19-18 Transponder, Muxponder, and Xponder PM Provisioning Options (continued)

Card	OTN Provisioning[1]
MXP_MR_10DME_L	G.709 FEC FEC Thresholds
40G-MXP-C	G.709 FEC Thresholds Trail Trace Identifier
TXPP_MR_2.5G	G.709 FEC FEC Thresholds
TXP_MR_10E	G.709 FEC FEC Thresholds
TXP_MR_10E_C	G.709 FEC FEC Thresholds
TXP_MR_10E_L	G.709 FEC FEC Thresholds
TXP_MR_10G	G.709 FEC FEC Thresholds
TXP_MR_2.5G	G.709 FEC FEC Thresholds
ADM-10G	G.709 FEC FEC Thresholds
GE_XP	G.709 FEC FEC Thresholds
10GE_XP	G.709 FEC FEC Thresholds
GE_XPE	G.709 FEC FEC Thresholds
10GE_XPE	G.709 FEC FEC Thresholds
OTU2_XP	G.709 FEC FEC Thresholds

1. OTN provisioning is performed from card view on the Provisioning > OTN > OTN Lines, G.709 Thresholds, and FEC Thresholds tabs.

Table 19-19 lists the OTN trunk-side PM parameters listed on the G.709 tab. OTN PMs are available when ITU G.709 is enabled from the card view Provisioning > OTN > OTN Lines tab. OTN PMs are not available on MXP_MR_2.5G and MXPP_MR_2.5G cards. For ITU G.709 section and path monitoring PM definitions, see the "19.6 ITU G.709 and ITU-T G.8021 Trunk-Side PM Parameter Definitions" section on page 19-28.

Table 19-19 ITU G.709 OTN Trunk-Side PMs

OTN Layer (Near End and Far End)[1]	Note
BBE-SM BBER-SM ES-SM ESR-SM FC-SM SES-SM SESR-SM UAS-SM FC-SM	ITU G.709 standard section monitoring ITU-T G.8021
BBE-PM BBER-PM ES-PM ESR-PM FC-PM SES-PM SESR-PM UAS-PM	ITU G.709 standard path monitoring ITU-T G.8021

1. Applicable to OCH facility.

Table 19-20 lists the forward error correction (FEC) PM parameters. FEC PMs are available when ITU-T G.709 is enabled and FEC is set to standard or enhanced. These parameters are provisioned from the card view Provisioning > OTN > OTN Lines tab. FEC PMs are not available on MXP_MR_2.5G and MXPP_MR_2.5G cards. For PM definitions, see the "19.8 FEC PM Parameter Definitions" section on page 19-33.

Table 19-20 FEC OTN Trunk-Side PMs

FEC Trunk-Side PMs	FEC (Near End)[1]
Bit Errors	BIT-EC
Uncorrectable Words	UNC-WORDS

1. Applicable to OCH facility.

Table 19-21 lists ONS 15454 optics and 8b10b PM parameters. For ONS 15454 optics and 8b10b definitions, see the "19.5 Optics and 8b10b PM Parameter Definitions" section on page 19-27.

Table 19-21 ONS 15454 Optics and 8b10b PMs

Optics (Near End)[1]	8B10B (Near End)[2]
LBCL-AVG	CGV
LBCL-MAX	DCG
LBCL-MIN	IOS
OPT-AVG	IPC
OPT-MAX	NIOS
OPT-MIN	VPC
OPR-AVG	
OPR-MAX	
OPR-MIN	

1. The TXP_MR_2.5G and TXPP_MR_2.5G card Enterprise System Connection (ESCON) payload does not support optics PMs on the client port due to Small Form-factor Pluggable (SFP)-imposed restrictions.
2. Applicable to TXP_MR_2.5G and TXPP_MR_2.5G cards only.

19.3.4 Ether Ports PM Window

CTC provides Ethernet port performance information, including line-level parameters, port bandwidth consumption, and historical Ethernet statistics. The Ethernet performance information is divided into the Statistics, Utilization, and History tabbed windows within the card view Performance tab window. For more information about provisioning ether ports, refer to the *Cisco ONS 15454 DWDM Procedure Guide*.

19.3.4.1 Ether Port Statistics Window

The Ethernet Statistics window lists Ethernet parameters at the line level. The Statistics window provides buttons to change the statistical values shown. The Baseline button resets the displayed statistics values to zero. The Refresh button manually refreshes statistics. Auto-Refresh sets a time interval at which automatic refresh occurs.

Table 19-22 defines the Ethernet Port statistics parameters.

Table 19-22 E-Series Ethernet Statistics Parameters

Parameter	Definition
Time Last Cleared	A time stamp indicating the last time statistics were reset.
ifInOctets	Number of bytes received since the last counter reset.
rxTotalPkts	Number of received packets.
ifInUcastPkts	Number of unicast packets received since the last counter reset.
ifInMulticastPkts	Number of multicast packets received since the last counter reset.
ifInDiscards	The number of inbound packets that were chosen to be discarded even though no errors had been detected to prevent their being deliverable to a higher-layer protocol. One possible reason for discarding such a packet could be to free buffer space.
ifOutOctets	Number of bytes transmitted since the last counter reset.
txTotalPkts	Number of transmitted packets.

Table 19-22 E-Series Ethernet Statistics Parameters (continued)

Parameter	Definition
ifOutMulticastPkts	Number of multicast packets transmitted.
ifOutBroadcastPkts	Number of broadcast packets transmitted.
ifOutDiscards	Number of outbound packets which were chosen to be discarded even though no errors had been detected to prevent their transmission. A possible reason for discarding such packets could be to free up buffer space.
ifOurErrors	Number of outbound packets or transmission units that could not be transmitted because of errors.
dot3StatsAlignmentErrors	A count of frames received on a particular interface that are not an integral number of octets in length and do not pass the FCS check.
dot3StatsFCSErrors	A count of frames received on a particular interface that are an integral number of octets in length but do not pass the FCS check.
dot3StatsFrameTooLong	A count of frames received on a particular interface that exceed the maximum permitted frame size.
etherStatsUndersizePkts	The total number of packets received that were less than 64 octets long (excluding framing bits, but including FCS octets) and were otherwise well formed.
etherStatsFragments	The total number of packets received that were less than 64 octets in length (excluding framing bits but including FCS octets) and had either a bad FCS with an integral number of octets (FCS Error) or a bad FCS with a nonintegral number of octets (Alignment Error). **Note** It is entirely normal for etherStatsFragments to increment. This is because it counts both runts (which are normal occurrences due to collisions) and noise hits.
etherStatsPkts64Octets	The total number of packets (including bad packets) received that were 64 octets in length (excluding framing bits but including FCS octets).
etherStatsPkts65to127Octets	The total number of packets (including bad packets) received that were between 65 and 127 octets in length inclusive (excluding framing bits but including FCS octets).
etherStatsPkts128to255Octets	The total number of packets (including bad packets) received that were between 128 and 255 octets in length inclusive (excluding framing bits but including FCS octets).
etherStatsPkts256to511Octets	The total number of packets (including bad packets) received that were between 256 and 511 octets in length inclusive (excluding framing bits but including FCS octets).
etherStatsPkts512to1023Octets	The total number of packets (including bad packets) received that were between 512 and 1023 octets in length inclusive (excluding framing bits but including FCS octets).
etherStatsPkts1024to1518Octets	The total number of packets (including bad packets) received that were between 1024 and 1518 octets in length inclusive (excluding framing bits but including FCS octets).
etherStatsBroadcastPkts	The total number of good packets received that were directed to the broadcast address. Note that this does not include multicast packets.

Table 19-22 E-Series Ethernet Statistics Parameters (continued)

Parameter	Definition
etherStatsMulticastPkts	The total number of good packets received that were directed to a multicast address. Note that this number does not include packets directed to the broadcast address.
etherStatsOversizePkts	The total number of packets received that were longer than 1518 octets (excluding framing bits, but including FCS octets) and were otherwise well formed. Note that for tagged interfaces, this number becomes 1522 bytes.
etherStatsJabbers	The total number of packets received that were longer than 1518 octets (excluding framing bits, but including FCS octets), and had either a bad FCS with an integral number of octets (FCS Error) or a bad FCS with a nonintegral number of octets (Alignment Error).
etherStatsOctets	The total number of octets of data (including those in bad packets) received on the network (excluding framing bits but including FCS octets.
etherStatsCRCAlignErrors	The total number of packets received that had a length (excluding framing bits, but including FCS octets) of between 64 and 1518 octets, inclusive, but had either a bad FCS with an integral number of octets (FCS Error) or a bad FCS with a nonintegral number of octets (Alignment Error).

Note In certain congestion scenarios in GE_XP and 10GE_XP cards, dropped packets are counted both in ingress (IfIndiscards) and egress interface (IfOutDiscards) interface. As a result of this, some dropped packets are counted twice. The dropped packets on ingress interface can be ignored under this scenario.

19.3.4.2 Ether Ports Utilization Window

The Utilization window shows the percentage of transmit (Tx) and receive (Rx) line bandwidth used by the Ethernet ports during consecutive time segments. The Mode field displays the real-time mode status, such as 100 Full, which is the mode setting configured on the E-Series port. However, if the E-Series port is set to autonegotiate the mode (Auto), this field shows the result of the link negotiation between the E-Series and the peer Ethernet device attached directly to the E-Series port.

The Utilization window provides an Interval drop-down list that enables you to set time intervals of 1 minute, 15 minutes, 1 hour, and 1 day. Line utilization is calculated with the following formulas:

Rx = (inOctets + inPkts * 20) * 8 / 100% interval * maxBaseRate

Tx = (outOctets + outPkts * 20) * 8 / 100% interval * maxBaseRate

The interval is defined in seconds. The maxBaseRate is defined by raw bits per second in one direction for the Ethernet port (that is, 1 Gbps).

19.3.4.3 Ether Ports History Window

The Ether Port History window lists past Ethernet statistics for the previous time intervals. Depending on the selected time interval, the History window displays the statistics for each port for the number of previous time intervals as shown in Table 19-23. The parameters are defined in Table 19-22 on page 19-20.

Table 19-23 Ethernet History Statistics per Time Interval

Time Interval	Number of Previous Intervals Displayed
1 minute	60
15 minutes	32
1 hour	24
1 day (24 hours)	7

19.4 DWDM Card Performance Monitoring

The following sections define PM parameters and definitions for the ONS 15454 OPT-PRE, OPT-BST, OPT-BST-L, OPT-AMP-L, OPT-AMP-17-C, 32MUX-O, 32DMX-O, 32DMX, 32DMX-L, 40-WSS-C, 40-WSS-CE, 40-WXC-C, 80-WXC-C, 40-DMX-C, 40-DMX-CE, 40-MUX-C, 40-SMR1-C, 40-SMR2-C, 4MD-xx.x, AD-1C-xx.x, AD-2C-xx.x, AD-4C-xx.x, AD-1B-xx.x, AD-4B-xx.x, OSCM, OSC-CSM, 32WSS, and 32WSS-LDWDM cards.

19.4.1 Optical Amplifier Card Performance Monitoring Parameters

The PM parameters for the OPT-PRE, OPT-AMP-L, OPT-AMP-17-C, OPT-BST, and OPT-BST-L cards are listed Table 19-24. For ONS 15454 optics definitions, see the "19.5 Optics and 8b10b PM Parameter Definitions" section on page 19-27.

Table 19-24 Optical PM Parameters for Optical Amplifier Cards

Optical Line	Optical Amplifier Line
OPT	OPR

19.4.2 Multiplexer and Demultiplexer Card Performance Monitoring Parameters

The PM parameters for the 32MUX-O, 32WSS, 32WSS-L, 32DMX, 32DMX-L, 32DMX-O, 40-WSS-C, 40-WSS-CE, 40-WXC-C, 80-WXC-C, 40-DMX-C, 40-DMX-CE, 40-MUX-C, 40-SMR1-C, and 40-SMR2-C cards are listed in Table 19-25. For ONS 15454 optics definitions, see the "19.5 Optics and 8b10b PM Parameter Definitions" section on page 19-27.

Table 19-25 Optical PM Parameters of Multiplexer and Demultiplexer Cards

Optical Channel	Optical Line
OPR	OPT

19.4.3 4MD-xx.x Card Performance Monitoring Parameters

The PM parameters for the 4MD-xx.x cards are listed in Table 19-26. For ONS 15454 optics definitions, see the "19.5 Optics and 8b10b PM Parameter Definitions" section on page 19-27.

Table 19-26 Optical PM Parameters for 4MD-xx.x Cards

Optical Channel	Optical Band
OPR	OPT

19.4.4 OADM Channel Filter Card Performance Monitoring Parameters

The PM parameters for the AD-1C-xx.x, AD-2C-xx.x, and AD-4C-xx.x cards are listed in Table 19-27. For ONS 15454 optics definitions, see the "19.5 Optics and 8b10b PM Parameter Definitions" section on page 19-27.

Table 19-27 Optical PM Parameters for AD-1C-xx.x, AD-2C-xx.x, and AD-4C-xx.x Cards

Optical Channel	Optical Line
OPR	OPT

19.4.5 OADM Band Filter Card Performance Monitoring Parameters

The PM parameters for the AD-1B-xx.x and AD-4B-xx.x cards are listed in Table 19-28. For ONS 15454 optics definitions, see the "19.5 Optics and 8b10b PM Parameter Definitions" section on page 19-27.

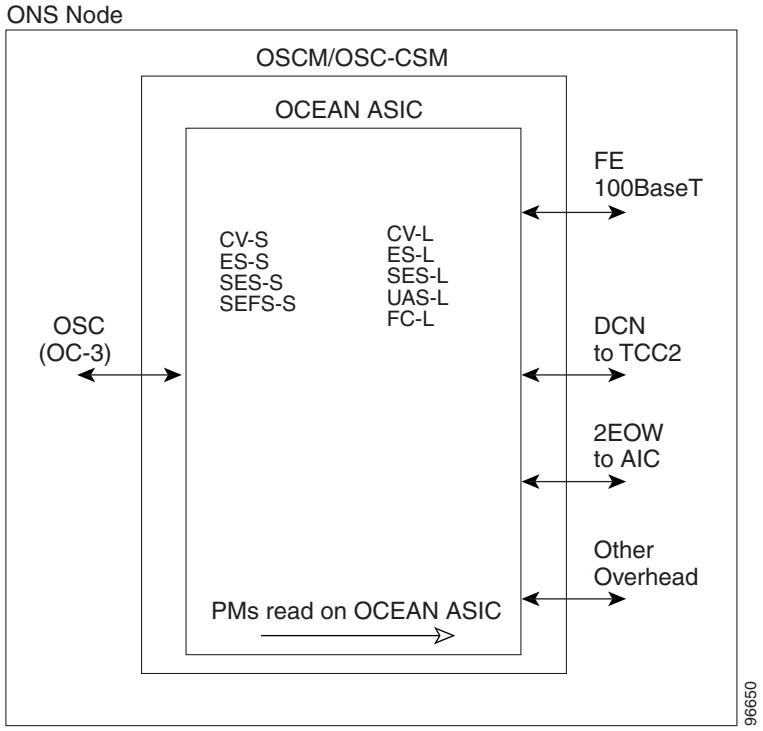
Table 19-28 Optical PM Parameters for AD-1B-xx.x and AD-4B-xx.x Cards

Optical Line	Optical Band
OPR	OPT

19.4.6 Optical Service Channel Card Performance Monitoring Parameters

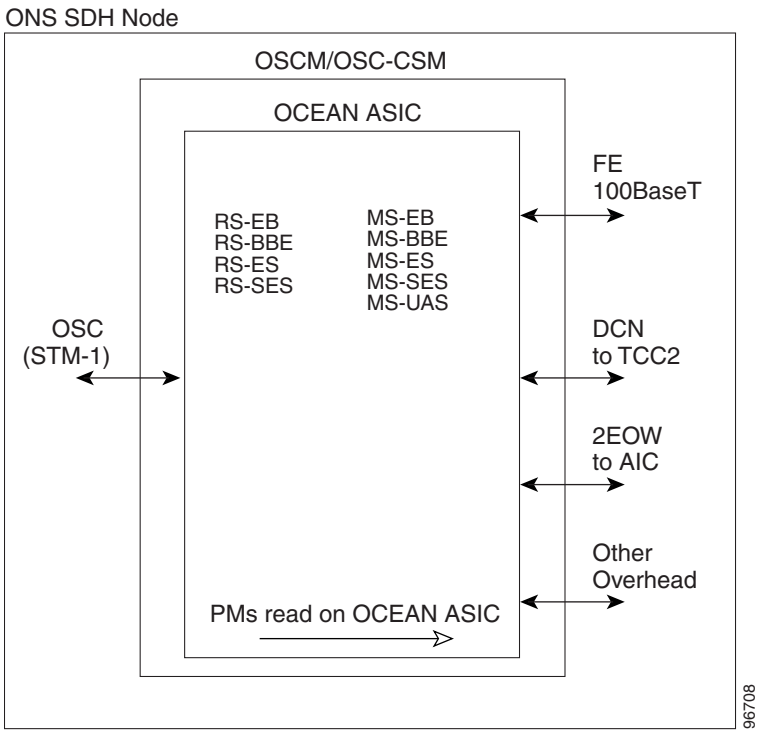
For ONS 15454 ANSI nodes, Figure 19-3 shows where overhead bytes detected on the ASICs produce PM parameters for the OSCM and OSC-CSM cards.

Figure 19-3 ONS 15454 ANSI Node PM Read Points on OSCM and OSC-CSM Cards



For ONS 15454 ETSI nodes, Figure 19-4 shows where overhead bytes detected on the ASICs produce PM parameters for the OSCM and OSC-CSM cards.

Figure 19-4 ONS 15454 ETSI Node PM Read Points on OSCM and OSC-CSM Cards



The ONS 15454 ANSI node PM parameters for the OSCM and OSC-CSM cards are listed in Table 19-29. For PM definitions, see the "19.9 SONET PM Parameter Definitions" section on page 19-34. For optics PM definitions, see the "19.5 Optics and 8b10b PM Parameter Definitions" section on page 19-27.

Table 19-29 ANSI OSCM/OSC-CSM (OC3) Card PMs

Section (Near End)[1]	Line (Near End/Far End)[1]	Optics (Near End)[2]
CV-S ES-S SEF-S SES-S	CV-L ES-L FC-L SES-L UAS-L	OPWR

1. Applicable to OC3
2. Applicable to OTS facilities

Table 19-30 ETSI OSCM and OSC-CSM Card PMs

Regeneration Section (Near End)	Multiplex Section (Near End/Far End)	Optics (Near End)
RS-BBE RS-EB RS-ES RS-SES	MS-BBE MS-EB MS-ES MS-SES MS-UAS	OPT

19.5 Optics and 8b10b PM Parameter Definitions

Table 19-31 on page 19-27 lists Cisco ONS 15454 optics and 8b10b PM parameter definitions.

Table 19-31 ONS 15454 Optics and 8b10b PM Parameter Definitions

Parameter	Definition
8b10bDataOrderedSets	8b10b takes 8 bits of data and sends it as 10 bits, which allows control information to be sent along with the data. DataOrderedSets is a count of data ordered sets.
8b10bErrors	8b10b takes 8 bits of data and sends it as 10 bits, which allows control information to be sent along with the data. Errors is a count of 10b errors received by the serial or deserializer (serdes 8b/10b).
8b10bIdleOrderedSets	8b10b takes 8 bits of data and sends it as 10 bits, which allows control information to be sent along with the data. IdleOrderedSets is a count of idle ordered sets.
8b10bInvalidOrderedSets	8b10b takes 8 bits of data and sends it as 10 bits, which allows control information to be sent along with the data. InvalidOrderedSets is a count of the received invalid work errors.
8b10bNonIdleOrderedSets	8b10b takes 8 bits of data and sends it as 10 bits, which allows control information to be sent along with the data. NonIdleOrderedSets is a count of ordered sets that are not idle.
8b10bStatsEncodingDispErrors	8b10b takes 8 bits of data and sends it as 10 bits, which allows control information to be sent along with the data. StatsEncodingDispErrors is a count of the received disparity errors.
BIE	The number of bit errors (BIE) corrected in the DWDM trunk line during the PM time interval.
BIT-EC	The number of Bit Errors Corrected (BIT-EC) in the DWDM trunk line during the PM time interval.
CGV	Code Group Violations (CGV) is a count of received code groups that do not contain a start or end delimiter.
DCG	Date Code Groups (DCG) is a count of received data code groups that do not contain ordered sets.
IOS	Idle Ordered Sets (IOS) is a count of received packets containing idle ordered sets.
IPC	Invalid Packets (IPC) is the count of received packets that contain errored data code groups that have start and end delimiters.
LBCL-AVG	Laser Bias Current Line-Average (LBCL-AVG) is the average percentage of laser bias current.
LBCL-MAX	Laser Bias Current Line-Maximum (LBCL-MAX) is the maximum percentage of laser bias current.
LBCL-MIN	Laser Bias Current Line-Minimum (LBCL-MIN) is the minimum percentage of laser bias current.

Table 19-31 ONS 15454 Optics and 8b10b PM Parameter Definitions (continued)

Parameter	Definition
LOFC	Loss of Frame Count (LOFC) is a count of the lost frames.
NIOS	Non-Idle Ordered Sets (NIOS) is a count of received packets containing non-idle ordered sets.
OPR	Optical Power Received (OPR) is the measure of average optical power received as a percentage of the nominal OPR.
OPR-AVG	Average Receive Optical Power (OPR-AVG) is the average received optical power measured in dBm.
OPR-MAX	Maximum Receive Optical Power (OPR-MAX) is the maximum received optical power measured in dBm.
OPR-MIN	Minimum Receive Optical Power (OPR-MIN) is the minimum received optical power measured in dBm.
OPT	Optical Power Transmitted (OPT) is the average optical power transmitted as a percentage of the nominal OPT.
OPT-AVG	Average Transmit Optical Power (OPT-AVG) is the average transmitted optical power measured in dBm.
OPT-MAX	Maximum Transmit Optical Power (OPT-MAX) is the maximum transmitted optical power measured in dBm.
OPT-MIN	Minimum Transmit Optical Power (OPT-MIN) is the minimum transmitted optical power measured in dBm.
OPWR-AVG	Optical Power - Average (OPWR-AVG) is the measure of average optical power on the unidirectional port.
OPWR-MAX	Optical Power - Maximum (OPWR-MAX) is the measure of maximum value of optical power on the unidirectional port.
OPWR-MIN	Optical Power - Minimum (OPWR-MIN) is the measure of minimum value of optical power on the unidirectional port.
UNC-WORDS	Uncorrectable Words (UNC-WORDS) is the number of uncorrectable words detected in the DWDM trunk line during the PM time interval.
VPC	Valid Packets (VPC) is a count of received packets that contain non-errored data code groups that have start and end delimiters.

19.6 ITU G.709 and ITU-T G.8021 Trunk-Side PM Parameter Definitions

Table 19-34 defines the ITU G.709 and ITU-T G.8021 section monitoring trunk-side PM parameters. For more information, see the "19.3 Transponder, Muxponder, Xponder, and ADM-10G Card Performance Monitoring" section on page 19-7.

Table 19-32 ITU G.709 and ITU-T G.8021 Section Monitoring PM Definitions

Parameter	Definition
BBE-SM	Section Monitoring Background Block Errors (BBE-SM) shows the number of background block errors recorded in the OTN section during the PM time interval.
BBER-SM	Section Monitoring Background Block Errors Ratio (BBER-SM) shows the background block errors ratio recorded in the OTN path during the PM time interval.
ES-SM	Section Monitoring Errored Seconds (ES-SM) shows the errored seconds recorded in the OTN section during the PM time interval.
ESR-SM	Section Monitoring Errored Seconds Ratio (ESR-SM) shows the severely errored seconds ratio recorded in the OTN section during the PM time interval.
FC-SM	Section Monitoring Failure Counts (FC-SM) shows the failure counts recorded in the OTN section during the PM time interval.
SES-SM	Section Monitoring Severely Errored Seconds (SES-SM) shows the severely errored seconds recorded in the OTN section during the PM time interval.
SESR-SM	Section Monitoring Severely Errored Seconds Ratio (SESR-SM) shows the severely errored seconds ratio recorded in the OTN section during the PM time interval.
UAS-SM	Section Monitoring Unavailable Seconds (UAS-SM) shows the unavailable seconds recorded in the OTN section during the PM time interval.

Table 19-33 defines the ITU G.709 path monitoring trunk-side PM parameters. For more information, see the "19.3 Transponder, Muxponder, Xponder, and ADM-10G Card Performance Monitoring" section on page 19-7.

Table 19-33 ITU G.709 Path Monitoring PM Definitions

Parameter	Definition
BBE-PM	Path Monitoring Background Block Errors (BBE-PM) shows the number of background block errors recorded in the OTN path during the PM time interval.
BBER-PM	Path Monitoring Background Block Errors Ratio (BBER-PM) shows the background block errors ratio recorded in the OTN path during the PM time interval.
ES-PM	Path Monitoring Errored Seconds (ES-PM) shows the errored seconds recorded in the OTN path during the PM time interval.
ESR-PM	Path Monitoring Errored Seconds Ratio (ESR-PM) shows the severely errored seconds ratio recorded in the OTN path during the PM time interval.
FC-PM	Path Monitoring Failure Counts (FC-PM) shows the failure counts recorded in the OTN path during the PM time interval.

Table 19-33 ITU G.709 Path Monitoring PM Definitions (continued)

Parameter	Definition
SES-PM	Path Monitoring Severely Errored Seconds (SES-PM) shows the severely errored seconds recorded in the OTN path during the PM time interval.
SESR-PM	Path Monitoring Severely Errored Seconds Ratio (SESR-PM) shows the severely errored seconds ratio recorded in the OTN path during the PM time interval.
UAS-PM	Path Monitoring Unavailable Seconds (UAS-PM) shows the unavailable seconds recorded in the OTN path during the PM time interval.

19.7 Full RMON Statistics PM Parameter Definitions

Table 19-34 defines the MXP_MR_2.5G, MXPP_MR_2.5G, TXP_MR_10E, TXP_MR_10E_C, TXP_MR_10E_L, and 40G-MXP-C card full RMON statistics PM parameters. For more information, see the "19.3 Transponder, Muxponder, Xponder, and ADM-10G Card Performance Monitoring" section on page 19-7.

Table 19-34 Full RMON Statistics PM Definitions

Parameter	Definition
dot3StatsFCSErrors	The number of frames with frame check errors.
dot3StatsFrameTooLong	The number of packets at least 64 octets long, without a bad Frame Check Sequence (FCS), where the 802.3 length/type field did not match the computed DATA field length.
etherStatsBroadcastPkts	The number of broadcast packets, excluding multicast packets, that are 64–16376 octets in length, and have a valid FCS.
etherStatsCRCAlignErrors	The number of packets that are 64–1518 octets in length without an integral number of octets, or with a bad FCS.
etherStatsFragments	The number of packets less than 64 octets long that do not have an integral number of octets or that have a bad FCS.
etherStatsJabbers	The number of octets of data, including bad packets, that were received on the network.
etherStatsMulticastPkts	The number of multicast packets, excluding broadcast packets, that are 64–16376 octets in length, and have a valid FCS.
etherStatsOctets	The number in bytes of received packets, including bad packets and excluding framing bits except for FCS bytes.
etherStatsOversizePkts	The number of packets more than 16376 octets long that have a valid FCS.
etherStatsPkts64Octets	The number of packet received, including error packets, that are 64 octets in length.
etherStatsPkts65to127Octets	The number of packets received, including error packets, that are 65–127 octets in length.

Table 19-34 Full RMON Statistics PM Definitions (continued)

Parameter	Definition
etherStatsPkts128to255Octets	The number of packets received, including error packets, that are 128–255 octets in length.
etherStatsPkts256to511Octets	The number of packets received, including error packets, that are 256–511 octets in length.
etherStatsPkts512to1023Octets	The number of packets received, including error packets, that are 512–1023 octets in length.
etherStatsPkts1024to1518Octets	The number of packets received, including error packets, that are 1024–1518 octets in length.
etherStatsUndersizePkts	The number of packets less than 64 octets long that have a valid FCS.
fcStatsLinkRecoveries	The number of link recoveries.
fcStatsRxCredits	The number of current receive buffer to buffer credits.
fcStatsTxCredits	The number of current transmit buffer to buffer credits.
fcStatsZeroTxCredits	This is a count that increments when the FC/FICON Tx credits go from a nonzero value to zero.
gfpStatsLFDRaised	The number of loss of frame delineation (LFD) raised.
gfpStatsRoundTripLatencyUSec	Round trip delay for the end-to-end Fibre Channel transport in microseconds.
gfpStatsRxCRCErrors	The number of packets received with a payload FCS error.
gfpStatsRxCSFRaised	Received GFP loss of client character synchronization (LOCCS).
gfpStatsRxDistanceExtBuffers	The number of receive buffer credit for GFP-T (valid only if distance extension is enabled).
gfpStatsRxMBitErrors	The received multibit errored core header count (cHEC).
gfpStatsRxSBitErrors	The received single-bit errored cHEC.
gfpStatsRxSblkCRCErrors	The number of packets received with a payload FCS error. Sblk stands for super block in the GFP payload.
gfpStatsRxTypeInvalid	Received invalid type.
gfpStatsTxDistanceExtBuffers	The number of transmit buffer credit for GFP-T (valid only if distance extension is enabled).
ifInUcastPkts	The number of packets, delivered by this sub-layer to a higher (sub-)layer, which were not addressed to a multicast or broadcast address at this sub-layer.
inInMulticastPkts	The number of packets, delivered by this sub-layer to a higher (sub-)layer, which were addressed to a multicast address at this sub-layer. For a MAC layer protocol, this includes both Group and Functional addresses.
ifInBroadcastPkts	The number of packets delivered to a higher sublayer and addressed to a broadcast address at this sublayer.

Table 19-34 Full RMON Statistics PM Definitions (continued)

Parameter	Definition
ifInDiscards	The number of inbound packets that were chosen to be discarded even though no errors were detected, to prevent them from being deliverable to a higher-layer protocol. One possible reason for discarding such a packet could be to free buffer space.
ifInErrors	The number of inbound packets (or transmission units) that contained errors preventing them from being delivered to a higher-layer protocol.
ifInErrorBytePkts	The number of received packets with an error symbol detected.
ifInFramingErrorPkts	The number of received packets with a control symbol other than an error detected.
ifInJunkInterPkts	The number of interpacket gaps between valid start symbols during which a symbol other than idle is detected, including packets of length 1–8 octets.
ifInMulticastPkts	The total number of multicast frames received error-free.
ifInOctets	The number of bytes received since the last counter reset.
ifOutBroadcastPkts	The number of packets requested by higher-level protocols and addressed to a broadcast address at this sublayer, including those not transmitted.
ifOutDiscards	The number of outbound packets that were chosen to be discarded even though no errors had been detected to prevent their being transmitted. One possible reason for discarding such a packet could be to free buffer space.
ifOutMulticastPkts	The number of multicast frames transmitted error-free.
ifOutOctets	The number of bytes transmitted since the last counter reset.
InvalidCRCError	A count of invalid cyclic redundancy checks (CRCs).
mediaIndStatsRxFramesBadCRC	The number of received frames with a CRC error.
mediaIndStatsRxFramesTooLong	The number of received frames that are too long.
mediaIndStatsRxFramesTruncated	The number of received frames that are too small.
mediaIndStatsTxFramesBadCRC	The number of transmitted frames with a CRC error.
Running Disparity Count	A count of errors that affect the disparity of the received data stream.
rxControlFrames	The number of MAC control packets that are type 0x8808 and contain at least 64 octets in length.
rxFrames	A count of the number of frames received without errors.
rxLinkReset (Only for FC Mode)	A count of the received link resets.
rxPauseFrames	The number of received 802.x paused frames.
rxTotalPkts	The number of received packets.
rxUnknownOpcodeFrames	Number of packets of at least 64 octets in length and type 0x8808, with opcode not equal to 1.
Time Last Cleared	A time stamp indicating the last time statistics were reset.

Table 19-34 Full RMON Statistics PM Definitions (continued)

Parameter	Definition
txBytes	A count of the number of bytes transmitted from the frame since the last counter reset.
txFrames	A count of the number of transmitted frames.
txTotalPkts	The number of transmitted packets.
dot3StatsFCSErrors	A count of frames received on a particular interface that are an integral number of octets in length but do not pass the FCS check.
dot3StatsFrameTooLong	A count of frames received on a particular interface that exceed the maximum permitted frame size.
dot3StatsInPauseFrames	A count of frames received on this interface with an opcode indicating the PAUSE operation.
dot3StatsOutPauseFrames	A count of MAC Control frames transmitted on this interface with an opcode indicating the PAUSE operation.
etherStatsUndersizePkts	The total number of packets received that were less than 64 octets long (excluding framing bits, but including FCS octets) and were otherwise well formed.
mediaIndStatsTxFramesTooLong	Total number of transmitted data frames that are less than 5 bytes. This value is a part of HDLC and GFP port statistics.
mediaIndStatsTxFramesTruncated	Number of transmitted data frames that exceed the MTU. This value is part of HDLC and GFP port statistics.
gfpStatsRxFrame	Total number of received data frames.
gfpStatsTxFrame	Total number of transmitted data frames.
gfpStatsRxOctets	Total number of GFP data octets received.
gfpStatsTxOctets	Total number of GFP data octets transmitted.
gfpRxCmfFrame	—
gfpTxCmfFrame	—

19.8 FEC PM Parameter Definitions

Table 19-35 defines the MXP_MR_2.5G, MXPP_MR_2.5G, TXP_MR_10E, TXP_MR_10E_C, and TXP_MR_10E_L card FEC PM parameters. For more information, see the "19.3 Transponder, Muxponder, Xponder, and ADM-10G Card Performance Monitoring" section on page 19-7.

Table 19-35 FEC PM Definitions

Parameter	Definition
Bit Errors	Bit Errors are the number of bit errors corrected.
FEC (NE)	FEC enables correction and detection of errors along the optical links where OTN and FEC are provisioned. FEC uses Reed Solomon code RS (255,239) encoding. The FEC field is found in Rows 1 to 4 and Columns 3835 to 4080. It will contain either the Reed-Solomon RS(255,239) codes, or if FEC is disabled, fixed stuff bytes (zeros). **Note** The FEC PM information can be found in the card view Performance > OTN PM tab. FEC must be enabled on the transponder units in order for FEC PM values to be reported.
UNC-Words	Uncorrectable Words (UNC-Words) occur when FEC detects and corrects errors to deliver a 7 to 8 dB improvement in the signal-to-noise ratio (also called margin). For ITU G.709, the FEC code used is Reed-Solomon RS (255, 239).

19.9 SONET PM Parameter Definitions

Table 19-36 gives definitions for each type of SONET PM parameter available on an ONS 15454 ANSI node. These parameters become available when the client type is set to OC-3, OC-12, or OC-48 on a TXP_MR_2.5G or TXPP_MR_2.5G card, OC-192 on a TXP_MR_10G, TXP_MR_10E, TXP_MR_10E_C, TXP_MR_10E_L, or ADM-10G card. The OC-48 client PM is available on MXP_2.5_10G, MXP_2.5G_10E, MXP_2.5G_10E_C, MXP_2.5G_10E_L, MXP_MR_10DME_C, and MXP_MR_10DME_L cards. The OC-48 trunk PM is available on MXP_MR_2.5G and MXPP_MR_2.5G cards.

Table 19-36 SONET PM Parameters

Parameter	Definition
CV-L	Line Coding Violation (CV-L) indicates the number of coding violations occurring on the line. This parameter is a count of bipolar violations (BPVs) and excessive zeros (EXZs) occurring over the accumulation period.
CV-S	Section Coding Violation (CV-S) is a count of bit interleaved parity (BIP) errors detected at the section layer (that is, using the B1 byte in the incoming SONET signal). Up to eight section BIP errors can be detected per STS-N frame; each error increments the current CV-S second register.
ES-L	Line Errored Seconds (ES-L) is a count of the seconds containing one or more anomalies (BPV + EXZ) and/or defects (that is, loss of signal) on the line.
ES-S	Section Errored Seconds (ES-S) is a count of the number of seconds when at least one section-layer BIP error was detected or an SEF or loss of signal (LOS) defect was present.

Table 19-36 SONET PM Parameters (continued)

Parameter	Definition
FC-L	Line Failure Count (FC-L) is a count of the number of near-end line failure events. A failure event begins when an Alarm Indication Signal Line (AIS-L) failure is declared or when a lower-layer, traffic-related, near-end failure is declared. This failure event ends when the failure is cleared. A failure event that begins in one period and ends in another period is counted only in the period where it begins.
SEF-S	Severely Errored Framing Seconds (SEFS-S) is a count of the seconds when an SEF defect was present. An SEF defect is expected to be present during most seconds when an LOS or loss of frame (LOF) defect is present. However, there can be situations when the SEFS-S parameter is only incremented based on the presence of the SEF defect. **Note** The RTRV-PM-<MOD2> command does not retrieve SEFS counter for OC192/STM64 payloads on ADM-10G, 40G/40E (TXP/MXP), and OTU2-XP cards.
SES-L	Line Severely Errored Seconds (SES-L) is a count of the seconds containing more than a particular quantity of anomalies (BPV + EXZ ≥ 44) and/or defects on the line.
SES-S	Section Severely Errored Seconds (SES-S) is a count of the seconds when K (see Telcordia GR-253 for value) or more section-layer BIP errors were detected or an SEF or LOS defect was present.
UAS-L	Line Unavailable Seconds (UAS-L) is a count of the seconds when the line is unavailable. A line becomes unavailable when ten consecutive seconds occur that qualify as SES-Ls, and it continues to be unavailable until ten consecutive seconds occur that do not qualify as SES-Ls.

19.10 SDH PM Parameter Definitions

Table 19-37 gives definitions for each type of SDH PM parameter available on an ONS 15454 ETSI node. These parameters become available when the client type is set to STM-1, STM-4, or STM-16 on a TXP_MR_2.5G or TXPP_MR_2.5G card, STM-64 on a TXP_MR_10G, TXP_MR_10E, TXP_MR_10E_C, TXP_MR_10E_L, or ADM-10G card. The STM-16 client PM is available on MXP_2.5G_10G, MXP_2.5G_10E, MXP_2.5G_10E_C, MXP_2.5G_10E_L, MXP_MR_10DME_C, and MXP_MR_10DME_L cards. The STM-16 trunk PM is available on MXP_MR_2.5G and MXPP_MR_2.5G cards.

Table 19-37 SDH PM Parameters

Parameter	Definition
MS-BBE	Multiplex Section Background Block Error (MS-BBE) is an errored block not occurring as part of an SES.
MS-BBER	Multiplex Section Background Block Error Ratio (MS-BBER) is the ratio of BBE to total blocks in available time during a fixed measurement interval. The count of total blocks excludes all blocks during SESs.
MS-EB	Multiplex Section Errored Block (MS-EB) indicates that one or more bits are in error within a block.

Table 19-37 SDH PM Parameters (continued)

Parameter	Definition
MS-ES	Multiplex Section Errored Second (MS-ES) is a one-second period with one or more errored blocks or at least one defect.
MS-ESR	Multiplex Section Errored Second Ratio (MS-ESR) is the ratio of errored seconds to total seconds in available time during a fixed measurement interval.
MS-SES	Multiplex Section Severely Errored Second (MS-SES) is a one-second period that contains 30 percent or more errored blocks or at least one defect. SES is a subset of ES. For more information, refer to ITU-T G.829 Section 5.1.3.
MS-SESR	Multiplex Section Severely Errored Second ratio (MS-SESR) is the ratio of SES to total seconds in available time during a fixed measurement interval.
MS-UAS	Multiplex Section Unavailable Seconds (MS-UAS) is a count of the seconds when the section was unavailable. A section becomes unavailable when ten consecutive seconds occur that qualify as MS-SESs, and it continues to be unavailable until ten consecutive seconds occur that do not qualify as MS-SESs. When the condition is entered, MS-SESs decrement and then count toward MS-UAS.
RS-BBE	Regenerator Section Background Block Error (RS-BBE) is an errored block not occurring as part of an SES.
RS-BBER	Regenerator Section Background Block Error Ratio (RS-BBER) is the ratio of BBE to total blocks in available time during a fixed measurement interval. The count of total blocks excludes all blocks during SESs.
RS-EB	Regenerator Section Errored Block (RS-EB) indicates that one or more bits are in error within a block.
RS-ES	Regenerator Section Errored Second (RS-ES) is a one-second period with one or more errored blocks or at least one defect.
RS-ESR	Regenerator Section Errored Second Ratio (RS-ESR) is the ratio of errored seconds to total seconds in available time during a fixed measurement interval.
RS-SES	Regenerator Section Severely Errored Second (RS-SES) is a one-second period which contains 30 percent or more errored blocks or at least one defect. SES is a subset of ES.
RS-SESR	Regenerator Section Severely Errored Second Ratio (RS-SESR) is the ratio of SES to total seconds in available time during a fixed measurement interval.
RS-UAS	Regenerator Section Unavailable Second (RS-UAS) is a count of the seconds when the regenerator section was unavailable. A section becomes unavailable when ten consecutive seconds occur that qualify as RS-UASs, and it continues to be unavailable until ten consecutive seconds occur that do not qualify as RS-UASs.

19.11 Pointer Justification Count Performance Monitoring

For the MultiService Transport Platform (MSTP), only the MXP_2.5G_10G card uses pointer justification counts. Pointers are used to compensate for frequency and phase variations. Pointer justification counts indicate timing errors on networks. When a network is out of synchronization, jitter and wander occur on the transported signal. Excessive wander can cause terminating equipment to slip.

Slips cause different effects in service. Voice service has intermittent audible clicks. Compressed voice technology has short transmission errors or dropped calls. Fax machines lose scanned lines or experience dropped calls. Digital video transmission has distorted pictures or frozen frames. Encryption service loses the encryption key, causing data to be transmitted again.

For ONS 15454 ANSI nodes, pointers provide a way to align the phase variations in STS and VT payloads. The STS payload pointer is located in the H1 and H2 bytes of the line overhead. Clocking differences are measured by the offset in bytes from the pointer to the first byte of the STS synchronous payload envelope (SPE) called the J1 byte. Clocking differences that exceed the normal range of 0 to 782 can cause data loss.

For ONS 15454 ETSI nodes, pointers provide a way to align the phase variations in VC4 payloads. The VC4 payload pointer is located in the H1 and H2 bytes of the AU pointers section and is a count of the number of bytes the VC4 path overhead (POH) J1 byte is away from the H3 byte, not including the section overhead bytes. Clocking differences are measured by the offset in bytes from the pointer to the first byte of the VC4 POH called the J1 byte. Clocking differences that exceed the normal range of 0 to 782 can cause data loss.

There are positive (PPJC) and negative (NPJC) pointer justification count parameters. PPJC is a count of path-detected (PPJC-PDET-P) or path-generated (PPJC-PGEN-P) positive pointer justifications. NPJC is a count of path-detected (NPJC-PDET-P) or path-generated (NPJC-PGEN-P) negative pointer justifications depending on the specific PM name. PJCDIFF is the absolute value of the difference between the total number of detected pointer justification counts and the total number of generated pointer justification counts. PJCS-PDET-P is a count of the one-second intervals containing one or more PPJC-PDET or NPJC-PDET. PJCS-PGEN-P is a count of the one-second intervals containing one or more PPJC-PGEN or NPJC-PGEN.

A consistent pointer justification count indicates clock synchronization problems between nodes. A difference between the counts means that the node transmitting the original pointer justification has timing variations with the node detecting and transmitting this count. For ONS 15454 SONET nodes, positive pointer adjustments occur when the frame rate of the SPE is too slow in relation to the rate of the STS-1. For ONS 15454 SDH nodes, positive pointer adjustments occur when the frame rate of the path overhead (POH) is too slow in relation to the rate of the VC4.

In CTC, the count fields for PPJC and NPJC PMs appear white and blank unless they are enabled on the card view Provisioning tab.

CHAPTER 20

SNMP

This chapter explains Simple Network Management Protocol (SNMP) as implemented by the Cisco ONS 15454.

For SNMP setup information, refer to the *Cisco ONS 15454 DWDM Procedure Guide*.

Note Unless otherwise specified, "ONS 15454" refers to both ANSI and ETSI shelf assemblies.

Chapter topics include:

- 20.1 SNMP Overview, page 20-1
- 20.2 Basic SNMP Components, page 20-3
- 20.3 SNMP External Interface Requirement, page 20-4
- 20.4 SNMP Version Support, page 20-4
- 20.5 SNMP Message Types, page 20-5
- 20.6 SNMP Management Information Bases, page 20-6
- 20.7 SNMP Trap Content, page 20-15
- 20.8 SNMPv1/v2 Community Names, page 20-22
- 20.9 SNMP in Multishelf Management, page 20-22
- 20.10 SNMPv1/v2 Proxy Over Firewalls, page 20-24
- 20.11 SNMPv3 Proxy Configuration, page 20-25
- 20.12 Remote Monitoring, page 20-25

20.1 SNMP Overview

SNMP is an application-layer communication protocol that allows ONS 15454 network devices to exchange management information among these systems and with other devices outside the network. Through SNMP, network administrators can manage network performance, find and solve network problems, and plan network growth. Up to 10 SNMP trap destinations and five concurrent Cisco Transport Controller (CTC) user sessions are allowed per node.

The ONS 15454 uses SNMP for asynchronous event notification to a network management system (NMS). ONS SNMP implementation uses standard Internet Engineering Task Force (IETF) management information bases (MIBs) to convey node-level inventory, fault, and performance management

information for generic DS-1, DS-3, SONET, and Ethernet read-only management. SNMP allows a generic SNMP manager such as HP OpenView Network Node Manager (NNM) or Open Systems Interconnection (OSI) NetExpert to be utilized for limited management functions.

The Cisco ONS 15454 supports SNMP Version 1 (SNMPv1), SNMP Version 2c (SNMPv2c), and SNMP Version 3 (SNMPv3). As compared to SNMPv1, SNMPv2c includes additional protocol operations and 64-bit performance monitoring support. SNMPv3 provides authentication, encryption, and message integrity and is more secure. This chapter describes the SNMP versions and describes the configuration parameters for the ONS 15454.

Note In Software Release 8.0 and later, you can retrieve automatic in service (AINS) state and soak time through the SNMP and Transaction Language One (TL1) interfaces.

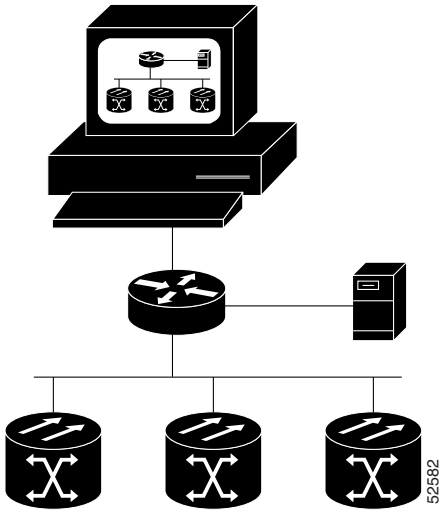
Note The CERENT-MSDWDM-MIB.mib, CERENT-FC-MIB.mib, and CERENT-GENERIC-PM-MIB.mib in the CiscoV2 directory support 64-bit performance monitoring counters. The SNMPv1 MIB in the CiscoV1 directory does not contain 64-bit performance monitoring counters, but supports the lower and higher word values of the corresponding 64-bit counter. The other MIB files in the CiscoV1 and CiscoV2 directories are identical in content and differ only in format.

Note It is recommended that the SNMP Manager timeout value be set to 60 seconds. Under certain conditions, if this value is lower than the recommended time, the TCC card can reset. However, the response time depends on various parameters such as object being queried, complexity of what and number of hops in the node, etc.

The SNMP management interface supports the IEEE 802.3 LAG MIB.

Figure 20-1 illustrates the basic layout idea of an SNMP-managed network.

Figure 20-1 Basic Network Managed by SNMP

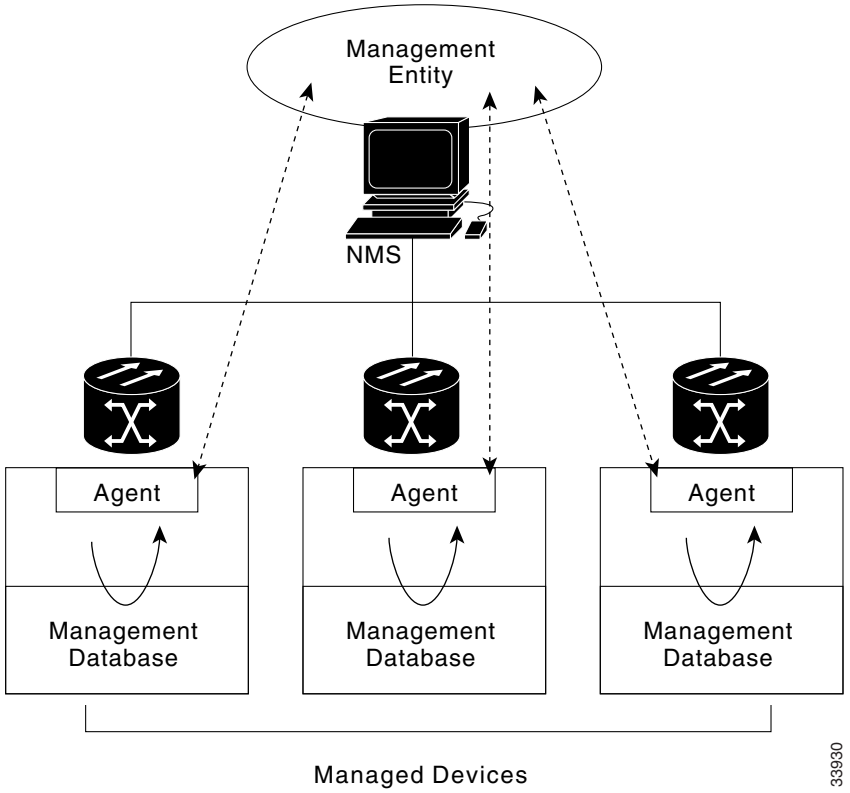


20.2 Basic SNMP Components

In general terms, an SNMP-managed network consists of a management system, agents, and managed devices.

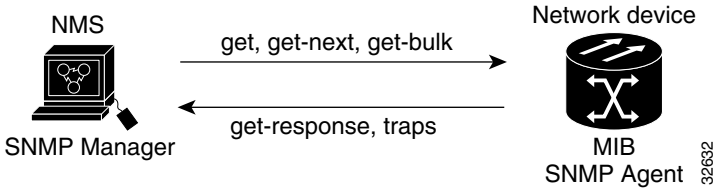
A management system such as HP OpenView executes monitoring applications and controls managed devices. Management systems execute most of the management processes and provide the bulk of memory resources used for network management. A network might be managed by one or several management systems. Figure 20-2 illustrates the relationship between the network manager, the SNMP agent, and the managed devices.

Figure 20-2 Example of the Primary SNMP Components



An agent (such as SNMP) residing on each managed device translates local management information data—such as performance information or event and error information—caught in software traps, into a readable form for the management system. Figure 20-3 illustrates SNMP agent get-requests that transport data to the network management software.

Figure 20-3 Agent Gathering Data from a MIB and Sending Traps to the Manager



The SNMP agent captures data from MIBs, which are device parameter and network data repositories, or from error or change traps.

A managed element—such as a router, access server, switch, bridge, hub, computer host, or network element (such as an ONS 15454)—is accessed through the SNMP agent. Managed devices collect and store management information, making it available through SNMP to other management systems having the same protocol compatibility.

20.3 SNMP External Interface Requirement

Since all SNMP requests come from a third-party application, the only external interface requirement is that a third-party SNMP client application can upload RFC 3273 SNMP MIB variables in the etherStatsHighCapacityTable, etherHistoryHighCapacityTable, or mediaIndependentTable.

20.4 SNMP Version Support

The ONS 15454 supports SNMPv1 and SNMPv2c traps and get requests. The ONS 15454 SNMP MIBs define alarms, traps, and status. Through SNMP, NMS applications can query a management agent for data from functional entities such as Ethernet switches and SONET multiplexers using a supported MIB.

Note ONS 15454 MIB files in the CiscoV1 and CiscoV2 directories are almost identical in content except for the difference in 64-bit performance monitoring features. The CiscoV2 directory contains three MIBs with 64-bit performance monitoring counters:. CERENT-MSDWDM-MIB.mib, CERENT-FC-MIB.mib, and CERENT-GENERIC-PM-MIB.mib The CiscoV1 directory does not contain any 64-bit counters, but it does support the lower and higher word values used in 64-bit counters. The two directories also have somewhat different formats.

20.4.1 SNMPv3 Support

Cisco ONS 15454 Software R9.0 and later supports SNMPv3 in addition to SNMPv1 and SNMPv2c. SNMPv3 is an interoperable standards-based protocol for network management. SNMPv3 provides secure access to devices by a combination of authentication and encryption packets over the network based on the User Based Security Model (USM) and the View-Based Access Control Model (VACM).

- **User-Based Security Model**—The User-Based Security Model (USM) uses the HMAC algorithm for generating keys for authentication and privacy. SNMPv3 authenticates data based on its origin, and ensures that the data is received intact. SNMPv1 and v2 authenticate data based on the plain text community string, which is less secure when compared to the user-based authentication model.

- **View-Based Access Control Model**—The view-based access control model controls the access to the managed objects. RFC 3415 defines the following five elements that VACM comprises:
  - Groups—A set of users on whose behalf the MIB objects can be accessed. Each user belongs to a group. The group defines the access policy, notifications that users can receive, and the security model and security level for the users.
  - Security level—The access rights of a group depend on the security level of the request.
  - Contexts—Define a named subset of the object instances in the MIB. MIB objects are grouped into collections with different access policies based on the MIB contexts.
  - MIB views—Define a set of managed objects as subtrees and families. A view is a collection or family of subtrees. Each subtree is included or excluded from the view.
  - Access policy—Access is determined by the identity of the user, security level, security model, context, and the type of access (read/write). The access policy defines what SNMP objects can be accessed for reading, writing, and creating.

  Access to information can be restricted based on these elements. Each view is created with different access control details. An operation is permitted or denied based on the access control details.

You can configure SNMPv3 on a node to allow SNMP get and set access to management information and configure a node to send SNMPv3 traps to trap destinations in a secure way. SNMPv3 can be configured in secure mode, non-secure mode, or disabled mode.

SNMP, when configured in secure mode, only allows SNMPv3 messages that have the authPriv security level. SNMP messages without authentication or privacy enabled are not allowed. When SNMP is configured in non-secure mode, it allows SNMPv1, SNMPv2, and SNMPv3 message types.

20.5 SNMP Message Types

The ONS 15454 SNMP agent communicates with an SNMP management application using SNMP messages. Table 20-1 describes these messages.

Table 20-1 ONS 15454 SNMP Message Types

Operation	Description
get-request	Retrieves a value from a specific variable.
get-next-request	Retrieves the value following the named variable; this operation is often used to retrieve variables from within a table. With this operation, an SNMP manager does not need to know the exact variable name. The SNMP manager searches sequentially to find the needed variable from within the MIB.
get-response	Replies to a get-request, get-next-request, get-bulk-request, or set-request sent by an NMS.
get-bulk-request	Fills the get-response with up to the max-repetition number of get-next interactions, similar to a get-next-request.
set-request	Provides remote network monitoring (RMON) MIB.
trap	Indicates that an event has occurred. An unsolicited message is sent by an SNMP agent to an SNMP manager.

20.6 SNMP Management Information Bases

A managed object, sometimes called a MIB object, is one of many specific characteristics of a managed device. The MIB consists of hierarchically organized object instances (variables) that are accessed by network-management protocols such as SNMP.

20.6.1 IETF-Standard MIBs for the ONS 15454

Table 20-2 lists the IETF-standard MIBs implemented in the ONS 15454 SNMP agents.

First compile the MIBs in Table 20-2, then compile the MIBs in Table 20-3.

Caution If you do not compile MIBs in the correct order, one or more might not compile correctly.

Table 20-2 IETF Standard MIBs Implemented in the ONS 15454 System

RFC[1] Number	Module Name	Title/Comments
—	IANAifType-MIB.mib	Internet Assigned Numbers Authority (IANA) ifType
1213	RFC1213-MIB-rfc1213.mib	Management Information Base for Network
1907	SNMPV2-MIB-rfc1907.mib	Management of TCP/IP-based Internets: MIB-II Management Information Base for Version 2 of the Simple Network Management Protocol (SNMPv2)
1253	RFC1253-MIB-rfc1253.mib	OSPF Version 2 Management Information Base
1493	BRIDGE-MIB-rfc1493.mib	Definitions of Managed Objects for Bridges (This defines MIB objects for managing MAC bridges based on the IEEE 802.1D-1990 standard between Local Area Network [LAN] segments.)
2819	RMON-MIB-rfc2819.mib	Remote Network Monitoring Management Information Base
2737	ENTITY-MIB-rfc2737.mib	Entity MIB (Version 2)
2233	IF-MIB-rfc2233.mib	Interfaces Group MIB using SNMPv2
2358	EtherLike-MIB-rfc2358.mib	Definitions of Managed Objects for the Ethernet-like Interface Types
2493	PerfHist-TC-MIB-rfc2493.mib	Textual Conventions for MIB Modules Using Performance History Based on 15 Minute Intervals
2495	DS1-MIB-rfc2495.mib	Definitions of Managed Objects for the DS1, E1, DS2 and E2 Interface Types
2496	DS3-MIB-rfc2496.mib	Definitions of Managed Object for the DS3/E3 Interface Type
2558	SONET-MIB-rfc2558.mib	Definitions of Managed Objects for the SONET/SDH Interface Type
2674	P-BRIDGE-MIB-rfc2674.mib Q-BRIDGE-MIB-rfc2674.mib	Definitions of Managed Objects for Bridges with Traffic Classes, Multicast Filtering and Virtual LAN Extensions

Table 20-2 IETF Standard MIBs Implemented in the ONS 15454 System (continued)

RFC[1] Number	Module Name	Title/Comments
3273	HC-RMON-MIB	The MIB module for managing remote monitoring device implementations, augmenting the original RMON MIB as specified in RFC 2819 and RFC 1513 and RMON-2 MIB as specified in RFC 2021
	CISCO-DOT3-OAM-MIB	A Cisco proprietary MIB defined for IEEE 802.3ah ethernet OAM.
3413	SNMP-NOTIFICATION-MIB	Defines the MIB objects that provide mechanisms to remotely configure the parameters used by an SNMP entity for generating notifications.
3413	SNMP-TARGET-MIB	Defines the MIB objects that provide mechanisms to remotely configure the parameters that are used by an SNMP entity for generating SNMP messages.
3413	SNMP-PROXY-MIB	Defines MIB objects that provide mechanisms to remotely configure the parameters used by a proxy forwarding application.
3414	SNMP-USER-BASED-SM-MIB	The management information definitions for the SNMP User-Based Security Model.
3415	SNMP-VIEW-BASED-ACM-MIB	The management information definitions for the View-Based Access Control Model for SNMP.

1. RFC = Request for Comment

20.6.2 Proprietary ONS 15454 MIBs

Each ONS 15454 is shipped with a software CD containing applicable proprietary MIBs. Table 20-3 lists the proprietary MIBs for the ONS 15454.

Table 20-3 ONS 15454 Proprietary MIBs

MIB Number	Module Name
1	CERENT-GLOBAL-REGISTRY.mib
2	CERENT-TC.mib
3	CERENT-454.mib
4	CERENT-GENERIC.mib (not applicable to ONS 15454)
5	CISCO-SMI.mib
6	CISCO-VOA-MIB.mib
7	CERENT-MSDWDM-MIB.mib
8	CERENT-OPTICAL-MONITOR-MIB.mib
9	CERENT-HC-RMON-MIB.mib
10	CERENT-ENVMON-MIB.mib
11	CERENT-GENERIC-PM-MIB.mib

Table 20-3 ONS 15454 Proprietary MIBs

MIB Number	Module Name
12	BRIDGE-MIB.my
13	CERENT-454-MIB.mib
14	CERENT-ENVMON-MIB.mib
15	CERENT-FC-MIB.mib
16	CERENT-GENERIC-MIB.mib
17	CERENT-GENERIC-PM-MIB.mib
18	CERENT-GLOBAL-REGISTRY.mib
19	CERENT-HC-RMON-MIB.mib
20	CERENT-IF-EXT-MIB.mib
21	CERENT-MSDWDM-MIB.mib
22	CERENT-OPTICAL-MONITOR-MIB.mib
23	CERENT-TC.mib
24	CISCO-IGMP-SNOOPING-MIB.mib
25	CISCO-OPTICAL-MONITOR-MIB.mib
26	CISCO-OPTICAL-PATCH-MIB.mib
27	CISCO-SMI.mib
28	CISCO-VOA-MIB.mib
29	CISCO-VTP-MIB.mib
30	INET-ADDRESS-MIB.mib
31	OLD-CISCO-TCP-MIB.my
32	OLD-CISCO-TS-MIB.my
33	RFC1155-SMI.my
34	RFC1213-MIB.my
35	RFC1315-MIB.my
36	BGP4-MIB.my
37	CERENT-454-MIB.mib
38	CERENT-ENVMON-MIB.mib
39	CERENT-FC-MIB.mib
40	CERENT-GENERIC-MIB.mib
41	CERENT-GENERIC-PM-MIB.mib
42	CERENT-GLOBAL-REGISTRY.mib
43	CERENT-HC-RMON-MIB.mib
44	CERENT-IF-EXT-MIB.mib
45	CERENT-MSDWDM-MIB.mib
46	CERENT-OPTICAL-MONITOR-MIB.mib

Table 20-3 ONS 15454 Proprietary MIBs

MIB Number	Module Name
47	CERENT-TC.mib
48	CISCO-CDP-MIB.my
49	CISCO-CLASS-BASED-QOS-MIB.my
50	CISCO-CONFIG-COPY-MIB.my
51	CISCO-CONFIG-MAN-MIB.my
52	CISCO-ENTITY-ASSET-MIB.my
53	CISCO-ENTITY-EXT-MIB.my
54	CISCO-ENTITY-VENDORTYPE-OID-MI
55	CISCO-FRAME-RELAY-MIB.my
56	CISCO-FTP-CLIENT-MIB.my
57	CISCO-HSRP-EXT-MIB.my
58	CISCO-HSRP-MIB.my
59	CISCO-IGMP-SNOOPING-MIB.mib
60	CISCO-IMAGE-MIB.my
61	CISCO-IP-STAT-MIB.my
62	CISCO-IPMROUTE-MIB.my
63	CISCO-MEMORY-POOL-MIB.my
64	CISCO-OPTICAL-MONITOR-MIB.mib
65	CISCO-OPTICAL-PATCH-MIB.mib
66	CISCO-PING-MIB.my
67	CISCO-PORT-QOS-MIB.my
68	CISCO-PROCESS-MIB.my
69	CISCO-PRODUCTS-MIB.my
70	CISCO-RTTMON-MIB.my
71	CISCO-SMI.mib
72	CISCO-SMI.my
73	CISCO-SYSLOG-MIB.my
74	CISCO-TC.my
75	CISCO-TCP-MIB.my
76	CISCO-VLAN-IFTABLE-RELATIONSHI
77	CISCO-VOA-MIB.mib
78	CISCO-VTP-MIB.mib
79	CISCO-VTP-MIB.my
80	ENTITY-MIB.my
81	ETHERLIKE-MIB.my

Table 20-3 ONS 15454 Proprietary MIBs

MIB Number	Module Name
82	HC-PerfHist-TC-MIB.my
83	HC-RMON-MIB.my
84	HCNUM-TC.my
85	IANA-RTPROTO-MIB.my
86	IANAifType-MIB.my
87	IEEE-802DOT17-RPR-MIB.my
88	IEEE8023-LAG-MIB.my
89	IF-MIB.my
90	IGMP-MIB.my
91	INET-ADDRESS-MIB.my
92	IPMROUTE-STD-MIB.my
93	OSPF-MIB.my
94	PIM-MIB.my
95	RMON-MIB.my
96	RMON2-MIB.my
97	SNMP-FRAMEWORK-MIB.my
98	SNMP-NOTIFICATION-MIB.my
99	SNMP-TARGET-MIB.my
100	SNMPv2-MIB.my
101	SNMPv2-SMI.my
102	SNMPv2-TC.my
103	TCP-MIB.my
104	TOKEN-RING-RMON-MIB.my
105	UDP-MIB.my
106	BRIDGE-MIB-rfc1493.mib
107	DS1-MIB-rfc2495.mib
108	DS3-MIB-rfc2496.mib
109	ENTITY-MIB-rfc2737.mib
110	EtherLike-MIB-rfc2665.mib
111	HC-RMON-rfc3273.mib
112	HCNUM-TC.mib
113	IANAifType-MIB.mib
114	IF-MIB-rfc2233.mib
115	INET-ADDRESS-MIB.mib
116	P-BRIDGE-MIB-rfc2674.mib

Table 20-3 ONS 15454 Proprietary MIBs

MIB Number	Module Name
117	PerfHist-TC-MIB-rfc2493.mib
118	Q-BRIDGE-MIB-rfc2674.mib
119	RFC1213-MIB-rfc1213.mib
120	RFC1253-MIB-rfc1253.mib
121	RIPv2-MIB-rfc1724.mib
122	RMON-MIB-rfc2819.mib
123	RMON2-MIB-rfc2021.mib
124	RMONTOK-rfc1513.mib
125	SNMP-FRAMEWORK-MIB-rfc2571.mib
126	SNMP-MPD-MIB.mib
127	SNMP-NOTIFY-MIB-rfc3413.mib
128	SNMP-PROXY-MIB-rfc3413.mib
129	SNMP-TARGET-MIB-rfc3413.mib
130	SNMP-USER-BASED-SM-MIB-rfc3414.mib
131	SNMP-VIEW-BASED-ACM-MIB-rfc3415.mib
132	SNMPv2-MIB-rfc1907.mib
133	SONET-MIB-rfc2558.mib

Note If you cannot compile the proprietary MIBs correctly, log into the Technical Support Website at http://www.cisco.com/techsupport or call Cisco TAC (800) 553-2447.

Note When SNMP indicates that the wavelength is unknown, it means that the corresponding card (MXP_2.5G_10E, TXP_MR_10E, MXP_2.5G_10G, TXP_MR_10G, TXP_MR_2.5G, or TXPP_MR_2.5G) works with the first tunable wavelength. For more information about MXP and TXP cards, see Chapter 10, "Transponder and Muxponder Cards."

20.6.3 Generic Threshold and Performance Monitoring MIBs

A MIB called CERENT-GENERIC-PM-MIB allows network management stations (NMS) to use a single, generic MIB for accessing threshold and performance monitoring data of different interface types. The MIB is generic in the sense that it is not tied to any particular kind of interface. The MIB objects can be used to obtain threshold values, current performance monitoring (PM) counts, and historic PM statistics for each kind of monitor and any supported interval at the near end and far end.

Previously existing MIBs in the ONS 15454 system provide some of these counts. For example, SONET interface 15-minute current PM counts and historic PM statistics are available using the SONET-MIB. DS-1 and DS-3 counts and statistics are available through the DS1-MIB and DS-3 MIB respectively. The

generic MIB provides these types of information and also fetches threshold values and single-day statistics. In addition, the MIB supports optics and dense wavelength division multiplexing (DWDM) threshold and performance monitoring information.

The CERENT-GENERIC-PM-MIB is organized into three different tables:

- cerentGenericPmThresholdTable
- cerentGenericPmStatsCurrentTable
- cerentGenericPmStatsIntervalTable

The cerentGenericPmThresholdTable is used to obtain the threshold values for the monitor types. It is indexed based on the following items:

- Interface index (cerentGenericPmThresholdIndex)
- Monitor type (cerentGenericPmThresholdMonType). The syntax of cerentGenericPmThresholdMonType is type cerentMonitorType, defined in CERENT-TC.mib.
- Location (cerentGenericPmThresholdLocation). The syntax of cerentGenericPmThresholdLocation is type cerentLocation, defined in CERENT-TC.mib.
- Time period (cerentGenericPmThresholdPeriod). The syntax of cerentGenericPmThresholdPeriod is type cerentPeriod, defined in CERENT-TC.mib.

Threshold values can be provided in 64-bit and 32-bit formats. (For more information about 64-bit counters, see the "20.12.2 HC-RMON-MIB Support" section on page 20-27.) The 64-bit values in cerentGenericPmThresholdHCValue can be used with agents that support SNMPv2. The two 32-bit values (cerentGenericPmThresholdValue and cerentGenericPmThresholdOverFlowValue) can be used by NMSs that only support SNMPv1.

Due to the 64-bit counter, the negative values for cerentGenericPmThresholdHCValue are displayed as large positive integers. If the cerentGenericPmThresholdOverFlowValue is less than zero, it indicates that the cerentGenericPmThresholdHCValue is representing a negative value.

The objects compiled in the cerentGenericPmThresholdTable are shown in Table 20-4.

Table 20-4 cerentGenericPmThresholdTable

Index Objects	Information Objects
cerentGenericPmThresholdIndex	cerentGenericPmThresholdValue
cerentGenericPmThresholdMonType	cerentGenericPmThresholdOverFlowValue
cerentGenericPmThresholdLocation	cerentGenericPmThresholdHCValue
cerentGenericPmThresholdPeriod	—

The second table within the MIB, cerentGenericPmStatsCurrentTable, compiles the current performance monitoring (PM) values for the monitor types. The table is indexed based on interface index (cerentGenericPmStatsCurrentIndex), monitor type (cerentGenericPmStatsCurrentMonType), location (cerentGenericPmStatsCurrentLocation) and time period (cerentGenericPmStatsCurrentPeriod). The syntax of cerentGenericPmStatsCurrentIndex is type cerentLocation, defined in CERENT-TC.mib. The syntax of cerentGenericPmStatsCurrentMonType is type cerentMonitor, defined in CERENT-TC.mib. The syntax of cerentGenericPmStatsCurrentPeriod is type cerentPeriod, defined in CERENT-TC.mib.

The cerentGenericPmStatsCurrentTable validates the current PM value using the cerentGenericPmStatsCurrentValid object and registers the number of valid intervals with historical PM statistics in the cerentGenericPmStatsCurrentValidIntervals object.

PM values are provided in 64-bit and 32-bit formats. The 64-bit values in cerentGenericPmStatsCurrentHCValue can be used with agents that support SNMPv2. The two 32-bit values (cerentGenericPmStatsCurrentValue and cerentGenericPmStatsCurrentOverFlowValue) can be used by NMS that only support SNMPv1.

Due to the 64-bit counter, the negative values for cerentGenericPmStatsCurrentHCValue are displayed as large positive integers. If the cerentGenericPmStatsCurrentOverFlowValue is less than zero, it indicates that the cerentGenericPmStatsCurrentHCValue is representing a negative value.

The cerentGenericPmStatsCurrentTable is shown in Table 20-5.

Table 20-5 32-Bit cerentGenericPmStatsCurrentTable

Index Objects	Informational Objects
cerentGenericPmStatsCurrentIndex	cerentGenericPmStatsCurrentValue
cerentGenericPmStatsCurrentMonType	cerentGenericPmStatsCurrentOverFlowValue
cerentGenericPmStatsCurrentLocation	cerentGenericPmStatsCurrentHCValue
cerentGenericPmStatsCurrentPeriod	cerentGenericPmStatsCurrentValidData
—	cerentGenericPmStatsCurrentValidIntervals

The third table in the MIB, cerentGenericPmStatsIntervalTable, obtains historic PM values for the monitor types. It validates the current PM value in the cerentGenericPmStatsIntervalValid object. This table is indexed based on interface index (cerentGenericPmStatsIntervalIndex), monitor type (cerentGenericPMStatsIntervalMonType), location (cerentGenericPmStatsIntervalLocation), and period (cerentGenericPmStatsIntervalPeriod). The syntax of cerentGenericPmStatsIntervalIndex is type cerentLocation, defined in CERENT-TC.mib. The syntax of cerentGenericPmStatsIntervalMonType is type cerentMonitor, defined in CERENT-TC.mib. The syntax of cerentGernicPmStatsIntervalPeriod is type cerentPeriod, defined in CERENT-TC.mib.

The table provides historic PM values in 64-bit and 32-bit formats. The 64-bit values contained in the cerentGenericPmStatsIntervalHCValue table can be used with SNMPv2 agents. The two 32-bit values (cerentGenericPmStatsIntervalValue and cerentGenericPmStatsIntervalOverFlowValue) can be used by SNMPv1 NMS.

Due to the 64-bit counter, the negative values for cerentGenericPmStatsIntervalHCValue are displayed as large positive integers. If the cerentGenericPmStatsIntervalOverFlowValue is less than zero, it indicates that the cerentGenericPmStatsIntervalHCValue is representing a negative value.

The cerentGenericPmStatsIntervalTable is shown in Table 20-6.

Table 20-6 32-Bit cerentGenericPmStatsIntervalTable

Index Objects	Informational Objects
cerentGenericPmStatsIntervalIndex	cerentGenericPmStatsIntervalValue
cerentGenericPmStatsIntervalMonType	cerentGenericPmStatsIntervalOverFlowValue
cerentGenericPmStatsIntervalLocation	cerentGenericPmStatsIntervalHCValue
cerentGenericPmStatsIntervalPeriod	cerentGenericPmStatsIntervalValidData
cerentGenericPmStatsIntervalNumber	—

20.6.4 MIBs Supported in GE-XP, 10GE-XP, GE-XPE, 10GE-XPE Cards

A comprehensive list of supported MIBs for the GE-XP, 10GE-XP, GE-XPE, and 10GE-XPE cards can be found in the MIBs README.txt file.

You can also locate and download MIBs for Cisco platforms, Cisco IOS releases, and feature sets, using the Cisco MIB Locator at the following URL:

http://www.cisco.com/go/mibs

Table 20-7 lists traps supported in GE-XP, 10GE-XP, GE-XPE, and 10GE-XPE cards

Table 20-7 Traps Supported in GE-XP, 10GE-XP, GE-XPE, and 10GE-XPE Cards

Trap Name	Description
multicastMacAddressAliasing	Multicast mac address aliasing
multicastMacAddressTableFull	Multicast mac address table full
fastAutomaticProtectionSwitching	Fast Automatic Protection Switching
fastAutomaticProtectionSwitchingConfigMismatch	Fast automatic protection switching config mismatch

20.6.5 MIBs Supported in TNC and TSC Cards

(Cisco ONS 15454 M2 and ONS 15454 M6 only)

You can locate and download MIBs for Cisco platforms, Cisco IOS releases, and feature sets, using the Cisco MIB Locator at the following URL:

http://www.cisco.com/go/mibs

Table 20-8 lists the MIBs supported in the TNC card.

Table 20-8 MIBs Supported in TNC Card

MIB Number	MIB Module
1	CERENT-454-MIB.mib
2	CERENT-ENVMON-MIB.mib
3	CERENT-GENERIC-MIB.mib
4	CERENT-GENERIC-PM-MIB.mib
5	CERENT-OPTICAL-MONITOR-MIB.mib
6	CERENT-GENERIC-MIB.mib
7	CERENT-MSDWDM-MIB.mib

Table 20-9 lists the MIBs supported in the TSC card.

Table 20-9 MIBs Supported in TSC Card

MIB Number	MIB Module
1	CERENT-454-MIB.mib
2	CERENT-GENERIC-MIB.mib

20.7 SNMP Trap Content

The ONS 15454 uses SNMP traps to generate all alarms and events, such as raises and clears. The traps contain the following information:

- Object IDs that uniquely identify each event with information about the generating entity (the slot or port; synchronous transport signal [STS] and Virtual Tributary [VT]; bidirectional line switched ring [BLSR], Spanning Tree Protocol [STP], etc.).
- Severity and service effect of the alarm (critical, major, minor, or event; service-affecting or non-service-affecting).
- Date and time stamp showing when the alarm occurred.

20.7.1 Generic and IETF Traps

The ONS 15454 supports the generic IETF traps listed in Table 20-10.

Table 20-10 Supported Generic IETF Traps

Trap	From RFC No. MIB	Description
coldStart	RFC1907-MIB	Agent up, cold start.
warmStart	RFC1907-MIB	Agent up, warm start.
authenticationFailure	RFC1907-MIB	Community string does not match.
newRoot	RFC1493/ BRIDGE-MIB	Sending agent is the new root of the spanning tree.
topologyChange	RFC1493/ BRIDGE-MIB	A port in a bridge has changed from Learning to Forwarding or Forwarding to Blocking.
entConfigChange	RFC2737/ ENTITY-MIB	The entLastChangeTime value has changed.
dsx1LineStatusChange	RFC2495/ DS1-MIB	The value of an instance of dsx1LineStatus has changed. The trap can be used by an NMS to trigger polls. When the line status change results from a higher-level line status change (for example, a DS-3), no traps for the DS-1 are sent.
dsx3LineStatusChange	RFC2496/ DS3-MIB	The value of an instance of dsx3LineStatus has changed. This trap can be used by an NMS to trigger polls. When the line status change results in a lower-level line status change (for example, a DS-1), no traps for the lower-level are sent.
risingAlarm	RFC2819/ RMON-MIB	The SNMP trap that is generated when an alarm entry crosses the rising threshold and the entry generates an event that is configured for sending SNMP traps.
fallingAlarm	RFC2819/ RMON-MIB	The SNMP trap that is generated when an alarm entry crosses the falling threshold and the entry generates an event that is configured for sending SNMP traps.

20.7.2 Variable Trap Bindings

Each SNMP trap contains variable bindings that are used to create the MIB tables. ONS 15454 traps and variable bindings are listed in Table 20-11. For each group (such as Group A), all traps within the group are associated with all of its variable bindings.

Table 20-11 Supported ONS 15454 SNMPv2 Trap Variable Bindings

Group	Trap Name(s) Associated with	Variable Binding Number	SNMPv2 Variable Bindings	Description
A	dsx1LineStatusChange (from RFC 2495)	(1)	dsx1LineStatus	This variable indicates the line status of the interface. It contains loopback, failure, received alarm and transmitted alarm information.
		(2)	dsx1LineStatusLastChange	The value of MIB II's sysUpTime object at the time this DS1 entered its current line status state. If the current state was entered prior to the last proxy-agent reinitialization, the value of this object is zero.
		(3)	cerent454NodeTime	The time that an event occurred.
		(4)	cerent454AlarmState	The alarm severity and service-affecting status. Severities are Minor, Major, and Critical. Service-affecting statuses are Service-Affecting and Non-Service Affecting.
		(5)	snmpTrapAddress	The address of the SNMP trap.
B	dsx3LineStatusChange (from RFC 2496)	(1)	dsx3LineStatus	This variable indicates the line status of the interface. It contains loopback state information and failure state information.
		(2)	dsx3LineStatusLastChange	The value of MIB II's sysUpTime object at the time this DS3/E3 entered its current line status state. If the current state was entered prior to the last reinitialization of the proxy-agent, then the value is zero.
		(3)	cerent454NodeTime	The time that an event occurred.

Table 20-11 Supported ONS 15454 SNMPv2 Trap Variable Bindings (continued)

Group	Trap Name(s) Associated with	Variable Binding Number	SNMPv2 Variable Bindings	Description
B (cont.)		(4)	cerent454AlarmState	The alarm severity and service-affecting status. Severities are Minor, Major, and Critical. Service-affecting statuses are Service-Affecting and Non-Service Affecting.
		(5)	snmpTrapAddress	The address of the SNMP trap.
C	coldStart (from RFC 1907)	(1)	cerent454NodeTime	The time that the event occurred.
	warmStart (from RFC 1907)	(2)	cerent454AlarmState	The alarm severity and service-affecting status. Severities are Minor, Major, and Critical. Service-affecting statuses are Service-Affecting and Non-Service Affecting.
	newRoot (from RFC)	(3)	snmpTrapAddress	The address of the SNMP trap.
	topologyChange (from RFC)		—	—
	entConfigChange (from RFC 2737)		—	—
	authenticationFailure (from RFC 1907)		—	—
D1	risingAlarm (from RFC 2819)	(1)	alarmIndex	This variable uniquely identifies each entry in the alarm table. When an alarm in the table clears, the alarm indexes change for each alarm listed.
		(2)	alarmVariable	The object identifier of the variable being sampled.
		(3)	alarmSampleType	The method of sampling the selected variable and calculating the value to be compared against the thresholds.
		(4)	alarmValue	The value of the statistic during the last sampling period.

Table 20-11 Supported ONS 15454 SNMPv2 Trap Variable Bindings (continued)

Group	Trap Name(s) Associated with	Variable Binding Number	SNMPv2 Variable Bindings	Description
D1 (cont.)		(5)	alarmRisingThreshold	When the current sampled value is greater than or equal to this threshold, and the value at the last sampling interval was less than this threshold, a single event is generated. A single event is also generated if the first sample after this entry is greater than or equal to this threshold.
		(6)	cerent454NodeTime	The time that an event occurred.
		(7)	cerent454AlarmState	The alarm severity and service-affecting status. Severities are Minor, Major, and Critical. Service-affecting statuses are Service-Affecting and Non-Service Affecting.
		(8)	snmpTrapAddress	The address of the SNMP trap.
D2	fallingAlarm (from RFC 2819)	(1)	alarmIndex	This variable uniquely identifies each entry in the alarm table. When an alarm in the table clears, the alarm indexes change for each alarm listed.
		(2)	alarmVariable	The object identifier of the variable being sampled.
		(3)	alarmSampleType	The method of sampling the selected variable and calculating the value to be compared against the thresholds.
		(4)	alarmValue	The value of the statistic during the last sampling period.
		(5)	alarmFallingThreshold	When the current sampled value is less than or equal to this threshold, and the value at the last sampling interval was greater than this threshold, a single event is generated. A single is also generated if the first sample after this entry is less than or equal to this threshold.
		(6)	cerent454NodeTime	The time that an event occurred.

Table 20-11 Supported ONS 15454 SNMPv2 Trap Variable Bindings (continued)

Group	Trap Name(s) Associated with	Variable Binding Number	SNMPv2 Variable Bindings	Description
D2 (cont.)		(7)	cerent454AlarmState	The alarm severity and service-affecting status. Severities are Minor, Major, and Critical. Service-affecting statuses are Service-Affecting and Non-Service Affecting.
		(8)	snmpTrapAddress	The address of the SNMP trap.
E	failureDetectedExternal ToTheNE (from CERENT-454-mib)	(1)	cerent454NodeTime	The time that an event occurred.
		(2)	cerent454AlarmState	The alarm severity and service-affecting status. Severities are Minor, Major, and Critical. Service-affecting statuses are Service-Affecting and Non-Service Affecting.
		(3)	cerent454AlarmObjectType	The entity that raised the alarm. The NMS should use this value to decide which table to poll for further information about the alarm.
		(4)	cerent454AlarmObjectIndex	Every alarm is raised by an object entry in a specific table. This variable is the index of objects in each table; if the alarm is interface-related, this is the index of the interface in the interface table.
		(5)	cerent454AlarmSlotNumber	The slot of the object that raised the alarm. If a slot is not relevant to the alarm, the slot number is zero.
		(6)	cerent454AlarmPortNumber	The port of the object that raised the alarm. If a port is not relevant to the alarm, the port number is zero.
		(7)	cerent454AlarmLineNumber	The object line that raised the alarm. If a line is not relevant to the alarm, the line number is zero.
		(8)	cerent454AlarmObjectName	The TL1-style user-visible name that uniquely identifies an object in the system.

Table 20-11 Supported ONS 15454 SNMPv2 Trap Variable Bindings (continued)

Group	Trap Name(s) Associated with	Variable Binding Number	SNMPv2 Variable Bindings	Description
E (cont.)		(9)	cerent454AlarmAdditionalInfo	Additional information for the alarm object. In the current version of the MIB, this object contains provisioned description for alarms that are external to the NE. If there is no additional information, the value is zero.
		(10)	snmpTrapAddress	The address of the SNMP trap.
F	performanceMonitor ThresholdCrossingAlert (from CERENT-454-mib)	(1)	cerent454NodeTime	The time that an event occurred.
		(2)	cerent454AlarmState	The alarm severity and service-affecting status. Severities are Minor, Major, and Critical. Service-affecting statuses are Service-Affecting and Non-Service Affecting.
		(3)	cerent454AlarmObjectType	The entity that raised the alarm. The NMS should use this value to decide which table to poll for further information about the alarm.
		(4)	cerent454AlarmObjectIndex	Every alarm is raised by an object entry in a specific table. This variable is the index of objects in each table; if the alarm is interface-related, this is the index of the interface in the interface table.
		(5)	cerent454AlarmSlotNumber	The slot of the object that raised the alarm. If a slot is not relevant to the alarm, the slot number is zero.
		(6)	cerent454AlarmPortNumber	The port of the object that raised the alarm. If a port is not relevant to the alarm, the port number is zero.
		(7)	cerent454AlarmLineNumber	The object line that raised the alarm. If a line is not relevant to the alarm, the line number is zero.
		(8)	cerent454AlarmObjectName	The TL1-style user-visible name that uniquely identifies an object in the system.
		(9)	cerent454ThresholdMonitorType	This object indicates the type of metric being monitored.

Table 20-11 Supported ONS 15454 SNMPv2 Trap Variable Bindings (continued)

Group	Trap Name(s) Associated with	Variable Binding Number	SNMPv2 Variable Bindings	Description
F (cont.)		(10)	cerent454ThresholdLocation	Indicates whether the event occurred at the near or far end.
		(11)	cerent454ThresholdPeriod	Indicates the sampling interval period.
		(12)	cerent454ThresholdSetValue	The value of this object is the threshold provisioned by the NMS.
		(13)	cerent454ThresholdCurrentValue	—
		(14)	cerent454ThresholdDetectType	—
		(15)	snmpTrapAddress	The address of the SNMP trap.
G	All other traps (from CERENT-454-MIB) not listed above	(1)	cerent454NodeTime	The time that an event occurred.
		(2)	cerent454AlarmState	The alarm severity and service-affecting status. Severities are Minor, Major, and Critical. Service-affecting statuses are Service-Affecting and Non-Service Affecting.
		(3)	cerent454AlarmObjectType	The entity that raised the alarm. The NMS should use this value to decide which table to poll for further information about the alarm.
		(4)	cerent454AlarmObjectIndex	Every alarm is raised by an object entry in a specific table. This variable is the index of objects in each table; if the alarm is interface-related, this is the index of the interface in the interface table.
		(5)	cerent454AlarmSlotNumber	The slot of the object that raised the alarm. If a slot is not relevant to the alarm, the slot number is zero.
		(6)	cerent454AlarmPortNumber	The port of the object that raised the alarm. If a port is not relevant to the alarm, the port number is zero.
		(7)	cerent454AlarmLineNumber	The object line that raised the alarm. If a line is not relevant to the alarm, the line number is zero.

Table 20-11 Supported ONS 15454 SNMPv2 Trap Variable Bindings (continued)

Group	Trap Name(s) Associated with	Variable Binding Number	SNMPv2 Variable Bindings	Description
G (cont.)		(8)	cerent454AlarmObjectName	The TL1-style user-visible name that uniquely identifies an object in the system.
		(9)	snmpTrapAddress	The address of the SNMP trap.

20.8 SNMPv1/v2 Community Names

Community names are used to group SNMP trap destinations. All ONS 15454 trap destinations can be provisioned as part of SNMP communities in CTC. When community names are assigned to traps, the ONS 15454 treats the request as valid if the community name matches one that is provisioned in CTC. In this case, all agent-managed MIB variables are accessible to that request. If the community name does not match the provisioned list, SNMP drops the request.

20.9 SNMP in Multishelf Management

When using the dense wavelength division multiplexing (DWDM) multishelf management feature to subtend shelves from a node controller shelf, SNMP for the subtended shelves must be specially provisioned. All shelves within a multishelf configuration share the node controller's ID and IP address. Thus, the only way to route SNMP messages to or from subtended shelves is by using proxy ARP.

The cerent454MultishelfEnabled object ID (OID) can be used to determine whether the node is single shelf or multishelf.

To view the OID, use the **snmpwalk** *node IP address* **ifDescr** SNMP command in global configuration mode. This command output displays the OID as

```
<interface_name>_x/y/z
```

where

x = Shelf number (for a multishelf node)

y = Card slot number

z = Card port number.

The following example shows how to obtain the OID using the **snmpwalk** *node IP address* **ifDescr** SNMP command.

```
Router(config)# snmpwalk 192.0.2.1 ifDescr
RFC1213-MIB::ifDescr.1 = STRING: "motfcc0"
RFC1213-MIB::ifDescr.6 = STRING: "pdcc0"
RFC1213-MIB::ifDescr.7 = STRING: "pdcc1"
RFC1213-MIB::ifDescr.8 = STRING: "pdcc2"
RFC1213-MIB::ifDescr.9 = STRING: "pdcc3"
RFC1213-MIB::ifDescr.10 = STRING: "pdcc4"
RFC1213-MIB::ifDescr.11 = STRING: "pdcc5"
RFC1213-MIB::ifDescr.12 = STRING: "pdcc6"
RFC1213-MIB::ifDescr.13 = STRING: "pdcc7"
RFC1213-MIB::ifDescr.14 = STRING: "pdcc8"
RFC1213-MIB::ifDescr.15 = STRING: "pdcc9"
RFC1213-MIB::ifDescr.16 = STRING: "pdcc10"
```

```
RFC1213-MIB::ifDescr.17 = STRING: "pdcc11"
RFC1213-MIB::ifDescr.18 = STRING: "pdcc12"
RFC1213-MIB::ifDescr.19 = STRING: "pdcc13"
RFC1213-MIB::ifDescr.20 = STRING: "pdcc14"
RFC1213-MIB::ifDescr.21 = STRING: "pdcc15"
RFC1213-MIB::ifDescr.22 = STRING: "pdcc16"
RFC1213-MIB::ifDescr.23 = STRING: "pdcc17"
RFC1213-MIB::ifDescr.24 = STRING: "pdcc18"
RFC1213-MIB::ifDescr.25 = STRING: "pdcc19"
RFC1213-MIB::ifDescr.26 = STRING: "pdcc20"
RFC1213-MIB::ifDescr.27 = STRING: "pdcc21"
RFC1213-MIB::ifDescr.28 = STRING: "pdcc22"
RFC1213-MIB::ifDescr.29 = STRING: "pdcc23"
RFC1213-MIB::ifDescr.30 = STRING: "pdcc24"
RFC1213-MIB::ifDescr.31 = STRING: "pdcc25"
RFC1213-MIB::ifDescr.32 = STRING: "pdcc26"
RFC1213-MIB::ifDescr.33 = STRING: "pdcc27"
RFC1213-MIB::ifDescr.34 = STRING: "pdcc28"
RFC1213-MIB::ifDescr.35 = STRING: "pdcc29"
RFC1213-MIB::ifDescr.36 = STRING: "pdcc30"
RFC1213-MIB::ifDescr.37 = STRING: "pdcc31"
RFC1213-MIB::ifDescr.38 = STRING: "pdcc32"
RFC1213-MIB::ifDescr.39 = STRING: "pdcc33"
RFC1213-MIB::ifDescr.40 = STRING: "pdcc34"
RFC1213-MIB::ifDescr.41 = STRING: "pdcc35"
RFC1213-MIB::ifDescr.42 = STRING: "pdcc36"
RFC1213-MIB::ifDescr.43 = STRING: "pdcc37"
RFC1213-MIB::ifDescr.44 = STRING: "pdcc38"
RFC1213-MIB::ifDescr.45 = STRING: "pdcc39"
RFC1213-MIB::ifDescr.46 = STRING: "pdcc40"
RFC1213-MIB::ifDescr.47 = STRING: "pdcc41"
RFC1213-MIB::ifDescr.48 = STRING: "pdcc42"
RFC1213-MIB::ifDescr.49 = STRING: "pdcc43"
RFC1213-MIB::ifDescr.50 = STRING: "pdcc44"
RFC1213-MIB::ifDescr.51 = STRING: "pdcc45"
RFC1213-MIB::ifDescr.52 = STRING: "pdcc46"
RFC1213-MIB::ifDescr.53 = STRING: "pdcc47"
RFC1213-MIB::ifDescr.54 = STRING: "pdcc48"
RFC1213-MIB::ifDescr.55 = STRING: "pdcc49"
RFC1213-MIB::ifDescr.56 = STRING: "pdcc50"
RFC1213-MIB::ifDescr.57 = STRING: "pdcc51"
RFC1213-MIB::ifDescr.58 = STRING: "pdcc52"
RFC1213-MIB::ifDescr.59 = STRING: "pdcc53"
RFC1213-MIB::ifDescr.60 = STRING: "pdcc54"
RFC1213-MIB::ifDescr.61 = STRING: "pdcc55"
RFC1213-MIB::ifDescr.62 = STRING: "pdcc56"
RFC1213-MIB::ifDescr.63 = STRING: "pdcc57"
RFC1213-MIB::ifDescr.64 = STRING: "pdcc58"
RFC1213-MIB::ifDescr.65 = STRING: "pdcc59"
RFC1213-MIB::ifDescr.66 = STRING: "pdcc60"
RFC1213-MIB::ifDescr.67 = STRING: "pdcc61"
RFC1213-MIB::ifDescr.68 = STRING: "pdcc62"
RFC1213-MIB::ifDescr.69 = STRING: "pdcc63"
RFC1213-MIB::ifDescr.70 = STRING: "pdcc64"
RFC1213-MIB::ifDescr.71 = STRING: "pdcc65"
RFC1213-MIB::ifDescr.72 = STRING: "pdcc66"
RFC1213-MIB::ifDescr.73 = STRING: "pdcc67"
RFC1213-MIB::ifDescr.74 = STRING: "pdcc68"
RFC1213-MIB::ifDescr.75 = STRING: "pdcc69"
RFC1213-MIB::ifDescr.76 = STRING: "pdcc70"
RFC1213-MIB::ifDescr.77 = STRING: "pdcc71"
RFC1213-MIB::ifDescr.78 = STRING: "pdcc72"
RFC1213-MIB::ifDescr.79 = STRING: "pdcc73"
RFC1213-MIB::ifDescr.80 = STRING: "pdcc74"
```

```
RFC1213-MIB::ifDescr.81 = STRING: "pdcc75"
RFC1213-MIB::ifDescr.82 = STRING: "pdcc76"
RFC1213-MIB::ifDescr.83 = STRING: "pdcc77"
RFC1213-MIB::ifDescr.84 = STRING: "pdcc78"
RFC1213-MIB::ifDescr.85 = STRING: "pdcc79"
RFC1213-MIB::ifDescr.86 = STRING: "pdcc80"
RFC1213-MIB::ifDescr.257 = STRING: "fog_1_36"
RFC1213-MIB::ifDescr.8194 = STRING: "TenGigabitEthernet2/1"
RFC1213-MIB::ifDescr.8195 = STRING: "TenGigabitEthernet2/2"
RFC1213-MIB::ifDescr.8196 = STRING: "TenGigabitEthernet2/3"
RFC1213-MIB::ifDescr.8197 = STRING: "TenGigabitEthernet2/4"
RFC1213-MIB::ifDescr.12290 = STRING: "dwdm-cli_2/3/1"
RFC1213-MIB::ifDescr.12291 = STRING: "dwdm-cli_2/3/2"
RFC1213-MIB::ifDescr.12292 = STRING: "dwdm-trk_2/3/3"
RFC1213-MIB::ifDescr.12293 = STRING: "dwdm-trk_2/3/4"
RFC1213-MIB::ifDescr.12294 = STRING: "TenGigabitEthernet3/1"
RFC1213-MIB::ifDescr.12295 = STRING: "TenGigabitEthernet3/2"
RFC1213-MIB::ifDescr.12296 = STRING: "TenGigabitEthernet3/3"
RFC1213-MIB::ifDescr.12297 = STRING: "TenGigabitEthernet3/4"
RFC1213-MIB::ifDescr.147458 = STRING: "GigabitEthernet36/1"
RFC1213-MIB::ifDescr.147459 = STRING: "GigabitEthernet36/2"
RFC1213-MIB::ifDescr.147502 = STRING: "TenGigabitEthernet36/45"
RFC1213-MIB::ifDescr.147503 = STRING: "TenGigabitEthernet36/46"
RFC1213-MIB::ifDescr.147504 = STRING: "TenGigabitEthernet36/47"
RFC1213-MIB::ifDescr.147505 = STRING: "TenGigabitEthernet36/48"
RFC1213-MIB::ifDescr.147554 = STRING: "ds1_36/1"
RFC1213-MIB::ifDescr.147555 = STRING: "ds1_36/2"
```

LAN-connected network elements (LNEs) can be set up as gateway network elements (GNEs) or as SOCKS proxies, depending upon network security requirements. If the GNE/ENE firewall feature is required, the LNE must be set up as a GNE. If the design does not require the firewall feature but does require all-IP networking, the LNE must be set up as a SOCKS proxy.

In a GNE/ENE firewall configuration, nonconnected network elements must be set up as end network elements (ENEs). With a SOCKS configuration, subtended nodes communicate with the proxy server by IP. For procedures to provision a node or shelf as a GNE, ENE or SOCKS proxy, refer to the *Cisco ONS 15454 DWDM Procedure Guide*.

20.10 SNMPv1/v2 Proxy Over Firewalls

SNMP and NMS applications have traditionally been unable to cross firewalls used for isolating security risks inside or from outside networks. CTC enables network operations centers (NOCs) to access performance monitoring data such as RMON statistics or autonomous messages across firewalls by using an SMP proxy element installed on a firewall.

The application-level proxy transports SNMP protocol data units (PDU) between the NMS and NEs, allowing requests and responses between the NMS and NEs and forwarding NE autonomous messages to the NMS. The proxy agent requires little provisioning at the NOC and no additional provisioning at the NEs.

The firewall proxy is intended for use in a gateway network element-end network element (GNE-ENE) topology with many NEs through a single NE gateway. Up to 64 SNMP requests (such as get, getnext, or getbulk) are supported at any time behind single or multiple firewalls. The proxy interoperates with common NMS such as HP OpenView.

For security reasons, the SNMP proxy feature must be enabled at all receiving and transmitting NEs to function. For instructions to do this, refer to the *Cisco ONS 15454 DWDM Procedure Guide*.

20.11 SNMPv3 Proxy Configuration

The GNE can act as a proxy for the ENEs and forward SNMP requests to other SNMP entities (ENEs) irrespective of the types of objects that are accessed. For this, you need to configure two sets of users, one between the GNE and NMS, and the other between the GNE and ENE. In addition to forwarding requests from the NMS to the ENE, the GNE also forwards responses and traps from the ENE to the NMS.

The proxy forwarder application is defined in RFC 3413. Each entry in the Proxy Forwarder Table consists of the following parameters:

- Proxy Type—Defines the type of message that may be forwarded based on the translation parameters defined by this entry. If the Proxy Type is read or write, the proxy entry is used for forwarding SNMP requests and their response between the NMS and the ENE. If the Proxy Type is trap, the entry is used for forwarding SNMP traps from the ENE to the NMS.
- Context Engine ID/Context Name—Specifies the ENE to which the incoming requests should be forwarded or the ENE whose traps should be forwarded to the NMS by the GNE.
- TargetParamsIn—Points to the Target Params Table that specifies the GNE user who proxies on behalf of an ENE user. When the proxy type is read or write, TargetParamsIn specifies the GNE user who receives requests from an NMS, and forwards requests to the ENE. When the proxy type is trap, TargetParamsIn specifies the GNE user who receives notifications from the ENE and forwards them to the NMS. TargetParamsIn and the contextEngineID or the contextName columns are used to determine the row in the Proxy Forwarder Table that could be used for forwarding the received message.
- Single Target Out—Refers to the Target Address Table. After you select a row in the Proxy Forwarder Table for forwarding, this object is used to get the target address and the target parameters that are used for forwarding the request. This object is used for requests with proxy types read or write, which only requires one target.
- Multiple Target Out (Tag)—Refers to a group of entries in the Target Address Table. Notifications are forwarded using this tag. The Multiple Target Out tag is only relevant when proxy type is Trap and is used to send notifications to one or more NMSs.

20.12 Remote Monitoring

The ONS 15454 incorporates RMON to allow network operators to monitor Ethernet card performance and events. The RMON thresholds are user-provisionable in CTC. Refer to the *Cisco ONS 15454 DWDM Procedure Guide* for instructions.

Note Typical RMON operations, other than threshold provisioning, are invisible to the CTC user.

ONS 15454 system RMON is based on the IETF-standard MIB RFC 2819 and includes the following five groups from the standard MIB: Ethernet Statistics, History Control, Ethernet History, Alarm, and Event.

20.12.1 64-Bit RMON Monitoring over DCC

The ONS 15454 DCC is implemented over the IP protocol, which is not compatible with Ethernet. The system builds Ethernet equipment History and Statistics tables using HDLC statistics that are gathered over the DCC (running point-topoint protocol, or PPP). RMON DCC monitoring (for both IP and Ethernet) monitors the health of remote DCC connections.

RMON DCC contains two MIBs for DCC interfaces. They are:

- cMediaIndependentTable—standard, rfc3273; the proprietary extension of the HC-RMON MIB used for reporting statistics
- cMediaIndependentHistoryTable—proprietary MIB used to support history

20.12.1.1 Row Creation in MediaIndependentTable

The SetRequest PDU for creating a row in the mediaIndependentTable should contain all the values required to activate a row in a single set operation along with an assignment of the status variable to createRequest (2). The SetRequest PDU for entry creation must have all the object IDs (OIDs) carrying an instance value of 0. That is, all the OIDs should be of the type OID.0.

In order to create a row, the SetRequest PDU should contain the following:

- mediaIndependentDataSource and its desired value
- mediaIndependentOwner and its desired value (The size of mediaIndependentOwner is limited to 32 characters.)
- mediaIndependentStatus with a value of createRequest (2)

The mediaIndependentTable creates a row if the SetRequest PDU is valid according to the above rules. When the row is created, the SNMP agent decides the value of mediaIndependentIndex. This value is not sequentially allotted or contiguously numbered. It changes when an Ethernet interface is added or deleted. The newly created row will have mediaIndependentTable value of valid (1). If the row already exists, or if the SetRequest PDU values are insufficient or do not make sense, the SNMP agent returns an error code.

Note mediaIndependentTable entries are not preserved if the SNMP agent is restarted.

The mediaIndependentTable deletes a row if the SetRequest PDU contains a mediaIndependentStatus with a value of invalid (4). The varbind's OID instance value identifies the row for deletion. You can recreate a deleted row in the table if desired.

20.12.1.2 Row Creation in cMediaIndependentHistoryControlTable

SNMP row creation and deletion for the cMediaIndependentHistoryControlTable follows the same processes as for the MediaIndependentTable; only the variables differ.

In order to create a row, the SetRequest PDU should contain the following:

- cMediaIndependentHistoryControlDataSource and its desired value
- cMediaIndependentHistoryControlOwner and its desired value
- cMediaIndependentHistoryControlStatus with a value of createRequest (2)

20.12.2 HC-RMON-MIB Support

For the ONS 15454, the implementation of the high-capacity remote monitoring information base (HC-RMON-MIB, or RFC 3273) enables 64-bit support of existing RMON tables. This support is provided with the etherStatsHighCapacityTable and the etherHistoryHighCapacityTable. An additional table, the mediaIndependentTable, and an additional object, hcRMONCapabilities, are also added for this support. All of these elements are accessible by any third-party SNMP client should have the ability to upload RFC 3273 SNMP MIB variables in the etherStatsHighCapacityTable, etherHistoryHighCapacityTable, or mediaIndependentTable.

20.12.3 Ethernet Statistics RMON Group

The Ethernet Statistics group contains the basic statistics monitored for each subnetwork in a single table called the etherStatsTable.

20.12.3.1 Row Creation in etherStatsTable

The SetRequest PDU for creating a row in this table should contain all the values needed to activate a row in a single set operation, and an assigned status variable to createRequest. The SetRequest PDU object ID (OID) entries must all carry an instance value, or type OID, of 0.

In order to create a row, the SetRequest PDU should contain the following:

- The etherStatsDataSource and its desired value
- The etherStatsOwner and its desired value (size of this value is limited to 32 characters)
- The etherStatsStatus with a value of createRequest (2)

The etherStatsTable creates a row if the SetRequest PDU is valid according to the above rules. When the row is created, the SNMP agent decides the value of etherStatsIndex. This value is not sequentially allotted or contiguously numbered. It changes when an Ethernet interface is added or deleted. The newly created row will have etherStatsStatus value of valid (1).

If the etherStatsTable row already exists, or if the SetRequest PDU values are insufficient or do not make sense, the SNMP agent returns an error code.

Note EtherStatsTable entries are not preserved if the SNMP agent is restarted.

20.12.3.2 Get Requests and GetNext Requests

Get requests and getNext requests for the etherStatsMulticastPkts and etherStatsBroadcastPkts columns return a value of zero because the variables are not supported by ONS 15454 Ethernet cards.

20.12.3.3 Row Deletion in etherStatsTable

To delete a row in the etherStatsTable, the SetRequest PDU should contain an etherStatsStatus “invalid” value (4). The OID marks the row for deletion. If required, a deleted row can be recreated.

20.12.3.4 64-Bit etherStatsHighCapacity Table

The Ethernet statistics group contains 64-bit statistics in the etherStatsHighCapacityTable, which provides 64-bit RMON support for the HC-RMON-MIB. The etherStatsHighCapacityTable is an extension of the etherStatsTable that adds 16 new columns for performance monitoring data in 64-bit format. There is a one-to-one relationship between the etherStatsTable and etherStatsHighCapacityTable when rows are created or deleted in either table.

20.12.4 History Control RMON Group

The History Control group defines sampling functions for one or more monitor interfaces in the historyControlTable. The values in this table, as specified in RFC 2819, are derived from the historyControlTable and etherHistoryTable.

20.12.4.1 History Control Table

The RMON is sampled at one of four possible intervals. Each interval or period contains specific history values (also called buckets). Table 20-12 lists the four sampling periods and corresponding buckets.

The historyControlTable maximum row size is determined by multiplying the number of ports on a card by the number of sampling periods. For example, a card that contains 24 ports when multiplied by periods allows 96 rows in the table. A card that contains 14 ports when multiplied by four periods allows 56 table rows.

Table 20-12 RMON History Control Periods and History Categories

Sampling Periods (historyControlValue Variable)	Total Values or Buckets (historyControl Variable)
15 minutes	32
24 hours	7
1 minute	60
60 minutes	24

20.12.4.2 Row Creation in historyControlTable

The SetRequest PDU must be able to activate a historyControlTable row in one single-set operation. In order to do this, the PDU must contain all needed values and have a status variable value of 2 (createRequest). All OIDs in the SetRequest PDU should be type OID.0 type for entry creation.

To create a SetRequest PDU for the historyControlTable, the following values are required:

- The historyControlDataSource and its desired value
- The historyControlBucketsRequested and it desired value
- The historyControlInterval and its desired value
- The historyControlOwner and its desired value
- The historyControlStatus with a value of createRequest (2)

The historyControlBucketsRequested OID value is ignored because the number of buckets allowed for each sampling period, based upon the historyControlInterval value, is already fixed. Table 20-12 lists these variables.

The historyControlInterval value cannot be changed from the four allowed choices. If you use another value, the SNMP agent selects the closest smaller time period from the set buckets. For example, if the set request specifies a 25-minute interval, this falls between the 15-minute (32 bucket) variable and the 60-minute (24 bucket) variable. The SNMP agent automatically selects the lower, closer value, which is 15 minutes, so it allows 32 buckets.

If the SetRequest PDU is valid, a historyControlTable row is created. If the row already exists, or if the SetRequest PDU values do not make sense or are insufficient, the SNMP agent does not create the row and returns an error code.

20.12.4.3 Get Requests and GetNext Requests

These PDUs are not restricted.

20.12.4.4 Row Deletion in historyControl Table

To delete a row from the table, the SetRequest PDU should contain a historyControlStatus value of 4 (invalid). A deleted row can be recreated.

20.12.5 Ethernet History RMON Group

The ONS 15454 implements the etherHistoryTable as defined in RFC 2819. The group is created within the bounds of the historyControlTable and does not deviate from the RFC in its design.

20.12.5.1 64-Bit etherHistoryHighCapacityTable

64-bit Ethernet history for the HC-RMON-MIB is implemented in the etherHistoryHighCapacityTable, which is an extension of the etherHistoryTable. The etherHistoryHighCapacityTable adds four columns for 64-bit performance monitoring data. These two tables have a one-to-one relationship. Adding or deleting a row in one table will also change the other.

20.12.6 Alarm RMON Group

The Alarm group consists of the alarmTable, which periodically compares sampled values with configured thresholds and raises an event if a threshold is crossed. This group requires the implementation of the event group, which follows this section.

20.12.6.1 Alarm Table

The NMS uses the alarmTable to determine and provision network performance alarmable thresholds.

20.12.6.2 Row Creation in alarmTable

To create a row in the alarmTable, the SetRequest PDU must be able to create the row in one single-set operation. All OIDs in the SetRequest PDU should be type OID.0 type for entry creation. The table has a maximum number of 256 rows.

To create a SetRequest PDU for the alarmTable, the following values are required:

- The alarmInterval and its desired value
- The alarmVariable and its desired value
- The alarmSampleType and its desired value
- The alarmStartupAlarm and its desired value
- The alarmOwner and its desired value
- The alarmStatus with a value of createRequest (2)

If the SetRequest PDU is valid, a historyControlTable row is created. If the row already exists, or if the SetRequest PDU values do not make sense or are insufficient, the SNMP agent does not create the row and returns an error code.

In addition to the required values, the following restrictions must be met in the SetRequest PDU:

- The alarmOwner is a string of length 32 characters.
- The alarmRisingEventIndex always takes value 1.
- The alarmFallingEventIndex always takes value 2.
- The alarmStatus has only two values supported in SETs: createRequest (2) and invalid (4).
- The AlarmVariable is of the type OID.ifIndex, where ifIndex gives the interface this alarm is created on and OID is one of the OIDs supported in Table 20-13.

Table 20-13 OIDs Supported in the AlarmTable

No.	Column Name	OID	Status
1	ifInOctets	{1.3.6.1.2.1.2.2.1.10}	—
2	IfInUcastPkts	{1.3.6.1.2.1.2.2.1.11}	—
3	ifInMulticastPkts	{1.3.6.1.2.1.31.1.1.1.2}	Unsupported in E100/E1000
4	ifInBroadcastPkts	{1.3.6.1.2.1.31.1.1.1.3}	Unsupported in E100/E1000
5	ifInDiscards	{1.3.6.1.2.1.2.2.1.13}	Unsupported in E100/E1000
6	ifInErrors	{1.3.6.1.2.1.2.2.1.14}	—
7	ifOutOctets	{1.3.6.1.2.1.2.2.1.16}	—
8	ifOutUcastPkts	{1.3.6.1.2.1.2.2.1.17}	—
9	ifOutMulticastPkts	{1.3.6.1.2.1.31.1.1.1.4}	Unsupported in E100/E1000
10	ifOutBroadcastPkts	{1.3.6.1.2.1.31.1.1.1.5}	Unsupported in E100/E1000
11	ifOutDiscards	{1.3.6.1.2.1.2.2.1.19}	Unsupported in E100/E1000
12	Dot3StatsAlignmentErrors	{1.3.6.1.2.1.10.7.2.1.2}	—
13	Dot3StatsFCSErrors	{1.3.6.1.2.1.10.7.2.1.3}	—
14	Dot3StatsSingleCollisionFrames	{1.3.6.1.2.1.10.7.2.1.4}	—
15	Dot3StatsMultipleCollisionFrames	{1.3.6.1.2.1.10.7.2.1.5}	—
16	Dot3StatsDeferredTransmissions	{1.3.6.1.2.1.10.7.2.1.7}	—
17	Dot3StatsLateCollisions	{1.3.6.1.2.1.10.7.2.1.8}	—
18	Dot3StatsExcessiveCollisions	{13.6.1.2.1.10.7.2.1.9}	—
19	Dot3StatsFrameTooLong	{1.3.6.1.2.1.10.7.2.1.13}	—
20	Dot3StatsCarrierSenseErrors	{1.3.6.1.2.1.10.7.2.1.11}	Unsupported in E100/E1000

Table 20-13 OIDs Supported in the AlarmTable (continued)

No.	Column Name	OID	Status
21	Dot3StatsSQETestErrors	{1.3.6.1.2.1.10.7.2.1.6}	Unsupported in E100/E1000
22	etherStatsUndersizePkts	{1.3.6.1.2.1.16.1.1.1.9}	—
23	etherStatsFragments	{1.3.6.1.2.1.16.1.1.1.11}	—
24	etherStatsPkts64Octets	{1.3.6.1.2.1.16.1.1.1.14}	—
25	etherStatsPkts65to127Octets	{1.3.6.1.2.1.16.1.1.1.15}	—
26	etherStatsPkts128to255Octets	{1.3.6.1.2.1.16.1.1.1.16}	—
27	etherStatsPkts256to511Octets	{1.3.6.1.2.1.16.1.1.1.17}	—
28	etherStatsPkts512to1023Octets	{1.3.6.1.2.1.16.1.1.1.18}	—
29	etherStatsPkts1024to1518Octets	{1.3.6.1.2.1.16.1.1.1.19}	—
30	EtherStatsBroadcastPkts	{1.3.6.1.2.1.16.1.1.1.6}	—
31	EtherStatsMulticastPkts	{1.3.6.1.2.1.16.1.1.1.7}	—
32	EtherStatsOversizePkts	{1.3.6.1.2.1.16.1.1.1.10}	—
33	EtherStatsJabbers	{1.3.6.1.2.1.16.1.1.1.12}	—
34	EtherStatsOctets	{1.3.6.1.2.1.16.1.1.1.4}	—
35	EtherStatsCollisions	{1.3.6.1.2.1.16.1.1.1.13}	—
36	EtherStatsCollisions	{1.3.6.1.2.1.16.1.1.1.8}	—
37	EtherStatsDropEvents	{1.3.6.1.2.1.16.1.1.1.3}	Unsupported in E100/E1000 and G1000

20.12.6.3 Get Requests and GetNext Requests

These PDUs are not restricted.

20.12.6.4 Row Deletion in alarmTable

To delete a row from the table, the SetRequest PDU should contain an alarmStatus value of 4 (invalid). A deleted row can be recreated. Entries in this table are preserved if the SNMP agent is restarted.

20.12.7 Event RMON Group

The Event group controls event generation and notification. It consists of two tables: the eventTable, which is a read-only list of events to be generated, and the logTable, which is a writable set of data describing a logged event. The ONS 15454 implements the logTable as specified in RFC 2819.

20.12.7.1 Event Table

The eventTable is read-only and unprovisionable. The table contains one row for rising alarms and another for falling ones. This table has the following restrictions:

- The eventType is always log-and-trap (4).

- The eventCommunity value is always a zero-length string, indicating that this event causes the trap to be despatched to all provisioned destinations.
- The eventOwner column value is always “monitor.”
- The eventStatus column value is always valid(1).

20.12.7.2 Log Table

The logTable is implemented exactly as specified in RFC 2819. The logTable is based upon data that is locally cached in a controller card. If there is a controller card protection switch, the existing logTable is cleared and a new one is started on the newly active controller card. The table contains as many rows as provided by the alarm controller.

APPENDIX A

Hardware Specifications

This appendix contains hardware and software specifications for the ONS 15454 ANSI and ETSI shelf assemblies and cards.

Note Unless otherwise specified, "ONS 15454" refers to both ANSI and ETSI shelf assemblies.

The following sections are included:

- A.1 ONS 15454, ONS 15454 M2, and ONS 15454 M6 Shelf Specifications, page A-1
- A.2 General Card Specifications, page A-2
- A.3 Common Control Card Specifications, page A-4
- A.4 Optical Service Channel Cards, page A-11
- A.5 Optical Amplifier Cards, page A-13
- A.6 PSM (Protection Switching Module) Card Specifications, page A-19
- A.7 Multiplexer and Demultiplexer Cards, page A-20
- A.8 Reconfigurable Optical Add/Drop Cards, page A-22
- A.9 Optical Add/Drop Cards, page A-44
- A.10 Transponder and Muxponder Card Specifications, page A-54
- A.11 TDC-CC and TDC-FC Card Specifications, page A-99
- A.12 Mesh Patch Panel Specifications, page A-100
- A.13 SFP and XFP Specifications, page A-102
- A.14 Patch Panel Specifications, page A-102

A.1 ONS 15454, ONS 15454 M2, and ONS 15454 M6 Shelf Specifications

For information on shelf bandwidth; list of topologies; Cisco Transport Controller (CTC) specifications; the LAN, Transaction Language One (TL1), modem, and alarm specifications; timing, power, and environmental specifications; and shelf dimensions, refer to *Appendix A, Hardware Specifications*" in the "*Cisco ONS 15454 Hardware Installation Guide*".

A.2 General Card Specifications

This section provides power specifications and temperature ranges for all ONS 15454 cards.

A.2.1 Power

Table A-1 provides power consumption information for the ONS 15454 cards.

Table A-1 Individual Card Power Requirements (Typical Values at 25 degrees C)

Card Type	Card Name	(Power in Watts)	Amperes at –48 V	BTU/Hr.
Common Control Cards	TCC2/TCC2P/TCC3	26	0.54	89
	TNC	45	0.94	153
	TSC	38	0.79	129
	AIC-I	8	0.17	28
	AEP	3	(from +5 VDC from AIC-I)	10
	MIC-A/P	0.13	via TCC2/TCC2P/TCC3	0.44
	MIC-C/T/P	0.38	via TCC2/TCC2P/TCC3	1.29
	MS-ISC-100T	53	1.10	181.0
Optical Service Channel Cards	OSCM	23	0.48	79
	OSC-CSM	24	0.5	82
Optical Amplifier Cards	OPT-PRE	30	0.63	103
	OPT-BST	30	0.63	103
	OPT-BST-E	30	0.63	103
	OPT-BST-L	25	0.52	86
	OPT-AMP-L	32	0.67	110
	OPT-AMP-17-C	40	0.83	137
	OPT-AMP-C	40	0.83	137
	OPT-RAMP-C	50	1.04	171
	OPT-RAMP-CE	40	0.83	137
PSM Card	PSM	20	0.41	69
Multiplexer and Demultiplexer Cards	32MUX-O	16	0.33	55
	32DMX-O	16	0.33	55
	4MD-xx.x	17	0.35	58.0

Table A-1 Individual Card Power Requirements (continued)(Typical Values at 25 degrees C)

Card Type	Card Name	(Power in Watts)	Amperes at –48 V	BTU/Hr.
ROADM Cards	32DMX	15	0.31	52
	32DMX-L	15	0.31	52
	32WSS	50	1.04	171
	32WSS-L	43	0.90	147
	40-MUX-C	35	0.73	120
	40-DMX-C	35	0.73	120
	40-DMX-CE	35	0.73	120
	40-WSS-C	73	1.53	250
	40-WSS-CE	73	1.53	250
	40-WXC-C	30	0.63	103
	80-WXC-C	20	0.42	69
	40-SMR1-C	35	0.73	120
	40-SMR2-C	40	0.83	137
	MMU	7	0.15	24
Optical Add/Drop Cards	AD-1C-xx.x	17	0.35	58.0
	AD-2C-xx.x	17	0.35	58.0
	AD-4C-xx.x	17	0.35	58.0
	AD-1B-xx.x	17	0.35	58.0
	AD-4B-xx.x	17	0.35	58.0
Transponder and Muxponder Cards	TXP_MR_10G	35	0.73	120
	TXP_MR_10E	50	1.05	171
	TXP_MR_10E_C	50	1.05	171
	TXP_MR_10E_L	50	1.05	171
	TXP_MR_10EX_C	42	0.88	144
	TXP_MR_2.5G	35	0.73	120
	TXPP_MR_2.5G	50	1.05	171
	MXP_2.5G_10G	50	1.05	171
	MXP_2.5G_10E	50	1.05	171
	MXP_2.5G_10E_C	50	1.05	171
	MXP_2.5G_10E_L	50	1.05	171
	MXP_2.5G_10EX_C	50	1.05	171
	MXP_MR_2.5G	50	1.05	171
	MXPP_MR_2.5G	50	1.05	171

Table A-1 Individual Card Power Requirements (continued)(Typical Values at 25 degrees C)

Card Type	Card Name	(Power in Watts)	Amperes at –48 V	BTU/Hr.
Transponder and Muxponder Cards	MXP_MR_10DME_C	60	1.25	205
	MXP_MR_10DME_L	60	1.25	205
	MXP_MR_10DMEX_C	60	1.25	205
	40G-MXP-C	112	2.34	383
	ADM-10G	135	2.81	461
	OTU2_XP	71	1.48	243
TDCU Cards	TDC-CC	8	0.17	28
	TDC-FC	8	0.17	28

A.2.2 Temperature

- Operating temperature:
  - Long term: 0 to 40 degrees Celsius (32 to 104 degrees Fahrenheit)
  - Short term: Functionality is guaranteed at -5 to 55 degrees Celsius (23 to 131 degrees Fahrenheit), according to GR-63 Issue 3

The indicated temperatures are the ambient ones in which the shelf can be placed.

A.3 Common Control Card Specifications

This section provides specifications for the TCC2, TCC2P, TCC3, TNC, TSC, AIC, and AIC-I cards, the alarm expansion panel (AEP), the MIC-A/P and MIC-C/T/P FMECs, and the MS-ISC-100T card.

For compliance information, refer to the *Cisco Optical Transport Products Safety and Compliance Information* document.

A.3.1 TCC2 Card Specifications

The TCC2 card has the following specifications:

- CTC software
  - Interface: EIA/TIA-232 (local craft access, on TCC2 faceplate)
  - Interface: 10BaseT LAN (on TCC2 faceplate)
  - Interface: 10BaseT LAN (through the backplane)
- Synchronization
  - Stratum 3, per Telcordia GR-253-CORE
  - Free running access: Accuracy +/– 4.6 ppm
  - Holdover stability: 3.7 x 10^{-7} per day including temperature (< 255 slips in first 24 hours)
  - Reference: External BITS, line, internal

- Supply voltage monitoring
  - Both supply voltage inputs are monitored.
  - Normal operation: –40.5 to –56.7 V
  - Undervoltage: Major alarm
  - Overvoltage: Major alarm
- Dimensions
  - Height: 12.650 in. (321.3 mm)
  - Width: 0.921 in. (23.4 mm) (The dimension of the finger gasket is not included)
  - Depth: 9.000 in. (228.6 mm)
  - Depth with backplane connector: 235 mm (9.250 in.)
  - Weight not including clam shell: 0.7 kg (1.5 lb)

A.3.2 TCC2P Card Specifications

The TCC2P card has the following specifications:

- CTC software
  - Interface: EIA/TIA-232 (local craft access, on TCC2P faceplate)
  - Interface: 10BaseT LAN (on TCC2P faceplate)
  - Interface: 10BaseT LAN (through the backplane)
- Synchronization
  - Stratum 3, per Telcordia GR-253-CORE
  - Free running access: Accuracy +/– 4.6 ppm
  - Holdover stability: 3.7 * 10 exp – 7 per day including temperature (< 255 slips in first 24 hours)
  - Reference: External BITS, line, internal
- Supply voltage monitoring
  - Both supply voltage inputs are monitored.
  - Normal operation: –40.5 to –56.7 V (in –48 VDC systems)
  - Undervoltage: Major alarm
  - Overvoltage: Major alarm
- Dimensions
  - Height: 12.650 in. (321.3 mm)
  - Width: 0.921 in. (23.4 mm) (The dimension of the finger gasket is not included)
  - Depth: 9.000 in. (228.6 mm)
  - Depth with backplane connector: 9.250 in. (235 mm)
  - Weight not including clam shell: 1.5 lb (0.7 kg)

A.3.3 TCC3 Card Specifications

The TCC3 card has the following specifications:

- CTC software
  - Interface: EIA/TIA-232 (local craft access, on TCC3 faceplate)
  - Interface: 10BaseT LAN (on TCC3 faceplate)
  - Interface: 10BaseT LAN (through the backplane)
- Synchronization
  - Stratum 3, per Telcordia GR-253-CORE
  - Free running access: Accuracy +/– 4.6 ppm
  - Holdover stability: 3.7 * 10 exp – 7 per day including temperature (< 255 slips in first 24 hours)
  - Reference: External BITS, line, internal
- Supply voltage monitoring
  - Both supply voltage inputs are monitored.
  - Normal operation: –40.5 to –56.7 V (in –48 VDC systems)
  - Undervoltage: Major alarm
  - Overvoltage: Major alarm
- Dimensions
  - Height: 12.650 in. (321.3 mm)
  - Width: 0.921 in. (23.4 mm) (The dimension of the finger gasket is not included)
  - Depth: 9.000 in. (228.6 mm)
  - Depth with backplane connector: 9.250 in. (235 mm)
  - Weight not including clam shell: 1.5 lb (0.7 kg)

A.3.4 TNC Card Specifications (Cisco ONS 15454 M2 and Cisco ONS 15454 M6)

The TNC card has the following specifications:

- CTC software
  - Interface: EIA/TIA-232 (local craft access, on TNC faceplate)
  - Interface: 10BaseT LAN (on TNC faceplate)
  - Interface: 10BaseT LAN (through the external connection unit for EMS, CT, MSM, VoIP, UDC and Line Cards)
  - Two SFP interfaces to support Optical Service Channels (OC-3/STM-1 or FE/GE)
- Synchronization
  - Stratum 3, per Telcordia GR-253-CORE
  - Free running access: Accuracy +/– 4.6 ppm
  - Holdover stability: 3.7 * 10 exp – 7 per day including temperature (< 255 slips in first 24 hours)
  - Reference: External BITS, line, internal

- Supply voltage monitoring
  - Both the input supply voltages are monitored.
  - Normal operation: –40.5 to –56.7 V (in –48 VDC systems)
  - AC input voltage range: Undervoltage TH 90V histeresis 5V; Overvoltage TH 254V histeresis 10V
  - Undervoltage: Major alarm
  - Overvoltage: Major alarm
- Dimensions
  - Height: 12.650 in. (321.3 mm)
  - Width: 0.921 in. (23.4 mm) (The dimension of the finger gasket is not included)
  - Depth: 9.000 in. (228.6 mm)
  - Depth with backplane connector: 9.250 in. (235 mm)
  - Weight not including clam shell: 1.6 lb (0.8 kg)

A.3.5 TSC Card Specifications (ONS 15454 M2 and ONS 15454 M6)

The TSC card has the following specifications:

- CTC software
  - Interface: EIA/TIA-232 (local craft access, on TSC faceplate)
  - Interface: 10BaseT LAN (on TSC faceplate)
  - Interface: 10BaseT LAN (through the external connection unit for EMS, CT, MSM, VoIP, UDC and Line Cards)
- Synchronization
  - Stratum 3, per Telcordia GR-253-CORE
  - Free running access: Accuracy +/– 4.6 ppm
  - Holdover stability: 3.7 * 10 exp – 7 per day including temperature (< 255 slips in first 24 hours)
  - Reference: External BITS, line, internal
- Supply voltage monitoring
  - Both the input supply voltages are monitored.
  - Normal operation: –40.5 to –56.7 V (in –48 VDC systems)
  - AC input voltage range: Undervoltage TH 90V histeresis 5V; Overvoltage TH 254V histeresis 10V
  - Undervoltage: Major alarm
  - Overvoltage: Major alarm
- Dimensions
  - Height: 12.650 in. (321.3 mm)
  - Width: 0.921 in. (23.4 mm) (The dimension of the finger gasket is not included)
  - Depth: 9.000 in. (228.6 mm)
  - Depth with backplane connector: 9.250 in. (235 mm)

  - Weight not including clam shell: 1.6 lb (0.8 kg)

A.3.6 AIC-I Card Specifications

The AIC-I card has the following specifications:

- Alarm inputs
  - Number of inputs: 12 without AEP, 32 with AEP
  - Opto-coupler isolated
  - Label customer provisionable
  - Severity customer provisionable
  - Common 32 V output for all alarm inputs
  - Each input limited to 2 mA
  - Termination: Wire-wrap on backplane without AEP, on AEP connectors with AEP
- Alarm outputs
  - Number of outputs: 4 (user configurable as inputs) without AEP, 16 with AEP
  - Switched by opto MOS (metal oxide semiconductor)
  - Triggered by definable alarm condition
  - Maximum allowed open circuit voltage: 60 VDC
  - Maximum allowed closed circuit current: 100 mA
  - Termination: Wire-wrap on backplane without AEP, on AEP connectors with AEP
- Express orderwire/local orderwire (EOW/LOW)
  - ITU-T G.711, ITU-T G.712, Telcordia GR-253-CORE
  - A-law, mu-law

    Note Due to the nature of mixed coding, in a mixed-mode (A-law/mu-law) configuration, the orderwire is not ITU-T G.712 compliant.

  - Orderwire party line
  - Dual tone, multifrequency (DTMF) signaling
- User data channel (UDC)
  - Bit rate: 64 kbps, codirectional
  - ITU-T G.703
  - Input/output impedance: 120 ohm
  - Termination: RJ-11 connectors
- Data communications channel (DCC)
  - Bit rate: 576 kbps
  - EIA/TIA-485/V11
  - Input/output impedance: 120 ohm
  - Termination: RJ-45 connectors

- ACC connection for additional alarm interfaces
  - Connection to AEP
- Power monitoring alarming states:
  - Power failure (0 to –38 VDC)
  - Undervoltage (–38 to –40.5 VDC)
  - Overvoltage (beyond –56.7 VDC)
- Dimensions
  - Height: 12.650 in. (321.3 mm)
  - Width: 0.921 in. (23.4 mm) (The dimension of the finger gasket is not included)
  - Depth: 9.000 in. (228.6 mm)
  - Weight: 1.8 lb (0.82 kg)

A.3.7 AEP Specifications (ANSI only)

The AEP has the following specifications:

- Alarm inputs
  - Number of inputs: 32
  - Optocoupler isolated
  - Label customer provisionable
  - Severity customer provisionable
  - Common 32 V output for all alarm inputs
  - Each input limited to 2 mA
  - Termination: 50-pin AMP champ connector
- Alarm outputs
  - Number of outputs: 16
  - Switched by opto MOS
  - Triggered by definable alarm condition
  - Maximum allowed open circuit voltage: 60 VDC
  - Maximum allowed closed circuit current: 100 mA
  - Termination: 50-pin AMP champ connector
- Environmental
  - Overvoltage protection: as in ITU-T G.703 Annex B
- Dimensions of AEP board
  - Height: 20 mm (0.79 in.)
  - Width: 330 mm (13.0 in.)
  - Depth: 89 mm (3.5 in.)
  - Weight: 0.18 kg (0.4 lb)

A.3.8 MIC-A/P FMEC Specifications (ETSI only)

The MIC-A/P FMEC card has the following specifications:

- Power supply input BATTERY B
  - System supply voltage: Nominal –48 VDC
    Tolerance limits: –40.5 to –57.0 VDC
  - Connector: 3WK3 Combo-D power cable connector
- Alarm outputs
  - Voltage (open contact): Maximum 60 VDC
  - Current (closed contact): Maximum 250 mA
  - Connector: 62-pin DB connector (common for inputs/outputs)
- Alarm inputs
  - Voltage (open contact): Maximum 60 VDC
  - Current (closed contact): Maximum 2 mA
  - Connector: 62-pin DB connector (common for inputs/outputs)
- Dimensions
  - Height: 182 mm (7.165 in.)
  - Width: 31.88 mm (1.255 in.)
  - Depth: 92 mm (3.62 in.)
  - Depth with backplane connector: 98 mm (3.87 in.)
  - Weight not including clam shell: 0.2 kg (0.5 lb)

A.3.9 MIC-C/T/P FMEC Specifications (ETSI only)

The MIC-C/T/P FMEC card has the following specifications:

- Power supply input BATTERY A
  - System supply voltage: Nominal –48 VDC
    Tolerance limits: –40.5 to –57.0 VDC
  - Connector: 3WK3 Combo-D power cable connector
- Timing connector
  - Frequency: 2.048 MHz +/–10 ppm
  - Signal level: 0.75 to 1.5 V
  - Impedance: 75 ohms +/–5 percent (switchable by jumper to high impedance > 3 kohms)

    Note 120 ohms balanced impedance is possible with external matching cable.

  - Cable attenuation: Up to 6 dB at 2 MHz
  - Connectors: 1.0/2.3 miniature coax connector
- System management serial port:

  - System management serial port craft interface
  - Modem port (for future use)
  - Connectors: 8-pin RJ-45
- System management LAN port connectors:
  - Signal: IEEE 802.3 10BaseT
  - Connectors: 8-pin RJ-45
- Dimensions
  - Height: 182 mm (7.165 in.)
  - Width: 31.88 mm (1.255 in.)
  - Depth: 92 mm (3.62 in.)
  - Depth with backplane connector: 98 mm (3.87 in.)
  - Weight not including clam shell: 0.2 kg (0.5 lb)

A.3.10 MS-ISC-100T Card Specifications

The MS-ISC-100T card has the following specifications:

- Dimensions
  - Height: 12.650 in. (321.3 mm)
  - Width: 0.921 in. (23.4 mm) (The dimension of the finger gasket is not included)
  - Depth: 9.000 in. (228.6 mm)
  - Depth with backplane connector: 9.250 in. (235 mm)
  - Weight not including clam shell: 2.3 lb (1.0 kg)

A.4 Optical Service Channel Cards

This section provides specifications for the OSCM and OSC-CSM cards.

A.4.1 OSCM Card Specifications

The OSCM card has the following specifications:

- Line
  - Bit rate: 155 Mbps
  - Code: Scrambled non-return to zero (NRZ)
  - Loopback modes: None
  - Connector: Duplex LC
- Transmitter optical service channel (OSC) signal
  - Maximum transmitter output power: –1 dBm
  - Minimum transmitter output power: –5 dBm

  - Nominal wavelength: 1510-nm +/–10 nm
  - Variable optical attenuator (VOA) necessary in the transmit path to adjust the in-fiber optical power level
- Receiver OSC signal
  - Maximum receiver level: –8 dBm at 10^{-10} bit error rate (BER)
  - Minimum receiver level: –40 dBm at 10^{-10} BER
  - Span budget: 40-dB span budget (about 150 km assuming fiber path loss equals 0.25 dB/km)
  - Jitter tolerance: Telcordia GR-253/G.823 compliant
- Dimensions
  - Height: 12.65 in. (321.3 mm)
  - Width: 0.921 in. (23.4 mm) (The dimension of the finger gasket is not included)
  - Depth: 9.00 in. (228.6 mm)

A.4.2 OSC-CSM Card Specifications

The OSC-CSM card has the following specifications:

- Line
  - Bit rate: 155 Mbps
  - Code: Scrambled NRZ
  - Loopback modes: None
  - Connector: Duplex LC
- Transmitter OSC signal
  - Maximum transmitter output power: –2 dBm
  - Minimum transmitter output power: –24 dBm
  - Nominal wavelength: 1510-nm +/–10 nm
  - VOA is necessary in the transmit path to adjust the in-fiber optical power level
- Receiver OSC signal
  - Maximum receiver level: –8 dBm at 10^{-10} BER
  - Minimum receiver level: –40 dBm at 10^{-10} BER
  - Span loss budget: 35-dB span budget (approximately 140 km assuming that the fiber path loss is equal to 0.25 dB/km)
  - Jitter tolerance: Telcordia GR-253/G.823 compliant
- Dimensions
  - Height: 12.65 in. (321.3 mm)
  - Width: 0.921 in. (23.4 mm) (The dimension of the finger gasket is not included)
  - Depth: 9.00 in. (228.6 mm)

A.5 Optical Amplifier Cards

This section provides specifications for the OPT-PRE amplifier, OPT-BST amplifier, OPT-BST-E amplifier, OPT-BST-L amplifier, OPT-AMP-L preamplifier (configurable as a preamplifier or booster amplifier), OPT-AMP-C amplifier (configurable as a preamplifier or booster amplifier), OPT-AMP-17-C, and OPT-RAMP-C amplifier cards.

A.5.1 OPT-PRE Amplifier Card Specifications

The OPT-PRE amplifier card has the following specifications:

- Optical characteristics:
  - Total operating wavelength range: 1530 to 1561.3 nm
  - Gain ripple (peak to valley): 1.5 dB
  - Mid-access loss (MAL) range (for dispersion compensation unit [DCU]): 3 to 9 dB
  - Gain range: 5 to 38.5 dBm in constant power mode, 5 to 28 dBm in constant gain mode
  - Minimum gain (standard range): 5.0 dBm
  - Maximum gain (standard range with programmable gain tilt): 21 dBm
  - Maximum gain (extended range with uncontrolled gain tilt): 38.5 dBm
  - Gain and power regulation over/undershoot: 0.5 dB
  - Limited maximum output power: 17.5 dBm
  - Maximum output power (with full channel load): 17 dB
  - Minimum output power (with one channel): –2 dBm
  - Input power (Pin) range at full channel load: –21.5 to 12 dBm
  - Input power (Pin) range at single channel load: –39.5 to –6 dBm
  - Noise figure at G^3 21 dB = 6.5 dB
  - OSC filter drop (channels) insertion loss maximum: 1 dB
  - OSC filter drop (OSC) insertion loss maximum: 1.8 dB
  - OSC filter add (OSC) insertion loss maximum: 1.3 dB
  - Optical connectors: LC-UPC/2
- Dimensions
  - Height: 12.65 in. (332 mm)
  - Width: 0.921 in. (23.4 mm) (The dimension of the finger gasket is not included)
  - Depth: 9.00 in. (240 mm)

A.5.2 OPT-BST Amplifier Card Specifications

The OPT-BST amplifier card has the following specifications:

- Optical characteristics:
  - Total operating wavelength range: 1530 to 1561.3 nm

  - Gain ripple (peak to valley): 1.5 dB
  - Gain range: 5 to 20 dBm with programmable gain tilt
  - Gain and power regulation over/undershoot: 0.5 dB
  - Limited maximum output power: 17.5 dBm
  - Maximum output power (with full channel load): 17 dB
  - Minimum output power (with one channel): –2 dBm
  - Input power (Pin) range at full channel load: –3 to 12 dBm
  - Input power (Pin) range at single channel load: –21 to –6 dBm
  - Noise figure at G^3 20 dB = 6 dB
  - OSC filter drop (channels) insertion loss maximum: 1 dB
  - OSC filter drop (OSC) insertion loss maximum: 1.8 dB
  - OSC filter add (OSC) insertion loss maximum: 1.3 dB
  - Optical connectors: LC-UPC/2
- Dimensions
  - Height: 12.65 in. (332 mm)
  - Width: 0.921 in. (23.4 mm) (The dimension of the finger gasket is not included)
  - Depth: 9.00 in. (240 mm)

A.5.3 OPT-BST-E Amplifier Card Specifications

The OPT-BST-E amplifier card has the following specifications:

- Optical characteristics:
  - Total operating wavelength range: 1530 to 1561.3 nm
  - Gain ripple (peak to valley): 1.8 dB
  - Gain range: 8 to 23 dB with programmable gain tilt
  - Extended gain range: 23 to 26 dB with gain tilt uncontrolled
  - Gain and power regulation over/undershoot: 0.5 dB
  - Limited maximum output power: 20.5 dBm
  - Maximum output power (with full channel load): 20 dB
  - Minimum output power (with one channel): –0 dBm
  - Input power (Pin) range at full channel load: –6 to 12 dBm
  - Input power (Pin) range at single channel load: –26 to –8 dBm
  - Noise figure at G^3 23 dB = 6 dB
  - OSC filter drop (channels) insertion loss maximum: 1 dB
  - OSC filter drop (OSC) insertion loss maximum: 1.8 dB
  - OSC filter add (OSC) insertion loss maximum: 1.3 dB
  - Optical connectors: LC-UPC/2
- Dimensions

- Height: 12.65 in. (332 mm)
- Width: 0.921 in. (23.4 mm) (The dimension of the finger gasket is not included)
- Depth: 9.00 in. (240 mm)

A.5.4 OPT-BST-L Amplifier Card Specifications

The OPT-BST-L amplifier card has the following specifications:

- Optical characteristics:
  - Total operating wavelength range: 1570.0 to 1605.0 nm
  - Gain ripple (peak to valley): 1.5 dB
  - Gain range: 8 to 20 dB with programmable gain tilt
  - Extended gain range: 20 to 27 dB with gain tilt uncontrolled
  - Gain and power regulation over/undershoot: 0.5 dB
  - Limited maximum output power: 10 dBm
  - Maximum output power (with full channel load): 17 dB
  - Minimum output power (with one channel): –1 dBm
  - Input power (Pin) range at full channel load: –10 to 9 dBm
  - Input power (Pin) range at single channel load: –37 to –18 dBm
  - Noise figure at G^3 20 dB = 7.5 dB
  - Insertion loss (Line RX to OSC TX): 0.3 to 1.8 dB
  - Insertion loss (Line RX to COM TX): 0.3 to 1.0 dB
  - Insertion loss (OSC RX to LINE TX): 0.3 to 1.3 dB
  - Optical connectors: LC-UPC/2
- Dimensions
  - Height: 12.65 in. (332 mm)
  - Width: 0.921 in. (23.4 mm) (The dimension of the finger gasket is not included)
  - Depth: 9.00 in. (240 mm)

A.5.5 OPT-AMP-L Preamplifier Card Specifications

The OPT-AMP-L card has the following specifications:

- Optical characteristics:
  - DWDM channel wavelength plan, 100 GHz, 4 skip 1, ITU-T wavelength grid channels 71 (1602.3 nm) to 90 (1570.4 nm)
  - DWDM channel wavelength plan, 50 GHz, 8 skip 2, ITU-T wavelength grid channels 70.5 (1602.7 nm) to 90 (1570.4 nm)
  - Channel spacing: 100 and 50 GHz
  - Total operating wavelength range 1570.0 - 1605.0 nm
  - Gain ripple (peak to valley): 1.5 dB

  - Standard gain range: 12 to 24 dB
  - Extended gain range (uncontrolled gain tilt): 24 to 35 dB
  - Gain and power regulation over/undershoot: 0.5 dB
  - Minimum output power (with one channel): +2 dBm
  - Maximum power output (standard or extended gain range): 20 dB
  - Input power range (full channel load): –15 to 8 dB
  - Input power range (single channel load): –40 to –17
  - Noise figure at G^3 20 dB = 8.9 dB
  - Insertion loss (Line RX to OSC TX): 0.3 to 1.8 dB
  - Insertion loss (Line RX to COM TX): 0.3 to 1.0 dB
  - Insertion loss (OSC RX to LINE TX): 0.3 to 1.3 dB
  - Optical connectors: LC-UPC/2
- Dimensions
  - Height: 12.65 in. (332 mm)
  - Width: 0.921 in. (23.4 mm) (The dimension of the finger gasket is not included)
  - Depth: 9.00 in. (240 mm)

A.5.6 OPT-AMP-17-C Amplifier Card Specifications

The OPT-AMP-17-C card has the following specifications:

- Optical characteristics:
  - DWDM channel wavelength plan: 80 channels at 50 GHz spacing, 1530.33 nm to 1561.83 nm
  - Channel spacing: 50 GHz
  - Total operating wavelength range 1529.0 to 1562.5 nm
  - Gain ripple (peak to valley): 1.5 dB
  - Gain range: 14 to 23 dB
  - Optimal gain (gain tilt = 0): 17 dB
  - Gain and power regulation over/undershoot: 0.5 dB
  - Minimum output power (with one channel): –2 dBm
  - Maximum power output (standard or extended gain range): 17.5 dBm
  - Input power range (full channel load): –6 to 3 dBm
  - Input power range (single channel load): –28 to –19 dBm
  - Noise figure at G=17dB = 6 dB maximum
  - Insertion loss (Line RX to OSC TX): 0.3 to 1.8 dB
  - Insertion loss (Line RX to COM TX): 0.3 to 1.0 dB
  - Insertion loss (OSC RX to LINE TX): 0.3 to 1.3 dB
  - Optical connectors: LC-UPC/2
- Dimensions

  - Height: 12.65 in. (321.3 mm)
  - Width: 0.921 in. (23.4 mm) (The dimension of the finger gasket is not included)
  - Depth: 9.00 in. (228.6 mm)

A.5.7 OPT-AMP-C Amplifier Card Specifications

The OPT-AMP-C amplifier card has the following specifications:

- Optical characteristics:
  - Total operating wavelength range: 1529.0 to 1562.5 nm
  - Gain ripple (peak to valley): 1.2 dB
  - Gain range: 12 to 24 dB with programmable gain tilt
  - Extended gain range: 24 to 35 dB with gain tilt uncontrolled
  - Gain and power regulation over/undershoot: 0.5 dB
  - Limited maximum output power: 20.5 dBm
  - Maximum output power (with full channel load): 20 dBm
  - Minimum output power (with one channel): –2 dBm
  - Input power (Pin) at full channel load: –15 dBm minimum
  - Input power (Pin) range at single channel load: –40 to –17 dBm
  - Noise figure at G3 20 dB: 7.6 dB
  - Insertion loss (Line RX to OSC TX): 0.3 to 1.8 dB
  - Insertion loss (Line RX to COM TX): 0.3 to 1.0 dB
  - Insertion loss (OSC RX to LINE TX): 0.3 to 1.3 dB
  - Optical connectors: LC-UPC/2
- Dimensions
  - Height: 12.65 in. (332 mm)
  - Width: 0.921 in. (23.4 mm) (The dimension of the finger gasket is not included)
  - Depth: 8.66 in. (220.1 mm)

A.5.8 OPT-RAMP-C Amplifier Card Specifications

The OPT-RAMP-C amplifier card has the following specifications:

- Raman pump
  - Raman pump 1 wavelength: 1425 nm
  - Raman pump 2 wavelength: 1452 nm
  - Total Raman Pump power - Line-RX port: 500 mW
  - Operating range Raman Pump power - Line-RX port: min 100 mW, max 450^2 mW
  - Raman pump laser class: 3B
- Embedded EDFA

  - Total operating signal wavelength range: 1529 to 1562.5 nm
  - EDFA nominal gain value (Line RX to DC-TX): 14 dB
  - EDFA gain settable range: 8 to 20 dB
  - EDFA Output Power range - DC-TX (Full Channel load): 17.5[3] dBm
  - VOA attenuation range: 0 to 25 dB
  - Gain and power regulation over/undershoot: 0.5 dB
  - EDFA laser class: 1M
  - Maximum EDFA output power: 17.5 dBm
  - Minimum output power (with one channel): –10 dBm
  - Input power (Pin) at full channel load: –3 dBm to +9 dBm
  - Input power (Pin) range at single channel load: –24dBm to –10 dBm
  - Noise figure at G 14 dB: 7.5 dB
  - Insertion loss (Line TX to OSC TX): 0.3 to 2.0 dB
  - Insertion loss (Line RX to COM TX): 0.3 to 1.0 dB
  - Insertion loss (OSC RX to LINE RX): 0.3 to 1.8 dB
  - Optical connectors: LC-UPC/2
- Dimensions
  - Height: 12.65 in. (332 mm)
  - Width: 1.866 in. (47.4 mm) (The dimension of the finger gasket is not included)
  - Depth: 8.665 in. (220.1 mm)

A.5.9 OPT-RAMP-CE Amplifier Card Specifications

The OPT-RAMP-CE amplifier card has the following specifications:

- Raman pump
  - Raman pump 1 wavelength: 1425 nm
  - Raman pump 2 wavelength: 1452 nm
  - Total Raman pump power - LINE-RX port: 500 mW
  - Operating range Raman pump power - LINE-RX port: min 100 mW, max 450 mW
  - Raman pump laser class: 3B
- Embedded EDFA
  - Total operating signal wavelength range: 1529 to 1562.5 nm
  - EDFA nominal gain value (LINE-RX to DC-TX): 11 dB
  - EDFA gain settable range: 5 to 17 dB
  - EDFA Output power range - DC-TX (Full Channel load): 20.2 dBm
  - VOA attenuation range: 0 to 25 dB
  - Gain and power regulation over/undershoot: 0.5 dB
  - EDFA laser class: 1M

  - Maximum EDFA output power: 20.5 dBm
  - Minimum output power (with one channel): –10 dBm
  - Input power (Pin) at full channel load: 15 dBm (maximum)
  - Input power (Pin) range at single channel load: –27dBm (minimum)
  - Noise figure at G 11 dB: 7 dB
  - Insertion loss (LINE-RX to MON-RX):22 to 26 dB
  - Insertion loss (LINE-TX to OSC-TX): 1.5 dB
  - Insertion loss (OSC-RX to LINE-RX): 0.7 to 1.7 dB
  - Insertion loss (LINE-TX to COM-RX): 0.6 to 1.0 dB
  - Insertion loss (LINE-TX to PD12): 1.7dB
  - Insertion loss (OSC-RX to LINE-RX): 0.7 to 1.7dB
  - Optical connectors: LC-UPC/2
- Dimensions
  - Height: 13.11 in. (333 mm)
  - Width: 1.866 in. (47.4 mm) (The dimension of the finger gasket is not included)
  - Depth: 9.88 in. (251 mm)

A.6 PSM (Protection Switching Module) Card Specifications

The PSM card has the following specifications:

- Wavelength:
  - Total operating signal wavelength range (C-band range): 1529.0 – 1562.5 nm
  - OSC wavelength range: 1500 – 1520 nm
  - L-band range: 1570 - 1605 nm
- Optical
  - Insertion loss:
    - COM-RX to W-TX and P-TX: 4.6 dB
    - W-RX and P-RX to COM-TX: 2.3 dB
  - Insertion loss ripple: 0.2 dB
  - Maximum optical input power: 300mW
  - Polarization dependent loss: 0.2 dB
  - Optical switches state setting time: 5 ms
  - VOA attenuation setting time in open loop: 20 ms
  - VOA attenuation setting time in closed loop: 500 ms (applicable to VOA in RX only)
  - VOA attenuation range: 0 - 15 dB
- Dimensions
  - Height: 12.65 in. (332 mm)
  - Width: 0.921 in. (23.4 mm) (The dimension of the finger gasket is not included)

- Depth: 8.66 in. (220.1 mm)

A.7 Multiplexer and Demultiplexer Cards

This section provides specifications for the 32MUX-O, 32DMX-O, and 4MD-xx.x cards.

A.7.1 32MUX-O Card Specifications

The 32MUX-O card optical specifications are listed in Table A-2.

Note For power specifications, see Table A-1 on page A-2.

Table A-2 32MUX-O Optical Specifications

Parameter	Note	Condition	Min	Max	Unit
Transmit (Tx) filter shape (–1 dB bandwidth)	All standard operating procedures (SOP) and within whole operating temperature range	In 1/32—Out beginning of life (BOL)	+/–180	+/–300	pm
		In 1/32—Out end of life (EOL)	+/–160	+/–300	pm
Insertion loss	All SOP and within whole operating temperature range	In 1/32—Out BOL	4	8.0	dB
		In 1/32—Out EOL	4	8.5	dB
VOA dynamic range	—	—	25	—	dB
Optical monitor tap-splitting ratio on monitor port	Optical monitor port with respect to output port in multiplexer only	—	19	21	dB
Maximum optical input power	—	—	300	—	mW

The 32MUX-O card has the following additional specifications:

- Dimensions
  - Height: 12.65 in. (321.3 mm)
  - Width: 1.866 in. (47.4 mm) (The dimension of the finger gasket is not included)
  - Depth: 9.00 in. (228.6 mm)

A.7.2 32DMX-O Card Specifications

The 32DMX-O card optical specifications are listed in Table A-3.

Note For power specifications, see Table A-1 on page A-2.

Table A-3 32DMX-O Optical Specifications

Parameter	Note	Condition	Min	Max	Unit
Receive (Rx) filter shape (–1 dB bandwidth)	All SOP and within whole operating temperature range	In 1/32—Out BOL	+/–180	+/–300	pm
		In 1/32—Out EOL	+/–160	+/–300	pm
Insertion loss	All SOP and within whole operating temperature range	In 1/32—Out BOL	4	8.0	dB
		In 1/32—Out EOL	4	8.5	dB
VOA dynamic range	—	—	25	—	dB
Maximum optical input power	—	—	300	—	mW

The 32DMX-O card has the following additional specifications:

- Dimensions
  - Height: 12.65 in. (321.3 mm)
  - Width: 0.921 in. (23.4 mm) (The dimension of the finger gasket is not included)
  - Depth: 9.00 in. (228.6 mm)

A.7.3 4MD-xx.x Card Specifications

The 4MD-xx.x card optical specifications are listed in Table A-4.

Note For power specifications, see Table A-1 on page A-2.

Table A-4 4MD-xx.x Optical Specifications

Parameter	Note	Condition	Min	Max	Unit
Trx filter shape (–0.5 dB bandwidth $TrxBW_2$)	All SOP and within whole operating temperature range	COM Rx—xx.xx Tx COM Rx—yy.yy Tx COM Rx—zz.zz Tx COM Rx—kk.kk Tx xx.xx Rx—COM Tx yy.yy Rx—COM Tx zz.zz Rx—COM Tx kk.kk Rx—COM Tx	+/–180	—	pm
Insertion loss demultiplexer section	All SOP and within whole operating temperature range	COM Rx—xx.xx Tx	—	1.9	dB
		COM Rx—yy.yy Tx	—	2.4	dB
		COM Rx—zz.zz Tx	—	2.8	dB
		COM Rx—kk.kk Tx	—	3.3	dB

Table A-4 4MD-xx.x Optical Specifications (continued)

Parameter	Note	Condition	Min	Max	Unit
Insertion loss multiplexer section	All SOP and within whole operating temperature range (two connectors included)	xx.xx Rx—COM Tx	—	3.6	dB
		yy.yy Rx—COM Tx	—	3.2	dB
		zz.zz Rx—COM Tx	—	3.0	dB
		kk.kk Rx—COM Tx	—	2.6	dB
VOA dynamic range	—	—	25	—	dB
Maximum optical input power	—	—	300	—	mW

The 4MD-xx.x card has the following additional specifications:

- Dimensions
  - Height: 12.65 in. (321.3 mm)
  - Width: 0.921 in. (23.4 mm) (The dimension of the finger gasket is not included)
  - Depth: 9.00 in. (228.6 mm)

A.8 Reconfigurable Optical Add/Drop Cards

This section provides specifications for the 32DMX, 32DMX-L, 32WSS, 32WSS-L, 40-MUX-C, 40-DMX-C, 40-DMX-CE, 40-WSS-C, 40-WSS-CE, 40-WXC-C, 80-WXC-C, 40-SMR1-C, 40-SMR2-C, and MMU cards.

A.8.1 32DMX Card Specifications

The 32DMX card optical specifications are listed in Table A-5.

Note For power specifications, see Table A-1 on page A-2.

Table A-5 32DMX Optical Specifications

Parameter	Note	Condition	Min	Typical	Max	Units
–1 dB bandwidth	All SOP and within whole operating temperature range, connectors included, and for maximum VOA operating attenuation.	COM RX => TX 1, 32 (OUT)	+/–110	—	—	pm
–3 dB bandwidth			+/–200	—	—	pm
Insertion loss	All SOP, and within whole operating temperature range, connectors included.	COM RX => TX 1, 32	—	—	5.5	dB

Table A-5 32DMX Optical Specifications (continued)

Parameter	Note	Condition	Min	Typical	Max	Units
VOA dynamic range	—	COM RX => TX 1, 32	25	—	—	dB
Maximum optical input power	—	—	300	—	—	mW

The 32DMX channel plan is shown in Table A-6. All 32DMX client interfaces must comply with this plan.

Table A-6 32DMX Channel Plan

Channel Number	Band	Channel ID	Frequency (GHz)	Wavelength (nm)
1	1	30.3	195.9	1530.33
2		31.2	195.8	1531.12
3		31.9	195.7	1531.90
4		32.6	195.6	1532.68
5	2	34.2	195.4	1534.25
6		35.0	195.3	1535.04
7		35.8	195.2	1535.82
8		36.6	195.1	1536.61
9	3	38.1	194.9	1538.19
10		38.9	194.8	1538.98
11		39.7	194.7	1539.77
12		40.5	194.6	1540.56
13	4	42.1	194.4	1542.14
14		42.9	194.3	1542.94
15		43.7	194.2	1543.73
16		44.5	194.1	1544.53
17	5	46.1	193.9	1546.12
18		46.9	193.8	1546.92
19		47.7	193.7	1547.72
20		48.5	193.6	1548.51
21	6	50.1	193.4	1550.12
22		50.9	193.3	1550.92
23		51.7	193.2	1551.72
24		52.5	193.1	1552.52

Table A-6 32DMX Channel Plan (continued)

Channel Number	Band	Channel ID	Frequency (GHz)	Wavelength (nm)
25	7	54.1	192.9	1554.13
26		54.9	192.8	1554.94
27		55.7	192.7	1555.75
28		56.5	192.6	1556.55
29	8	58.1	192.4	1558.17
30		58.9	192.3	1558.98
31		59.7	192.2	1559.79
32		60.6	192.1	1560.61

The 32DMX card has the following additional specifications:

- Dimensions
  - Height: 12.65 in. (321.3 mm)
  - Width: 0.921 in. (23.4 mm) (The dimension of the finger gasket is not included)
  - Depth: 9.00 in. (228.6 mm)

A.8.2 32DMX-L Card Specifications

The 32DMX-L card optical specifications are listed in Table A-5.

Note For power specifications, see Table A-1 on page A-2.

Table A-7 32DMX -L Optical Specifications

Parameter	Note	Condition	Min	Typical	Max	Units
–1 dB bandwidth	All SOP and within whole operating temperature range, connectors included, and for maximum VOA operating attenuation.	COM RX => TX 1, 32 (OUT)	+/–100	—	—	pm
–3 dB bandwidth			+/–199	—	—	pm
Insertion loss	All SOP, and within whole operating temperature range, connectors included.	COM RX => TX 1, 32	—	—	5.8	dB
VOA dynamic range	—	COM RX => TX 1, 32	25	—	—	dB
Maximum optical input power	—	—	300	—	—	mW

The 32DMX-L channel plan is shown in Table A-8. All 32DMX-L client interfaces must comply with this plan.

Table A-8 32DMX-L Channel Plan

Band ID	Channel Label	Frequency (THz)	Wavelength (nm)
B77.8	77.8	190	1577.86
	78.6	189.9	1578.69
	79.5	189.8	1579.52
	80.3	189.7	1580.35
B81.1	81.1	189.6	1581.18
	82.0	189.5	1582.02
	82.8	189.4	1582.85
	83.6	189.3	1583.69
B84.5	84.5	189.2	1584.53
	85.3	189.1	1585.36
	86.2	189	1586.20
	87.0	188.9	1587.04
B87.8	87.8	188.8	1587.88
	88.7	188.7	1588.73
	89.5	188.6	1589.57
	90.4	188.5	1590.41
B91.2	91.2	188.4	1591.26
	92.1	188.3	1592.10
	92.9	188.2	1592.95
	93.7	188.1	1593.79
B94.6	94.6	188	1594.64
	95.4	187.9	1595.49
	96.3	187.8	1596.34
	97.1	187.7	1597.19
B98.0	98.0	187.6	1598.04
	98.8	187.5	1598.89
	99.7	187.4	1599.75
	00.6	187.3	1600.60
B01.4	01.4	187.2	1601.46
	02.3	187.1	1602.31
	03.1	187	1603.17
	04.0	186.9	1604.03

The 32DMX-L card has the following additional specifications:

- Dimensions
  - Height: 12.65 in. (321.3 mm)
  - Width: 0.921 in. (23.4 mm) (The dimension of the finger gasket is not included)
  - Depth: 9.00 in. (228.6 mm)

A.8.3 32WSS Card Specifications

The 32WSS card optical specifications are listed in Table A-9.

Note For power specifications, see Table A-1 on page A-2.

Table A-9 32WSS Optical Specifications

Parameter	Note	Condition	Min	Typical	Max	Units
–0.25 dB bandwidth	All SOP and within whole operating temperature range, connectors included, and for maximum VOA operating attenuation.	EXP RX => COM TX	+/–/95	—	—	pm
–0.5 dB bandwidth			+/–115	—	—	pm
–1.0 dB bandwidth			+/–135	—	—	pm
–0.25 dB bandwidth		Add 1, 32 => COM TX	+/–115	—	—	pm
–0.5 dB bandwidth			+/–135	—	—	pm
–1.0 dB bandwidth			+/–160	—	—	pm
Insertion loss	All SOP, any optical switch state, and within whole operating temperature range, connectors included.	EXP RX => COM TX	—	—	11.3	dB
	—	COM RX => EXP TX	—	—	1.5	dB
	—	Add 1, 32 => COM TX	—	—	7.6	dB
	—	COM RX => DROP TX	6	—	8.5	dB
VOA dynamic range	—	EXP RX => COM TX	20	—	—	dB
	—	Add 1, 32 => COM TX	25	—	—	dB
Maximum optical input power	—	—	300	—	—	mW

The 32WSS channel plan is shown in Table A-10. All 32WSS client interfaces must comply with this plan.

Table A-10 32WSS Channel Plan

Channel Number	Band	Channel ID	Frequency (GHz)	Wavelength (nm)
1	1	30.3	195.9	1530.33
2		31.2	195.8	1531.12
3		31.9	195.7	1531.90
4		32.6	195.6	1532.68
5	2	34.2	195.4	1534.25
6		35.0	195.3	1535.04
7		35.8	195.2	1535.82
8		36.6	195.1	1536.61
9	3	38.1	194.9	1538.19
10		38.9	194.8	1538.98
11		39.7	194.7	1539.77
12		40.5	194.6	1540.56
13	4	42.1	194.4	1542.14
14		42.9	194.3	1542.94
15		43.7	194.2	1543.73
16		44.5	194.1	1544.53
17	5	46.1	193.9	1546.12
18		46.9	193.8	1546.92
19		47.7	193.7	1547.72
20		48.5	193.6	1548.51
21	6	50.1	193.4	1550.12
22		50.9	193.3	1550.92
23		51.7	193.2	1551.72
24		52.5	193.1	1552.52
25	7	54.1	192.9	1554.13
26		54.9	192.8	1554.94
27		55.7	192.7	1555.75
28		56.5	192.6	1556.55
29	8	58.1	192.4	1558.17
30		58.9	192.3	1558.98
31		59.7	192.2	1559.79
32		60.6	192.1	1560.61

The 32WSS card has the following additional specifications:

- Dimensions

- Height: 12.65 in. (321.3 mm)
- Width: 1.866 in. (47.4 mm) (The dimension of the finger gasket is not included)
- Depth: 9.00 in. (228.6 mm)

A.8.4 32WSS-L Card Specifications

The 32WSS-L card optical specifications are listed in Table A-11.

Note For power specifications, see Table A-1 on page A-2.

Table A-11 32WSS-L Optical Specifications

Parameter	Note	Condition	Min	Typical	Max	Units
–0.1 dB bandwidth	All SOP and within whole operating temperature range, connectors included, and for maximum VOA operating attenuation.	EXP RX => COM TX	—	+/–/57	—	pm
–0.25 dB bandwidth			+/–/61	+/–/89	—	
–0.5 dB bandwidth			+/–91	+/–/116	—	
–1.0 dB bandwidth			+/–135	+/–/149	—	
–0.1 dB bandwidth		Add 1, 32 => COM TX	+/–32	+/–/69	—	
–0.25 dB bandwidth			+/–98	+/–/129	—	
–0.5 dB bandwidth			+/–135	+/–/161	—	
–1.0 dB bandwidth			+/–160	+/–/201	—	
Insertion loss	All SOP, any optical switch state, and within whole operating temperature range, connectors included.	EXP RX => COM TX	—	9.7	11.3	dB
		COM RX => EXP TX	—	1.4	1.6	dB
		Add 1, 32 => COM TX	—	6.2	8.0	dB
		COM RX => DROP TX	6.0	8.0	8.5	dB
VOA dynamic range	—	EXP RX => COM TX	20	25	—	dB
	—	Add 1, 32 => COM TX	25	25	—	dB
Maximum optical input power	—	—	300	—	—	mW

The 32WSS-L channel plan is shown in Table A-12. All 32WSS-L client interfaces must comply with this plan.

Table A-12 32WSS-L Channel Plan

Band ID	Channel Label	Frequency (THz)	Wavelength (nm)
B77.8	77.8	190	1577.86
	78.6	189.9	1578.69
	79.5	189.8	1579.52
	80.3	189.7	1580.35
B81.1	81.1	189.6	1581.18
	82.0	189.5	1582.02
	82.8	189.4	1582.85
	83.6	189.3	1583.69
B84.5	84.5	189.2	1584.53
	85.3	189.1	1585.36
	86.2	189	1586.20
	87.0	188.9	1587.04
B87.8	87.8	188.8	1587.88
	88.7	188.7	1588.73
	89.5	188.6	1589.57
	90.4	188.5	1590.41
B91.2	91.2	188.4	1591.26
	92.1	188.3	1592.10
	92.9	188.2	1592.95
	93.7	188.1	1593.79
B94.6	94.6	188	1594.64
	95.4	187.9	1595.49
	96.3	187.8	1596.34
	97.1	187.7	1597.19
B98.0	98.0	187.6	1598.04
	98.8	187.5	1598.89
	99.7	187.4	1599.75
	00.6	187.3	1600.60
B01.4	01.4	187.2	1601.46
	02.3	187.1	1602.31
	03.1	187	1603.17
	04.0	186.9	1604.03

The 32WSS-L card has the following additional specifications:

- Dimensions
  - Height: 12.65 in. (321.3 mm)

- Width: 1.866 in. (47.4 mm) (The dimension of the finger gasket is not included)
- Depth: 9.00 in. (228.6 mm)

A.8.5 40-MUX-C Card Specifications

The 40-MUX-C card optical specifications are listed in Table A-13.

Note For power specifications, see Table A-1 on page A-2.

Table A-13 40-MUX-C Card Optical Specifications

Parameter	Note	Condition	Min	Max	Unit
Transmit (Tx) filter shape	All standard operating procedures (SOP) and within whole operating temperature range	–1 dB bandwidth, RX 1, 40 => COM TX	+/–100	—	pm
		–3 dB bandwidth, RX 1, 40 => COM TX	+/–199	—	pm
Insertion loss	All SOP and within whole operating temperature range	RX 1, 40 => COM TX		5.8	dB
VOA dynamic range	—	RX 1, 40 => COM TX	25	—	dB
Maximum optical input power	—	—	300	—	mW

The 40-MUX-C card has the following additional specifications:

- Dimensions
  - Height: 12.65 in. (321.3 mm)
  - Width: 0.921 in. (23.4 mm) (The dimension of the finger gasket is not included)
  - Depth: 9.00 in. (228.6 mm)

A.8.6 40-DMX-C Card Specifications

The 40-DMX-C card optical specifications are listed in Table A-14.

Note For power specifications, see Table A-1 on page A-2.

Table A-14 40-DMX-C Card Optical Specifications

Parameter	Note	Condition	Min	Max	Unit
Receive (Rx) filter shape	All SOP and within whole operating temperature range	–1 dB bandwidth, COM RX => TX 1, 40 (OUT)	+/–100	—	pm
		–3 dB bandwidth, COM RX => TX 1, 40 (OUT)	+/–199	—	pm
Insertion loss	All SOP and within whole operating temperature range	COM RX => TX 1, 40	—	5.8	dB
VOA dynamic range	—	COM RX => TX 1, 40	25	—	dB
Maximum optical input power	—	—	300	—	mW

The 40-DMX-C card has the following additional specifications:

- Dimensions
  - Height: 12.65 in. (321.3 mm)
  - Width: 0.921 in. (23.4 mm) (The dimension of the finger gasket is not included)
  - Depth: 9.00 in. (228.6 mm)

A.8.7 40-DMX-CE Card Specifications

The 40-DMX-CE card optical specifications are listed in Table A-15.

Note For power specifications, see Table A-1 on page A-2.

Table A-15 40-DMX-CE Card Optical Specifications

Parameter	Note	Condition	Min	Max	Unit
Receive (Rx) filter shape	All SOP and within whole operating temperature range	–1 dB bandwidth, COM RX => TX 1, 40 (OUT)	+/–100	—	pm
		–3 dB bandwidth, COM RX => TX 1, 40 (OUT)	+/–199	—	pm
Insertion loss	All SOP and within whole operating temperature range	COM RX => TX 1, 40	—	5.8	dB

Table A-15 40-DMX-CE Card Optical Specifications (continued)

Parameter	Note	Condition	Min	Max	Unit
VOA dynamic range	—	COM RX => TX 1, 40	25	—	dB
Maximum optical input power	—	—	300	—	mW

The 40-DMX-CE card has the following additional specifications:

- Dimensions
  - Height: 12.65 in. (321.3 mm)
  - Width: 0.921 in. (23.4 mm) (The dimension of the finger gasket is not included)
  - Depth: 9.00 in. (228.6 mm)

A.8.8 40-WSS-C Card Specifications

The 40-WSS-C card optical specifications are listed in Table A-16.

Note For power specifications, see Table A-1 on page A-2.

Table A-16 40-WSS-C Optical Specifications

Parameter	Note	Condition	Min	Max	Unit
Channel grid: –0.1 dB	All SOP and within whole operating temperature range	EXP_RX to COM_TX	—	—	pm
Channel grid: –0.25 dB			+/– 61	—	pm
Channel grid: –0.5 dB			+/– 91	—	pm
Channel grid: –1.0 dB			+/– 135	—	pm
Channel grid: –0.1 dB	All SOP and within whole operating temperature range	EXP_RX to COM_TX	+/– 32	—	pm
Channel grid: –0.25 dB			+/– 98	—	pm
Channel grid: –0.5 dB			+/– 135	—	pm
Channel grid: –1.0 dB			+/– 160	—	pm

Table A-16 40-WSS-C Optical Specifications (continued)

Parameter	Note	Condition	Min	Max	Unit
Insertion loss	All SOP and within whole operating temperature range	EXP_RX to COM_TX	—	7.5	dB
		EXP_RX to COM_TX	—	2.3	dB
		EXP_RX to COM_TX	—	6.0	dB
		EXP_RX to COM_TX	—	6.8	dB
VOA dynamic range	—	EXP_RX to COM_TX	20	—	dB
		EXP_RX to COM_TX	25	—	dB
Maximum optical input power	—	—	300	—	mW

The 40-WSS-C card channel grid is listed in Table A-17.

Table A-17 40-WSS-C Channel Grid

Band ID	Channel Label	Frequency (THz)	Wavelength (nm)
B30.3	30.3	195.9	1530.33
	31.1	195.8	1531.12
	31.9	195.7	1531.90
	32.6	195.6	1532.68
	33.4	195.5	1533.47
B34.2	34.2	195.4	1534.25
	35.0	195.3	1535.04
	35.8	195.2	1535.82
	36.6	195.1	1536.61
	37.4	195.0	1537.4
B38.1	38.1	194.9	1538.19
	38.9	194.8	1538.98
	39.7	194.7	1539.77
	40.5	194.6	1540.56
	41.3	194.5	1541.35

Table A-17 40-WSS-C Channel Grid (continued)

Band ID	Channel Label	Frequency (THz)	Wavelength (nm)
B42.1	42.1	194.4	1542.14
	42.9	194.3	1542.94
	43.7	194.2	1543.73
	44.5	194.1	1544.53
	45.3	194.0	1545.32
B46.1	46.1	193.9	1546.12
	46.9	193.8	1546.92
	47.7	193.7	1547.72
	48.5	193.6	1548.51
	49.3	193.5	1549.32
B50.1	50.1	193.4	1550.12
	50.9	193.3	1550.92
	51.7	193.2	1551.72
	52.5	193.1	1552.52
	53.3	193.0	1553.33
54.1	54.1	192.9	1544.13
	54.9	192.8	1544.94
	55.7	192.7	1555.75
	56.5	192.6	1556.55
	57.3	192.5	1557.36
B58.1	58.1	192.4	1558.17
	58.9	192.3	1558.98
	59.7	192.2	1559.79
	60.6	192.1	1560.61
	61.4	192.0	1561.42

The 40-WSS-C card has the following additional specifications:

- Dimensions
  - Height: 8.66 in. (220 mm)
  - Width: 1.866 in. (47.4 mm) (The dimension of the finger gasket is not included)
  - Depth: 1.42 in. (36 mm)

A.8.9 40-WSS-CE Card Specifications

The 40-WSS-CE card optical specifications are listed in Table A-18.

Note For power specifications, see Table A-1 on page A-2.

Table A-18 40-WSS-C Card Optical Specifications

Parameter	Note	Condition	Min	Max	Unit
Channel grid: –0.1 dB	All SOP and within whole operating temperature range	EXP RX greater than or equal to COM TX	—	—	pm
Channel grid: –0.25 dB			+/– 61	—	pm
Channel grid: –0.5 dB			+/– 91	—	pm
Channel grid: –1.0 dB			+/– 135	—	pm
Channel grid: –0.1 dB	All SOP and within whole operating temperature range	Add 1, 40 greater than or equal to COM TX	+/– 32	—	pm
Channel grid: –0.25 dB			+/– 98	—	pm
Channel grid: –0.5 dB			+/– 135	—	pm
Channel grid: –1.0 dB			+/– 160	—	pm
Insertion loss	All SOP and within whole operating temperature range	EXP RX greater than or equal to COM TX	—	7.5	dB
		COM RX greater than or equal to EXP TX	—	2.3	dB
		Add 1, 40 greater than or equal to COM TX	—	6.0	dB
		COM RX greater than or equal to DROP TX	—	6.8	dB
VOA dynamic range	—	EXP RX greater than COM TX	20	—	dB
		Add 1, 40 greater than or equal to COM TX	25	—	dB
Maximum optical input power	—	—	300	—	mW

The 40-WSS-CE card channel grid is listed in Table A-19.

Table A-19 40-WSS-C Card Channel Grid

Band ID	Channel Label	Frequency (THz)	Wavelength (nm)
B30.7	30.7	195.85	1530.72
	31.5	195.75	1531.51
	32.3	195.65	1532.29
	33.1	195.55	1533.07
	33.9	195.45	1533.86
B34.6	34.6	195.35	1534.64
	35.4	195.25	1535.43
	36.2	195.15	1536.22
	37.0	195.05	1537.00
	37.8	194.95	1537.79
B38.6	38.6	194.85	1538.58
	39.4	194.75	1539.37
	40.1	194.65	1540.16
	40.9	194.55	1540.95
	41.8	194.45	1541.75
B42.5	42.5	194.35	1542.54
	43.3	194.25	1543.33
	44.1	194.15	1544.13
	44.9	194.05	1544.92
	45.7	193.95	1545.72
B46.5	46.5	193.85	1546.52
	47.3	193.75	1547.32
	48.1	193.65	1548.11
	48.9	193.55	1548.91
	49.7	193.45	1549.72
B50.5	50.5	193.35	1550.52
	51.3	193.25	1551.32
	52.1	193.15	1552.12
	52.9	193.05	1552.93
	53.7	192.95	1553.73
B54.4	54.4	192.85	1554.54
	55.3	192.75	1555.34
	56.1	192.65	1556.15
	56.9	192.55	1556.96
	57.8	192.45	1557.77

Table A-19 40-WSS-C Card Channel Grid (continued)

Band ID	Channel Label	Frequency (THz)	Wavelength (nm)
B58.6	58.6	192.35	1558.58
	59.4	192.25	1559.39
	60.2	192.15	1560.20
	61.0	192.05	1561.01
	61.8	191.95	1561.83

The 40-WSS-CE card has the following additional specifications:

- Dimensions
  - Height: 8.66 in. (220 mm)
  - Width: 1.866 in. (47.4 mm) (The dimension of the finger gasket is not included)
  - Depth: 1.42 in. (36 mm)

A.8.10 40-WXC-C Card Specifications

The 40-WXC-C card optical specifications are listed in Table A-20.

Note For power specifications, see Table A-1 on page A-2.

Table A-20 40-WXC-C Optical Specifications

Parameter	Note	Condition	Min	Max	Unit
Channel bandwidth: –0.25 dB	All SOP and within whole operating temperature range	All paths	—	—	GHz
Channel bandwidth: –0.5 dB			+/- 20.5	—	GHz
Channel bandwidth: –1.5 dB			—	—	GHz
Channel bandwidth: –03.0 dB			+/- 37.5	—	GHz
Insertion loss	All SOP and within whole operating temperature range	All paths	—	8.5	dB
VOA dynamic range	—	All paths	20	—	dB
Maximum optical input power	—	—	300	—	mW

The 40-WXC-C card has the following additional specifications:

- Dimensions
  - Height: 12.65 in. (321.3 mm) for a standard DWDM unit

- Width: 1.866 in. (47.4 mm) (The dimension of the finger gasket is not included)
- Depth: 9.00 in. (228.6 mm) for a standard DWDM unit

A.8.11 80-WXC-C Card Specifications

The 80-WXC-C card optical specifications are listed in Table A-21.

Note For power specifications, see Table A-1 on page A-2.

Table A-21 80-WXC-C Card Optical Specifications

Parameter	Note	Condition	Min	Max	Unit
Channel grid	50 GHz spaced standard ITU Grid and Channel Zero at 1529.55nm (196 THz)		191.95	196.00	THz
Operating Wavelength Bandwidth	All SOP; and within whole operating temperature range; connectors included and for minimum operating attenuation	All paths	+/- 12.5	—	GHz
Channel bandwidth: –0.25 dB			Vendor provided [1]	—	GHz
Channel bandwidth: –0.5 dB			+/- 12.5	—	
Channel bandwidth: –1.5 dB			+/- 17	—	
Channel bandwidth: –03.0 dB			Vendor provided [1]	—	
Insertion loss	All SOP; any optical switch state and within whole operating temperature range; connectors included and for minimum attenuation	All paths	2.0	7.0	dB
VOA dynamic range	—	All paths	25	—	dB
Maximum optical input power	—	All ports	500	—	mW

1. Use the value provided by the third-party vendor.

The 80-WXC-C card has the following additional specifications:

- Dimensions
  - Height: 13.11 in. (333 mm) for a standard DWDM unit

- Width: 1.866 in. (47.4 mm) (The dimension of the finger gasket is not included)
- Depth:9.88 in. (251 mm) for a standard DWDM unit

A.8.12 40-SMR1-C Card Specifications

The 40-SMR1-C card optical specifications are listed in Table A-22.

Note For power specifications, see Table A-1 on page A-2.

Table A-22 40-SMR1-C Optical Specifications

Parameter	Note	Condition	Min	Max	Unit
Channel bandwidth: –0.25 dB	All SOP and within whole operating temperature range, connectors included, and for maximum VOA operating attenuation	All WXC paths (ADD-RX to LINE-TX and EXP-RX to LINE-TX)	—	—	pm
Channel bandwidth: –0.5 dB			+/- 160	—	pm
Channel bandwidth: –1.5 dB			—	—	pm
Channel bandwidth: –3.0 dB			+/- 240	—	pm
Insertion loss	All SOP, any optical switch state, and within whole operating temperature range, connectors included	All WXC paths (ADD-RX to LINE-TX and EXP-RX to LINE-TX)	2.0	8.1	dB
	All SOP, within whole operating temperature range, connectors included	DROP-TX with respect to EXP-TX	—	5.3	dB
VOA dynamic range	—	All WXC paths (ADD-RX to LINE-TX and EXP-RX to LINE-TX)	20	—	dB
		DROP-TX	—	25	dB
Maximum optical input power	Total power sum of all ports	—	500	—	mW

The EDFA1 amplifier within the 40-SMR1-C card has the following specifications:

- Optical characteristics (specified from LINE-RX to EXP-TX)
  - Total operating wavelength range: 1530 to 1561.5 nm
  - Gain ripple (peak to valley): 1.2 dB
  - Mid-access loss (MAL) range (for dispersion compensation unit [DCU]): 0 to 9 dB

- Gain range: 7 to 38 dB
- Minimum gain (standard range): 7.0 dB
- Maximum gain (standard range with programmable gain tilt): 21 dB
- Maximum gain (extended range with uncontrolled gain tilt): 38 dB
- Gain and power regulation over/undershoot: 0.5 dB
- Maximum output power (with full channel load): 17 dBm
- Minimum output power (with one channel): -5 dBm
- Input power (pin) range at full channel load: -21 to 12 dBm
- Input power (pin) range at single channel load: -43 to -10 dBm
- Noise figure at G = 21 dB = 7.5 dB

The OSC filter within the 40-SMR1-C card has the following specifications:

- OSC filter drop (OSC) insertion loss maximum: 1.8 dB
- OSC filter add (OSC) insertion loss maximum: 1.3 dB

The 40-SMR1-C card has the following additional specifications:

- Dimensions
  - Height: 13.11 in. (333 mm)
  - Width: 0.921 in. (23.4 mm) (The dimension of the finger gasket is not included)
  - Depth: 9.88 in. (251 mm)

A.8.13 40-SMR2-C Card Specifications

The 40-SMR2-C card optical specifications are listed in Table A-23.

Note For power specifications, see Table A-1 on page A-2.

Table A-23 40-SMR2-C Optical Specifications

Parameter	Note	Condition	Min	Max	Unit
Channel bandwidth: –0.25 dB	All SOP and within whole operating temperature range, connectors included, and for maximum VOA operating attenuation	All WXC paths (ADD-RX to WXC output, EXP1-RX to WXC output, EXP2-RX to WXC output, and EXP3-RX to WXC output)	—	—	pm
Channel bandwidth: –0.5 dB			+/- 160	—	pm
Channel bandwidth: –1.5 dB			—	—	pm
Channel bandwidth: –3.0 dB			+/- 240	—	pm

Table A-23 40-SMR2-C Optical Specifications (continued)

Parameter	Note	Condition	Min	Max	Unit
Insertion loss	All SOP, any optical switch state, and within whole operating temperature range, connectors included	All WXC paths (ADD-RX to WXC output, EXP1-RX to WXC output, EXP2-RX to WXC output, and EXP3-RX to WXC output)	2.0	7	dB
	All SOP, within whole operating temperature range, connectors included	DROP-TX with respect to EXP-TX	—	5.3	dB
VOA dynamic range	—	All WXC paths (ADD-RX to WXC output, EXP1-RX to WXC output, EXP2-RX to WXC output, and EXP3-RX to WXC output)	20	—	dB
		DROP-TX	—	25	dB
Maximum optical input power	Total power sum of all ports	—	500	—	mW

The EDFA1 amplifier within the 40-SMR2-C card has the following specifications:

- Optical characteristics (specified from LINE-RX to EXP-TX)
  - Total operating wavelength range: 1530 to 1561.5 nm
  - Gain ripple (peak to valley): 1.2 dB
  - Mid-access loss (MAL) range (for dispersion compensation unit [DCU]): 0 to 9 dB
  - Gain range: 7 to 38 dBm in constant gain mode
  - Minimum gain (standard range): 7.0 dBm
  - Maximum gain (standard range with programmable gain tilt): 21 dBm
  - Maximum gain (extended range with uncontrolled gain tilt): 38 dBm
  - Gain and power regulation over/undershoot: 0.5 dB
  - Maximum output power (with full channel load): 17 dBm
  - Minimum output power (with one channel): -5 dBm
  - Input power (pin) range at full channel load: -21 to 12 dBm
  - Input power (pin) range at single channel load: -43 to -10 dBm
  - Noise figure at G= 21 dB = 7.5 dB

The EDFA2 amplifier within the 40-SMR2-C card has the following specifications:

- Optical characteristics (specified from WXC output to LINE-TX)

- Total operating wavelength range 1530.0 to 1561.5 nm
- Gain ripple (peak to valley): 1.2 dB
- Gain range: 13 to 26 dB
- Optimal gain (gain tilt = 0): 17 dB
- Gain and power regulation over/undershoot: 0.5 dB
- Minimum output power (with one channel): -5 dBm
- Input power range (full channel load): -9 to 4 dBm
- Input power range (single channel load): -31 to -18 dBm
- Noise figure at G=17dB = 6 dB maximum

The OSC filter within the 40-SMR2-C card has the following specifications:

- OSC filter drop (OSC) insertion loss maximum: 1.8 dB
- OSC filter add (OSC) insertion loss maximum: 1.3 dB

The 40-SMR2-C card has the following additional specifications:

- Dimensions
  - Height: 13.11 in. (333 mm)
  - Width: 0.921 in. (23.4 mm) (The dimension of the finger gasket is not included)
  - Depth: 9.88 in. (251 mm)

A.8.14 MMU Card Specifications

The MMU card optical specifications are listed in Table A-24.

Note For power specifications, see Table A-1 on page A-2.

Table A-24 MMU Optical Specifications

Parameter	Note	Condition	Min	Typical	Max	Units
Operating bandwidth	All SOP, any optical switch state, and within whole operating temperature range, connectors included.	All paths	1500	—	1605	nm

Table A-24 MMU Optical Specifications (continued)

Parameter	Note	Condition	Min	Typical	Max	Units
Insertion loss	All SOP, any optical switch state, and within whole operating temperature range, connectors included.	EXP RX => COM TX	—	—	7.0	dB
		EXP A RX => COM TX	—	—	2.3	dB
		COM RX => EXP TX	—	—	0.8	dB
		COM RX => EXP A TX	—	—	14.8	dB
Wavelength dependent losses	All SOP, any optical switch state, and within whole operating temperature range, connectors included.	C-band only	—	—	0.3	dB
		L-band only	—	—	0.3	dB
		C and L bands	—	—	0.5	dB
Polarization dependent loss (PDL)	—	C-band only	—	—	0.2	dB
	—	L-band only	—	—	0.2	dB
	—	C and L bands	—	—	0.3	dB
Chromatic dispersion		All paths	–20	—	+20	ps/nm
Polarization mode dispersion (PMD)	—	All paths	—	—	0.1	ps
Optical power reading resolution	—	All photodiodes (both real and virtual)	—	—	0.1	dB
Optical power reading precision	—		–0.1	—	0.1	dB
Directivity	All SOP, any optical switch state, and within whole operating temperature range, connectors included.	EXP RX => EXP A RX	40	—	—	dB
		EXP RX => EXP B RX	40	—	—	dB
		EXP A RX => EXP B RX	40	—	—	dB
Return loss	—	—	40	—	—	dB
Maximum optical input power	Maximum handling power	—	500	—	—	mW

The MMU card has the following additional specifications:

- Dimensions
  - Height: 12.65 in. (321.3 mm)
  - Width: 0.921 in. (23.4 mm) (The dimension of the finger gasket is not included)
  - Depth: 8.66 in. (220.1 mm)

A.9 Optical Add/Drop Cards

This section provides specifications for the AD-IC-xx.x, AD-2C-xx.x, AD-4C-xx.x, AD-1B-xx.x, and AD-4B-xx.x cards.

A.9.1 AD-1C-xx.x Card Specifications

Table A-25 lists the AD-1C-xx.x optical specifications.

Table A-25 AD-1C-xx.x Card Optical Specifications

Parameter	Note	Condition	Min	Max	Unit
Trx filter shape (–0.5 dB bandwidth) $TrxBW_2$	All SOP and within whole operating temperature range	COM Rx—xx.xx Tx xx.xx Rx—COM Tx	+/–180	—	pm
Rfx filter shape (–0.5 dB bandwidth) $RfxBW_2$	All SOP and within whole operating temperature range	COM Rx—Exp Tx Exp Rx—COM Tx	+/–180	—	pm
Insertion loss (drop section)	All SOP and within whole operating temperature range (two connectors included)	COM Rx—xx.xx Tx	—	2.0	dB
Insertion loss (express section)	VOA at minimum attenuation; all SOP and within whole operating temperature range (two connectors included)	COM Rx—Exp Tx Exp Rx—COM Tx	—	2.4 or 1.2	dB
Insertion loss (add section)	VOA at minimum attenuation; all SOP and within whole operating temperature range (two connectors included)	xx.xx Rx—COM Tx	—	2.6	dB
VOA dynamic range	—	—	30	—	dB
Maximum optical input power	—	—	300	—	mW

The AD-1C-xx.x card optical input and output power varies with amplifier output levels and the class of transponder interfaces used. See Table 8-3 on page 8-4 through Table 8-7 on page 8-7 for this information.

The AD-1C-xx.x card has the following additional specifications:

- Dimensions
  - Height: 12.650 in. (321.3 mm)
  - Width: 0.921 in. (23.4 mm) (The dimension of the finger gasket is not included)
  - Depth: 9.0 in. (228.6 mm)

A.9.2 AD-2C-xx.x Card Specifications

Table A-26 lists the AD-2C-xx.x optical specifications.

Table A-26 AD-2C-xx.x Card Optical Specifications

Parameter	Note	Condition	Min	Max	Unit
Trx filter shape (–0.5 dB bandwidth) $TrxBW_2$	All SOP and within whole operating temperature range	COM Rx—xx.xx Tx COM Rx—yy.yy Tx	+/–180	—	pm
		xx.xx Rx—COM Tx yy.yy Rx—COM Tx	+/–180	—	
Rfx filter shape (–0.5 dB bandwidth) $RfxBW_2$	All SOP and within whole operating temperature range	COM Rx—Exp Tx Exp Rx—COM Tx	+/–180	—	pm
Insertion loss (drop section)	All SOP and within whole operating temperature range (two connectors included)	COM Rx—xx.xx Tx	—	2.0	dB
		COM Rx—yy.yy Tx	—	2.4	dB
Insertion loss (express section)	VOA at minimum attenuation; all SOP and within whole operating temperature range (two connectors included)	COM Rx—Exp Tx	—	2.7	dB
		Exp Rx—COM Tx	—	1.6	dB
Insertion loss (add section)	VOA at minimum attenuation; all SOP and within whole operating temperature range (two connectors included)	xx.xx Rx—COM Tx	—	3.1	dB
		yy.yy Rx—COM Tx	—	2.7	dB
VOA dynamic range	—	—	30	—	dB
Maximum optical input power	—	—	300	—	mW

The AD-2C-xx.x card optical input and output power varies with amplifier output levels and the class of transponder interfaces used. See Table 8-3 on page 8-4 through Table 8-7 on page 8-7 for this information.

The AD-2C-xx.x has the following additional specifications:

- Dimensions
  - Height: 12.650 in. (321.3 mm)
  - Width: 0.921 in. (23.4 mm) (The dimension of the finger gasket is not included)
  - Depth: 9.0 in. (228.6 mm)

A.9.3 AD-4C-xx.x Card Specifications

Table A-27 lists the AD-4C-xx.x optical specifications.

Table A-27 AD-4C-xx.x Optical Specifications

Parameter	Note	Condition	Min	Max	Unit
Channel grid	See Table A-28. The channel plan for the AD-4C-xx.x card is identical to the channel plan for the AD-1B-xx.x card.	—	—	—	—
Trx filter shape (–0.5 dB bandwidth) $TrxBW_2$	All SOP and within whole operating temperature range	COM Rx—xx.xx Tx COM Rx—yy.yy Tx COM Rx—zz.zz Tx COM Rx—kk.kk Tx xx.xx Rx—COM Tx yy.yy Rx—COM Tx	+/–180	—	pm
Rfx filter shape (–1 dB bandwidth) $RfxBW_2$	All SOP and within whole operating temperature range	COM Rx—Exp Tx Exp Rx—COM Tx	—	—	pm
Insertion loss (drop section)	All SOP and within whole operating temperature range (two connectors included)	COM Rx—xx.xx Tx	—	5.5	dB
		COM Rx—yy.yy Tx	—	5.0	dB
		COM Rx—zz.zz Tx	—	4.5	dB
		COM Rx—kk.kk Tx	—	4.1	dB
Insertion loss (express section)	VOA at minimum attenuation; all SOP and within whole operating temperature range (two connectors included)	COM Rx—Exp Tx	—	2.7	dB
		Exp Rx—COM Tx	—	1.2	dB
Insertion loss (add section)	VOA at minimum attenuation; all SOP and within whole operating temperature range (two connectors included)	xx.xx Rx—COM Tx	—	3.9	dB
		yy.yy Rx—COM Tx	—	4.3	dB
		zz.zz Rx—COM Tx	—	4.5	dB
		kk.kk Rx—COM Tx	—	4.9	dB
VOA dynamic range	—	—	30	—	dB
Maximum optical input power	—	—	300	—	mW

The AD-4C-xx.x card optical input and output power varies with amplifier output levels and the class of transponder interfaces used. See Table 8-3 on page 8-4 through Table 8-7 on page 8-7 for this information.

The AD-4C-xx.x has the following additional specifications:

- Dimensions
  - Height: 12.650 in. (321.3 mm)
  - Width: 0.921 in. (23.4 mm) (The dimension of the finger gasket is not included)
  - Depth: 9.0 in. (228.6 mm)

A.9.4 AD-1B-xx.x Card Specifications

Table A-28 lists the unit names, band IDs, channel IDs, frequencies, and wavelengths assigned to the eight versions of the AD-1B-xx.x card.

Table A-28 AD-1B-xx.x Channel Allocation Plan by Band

Unit Name	Band ID	Channel ID	Frequency (GHz)	Wavelength (nm)
AD-1B-30.3	B30.3	30.3	195.9	1530.33
		30.7	195.85	1530.72
		31.1	195.8	1531.12
		31.5	195.75	1531.51
		31.9	195.7	1531.90
		32.2	195.65	1532.29
		32.6	195.6	1532.68
		33.3	195.55	1533.07
AD-1B-34.2	B34.2	34.2	195.4	1534.25
		34.6	195.35	1534.64
		35.0	195.3	1535.04
		35.4	195.25	1535.43
		35.8	195.2	1535.82
		36.2	195.15	1536.22
		36.6	195.1	1536.61
		37.0	195.05	1537.00
AD-1B-38.1	B38.1	38.1	194.9	1538.19
		38.5	194.85	1538.58
		38.9	194.8	1538.98
		39.3	194.75	1539.37
		39.7	194.7	1539.77
		40.1	194.65	1540.16
		40.5	194.6	1540.56
		40.9	194.55	1540.95
AD-1B-42.2	B42.1	42.1	194.4	1542.14
		42.5	194.35	1542.54
		42.9	194.3	1542.94
		43.3	194.25	1543.33
		43.7	194.2	1543.73
		44.1	194.15	1544.13
		44.5	194.1	1544.53
		44.9	194.05	1544.92

Table A-28 AD-1B-xx.x Channel Allocation Plan by Band (continued)

Unit Name	Band ID	Channel ID	Frequency (GHz)	Wavelength (nm)
AD-1B-46.1	B46.1	46.1	193.9	1546.12
		46.5	193.85	1546.52
		46.9	193.8	1546.92
		47.3	193.75	1547.32
		47.7	193.7	1547.72
		48.1	193.65	1548.11
		48.5	193.6	1548.51
		48.9	193.55	1548.91
AD-1B-50.1	B50.1	50.1	193.4	1550.12
		50.5	193.35	1550.52
		50.9	193.3	1550.92
		51.3	193.25	1551.32
		51.7	193.2	1551.72
		52.1	193.15	1552.12
		52.5	193.1	1552.52
		52.9	193.05	1552.93
AD-1B-54.1	B54.1	54.1	192.9	1554.13
		54.5	192.85	1554.54
		54.9	192.8	1554.94
		55.3	192.75	1555.34
		55.7	192.7	1555.75
		56.1	192.65	1556.15
		56.5	192.6	1556.96
		56.9	192.55	1556.96
AD-1B-58.1	B58.1	58.1	192.4	1558.17
		58.5	192.35	1558.58
		58.9	192.3	1558.98
		59.3	192.25	1559.39
		59.7	192.2	1559.79
		60.2	192.15	1560.20
		60.6	192.1	1560.61
		61.0	192.05	1561.01

Table A-29 lists AD-1B-xx.x optical specifications.

Table A-29 AD-1B-xx.x Optical Specifications

Parameter	Note	Condition	Min	Max	Unit
–1 dB bandwidth	All SOP and within whole operating environmental range	COM Rx—Band Tx Band Rx—COM Tx	3.6	—	nm
–1 dB bandwidth	All SOP and within whole operating temperature range	COM Rx—Exp Tx Exp Rx—COM Tx	See Table A-30.		nm
Insertion loss (drop section)	All SOP and within whole operating environmental range; two connectors included, VOA set at minimum attenuation	COM Rx—Band Tx	—	3.0	dB
Insertion loss (express section)	All SOP and within whole operating environmental range; two connectors included	Exp Rx—COM Tx	—	1.6	dB
	All SOP and within whole operating environmental range; two connectors included, VOA set at its minimum attenuation	COM Rx—Exp Tx	—	2.2	dB
Insertion loss (add section)	All SOP and within whole operating environmental range; two connectors included	Band Rx—COM Tx	—	2.2	dB
VOA dynamic range	—	—	30	—	dB
Maximum optical input power	—	—	300	—	mW

Table A-30 lists the range of wavelengths for the receive (express) band.

Table A-30 AD-1B-xx.x Transmit and Receive Dropped Band Wavelength Ranges

	Rx (Express) Band	
Tx (Dropped) Band	Left Side (nm)	Right Side (nm)
B30.3	—	Wavelengths 1533.825 or higher
B34.2	Wavelengths 1533.395 or lower	Wavelengths 1537.765 or higher
B38.1	Wavelengths 1537.325 or lower	Wavelengths 1541.715 or higher
42.1	Wavelengths 1541.275 or lower	Wavelengths 1545.695 or higher
46.1	Wavelengths 1545.245 or lower	Wavelengths 1549.695 or higher
50.1	Wavelengths 1549.235 or lower	Wavelengths 1553.705 or higher
54.1	Wavelengths 1553.255 or lower	Wavelengths 1557.745 or higher
58.1	Wavelengths 1557.285 or lower	—

The AD-1B-xx.x card optical input and output power varies with amplifier output levels and the class of transponder interfaces used. See Table 8-3 on page 8-4 through Table 8-7 on page 8-7 for this information.

The AD-1B-xx.x card has the following additional specifications:

- Dimensions
  - Height: 12.650 in. (321.3 mm)
  - Width: 0.921 in. (23.4 mm) (The dimension of the finger gasket is not included)
  - Depth: 9.0 in. (228.6 mm)

A.9.5 AD-4B-xx.x Card Specifications

Table A-31 lists the unit names, band IDs, channel IDs, frequencies, and wavelengths assigned to the two versions of the card.

Table A-31 AD-4B-xx.x Channel Allocation Plan by Band

Unit Name	Band ID	Channel ID	Frequency (GHz)	Wavelength (nm)
AD-4B-30.3	B30.3	30.3	195.9	1530.33
		30.7	195.85	1530.72
		31.1	195.8	1531.12
		31.5	195.75	1531.51
		31.9	195.7	1531.90
		32.2	195.65	1532.29
		32.6	195.6	1532.68
		33.3	195.55	1533.07
	B34.2	34.2	195.4	1534.25
		34.6	195.35	1534.64
		35.0	195.3	1535.04
		35.4	195.25	1535.43
		35.8	195.2	1535.82
		36.2	195.15	1536.22
		36.6	195.1	1536.61
		37.0	195.05	1537.00
	B38.1	38.1	194.9	1538.19
		38.5	194.85	1538.58
		38.9	194.8	1538.98
		39.3	194.75	1539.37
		39.7	194.7	1539.77
		40.1	194.65	1540.16
		40.5	194.6	1540.56
		40.9	194.55	1540.95
	B42.1	42.1	194.4	1542.14
		42.5	194.35	1542.54
		42.9	194.3	1542.94
		43.3	194.25	1543.33
		43.7	194.2	1543.73
		44.1	194.15	1544.13
		44.5	194.1	1544.53
		44.9	194.05	1544.92

Table A-31 AD-4B-xx.x Channel Allocation Plan by Band (continued)

Unit Name	Band ID	Channel ID	Frequency (GHz)	Wavelength (nm)
AD-4B-46.1	B46.1	46.1	193.9	1546.12
		46.5	193.85	1546.52
		46.9	193.8	1546.92
		47.3	193.75	1547.32
		47.7	193.7	1547.72
		48.1	193.65	1548.11
		48.5	193.6	1548.51
		48.9	193.55	1548.91
	B50.1	50.1	193.4	1550.12
		50.5	193.35	1550.52
		50.9	193.3	1550.92
		51.3	193.25	1551.32
		51.7	193.2	1551.72
		52.1	193.15	1552.12
		52.5	193.1	1552.52
		52.9	193.05	1552.93
	B54.1	54.1	192.9	1554.13
		54.5	192.85	1554.54
		54.9	192.8	1554.94
		55.3	192.75	1555.34
		55.7	192.7	1555.75
		56.1	192.65	1556.15
		56.5	192.6	1556.96
		56.9	192.55	1556.96
	B58.1	58.1	192.4	1558.17
		58.5	192.35	1558.58
		58.9	192.3	1558.98
		59.3	192.25	1559.39
		59.7	192.2	1559.79
		60.2	192.15	1560.20
		60.6	192.1	1560.61
		61.0	192.05	1561.01

Table A-32 lists AD-4B-xx.x optical specifications.

Table A-32 AD-4B-xx.x Optical Specifications

Parameter	Note	Condition	Min	Max	Unit
–1 dB bandwidth	All SOP and within whole operating environmental range	COM Rx—Band Tx Band Rx—COM Tx	3.6	—	nm
–1 dB bandwidth	All SOP and within whole operating temperature range	COM Rx—Exp Tx Exp Rx—COM Tx	Refer to Table A-33.		nm
Insertion loss (drop section)	All SOP and within whole operating environmental range; two connectors included, VOA set at minimum attenuation	COM Rx—Band Tx 30.3/46.1	—	2.9	dB
		COM Rx—Band Tx 34.2/50.1	—	3.3	dB
		COM Rx—Band Tx 38.1/54.1	—	3.8	dB
		COM Rx—Band Tx 42.1/58.1	—	4.5	dB
Insertion loss (express section)	All SOP and within whole operating environmental range; two connectors included	Exp Rx—COM Tx	—	4.9	dB
	All SOP and within whole operating environmental range; two connectors included, VOA set at its minimum attenuation	COM Rx—Exp Tx	—	3	dB
Insertion loss (add section)	All SOP and within whole operating environmental range; two connectors included	Band Rx 30.3/46.1—COM Tx	—	3.5	dB
		Band Rx 34.2/50.1—COM Tx	—	2.8	dB
		Band Rx 38.1/54.1—COM Tx	—	2.3	dB
		Band Rx 42.1/58.1—COM Tx	—	1.8	dB
VOA dynamic range	—	—	30	—	dB
Maximum optical input power	—	—	300	—	mW

Table A-33 lists the range of wavelengths for the receive (express) band.

Table A-33 AD-4B-xx.x Transmit and Receive Dropped Band Wavelength Ranges

	Rx (Express) Band	
Tx (Dropped) Band	Left Side (nm)	Right Side (nm)
B30.3	—	Wavelengths 1533.825 or higher
B34.2	Wavelengths 1533.395 or lower	Wavelengths 1537.765 or higher
B38.1	Wavelengths 1537.325 or lower	Wavelengths 1541.715 or higher
B42.1	Wavelengths 1541.275 or lower	Wavelengths 1545.695 or higher

Table A-33 AD-4B-xx.x Transmit and Receive Dropped Band Wavelength Ranges (continued)

	Rx (Express) Band	
Tx (Dropped) Band	**Left Side (nm)**	**Right Side (nm)**
B46.1	Wavelengths 1545.245 or lower	Wavelengths 1549.695 or higher
B50.1	Wavelengths 1549.235 or lower	Wavelengths 1553.705 or higher
B54.1	Wavelengths 1553.255 or lower	Wavelengths 1557.745 or higher
B58.1	Wavelengths 1557.285 or lower	—

The AD-4B-xx.x card optical input and output power varies with amplifier output levels and the class of transponder interfaces used. See Table 8-3 on page 8-4 through Table 8-7 on page 8-7 for this information.

The AD-4B-xx.x has the following additional specifications:

- Dimensions
  - Height: 12.650 in. (321.3 mm)
  - Width: 0.921 in. (23.4 mm) (The dimension of the finger gasket is not included)
  - Depth: 9.0 in. (228.6 mm)

A.10 Transponder and Muxponder Card Specifications

This section provides specifications for the TXP_MR_10G, MXP_2.5G_10G, TXP_MR_2.5G, TXPP_MR_2.5G, MXP_MR_2.5G, MXPP_MR_2.5G, MXP_2.5G_10E, MXP_2.5G_10E_C, MXP_2.5G_10EX_C, MXP_2.5G_10E, TXP_MR_10E, TXP_MR_10E_C, TXP_MR_10E_L, TXP_MR_10EX_C, MXP_MR_10DME_C, MXP_MR_10DME_L, MXP_MR_10DMEX_C, 40G-MXP-C, ADM-10G, and OTU2_XP cards.

For compliance information, refer to the *Cisco Optical Transport Products Safety and Compliance Information* document.

A.10.1 TXP_MR_10G Card Specifications

The TXP_MR_10G card has the following specifications:

- Line (trunk side)
  - Bit rate:

    9.95328 Gbps for OC-192/STM-64

    10.70923 Gbps with ITU-T G.709 Digital Wrapper/forward error correction (FEC)

    10.3125 Gbps for 10 Gigabit Ethernet (GE)

    11.095 Gbps with ITU-T G.709 Digital Wrapper/FEC over 10 GE
  - Code: Scrambled NRZ
  - Fiber: 1550-nm single-mode
  - Maximum chromatic dispersion allowance: 1000 ps/nm
  - Loopback modes: Terminal and facility

Caution You must use a 15-dB fiber attenuator (10 to 20 dB) when working with the TXP_MR_10G card in a loopback on the trunk port. Do not use direct fiber loopbacks with the TXP_MR_10G card. Using direct fiber loopbacks causes irreparable damage to the TXP_MR_10G card.

  - Connectors: LC
  - Compliance Telcordia GR-253-CORE, ITU-T G.707, ITU-T G.691
- Transmitter (trunk side)
  - Maximum transmitter output power: +3.5 dBm
  - Minimum transmitter output power: +2.5 dBm
  - Transmitter: Lithium Niobate (LN) external modulator transmitter
  - Wavelength stability (drift): +/– 25 picometers (pm)

Note An optical device on the card keeps the laser wavelength locked as closely as possible to the ITU nominal value. The allowed drift is +/– 25 pm.

- Currently available wavelengths and versions of TXP_MR_10G (16 card versions, each covering two wavelengths):
  - 1530.33 to 1531.12 nm (two wavelengths)
  - 1531.90 to 1532.68 nm (two wavelengths)
  - 1534.25 to 1535.04 nm (two wavelengths)
  - 1535.82 to 1536.61 nm (two wavelengths)
  - 1538.19 to 1538.98 nm (two wavelengths)
  - 1539.77 to 1540.56 nm (two wavelengths)
  - 1542.14 to 1542.94 nm (two wavelengths)
  - 1543.73 to 1544.53 nm (two wavelengths)
  - 1546.12 to 1546.92 nm (two wavelengths)
  - 1547.72 to 1548.51 nm (two wavelengths)
  - 1550.12 to 1550.92 nm (two wavelengths)
  - 1551.72 to 1552.52 nm (two wavelengths)
  - 1554.13 to 1554.94 nm (two wavelengths)
  - 1555.75 to 1556.55 nm (two wavelengths)
  - 1558.17 to 1558.98 nm (two wavelengths)
  - 1559.79 to 1560.61 nm (two wavelengths)
- Receiver (trunk side):
  - Receiver input power (no FEC, unamplified, 23 dB optical signal-to-noise ratio [OSNR], BER 1 * 10 exp – 12): –8 to –21 dBm
  - Receiver input power (no FEC, unamplified, 23 dB OSNR, at +/– 1000 ps/nm BER 1 * 10 exp – 12): –8 to –19 dBm
  - Receiver input power (no FEC, amplified, 19 dB OSNR, BER 1 * 10 exp – 12): –8 to –20 dBm

  - Receiver input power (no FEC, amplified, 19 dB OSNR, at +/– 1000 ps/nm BER 1 * 10 exp – 12):–8 to –18 dBm
  - Receiver input power (FEC, unamplified, 23 dB OSNR, BER 8 * 10 exp – 5): –8 to –24 dBm
  - Receiver input power (FEC, unamplified, 23 dB OSNR, at +/– 1000 ps/nm, BER 8 * 10 exp – 5): –8 to –22 dBm
  - Receiver input power (FEC, amplified, 9 dB OSNR, BER 8 * 10 exp – 5): –8 to –18 dBm
  - Receiver input power (FEC, unamplified, 11 dB OSNR, at +/– 800 ps/nm, BER 8 * 10 exp – 5): –8 to –18 dBm
- Line (client side)
  - Bit rate: 9.95328 Gbps or 10.3125 Gbps
  - Code: Scrambled NRZ
  - Fiber: 1550-nm single-mode
  - Maximum chromatic dispersion allowance: Compliant with SR-1 specification for OC-192. In the case of 10 GE, the allowance is up to 10 km of single-mode fiber (SMF) dispersion.
  - Loopback modes: Terminal and facility
  - Connectors: LC
- Transmitter (client side)
  - Maximum transmitter output power: –1 dBm
  - Minimum transmitter output power: –6 dBm
  - Center wavelength: 1290 to 1330 nm
  - Nominal wavelength: 1310 nm
  - Transmitter: Distributed feedback (DFB) laser
- Receiver (client side)
  - Maximum receiver level: –1 dBm at BER 1 * 10 exp – 12
  - Minimum receiver level: –14 dBm at BER 1 * 10 exp – 12
  - Receiver: avalanche photodiode (APD)
  - Link loss budget: 8 dB minimum, at BER = 1 * 10 exp – 12
  - Receiver input wavelength range: 1290 to 1605 nm
- Dimensions
  - Height: 12.650 in. (321.3 mm)
  - Width: 0.921 in. (23.4 mm) (The dimension of the finger gasket is not included)
  - Depth: 9.000 in. (228.6 mm)
  - Depth with backplane connector: 9.250 in. (235 mm)
  - Weight not including clam shell: 3.1 lb (1.3 kg)

A.10.2 MXP_2.5G_10G Card Specifications

The MXP_2.5G_10G card has the following specifications:

- Line (trunk side)

  - Bit rate:

    9.95328 Gbps for OC-192/STM-64

    10.70923 Gbps with ITU-T G.709 Digital Wrapper/FEC
  - Code: Scrambled NRZ
  - Fiber: 1550-nm single-mode
  - Maximum chromatic dispersion allowance: 1000 ps/nm
  - Loopback modes: Terminal and facility

Caution You must use a 20-dB fiber attenuator (15 to 25 dB) when working with the MXP_2.5G_10G card in a loopback on the trunk port. Do not use direct fiber loopbacks with the MXP_2.5G_10G card. Using direct fiber loopbacks causes irreparable damage to the MXP_2.5G_10G card.

  - Connectors: LC
- Transmitter (trunk side)
  - Maximum transmitter output power: +3.5 dBm
  - Minimum transmitter output power: +2.5 dBm
  - Transmitter: LN external modulator transmitter
  - Wavelength stability (drift): +/– 25 picometers (pm)

Note An optical device on the card keeps the laser wavelength locked as closely as possible to the ITU nominal value. The allowed drift is +/– 25 pm.

- Currently available wavelengths and versions of MXP_2.5G_10G (16 card versions, each covering two wavelengths):
  - 1530.33 to 1531.12 nm (two wavelengths)
  - 1531.90 to 1532.68 nm (two wavelengths)
  - 1534.25 to 1535.04 nm (two wavelengths)
  - 1535.82 to 1536.61 nm (two wavelengths)
  - 1538.19 to 1538.98 nm (two wavelengths)
  - 1539.77 to 1540.56 nm (two wavelengths)
  - 1542.14 to 1542.94 nm (two wavelengths)
  - 1543.73 to 1544.53 nm (two wavelengths)
  - 1546.12 to 1546.92 nm (two wavelengths)
  - 1547.72 to 1548.51 nm (two wavelengths)
  - 1550.12 to 1550.92 nm (two wavelengths)
  - 1551.72 to 1552.52 nm (two wavelengths)
  - 1554.13 to 1554.94 nm (two wavelengths)
  - 1555.75 to 1556.55 nm (two wavelengths)
  - 1558.17 to 1558.98 nm (two wavelengths)

  - 1559.79 to 1560.61 nm (two wavelengths)
- Receiver (trunk side)
  - Receiver input power (no FEC, unamplified, 23 dB OSNR, BER 1 * 10 exp – 12): –8 to –21 dBm
  - Receiver input power (no FEC, unamplified, 23 dB OSNR, at +/– 1000 ps/nm BER 1 * 10 exp – 12): –8 to –19 dBm
  - Receiver input power (no FEC, amplified, 19 dB OSNR, BER 1 * 10 exp – 12): –8 to –20 dBm
  - Receiver input power (no FEC, amplified, 19 dB OSNR, at +/– 1000 ps/nm BER 1 * 10 exp – 12): –8 to –18 dBm
  - Receiver input power (FEC, unamplified, 23 dB OSNR, BER 8 * 10 exp – 5): –8 to –24 dBm
  - Receiver input power (FEC, unamplified, 23 dB OSNR, at +/– 1000 ps/nm, BER 8 * 10 exp – 5): –8 to –22 dBm
  - Receiver input power (FEC, amplified, 9 dB OSNR, BER 8 * 10 exp – 5): –8 to –18 dBm
  - Receiver input power (FEC, unamplified, 11 dB OSNR, at +/– 800 ps/nm, BER 8 * 10 exp – 5): –8 to –18 dBm
- Line (client side)
  - Bit rate: 2.48832 Gbps
  - Code: Scrambled NRZ
  - Fiber: 1550-nm single-mode
  - Maximum chromatic dispersion allowance: Compliant with SR-1 specification for OC-192. In the case of 10 GE, allowance is up to 10 km of SMF fiber of dispersion.
  - Loopback modes: Terminal and facility
  - Connectors: LC
- Transmitter (client side): Depends on the Small Form-factor Pluggable (SFP) that is used.
- Receiver (client side): Depends on the SFP that is used.
- Dimensions
  - Height: 12.650 in. (321.3 mm)
  - Width: 0.921 in. (23.4 mm) (The dimension of the finger gasket is not included)
  - Depth: 9.000 in. (228.6 mm)
  - Depth with backplane connector: 9.250 in. (235 mm)
  - Weight not including clam shell: 3.1 lb (1.3 kg)

A.10.3 TXP_MR_2.5G and TXPP_MR_2.5G Card Specifications

The TXP_MR_2.5G and TXPP_MR_2.5G cards have the following specifications:

- Line (trunk side)
  - Bit rate:

    2.488 Gbps for OC-48/STM-16

    2.66 Gbps with ITU-T G.709 Digital Wrapper/FEC
  - Code: Scrambled NRZ

  - Fiber: 1550-nm single-mode
  - Maximum chromatic dispersion allowance: 5400 ps/nm
  - Loopback modes: Terminal and facility

Caution You must use a 20-dB fiber attenuator (15 to 25 dB) when working with the TXP_MR_2.5G and TXPP_MR_2.5G cards in a loopback on the trunk port. Do not use direct fiber loopbacks with the TXP_MR_2.5G and TXPP_MR_2.5G cards. Using direct fiber loopbacks causes irreparable damage to the TXP_MR_2.5G and TXPP_MR_2.5G cards.

  - Connectors: LC

- Transmitter (trunk side)
  - Maximum transmitter output power: +1 dBm
  - Minimum transmitter output power: –4.5 dBm
  - Transmitter: Direct modulated laser
  - Wavelength stability (drift): +/– 25 picometers (pm)

Note An optical device on the card keeps the laser wavelength locked as closely as possible to the ITU nominal value. The allowed drift is +/– 25 pm.

- Currently available wavelengths of TXP_MR_2.5G and TXPP_MR_2.5G (eight card versions):

  ITU grid blue band: 1530.334 to 1544.526 nm (four card versions covering four wavelengths each)

  ITU grid red band: 1546.119 to 1560.606 nm (four card versions covering four wavelengths each)
- Receiver (trunk side, see Table A-34)

Table A-34 TXP_MR_2.5G/TXPP_MR_2.5G Card Receiver Trunk Side Specifications

OSNR[1]	FEC Type	Pre-FEC BER	Post-FEC BER	Input Power Sensitivity	Chromatic Dispersion Tolerance
22 dB	Off - 2R	< 10 exp – 12	N/A	– 9 to – 24 dBm	—
22 dB	Off - 2R	< 10 exp – 12	N/A	– 9 to – 21 dBm	+/– 3300ps/nm
21 dB	Off - 3R	< 10 exp – 12	N/A	– 9 to – 30 dBm	—
22 dB	Off - 3R	< 10 exp – 12	N/A	– 9 to – 30 dBm	+/– 1800ps/nm
23 dB	Off - 3R	< 10 exp – 12	N/A	– 9 to – 30 dBm	+/– 5400ps/nm
12 dB	Standard- 3R	< 10 exp – 5	< 10 exp – 15	– 9 to – 25 dBm	—
12 dB	Standard- 3R	< 10 exp – 5	< 10 exp – 15	– 9 to – 24 dBm	+/– 1800ps/nm
12 dB	Standard- 3R	< 10 exp – 5	< 10 exp – 15	– 9 to – 23 dBm	+/– 5400ps/nm
21 dB	Standard- 3R	< 10 exp – 5	< 10 exp – 15	– 9 to – 31 dBm	—

1. OSNR defined with 0.1 nm resolution bandwidth (RBW)

  - Receiver: APD
  - Link loss budget: 24 dB minimum, with no dispersion or 22 dB optical path loss at BER = 1 * 10 exp – 12 including dispersion

- Line (client side)
  - Bit rate: 8 Mbps to 2.488 Gbps
  - Code: Scrambled NRZ
  - Fiber: Based on SFP (1310-nm single-mode or 850-nm multimode)
  - Maximum chromatic dispersion allowance: Based on SFP
  - Loopback modes: Terminal and facility
  - Connectors: LC
- Transmitter (client side)
  - Maximum transmitter output power: –1 dBm
  - Minimum transmitter output power: –6 dBm
  - Center wavelength: Based on SFP
  - Nominal wavelength: Based on SFP
  - Transmitter: Based on SFP
- Receiver (client side)
  - Maximum receiver level: –1 dBm at BER 1 * 10 exp – 12
  - Minimum receiver level: –14 dBm at BER 1 * 10 exp – 12
  - Receiver: APD
  - Link loss budget: 8 dB minimum, at BER = 1 * 10 exp – 12
  - Receiver input wavelength range: 850nm to 1605 nm
- Dimensions
  - Height: 12.650 in. (321.3 mm)
  - Width: 0.921 in. (23.4 mm) (The dimension of the finger gasket is not included)
  - Depth: 9.000 in. (228.6 mm)
  - Depth with backplane connector: 9.250 in. (235 mm)
  - Weight not including clam shell: 3.1 lb (1.3 kg)

A.10.4 MXP_MR_2.5G and MXPP_MR_2.5G Card Specifications

The MXP_MR_2.5G and MXPP_MR_2.5G cards have the following specifications:

- Payload configuration
  - FC1G—Fibre Channel 1.06 Gbps
  - FC2G—Fibre Channel 2.125 Gbps
  - FICON1G—Fiber connectivity 1.06 Gbps (IBM signal)
  - FICON2G—Fiber connectivity 2.125 Gbps (IBM signal)
  - ESCON—Enterprise System Connection 200 Mbps
  - ONE_GE—One Gigabit Ethernet 1.125 Gbps

  - Mixed configurations up to maximum line rate of 2.5 Gbps (for example, if you have a port configured for FC2G, you cannot use another port at the same time). See the "10.9 MXP_MR_2.5G and MXPP_MR_2.5G Cards" section on page 10-49 for more information on mixed-mode operation.

- Client ports: 8x SFP
- Performance monitoring (PM) for all interfaces
- Buffer-to-buffer credit management for distance extension
- Line (trunk side)
  - Bit rate: 2.488 Gbps for OC-48/STM-16
  - Code: Scrambled NRZ
  - Fiber: 1550-nm single-mode
  - Maximum chromatic dispersion allowance: 6000 ps/nm
  - Loopback modes: Terminal and facility

Caution You must use a 20-dB fiber attenuator (15 to 25 dB) when working with the MXP_MR_2.5G and MXPP_MR_2.5G cards in a loopback on the trunk port. Do not use direct fiber loopbacks with the MXP_MR_2.5G and MXPP_MR_2.5G cards. Using direct fiber loopbacks causes irreparable damage to the MXP_MR_2.5G and MXPP_MR_2.5G cards.

  - Connectors: LC
- Transmitter (trunk side)
  - Transmit power: +3 +/– 1 dBm with MXP_MR_2.5G card, and +/– 1 dBm with MXPP_MR_2.5G card
  - 50-GHz DWDM migration ready (the wavelength deviation is less than +/– 0.040 nm through wavelocker deployment)
  - Four-channel wavelength tunability at 100-GHz spacing
  - Transmitter maximum return reflectance: –27 dB
  - Chromatic dispersion allowance: 5400 ps/nm, giving an optical power penalty < 2.0 dB
  - Minimum side mode suppression ratio: 30 dB
  - Transmitter is a direct modulated laser
  - Wavelength stability (drift): +/– 25 picometers (pm)

Note An optical device on the card keeps the laser wavelength locked as closely as possible to the ITU nominal value. The allowed drift is +/– 25 pm.

- Currently available wavelengths of the TXP_MR_2.5G and TXPP_MR_2.5G cards (eight card versions):
  - ITU grid blue band: 1530.334 to 1544.526 nm (four card versions, four wavelengths each)
  - ITU grid red band: 1546.119 to 1560.606 nm (four card versions, four wavelengths each)
- Receiver (trunk side, see Table A-35)

Table A-35 MXP_MR_2.5G/MXPP_MR_2.5G Card Receiver Trunk Side Specifications

OSNR[1]	FEC Type	Pre-FEC BER	Post-FEC BER	Input Power Sensitivity	Chromatic Dispersion Tolerance
17 dB	N/A	< 10 exp – 12	N/A	– 9 to – 23 dBm	—
17 dB	N/A	< 10 exp – 12	N/A	– 9 to – 22 dBm	+/– 1800 ps/nm
17 dB	N/A	< 10 exp – 12	N/A	– 9 to – 21 dBm	+/– 5400 ps/nm
18 dB	N/A	< 10 exp – 12	N/A	– 9 to – 23 dBm	+/– 1800 ps/nm
19 dB	N/A	< 10 exp – 12	N/A	– 9 to – 23 dBm	+/– 5400 ps/nm
21 dB	N/A	< 10 exp – 12	N/A	– 9 to – 30 dBm	—
21 dB	N/A	< 10 exp – 12	N/A	– 9 to – 29 dBm	+/– 1800 ps/nm
21 dB	N/A	< 10 exp – 12	N/A	– 9 to – 28 dBm	+/– 5400 ps/nm
22 dB	N/A	< 10 exp – 12	N/A	– 9 to – 30 dBm	+/– 1800 ps/nm
23 dB	N/A	< 10 exp – 12	N/A	– 9 to – 30 dBm	+/– 5400 ps/nm

1. OSNR defined with 0.1 nm RBW

  - Receiver sensitivity –28 dBm, BER 1 * 10 exp – 12
  - Receiver overload is equal to or exceeds –8 dBm
  - Receiver maximum reflectance of –27 dB
- Line (client side)
  - Bit rate: 200Mbps or 1.06 Gbps to 2.125 Gbps per client
  - Code: Scrambled NRZ
  - Fiber: Based on SFP (1310-nm single-mode or 850-nm multimode)
  - Loopback modes: Terminal and facility
  - Connectors: LC
- Transmitter (client side)
  - Maximum transmitter output power: –1 dBm
  - Minimum transmitter output power: –6 dBm
  - Center wavelength: Based on SFP
  - Nominal wavelength: Based on SFP
  - Transmitter: Based on SFP
- Receiver (client side)
  - Maximum receiver level: –1 dBm at BER 1 * 10 exp – 12
  - Minimum receiver level: –14 dBm at BER 1 * 10 exp – 12
  - Receiver: APD
  - Link loss budget: 8 dB minimum, at BER = 1 * 10 exp – 12
  - Receiver input wavelength range: 1290 to 1605 nm or 850nm
- Dimensions
  - Height: 12.650 in. (321.3 mm)

  - Width: 0.921 in. (23.4 mm) (The dimension of the finger gasket is not included)
  - Depth: 9.000 in. (228.6 mm)
  - Depth with backplane connector: 9.250 in. (235 mm)
  - Weight not including clam shell: 2.25 lb (1.02 kg)

A.10.5 MXP_2.5G_10E Card Specifications

The MXP_2.5G_10E card has the following specifications:

- Line (trunk side)
  - Bit rate: 10.70923 Gbps (in ITU-T G.709 Digital Wrapper/FEC mode)
  - Code: Scrambled NRZ
  - Fiber: 1550-nm single-mode
  - Maximum chromatic dispersion allowance: +/– 1200 ps/nm (specified penalty)
  - Loopback modes: Terminal and facility

Caution You must use a 20-dB fiber attenuator (15 to 25 dB) when working with the MXP_2.5G_10E card in a loopback on the trunk port. Do not use direct fiber loopbacks with the MXP_2.5G_10E card. Using direct fiber loopbacks causes irreparable damage to the MXP_2.5G_10E card.

  - Connectors: LC
- Transmitter (trunk side)
  - Maximum transmitter output power: +6 dBm
  - Minimum transmitter output power: +3 dBm
  - Transmitter: LN external modulator transmitter
  - Wavelength stability (drift): +/– 25 picometers (pm)

Note An optical device on the card keeps the laser wavelength locked as closely as possible to the ITU nominal value. The allowed drift is +/– 25 pm.

- Currently available wavelengths and versions of MXP_2.5G_10E (eight card versions):

  ITU grid blue band:
  - 1530.33 to 1533.07 nm (four channels)
  - 1534.25 to 1537.00 nm (four channels)
  - 1538.19 to 1540.95 nm (four channels)
  - 1542.14 to 1544.92 nm (four channels)

  ITU grid red band:
  - 1546.12 to 1548.92 nm (four channels)
  - 1550.12 to 1552.93 nm (four channels)
  - 1554.13 to 1556.96 nm (four channels)
  - 1558.17 to 1561.01 nm (four channels)

- Receiver (trunk side, see Table A-36)
  - Receiver: APD
  - Link loss budget: 24 dB minimum, with no dispersion or 22 dB optical path loss at BER = 1 * 10 exp – 12 including dispersion

Table A-36 MXP_2.5G_10E Card Receiver Trunk Side Specifications

OSNR[1]	FEC Type	Pre-FEC BER	Post-FEC BER	Input Power Sensitivity[2]	Chromatic Dispersion Tolerance
30 dB	Off	< 10 exp – 12	N/A	– 8 to – 20 dBm	+/– 1200 ps/nm
26 dB	Off	< 10 exp – 12	N/A	– 8 to – 20 dBm	+/– 1000 ps/nm
26 dB	Off	< 10 exp – 12	N/A	– 8 to – 22 dBm	—
17 dB	Standard	< 10 exp – 5	< 10 exp – 15	– 8 to – 18 dBm	+/– 800 ps/nm
15 dB	Standard	< 10 exp – 5	< 10 exp – 15	– 8 to – 18 dBm	—
15 dB	Enhanced	< 7 x 10 exp – 4	< 10 exp – 15	– 8 to – 18 dBm	+/– 800 ps/nm
14 dB	Enhanced	< 7 x 10 exp – 4	< 10 exp – 15	– 8 to – 18 dBm	—

1. OSNR defined with 0.1 nm RBW
2. Receiver filter bandwidth greater than or equal to 180 pm (at – 3 dBm)

- Line (client side)
  - Bit rate: 2.5 Gbps per port (OC-48/STM-16)
  - Code: Scrambled NRZ
  - Fiber: 1310-nm single-mode
  - Maximum chromatic dispersion allowance: 12 ps/nm (SR SFP version)
  - Loopback modes: Terminal and facility
  - Connectors: LC (optical)
- Transmitter (client side): Depends on the SFP that is used.
- Receiver (client side): Depends on the SFP that is used.
- Dimensions
  - Height: 12.650 in. (321.3 mm)
  - Width: 0.921 in. (23.4 mm) (The dimension of the finger gasket is not included)
  - Depth: 9.000 in. (228.6 mm)
  - Depth with backplane connector: 9.250 in. (235 mm)
  - Weight not including clam shell: 3.1 lb (1.3 kg)

A.10.6 MXP_2.5G_10E_C Card Specifications

The MXP_2.5G_10E_C card has the following specifications:

- Line (trunk side)
  - Bit rate: 10.70923 Gbps (in ITU-T G.709 Digital Wrapper/FEC mode)

  - Code: Scrambled NRZ
  - Fiber: 1550-nm single-mode
  - Maximum chromatic dispersion allowance: +/– 1200 ps/nm (specified penalty)
  - Loopback modes: Terminal and facility

Caution You must use a 20-dB fiber attenuator (15 to 25 dB) when working with the MXP_2.5G_10E_C card in a loopback on the trunk port. Do not use direct fiber loopbacks with the MXP_2.5G_10E_C card. Using direct fiber loopbacks causes irreparable damage to the card.

  - Connectors: LC
- Transmitter (trunk side)
  - Maximum transmitter output power: +6 dBm
  - Minimum transmitter output power: +3 dBm
  - Transmitter: LN external modulator transmitter
  - Wavelength stability (drift): +/– 25 picometers (pm)

Note An optical device on the card keeps the laser wavelength locked as closely as possible to the ITU nominal value. The allowed drift is +/– 25 pm.

- Currently available wavelengths and versions of MXP_2.5G_10E_C card:

  There is a single version of the MXP_2.5G_10E_C card. It is tunable across 82 wavelengths in the C-band frequency plan, with channels on the ITU 50-GHz grid, as shown in Table A-37.

Table A-37 MXP_2.5G_10E_C Card Trunk Wavelengths

Channel Number	Frequency (THz)	Wavelength (nm)	Channel Number	Frequency (THz)	Wavelength (nm)
1	196.00	1529.55	42	193.95	1545.72
2	195.95	1529.94	43	193.90	1546.119
3	195.90	1530.334	44	193.85	1546.518
4	195.85	1530.725	45	193.80	1546.917
5	195.80	1531.116	46	193.75	1547.316
6	195.75	1531.507	47	193.70	1547.715
7	195.70	1531.898	48	193.65	1548.115
8	195.65	1532.290	49	193.60	1548.515
9	195.60	1532.681	50	193.55	1548.915
10	195.55	1533.073	51	193.50	1549.32
11	195.50	1533.47	52	193.45	1549.71
12	195.45	1533.86	53	193.40	1550.116
13	195.40	1534.250	54	193.35	1550.517
14	195.35	1534.643	55	193.30	1550.918

Table A-37 MXP_2.5G_10E_C Card Trunk Wavelengths (continued)

Channel Number	Frequency (THz)	Wavelength (nm)	Channel Number	Frequency (THz)	Wavelength (nm)
15	195.30	1535.036	56	193.25	1551.319
16	195.25	1535.429	57	193.20	1551.721
17	195.20	1535.822	58	193.15	1552.122
18	195.15	1536.216	59	193.10	1552.524
19	195.10	1536.609	60	193.05	1552.926
20	195.05	1537.003	61	193.00	1553.33
21	195.00	1537.40	62	192.95	1553.73
22	194.95	1537.79	63	192.90	1554.134
23	194.90	1538.186	64	192.85	1554.537
24	194.85	1538.581	65	192.80	1554.940
25	194.80	1538.976	66	192.75	1555.343
26	194.75	1539.371	67	192.70	1555.747
27	194.70	1539.766	68	192.65	1556.151
28	194.65	1540.162	69	192.60	1556.555
29	194.60	1540.557	70	192.55	1556.959
30	194.55	1540.953	71	192.50	1557.36
31	194.50	1541.35	72	192.45	1557.77
32	194.45	1541.75	73	192.40	1558.173
33	194.40	1542.142	74	192.35	1558.578
34	194.35	1542.539	75	192.30	1558.983
35	194.30	1542.936	76	192.25	1559.389
36	194.25	1543.333	77	192.20	1559.794
37	194.20	1543.730	78	192.15	1560.200
38	194.15	1544.128	79	192.10	1560.606
39	194.10	1544.526	80	192.05	1561.013
40	194.05	1544.924	81	192.00	1561.42
41	194.00	1545.32	82	191.95	1561.83

- Receiver (trunk side, see Table A-38)

Table A-38 MXP_2.5G_10E_C Card Receiver Trunk Side Specifications

OSNR[1]	FEC Type	Pre-FEC BER	Post-FEC BER	Input Power Sensitivity[2]	Chromatic Dispersion Tolerance
30 dB	Off	< 10 exp – 12	N/A	– 8 to – 18 dBm	+/– 1200 ps/nm
26 dB	Off	< 10 exp – 12	N/A	– 8 to – 18 dBm	+/– 1000 ps/nm
26 dB	Off	< 10 exp – 12	N/A	– 8 to – 18 dBm	—

Table A-38 MXP_2.5G_10E_C Card Receiver Trunk Side Specifications (continued)

OSNR[1]	FEC Type	Pre-FEC BER	Post-FEC BER	Input Power Sensitivity[2]	Chromatic Dispersion Tolerance
17 dB	Standard	< 10 exp – 5	< 10 exp – 15	– 8 to – 18 dBm	+/– 800 ps/nm
15.5 dB	Standard	< 10 exp – 5	< 10 exp – 15	– 8 to – 18 dBm	—
14 dB	Enhanced	< 7 x 10 exp – 4	< 10 exp – 15	– 8 to – 18 dBm	+/– 800 ps/nm

Table A-38 MXP_2.5G_10E_C Card Receiver Trunk Side Specifications (continued)

OSNR[1]	FEC Type	Pre-FEC BER	Post-FEC BER	Input Power Sensitivity[2]	Chromatic Dispersion Tolerance
12 dB	Enhanced	< 7 x 10 exp – 4	< 10 exp – 15	– 8 to – 18 dBm	—

1. OSNR defined with 0.1 nm RBW
2. Receiver filter bandwidth 32.5GHz (at - 3 dB)

  - Receiver: APD
  - Link loss budget: 24 dB minimum, with no dispersion or 22 dB optical path loss at BER = 1 * 10 exp – 12 including dispersion
  - Receiver input wavelength range: 1529 to 1562 nm
- Line (client side)
  - Bit rate: 2.5 Gbps per port (OC-48/STM-16)
  - Code: Scrambled NRZ
  - Fiber: 1310-nm single-mode
  - Maximum chromatic dispersion allowance: 12 ps/nm (SR SFP version)
  - Loopback modes: Terminal and facility
  - Connectors: LC (optical)
- Transmitter (client side): Depends on the SFP that is used.
- Receiver (client side): Depends on the SFP that is used.
- Dimensions
  - Height: 12.650 in. (321.3 mm)
  - Width: 0.921 in. (23.4 mm) (The dimension of the finger gasket is not included)
  - Depth: 9.000 in. (228.6 mm)
  - Depth with backplane connector: 9.250 in. (235 mm)
  - Weight not including clam shell: 3.1 lb (1.3 kg)

A.10.7 MXP_2.5G_10E_L Card Specifications

The MXP_2.5G_10E_L card has the following specifications:

- Line (trunk side)
  - Bit rate: 10.70923 Gbps (in ITU-T G.709 Digital Wrapper/FEC mode)
  - Code: Scrambled NRZ
  - Fiber: 1550-nm single-mode
  - Maximum chromatic dispersion allowance: +/– 1200 ps/nm (specified penalty)
  - Loopback modes: Terminal and facility

Caution You must use a 20-dB fiber attenuator (15 to 25 dB) when working with the MXP_2.5G_10E_L card in a loopback on the trunk port. Do not use direct fiber loopbacks with the MXP_2.5G_10E_L card. Using direct fiber loopbacks causes irreparable damage to the card.

  - Connectors: LC
- Transmitter (trunk side)
  - Maximum transmitter output power: +6 dBm
  - Minimum transmitter output power: +3 dBm
  - Transmitter: LN external modulator transmitter
  - Wavelength stability (drift): +/– 25 picometers (pm)

Note An optical device on the card keeps the laser wavelength locked as closely as possible to the ITU nominal value. The allowed drift is +/– 25 pm.

- Currently available wavelengths and versions of MXP_2.5G_10E_L card:

  There is a single version of the MXP_2.5G_10E_L card. It is tunable across 80 wavelengths in the L band frequency plan, with channels on the ITU 50-GHz grid, as shown in Table A-39.

Table A-39 MXP_2.5G_10E_L Card Trunk Wavelengths

Channel Number	Frequency (THz)	Wavelength (nm)	Channel Number	Frequency (THz)	Wavelength (nm)
1	190.85	1570.83	41	188.85	1587.46
2	190.8	1571.24	42	188.8	1587.88
3	190.75	1571.65	43	188.75	1588.30
4	190.7	1572.06	44	188.7	1588.73
5	190.65	1572.48	45	188.65	1589.15
6	190.6	1572.89	46	188.6	1589.57
7	190.55	1573.30	47	188.55	1589.99
8	190.5	1573.71	48	188.5	1590.41
9	190.45	1574.13	49	188.45	1590.83
10	190.4	1574.54	50	188.4	1591.26
11	190.35	1574.95	51	188.35	1591.68
12	190.3	1575.37	52	188.3	1592.10
13	190.25	1575.78	53	188.25	1592.52
14	190.2	1576.20	54	188.2	1592.95
15	190.15	1576.61	55	188.15	1593.37
16	190.1	1577.03	56	188.1	1593.79
17	190.05	1577.44	57	188.05	1594.22
18	190	1577.86	58	188	1594.64

Table A-39 MXP_2.5G_10E_L Card Trunk Wavelengths (continued)

Channel Number	Frequency (THz)	Wavelength (nm)	Channel Number	Frequency (THz)	Wavelength (nm)
19	189.95	1578.27	59	187.95	1595.06
20	189.9	1578.69	60	187.9	1595.49
21	189.85	1579.10	61	187.85	1595.91
22	189.8	1579.52	62	187.8	1596.34
23	189.75	1579.93	63	187.75	1596.76
24	189.7	1580.35	64	187.7	1597.19
25	189.65	1580.77	65	187.65	1597.62
26	189.6	1581.18	66	187.6	1598.04
27	189.55	1581.60	67	187.55	1598.47
28	189.5	1582.02	68	187.5	1598.89
29	189.45	1582.44	69	187.45	1599.32
30	189.4	1582.85	70	187.4	1599.75
31	189.35	1583.27	71	187.35	1600.17
32	189.3	1583.69	72	187.3	1600.60
33	189.25	1584.11	73	187.25	1601.03
34	189.2	1584.53	74	187.2	1601.46
35	189.15	1584.95	75	187.15	1601.88
36	189.1	1585.36	76	187.1	1602.31
37	189.05	1585.78	77	187.05	1602.74
38	189	1586.20	78	187	1603.17
39	188.95	1586.62	79	186.95	1603.60
40	188.9	1587.04	80	186.9	1604.03

- Receiver (trunk side, see Table A-40)

Table A-40 MXP_2.5G_10E_L Card Receiver Trunk Side Specifications

OSNR[1]	FEC Type	Pre-FEC BER	Post-FEC BER	Input Power Sensitivity[2]	Chromatic Dispersion Tolerance
30 dB	Off	< 10 exp – 12	N/A	– 8 to – 20 dBm	+/– 1200 ps/nm
26 dB	Off	< 10 exp – 12	N/A	– 8 to – 20 dBm	+/– 1000 ps/nm
26 dB	Off	< 10 exp – 12	N/A	– 8 to – 22 dBm	—
17 dB	Standard	< 10 exp – 5	< 10 exp – 15	– 8 to – 18 dBm	+/– 800 ps/nm
15.5 dB	Standard	< 10 exp – 5	< 10 exp – 15	– 8 to – 18 dBm	—
15 dB	Enhanced	< 7 x 10 exp – 4	< 10 exp – 15	– 8 to – 18 dBm	+/– 800 ps/nm

Table A-40 MXP_2.5G_10E_L Card Receiver Trunk Side Specifications (continued)

OSNR[1]	FEC Type	Pre-FEC BER	Post-FEC BER	Input Power Sensitivity[2]	Chromatic Dispersion Tolerance
13 dB	Enhanced	< 7 x 10 exp – 4	< 10 exp – 15	– 8 to – 18 dBm	—

1. OSNR defined with 0.1 nm RBW
2. Receiver filter bandwidth greater than or equal to 180 pm (at – 3 dBm)

  - Receiver: APD
  - Link loss budget: 24 dB minimum, with no dispersion or 22 dB optical path loss at BER = 1 * 10 exp – 12 including dispersion
  - Receiver input wavelength range: 1570 to 1604 nm
- Line (client side)
  - Bit rate: 2.5 Gbps per port (OC-48/STM-16)
  - Code: Scrambled NRZ
  - Fiber: 1310-nm single-mode
  - Maximum chromatic dispersion allowance: 12 ps/nm (SR SFP version)
  - Loopback modes: Terminal and facility
  - Connectors: LC (optical)
- Transmitter (client side): Depends on the SFP that is used.
- Receiver (client side): Depends on the SFP that is used.
- Dimensions
  - Height: 12.650 in. (321.3 mm)
  - Width: 0.921 in. (23.4 mm) (The dimension of the finger gasket is not included)
  - Depth: 9.000 in. (228.6 mm)
  - Depth with backplane connector: 9.250 in. (235 mm)
  - Weight not including clam shell: 3.1 lb (1.3 kg)

A.10.8 MXP_2.5G_10EX_C Card Specifications

The MXP_2.5G_10EX_C card has the following specifications:

- Line (trunk side)
  - Bit rate: 10.70923 Gbps (in ITU-T G.709 Digital Wrapper/FEC mode)
  - Code: Scrambled NRZ
  - Fiber: 1550-nm single-mode
  - Maximum chromatic dispersion allowance: +/– 1600 ps/nm (specified penalty)
  - Loopback modes: Terminal and facility

Caution You must use a 20-dB fiber attenuator (15 to 25 dB) when working with the MXP_2.5G_10EX_C card in a loopback on the trunk port. Do not use direct fiber loopbacks with the MXP_2.5G_10EX_C card. Using direct fiber loopbacks causes irreparable damage to the card.

  - Connectors: LC
- Transmitter (trunk side)
  - Maximum transmitter output power: +6 dBm
  - Minimum transmitter output power: +3 dBm
  - Transmitter: LN external modulator transmitter
  - Wavelength stability (drift): +/– 25 picometers (pm)

Note An optical device on the card keeps the laser wavelength locked as closely as possible to the ITU nominal value. The allowed drift is +/– 25 pm.

- Currently available wavelengths and versions of MXP_2.5G_10EX_C card:

  There is a single version of the MXP_2.5G_10EX_C card. It is tunable across 82 wavelengths in the C-band frequency plan, with channels on the ITU 50-GHz grid, as shown in Table A-37.

Table A-41 MXP_2.5G_10EX_C Card Trunk Wavelengths

Channel Number	Frequency (THz)	Wavelength (nm)	Channel Number	Frequency (THz)	Wavelength (nm)
1	196.00	1529.55	42	193.95	1545.72
2	195.95	1529.94	43	193.90	1546.12
3	195.90	1530.334	44	193.85	1546.52
4	195.85	1530.725	45	193.80	1546.92
5	195.80	1531.116	46	193.75	1547.32
6	195.75	1531.507	47	193.70	1547.72
7	195.70	1531.898	48	193.65	1548.11
8	195.65	1532.290	49	193.60	1548.51
9	195.60	1532.681	50	193.55	1548.91
10	195.55	1533.073	51	193.50	1549.32
11	195.50	1533.47	52	193.45	1549.72
12	195.45	1533.86	53	193.40	1550.12
13	195.40	1534.250	54	193.35	1550.52
14	195.35	1534.643	55	193.30	1550.92
15	195.30	1535.036	56	193.25	1551.32
16	195.25	1535.429	57	193.20	1551.72
17	195.20	1535.822	58	193.15	1552.12
18	195.15	1536.216	59	193.10	1552.52

Table A-41 MXP_2.5G_10EX_C Card Trunk Wavelengths (continued)

Channel Number	Frequency (THz)	Wavelength (nm)	Channel Number	Frequency (THz)	Wavelength (nm)
19	195.10	1536.609	60	193.05	1552.93
20	195.05	1537.003	61	193.00	1553.33
21	195.00	1537.40	62	192.95	1553.73
22	194.95	1537.79	63	192.90	1554.13
23	194.90	1538.186	64	192.85	1554.54
24	194.85	1538.581	65	192.80	1554.94
25	194.80	1538.976	66	192.75	1555.34
26	194.75	1539.371	67	192.70	1555.75
27	194.70	1539.766	68	192.65	1556.15
28	194.65	1540.162	69	192.60	1556.55
29	194.60	1540.557	70	192.55	1556.96
30	194.55	1540.953	71	192.50	1557.36
31	194.50	1541.35	72	192.45	1557.77
32	194.45	1541.75	73	192.40	1558.17
33	194.40	1542.142	74	192.35	1558.58
34	194.35	1542.539	75	192.30	1558.98
35	194.30	1542.936	76	192.25	1559.39
36	194.25	1543.333	77	192.20	1559.79
37	194.20	1543.730	78	192.15	1560.20
38	194.15	1544.128	79	192.10	1560.61
39	194.10	1544.526	80	192.05	1561.01
40	194.05	1544.924	81	192.00	1561.42
41	194.00	1545.32	82	191.95	1561.83

- Receiver (trunk side, see Table A-42)

Table A-42 TMXP_2.5G_10EX_C Card Receiver Trunk Side Specifications

OSNR[1]	FEC Type	Pre-FEC BER	Post-FEC BER	Input Power Sensitivity[2]	Chromatic Dispersion Tolerance	PMD tolerance
16 dB	Standard	< 10 exp – 5	< 10 exp – 15	– 8 to – 20 dBm	+/– 1600 ps/nm	—
15 dB	Standard	< 10 exp – 5	< 10 exp – 15	– 8 to – 20 dBm	—	—
TBD	Standard	< 10 exp – 5	< 10 exp – 15	– 8 to – 20 dBm	—	[3]
12.5 dB	Enhanced	< 7 x 10 exp – 4	< 10 exp – 15	– 8 to – 20 dBm	—	—

Table A-42 TMXP_2.5G_10EX_C Card Receiver Trunk Side Specifications (continued)

OSNR[1]	FEC Type	Pre-FEC BER	Post-FEC BER	Input Power Sensitivity[2]	Chromatic Dispersion Tolerance	PMD tolerance
17 dB	Enhanced	< 7 x 10 exp – 4	< 10 exp – 15	– 8 to – 20 dBm	+/- 4000 ps/nm	—
15.2 dB	Enhanced	< 7 x 10 exp – 4	< 10 exp – 15	– 8 to – 20 dBm	+/- 2500 ps/nm	—
17.4 dB	Enhanced	< 7 x 10 exp – 4	< 10 exp – 15	– 8 to – 20 dBm		[3]

1. OSNR defined with 0.1 nm RBW
2. Receiver filter bandwidth 32.5GHz (at - 3 dBm)
3. PMD = 30 ps; DGD = 90 ps, hence PMD = 3000 ps^2

  - Receiver: APD
  - Link loss budget: 24 dB minimum, with no dispersion or 22 dB optical path loss at BER = 1 * 10 exp – 12 including dispersion
  - Receiver input wavelength range: 1529 to 1562 nm
- Line (client side)
  - Bit rate: 2.5 Gbps per port (OC-48/STM-16)
  - Code: Scrambled NRZ
  - Fiber: 1310-nm single-mode
  - Maximum chromatic dispersion allowance: 12 ps/nm (SR SFP version)
  - Loopback modes: Terminal and facility
  - Connectors: LC (optical)
- Transmitter (client side): Depends on the SFP that is used.
- Receiver (client side): Depends on the SFP that is used.
- Dimensions
  - Height: 12.650 in. (321.3 mm)
  - Width: 0.921 in. (23.4 mm) (The dimension of the finger gasket is not included)
  - Depth: 9.000 in. (228.6 mm)
  - Depth with backplane connector: 9.250 in. (235 mm)
  - Weight not including clam shell: 3.1 lb (1.3 kg)

A.10.9 MXP_MR_10DME_C Card Specifications

The MXP_MR_10DME_C card has the following specifications:

- Payload configuration
  - FC1G—Fibre Channel 1.06 Gbps
  - FC2G—Fibre Channel 2.125 Gbps

  - FC4G—Fibre Channel 4.25 Gbps
  - FICON1G—Fiber connectivity 1.06 Gbps (IBM signal)
  - FICON2G—Fiber connectivity 2.125 Gbps (IBM signal)
  - FICON4G—Fiber connectivity 4.25 Gbps (IBM signal)
  - ISC compatibility
  - ISC peer 1G
  - ISC peer 2G
  - ONE_GE—One Gigabit Ethernet 1.125 Gbps
  - Mixed configurations up to maximum line rate of 10.0 Gbps. See the "10.10 MXP_MR_10DME_C and MXP_MR_10DME_L Cards" section on page 10-55 for more information on mixed-mode operation.
- Client ports: 8x SFP
- Line (trunk side)
  - Bit rate: 9.952 Gbps for OC-192/STM-64
  - Code: Scrambled NRZ
  - Fiber: 1550-nm single-mode
  - Loopback modes: Terminal and facility

Caution You must use a 20-dB fiber attenuator (15 to 25 dB) when working with the MXP_MR_10DME_C card in a loopback on the trunk port. Do not use direct fiber loopbacks with the MXP_MR_10DME_C cards. Using direct fiber loopbacks causes irreparable damage to the MXP_MR_10DME_C cards.

  - Connectors: LC
- Transmitter (trunk side)
  - Minimum output power: +3 dBm
  - Maximum output power: +6 dBm
  - Minimum Single-Mode Suppression Ratio (SMSR): 30 dB
  - Minimum optical extinction ratio: 10 dB
  - 41 wavelength tunability at 100-GHz spacing
  - Receiver maximum return reflectance (Rx return loss): –27 dB
  - Chromatic dispersion allowance: 5400 ps/nm, giving an optical power penalty < 2.0 dB
  - Minimum side mode suppression ratio: 30 dB
  - Wavelength stability (drift): +/– 25 picometers (pm)

Note An optical device on the card keeps the laser wavelength locked as closely as possible to the ITU nominal value. The allowed drift is +/– 25 pm.

  - For available wavelengths for the MXP_MR_10DME_C card, see Table 10-29 on page 10-61.
- For the receiver trunk side, see Table A-43:

Table A-43 MXP_MR_10DME_C Card Receiver Trunk Side Specifications

FEC Applications	OSNR[1]	Pre-FEC BER	Post-FEC BER	Input Power Sensitivity	Chromatic Dispersion Tolerance	Power Penalty	OSNR Penalty
None	23 dB	< 10 exp – 12	—	–8 to –20 dBm	+/– 1200 ps/nm	2 dBm	—
	19 dB	< 10 exp – 12	—	–9 to –22 dBm	+/– 1000 ps/nm	2 dBm	—
FEC	10 dB	< 10 exp – 5	< 10 exp – 15	–8 to –18 dBm	+/– 800 ps/nm	—	1.5 dB
Enhanced FEC	19 dB	< 10 exp – 4	< 10 exp – 15	–8 to –26 dBm	+/– 800 ps/nm	2 dBm	2 dB
	8 dB	< 10 exp – 4	< 10 exp – 15	–8 to –18 dBm	+/– 800 ps/nm	2 dBm	1.5 dB

1. OSNR defined with 0.5 nm RBW

  - Receiver: APD
  - Link loss budget: 24 dB minimum, with no dispersion or 22 dB optical path loss at BER = 1 * 10 exp – 12 including dispersion
  - Receiver input wavelength range: 1529 to 1562 nm
- Line (client side)
  - Bit rate: 1.06 Gbps to 4.25 Gbps per client
  - Code: Scrambled NRZ
  - Fiber: Based on SFP (1310-nm single-mode or 850-nm multimode)
  - Maximum chromatic dispersion allowance: Based on SFP
  - Loopback modes: Terminal and facility
  - Connectors: LC
- Transmitter (client side)
  - Maximum transmitter output power: –1 dBm
  - Minimum transmitter output power: –6 dBm
  - Center wavelength: Based on SFP
  - Nominal wavelength: Based on SFP
  - Transmitter: Based on SFP
- Receiver (client side)
  - Maximum receiver level: –1 dBm at BER 1 * 10 exp – 12
  - Minimum receiver level: –14 dBm at BER 1 * 10 exp – 12
  - Receiver: APD
  - Link loss budget: 8 dB minimum, at BER = 1 * 10 exp – 12
  - Receiver input wavelength range: 1290 to 1605 nm or 850nm
- Dimensions
  - Height: 12.650 in. (321.3 mm)
  - Width: 0.921 in. (23.4 mm) (The dimension of the finger gasket is not included)
  - Depth: 9.000 in. (228.6 mm)
  - Depth with backplane connector: 9.250 in. (235 mm)

- Weight not including clam shell: 2.25 lb (1.02 kg)

A.10.10 MXP_MR_10DME_L Card Specifications

The MXP_MR_10DME_L card has the following specifications:

- Payload configuration
  - FC1G—Fibre Channel 1.06 Gbps
  - FC2G—Fibre Channel 2.125 Gbps
  - FC4G—Fibre Channel 4.25 Gbps
  - FICON1G—Fiber connectivity 1.06 Gbps (IBM signal)
  - FICON2G—Fiber connectivity 2.125 Gbps (IBM signal)
  - FICON4G—Fiber connectivity 4.25 Gbps (IBM signal)
  - ISC compatibility
  - ISC peer 1G
  - ISC peer 2G
  - ONE_GE—One Gigabit Ethernet 1.125 Gbps
  - Mixed configurations up to maximum line rate of 10.0 Gbps. See the "10.10 MXP_MR_10DME_C and MXP_MR_10DME_L Cards" section on page 10-55 for more information on mixed-mode operation.
- Client ports: 8x SFP
- Line (trunk side)
  - Bit rate: 9.952 Gbps for OC-192/STM-64
  - Code: Scrambled NRZ
  - Fiber: 1550-nm single-mode
  - Loopback modes: Terminal and facility

Caution You must use a 20-dB fiber attenuator (15 to 25 dB) when working with the MXP_MR_10DME_L card in a loopback on the trunk port. Do not use direct fiber loopbacks with the MXP_MR_10DME_L cards. Using direct fiber loopbacks causes irreparable damage to the MXP_MR_10DME_L cards.

  - Connectors: LC
- Transmitter (trunk side)
  - Minimum output power: +3 dBm
  - Maximum output power: +6 dBm
  - Minimum SMSR: 30 dB
  - Minimum optical extinction ratio: 10.5 dB
  - 40 wavelength tunability at 100-GHz spacing, 80 wavelength tunability at 50-GHz spacing
  - Receiver maximum return reflectance (Rx return loss): –27 dB
  - Chromatic dispersion allowance: 5400 ps/nm, giving an optical power penalty < 2.0 dB

  - Minimum side mode suppression ratio: 30 dB
  - Wavelength stability (drift): +/– 25 picometers (pm)

Note An optical device on the card keeps the laser wavelength locked as closely as possible to the ITU nominal value. The allowed drift is +/– 25 pm.

  - For the currently available wavelengths for the MXP_MR_10DME_L card, see Table 10-30 on page 10-62.

- Table A-44 provides the receiver trunk side specifications:

Table A-44 MXP_MR_10DME_L Card Receiver Trunk Side Specifications

FEC Applications	OSNR[1]	Pre-FEC BER	Post-FEC BER	Input Power Sensitivity	Chromatic Dispersion Tolerance	Power Penalty	OSNR Penalty
None	23 dB	< 10 exp – 12	—	–8 to –19 dBm	+/– 1200 ps/nm	2 dBm	—
	19 dB	< 10 exp – 12	—	–9 to –19 dBm	+/– 1000 ps/nm	2 dBm	—
FEC	10 dB	< 10 exp – 5	< 10 exp – 15	–8 to –18 dBm	+/– 800 ps/nm	—	1.5 dB
Enhanced FEC	19 dB	< 10 exp – 4	< 10 exp – 15	–8 to –26 dBm	+/– 800 ps/nm	—	2 dB
	8 dB	< 10 exp – 4	< 10 exp – 15	–8 to –18 dBm	+/– 800 ps/nm	—	1.5 dB

1. OSNR defined with 0.5 nm RBW

  - Receiver: APD
  - Link loss budget: 24 dB minimum, with no dispersion or 22 dB optical path loss at BER = 1 * 10 exp – 12 including dispersion
  - Receiver input wavelength range: 1570 to 1604 nm

- Line (client side)
  - Bit rate: 1.06 Gbps to 4.25 Gbps per client
  - Code: Scrambled NRZ
  - Fiber: Based on SFP (1310-nm single-mode or 850-nm multimode)
  - Maximum chromatic dispersion allowance: Based on SFP
  - Loopback modes: Terminal and facility
  - Connectors: LC
- Transmitter (client side)
  - Maximum transmitter output power: –1 dBm
  - Minimum transmitter output power: –6 dBm
  - Center wavelength: Based on SFP
  - Nominal wavelength: Based on SFP
  - Transmitter: Based on SFP
- Receiver (client side)
  - Maximum receiver level: –1 dBm at BER 1 * 10 exp – 12
  - Minimum receiver level: –14 dBm at BER 1 * 10 exp – 12

  - Receiver: APD
  - Link loss budget: 8 dB minimum, at BER = 1 * 10 exp – 12
  - Receiver input wavelength range: 1290 to 1605 nm or 850nm
- Dimensions
  - Height: 12.650 in. (321.3 mm)
  - Width: 0.921 in. (23.4 mm) (The dimension of the finger gasket is not included)
  - Depth: 9.000 in. (228.6 mm)
  - Depth with backplane connector: 9.250 in. (235 mm)
  - Weight not including clam shell: 2.25 lb (1.02 kg)

A.10.11 MXP_MR_10DMEX_C Card Specifications

The MXP_MR_10DMEX_C card has the following specifications:

- Payload configuration
  - FC1G—Fibre Channel 1.06 Gbps
  - FC2G—Fibre Channel 2.125 Gbps
  - FC4G—Fibre Channel 4.25 Gbps
  - FICON1G—Fiber connectivity 1.06 Gbps (IBM signal)
  - FICON2G—Fiber connectivity 2.125 Gbps (IBM signal)
  - FICON4G—Fiber connectivity 4.25 Gbps (IBM signal)
  - ISC compatibility
  - ISC peer 1G
  - ISC peer 2G
  - ONE_GE—One Gigabit Ethernet 1.125 Gbps
  - Mixed configurations up to maximum line rate of 10.0 Gbps.
- Client ports: 8x SFP
- Line (trunk side)
  - Bit rate: 9.952 Gbps for OC-192/STM-64
  - Code: Scrambled NRZ
  - Fiber: 1550-nm single-mode
  - Loopback modes: Terminal and facility

Caution You must use a 20-dB fiber attenuator (15 to 25 dB) when working with the MXP_MR_10DMEX_C card in a loopback on the trunk port. Do not use direct fiber loopbacks with the MXP_MR_10DMEX_C cards. Using direct fiber loopbacks causes irreparable damage to the MXP_MR_10DMEX_C cards.

  - Connectors: LC
- Transmitter (trunk side)

- Minimum output power: +3 dBm
- Maximum output power: +7 dBm
- Minimum Single-Mode Suppression Ratio (SMSR): 30 dB
- Minimum optical extinction ratio: 10 dB
- 41 wavelength tunability at 100-GHz spacing
- Receiver maximum return reflectance (Rx return loss): –27 dB
- Chromatic dispersion allowance: 5400 ps/nm, giving an optical power penalty < 2.0 dB
- Minimum side mode suppression ratio: 30 dB
- Wavelength stability (drift): +/– 25 picometers (pm)

Note An optical device on the card keeps the laser wavelength locked as closely as possible to the ITU nominal value. The allowed drift is +/– 25 pm.

- For available wavelengths for the MXP_MR_10DMEX_C card, see Table 10-29 on page 10-61.

- For the receiver trunk side, see Table A-45:

Table A-45 MXP_MR_10DMEX_C Card Receiver Trunk Side Specifications

OSNR[1]	FEC Type	Pre-FEC BER	Post-FEC BER	Input Power Sensitivity[2]	Chromatic Dispersion Tolerance	PMD tolerance
16 dB	Standard	< 10 exp – 5	< 10 exp – 15	– 8 to – 20 dBm	+/– 1600 ps/nm	—
15 dB	Standard	< 10 exp – 5	< 10 exp – 15	– 8 to – 20 dBm	—	—
TBD	Standard	< 10 exp – 5	< 10 exp – 15	– 8 to – 20 dBm	—	[3]
12.5 dB	Enhanced	< 7 x 10 exp – 4	< 10 exp – 15	– 8 to – 20 dBm	—	—
17 dB	Enhanced	< 7 x 10 exp – 4	< 10 exp – 15	– 8 to – 20 dBm	+/- 4000 ps/nm	—
15.2 dB	Enhanced	< 7 x 10 exp – 4	< 10 exp – 15	– 8 to – 20 dBm	+/- 2500 ps/nm	—
17.4 dB	Enhanced	< 7 x 10 exp – 4	< 10 exp – 15	– 8 to – 20 dBm		[3]

1. OSNR defined with 0.1 nm RBW
2. Receiver filter bandwidth 32.5GHz (at - 3 dBm)
3. PMD = 30 ps; DGD = 90 ps, hence PMD = 3000 ps^2

- Receiver: APD
- Link loss budget: 24 dB minimum, with no dispersion or 22 dB optical path loss at BER = 1 * 10 exp – 12 including dispersion
- Receiver input wavelength range: 1529 to 1562 nm

- Line (client side)
  - Bit rate: 1.06 Gbps to 4.25 Gbps per client

  - Code: Scrambled NRZ
  - Fiber: Based on SFP (1310-nm single-mode or 850-nm multimode)
  - Maximum chromatic dispersion allowance: Based on SFP
  - Loopback modes: Terminal and facility
  - Connectors: LC
- Transmitter (client side)
  - Maximum transmitter output power: –1 dBm
  - Minimum transmitter output power: –6 dBm
  - Center wavelength: Based on SFP
  - Nominal wavelength: Based on SFP
  - Transmitter: Based on SFP
- Receiver (client side)
  - Maximum receiver level: –1 dBm at BER 1 * 10 exp – 12
  - Minimum receiver level: –14 dBm at BER 1 * 10 exp – 12
  - Receiver: APD
  - Link loss budget: 8 dB minimum, at BER = 1 * 10 exp – 12
  - Receiver input wavelength range: 1290 to 1605 nm or 850nm
- Dimensions
  - Height: 12.650 in. (321.3 mm)
  - Width: 0.921 in. (23.4 mm) (The dimension of the finger gasket is not included)
  - Depth: 9.000 in. (228.6 mm)
  - Depth with backplane connector: 9.250 in. (235 mm)
  - Weight not including clam shell: 2.25 lb (1.02 kg)

A.10.12 TXP_MR_10E Card Specifications

The TXP_MR_10E card has the following specifications:

- Line (trunk side)
  - Bit rate: OC-192/STM-64 (9.95328 Gbps), OTU2 (10.70923 Gbps), 10GE (10.3125 Gbps), 10GE into OTU2 (non-standard 11.0957 Gbps), 10G FC (10.51875 Gbps), or 10G FC into OTU2 (non-standard 11.31764 Gbps)
  - Code: Scrambled NRZ
  - Fiber: 1550-nm single-mode
  - Maximum chromatic dispersion allowance: +/– 1200 ps/nm (specified penalty)
  - Loopback modes: Terminal and facility

Caution You must use a 15-dB fiber attenuator (10 to 20 dB) when working with the TXP_MR_10E card in a loopback on the trunk port. Do not use direct fiber loopbacks with the TXP_MR_10E card. Using direct fiber loopbacks causes irreparable damage to the TXP_MR_10E card.

  - Connectors: LC
- Transmitter (trunk side)
  - Maximum transmitter output power: +6 dBm
  - Minimum transmitter output power: +3 dBm for C-band and +2 dBm for L-band
  - Transmitter: LN external modulator transmitter
  - Wavelength stability (drift): +/– 25 picometers (pm)

Note An optical device on the card keeps the laser wavelength locked as closely as possible to the ITU nominal value. The allowed drift is +/– 25 pm.

- Currently available wavelengths and versions of TXP_MR_10E:

  C-band frequency plan (eight card versions, each with four tunable channels on the ITU 100-GHz grid):
  - 1530.33 to 1533.07 nm (four channels)
  - 1534.25 to 1537.00 nm (four channels)
  - 1538.19 to 1540.95 nm (four channels)
  - 1542.14 to 1544.92 nm (four channels)
  - 1546.12 to 1548.92 nm (four channels)
  - 1550.12 to 1552.93 nm (four channels)
  - 1554.13 to 1556.96 nm (four channels)
  - 1558.17 to 1561.01 nm (four channels)

  L-band frequency plan (five card versions, each with eight tunable channels on the ITU 50-GHz grid):
  - 1577.44 to 1580.35 nm (eight channels)
  - 1580.77 to 1583.69 nm (eight channels)
  - 1584.11 to 1587.04 nm (eight channels)
  - 1587.46 to 1590.41 nm (eight channels)
  - 1590.83 to 1593.79 nm (eight channels)
- Receiver (trunk side, see Table A-46)

Table A-46 TXP_MR_10E Card Receiver Trunk Side Specifications

OSNR[1]	FEC Type	Pre-FEC BER	Post-FEC BER	Input Power Sensitivity[2]	Chromatic Dispersion Tolerance
30 dB	Off	< 10 exp – 12	N/A	– 8 to – 20 dBm	+/– 1200 ps/nm
26 dB	Off	< 10 exp – 12	N/A	– 8 to – 20 dBm	+ – 1000 ps/nm
26 dB	Off	< 10 exp – 12	N/A	– 8 to – 22 dBm	—
17 dB	Standard	< 10 exp – 5	< 10 exp – 15	– 8 to – 18 dBm	+/– 800 ps/nm
15 dB	Standard	< 10 exp – 5	< 10 exp – 15	– 8 to – 18 dBm	—

Table A-46 TXP_MR_10E Card Receiver Trunk Side Specifications (continued)

OSNR[1]	FEC Type	Pre-FEC BER	Post-FEC BER	Input Power Sensitivity[2]	Chromatic Dispersion Tolerance
15 dB	Enhanced	< 7 x 10 exp – 4	< 10 exp – 15	– 8 to – 18 dBm	+/– 800 ps/nm
14 dB	Enhanced	< 7 x 10 exp – 4	< 10 exp – 15	– 8 to – 18 dBm	—

1. OSNR defined with 0.1 nm RBW
2. Receiver filter bandwidth greater than or equal to 180 pm (at – 3 dBm)

  - Receiver: APD
  - Link loss budget: 24 dB minimum, with no dispersion or 22 dB optical path loss at BER = 1 * 10 exp – 12 including dispersion
- Line (client side):
  - 10-Gigabit Small Form-factor Pluggable (XFP)-based SR
  - Bit rate: 10GE (10.3125 Gbps), 10G FC (10.51875 Gbps), or STM-64/OC-192
  - Code: Scrambled NRZ
  - Fiber: 1310-nm single-mode
  - Maximum chromatic dispersion allowance: 6.6 ps/nm
  - Loopback modes: Terminal and facility
  - Connectors: LC
  - Compliance: Telcordia GR-253-CORE, ITU-T G.707, ITU-T G.957, ITU-T G.691
- Transmitter (client side)
  - Maximum transmitter output power: –1 dBm
  - Minimum transmitter output power: –6 dBm
  - Center wavelength: 1290 to 1330 nm
  - Nominal wavelength: 1310 nm
  - Transmitter: DFB laser
- Receiver (client side)
  - Maximum receiver level: –1 dBm at BER 1 * 10 exp – 12
  - Minimum receiver level: –14 dBm at BER 1 * 10 exp – 12
  - Receiver: APD
  - Link loss budget: 8 dB minimum, at BER = 1 * 10 exp – 12
  - Receiver input wavelength range: 1290 to 1605 nm
- Dimensions
  - Height: 12.650 in. (321.3 mm)
  - Width: 0.921 in. (23.4 mm) (The dimension of the finger gasket is not included)
  - Depth: 9.000 in. (228.6 mm)
  - Depth with backplane connector: 9.250 in. (235 mm)
  - Weight not including clam shell: 3.1 lb (1.3 kg)

A.10.13 TXP_MR_10E_C Card Specifications

The TXP_MR_10E_C card has the following specifications:

- Line (trunk side)
  - Bit rate: OC-192/STM-64 (9.95328 Gbps), OTU2 (10.70923 Gbps), 10GE (10.3125 Gbps), 10GE into OTU2 (non-standard 11.0957 Gbps), 10G FC (10.51875 Gbps), or 10G FC into OTU2 (non-standard 11.31764 Gbps)
  - Code: Scrambled NRZ
  - Fiber: 1550-nm single-mode
  - Maximum chromatic dispersion allowance: +/– 1200 ps/nm (specified penalty)
  - Loopback modes: Terminal and facility

Caution You must use a 15-dB fiber attenuator (10 to 20 dB) when working with the TXP_MR_10E_C card in a loopback on the trunk port. Do not use direct fiber loopbacks with the TXP_MR_10E_C card. Using direct fiber loopbacks causes irreparable damage to the TXP_MR_10E_C card.

  - Connectors: LC
  - Compliance: Telcordia GR-253-CORE, ITU-T G.707, ITU-T G.957, and ITU-T G.709
- Transmitter (trunk side)
  - Maximum transmitter output power: +6 dBm
  - Minimum transmitter output power: +3 dBm
  - Transmitter: LN external modulator transmitter
  - Wavelength stability (drift): +/– 25 picometers (pm)

Note An optical device on the card keeps the laser wavelength locked as closely as possible to the ITU nominal value. The allowed drift is +/– 25 pm.

- Currently available wavelengths and versions of TXP_MR_10E_C card:

  There is a single version of the TXP_MR_10E_C card. It is tunable across 82 wavelengths in the C-band frequency plan, with channels on the ITU 50-GHz grid, as shown in Table A-47.

Table A-47 TXP_MR_10E_C Card Trunk Wavelengths

Channel Number	Frequency (THz)	Wavelength (nm)	Channel Number	Frequency (THz)	Wavelength (nm)
1	196.00	1529.55	42	193.95	1545.72
2	195.95	1529.94	43	193.90	1546.119
3	195.90	1530.334	44	193.85	1546.518
4	195.85	1530.725	45	193.80	1546.917
5	195.80	1531.116	46	193.75	1547.316
6	195.75	1531.507	47	193.70	1547.715

Table A-47 TXP_MR_10E_C Card Trunk Wavelengths (continued)

Channel Number	Frequency (THz)	Wavelength (nm)	Channel Number	Frequency (THz)	Wavelength (nm)
7	195.70	1531.898	48	193.65	1548.115
8	195.65	1532.290	49	193.60	1548.515
9	195.60	1532.681	50	193.55	1548.915
10	195.55	1533.073	51	193.50	1549.32
11	195.50	1533.47	52	193.45	1549.71
12	195.45	1533.86	53	193.40	1550.116
13	195.40	1534.250	54	193.35	1550.517
14	195.35	1534.643	55	193.30	1550.918
15	195.30	1535.036	56	193.25	1551.319
16	195.25	1535.429	57	193.20	1551.721
17	195.20	1535.822	58	193.15	1552.122
18	195.15	1536.216	59	193.10	1552.524
19	195.10	1536.609	60	193.05	1552.926
20	195.05	1537.003	61	193.00	1553.33
21	195.00	1537.40	62	192.95	1553.73
22	194.95	1537.79	63	192.90	1554.134
23	194.90	1538.186	64	192.85	1554.537
24	194.85	1538.581	65	192.80	1554.940
25	194.80	1538.976	66	192.75	1555.343
26	194.75	1539.371	67	192.70	1555.747
27	194.70	1539.766	68	192.65	1556.151
28	194.65	1540.162	69	192.60	1556.555
29	194.60	1540.557	70	192.55	1556.959
30	194.55	1540.953	71	192.50	1557.36
31	194.50	1541.35	72	192.45	1557.77
32	194.45	1541.75	73	192.40	1558.173
33	194.40	1542.142	74	192.35	1558.578
34	194.35	1542.539	75	192.30	1558.983
35	194.30	1542.936	76	192.25	1559.389
36	194.25	1543.333	77	192.20	1559.794
37	194.20	1543.730	78	192.15	1560.200
38	194.15	1544.128	79	192.10	1560.606
39	194.10	1544.526	80	192.05	1561.013
40	194.05	1544.924	81	192.00	1561.42
41	194.00	1545.32	82	191.95	1561.83

- Receiver (trunk side, see Table A-48)

Table A-48 TXP_MR_10E _C Card Receiver Trunk Side Specifications

OSNR[1]	FEC Type	Pre-FEC BER	Post-FEC BER	Input Power Sensitivity[2]	Chromatic Dispersion Tolerance
30 dB	Off	< 10 exp – 12	N/A	– 8 to – 18 dBm	+/– 1200 ps/nm
26 dB	Off	< 10 exp – 12	N/A	– 8 to – 18 dBm	+ – 1000 ps/nm
26 dB	Off	< 10 exp – 12	N/A	– 8 to – 18 dBm	—
17 dB	Standard	< 10 exp – 5	< 10 exp – 15	– 8 to – 18 dBm	+/– 800 ps/nm
15.5 dB	Standard	< 10 exp – 5	< 10 exp – 15	– 8 to – 18 dBm	—
14 dB	Enhanced	< 7 x 10 exp – 4	< 10 exp – 15	– 8 to – 18 dBm	+/– 800 ps/nm
12 dB	Enhanced	< 7 x 10 exp – 4	< 10 exp – 15	– 8 to – 18 dBm	—

1. OSNR defined with 0.1 nm RBW
2. Receiver filter bandwidth 32.5GHz (at - 3 dB)

  - Receiver: APD
  - Link loss budget: 24 dB minimum, with no dispersion or 22 dB optical path loss at BER = 1 * 10 exp – 12 including dispersion
  - Receiver input wavelength range: 1529 to 1562 nm
- Line (client side):
  - XFP-based SR
  - Bit rate: 10GE (10.3125 Gbps), 10G FC (10.51875 Gbps), or STM-64/OC-192
  - Code: Scrambled NRZ
  - Fiber: 1310-nm single-mode
  - Maximum chromatic dispersion allowance: 6.6 ps/nm
  - Loopback modes: Terminal and facility
  - Connectors: LC
- Transmitter (client side)
  - Maximum transmitter output power: –1 dBm
  - Minimum transmitter output power: –6 dBm
  - Center wavelength: 1290 to 1330 nm
  - Nominal wavelength: 1310 nm
  - Transmitter: DFB laser
- Receiver (client side)
  - Maximum receiver level: –1 dBm at BER 1 * 10 exp – 12
  - Minimum receiver level: –14 dBm at BER 1 * 10 exp – 12
  - Receiver: APD
  - Link loss budget: 8 dB minimum, at BER = 1 * 10 exp – 12
  - Receiver input wavelength range: 1290 to 1605 nm

- Dimensions
  - Height: 12.650 in. (321.3 mm)
  - Width: 0.921 in. (23.4 mm) (The dimension of the finger gasket is not included)
  - Depth: 9.000 in. (228.6 mm)
  - Depth with backplane connector: 9.250 in. (235 mm)
  - Weight not including clam shell: 3.1 lb (1.3 kg)

A.10.14 TXP_MR_10E_L Card Specifications

The TXP_MR_10E_L card has the following specifications:

- Line (trunk side)
  - Bit rate: OC-192/STM-64 (9.95328 Gbps), OTU2 (10.70923 Gbps), 10GE (10.3125 Gbps), 10GE into OTU2 (non-standard 11.0957 Gbps), 10G FC (10.51875 Gbps), or 10G FC into OTU2 (non-standard 11.31764 Gbps)
  - Code: Scrambled NRZ
  - Fiber: 1550-nm single-mode
  - Maximum chromatic dispersion allowance: +/– 1200 ps/nm (specified penalty)
  - Loopback modes: Terminal and facility

Caution You must use a 15-dB fiber attenuator (10 to 20 dB) when working with the TXP_MR_10E_L card in a loopback on the trunk port. Do not use direct fiber loopbacks with the TXP_MR_10E_L card. Using direct fiber loopbacks causes irreparable damage to the TXP_MR_10E_L card.

  - Connectors: LC
- Transmitter (trunk side)
  - Maximum transmitter output power: +6 dBm
  - Minimum transmitter output power: +2 dBm
  - Transmitter: LN external modulator transmitter
  - Wavelength stability (drift): +/– 25 picometers (pm)

Note An optical device on the card keeps the laser wavelength locked as closely as possible to the ITU nominal value. The allowed drift is +/– 25 pm.

- Currently available wavelengths and versions of TXP_MR_10E_L card:

  There is a single version of the TXP_MR_10E_L card. It is tunable across 80 wavelengths in the L band frequency plan, with channels on the ITU 50-GHz grid, as shown in Table A-49.

Table A-49 TXP_MR_10E_L Card Trunk Wavelengths

Channel Number	Frequency (THz)	Wavelength (nm)	Channel Number	Frequency (THz)	Wavelength (nm)
1	190.85	1570.83	41	188.85	1587.46
2	190.8	1571.24	42	188.8	1587.88
3	190.75	1571.65	43	188.75	1588.30
4	190.7	1572.06	44	188.7	1588.73
5	190.65	1572.48	45	188.65	1589.15
6	190.6	1572.89	46	188.6	1589.57
7	190.55	1573.30	47	188.55	1589.99
8	190.5	1573.71	48	188.5	1590.41
9	190.45	1574.13	49	188.45	1590.83
10	190.4	1574.54	50	188.4	1591.26
11	190.35	1574.95	51	188.35	1591.68
12	190.3	1575.37	52	188.3	1592.10
13	190.25	1575.78	53	188.25	1592.52
14	190.2	1576.20	54	188.2	1592.95
15	190.15	1576.61	55	188.15	1593.37
16	190.1	1577.03	56	188.1	1593.79
17	190.05	1577.44	57	188.05	1594.22
18	190	1577.86	58	188	1594.64
19	189.95	1578.27	59	187.95	1595.06
20	189.9	1578.69	60	187.9	1595.49
21	189.85	1579.10	61	187.85	1595.91
22	189.8	1579.52	62	187.8	1596.34
23	189.75	1579.93	63	187.75	1596.76
24	189.7	1580.35	64	187.7	1597.19
25	189.65	1580.77	65	187.65	1597.62
26	189.6	1581.18	66	187.6	1598.04
27	189.55	1581.60	67	187.55	1598.47
28	189.5	1582.02	68	187.5	1598.89
29	189.45	1582.44	69	187.45	1599.32
30	189.4	1582.85	70	187.4	1599.75
31	189.35	1583.27	71	187.35	1600.17
32	189.3	1583.69	72	187.3	1600.60
33	189.25	1584.11	73	187.25	1601.03
34	189.2	1584.53	74	187.2	1601.46
35	189.15	1584.95	75	187.15	1601.88

Table A-49 TXP_MR_10E_L Card Trunk Wavelengths (continued)

Channel Number	Frequency (THz)	Wavelength (nm)	Channel Number	Frequency (THz)	Wavelength (nm)
36	189.1	1585.36	76	187.1	1602.31
37	189.05	1585.78	77	187.05	1602.74
38	189	1586.20	78	187	1603.17
39	188.95	1586.62	79	186.95	1603.60
40	188.9	1587.04	80	186.9	1604.03

- Receiver (trunk side, see Table A-50)

Table A-50 TXP_MR_10E Card Receiver Trunk Side Specifications

OSNR[1]	FEC Type	Pre-FEC BER	Post-FEC BER	Input Power Sensitivity[2]	Chromatic Dispersion Tolerance
30 dB	Off	< 10 exp – 12	N/A	– 8 to – 20 dBm	+/– 1200 ps/nm
26 dB	Off	< 10 exp – 12	N/A	– 8 to – 20 dBm	+ – 1000 ps/nm
26 dB	Off	< 10 exp – 12	N/A	– 8 to – 22 dBm	—
17 dB	Standard	< 10 exp – 5	< 10 exp – 15	– 8 to – 18 dBm	+/– 800 ps/nm
15.5 dB	Standard	< 10 exp – 5	< 10 exp – 15	– 8 to – 18 dBm	—
15 dB	Enhanced	< 7 x 10 exp – 4	< 10 exp – 15	– 8 to – 18 dBm	+/– 800 ps/nm
13 dB	Enhanced	< 7 x 10 exp – 4	< 10 exp – 15	– 8 to – 18 dBm	—

1. OSNR defined with 0.1 nm RBW
2. Receiver filter bandwidth greater than or equal to 180 pm (at – 3 dBm)

  - Receiver: APD
  - Link loss budget: 24 dB minimum, with no dispersion or 22 dB optical path loss at BER = 1 * 10 exp – 12 including dispersion
  - Receiver input wavelength range: 1570 to 1604 nm
- Line (client side):
  - XFP-based SR
  - Bit rate: 10GE (10.3125 Gbps), 10G FC (10.51875 Gbps), or STM-64/OC-192
  - Code: Scrambled NRZ
  - Fiber: 1310-nm single-mode
  - Maximum chromatic dispersion allowance: 6.6 ps/nm
  - Loopback modes: Terminal and facility
  - Connectors: LC
- Transmitter (client side)
  - Maximum transmitter output power: –1 dBm
  - Minimum transmitter output power: –6 dBm

  - Center wavelength: 1290 to 1330 nm
  - Nominal wavelength: 1310 nm
  - Transmitter: DFB laser
- Receiver (client side)
  - Maximum receiver level: –1 dBm at BER 1 * 10 exp – 12
  - Minimum receiver level: –14 dBm at BER 1 * 10 exp – 12
  - Receiver: APD
  - Link loss budget: 8 dB minimum, at BER = 1 * 10 exp – 12
  - Receiver input wavelength range: 1290 to 1605 nm
- Dimensions
  - Height: 12.650 in. (321.3 mm)
  - Width: 0.921 in. (23.4 mm) (The dimension of the finger gasket is not included)
  - Depth: 9.000 in. (228.6 mm)
  - Depth with backplane connector: 9.250 in. (235 mm)
  - Weight not including clam shell: 3.1 lb (1.3 kg)

A.10.15 TXP_MR_10EX_C Card Specifications

The TXP_MR_10EX_C card has the following specifications:

- Line (trunk side)
  - Bit rate: OC-192/STM-64 (9.95328 Gbps), OTU2 (10.70923 Gbps), 10GE (10.3125 Gbps), 10GE into OTU2 (non-standard 11.0957 Gbps), 10G FC (10.51875 Gbps), or 10G FC into OTU2 (non-standard 11.31764 Gbps)
  - Code: Scrambled NRZ
  - Fiber: 1550-nm single-mode
  - Maximum chromatic dispersion allowance: +/– 1600 ps/nm (specified penalty)
  - Loopback modes: Terminal and facility

Caution You must use a 15-dB fiber attenuator (10 to 20 dB) when working with the TXP_MR_10EX_C card in a loopback on the trunk port. Do not use direct fiber loopbacks with the TXP_MR_10EX_C card. Using direct fiber loopbacks causes irreparable damage to the TXP_MR_10EX_C card.

  - Connectors: LC
  - Compliance: Telcordia GR-253-CORE, ITU-T G.707, ITU-T G.957, and ITU-T G.709
- Transmitter (trunk side)
  - Maximum transmitter output power: +6 dBm
  - Minimum transmitter output power: +3 dBm
  - Transmitter: LN external modulator transmitter
  - Wavelength stability (drift): +/– 25 picometers (pm)

Note An optical device on the card keeps the laser wavelength locked as closely as possible to the ITU nominal value. The allowed drift is +/– 25 pm.

- Currently available wavelengths and versions of TXP_MR_10EX_C card:

  There is a single version of the TXP_MR_10EX_C card. It is tunable across 82 wavelengths in the C-band frequency plan, with channels on the ITU 50-GHz grid, as shown in Table A-51.

Table A-51 TXP_MR_10EX_C Card Trunk Wavelengths

Channel Number	Frequency (THz)	Wavelength (nm)	Channel Number	Frequency (THz)	Wavelength (nm)
1	196.00	1529.55	42	193.95	1545.72
2	195.95	1529.94	43	193.90	1546.12
3	195.90	1530.334	44	193.85	1546.52
4	195.85	1530.725	45	193.80	1546.92
5	195.80	1531.116	46	193.75	1547.32
6	195.75	1531.507	47	193.70	1547.72
7	195.70	1531.898	48	193.65	1548.11
8	195.65	1532.290	49	193.60	1548.51
9	195.60	1532.681	50	193.55	1548.91
10	195.55	1533.073	51	193.50	1549.32
11	195.50	1533.47	52	193.45	1549.72
12	195.45	1533.86	53	193.40	1550.12
13	195.40	1534.250	54	193.35	1550.52
14	195.35	1534.643	55	193.30	1550.92
15	195.30	1535.036	56	193.25	1551.32
16	195.25	1535.429	57	193.20	1551.72
17	195.20	1535.822	58	193.15	1552.12
18	195.15	1536.216	59	193.10	1552.52
19	195.10	1536.609	60	193.05	1552.93
20	195.05	1537.003	61	193.00	1553.33
21	195.00	1537.40	62	192.95	1553.73
22	194.95	1537.79	63	192.90	1554.13
23	194.90	1538.186	64	192.85	1554.54
24	194.85	1538.581	65	192.80	1554.94
25	194.80	1538.976	66	192.75	1555.34
26	194.75	1539.371	67	192.70	1555.75
27	194.70	1539.766	68	192.65	1556.15
28	194.65	1540.162	69	192.60	1556.55
29	194.60	1540.557	70	192.55	1556.96

Table A-51 TXP_MR_10EX_C Card Trunk Wavelengths (continued)

Channel Number	Frequency (THz)	Wavelength (nm)	Channel Number	Frequency (THz)	Wavelength (nm)
30	194.55	1540.953	71	192.50	1557.36
31	194.50	1541.35	72	192.45	1557.77
32	194.45	1541.75	73	192.40	1558.17
33	194.40	1542.142	74	192.35	1558.58
34	194.35	1542.539	75	192.30	1558.98
35	194.30	1542.936	76	192.25	1559.39
36	194.25	1543.333	77	192.20	1559.79
37	194.20	1543.730	78	192.15	1560.20
38	194.15	1544.128	79	192.10	1560.61
39	194.10	1544.526	80	192.05	1561.01
40	194.05	1544.924	81	192.00	1561.42
41	194.00	1545.32	82	191.95	1561.83

- Receiver (trunk side, see Table A-48)

Table A-52 TXP_MR_10E _C Card Receiver Trunk Side Specifications

OSNR[1]	FEC Type	Pre-FEC BER	Post-FEC BER	Input Power Sensitivity[2]	Chromatic Dispersion Tolerance	PMD tolerance
16 dB	Standard	< 10 exp – 5	< 10 exp – 15	– 8 to – 20 dBm	+/– 1600 ps/nm	—
15 dB	Standard	< 10 exp – 5	< 10 exp – 15	– 8 to – 20 dBm	—	—
TBD	Standard	< 10 exp – 5	< 10 exp – 15	– 8 to – 20 dBm	—	[3]
12.5 dB	Enhanced	< 7 x 10 exp – 4	< 10 exp – 15	– 8 to – 20 dBm	—	—
17 dB	Enhanced	< 7 x 10 exp – 4	< 10 exp – 15	– 8 to – 20 dBm	+/- 4000 ps/nm	—
15.2 dB	Enhanced	< 7 x 10 exp – 4	< 10 exp – 15	– 8 to – 20 dBm	+/- 2500 ps/nm	—
17.4 dB	Enhanced	< 7 x 10 exp – 4	< 10 exp – 15	– 8 to – 20 dBm		[3]

1. OSNR defined with 0.1 nm RBW
2. Receiver filter bandwidth 32.5GHz (at - 3 dBm)
3. PMD = 30 ps; DGD = 90 ps, hence PMD = 3000 ps^2

  - Receiver: APD
  - Link loss budget: 24 dB minimum, with no dispersion or 22 dB optical path loss at BER = 1 * 10 exp – 12 including dispersion
  - Receiver input wavelength range: 1529 to 1562 nm

- Line (client side):
  - XFP-based SR
  - Bit rate: 10GE (10.3125 Gbps), 10G FC (10.51875 Gbps), or STM-64/OC-192
  - Code: Scrambled NRZ
  - Fiber: 1310-nm single-mode
  - Maximum chromatic dispersion allowance: 6.6 ps/nm
  - Loopback modes: Terminal and facility
  - Connectors: LC
- Transmitter (client side)
  - Maximum transmitter output power: –1 dBm
  - Minimum transmitter output power: –6 dBm
  - Center wavelength: 1290 to 1330 nm
  - Nominal wavelength: 1310 nm
  - Transmitter: DFB laser
- Receiver (client side)
  - Maximum receiver level: –1 dBm at BER 1 * 10 exp – 12
  - Minimum receiver level: –14 dBm at BER 1 * 10 exp – 12
  - Receiver: APD
  - Link loss budget: 8 dB minimum, at BER = 1 * 10 exp – 12
  - Receiver input wavelength range: 1290 to 1605 nm
- Dimensions
  - Height: 12.650 in. (321.3 mm)
  - Width: 0.921 in. (23.4 mm) (The dimension of the finger gasket is not included)
  - Depth: 9.000 in. (228.6 mm)
  - Depth with backplane connector: 9.250 in. (235 mm)
  - Weight not including clam shell: 3.1 lb (1.3 kg)

A.10.16 40G-MXP-C Card Specifications

The 40G-MXP-C card has the following specifications:

- Payload configuration
  - FC8G—Fibre Channel 8.50 Gbps
  - FC10G—Fiber Channel 10.519 Gbps
  - FICON10G—Fiber connectivity 10.519 Gbps
  - OC192/STM64/10GE WAN-Phy—9.953 Gbps
  - 10-GE LAN-Phy—10.312 Gbps
  - OTU2 (OC192/STM64/10GE WAN-Phy)—10.709 Gbps
  - OTU2e (10GE LAN-Phy)—11.096 Gbps

- Client ports: 4 X SFP
- Line (trunk side)
  - Bit rate: 43.018 Gbps for OTU3, 44.57 Gbps for OTU3e
  - Code: RZ-DQPSK 40G
  - Fiber: 1550-nm single-mode
  - Loopback modes: Terminal and facility

Caution You must use a 20-dB fiber attenuator (15 to 25 dB) when working with the 40G-MXP-C card in a loopback on the trunk port. Do not use direct fiber loopbacks with the 40G-MXP-C cards. Using direct fiber loopbacks causes irreparable damage to the 40G-MXP-C cards.

  - Connectors: LC
- Transmitter (trunk side)
  - Minimum output power: –2 dBm
  - Maximum output power: +2 dBm
  - Minimum Single-Mode Suppression Ratio (SMSR): 35 dB
  - Minimum optical extinction ratio: 25 dB
  - Wavelength tunability (total 82 wavelengths) at 50-GHz spacing
  - Receiver maximum return reflectance (Rx return loss): –27 dB
  - Chromatic dispersion allowance: 750 ps/nm, giving an optical OSNR penalty < 2.0 dB
  - Minimum side mode suppression ratio: 30 dB
  - Wavelength stability (drift): +/– 25 picometers (pm)

Note An optical device on the card keeps the laser wavelength locked as closely as possible to the ITU nominal value. The allowed drift is +/– 25 pm.

  - For wavelengths available for the 40G-MXP-C card, see Table 10-29 on page 10-61.
- Receiver (trunk side)
  - Receiver: PIN
  - Link loss budget: 24 dB minimum, with no dispersion or 22 dB optical path loss at BER = 1 * 10 exp – 12 including dispersion
  - Receiver input wavelength range: 1529 to 1562 nm

Table A-53 lists the trunk side specifications of the receiver.

Table A-53 40G-MXP-C Card Receiver (Trunk) Side Specifications

FEC Applications	OSNR[1]	Pre-FEC BER	Post-FEC BER	Input Power Sensitivity	Chromatic Dispersion Tolerance	Power Penalty	OSNR Penalty
FEC	12 dB	< 10 exp – 5	< 10 exp – 15	–8 to –20 dBm	+/– 750 ps/nm	—	2 dB
Enhanced FEC	19 dB	< 10 exp – 3	< 10 exp – 15	–8 to –24 dBm	+/– 750 ps/nm	2 dBm	—
	8 dB	< 10 exp – 3	< 10 exp – 15	–8 to –20 dBm	+/– 750 ps/nm	—	2 dB

1. OSNR defined with 0.5 nm RBW

- Line (client side)
  - Bit rate: 8.50 Gbps to 11.096 Gbps per client
  - Code: NRZ 40G
  - Fiber: Based on SFP (1310-nm single-mode or 850-nm multimode)
  - Maximum chromatic dispersion allowance: Based on XFP
  - Loopback modes: Terminal and facility
  - Connectors: LC
- Transmitter (client side)
  - Maximum transmitter output power: Based on XFP
  - Minimum transmitter output power: Based on XFP
  - Center wavelength: Based on XFP
  - Nominal wavelength: Based on XFP
  - Transmitter: Based on XFP
- Receiver (client side)
  - Maximum receiver level: Based on XFP
  - Minimum receiver level: Based on XFP
  - Receiver: Based on XFP
  - Link loss budget: Based on XFP
  - Receiver input wavelength range: Based on XFP
- Environmental Exception
  - Short term ambient temperature: Functionality is guaranteed, according to GR-63 Issue 3 for the thermal cycles except for the temperature values which are -5 to 45 degrees Celsius (23 to 113 degrees Fahrenheit) instead of -5 to 55 degrees Celsius (23 to 131 degrees Fahrenheit).
- Dimensions
  - Height: 12.650 in. (321.3 mm)
  - Width: 1.866 in. (47.4 mm) (The dimension of the finger gasket is not included)
  - Depth: 9.000 in. (228.6 mm)
  - Depth with backplane connector: 9.250 in. (235 mm)
  - Weight excluding clam shell: 7.7 lb (3.5 kg)

A.10.17 ADM-10G Card Specifications

The ADM-10G card has the following specifications:

- Line
  - Bit rate: OC-3/STM-1 (155.520 Mb/s); OC-12/STM-3 (622.08 Mb/s); OC-48/STM-16 (2488.32 Mb/s); OC-192/STM-64 (9.95328 Gbps)
  - Code: Scrambled NRZ

  - Fiber: 1310-nm single-mode for ONS-XC-10GS1 XFP or 1530.33 to 1554.94-nm single-mode for ONS-XC-10G-xx.x XFP
  - Maximum chromatic dispersion allowance: up to 3600 ps/nm
  - Loopback modes: Terminal, facility, and cross-connect
  - Connectors: LC
- Transmitter (trunk side)
  - Transmitter: LN external modulator transmitter
  - Maximum transmitter output power: Depends on XFP that is used
  - Minimum transmitter output power: Depends on XFP that is used
  - Wavelength stability (drift): +/– 25 picometers (pm)
- Receiver (trunk side)
  - Receiver: APD
  - Receiver input wavelength range: Depends on XFP that is used
  - Receiver sensitivity: depends on XFP that is used
  - Link loss budget: 24 dB minimum, with no dispersion or 22 dB optical path loss at BER = 1 * 10 exp – 12 including dispersion
- Dimensions
  - Height: 12.65 in. (321.3 mm)
  - Width: 1.866 in. (47.4 mm) (The dimension of the finger gasket is not included)
  - Depth: 9.00 in. (228.6 mm)
  - Depth with backplane connector: 9.250 in. (235 mm)
  - Weight not including clam shell: 5.07 lb (2.3 kg)

A.10.18 GE_XP, 10GE_XP, GE_XPE, and 10GE_XPE Card Specifications

The GE_XP, 10GE_XP, GE_XPE, and 10GE_XPE cards have the following specifications:

- Line (trunk side)
  - Bit rate: 11.1 Gbps (in ITU-T G.709 Digital Wrapper/FEC mode) or 10.3125 Gbps (in ITU-T G.709 Digital Wrapper/FEC mode disabled)
  - Code: Scrambled NRZ
  - Fiber: 1550-nm single-mode
  - Maximum chromatic dispersion allowance: – 500 to 1600 ps/nm (specified penalty)
  - Loopback modes: Terminal and facility

Caution You must use a 20-dB fiber attenuator (15 to 25 dB) when working with the GE_XP and GE_XPE card in a loopback on the trunk port. Do not use direct fiber loopbacks with the GE_XP and GE_XPE card. Using direct fiber loopbacks causes irreparable damage to the GE_XP and GE_XPE card.

  - Connectors: LC
- Transmitter (trunk side)

- Maximum transmitter output power: +3 dBm
- Minimum transmitter output power: -1 dBm
- Transmitter: EML laser
- Wavelength stability (drift): +/– 100 picometers (pm)

Note An optical device on the card keeps the laser wavelength locked as closely as possible to the ITU nominal value. The allowed drift is +/– 25 pm.

- Currently available wavelengths and versions of GE_XP, 10GE_XP, GE_XPE, and 10GE_XPE: C Band, 100 GHz spacing.
- Receiver (trunk side, see Table A-54)
  - Receiver: APD
  - Link loss budget: 24 dB minimum, with no dispersion or 22 dB optical path loss at BER = 1 * 10 exp – 12 including dispersion

Table A-54 GE_XP and GE_XPE Card Receiver Trunk Side Specifications

OSNR[1]	FEC Type	Pre-FEC BER	Post-FEC BER	Input Power Sensitivity[2]	Chromatic Dispersion Tolerance
30 dB	Off	1.00E – 12	N/A	– 7 to – 23 dBm	—
30 dB	Off	1.00E – 12	N/A	– 7 to – 20 dBm	– 500 to 1600 ps/nm
24 dB	Off	1.00E – 12	N/A	– 7 to – 18 dBm	—
27 dB	Off	1.00E – 12	N/A	– 7 to – 18 dBm	– 500 to 1600 ps/nm
18 dB	Standard	1.00E – 05	1.00E – 15	– 7 to – 18 dBm	—
19 dB	Standard	1.00E – 05	1.00E – 15	– 7 to – 18 dBm	– 500 to 1600 ps/nm
30 dB	Enhanced	1.00E – 04	1.00E – 15	– 7 to – 27 dBm	—
30 dB	Enhanced	1.00E – 04	1.00E – 15	– 7 to – 24 dBm	– 500 to 1600 ps/nm
15 dB	Enhanced	1.00E – 04	1.00E – 15	– 7 to – 18 dBm	—
15 dB	Enhanced	1.00E – 04	1.00E – 15	– 7 to – 18 dBm	– 500 to 1600 ps/nm

1. OSNR defined with 0.1 nm RBW
2. Receiver filter bandwidth greater than or equal to 180 pm (at – 3 dBm)

- Line (client side)
  - Bit rate: 1.125Gbps (GE) or 10.3125Gbps (10GE)
  - Code: Scrambled NRZ
  - Fiber: 1310-nm single-mode or 850-nm multimode
  - Maximum chromatic dispersion allowance: 12 ps/nm (SR SFP version)
  - Loopback modes: Terminal and facility
  - Connectors: LC (optical)
- Transmitter (client side): Depends on the SFP that is used.
- Receiver (client side): Depends on the SFP that is used.

- Environmental
  - Power consumption: 95.00 W (maximum), 2 A at -48 V for GE_XP and GE_XPE cards
  - Power consumption: 80.00 W (maximum), 1.67 A at -48 V for 10GE_XP and 10GE_XPE cards
- Dimensions
  - Height: 12.992 in. (330 mm)
  - Width: 10GE_XP and 10GE_XPE: 0.921 in. (23.4 mm)
    GE_XP and GE_XPE: 1.866 in. (47.4 mm) (The dimension of the finger gasket is not included)
  - Depth: 9.448 in. (240 mm)
  - Weight not including clam shell: 10GE-XP and 10GE_XPE, 1.04 kg;
    GE-XP and GE_XPE, 1.36 kg.

A.10.19 OTU2_XP Card Specifications

The OTU2_XP card has the following specifications:

- Line
  - Bit rate: OC-192/STM-64 (9.95328 Gbps), 10GE (10.3125 Gbps), or 10G FC (10.51875 Gbps)
  - Code: Scrambled NRZ
  - Fiber: 1310-nm single-mode for ONS-XC-10GS1 XFP or 1530.33-nm to 1561.42-nm single-mode for ONS-XC-10G-xx.x XFP
  - Maximum chromatic dispersion allowance: Depends on the XFP that is used
  - Loopback modes: Terminal and facility
  - Connectors: LC
- Transmitter (trunk side)
  - Transmitter: EML
  - Maximum transmitter output power: Depends on the XFP that is used
  - Minimum transmitter output power: Depends on the XFP that is used
  - Wavelength stability (drift): Depends on the XFP that is used
- Receiver (trunk side)
  - Receiver: APD
  - Receiver input wavelength range: Depends on XFP that is used
  - Receiver sensitivity: Depends on XFP that is used
  - Link loss budget: Depends on XFP that is used
- Dimensions
  - Height: 13.043 in. (331.3 mm)
  - Width: 0.921 in. (23.4 mm) (The dimension of the finger gasket is not included)
  - Depth: 9.413 in. (239.1 mm)
  - Depth with backplane connector: 9.909 in. (251.7 mm)
  - Weight not including clam shell: 2.38 lb (1.08 kg)

A.11 TDC-CC and TDC-FC Card Specifications

The TDC-CC and TDC-FC card specifications are as follows:

- Wavelength
  - Total operating signal wavelength range (C-band range): 1529.0 - 1562.5 nm
- Optical
  - Insertion loss — DC-RX to DC-TX: Maximum 12.5 for TDC-CC and 9.5 for TDC-FC @ 1545.32 nm at room temperature
  - Wavelength dependant loss: 0.8 dB max
  - Maximum optical input power: 200mW
  - Polarization dependent loss: 0.2 dB max
- Dimensions
  - Height: 12.65 in. (332 mm)
  - Width: 0.921 in. (23.4 mm) (The dimension of the finger gasket is not included)
  - Depth: 8.66 in. (220.1 mm)
  - Depth with backplane connector: 235 mm (9.250 in)
  - Weight not including clam shell:
  - TDC-CC—1.26 Kg
  - TDC-FC—1.14 Kg
  - The TDC-CC and TDC-FC tunable CD values are listed in Table A-55.

Table A-55 TDC-CC and TDC-FC Tunable CD Value

Unit Configuration	TDC-CC [ps/nm]	TDC-FC [ps/nm]
0	0 [1]	0[2]
1	-110	-45
2	-220	-90
3	-330	-135
4	-440	-180
5	-550	-225
6	-660	-270
7	-770	-315
8	-880	-360
9	-990	-405
10	-1100	-450
11	-1210	-495
12	-1320	-540
13	-1430	-585
14	-1540	-630
15	-1650	-675

1. The default value of the TDC-CC CD value for Coarse Unit is 0.
2. The default value of the TDC-FC value for Fine Unit is 0.

A.12 Mesh Patch Panel Specifications

This section provides specifications for the PP-MESH-4, PP-MESH-8, and 15454-PP-4-SMR patch panels.

A.12.1 PP-MESH-4 Patch Panel Specifications

The PP-MESH-4 patch panel optical specifications are listed in Table A-56.

Table A-56 PP-MESH-4 Patch Panel Optical Specifications

Parameter	Note	Condition	Min	Max	Unit
Wavelength range	—	—	1530	1570	nm
Insertion loss [1] [2]	—	In all the wavelength ranges (local ADD or test access RX to EXP TX, COM RX to EXP TX, COM RX to test access TX)	—	7.5	dB
Insertion Loss Uniformity[1] [2]	—	In all the wavelength ranges	—	0.9	dB
Polarization dispersion loss (PDL) [1]	—	—	—	0.3	dB
Polarization mode dispersion (PMD) [1]	—	—	—	0.1	dB
Optical Return Loss [1]	—	—	50	—	dB
Directivity [1]	—	—	50	—	dB

1. Under all SOPs and all operating environmental conditions
2. Values are referenced with connector loss (LC=0.3 dB, MPO=0.5dB)

The PP-MESH-4 patch panel has the following additional specifications:

- Environmental
  - Operating temperature: +23 to +149 degrees Fahrenheit (–5 to +65 degrees Celsius)
  - Operating humidity: 5 to 95 percent, noncondensing
- Dimensions
  - Height: 17.42 in. (442.5 mm)
  - Width: 3.457 in. (87.8 mm)
  - Depth: 11.025 in. (280 mm)

A.12.2 PP-MESH-8 Patch Panel Specifications

The PP-MESH-8 patch panel optical specifications are listed in Table A-57.

Table A-57 PP-MESH-8 Patch Panel Optical Specifications

Parameter	Note	Condition	Min	Max	Unit
Wavelength range	—	—	1530	1570	nm
Insertion loss [1] [2]	—	In all the wavelength ranges (local ADD or test access RX to EXP TX, COM RX to EXP TX, COM RX to test access TX)	—	10.6	dB
Insertion loss uniformity [1] [2]	—	In all the wavelength ranges	—	1.3	dB
PDL [1]	—	—	—	0.5	dB
PMD [1]	—	—	—	0.1	dB
Optical Return Loss [1]	—	—	50	—	dB
Directivity [1]	—	—	50	—	dB

1. Under all SOPs and all operating environmental conditions
2. Values are referenced with connector loss (LC=0.3 dB, MPO=0.5dB)

The PP-MESH-8 patch panel has the following additonal specifications:

- Environmental
  - Operating temperature: +23 to +149 degrees Fahrenheit (–5 to +65 degrees Celsius)
  - Operating humidity: 5 to 95 percent, noncondensing
- Dimensions
  - Height: 17.42 in. (442.5 mm)
  - Width: 3.457 in. (87.8 mm)
  - Depth: 11.025 in. (280 mm)

A.12.3 15454-PP-4-SMR Patch Panel Specifications

The 15454-PP-4-SMR patch panel optical specifications are listed in Table A-58.

Table A-58 15454-PP-4-SMR Patch Panel Optical Specifications

Parameter	Note	Condition	Min	Max	Unit
Wavelength range	All SOP within operating temperature range	—	1520	1570	nm

Table A-58 15454-PP-4-SMR Patch Panel Optical Specifications (continued)

Parameter	Note	Condition	Min	Max	Unit
Insertion loss	All SOP within operating temperature range, wavelength range, from each input port of any MPO connector to any output port including two MPO connections	—	5.5	7.5	dB
Insertion loss uniformity [1]		—	—	0.5	dB
Insertion loss ripple		—	—	0.2	dB
Chromatic dispersion		—	—	+/- 5	ps/nm
PDL		—	—	0.1	dB
PMD		—	—	0.1	dB
Optical return loss		—	50	—	dB
Directivity		—	50.0	—	dB

1. Defined as the difference between theinsertion loss values of any of the four branches of each 1x4 coupler.

The 15454-PP-4-SMR patch panel has the following additional specifications:

- Environmental
  - Operating temperature: +23 to +149 degrees Fahrenheit (–5 to +65 degrees Celsius)

A.13 SFP and XFP Specifications

Note The CC-FTA fan tray is mandatory if CWDM SFPs and DWDM SFPs are used on MSTP units.

Note Use hardware version 2.0 DWDM SFP for MSTP units.

See the Installing the GBIC, SFP, and XFP Optics Modules in Cisco ONS Platforms for SFP and XFP specifications.

A.14 Patch Panel Specifications

For information on 15216 40-Channel Mux/Demux Patch Panel specifications, refer to the “Patch Panel Specifications” section in the *“Installing Cisco ONS 15216 40-Channel Mux/Demux Patch Panel”* guide.

For information on 15454-PP-4-SMR Patch Panel specifications, refer to the “Patch Panel Specifications” section in the *“Installing Cisco ONS 15454-PP-4-SMR Patch Panel”* guide.

APPENDIX B

Administrative and Service States

This appendix describes the administrative and service states for Cisco ONS 15454 dense wavelength division multiplexing (DWDM) cards, optical payload ports, out-of-band optical service channel (OSC) ports, optical channel network connections (OCHNCs), and transponder/muxponder cards and ports. States for Software Release 5.0 and later are based on the generic state model defined in Telcordia GR-1093-Core, Issue 2 and ITU-T X.731.

B.1 Service States

Service states include a Primary State (PST), a Primary State Qualifier (PSTQ), and one or more Secondary States (SST). Table B-1 lists the ANSI and ETSI service state PSTs and PSTQs supported by the ONS 15454.

Table B-1 ONS 15454 Service State Primary States and Primary State Qualifiers

ANSI Primary State, Primary State Qualifier	ETSI Primary State, Primary State Qualifier	Definition
IS-NR (In-Service and Normal)	Unlocked-enabled	The entity is fully operational and will perform as provisioned.
OOS-AU (Out-of-Service and Autonomous)	Unlocked-disabled	The entity is not operational because of an autonomous event.
OOS-AUMA (Out-of-Service and Autonomous Management)	Locked-disabled	The entity is not operational because of an autonomous event and has also been manually removed from service.
OOS-MA (Out-of-Service and Management)	Locked-enabled	The entity has been manually removed from service.

Table B-2 defines the ANSI and ETSI SSTs supported by the ONS 15454.

Table B-2 ONS 15454 Secondary States

ANSI Secondary State	ETSI Secondary State	Definition
AINS	automaticInService	The entity is delayed before transitioning to the IS-NR (ANSI)/Unlocked-enabled (ETSI) service state. The transition to IS-NR/Unlocked-enabled depends on correction of conditions. Alarm reporting is suppressed, but traffic is carried. Raised fault conditions, whether or not their alarms are reported, can be retrieved on the Cisco Transport Controller (CTC) Conditions tab or by using the TL1 RTRV-COND command.
DSBLD	disabled	The entity was manually removed from service and does not provide its provisioned functions. All services are disrupted; unable to carry traffic.
FLT	failed	The entity has a raised alarm or condition.
MEA	mismatchOfEquipment	An improper card is installed. For example, an installed card is not compatible with the card preprovisioning or the slot. This SST applies only to cards.
MT	maintenance	The entity has been manually removed from service for a maintenance activity but still performs its provisioned functions. Alarm reporting is suppressed, but traffic is carried. Raised fault conditions, whether or not their alarms are reported, can be retrieved on the CTC Conditions tab or by using the TL1 RTRV-COND command.
SWDL	softwareDownload	The card is involved in a software and database download. This SST applies only to cards.
UAS	unassigned	The card is not provisioned in the database. This SST applies only to cards.
UEQ (Unequipped)	notInstalled	The card is not physically present (that is, an empty slot). This SST applies only to cards.

B.2 Administrative States

Administrative states are used to manage service states. Administrative states consist of a PST and an SST. Table B-3 lists the ANSI and ETSI administrative states supported by the ONS 15454. See Table B-2 for SST definitions.

Note A change in the administrative state of an entity does not change the service state of supporting or supported entities.

Table B-3 ONS 15454 Administrative States

ANSI Administrative State (PST,SST)	ETSI Administrative State (PST,SST)	Definition
IS	Unlocked	Puts the entity in service.
IS,AINS	Unlocked,automaticInService	Puts the entity in automatic in-service.

Table B-3 ONS 15454 Administrative States (continued)

ANSI Administrative State (PST,SST)	ETSI Administrative State (PST,SST)	Definition
OOS,DSBLD	Locked,disabled	Removes the entity from service and disables it.
OOS,MT	Locked,maintenance	Removes the entity from service for maintenance.

B.3 Service State Transitions

This section describes the transition from one service state to the next state for DWDM shelves, cards, optical payload ports, OSC ports, OCHNCs, and transponder/muxponder cards and ports. A service state transition is based on the action performed on the entity and any autonomous activity.

Note When an entity is put in the OOS,MT administrative state, the ONS node suppresses all standing alarms on that entity. All alarms and events appear on the Conditions tab. You can change this behavior for the LPBKFACILITY and LPBKTERMINAL alarms. To display these alarms on the Alarms tab, set the NODE.general.ReportLoopbackConditionsOnOOS-MTPorts (ANSI) or NODE.general.ReportLoopbackConditionsOnPortsInLocked,Maintenance (ETSI) to TRUE on the NE Defaults tab.

B.3.1 DWDM Shelf Service State Transitions

Table B-4 lists ANSI and ETSI service state transitions for shelf entities.

Table B-4 ONS 15454 Shelf Service State Transitions

Current Service State	Action	Next Service State
OOS-AUMA,UAS & UEQ (ANSI) Locked-disabled,unassigned & notInstalled (ETSI)	Connect a shelf.	IS-NR (ANSI) Unlocked-enabled (ETSI)
	Connect an invalid shelf.	OOS-AUMA,MEA & UAS (ANSI) Locked-disabled,mismatchOfEquipment & unassigned (ETSI)
	Add a shelf.	OOS-AU,AINS & UEQ (ANSI) Unlocked-disabled,automaticInService & notInstalled (ETSI)
OOS-AUMA,UAS (ANSI) Locked-disabled,unassigned (ETSI)	Disconnect a shelf.	OOS-AUMA,UAS & UEQ (ANSI) Locked-disabled,unassigned & notInstalled (ETSI)
	Add a shelf.	IS-NR (ANSI) Unlocked-enabled (ETSI)

Table B-4 ONS 15454 Shelf Service State Transitions (continued)

Current Service State	Action	Next Service State
OOS-AU,AINS & UEQ (ANSI) Unlocked-disabled,automaticInService & notInstalled (ETSI)	Connect a shelf.	IS-NR (ANSI) Unlocked-enabled (ETSI)
	Connect an invalid shelf.	OOS-AU,AINS & MEA (ANSI) Unlocked-disabled,automaticInService & mismatchOfEquipment (ETSI)
	Delete a shelf.	OOS-AUMA,UAS & UEQ (ANSI) Locked-disabled,unassigned & notInstalled (ETSI)
OOS-AU,UEQ (ANSI) Unlocked-disabled,notInstalled (ETSI)	Connect a shelf.	IS-NR (ANSI) Unlocked-enabled (ETSI)
	Connect an invalid shelf.	OOS-AU,MEA (ANSI) Unlocked-disabled,mismatchOfEquipment (ETSI)
	Delete a shelf.	OOS-AUMA,UAS & UEQ (ANSI) Locked-disabled,unassigned & notInstalled (ETSI)
IS-NR (ANSI) Unlocked-enabled (ETSI)	Delete a shelf.	OOS-AUMA,UAS (ANSI) Locked-disabled,unassigned (ETSI)
	Disconnect a shelf.	OOS-AU,UEQ (ANSI) Unlocked-disabled,notInstalled (ETSI)
OOS-AUMA,MEA & UAS (ANSI) Locked-disabled,mismatchOfEquipment & unassigned (ETSI)	Disconnect a shelf.	OOS-AUMA,UAS & UEQ (ANSI) Locked-disabled,unassigned & notInstalled (ETSI)
OOS-AUMA,AINS & MEA (ANSI) Locked-disabled,automaticInService & mismatchOfEquipment (ETSI)	Disconnect a shelf.	OOS-AU,AINS & UEQ (ANSI) Unlocked-disabled,automaticInService & notInstalled (ETSI)
OOS-AU,MEA (ANSI) Unlocked-disabled,mismatchOfEquipment (ETSI)	Disconnect a shelf.	OOS-AU,UEQ (ANSI) Unlocked-disabled,notInstalled (ETSI)
	Delete a shelf.	OOS-AUMA,MEA & UAS (ANSI) Locked-disabled,mismatchOfEquipment & unassigned (ETSI)

B.3.2 DWDM Card Service State Transitions

Table B-5 lists ANSI and ETSI service state transitions for AD-1B-xx.x, AD-4B-xx.x, AD-1C-xx.x, AD-2C-xx.x, AD-4C-xx.x, OSC-CSM, OSCM, OPT-BST, OPT-BST-E, OPT-BST-L, OPT-AMP-L, OPT-PRE, OPT-AMP-17-C, OPT-AMP-17-C, 4MD-xx.x, 32WSS, 32WSS-L, 32MUX-O, 32DMX, 32DMX-L, 32DMX-O, 40-MUX-C, 40-DMX-C, 40-DMX-CE, 40-WSS-C, 40-WSS-CE, 40-WXC-C, and 80-WXC-C cards.

Table B-5 ONS 15454 Optical Unit Service State Transitions

Current Service State	Action	Next Service State
IS-NR (ANSI) Unlocked-enabled (ETSI)	Delete the card.	OOS-AUMA,UAS (ANSI) Locked-disabled,unassigned (ETSI)
	Pull the card.	OOS-AU,UEQ (ANSI) Unlocked-disabled,notInstalled (ETSI)
	Reset the card.	OOS-AU,SWDL (ANSI) Unlocked-disabled,softwareDownload (ETSI)
	Alarm/condition is raised.	OOS-AU,FLT (ANSI) Unlocked-disabled,failed (ETSI)
OOS-AU,AINS & MEA (ANSI) Unlocked-disabled,automaticInService & mismatchOfEquipment (ETSI)	Pull the card.	OOS-AU,AINS & UEQ (ANSI) Unlocked-disabled,automaticInService & notInstalled (ETSI)
	Delete the card.	If the card is valid: • OOS-AUMA,UAS (ANSI) • Locked-disabled,unassigned (ETSI) If the card is invalid: • OOS-AUMA,MEA & UAS (ANSI) • Locked-disabled,mismatchOfEquipment & unassigned (ETSI)
OOS-AU,AINS & SWDL (ANSI) Unlocked-disabled,automaticInService & softwareDownload (ETSI)	Restart completed.	IS-NR (ANSI) Unlocked-enabled (ETSI)
		OOS-AU,AINS & MEA (ANSI) Unlocked-disabled,automaticInService & mismatchOfEquipment (ETSI)
	Pull the card.	OOS-AU,AINS & UEQ (ANSI) Unlocked-disabled,automaticInService & notInstalled (ETSI)
OOS-AU,AINS & UEQ (ANSI) Unlocked-disabled,automaticInService & notInstalled (ETSI)	Insert a valid card.	OOS-AU,AINS & SWDL (ANSI) Unlocked-disabled,automaticInService & softwareDownload (ETSI)
	Insert an invalid card.	OOS-AU,AINS & MEA (ANSI) Unlocked-disabled,automaticInService & mismatchOfEquipment (ETSI)
	Delete the card.	OOS-AUMA,UAS & UEQ (ANSI) Locked-disabled,unassigned & notInstalled (ETSI)

Table B-5 ONS 15454 Optical Unit Service State Transitions (continued)

Current Service State	Action	Next Service State
OOS-AU,FLT (ANSI) Unlocked-disabled,failed (ETSI)	Pull the card.	OOS-AU,UEQ (ANSI) Unlocked-disabled,unequipped (ETSI)
	Delete the card.	OOS-AUMA,UAS (ANSI) Locked-disabled,unassigned (ETSI)
	Change the administrative state to OOS,MT (ANSI) or Locked,maintenance (ETSI).	OOS-AUMA,FLT & MT (ANSI) Locked-disabled,failed & maintenance (ETSI)
	Reset the card.	OOS-AU,SWDL (ANSI) Unlocked-disabled,softwareDownload (ETSI)
	Alarm/condition is cleared.	IS-NR (ANSI) Unlocked-enabled (ETSI)
OOS-AU,MEA (ANSI) Unlocked-disabled,mismatchOfEquipment (ETSI)	Pull the card.	OOS-AU,UEQ (ANSI) Unlocked-disabled,notInstalled (ETSI)
	Delete the card.	If the card is valid: • OOS-AUMA,UAS (ANSI) • Locked-disabled,unassigned (ETSI) If the card is invalid: • OOS-AUMA,MEA & UAS (ANSI) • Locked-disabled,mismatchOfEquipment & unassigned (ETSI)
OOS-AU,SWDL (ANSI) Unlocked-disabled,softwareDownload (ETSI)	Restart completed.	IS-NR (ANSI) Unlocked-enabled (ETSI)
		OOS-AU,MEA (ANSI) Unlocked-disabled,mismatchOfEquipment (ETSI)
	Pull the card.	OOS-AU,UEQ (ANSI) Unlocked-disabled,notInstalled (ETSI)
OOS-AU,UEQ (ANSI) Unlocked-disabled,notInstalled (ETSI)	Insert a valid card.	OOS-AU,SWDL (ANSI) Unlocked-disabled,softwareDownload (ETSI)
	Insert an invalid card.	OOS-AU,MEA (ANSI) Unlocked-disabled,mismatchOfEquipment (ETSI)
	Delete the card.	OOS-AUMA,UAS & UEQ (ANSI) Locked-disabled,unassigned & notInstalled (ETSI)

Table B-5 ONS 15454 Optical Unit Service State Transitions (continued)

Current Service State	Action	Next Service State
OOS-AUMA,FLT & MT (ANSI) Locked-disabled,failed & maintenance (ETSI)	Pull the card.	OOS-AUMA,MT & UEQ (ANSI) Locked-disabled,maintenance & notInstalled (ETSI)
	Delete the card.	OOS-AUMA,UAS (ANSI) Locked-disabled,unassigned (ETSI)
	Change the administrative state to IS (ANSI) or Unlocked (ETSI).	OOS-AU,FLT (ANSI) Unlocked-disabled,failed (ETSI)
	Reset the card.	OOS-AUMA,MT & SWDL (ANSI) Locked-disabled,maintenance & softwareDownload (ETSI)
	Alarm/condition is cleared.	IS-NR (ANSI) Unlocked-enabled (ETSI)
OOS-AUMA,MEA & UAS (ANSI) Locked-disabled,mismatchOfEquipment & unassigned (ETSI)	Pull the card.	OOS-AUMA,UAS & UEQ (ANSI) Locked-disabled,unassigned & notInstalled (ETSI)
	Provision the card.	OOS-AU,MEA (ANSI) Unlocked-disabled,mismatchOfEquipment (ETSI)
OOS-AUMA,MT & SWDL (ANSI) Locked-disabled,maintenance & softwareDownload (ETSI)	Restart completed.	OOS-MA,MT (ANSI) Locked-enabled,maintenance (ETSI)
		OOS-AUMA,MEA & MT (ANSI) Locked-disabled,mismatchOfEquipment & maintenance (ETSI)
	Pull the card.	OOS-AUMA,MT & UEQ (ANSI) Locked-disabled,maintenance & notInstalled (ETSI)
OOS-AUMA,UAS (ANSI) Locked-disabled,unassigned (ETSI)	Pull the card.	OOS-AUMA,UAS & UEQ (ANSI) Locked-disabled,unassigned & notInstalled (ETSI)
	Provision an invalid card.	OOS-AU,MEA (ANSI) Unlocked-disabled,mismatchOfEquipment (ETSI)
	Provision a valid card.	OOS-AU,SWDL (ANSI) Unlocked-disabled,softwareDownload (ETSI)
OOS-AUMA,UAS & UEQ (ANSI) Locked-disabled,unassigned & notInstalled (ETSI)	Insert a valid card.	OOS-AU,SWDL (ANSI) Unlocked-disabled,softwareDownload (ETSI)
	Insert an invalid card.	OOS-AUMA,MEA & UAS (ANSI) Locked-disabled,mismatchOfEquipment & unassigned (ETSI)
	Preprovision a card.	OOS-AU,AINS & UEQ (ANSI) Unlocked-disabled,automaticInService & notInstalled (ETSI)

B.3.3 Optical Payload Port Service State Transitions

Table B-6 lists the ANSI and ETSI optical payload port service state transitions.

Table B-6 ONS 15454 Optical Payload Port Service State Transitions

Current Service State	Action	Next Service State
IS-NR (ANSI) Unlocked-enabled (ETSI)	Put the port in the OOS,DSBLD (ANSI) or Locked,disabled (ETSI) administrative state.	OOS-MA,DSBLD (ANSI) Locked-enabled,disabled (ETSI)
	The OCHNC end-to-end path no longer exists.	OOS-AU,AINS (ANSI) Unlocked-disabled,automaticInService (ETSI)
	Alarm/condition is raised.	OOS-AU,FLT (ANSI) Unlocked-disabled,failed (ETSI)
OOS-AU,AINS (ANSI) Unlocked-disabled,automaticInService (ETSI)	All required OCHNC connections exist.	IS-NR (ANSI) Unlocked-enabled (ETSI)
	Put the port in the OOS,MT (ANSI) or Locked,maintenance (ETSI) administrative state.	OOS-MA,MT (ANSI) Locked-enabled,maintenance (ETSI)
	Put the port in the OOS,DSBLD (ANSI) or Locked,disabled (ETSI) administrative state.	OOS-MA,DSBLD (ANSI) Locked-enabled,disabled (ETSI)
	Alarm/condition is raised.	OOS-AU,AINS & FLT (ANSI) Unlocked-disabled,automaticInService & failed (ETSI)
OOS-AU,AINS & FLT (ANSI) Unlocked-disabled,automaticInService & failed (ETSI)	Alarm/condition is cleared.	OOS-AU,AINS (ANSI) Unlocked-disabled,automaticInService (ETSI)
	Put the port or cross-connect in the IS (ANSI) or Unlocked (ETSI) administrative state.	OOS-AU,FLT (ANSI) Unlocked-disabled,failed (ETSI)
	Put the port or cross-connect in the OOS,DSBLD (ANSI) or Locked,disabled (ETSI) administrative state.	OOS-MA,DSBLD (ANSI) Locked-enabled,disabled (ETSI)
	Put the port or cross-connect in the OOS,MT (ANSI) or Locked,maintenance (ETSI) administrative state.	OOS-AUMA,FLT & MT (ANSI) Locked-disabled,failed & maintenance (ETSI)

Table B-6 ONS 15454 Optical Payload Port Service State Transitions (continued)

Current Service State	Action	Next Service State
OOS-AU,FLT (ANSI) Unlocked-disabled,failed (ETSI)	Alarm/condition is cleared.	IS-NR (ANSI) Unlocked-enabled (ETSI)
	Put the port or cross-connect in the IS,AINS (ANSI) or Unlocked,automaticInService (ETSI) administrative state.	OOS-AU,AINS & FLT (ANSI) Unlocked-disabled,automaticInService & failed (ETSI)
	Put the port or cross-connect in the OOS,DSBLD (ANSI) or Locked,disabled (ETSI) administrative state.	OOS-MA,DSBLD (ANSI) Locked-enabled,disabled (ETSI)
	Put the port or cross-connect in the OOS,MT (ANSI) or Locked,maintenance (ETSI) administrative state.	OOS-AUMA,FLT & MT (ANSI) Locked-disabled,failed & maintenance (ETSI)
OOS-AUMA,FLT & LPBK & MT (ANSI) Locked-disabled,failed & loopback & maintenance (ETSI)	Release the loopback.	OOS-AUMA,FLT & MT (ANSI) Locked-disabled,failed & maintenance (ETSI)
	Alarm/condition is cleared.	OOS-MA,LPBK & MT (ANSI) Locked-enabled,loopback & maintenance (ETSI)
OOS-AUMA,FLT & MT (ANSI) Locked-disabled,failed & maintenance (ETSI)	Alarm/condition is cleared.	OOS-MA,MT (ANSI) Locked-enabled,maintenance (ETSI)
	Put the port or cross-connect in the IS (ANSI) or Unlocked-enabled (ETSI) administrative state.	OOS-AU,FLT (ANSI) Unlocked-disabled,failed (ETSI)
	Put the port or cross-connect in the IS,AINS (ANSI) or Unlocked,automaticInService (ETSI) administrative state.	OOS-AU,AINS & FLT (ANSI) Unlocked-disabled,automaticInService & failed (ETSI)
	Put the port or cross-connect in the OOS,DSBLD (ANSI) or Locked,disabled (ETSI) administrative state.	OOS-MA,DSBLD (ANSI) Locked-enabled,disabled (ETSI)
	Put the port or cross-connect in a loopback.	OOS-AUMA,FLT & LPBK & MT (ANSI) Locked-disabled,failed & loopback & maintenance (ETSI)

Table B-6 ONS 15454 Optical Payload Port Service State Transitions (continued)

Current Service State	Action	Next Service State
OOS-MA,DSBLD (ANSI) Locked-enabled,disabled (ETSI)	Put the port in the IS,AINS (ANSI) or Unlocked,automaticInService (ETSI) administrative state.	OOS-AU,AINS (ANSI) Unlocked-disabled,automaticInService (ETSI)
	Put the port in the OOS,MT (ANSI) or Locked,maintenance (ETSI) administrative state.	OOS-MA,MT (ANSI) Locked-enabled,maintenance (ETSI)
OOS-MA,MT (ANSI) Locked-enabled,maintenance (ETSI)	Put the port in the IS,AINS (ANSI) or Unlocked,automaticInService (ETSI) administrative state.	OOS-AU,AINS (ANSI) Unlocked-disabled,automaticInService (ETSI)
	Put the port in the OOS,DSBLD (ANSI) or Locked,disabled (ETSI) administrative state.	OOS-MA,DSBLD (ANSI) Locked-enabled,disabled (ETSI)
	Alarm/condition is raised.	OOS-AUMA,FLT & MT (ANSI) Locked-disabled,failed & maintenance (ETSI)

B.3.4 OSC Port Service State Transitions

Table B-7 lists the ANSI and ETSI OSC port service state transitions.

Table B-7 ONS 15454 OSC Port Service State Transitions

Current Service State	Action	Next Service State
IS-NR (ANSI) Unlocked-enabled (ETSI)	Delete the OSC.	OOS-AU,AINS (ANSI) Unlocked-disabled,automaticInService (ETSI)
	Alarm/condition is raised.	OOS-AU,FLT (ANSI) Unlocked-disabled,failed (ETSI)
OOS-AU,AINS (ANSI) Unlocked-disabled,automaticInService (ETSI)	Create the OSC.	IS-NR (ANSI) Unlocked-enabled (ETSI)
	Put the port in the OOS,MT (ANSI) or Locked,maintenance (ETSI) administrative state.	OOS-MA,MT (ANSI) Locked-enabled,maintenance (ETSI)
	Alarm/condition is raised.	OOS-AU,AINS & FLT (ANSI) Unlocked-disabled,automaticInService & failed (ETSI)

Table B-7 ONS 15454 OSC Port Service State Transitions (continued)

Current Service State	Action	Next Service State
OOS-AU,AINS & FLT (ANSI) Unlocked-disabled,automaticInService & failed (ETSI)	Alarm/condition is cleared.	OOS-AU,AINS (ANSI) Unlocked-disabled,automaticInService (ETSI)
	Put the port in the IS (ANSI) or Unlocked (ETSI) administrative state.	OOS-AU,FLT (ANSI) Unlocked-disabled,failed (ETSI)
	Put the port in the OOS,DSBLD (ANSI) or Locked,disabled (ETSI) administrative state.	OOS-MA,DSBLD (ANSI) Locked-enabled,disabled (ETSI)
	Put the port in the OOS,MT (ANSI) or Locked,maintenance (ETSI) administrative state.	OOS-AUMA,FLT & MT (ANSI) Locked-disabled,failed & maintenance (ETSI)
OOS-AU,FLT (ANSI) Unlocked-disabled,failed (ETSI)	Alarm/condition is cleared.	IS-NR (ANSI) Unlocked-enabled (ETSI)
	Put the port in the IS,AINS (ANSI) or Unlocked,automaticInService (ETSI) administrative state.	OOS-AU,AINS & FLT (ANSI) Unlocked-disabled,automaticInService & failed (ETSI)
	Put the port in the OOS,DSBLD (ANSI) or Locked,disabled (ETSI) administrative state.	OOS-MA,DSBLD (ANSI) Locked-enabled,disabled (ETSI)
	Put the port in the OOS,MT (ANSI) or Locked,maintenance (ETSI) administrative state.	OOS-AUMA,FLT & MT (ANSI) Locked-disabled,failed & maintenance (ETSI)
OOS-AUMA,FLT & MT (ANSI) Locked-disabled,failed & maintenance (ETSI)	Alarm/condition is cleared.	OOS-MA,MT (ANSI) Locked-enabled,maintenance (ETSI)
	Put the port in the IS (ANSI) or Unlocked-enabled (ETSI) administrative state.	OOS-AU,FLT (ANSI) Unlocked-disabled,failed (ETSI)
	Put the port in the IS,AINS (ANSI) or Unlocked,automaticInService (ETSI) administrative state.	OOS-AU,AINS & FLT (ANSI) Unlocked-disabled,automaticInService & failed (ETSI)
	Put the port in the OOS,DSBLD (ANSI) or Locked,disabled (ETSI) administrative state.	OOS-MA,DSBLD (ANSI) Locked-enabled,disabled (ETSI)
	Put the port in a loopback.	OOS-AUMA,FLT & LPBK & MT (ANSI) Locked-disabled,failed & loopback & maintenance (ETSI)

Table B-7 ONS 15454 OSC Port Service State Transitions (continued)

Current Service State	Action	Next Service State
OOS-MA,MT (ANSI) Locked-enabled,maintenance (ETSI)	Put the port in the IS,AINS (ANSI) or Unlocked,automaticInService (ETSI) administrative state.	OOS-AU,AINS (ANSI) Unlocked-disabled,automaticInService (ETSI)
	Alarm/condition is raised.	OOS-AUMA,FLT & MT (ANSI) Locked-disabled,failed & maintenance (ETSI)

B.3.5 OCHNC, OCHCC, and OCH-Trail Service State Transitions

Table B-8 lists the ANSI and ETSI OCHNC, OCHCC, and OCH-Trail service state transitions.

Table B-8 ONS 15454 OCHNC Service State Transitions

Current Service State	Action	Next Service State
IS-NR (ANSI) Unlocked-enabled (ETSI)	Put the connection in the IS,AINS (ANSI) or Unlocked,automaticInService (ETSI) administrative state.	OOS-AU,AINS (ANSI) Unlocked-disabled,automaticInService (ETSI)
	Alarm/condition is raised.	OOS-AU,FLT (ANSI) Unlocked-disabled,failed (ETSI)
OOS-AU,AINS (ANSI) Unlocked-disabled,automaticInService (ETSI)	Put the connection in the IS (ANSI) or Unlocked (ETSI) administrative state.	IS-NR (ANSI) Unlocked-enabled (ETSI)
	Alarm/condition is raised.	OOS-AU,AINS & FLT (ANSI) Unlocked-disabled,automaticInService & failed (ETSI)
OOS-AU,AINS & FLT (ANSI) Unlocked-disabled,automaticInService & failed (ETSI)	Alarm/condition is cleared.	OOS-AU,AINS (ANSI) Unlocked-disabled,automaticInService (ETSI)
	Put the port in the IS (ANSI) or Unlocked (ETSI) administrative state.	OOS-AU,FLT (ANSI) Unlocked-disabled,failed (ETSI)
	Put the port in the OOS,DSBLD (ANSI) or Locked,disabled (ETSI) administrative state.	OOS-MA,DSBLD (ANSI) Locked-enabled,disabled (ETSI)
	Put the port in the OOS,MT (ANSI) or Locked,maintenance (ETSI) administrative state.	OOS-AUMA,FLT & MT (ANSI) Locked-disabled,failed & maintenance (ETSI)

Table B-8 ONS 15454 OCHNC Service State Transitions (continued)

Current Service State	Action	Next Service State
OOS-AU,FLT (ANSI) Unlocked-disabled,failed (ETSI)	Alarm/condition is cleared.	IS-NR (ANSI) Unlocked-enabled (ETSI)
	Put the port in the IS,AINS (ANSI) or Unlocked,automaticInService (ETSI) administrative state.	OOS-AU,AINS & FLT (ANSI) Unlocked-disabled,automaticInService & failed (ETSI)
	Put the port in the OOS,DSBLD (ANSI) or Locked,disabled (ETSI) administrative state.	OOS-MA,DSBLD (ANSI) Locked-enabled,disabled (ETSI)
	Put the port in the OOS,MT (ANSI) or Locked,maintenance (ETSI) administrative state.	OOS-AUMA,FLT & MT (ANSI) Locked-disabled,failed & maintenance (ETSI)
OOS-AUMA,FLT & LPBK & MT (ANSI) Locked-disabled,failed & loopback & maintenance (ETSI)	Release the loopback.	OOS-AUMA,FLT & MT (ANSI) Locked-disabled,failed & maintenance (ETSI)
	Alarm/condition is cleared.	OOS-MA,LPBK & MT (ANSI) Locked-enabled,loopback & maintenance (ETSI)
OOS-AUMA,FLT & MT (ANSI) Locked-disabled,failed & maintenance (ETSI)	Alarm/condition is cleared.	OOS-MA,MT (ANSI) Locked-enabled,maintenance (ETSI)
	Put the port in the IS (ANSI) or Unlocked-enabled (ETSI) administrative state.	OOS-AU,FLT (ANSI) Unlocked-disabled,failed (ETSI)
	Put the port in the IS,AINS (ANSI) or Unlocked,automaticInService (ETSI) administrative state.	OOS-AU,AINS & FLT (ANSI) Unlocked-disabled,automaticInService & failed (ETSI)
	Put the port in the OOS,DSBLD (ANSI) or Locked,disabled (ETSI) administrative state.	OOS-MA,DSBLD (ANSI) Locked-enabled,disabled (ETSI)
	Put the port in a loopback.	OOS-AUMA,FLT & LPBK & MT (ANSI) Locked-disabled,failed & loopback & maintenance (ETSI)
OOS-MA,DSBLD (ANSI) Locked-enabled,disabled (ETSI)	Put the connection in the IS,AINS (ANSI) or Unlocked,automaticInService (ETSI) administrative state.	OOS-AU,AINS (ANSI) Unlocked-disabled,automaticInService (ETSI)

B.3.6 Transponder/Muxponder Card Service State Transitions

Table B-9 lists ANSI and ETSI transponder and muxponder card service state transitions.

Table B-9 ONS 15454 Transponder/Muxponder Card Service State Transitions

Current Service State	Action	Next Service State
IS-NR (ANSI) Unlocked-enabled (ETSI)	Change the administrative state to OOS,MT (ANSI) or Locked,maintenance (ETSI).	OOS-MA,MT (ANSI) Locked-enabled,maintenance (ETSI)
	Delete the card.	OOS-AUMA,UAS (ANSI) Locked-disabled,unassigned (ETSI)
	Pull the card.	OOS-AU,UEQ (ANSI) Unlocked-disabled,notInstalled (ETSI)
	Reset the card.	OOS-AU,SWDL (ANSI) Unlocked-disabled,softwareDownload (ETSI)
	Alarm/condition is raised.	OOS-AU,FLT (ANSI) Unlocked-disabled,failed (ETSI)
OOS-AU,AINS & MEA (ANSI) Unlocked-disabled,automaticInService & mismatchOfEquipment (ETSI)	Change the administrative state to OOS,MT (ANSI) or Locked,maintenance (ETSI).	OOS-AUMA,MEA & MT (ANSI) Locked-disabled,mismatchOfEquipment & maintenance (ETSI)
	Pull the card.	OOS-AU,AINS & UEQ (ANSI) Unlocked-disabled,automaticInService & notInstalled (ETSI)
	Delete the card.	If the card is valid: • OOS-AUMA,UAS (ANSI) • Locked-disabled,unassigned (ETSI) If the card is invalid: • OOS-AUMA,MEA & UAS (ANSI) • Locked-disabled,mismatchOfEquipment & unassigned (ETSI)
OOS-AU,AINS & SWDL (ANSI) Unlocked-disabled,automaticInService & softwareDownload (ETSI)	Restart completed.	IS-NR (ANSI) Unlocked-enabled (ETSI)
	Pull the card.	OOS-AU,AINS & UEQ (ANSI) Unlocked-disabled,automaticInService & notInstalled (ETSI)

Table B-9 ONS 15454 Transponder/Muxponder Card Service State Transitions (continued)

Current Service State	Action	Next Service State
OOS-AU,AINS & UEQ (ANSI) Unlocked-disabled,automaticInService & notInstalled (ETSI)	Insert a valid card.	OOS-AU,AINS & SWDL (ANSI) Unlocked-disabled,automaticInService & softwareDownload (ETSI)
	Insert an invalid card.	OOS-AU,AINS & MEA (ANSI) Unlocked-disabled,automaticInService & mismatchOfEquipment (ETSI)
	Delete the card.	OOS-AUMA,UAS & UEQ (ANSI) Locked-disabled,unassigned & notInstalled (ETSI)
	Change the administrative state to OOS,MT (ANSI) or Locked,maintenance (ETSI).	OOS-AUMA,MT & UEQ (ANSI) Locked-disabled,maintenance & notInstalled (ETSI)
OOS-AU,FLT (ANSI) Unlocked-disabled,failed (ETSI)	Pull the card.	OOS-AU,UEQ (ANSI) Unlocked-disabled,unequipped (ETSI)
	Delete the card.	OOS-AUMA,UAS (ANSI) Locked-disabled,unassigned (ETSI)
	Change the administrative state to OOS,MT (ANSI) or Locked,maintenance (ETSI).	OOS-AUMA,FLT & MT (ANSI) Locked-disabled,failed & maintenance (ETSI)
	Reset the card.	OOS-AU,SWDL (ANSI) Unlocked-disabled,softwareDownload (ETSI)
	Alarm/condition is cleared.	IS-NR (ANSI) Unlocked-enabled (ETSI)
OOS-AU,MEA (ANSI) Unlocked-disabled,mismatchOfEquipment (ETSI)	Pull the card.	OOS-AU,UEQ (ANSI) Unlocked-disabled,notInstalled (ETSI)
	Delete the card.	If the card is valid: • OOS-AUMA,UAS (ANSI) • Locked-disabled,unassigned (ETSI) If the card is invalid: • OOS-AUMA,MEA & UAS (ANSI) • Locked-disabled,mismatchOfEquipment & unassigned (ETSI)
	Change the administrative state to OOS,MT (ANSI) or Locked,maintenance (ETSI).	OOS-AUMA,MT & UEQ (ANSI) Locked-disabled,maintenance & notInstalled (ETSI)

Table B-9 ONS 15454 Transponder/Muxponder Card Service State Transitions (continued)

Current Service State	Action	Next Service State
OOS-AU,SWDL (ANSI) Locked-disabled,softwareDownload (ETSI)	Restart completed.	IS-NR (ANSI) Unlocked-enabled (ETSI)
	Pull the card.	OOS-AU,UEQ (ANSI) Locked-disabled,notInstalled (ETSI)
OOS-AU,UEQ (ANSI) Locked-disabled,notInstalled (ETSI)	Insert a valid card.	OOS-AU,SWDL (ANSI) Locked-disabled,softwareDownload (ETSI)
	Insert an invalid card.	OOS-AU,MEA (ANSI) Locked-disabled,mismatchOfEquipment (ETSI)
	Delete the card.	OOS-AUMA,UAS & UEQ (ANSI) Locked-disabled,unassigned & notInstalled (ETSI)
	Change the administrative state to OOS,MT (ANSI) or Locked,maintenance (ETSI).	OOS-AUMA,MT & UEQ (ANSI) Locked-disabled,maintenance & notInstalled (ETSI)
OOS-AUMA,FLT & MT (ANSI) Locked-disabled,failed & maintenance (ETSI)	Pull the card.	OOS-AUMA,MT & UEQ (ANSI) Locked-disabled,maintenance & notInstalled (ETSI)
	Delete the card.	OOS-AUMA,UAS (ANSI) Locked-disabled,unassigned (ETSI)
	Change the administrative state to IS (ANSI) or Unlocked (ETSI).	OOS-AU,FLT (ANSI) Unlocked-disabled,failed (ETSI)
	Reset the card.	OOS-AUMA,MT & SWDL (ANSI) Locked-disabled,maintenance & softwareDownload (ETSI)
	Alarm/condition is cleared.	IS-NR (ANSI) Unlocked-enabled (ETSI)

Table B-9 ONS 15454 Transponder/Muxponder Card Service State Transitions (continued)

Current Service State	Action	Next Service State
OOS-AUMA,MEA & MT (ANSI) Locked-disabled,mismatchOfEquipment & maintenance (ETSI)	Change the administrative state to IS (ANSI) or Unlocked (ETSI).	OOS-AU,MEA (ANSI) Locked-disabled,mismatchOfEquipment (ETSI)
	Pull the card.	OOS-AUMA,MT & UEQ (ANSI) Locked-disabled,maintenance & notInstalled (ETSI)
	Delete the card.	If the card is valid: • OOS-AUMA,UAS (ANSI) • Locked-disabled,unassigned (ETSI) If the card is invalid: • OOS-AUMA,MEA & UAS (ANSI) • Locked-disabled,mismatchOfEquipment & unassigned (ETSI)
OOS-AUMA,MEA & UAS (ANSI) Locked-disabled,mismatchOfEquipment & unassigned (ETSI)	Pull the card.	OOS-AUMA,UAS & UEQ (ANSI) Locked-disabled,unassigned & notInstalled (ETSI)
	Provision the card.	OOS-AU,MEA (ANSI) Locked-disabled,mismatchOfEquipment (ETSI)
OOS-AUMA,MT & SWDL (ANSI) Locked-disabled,maintenance & softwareDownload (ETSI)	Restart completed.	OOS-MA,MT (ANSI) Locked-enabled,maintenance (ETSI)
	Pull the card.	OOS-AUMA,MT & UEQ (ANSI) Locked-disabled,maintenance & notInstalled (ETSI)
OOS-AUMA,MT & UEQ (ANSI) Locked-disabled,maintenance & notInstalled (ETSI)	Change the administrative state to IS (ANSI) or Unlocked (ETSI).	OOS-AU,UEQ (ANSI) Locked-disabled,notInstalled (ETSI)
	Insert a valid card.	OOS-AUMA,MT & SWDL (ANSI) Locked-disabled,maintenance & softwareDownload (ETSI)
	Insert an invalid card.	OOS-AUMA,MEA & MT (ANSI) Locked-disabled,mismatchOfEquipment & maintenance (ETSI)
	Delete the card.	OOS-AUMA,UAS & UEQ (ANSI) Locked-disabled,unassigned & notInstalled (ETSI)

Table B-9 ONS 15454 Transponder/Muxponder Card Service State Transitions (continued)

Current Service State	Action	Next Service State
OOS-AUMA,UAS (ANSI) Locked-disabled,unassigned (ETSI)	Pull the card.	OOS-AUMA,UAS & UEQ (ANSI) Locked-disabled,unassigned & notInstalled (ETSI)
	Provision an invalid card.	OOS-AU,MEA (ANSI) Locked-disabled,mismatchOfEquipment (ETSI)
	Provision a valid card.	OOS-AU,SWDL (ANSI) Locked-disabled,softwareDownload (ETSI)
OOS-AUMA,UAS & UEQ (ANSI) Locked-disabled,unassigned & notInstalled (ETSI)	Insert a valid card.	OOS-AU,SWDL (ANSI) Locked-disabled,softwareDownload (ETSI)
	Insert an invalid card.	OOS-AUMA,MEA & UAS (ANSI) Locked-disabled,mismatchOfEquipment & unassigned (ETSI)
	Preprovision a card.	OOS-AU,AINS & UEQ (ANSI) Unlocked-disabled,automaticInService & notInstalled (ETSI)
OOS-MA,MT (ANSI) Locked-enabled,maintenance (ETSI)	Change the administrative state to IS (ANSI) or Unlocked (ETSI).	IS-NR (ANSI) Unlocked-enabled (ETSI)
	Delete the card.	OOS-AUMA,UAS (ANSI) Locked-disabled,unassigned (ETSI)
	Pull the card.	OOS-AUMA,MT & UEQ (ANSI) Locked-disabled,maintenance & notInstalled (ETSI)
	Reset the card.	OOS-AUMA,MT & SWDL (ANSI) Locked-disabled,maintenance & softwareDownload (ETSI)
	Alarm/condition is raised.	OOS-AUMA,FLT & MT (ANSI) Locked-disabled,failed & maintenance (ETSI)

B.3.7 Transponder/Muxponder Port Service State Transitions

Table B-10 lists the ANSI and ETSI transponder and muxponder port service state transitions.

Table B-10 ONS 15454 Transponder/Muxponder Port Service State Transitions

Current Service State	Action	Next Service State
IS-NR (ANSI) Unlocked-enabled (ETSI)	Put the port in the OOS,MT (ANSI) or Locked,maintenance (ETSI) administrative state.	OOS-MA,MT (ANSI) Locked-enabled,maintenance (ETSI)
	Put the port in the OOS,DSBLD (ANSI) or Locked,disabled (ETSI) administrative state.	OOS-MA,DSBLD (ANSI) Locked-enabled,disabled (ETSI)
	Put the port in the IS,AINS (ANSI) or Unlocked,automaticInService (ETSI) administrative state.	OOS-AU,AINS (ANSI) Unlocked-disabled,automaticInService (ETSI)
	Alarm/condition is raised.	OOS-AU,FLT (ANSI) Unlocked-disabled,failed (ETSI)
OOS-AU,AINS (ANSI) Unlocked-disabled,automaticInService (ETSI)	Put the port in the IS (ANSI) or Unlocked (ETSI) administrative state.	IS-NR[1] (ANSI) Unlocked-enabled (ETSI)
	Put the port in the OOS,MT (ANSI) or Locked,maintenance (ETSI) administrative state.	OOS-MA,MT (ANSI) Locked-enabled,maintenance (ETSI)
	Put the port in the OOS,DSBLD (ANSI) or Locked,disabled (ETSI) administrative state.	OOS-MA,DSBLD (ANSI) Locked-enabled,disabled (ETSI)
	Alarm/condition is raised.	OOS-AU,AINS & FLT (ANSI) Unlocked-disabled,automaticInService & failed (ETSI)
OOS-AU,AINS & FLT (ANSI) Unlocked-disabled,automaticInService & failed (ETSI)	Alarm/condition is cleared.	OOS-AU,AINS (ANSI) Unlocked-disabled,automaticInService (ETSI)
	Put the port in the IS (ANSI) or Unlocked (ETSI) administrative state.	OOS-AU,FLT (ANSI) Unlocked-disabled,failed (ETSI)
	Put the port in the OOS,DSBLD (ANSI) or Locked,disabled (ETSI) administrative state.	OOS-MA,DSBLD (ANSI) Locked-enabled,disabled (ETSI)
	Put the port in the OOS,MT (ANSI) or Locked,maintenance (ETSI) administrative state.	OOS-AUMA,FLT & MT (ANSI) Locked-disabled,failed & maintenance (ETSI)

Table B-10 ONS 15454 Transponder/Muxponder Port Service State Transitions (continued)

Current Service State	Action	Next Service State
OOS-AU,FLT (ANSI) Unlocked-disabled,failed (ETSI)	Alarm/condition is cleared.	IS-NR (ANSI) Unlocked-enabled (ETSI)
	Put the port in the IS,AINS (ANSI) or Unlocked,automaticInService (ETSI) administrative state.	OOS-AU,AINS & FLT (ANSI) Unlocked-disabled,automaticInService & failed (ETSI)
	Put the port in the OOS,DSBLD (ANSI) or Locked,disabled (ETSI) administrative state.	OOS-MA,DSBLD (ANSI) Locked-enabled,disabled (ETSI)
	Put the port in the OOS,MT (ANSI) or Locked,maintenance (ETSI) administrative state.	OOS-AUMA,FLT & MT (ANSI) Locked-disabled,failed & maintenance (ETSI)
OOS-AUMA,FLT & LPBK & MT (ANSI) Locked-disabled,failed & loopback & maintenance (ETSI)	Release the loopback.	OOS-AUMA,FLT & MT (ANSI) Locked-disabled,failed & maintenance (ETSI)
	Alarm/condition is cleared.	OOS-MA,LPBK & MT (ANSI) Locked-enabled,loopback & maintenance (ETSI)
OOS-AUMA,FLT & MT (ANSI) Locked-disabled,failed & maintenance (ETSI)	Alarm/condition is cleared.	OOS-MA,MT (ANSI) Locked-enabled,maintenance (ETSI)
	Put the port in the IS (ANSI) or Unlocked-enabled (ETSI) administrative state.	OOS-AU,FLT (ANSI) Unlocked-disabled,failed (ETSI)
	Put the port in the IS,AINS (ANSI) or Unlocked,automaticInService (ETSI) administrative state.	OOS-AU,AINS & FLT (ANSI) Unlocked-disabled,automaticInService & failed (ETSI)
	Put the port in the OOS,DSBLD (ANSI) or Locked,disabled (ETSI) administrative state.	OOS-MA,DSBLD (ANSI) Locked-enabled,disabled (ETSI)
	Put the port in a loopback.	OOS-AUMA,FLT & LPBK & MT (ANSI) Locked-disabled,failed & loopback & maintenance (ETSI)

Table B-10 ONS 15454 Transponder/Muxponder Port Service State Transitions (continued)

Current Service State	Action	Next Service State
OOS-MA,DSBLD (ANSI) Locked-enabled,disabled (ETSI)	Put the port in the IS (ANSI) or Unlocked (ETSI) administrative state.	IS-NR[1] (ANSI) Unlocked-enabled (ETSI)
	Put the port in the IS,AINS (ANSI) or Unlocked,automaticInService (ETSI) administrative state.	OOS-AU,AINS (ANSI) Unlocked-disabled,automaticInService (ETSI)
	Put the port in the OOS,MT (ANSI) or Locked,maintenance (ETSI) administrative state.	OOS-MA,MT (ANSI) Locked-enabled,maintenance (ETSI)
OOS-MA,LPBK & MT (ANSI) Locked-enabled,loopback & maintenance (ETSI)	Release the loopback.	OOS-MA,MT (ANSI) Locked-enabled,maintenance (ETSI)

Table B-10 ONS 15454 Transponder/Muxponder Port Service State Transitions (continued)

Current Service State	Action	Next Service State
OOS-MA,MT (ANSI) Locked-enabled,maintenance (ETSI)	Put the port in the IS (ANSI) or Unlocked (ETSI) administrative state.	IS-NR[1] Unlocked-enabled (ETSI)
	Put the port in the IS,AINS (ANSI) or Unlocked,automaticInService (ETSI) administrative state.	OOS-AU,AINS (ANSI) Unlocked-disabled,automaticInService (ETSI)
	Put the port in the OOS,DSBLD (ANSI) or Locked,disabled (ETSI) administrative state.	OOS-MA,DSBLD (ANSI) Locked-enabled,disabled (ETSI)
	Put the port in loopback.	OOS-MA,LPBK & MT[2] [3] (ANSI) Locked-enabled,loopback & maintenance (ETSI)
	Alarm/condition is raised.	OOS-AUMA,FLT & MT (ANSI) Locked-disabled,failed & maintenance (ETSI)

1. The transponder and muxponder cards have both client and trunk ports. To bring up service, it is not necessary for both the client side and trunk side to be in the IS-NR (ANSI)/Unlocked-enabled (ETSI) service state.
2. In a client-side facility loopback, the client port is in the OOS-MA,LPBK & MT (ANSI)/Locked-enabled,loopback and maintenance (ETSI) service state and the remaining client and trunk ports can be in any other service state. In a client-side terminal loopback on transponder cards, the client port is in the OOS-MA,LPBK & MT service state and the trunk ports are in IS-NR (ANSI)/Unlocked-enabled (ETSI). For client-side terminal loopbacks on muxponder cards, the client port is in the OOS-MA,LPBK & MT service state and the remaining client and trunk ports can be in any service state.
3. In a trunk-side facility loopback, the trunk port is in the OOS-MA,LPBK & MT (ANSI)/Locked-enabled,loopback and maintenance (ETSI) service state and the remaining client and trunk ports can be in any other service state. In a trunk-side terminal loopback, the trunk port is in the OOS-MA,LPBK & MT (ANSI)/Locked-enabled,loopback and maintenance (ETSI) service state and the client ports are in IS-NR (ANSI)/Unlocked-enabled (ETSI) for complete loopback functionality. This type of loopback affects all client ports because it is performed on the aggregate signal.

APPENDIX C

Pseudo Command Line Interface Reference

This chapter describes Pseudo-IOS command line interface (PCLI) for GE_XP, 10GE_XP, GE_XPE, and 10GE_XPE cards.

Note Unless otherwise specified, "ONS 15454" refers to both ANSI and ETSI shelf assemblies.

C.1 Understanding PCLI

PCLI provides an IOS-like command line interface for GE_XP, 10GE_XP, GE_XPE, and 10GE_XPE cards in Layer 2 (L2) mode. PCLI employs the Cisco IOS Modular QoS CLI (MQC).

PCLI is a text interface from where you can operate, provision and retrieve GE_XP, 10GE_XP, GE_XPE, and 10GE_XPE card information. PCLI runs on the Timing, Communications, and Control (TCC) of the node controller, to access card level information. PCLI acts as a Corba client and provides the same provisioning mechanisms as CTC or TL1. PCLI can be accessed via CTC by selecting **Tools > Open Pseudo IOS Connection** menu option or right-click on the node in the Network View and select **Open Pseudo IOS Connection**. To access the PCLI text interface use Telnet, or SSH to open a shell session to connect to a GE_XP, 10GE_XP, GE_XPE, or 10GE_XPE card and input IOS-like commands.

To access PCLI from Windows XP, enter the following command at the Windows command prompt:

```
telnet <node name> <port number>
```

To access PCLI from Solaris 8, enter the following command:

```
ssh -p <Port Number> <Node Name>
telnet <Node Name> <Port Number>
```

The PCLI shell supports the 454 multi-shelf architecture. Multi-shelf supports 16 shelves with each shelf containing 17 slots. The GE_XP, 10GE_XP, GE_XPE, or 10GE_XPE cards can be inserted in any Input/Output (IO) slot or shelf. PCLI also provides a command to virtually connect to a specified shelf/slot. However, connection to a non-Xponder slot or to an Xponder slot that is not in L2 mode is not supported. PCLI supports a maximum of 16 concurrent login sessions per node controller. A session can be cancelled by logging out of the PCLI session or when the idle timer times out.

Note PCLI adheres to the idle user timeout period security policy set via CTC or TL1.

Note For information on viewing security policies, refer the task, "DLP-G189 Change Security Policy for Multiple Nodes" in the *Cisco ONS 15454 DWDM Procedure Guide.*

If a PCLI session on a node using a given port number is open, the port number used by the PCLI session cannot be changed. When connecting in a Non-Secure state to a node and a port, use the configured port number for non-secured mode only, and when connecting via a Secure state to a node and a port, use the configured port number for Secure mode.

C.1.1 PCLI Security

PCLI supports configurable secure or unsecure access with a configurable port number per access mechanism. Use CTC to view or modify these settings. The default access state is "Non-secure" and the default port number is "65000".

PCLI supports an unsecured connection via Telnet and a secure connection via Secure Shell (SSH) by using existing system authentication, authorization and accounting (AAA) mechanisms. Login with user/password that is configured at the Network Element (NE). Use CTC or TL1 to manage user accounts.

Note If you have logged in to a PCLI connection in an Non-Secure state and change the connection via CTC to a Secure one (or vice versa), the Non-Secure state in PCLI (or Secure, as the case may be) is closed once the CTC configuration is completed.

For information on setting the access states (Non-secure or Secure), refer *Cisco ONS 15454 DWDM Procedure Guide*.

C.2 PCLI Command Modes

The PCLI supports eight different command modes. Each command mode can be accessed by specifying a command. The prompt changes to reflect the new command mode that you are in. Consequently, the set of valid commands changes to reflect the sub-commands that are allowed within that mode.

The following section shows supported PCLI commands for each command mode.

C.2.1 Common Commands

The following commands are common across all command modes.

- ?—Enter a question mark (?) at the system prompt to display a list of commands available in each command mode.
- !— Enter an exclamation symbol (!) at the system prompt to add comments.
- exit—Enter exit at the system prompt to exit from the mode you are currently in.

C.2.2 User EXEC Mode

Prompt: (>)

After a successful login, the system goes to User Executive (EXEC) command mode. Most PCLI commands in the User EXEC mode do not change system operation. The User EXEC mode allows you to work on multiple GE_XP, 10GE_XP, GE_XPE, and 10GE_XPE cards during a single session while restricting the view at any given time to a single card in a specific shelf and slot. This mode displays system wide parameters that span all cards in the node.

The following commands are supported in the User EXEC mode:

- enable shelf/slot
- show modules
- show users

C.2.3 Privileged EXEC Mode

Prompt: (#)

In general, the Privileged EXEC commands allow you to connect to remote devices, perform basic tests, and lists system information. Most CLI commands in Privileged EXEC mode do not change or modify provisioning and system operation. The most common EXEC commands are show commands and are used to display configuration or operational data, and do not have capability to modify provisioning.

To enter privileged EXEC mode, use the enable shelf/slot command.

The following commands are part of Privileged EXEC mode:

- configure terminal
- reload
- show startup-config
- show users
- show ip igmp snooping groups vlan vlanid
- show interfaces
- show ethernet service instance name
- show vlan profiles
- show vlans
- show modules
- show controllers type port
- show history
- show policy-maps
- show policy-map name
- show policy-map type port
- show lacp [detail]
- ethernet oam remote-loopback
- show ethernet oam discovery
- show ethernet oam statistics
- show ethernet oam status
- show ethernet oam summary

- clear ethernet cfm
- clear ethernet cfm statistics
- show ethernet cfm domain
- show ethernet cfm maintenance-points local
- show ethernet cfm maintenance-points
- show ethernet cfm mpdb
- show ethernet cfm statistics
- show interfaces rep
- show rep topology

C.2.4 Global Configuration Mode

Prompt: Node Name# (Config)

Enter global configuration mode from privileged EXEC mode. Global configuration commands generally apply to the whole system rather than just one protocol or interface. You can enter other configuration sub modes listed in this section from global configuration mode.

To enter global configuration mode, use the configure terminal command.

Note The node name can be configured by using CTC. Select **Node view > General > General > Node Name**

The following commands are part of global configuration mode:

- interface channel-group
- ethernet cfm ieee
- ethernet cfm domain
- ethernet cfm service
- mac-address-table learning vlan vlanid
- [no] mac-address-table learning interface type port
- [no] vlan vlan-id
- interface gigabitethernet port
- interface tengigabitethernet port
- policy-map name
- [no] mvr
- mvr vlan
- mvr group ip address count
- rep admin svlan

C.2.5 VLAN Configuration Mode

Prompt: (config-vlan)

Enter VLAN configuration mode from global configuration mode. You can configure parameters for an individual VLAN.

To enter VLAN configuration mode, use the **vlan <vlanid>** command.

The following commands are part of VLAN configuration mode:

- name vlan name
- protected
- ip igmp snooping
- ip igmp snooping immediate-leave
- ip igmp snooping report-suppression

C.2.6 Interface Configuration Mode

Prompt: (config-if)

Enter interface configuration mode from global configuration mode. In this mode and other interface sub modes, a wide variety of capabilities are supported. You can configure provisioning on a specific module interface, i.e. port.

To enter interface configuration mode, use the interface gigabitethernet port or interface tengigabitethernet port command.

The following commands are part of interface configuration mode:

- channel-group channel-number mode chanlgrp-mode
- channel-group channel-number hash chanlgrp-hash
- channel-group channel-number expected speed chanlgrp-speed
- description description
- ethernet oam
- ethernet oam mode
- ethernet oam link-monitor frame
- ethernet oam link-monitor frame-period
- ethernet oam link-monitor frame-seconds
- ethernet oam link-monitor high-threshold
- ethernet oam remote-failure link-fault
- ethernet cfm mip
- ethernet cfm mep
- ethernet cfm interface
- rep segment
- rep stcn
- rep preempt delay
- rep preempt
- rep preempt segment
- rep block port

- shutdown
- mtu bytes
- speed autol1000, 10000
- flowcontrol onloff
- switchport mode trunk
- switchport mode dot1q-tunnel
- service-policy input name
- service-policy output name
- service instance ethernet name
- l2protocol-tunnel
- [no] switchport port-security mac-address mac-address
- ip igmp snooping mrouter

C.2.7 Service Instance Configuration Mode

Prompt: (config-if-srv)

Service instance configuration mode is a sub mode of the interface configuration mode and can be used to define service instances, i.e. Ethernet Flow Points (EFPs). EFPs are specific to a particular interface. Multiple EFPs can be strung together to make an Ethernet Virtual Circuit (EVC).

The encapsulation commands can be used in any combination to implement flexible EFPs. However, the **dot1q** and **untagged** commands must be used for selective mode translations, and the **default** command must be used for transparent mode translations. The following restrictions apply to encapsulation commands:

- Selective and transparent mode apply to a whole port and are mutually exclusive.
- Encapsulation default is for transparent translations. Only one transparent service instance is allowed per port.
- Encapsulation untagged is for selective translation with no *cvlan* tag. If the operation is DOUBLE_ADD (**rewrite ingress tag push dot1q** <*multipurpose vlan*> *second-dot1q* <*svlan*>), only one service instance is allowed per port.

To enter service instance configuration mode, use the service instance ethernet name command.

The following commands are part of service instance configuration mode:

- encapsulation default
- encapsulation dot1q first cvlan last cvlan
- encapsulation untagged
- service-policy input name
- bridge-domain svlan

Note The encapsulation and rewrite commands are work together. These commands take effect only if the following sequence is followed:

1. Enter the encapsulation command.

2. Enter the rewrite command.

Note A service instance cannot be edited once user exits the service instance configuration mode. To make changes to any of these parameters, delete the service instance and recreate it.

C.2.8 Policy Map Configuration Mode

Prompt: (config-pmap)

Enter policy map configuration mode from global configuration mode by using the **policy-map** command to create a policy map or modify an existing policy map. This mode is part of the quality-of-service (QoS) feature.

To attach a QoS policy to a specific interface, you must enter interface configuration mode from global configuration mode by identifying the interface and then using the service-policy command to attach an existing policy. QoS policy map provisioning can be accessed across multiple GE_XP, 10GE_XP, GE_XPE, and 10GE_XPE cards.

To enter policy map configuration mode, enter the policy-map name command from the global config mode.

The following commands are part of policy map configuration mode:

- police cir percent % bc bytes be bytes
- set cos number
- wrr-queue cos-map queue-id cos1 … cosn
- wrr-queue queue-id weight 1-16 bandwidth percent %

C.2.9 VLAN Profile Config Mode

Prompt: (config-profile)

VLAN profile configuration mode can be used to provision the parameters for a VLAN profile. A VLAN profile can later be applied to multiple VLANs. VLAN profile provisioning can be accessed across multiple GE cards.

To enter VLAN profile configuration mode, use the vlan profile *name* command from the global config mode.

The following commands are part of VLAN profile configuration mode:

- police cir percent % bc bytes be bytes

enable *shelf/slot*

To enter privileged EXEC mode, use the **enable** command in user EXEC mode.

enable *shelf/slot*

Syntax Description

shelf/slot	Shelf and slot number.

Command Modes

User EXEC

Usage Guidelines

Use this command to enter privileged configuration mode. Entering privileged EXEC mode enables the use of privileged commands. Note the prompt for user EXEC mode is the greater than symbol (>), and the prompt for privileged EXEC mode is the hash symbol (#).

Examples

```
MSTP-176> enable 2/12
MSTP-176#
```

configure terminal

To enter global configuration mode, use the **configure terminal** command in privileged EXEC mode.

configure terminal

Syntax Description

This command has no arguments or keywords.

Command Modes

Privileged EXEC

Usage Guidelines

Use this command to enter global configuration mode.

After you enter the **configure terminal** command, the system prompt changes from `<node-name>#` to `<node-name>(config)#`, indicating that the card is now in global configuration mode. To leave global configuration mode and return to privileged EXEC mode, type `exit`.

Examples

```
MSTP-176# configure terminal
MSTP-176(config)#
```

show modules

To display summary information (shelf/slot/port, equipment type, service state) of the GE_XP, 10GE_XP, GE_XPE, or 10GE_XPE card, use the **show modules** command in User EXEC and privileged EXEC mode.

show modules

Syntax Description

This command has no arguments or keywords.

Command Default

No default behavior or values.

Command Modes

User EXEC and Privileged EXEC

Examples

The following is sample output of the **show modules** command:

```
MSTP-176# show modules
Shelf/Slot/Port        EquipType              ServiceState
    1/NA/NA              BIC_UNKNOWN              IS-NR
    1/1 /NA           XP_GE_LINE_CARD             IS-NR
    1/1 /1                 PPM_1_PORT     OOS-AU,AINS&UEQ
    1/1 /2                 PPM_1_PORT     OOS-AU,AINS&UEQ
    1/1 /8                 PPM_1_PORT     OOS-AU,AINS&UEQ
    1/1 /9                 PPM_1_PORT     OOS-AU,AINS&UEQ
    1/1 /11                PPM_1_PORT              IS-NR
    1/1 /15                PPM_1_PORT              IS-NR
    1/1 /16                PPM_1_PORT     OOS-AU,AINS&UEQ
MSTP-176#
```

show vlans

To display VLAN information, use the **show vlans** command in privileged EXEC mode.

show vlans

Syntax Description

This command has no arguments or keywords.

Command Default

No default behavior or values

Command Modes

Privileged EXEC

Examples

The following is sample output of the **show vlans** command which shows the status of 1+1 protection, MAC address learning, IGMP snooping, immediate leave, and report suppression on the GE_XP, 10GE_XP, GE_XPE, or 10GE_XPE card for a given VLAN.

```
MSTP-176# show vlans
                                    IGMP
VLAN Name Prot MAC Learn   Enable Immed Suppress
2          F    F            F     F     T
50         F    F            F     F     F
100        F    F            T     F     T
101        F    F            F     F     T
MSTP-176#
```

show interfaces

To display port level parameters and statistics of interfaces configured on the GE_XP, 10GE_XP, GE_XPE, or 10GE_XPE, use the **show interfaces** command in privileged EXEC mode.

show interfaces

Syntax Description

This command has no arguments or keywords.

Defaults

Privileged EXEC

Examples

The following is sample output of the **show interfaces** command. The output in the example depends on the type and number of interfaces in the card. For this reason only a part of the output is shown.

```
MSTP-176# show interfaces
Port 22 (Trunk),  Port name:
Admin State: ADMIN_IS, Service State: IS_NR
Reach: LR, Wavelength: WV_1310, AIS Action: NONE
Flow Control: DISABLED, Duplex Mode: FULL, Speed: SPEED_10G, MTU: 9700
NI Mode: NNI, MAC Learning: DISABLED, IGMP Static Router Port: DISABLED
Ingress CoS: 0, Ethertype Inner/Outer: 8100/8100, Egress QoS: DISABLED
Committed Info Rate: 100, Burst Size Committed/Excess: BCKT_4K/BCKT_4K
ifInOctets: 196928,  rxTotalPkts: 2896, ifInUcastPkts: 0
ifInMulticastPkts: 2896, ifInBroadcastPkts: 0
ifInDiscards: 0, ifOutOctets: 448072424, txTotalPkts: 132911365
ifOutMulticastPkts: 132911359, ifOutBroadcastPkts: 0
ifOutDiscards: 0, ifOutErrors: 0
dot3StatsAlignmentErrors: 0, dot3StatsFCSErrors: 0
dot3StatsFrameTooLong: 0, dot3StatsControlInUnknownOpCodes: 0
dot3StatsInPauseFrames: 0, dot3StatsOutPauseFrames: 0
etherStatsUndersizePkts: 0, etherStatsFragments: 0
etherStatsPkts: 132914261, etherStatsPkts64Octets: 0
65-127 Octets: 132914247, 128-255 Octets: 0
256-511 Octets: 0, 512-1023 Octets: 0
1024-1518 Octets: 0, 1519-1522: 0
etherStatsBroadcastPkts: 0, etherStatsMulticastPkts: 132914255
etherStatsOversizePkts: 0, etherStatsJabbers: 0
etherStatsOctets: 448269352, etherStatsCRCAlignErrors: 0
etherStatsOctets: 448269352, etherStatsCRCAlignErrors: 0
ifHCInOctets: 196928, ifHCInUcastPkts: 0
ifHCInMulticastPkts: 2896, ifHCInBroadcastPkts: 0
ifHCOutOctets: 448072424, ifHCOutMulticastPkts: 132911359
ifHCOutBroadcastPkts: 0, etherStatsHighCapacityPkts: 132914261
etherStatsHighCapacityOctets: 448269352
etherStatsHighCapacityPkts64Octets: 0
etherStatsHighCapacityPkts65to127Octets: 132914247
etherStatsHighCapacityPkts128to255Octets: 0
etherStatsHighCapacityPkts256to511Octets: 0
etherStatsHighCapacityPkts512to1023Octets: 0
etherStatsHighCapacityPkts1024to1518Octets: 0
cisRxReports: 2854, cisRxLeaves: 2
cisTxReports: 0, cisTxLeaves: 2
cisTxGeneralQueries: 2251, cisTxGroupSpecificQueries: 6
cisRxGeneralQueries: 35, RxGroupSpecificQueries 5
cisRxValidPackets: 2896, cisRxInvalidPackets: 0
MSTP-176#
```

show policy-maps

To display all policy maps in the node, use the **show policy-maps** command.

Syntax Description

This command has no arguments or keywords.

Defaults

Privileged EXEC

Examples

The following example displays all the policy maps on the GE_XP, 10GE_XP, GE_XPE, or 10GE_XPE cards:

```
MSTP-176# show policy-map
Policy Name: port1
Policy Type: SERVICE INSTANCE
CoS: 2

Policy Name: cos3
Policy Type: INGRESS
Ingress CoS: 3   Committed Info Rate: 80   Committed Burst Size: 1
Excess Burst Size: 2 Excess Info Rate: 100
MSTP-176#
```

show policy-map *name*

To display the information of an unnamed class, use the **show policy-map** command in privileged EXEC mode.

show policy-map *name*

Syntax Description

name	(Optional) The name of the service policy map whose complete configuration is to be displayed. The name can be a maximum of 31 characters.

Defaults

Existing policy map configurations are displayed.

Command Modes

Privileged EXEC

Examples

The **show policy-map** command displays the configuration of a service policy map that was created using the policy-map name command.

The following example displays the contents of policy map “pmapegress” on the GE_XP, 10GE_XP, GE_XPE, or 10GE_XPE card:

```
MSTP-176# show policy-maps pmapegress
Policy Name: pmapegress
Policy Type: EGRESS
CoS: 0     Queue: 0   Bandwidth: 15   Weight: 1
CoS: 1     Queue: 1   Bandwidth: 100   Weight: 1
CoS: 2     Queue: 2   Bandwidth: 100   Weight: 1
CoS: 3     Queue: 3   Bandwidth: 100   Weight: 1
CoS: 4     Queue: 4   Bandwidth: 100   Weight: 1
CoS: 5     Queue: 5   Bandwidth: 100   Weight: 1
CoS: 6     Queue: 6   Bandwidth: 100   Weight: 1
CoS: 7     Queue: 7   Bandwidth: 100   Weight: 1
MSTP-176#
```

show policy-map *type port*

To display all the policy maps configured on the port, use the **show policy-map type port** in privileged EXEC mode.

show policy-map *type port*

Syntax Description

type port	Interface type and port number.

Command Default

This command has no default behavior or values.

Command Modes

Privileged EXEC

Usage Guidelines

The **show policy-map type port** command displays the configuration of classes on the specified interface.

Examples

This section provides sample output of a typical **show policy-map type port** command. The output in the example depends on the type, number of interfaces and options enabled on the card. For this reason only a part of the output is shown and may vary.

```
MSTP-176# show policy-map int g 1
Policy Name: ingress
Policy Type: INGRESS
Ingress CoS: 3   Committed Info Rate: 50   Committed Burst Size: 4K
Excess Burst Size: 4K

Policy Name: new
Policy Type: EGRESS
CoS: 0     Queue: 0   Bandwidth: 100   Weight: 1
CoS: 1     Queue: 1   Bandwidth: 90   Weight: 2
CoS: 2     Queue: 0   Bandwidth: 100   Weight: 1
CoS: 3     Queue: 3   Bandwidth: 100   Weight: 1
CoS: 4     Queue: 4   Bandwidth: 100   Weight: 1
CoS: 5     Queue: 5   Bandwidth: 100   Weight: 1
CoS: 6     Queue: 6   Bandwidth: 100   Weight: 1
CoS: 7     Queue: 7   Bandwidth: 100   Weight: 1
MSTP-176#
```

show controllers *type port*

To display information about Small Form-factor Pluggable (SFP) installed, use the **show controllers *type port*** command in privileged EXEC mode.

show controllers *type port*

Syntax Description

type port	Interface type and port number.

Defaults

No defaults

Command Modes

Privileged EXEC

Examples

This section provides sample output of a typical **show controllers *type port*** command.

```
MSTP-176# show controllers g 2
Port 22 SFP is Present
Equipment Type                   : 1GE/1FC/2FC-1310nm
HW Part Number                   : 10-2273-01
HW Revision                      : A
Serial Number                    : FNS1032J435
CLEI Code                        : WMOTB17AAA
Product ID                       : ONS-SE-G2F-LX
Version ID                       : V01
```

MSTP-176#

show vlan profiles

To display the parameters of all configured VLANs or one VLAN (if the VLAN ID or name is specified), use the **show vlan profiles** command in privileged EXEC mode.

Note A vlan profile is a named set of vlan attributes. A profile can be associated to a VLAN ID on an interface. A profile can be attached to multiple vlan/interface pairs.

show vlan profiles

Command Modes

Privileged EXEC

Examples

The following example shows the output of the **show vlan profiles** command:

```
MSTP-176# show vlan profiles
Name           CIR BC    PIR BE    LinkIntegrity
a_profile      100 4     100 4           F
d_profile      200 4     100 4           T
e_profile      300 4     100 4           F
v_profile      400 4     100 4           T

MSTP-176#
```

show vlan profiles *name*

To display the parameters of all configured VLANs or one VLAN (if the VLAN ID or name is specified), use the **show vlan profiles *name*** command in privileged EXEC mode.

Syntax Description

name	Displays information about a single VLAN identified by VLAN name.

Note A vlan profile is a named set of vlan attributes. A profile can be associated to a VLAN ID on an interface. A profile can be attached to multiple vlan/interface pairs.

Command Modes

Privileged EXEC

Examples

The following example shows the output of the **show vlan profiles *name*** command:

```
MSTP-176# show vlan profiles a_profile
Name           CIR BC    PIR BE    LinkIntegrity
a_profile      100 4     100 4           F
```

show ethernet service instance *name*

To display information about ethernet customer service instances, use the **show ethernet service instance *name*** command in privileged EXEC mode.

show ethernet service instance *name*

Syntax Description

name	Displays service instance information of the specified service instance.

Command Modes

Privileged EXEC

Usage Guidelines

This command is useful for system monitoring and troubleshooting.

Examples

The following is an example of output from the **show ethernet service instance** command:

```
MSTP-176# show ethernet service instance
Identifier Interface              CE-Vlans
222        FastEthernet0/1       untagged,1-4093
10         FastEthernet0/2
222        FastEthernet0/2       200
333        FastEthernet0/2       default
10         FastEthernet0/3       300
11         FastEthernet0/3
10         FastEthernet0/4       300
10         FastEthernet0/6       untagged,1-4093
10         FastEthernet0/7       untagged,1-4093
10         FastEthernet0/8       untagged,1-4093
10         FastEthernet0/9       untagged
20         FastEthernet0/9
222        FastEthernet0/11      300-350,900-999
333        FastEthernet0/11      100-200,1000,1999-4093
222        FastEthernet0/12      20
333        FastEthernet0/12      10
10         FastEthernet0/13      10
20         FastEthernet0/13      20
30         FastEthernet0/13      30
200        FastEthernet0/13      222
200        FastEthernet0/14      200,222
300        FastEthernet0/14      333
555        FastEthernet0/14      555
```

show users

To display information about the active users on the node, use the **show users** command in user EXEC or privileged EXEC mode.

show users

Syntax Description

This command has no arguments or keywords.

Command Modes

User EXEC or Privileged EXEC

Usage Guidelines

This command displays user name, security level, aaplications users are using and login time of all users on the node.

Examples

The following is a sample output of the **show users** command:

```
MSTP-176# show users
User1, SUPERUSER, PCLI, loginTime:05.13.2000  10:08:29
User2, SUPERUSER, EMS, loginTime:05.13.2000  10:05:27
User3, SUPERUSER, EMS, loginTime:05.13.2000  09:39:35
User4, SUPERUSER, EMS, loginTime:05.13.2000  07:35:18
MSTP-176#
```

reload

To reset a card, use the **reload** command in privileged EXEC mode.

reload

Syntax Description

This command has no arguments or keywords.

Command Modes

Privileged EXEC

Usage Guidelines

This command resets the card that is currently used.

Examples

The following is a sample output of the **reload** command:

```
MSTP-176> reload
Warning! Resetting this card may impact traffic.
Please confirm (yes/no): n
Command cancelled.

MSTP-176>
```

show history

To list the commands you have entered in the current session (in all modes), use the **show history** command.

show history

Syntax Description

This command has no arguments or keywords.

Command Modes

All modes

Usage Guidelines

The **show history** command provides a record of commands you have entered. The history buffer records 100 commands.

The **show history** command can be used with the help of certain keys as shown in Table C-1.

Table C-1 History Keys

Card	Port Description
Ctrl-P or Up Arrow1[1]	Recalls commands in the history buffer in a backward sequence, beginning with the most recent command. Repeat the key sequence to recall successively older commands.
Ctrl-N or Down Arrow[1]	Returns to more recent commands in the history buffer after recalling commands with Ctrl-P or the Up Arrow. Repeat the key sequence to recall successively more recent commands.

1. The arrow keys function only with ANSI-compatible terminals.

Examples

The following is a sample output from the **show history** command, which lists the commands the user has entered in privileged EXEC mode for this session:

```
MSTP-176# show history
help
show users
show history
MSTP-176#
```

show startup-config

To display the current configuration of the GE_XP, 10GE_XP, GE_XPE, or 10GE_XPE card, use the **show startup-config** command in privileged EXEC mode. The start-up config and the running-config are the same.

show startup-config

Syntax Description

This command has no arguments or keywords.

Command Modes

Privileged EXEC

Command Default

No defaults

Examples

The following partial sample output displays the configuration file named startup-config:

```
MSTP-176# show startup-config

interface tengigabitethernet 22
speed 10000
mtu 9700
flowcontrol off
switchport mode trunk
switchport dot1q ethertype 8100
switchport dot1q ethertype inner 8100
no ip igmp snooping mrouter
switchport port-security mac-address blocked
no l2protocol-tunnel
link integrity action none
service instance ethernet
no shutdown

vlan profile a
no link integrity
police cir percent 100 pir percent 100 bc 4 be 4

no mac-address-table learning interface gigabitethernet 11
no mac-address-table learning interface gigabitethernet 13
no mac-address-table learning interface tengigabitethernet 21
no mac-address-table learning interface tengigabitethernet 22
end
MSTP-176#
```

show ip igmp snooping groups vlan *vlanid*

To display the multicast groups that were learned through Internet Group Management Protocol (IGMP) on a given SVLAN/MVLAN, use the **show ip igmp groups vlan *vlanid*** in privileged EXEC mode.

show ip igmp groups vlan *vlanid*

Syntax Description

vlanid	VLAN ID range is 1 to 4093.

Command Modes

Privileged EXEC

Command Default

No defaults.

Examples

The following partial sample output displays the multicast groups for VLAN 10:

```
MSTP-176# show ip igmp sn gr vlan 128
MCAST IP ADDR                   VLAN    Ports
224.1.1.1                       128     ETHER(99)/SH-1/SL-13/PRT-2
224.1.1.2                       128     ETHER(99)/SH-1/SL-13/PRT-2
224.1.1.3                       128     ETHER(99)/SH-1/SL-13/PRT-2

MSTP-176#
```

show lacp [detail]

To display detailed LACP information from the GE_XP, 10GE_XP, GE_XPE, or 10GE_XPE cards, use the **show lacp** command in privileged EXEC mode.

show lacp [detail]

Syntax Description

detail	Shows the detailed LACP information.

Command Default

None

Command Modes

Privileged EXEC (#)

Usage Guidelines

If you omit the **detail** keyword, basic LACP information is shown.

Examples

The following is a sample output for the **show lacp** command:

```
MSTP-176# show lacp
Flags: S - Device is requesting Slow LACPDUs
         F - Device is requesting Fast LACPDUs
         A - Device is in Active mode
         P - Device is in Passive mode
Link state can be:
         bndl:     active in an aggregation
         hot-sby:  In hot standby mode (Not supported)
         susp:     LACP not up
         down:     link is not available
_____________________________________________________________________________
Channel Group 1
_____________________________________________________________________________
Actor    Port     Flags   State   LACP Port   Admin   Oper   Port
         Number                   Priority    Key     Key    State
         Phy21    SP      down    32768       1       0      0x44
-----------------------------------------------------------------------------
Partner  Oper     Flags   State   LACP Port   Admin   Oper   Port
         Port #                   Priority    Key     Key    State
Phy21    0        SP      down    0           0       0      0x0
_____________________________________________________________________________
MSTP-176#
```

ethernet oam remote-loopback

To turn on or off the remote loopback function on an EFM interface, use the **ethernet oam remote-loopback** command in privileged EXEC mode. This command does not have a **no** form.

ethernet oam remote-loopback {start|stop} {interface *number***}**

Syntax Description

start	Starts the remote loopback operation.
stop	Stops the remote loopback operation.
interface	Specifies an Ethernet interface.
number	Number of the Ethernet interface. If the operation is start, the range of number is 1 to 20; if the operation is stop, the range of number is 21 to 22.

Command Default

By default, the remote loopback function is turned off.

Command Modes

Privileged EXEC (#)

Usage Guidelines

When the remote loopback function is enabled on an EFM interface, traffic passed on this interface is discarded by the remote interface.

Examples

The following example shows how to start a remote loopback session on a specific interface:

```
MSTP-176# ethernet oam remote-loopback start interface 8
```

show ethernet oam discovery

To display discovery information for all EFM interfaces or for a specific EFM interface, use the **show ethernet oam discovery** command in privileged EXEC mode.

show ethernet oam discovery [interface *number***]**

Syntax Description

interface	Specifies an Ethernet interface.
number	Number of the Ethernet interface. The number ranges from 1 to 22.

Command Default

None

Command Modes

Privileged EXEC (#)

Usage Guidelines

This command displays the following information pertaining to Ethernet OAM discovery:

- Remote device which is directly connected to this device
- Local and remote OAM configuration and capability
- Local and remote OAM mode
- Remote platform identity
- State of the local discovery state machine

If an interface is specified, only data pertaining to the OAM peer on that interface is displayed; otherwise, data for all OAM peers on all interfaces is displayed.

Examples

The following example shows how to display discovery information for a specific EFM interface.

```
MSTP-176# show ethernet oam discovery
Interface-22:
Local client
------------
  Administrative configurations:
                Mode: active
         Link monitor: (on)
      Remote loopback: supported
             Mtu size: 1500
  Operational status:
          Port status: active send
      Loopback status: no loopback
         PDU revision: 0
Remote client
-------------
  Remote Ethernet OAM client has not been found!
MSTP-176#
```

show ethernet oam statistics

To display detailed information about the EFM packets, use the **show ethernet oam statistics** command in privileged EXEC mode.

show ethernet oam statistics [interface *number***]**

Syntax Description

interface	Specifies an Ethernet interface.
number	Number of the Ethernet interface. The number ranges from 1 to 22.

Command Default

None

Command Modes

Privileged EXEC (#)

Usage Guidelines

This command displays the following statistics:

- Rx/Tx OAM Protocol Data Unit (PDU) counters
- Link monitoring events, including event logs, if available
- Remote fault detection events
- Remote loopback events

Examples

The following example shows how to display information for a specific interface:

```
MSTP-176# show ethernet oam statistics interface 22
Interface-22:
Counters:
---------
                     Information OAMPDU Tx: 1
                     Information OAMPDU Rx: 0
       Unique Event Notification OAMPDU Tx: 0
       Unique Event Notification OAMPDU Rx: 0
    Duplicate Event Notification OAMPDU TX: 0
    Duplicate Event Notification OAMPDU RX: 0
                Loopback Control OAMPDU Tx: 0
                Loopback Control OAMPDU Rx: 0
                Variable Request OAMPDU Tx: 0
                Variable Request OAMPDU Rx: 0
              Variable Response OAMPDU Tx: 0
              Variable Response OAMPDU Rx: 0
                          Cisco OAMPDU Tx: 0
                          Cisco OAMPDU Rx: 0
                    Unsupported OAMPDU Tx: 0
                    Unsupported OAMPDU Rx: 0
                   Frames Lost due to OAM: 0
Local Faults:
-------------
1 Link Fault records
```

```
Total link faults: 1
Time stamp: 1271800854d
0 Dying Gasp records
0 Critical Event records
Remote Faults:
--------------
0 Link Fault records
0 Dying Gasp records
0 Critical Event records
Local event logs:
-----------------
0 Errored Symbol Period records
0 Errored Frame records
0 Errored Frame Period records
0 Errored Frame Second records
Remote event logs:
------------------
0 Errored Symbol Period records
0 Errored Frame records
0 Errored Frame Period records
0 Errored Frame Second records
MSTP-176#
```

show ethernet oam status

To display EFM configurations for all interfaces or for a specific interface, use the **show ethernet oam status** command in privileged EXEC mode.

show ethernet oam status [interface *number***]**

Syntax Description

interface	Specifies an Ethernet interface.
number	Number of the Ethernet interface. The number ranges from 1 to 22.

Command Default

None

Command Modes

Privileged EXEC (#)

Usage Guidelines

Use this command to display the runtime settings of link monitoring and general OAM operations for all the interfaces or for a specific interface.

OAM must be operational on the interfaces before you use this command.

Examples

The following example shows how to display EFM configurations for a specific interface:

```
MSTP-176# show ethernet oam status interface 22
Interface-22:
General
-------
            Admin state: enabled
                   Mode: active
               PDU rate: 1 packet per 1 second
           Link timeout: 5 seconds
  High threshold action: error block interface
      Link fault action: error block interface
Link Monitoring
---------------
  Status:
  Frame Error
                 Window: 10 x 100 milliseconds
          Low threshold: 10 error frame(s)
         High threshold: 10 error frame(s)
  Frame Period Error
                 Window: 1000 x 10000 frames
          Low threshold: 9 error frame(s)
         High threshold: 10 error frame(s)
  Frame Seconds Error
                 Window: 100 x 100 milliseconds
          Low threshold: 1 error second(s)
         High threshold: none
MSTP-176#
```

show ethernet oam summary

To display the active EFM sessions on a device, use the **show ethernet oam summary** command in privileged EXEC mode.

show ethernet oam summary

Syntax Description

This command has no arguments or keywords.

Command Default

None

Command Modes

Privileged EXEC (#)

Examples

The following example shows how to display the active EFM sessions on a device:

```
MSTP-176# show ethernet oam summary
Symbols:          * - Master Loopback State,  # - Slave Loopback State
                  & - Error Block State
Capability codes: L - Link Monitor,  R - Remote Loopback
                  U - Unidirection,  V - Variable Retrieval
  Local                        Remote
Interface       MAC Address    OUI    Mode    Capability
Interface-22
MSTP-176#
```

clear ethernet cfm

To clear the Maintenance Intermediate Point (MIP) and Maintenance End Point (MEP) database in CFM, use the **clear ethernet cfm maintenance-points remote** command in privileged EXEC mode.

clear ethernet cfm maintenance-points remote

Syntax Description

This command has no arguments or keywords.

Command Default

None

Command Modes

Privileged EXEC (#)

Examples

The following example shows how to clear MIP and MEP database:

```
MSTP-176# clear ethernet cfm maintenance-points remote
```

clear ethernet cfm statistics

To clear the CFM statistics, use the **clear ethernet cfm statistics** command in privileged EXEC mode.

clear ethernet cfm statistics

Syntax Description This command has no arguments or keywords.

Command Default None

Command Modes Privileged EXEC (#)

Examples The following example shows how to clear the CFM statistics:

```
MSTP-176# clear ethernet cfm statistics
```

show ethernet cfm domain

To display brief information or detailed information about CFM maintenance domains and services configured under the domains, use the **show ethernet cfm domain** in privileged EXEC mode.

show ethernet cfm domain [brief | *domain_name***]**

Syntax Description

brief	Displays brief information about CFM maintenance domains.
domain_name	Name of the maintenance domain.

Command Default

None

Command Modes

Privileged EXEC (#)

Examples

The following example shows how to display detailed information about a specific CFM maintenance domain:

```
MSTP-176# show ethernet cfm domain test_domain
Domain Name: test_domain           Level:2

Attached to MAProfile: maprofile1  VlanId:150   CCEnabled: True
MSTP-176#
```

show ethernet cfm maintenance-points local

To display the maintenance points configured on a device, use the **show ethernet cfm maintenance-points local** command in privileged EXEC mode.

show ethernet cfm maintenance-points local [mip [level *level*] **[service** *vlan*] **| mep [domain** *domain_name*] **[service** *vlan*]]

Syntax Description

level	Maintenance level. The level range is from 0 to 7.
vlan	VLAN range. The VLAN range is from 1 to 4093.
domain_name	Name of the maintenance domain.

Command Default

None

Command Modes

Privileged EXEC (#)

Examples

The following example shows how to display all the maintenance points configured on a device:

```
MSTP-176# show ethernet cfm maintenance-points local
Local MEP Configuration
Local MIP Configuration
Port: 1   SvlanId :150     level:2
MSTP-176#
```

show ethernet cfm maintenance-points

To display information about remote maintenance point domains, use the **show ethernet cfm maintenance-points remote** in privileged EXEC mode.

show ethernet cfm maintenance-points remote [domain *domain_name***] [service** *vlan***]]**

Syntax Description

domain_name	Name of the maintenance domain.
vlan	VLAN range. The VLAN range is from 1 to 4093.

Command Default

None

Command Modes

Privileged EXEC (#)

Examples

The following example shows how to display information about remote maintenance point domains:

```
MSTP-176# show ethernet cfm maintenance-points remote domain test_domain service 6
Maintenance Domain   Name: test_domain level:6
Domain Name: ma6         VlanId:6
MPId:34  Remote MAC: 22:22:22:22:31:34
Incoming Port:21  ccLifeTime: 3500   ageOfLastCC: 266
MSTP-176#
```

show ethernet cfm mpdb

To display the output of the Ethernet CFM MIP database, use the **show ethernet cfm mpdb** command in privileged EXEC mode.

show ethernet cfm mpdb [level *level***] [service** *vlan***]**

Syntax Description

level	Maintenance level. The level range is from 0 to 7.
vlan	VLAN range. The VLAN range is from 1 to 4093.

Command Default

None

Command Modes

Privileged EXEC (#)

Examples

The following example shows how to displays the output of the CFM MIP database:

```
MSTP-176# show ethernet cfm mpdb level 6 service 6
Level: 6         VlanId:6
MPId:34  Remote MAC: 22:22:22:22:31:34
Ingress Port:21  archiveTimer: 6003500
MSTP-176#
```

show ethernet cfm statistics

To display the CFM statistics, use the **show ethernet cfm statistics** command in privileged EXEC mode.

show ethernet cfm statistics [domain *domain_name*] **[service** *vlan*]

Syntax Description

domain_name	Name of the maintenance domain.
vlan	VLAN range. The VLAN range is from 1 to 4093.

Command Default

None

Command Modes

Privileged EXEC (#)

Examples

The following example shows how to display the CFM statistics:

```
MSTP-176# show ethernet cfm statistics domain test_domain service 6
Domain Name: test_domain VlanId:6     mpId:6
Ccm transmitted:70268  ccmRececived: 583  ccRecvSeqErr: 1 Lt Unexpected recv:0  lbr
transmitted: 0  lbr rcvd in order: 0 Lbr Recvd Seq Error:0  lbr rcvd bad msdu: 0
MSTP-176#
```

show interfaces rep

To display REP configuration and status for a specific interface or for all interfaces, use the **show interfaces rep** command in privileged EXEC mode.

show interfaces [*interface_name***] rep [detail]**

Syntax Description

interface_name	REP configuration and status for a specific physical interface or port channel ID.
detail	Displays detailed REP configuration and status information.

Command Default

None

Command Modes

Privileged EXEC (#)

Examples

The following is a sample output for the **show interfaces rep** command:

```
MSTP-176# show interfaces rep detail
Phy1   REP enabled
Segment-id: 2 (Preferred)
PortID: 00000019076cb77a
Preferred flag: Yes
Operational Link Status: NO_NEIGHBOR
Current Key: 00000019076cb77a5bdd
Port Role: Fail No Ext Neighbor
Blocked VLAN: 1-4094
Rcvd VLAN: <empty>
Admin-svlan: 0
Admin-cvlan: 0
Preempt Delay Timer: disabled
LSL Ageout Timer: 5000 ms
VLAN load balancing: disabled
STCN Propagate to: none
LSL PDU rx: 0, tx: 102
HFL PDU rx: 0, tx: 0
BPA TLV rx: 0, tx: 0
BPA (STCN, LSL) TLV rx: 0, tx: 0
BPA (STCN, HFL) TLV rx: 0, tx: 0
EPA-ELECTION TLV rx: 0, tx: 0
EPA-COMMAND TLV rx: 0, tx: 0
EPA-INFO TLV rx: 0, tx: 0
MSTP-176#
```

show rep topology

To display REP topology information for a segment or for all the segments (including the primary and secondary edge ports in the segment), use the **show rep topology** command in privileged EXEC mode.

show rep topology [segment *id***] [archive] [detail]**

Syntax Description

segment *id*	Displays the REP topology information for a specific segment. The ID range is from 1 to 1024.
archive	Displays the previous topology of the segment.
detail	Displays detailed REP topology information.

Command Default

None

Command Modes

Privileged EXEC (#)

Usage Guidelines

The **archive** keyword is useful for troubleshooting a link failure.

Examples

The following is a sample output for the **show rep topology**command:

```
MSTP-176# show rep topology
BridgeName          PortName   Edge Role
------------------- ---------- ---- ----
     10.64.106.37-s1       Phy1      FailNoNbr
MSTP-176#
```

interface channel-group

To create a channel group on the GE_XP, 10GE_XP, GE_XPE, and 10GE_XPE cards, use the **interface channel-group** command in global configuration mode.

interface channel-group *chanlgrp-num*

Syntax Description

chanlgrp-num	ID of the channel group. The channel group range is as follows: • 1 to 11 on the GE_XP and GE_XPE cards. • 1 to 2 on the 10GE_XP and 10GE_XPE cards.

Command Default

No channel groups are created.

Command Modes

Global Configuration (config)

Examples

The following example shows how to create a channel group with id 7:

```
MSTP-176(config)# interface channel-group 7
```

ethernet cfm ieee

To enable CFM on the GE_XP, 10GE_XP, GE_XPE, and 10GE_XPE cards, use the **ethernet cfm ieee** command in global configuration mode. To disable CFM on the card, use the **no** form of this command.

ethernet cfm ieee

[no] ethernet cfm ieee

Syntax Description

This command has no arguments or keywords.

Command Default

None

Command Modes

Global configuration (config)

Examples

The following example shows how to enable CFM on the GE_XP, 10GE_XP, GE_XPE, and 10GE_XPE cards:

```
MSTP-176# ethernet cfm ieee
```

ethernet cfm domain

To create a maintenance domain, use the **ethernet cfm domain** in global configuration mode.

ethernet cfm domain *domain_name* **level** *level*

[no] ethernet cfm domain *domain_name* **level** *level*

Syntax Description

domain_name	Name of the maintenance domain
level	Maintenance level. The level range is from 0 to 7

Command Default

No maintenance domain is created.

Command Modes

Global configuration (config)

Examples

The following example shows how to create a maintenance domain with level 4:

```
MSTP-176# ethernet cfm domain test_domain level 4
```

ethernet cfm service

To attach the maintenance association to a maintenance domain, use the **ethernet cfm service** command in global configuration mode.

ethernet cfm service *service_name* **vlan** *vlan*

[no] ethernet cfm service *service_name* **vlan** *vlan*

Syntax Description

service_name	Name of the service identified by the maintenance association.
vlan	VLAN range. The VLAN range is from 1 to 4093.

Command Modes

Global configuration (config)

Examples

The following example shows how to attach a maintenance association to a maintenance domain:

```
MSTP-176# ethernet cfm service service name vlan 100
```

rep admin svlan

To configure the REP administrative VLAN to transmit hardware flood layer (HFL) messages, use the **rep admin svlan** command in global configuration mode. To return to the default configuration with VLAN 1 as the administrative VLAN, use the **no** form of this command.

rep admin svlan *svlanid*

no rep admin svlan

Syntax Description

svlanid	SVLAN identifier. The SVLAN range is from 1 to 4093.

Command Default

The default administrative VLAN is VLAN 1.

Command Modes

Global configuration (config)

Usage Guidelines

If the REP administrative VLAN is not configured, the default is VLAN 1. There can be only one administrative VLAN on a switch and on a segment.

Examples

The following example shows how to configure the REP administrative VLAN:

```
MSTP-176(config)# rep admin svlan 4000
```

mac-address-table learning vlan *vlanid*

Use the **mac-address-table learning vlan** global configuration command to enable MAC address learning on a VLAN. Use the no form of this command to disable MAC address learning on a VLAN to control which VLANs can learn MAC addresses.

mac-address-table learning vlan *vlanid*

no mac-address-table learning vlan <vlanid>

Syntax Description

vlanid	VLAN ID range is 1 to 4093.

Command Modes

Global configuration

Command Default

By default, MAC address learning is disabled on all VLANs.

Usage Guidelines

Customers in a service provider network can tunnel a large number of MAC addresses through the network and fill the available MAC address table space. When you control MAC address learning on a VLAN, you can manage the available MAC address table space by controlling which VLANs, and therefore which ports, can learn MAC addresses.

Examples

An example to enable MAC address learning on VLAN 10 is shown:

```
MSTP-176# mac-address-table learning vlan 10
MSTP-176#
```

[no] mac-address-table learning interface *type port*

Use the **mac-address-table learning interface *type port*** global configuration command to specify interface based learning of MAC addresses.

Syntax Description

type/port	Interface type, and the port number.

Command Modes

Global configuration

Command Default

None

Usage Guidelines

None

Examples

This example shows how to enable MAC-address learning on an interface:

```
MSTP-176# mac-address-table learning interface gig 1
MSTP-176#
```

[no] vlan *vlan-id*

To add a VLAN and enter config-VLAN submode, use the vlan command. Use the no form of this command to delete the VLAN.

vlan *vlan-id*

Syntax Description

vlan-id	VLAN ID.

Command Modes

Global configuration

Command Default

None

Usage Guidelines

None

Examples

This example shows how to add a new VLAN and to enter config-VLAN submode:

```
MSTP-176# (config)# vlan 2
MSTP-176# (config-vlan)#
```

interface gigabitethernet *port*

To enter gigabit ethernet (GigE) interface configuration, use the **interface gigabitethernet** command in the appropriate configuration mode.

interface gigabitethernet *port*

Syntax Description

port	Enter port number 1-20.

Command Modes

Global configuration

Command Default

Usage Guidelines

Examples

This example shows how to enter Gigabit Ethernet interface on port 2:

```
MSTP-176(config)# interface gigabitethernet 2
MSTP-176(config-if)#
```

interface tengigabitethernet *port*

To enter ten gigabit ethernet (10 GigE) interface configuration, use the **interface tengigabitethernet** command in the appropriate configuration mode.

interface tengigabitethernet *port*

Syntax Description

port	Enter port number 21-22.

Command Modes

Global configuration

Command Default

Usage Guidelines

Examples

This example shows how to enter 10GigE interface on port 21:

```
MSTP-176(config)# interface tengigabitethernet 21
MSTP-176(config-if)#
```

policy-map *name*

To configure the Quality of Service (QoS) policy map, use the **policy-map** command. Use the no form of this command to delete a policy map.

policy-map name

[no] policy-map name

Syntax Description

name	Policy map name.

Command Modes

Global configuration

Command Default

None

Usage Guidelines

None

Examples

This example shows how to create a QoS policy for ingress traffic on an interface command:

```
MSTP-176(config)# policy map pmap
MSTP-176(config-pmap)# police cir percent 60 pir percent 80 bc 4 be 16
MSTP-176(config-pmap)# set cos 8
MSTP-176(config-pmap)# service-policy input servpol1
MSTP-176# end
```

[no] mvr

Use the **mvr** global configuration command to enable the multicast VLAN registration (MVR) feature on the GE_XP, 10GE_XP, GE_XPE, and 10GE_XPE. Use the **[no] mvr** form of this command to disable MVR and its options.

mvr group ip-address vlan *vlan-id*

[no] mvr group ip-address vlan *vlan-id*

Command Modes

Global Configuration

Command Default

MVR is disabled by default.

Usage Guidelines

A maximum of 256 MVR multicast groups can be configured on the GE_XP, 10GE_XP, GE_XPE, and 10GE_XPE. MVR can be enabled only after the multi-group address and VLAN are configured.

Examples

This example shows how to configure 228.1.23.4 as an IP multicast address:

```
MSTP-176(config)# mvr group 228.1.23.4
```

This example shows how to set VLAN 2 as the multicast VLAN:

```
MSTP-176(config)# mvr vlan 2
```

This example shows how to enable MVR:

```
MSTP-176(config)# mvr
```

This example shows how to disable MVR:

```
MSTP-176(config)# no mvr
```

mvr vlan

To specify the VLAN (SVLAN) to act as a multicast VLAN, use the **mvr vlan** command. All ports must belong to this VLAN.

mvr vlan *svlan*

Syntax Description

svlan	SVLAN ID.

Command Modes

Global Configuration

Command Default

By default MVR is disabled on a SVLAN.

Usage Guidelines

None

Examples

This example shows how to set a VLAN to act as the multicast VLAN:

```
MSTP-176(config)# mvr vlan 22
```

mvr group *ip address count*

To configure an IP multicast address on the GE_XP, 10GE_XP, GE_XPE, or 10GE_XPE card, use the *count* parameter to configure a contiguous series of MVR group addresses. Any multicast data sent to this address is sent to all source ports on the switch and all receiver ports that have elected to receive data on that multicast address. Each multicast address would correspond to one television channel.

mvr group *ip address count*

Syntax Description

count	The range for *count* is 1 to 256.

Command Modes

Global Configuration (config)

Command Default

By default MVR is disabled on a SVLAN.

Examples

The following example shows how to configure two contiguous MVR address groups:

```
MSTP-176(config)# mvr group 228.1.23.4 2
```

ethernet cfm cc_interval *interval*

To configure the value of the Continuity Check timer (CC timer), use the **ethernet cfm cc_interval** command in CFM maintenance association configuration mode.

ethernet cfm cc_interval *interval*

[no] ethernet cfm cc_interval *interval*

Syntax Description

interval	Continuity Check timer interval. The interval values are 1 second, 10 seconds, and 1 minute.

Command Default

The default configuration is 1 second.

Command Modes

CFM Maintenance Association configuration (config-ecfm-srv)

Examples

The following example shows how to set the value of the CC timer to 10 seconds:

```
MSTP-176(config-ecfm-srv)# ethernet cfm cc_interval 10s
```

service *service_name*

To configure the service name for the maintenance association, use the **service** ***service_name*** command in CFM maintenance association configuration mode.

service *service_name*

Syntax Description

service_name	Service name of the maintenance association.

Command Modes

CFM Maintenance Association configuration (config-ecfm-srv)

Examples

The following example shows how to configure a CFM service:

```
MSTP-176(config-ecfm-srv)# service service name
```

continuity-check

To enable the CC timer for the maintenance association profile, use the **continuity-check** command in CFM maintenance association configuration mode. To disable the CC timer for the maintenance association profile, use the **no** form of this command.

continuity-check

[no] continuity-check

Syntax Description

This command has no arguments or keywords.

Command Default

Continuity check is disabled by default.

Command Modes

CFM Maintenance Association configuration (config-ecfm-srv)

Examples

The following example shows how to enable the CC timer for the maintenance association profile:

```
MSTP-176(config-ecfm-srv)# continuity-check
```

name vlan *name*

To configure the VLAN, use the **name vlan** *name* command in VLAN interface configuration mode.

name vlan *name*

Syntax Description

name	Specify the name of the VLAN.

Command Modes

VLAN interface configuration

Command Default

By default, no name is assigned to a VLAN.

Usage Guidelines

Names with blank spaces can be provided by enclosing the name within double quotes.

Examples

The following example shows how to set the VLAN name:

```
MSTP-176(config-vlan)# name MYVLAN
```

protected

To enables or disable Fast Automatic Protection Switching (FAPS) on the specified SVLAN, use the protected command.

protected

[no] protected

Syntax Description

This command has no arguments or keywords.

Command Modes

VLAN interface configuration

Command Default

By default, FAPS is disabled on all SVLANs.

Examples

The following example shows how to configure the card for protection:

```
MSTP-176(config-vlan)# protected
```

ip igmp snooping

To enable IGMP snooping, use the **ip igmp snooping** command. Use the no form of this command to disable IGMP snooping.

ip igmp snooping

no ip igmp snooping

Syntax Description

This command has no arguments or keywords.

Command Default

By default, IGMP snooping is disabled on all SVLANs.

Command Modes

VLAN interface configuration

Usage Guidelines

Before you can enable IGMP snooping configure the VLAN interface for multicast routing.

Examples

This example shows how to enable IGMP snooping:

```
MSTP-176(config-vlan)# ip igmp snooping
MSTP-176(config-vlan)#
```

ip igmp snooping immediate-leave

To enable IGMPv2 snooping immediate-leave processing on all existing VLAN interfaces, use the **ip igmp snooping immediate-leave** command. Use the no form of this command to disable immediate-leave processing.

ip igmp snooping immediate-leave

no ip igmp snooping immediate-leave

Syntax Description

This command has no arguments or keywords.

Defaults

By default, IGMP snooping immediate leave is disabled on all SVLANs.

Command Modes

VLAN interface configuration

Usage Guidelines

The immediate-leave feature is supported only with IGMP version 2.

Examples

This example shows how to enable IGMP immediate-leave processing:

```
MSTP-176(config-vlan)# ip igmp snooping immediate-leave
MSTP-176(config-vlan)#
```

ip igmp snooping report-suppression

To enable report suppression, use the **ip igmp snooping report-suppression** command. Use the no form of this command to disable report suppression and forward the reports to the multicast devices.

ip igmp snooping report-suppression

no igmp snooping report-suppression

Syntax Description

This command has no arguments or keywords.

Defaults

By default, IGMP snooping report-suppression is disabled on all SVLANs.

Command Modes

VLAN interface configuration

Examples

This example shows how to enable report suppression:

```
MSTP-176(config-vlan)# ip igmp snooping report-suppression
MSTP-176(config-vlan)#
```

This example shows how to disable report suppression:

```
MSTP-176(config-vlan)# )# no ip igmp snooping report-suppression
MSTP-176(config-vlan)#
```

channel-group *channel-number* mode *chanlgrp-mode*

To configure the mode for the channel group on the GE_XP, 10GE_XP, GE_XPE, and 10GE_XPE cards, use the **channel-group** *channel-number* **mode** *chanlgrp-mode* command in interface configuration mode. To set the channel group mode to active, use the **no** form of this command.

channel-group *channel-number* **mode** *chanlgrp-mode*

[no] channel-group *channel-number* **mode** *chanlgrp-mode*

Syntax Description

channel-number	Number of the channel group.
chanlgrp-mode	Mode of the channel group. The channel group mode values are active, passive, and manual.

Command Default

The channel group mode is set to active.

Command Modes

Interface Configuration (config-if)

Examples

The following example shows how to change the channel group mode to passive:

```
MSTP-176(config-if)# channel-group 6 mode passive
```

channel-group *channel-number* hash *chanlgrp-hash*

To configure the hashing algorithm for the channel group on the GE_XP, 10GE_XP, GE_XPE, and 10GE_XPE cards, use the **channel-group** *channel-number* **hash** *chanlgrp-hash* command in interface configuration mode.

channel-group *channel-number* **hash** *chanlgrp-hash*

[no] channel-group *channel-number* **hash** *chanlgrp-hash*

Syntax Description

channel-number	Number of the channel group.
chanlgrp-hash	Hashing algorithm for the channel group. The channel group hash values are sa-incoming, da-incoming, sa-da-incoming, src-ip-tcp-udp, dst-ip-tcp-udp, and src-dst-ip-tcp-udp.

Command Default

The hashing algorithm is set to to sa-da-incoming.

Command Modes

Interface Configuration (config-if)

Examples

The following example shows how to change the hashing algorithm for the channel group mode to src-ip-tcp-udp:

```
MSTP-176(config-if)# channel-group 2 hash src-ip-tcp-udp
```

channel-group *channel-number* expected speed *chanlgrp-speed*

To change the expected speed of the channel group on the GE_XP, 10GE_XP, GE_XPE, and 10GE_XPE cards, use the **channel-group** *channel-number* **expected speed** *chanlgrp-speed* command in interface configuration mode.

channel-group *channel-number* **expected speed** *chanlgrp-speed*

[no] channel-group *channel-number* **expected speed** *chanlgrp-speed*

Syntax Description

channel-number	Number of the channel group.
chanlgrp-speed	Expected speed of the channel group. The channel group speed values are 10, 100, and 1000.

Command Default

The default expected speed is 1000.

Command Modes

Interface Configuration (config-if)

Examples

The following example shows how to change the expected speed for the channel group to 100:

```
MSTP-176(config-if)# channel-group 2 expected speed 100
```

description *description*

To specify the port name, use the **description** command in interface configuration mode.

description

Syntax Description

description	Port name can be a maximum of 32 characters

Command Modes

Interface configuration

Usage Guidelines

To view the ports on an interface, use the show interfaces command in privileged EXEC mode.

Examples

This example shows how to specify a port name:

```
MSTP-176(config-if)# description 5p
```

The following partial sample output displays the port name that was set:

```
MSTP-176# show interface

Port 2 (Client),  Port name: 5p
Admin State: ADMIN_OOS_DSBLD, Service State: OOS_MA_DSBLD
Reach: REACH_UNKNOWN, Wavelength: WV_UNKNOWN, AIS Action: NONE
Flow Control: DISABLED, Duplex Mode: FULL, Speed: SPEED_AUTO, MTU: 9700
NI Mode: UNI, MAC Learning: DISABLED, IGMP Static Router Port: DISABLED
Ingress CoS: 0, Ethertype Inner/Outer: 8100/8100, Egress QoS: DISABLED
Committed Info Rate: 100, Burst Size Committed/Excess: BCKT_4K/BCKT_4K
Failed to get PM counters for this port

MSTP-176#
```

ethernet oam

To enable EFM on an interface, use the **ethernet oam** command in interface configuration mode. To disable EFM on an interface, use the **no** form of this command.

ethernet oam

[no] ethernet oam

Syntax Description

This command has no arguments or keywords.

Command Default

EFM is disabled by default.

Command Modes

Interface Configuration (config-if)

Usage Guidelines

When EFM is configured on an interface, the default mode of the EFM client is active. When the EFM mode is enabled on two interfaces passing traffic, both interfaces cannot be in passive mode. Both interfaces can be in active mode, and one can be in active mode and the other in passive mode.

Examples

The following example shows how to enable EFM on an interface:

```
MSTP-176(config-if)# ethernet oam
```

ethernet oam mode

To configure the EFM mode (active or passive) and the timeout parameter, use the **ethernet oam command** in interface configuration mode. To return to the default configuration, use the **no** form of this command.

ethernet oam [mode {active | passive} | timeout *seconds***]**

[no] ethernet oam [mode {active | passive} | timeout *seconds***]**

Syntax Description

mode	Sets the EFM client mode.
active	Sets the EFM client mode to active after the interface was previously placed in passive mode. The default mode is active.
passive	Sets the EFM client mode to passive. In passive mode, a device cannot initiate discovery, inquire about variables, or set loopback mode.
timeout	Specifies the amount of time, in seconds, after which a device declares its EFM peer to be nonoperational and resets its state machine.
seconds	Number of seconds of the timeout period. The range is from 2 to 30 seconds. The default is 5.

Command Default

EFM mode is active by default.

Command Modes

Interface Configuration (config-if)

Usage Guidelines

When EFM is configured on an interface, the default mode of the EFM client is active. When the EFM mode is enabled on two interfaces passing traffic, both interfaces cannot be in passive mode. Both interfaces can be in active mode, and one can be in active mode and the other in passive mode.

Examples

The following example shows how to set the EFM mode as passive with 25 seconds as timeout period:

```
MSTP-176(config-if)# ethernet oam mode passive timeout 25
```

ethernet oam link-monitor frame

To configure an error frame threshold or window on an EFM interface, use the **ethernet oam link-monitor frame** command in interface configuration mode. To remove the error frame threshold or window, use the **no** form of this command.

ethernet oam link-monitor frame {threshold {high {none| *high frames***} | low {***low frames***}} | window** *milliseconds***}**

[no] ethernet oam link-monitor frame {threshold {high {none| *high frames***} | low {***low frames***}} | window** *milliseconds***}**

Syntax Description

threshold	Sets the number of error frames at, above, or below which an action is triggered.
high	Sets a high error frame threshold in number of frames. High threshold must be greater than the low threshold.
none	Disables a high threshold.
high-frames	Integer in the range of 1 to 65535 that sets the high threshold in number of frames. There is no default. The high threshold must be configured.
low	Sets a low error frame threshold in number of frames.
low-frames	Integer in the range of 0 to 65535 that sets the low threshold in number of frames. The default is 1.
window	Sets a window and period of time during which error frames are counted.
milliseconds	Integer in the range of 10 to 600 that represents milliseconds in multiples of 100. The default is 10.

Command Default

The **ethernet oam link-monitor frame** command is not configured.

Command Modes

Interface Configuration (config-if)

Usage Guidelines

The **ethernet oam link-monitor frame** command configures a number of error frames that triggers an action or a period of time in which error frames are counted.

Examples

The following example shows how to configure an EFM link-monitor frame window of 300 milliseconds:

```
MSTP-176(config-if)# ethernet oam link-monitor frame window 300
```

ethernet oam link-monitor frame-period

To configure an error frame period on an EFM interface, use the **ethernet oam link-monitor frame-period** command in interface configuration mode. To remove the error frame period, use the **no** form of this command.

ethernet oam link-monitor frame-period {threshold {high {none| *high-frames*} | low {*low-frames*}} | window *frames*}

[no] ethernet oam link-monitor frame-period {threshold {high {none| *high-frames*} | low {*low-frames*}} | window *frames*}

Syntax Description

threshold	Sets the number of error frames for the period at, above, or below which an action is triggered.
high	Sets a high threshold for the error frame period in number of frames.
none	Disables a high threshold.
high-frames	Integer in the range of 1 to 65535 that sets the high threshold in number of frames. There is no default. The high threshold must be configured.
low	Sets a low error frame threshold for the error frame period in number of frames.
low-frames	Integer in the range of 0 to 65535 that sets the low threshold in number of frames. The default is 1.
window	Sets a window and period of time during which error frames are counted.
frames	Integer in the range of 1 to 65535 that sets the window size in number of frames. Each value is a multiple of 10000. The default is 1000.

Command Default

The **ethernet oam link-monitor frame-period** command is not configured.

Command Modes

Interface Configuration (config-if)

Usage Guidelines

The **ethernet oam link-monitor frame-period** command configures an error frame period in number of frames. When a high threshold is configured, it must be at least as same as the low threshold for frame errors.

Examples

The following example shows how to configure an EFM link-monitor frame-period window of 20000 frames:

```
MSTP-176(config-if)# ethernet oam link-monitor frame-period window 2
```

The following example shows how to configure an EFM link-monitor frame-period low threshold of 500 frames:

```
MSTP-176(config-if)# ethernet oam link-monitor frame-period threshold low 500
```

ethernet oam link-monitor frame-seconds

To configure the frame-seconds period on an EFM interface, use the **ethernet oam link-monitor frame-seconds** command in interface configuration mode. To remove the frame-seconds period, use the **no** form of this command.

ethernet oam link-monitor frame-seconds {threshold {high {none| *high-frames*} | low {*low-frames*}} | window *milliseconds***}**

[no] ethernet oam link-monitor frame-seconds {threshold {high {none| *high-frames*} | low {*low-frames*}} | window *milliseconds***}**

Syntax Description

threshold	Sets a number at, above, or below which an action is triggered.
high	Sets a high error frame-seconds threshold in number of seconds.
none	Disables a high threshold.
high-frames	Integer in the range of 1 to 900 that sets the high threshold in number of frames. There is no default. The high threshold must be configured.
low	Sets a low error frame-seconds threshold in number of seconds.
low-frames	Integer in the range of 0 to 900 that sets the low threshold in number of frames. The default is 1.
window	Sets a window and period of time during which error frames are counted.
milliseconds	Integer in the range of 100 to 9000 that represents a number of milliseconds in multiples of 100. The default is 100.

Command Default

The **ethernet oam link-monitor frame-seconds** command is not configured.

Command Modes

Interface Configuration (config-if)

Usage Guidelines

The **ethernet oam link-monitor frame-seconds** command configures a number of error frames that triggers an action or a period of time in which error frames are counted.

Examples

The following example shows how to configure an EFM link-monitor frame-seconds window of 30000 milliseconds (30 seconds):

```
MSTP-176(config-if)# ethernet oam link-monitor frame-seconds window 300
```

ethernet oam link-monitor high-threshold

To configure a specific action to occur when a high threshold for an error is exceeded on an EFM interface, use the **ethernet oam link-monitor high-threshold** command in interface configuration mode. To remove the high-threshold action, use the **no** form of this command.

ethernet oam link-monitor high-threshold action {none|disable-port}

[no] ethernet oam link-monitor high-threshold action {none|disable-port}

Syntax Description

action	Specifies the action taken when the high threshold for an error is exceeded.
none	Specifies that no action is taken.
disable-port	Performs an error-disable function on the interface.

Command Default

A high-threshold action is not configured.

Command Modes

Interface Configuration (config-if)

Examples

The following example shows how to configure the disable-port action to occur when the high threshold for an error is exceeded:

```
MSTP-176(config-if)# ethernet oam link-monitor high-threshold action disable-port
```

ethernet oam remote-failure link-fault

To configure the EFM Remote Failure Indication (RFI), use the **ethernet oam remote-failure link-fault** command in interface configuration mode. To remove the configuration, use the **no** form of this command.

ethernet oam remote-failure link-fault action error-block-interface

[no] ethernet oam remote-failure link-fault action error-block-interface

Syntax Description

action	Specifies the action that is taken for RFI.
error-block-interface	Specifies the interface that is placed in the error-block state.

Command Default

The remote failure action is not configured.

Command Modes

Interface Configuration (config-if)

Examples

The following example shows how to configure the error-block-interface action to occur for a remote failure:

```
MSTP-176(config-if)# ethernet oam remote-failure link-fault action error-block-interface
```

ethernet cfm mip

To create a MIP and configure the MIP parameters, use the **ethernet cfm mip** command in interface configuration mode.

ethernet cfm mip level *level* **vlan** *vlan*

[no] ethernet cfm mip level *level* **vlan** *vlan*

Syntax Description

level	Maintenance level. The level range is from is 0 to 7.
vlan	VLAN level. The VLAN range is from 1 to 4093.

Command Default

No MIP is created.

Command Modes

Interface configuration (config-if)

Examples

The following example shows how to create a MIP with the maintenance level 4 and VLAN 100:

```
MSTP-176(config-if)# ethernet cfm mip level 4 vlan 100
```

ethernet cfm mep

To create a MEP and configure the MEP parameters, use the **ethernet cfm mep** command in interface configuration mode.

ethernet cfm mep domain *domain_name* **mepid** *mepid* **vlan** *vlan*

[no] ethernet cfm mep domain *domain_name* **mepid** *mepid* **vlan** *vlan*

Syntax Description

domain_name	Name of the maintenance domain that contains this MEP.
mepid	ID of MEP. The MEPID range is from 1 to 8191.
vlan	VLAN level. The VLAN range is from 1 to 4093.

Command Default

No MEP is created by default.

Command Modes

Interface configuration (config-if)

Examples

The following example shows how to create a MEP:

```
MSTP-176(config-if)# ethernet cfm mep domain test_mep mepid 100 vlan 200
```

ethernet cfm interface

To enable CFM on the interface, use the **ethernet cfm interface** in interface configuration mode. To disable CFM on the interface, use the **no** form of this command.

ethernet cfm interface

[no] ethernet cfm interface

Syntax Description

This command has no arguments or keywords.

Command Default

CFM is disabled on the interface by default.

Command Modes

Interface configuration (config-if)

Examples

The following example shows how to enable CFM on the interface:

```
MSTP-176(config-if)# ethernet cfm interface
```

rep segment

To enable REP on an interface and to assign a segment ID to it, use the **rep segment** command in interface configuration mode. REP is disabled on all interfaces by default. To disable REP on an interface, use the **no** form of this command.

rep segment {*id*} **[edge [no-neighbor] [primary]] [preferred]**

[no] rep segment {*id*} **[edge [no-neighbor] [primary]] [preferred]**

Syntax Description

id	Segment ID assigned to the interface; The range of ID is from 1 to 1024.
edge	Configures the port as an edge port. If you enter the **edge** keyword without the **primary** keyword, the port is configured as a secondary edge port. Each segment has only two edge ports.
no-neighbor	Specifies that the edge port must not have a neighbor port.
primary	Specifies that the port is the primary edge port. A segment has only one primary edge port. If you configure two ports in a segment as the primary edge port, for example ports on different switches, the REP selects one of them to serve as the segment primary edge port.
preferred	Configures the edge port as the preferred alternate port or the preferred port for VLAN load balancing. Configuring a port as **preferred** does not guarantee the port to become an alternate port; it gives the port preference over other similar ports. The alternate port is usually a previously failed port.

Command Default

REP is disabled on the interface.

Command Modes

Interface configuration (config-if)

Usage Guidelines

When REP is enabled on an interface, the default is for the port to be a regular segment port

You must configure two edge ports on each REP segment. If you configure two ports in a segment as the primary edge port, for example, ports on different switches, the configuration is allowed. However, REP selects one of the ports to serve as the segment primary edge port. If you enable REP on two ports on a switch, the ports must be either regular segment ports or edge ports.

Examples

The following example shows how to enable REP on a regular segment port:

```
MSTP-176(config-if)# rep segment 100
```

The following example shows how to enable REP on a port and identify the port as the REP primary edge port:

```
MSTP-176(config-if)# rep segment 100 edge primary
```

The following example shows how to enable REP on a port and identify the port as the REP secondary edge port:

```
MSTP-176(config-if)# rep segment 100 edge
```

Other Examples:

```
MSTP-176(config-if)# rep segment 100 edge no-neighbor
MSTP-176(config-if)# rep segment 100 edge no-neighbor primary
MSTP-176(config-if)# rep segment 100 preferred
MSTP-176(config-if)# rep segment 100 edge preferred
MSTP-176(config-if)# rep segment 100 edge primary preferred
MSTP-176(config-if)# rep segment 100 edge no-neighbor preferred
MSTP-176(config-if)# rep segment 100 edge no-neighbor primary preferred
```

rep stcn

To configure the edge port to send REP segment topology change notifications (STCNs) to another interface or to other segments, use the **rep stcn** command in interface configuration mode. To disable the sending of STCNs to the interface or segment, use the **no** form of this command.

rep stcn {interface {*interface-id***} | segment {***id_list***}}**

[no] rep stcn {interface {*interface-id***} | segment {***id_list***}}**

Syntax Description

interface *interface-id*	Identifies a physical interface or port channel to receive STCNs.
segment	Identifies one REP segment or list of segments to receive STCNs.
id_list	Segment ID list. The valid range is from 1 to 1024.

Command Default

Transmission of STCNs to other interfaces and segments is disabled by default.

Command Modes

Interface configuration (config-if)

Usage Guidelines

STCNs are disabled by default. This command does not apply to regular segment ports.

Examples

The following example shows how to configure a REP edge port to send STCNs:

```
MSTP-176(config-if)# rep stcn segment 50
MSTP-176(config-if)# rep stcn interface <1-22>
```

rep preempt delay

To configure a waiting period after a segment port failure and recovery before VLAN load balancing is triggered, use the **rep preempt delay** command in interface configuration mode. To remove the configured delay, use the **no** form of this command.

rep preempt delay {*seconds*}

[no] rep preempt delay

Syntax Description

seconds	Number of seconds to delay REP preemption. The time delay range is from 15 to 300.

Command Default

No preemption delay is set if you do not enter the **rep preempt delay** command. The default setting is manual preemption with no delay.

Command Modes

Interface configuration (config-if)

Usage Guidelines

Enter this command only on the REP primary edge port. Enter this command and configure a preempt delay if you want VLAN load balancing to automatically trigger after a link failure and recovery.

Examples

The following example shows how to configure REP preemption time delay of 100 seconds on the primary edge port:

```
MSTP-176(config-if)# rep preempt delay 100
```

rep preempt

To manually start the REP preemption, use the **rep preempt** command in interface configuration mode. The **no** form of this command is used to de-activate the REP VLAN load balancing.

rep preempt

Syntax Description This command has no arguments or keywords.

Command Default Manual preemption is the default behavior.

Command Modes Interface configuration (config-if)

Usage Guidelines Enter this command on the primary edge port where VLAN load balancing is configured.

Examples The following example shows how to manually trigger REP preemption:

```
MSTP-176(config-if)# rep preempt
```

rep preempt segment

To manually start the REP preemption on a segment, use the **rep preempt segment** command in interface configuration mode. This command does not have a **no** form.

rep preempt segment *segment_id*

Syntax Description

segment_id	ID of the REP segment. The value ranges from 1 to 1024.

Command Default

Manual preemption is the default behavior.

Command Modes

Interface configuration (config-if)

Usage Guidelines

Enter this command on the switch that has the primary edge port.

Examples

The following example shows how to manually trigger REP preemption on segment 100:

```
MSTP-176(config-if)# rep preempt segment 100
```

rep block port

To configure REP VLAN load balancing on the REP primary edge port, use the **rep block port** in interface configuration mode. To return to the default configuration, use the **no** form of this command.

rep block port {id *port_id* **| preferred} vlan {***vlan_list* **| all}**

[no] rep block port {id *port_id* **| preferred} vlan {***vlan_list* **| all}**

Syntax Description

id *port_id*	Identifies the VLAN blocking alternate port by entering the unique port ID that is automatically generated when REP is enabled. The REP port ID is a 16 character hexadecimal value. For example, 0X0080001647FB1780
preferred	Identifies the VLAN blocking alternate port as the segment port. Entering the **preferred** keyword does not ensure that the preferred port is the alternate port; it gives it preference over other similar ports.
vlan	Identifies the VLANs to be blocked.
vlan_list	VLAN ID from 1 to 4094 or a range or sequence of VLANs (such as 1-3, 22, 41-44) of VLANs to be blocked.
all	Blocks all VLANs.

Command Default

All VLANs are blocked at the primary edge port by default.

Command Modes

Interface configuration (config-if)

Usage Guidelines

The default behavior after you enter the **rep preempt segment** privileged EXEC command (for manual preemption) is to block all VLANs at the primary edge port. This behavior remains until you configure the **rep block port** command.

If the primary edge port cannot determine which port is to be the alternate port, the default action is no preemption and no VLAN load balancing.

Examples

The following example shows how to configure the alternate port to block VLANs 1 to 100:

```
MSTP-176(config-if)# rep block port id 0X0080001647FB1780 vlan 1-100
```

shutdown

To disable a port, use the **shutdown** command. Use the **no shutdown** command to enable the port. This command can be executed only by administrators.

shutdown

no shutdown

Syntax Description

This command has no arguments or keywords.

Command Modes

Interface configuration

Examples

This example shows how to shutdown traffic on vlan 2:

```
MSTP-176(config-if)# shutdown vlan 2
```

mtu *bytes*

To set the maximum frame size that will be accepted by the port, use the **mtu** command.

To enable jumbo frames on an interface by adjusting the maximum transmission unit (MTU), use the **mtu** command.

mtu <bytes>

Syntax Description

bytes	Byte size; Valid values are 64-9700.

Defaults

By default, jumbo frames are disabled. The default mtu value is 9700

Command Modes

Interface configuration

Usage Guidelines

Login as an administrator and make sure that the port is down administratively to make this setting.

Examples

This example shows how to specify an MTU of 1800 bytes:

```
MSTP (config)# interface GigabitEthernet 2
MSTP (config-if)# mtu 1800
```

speed *auto|1000, 10000*

To enable auto negotiation or to set the speed manually, use the **speed** command in interface configuration mode.

Syntax Description

auto	Enables Fast Ethernet auto negotiation. The interface automatically operates at 1000 Mbps or 10000 Mbps depending on environmental factors, such as the type of media and transmission speeds for the peer cards, hubs, and switches used in the network configuration. Auto negotiation is the default.

Command Modes

Interface configuration

Usage Guidelines

The speed of client and trunk ports of GE_XP, 10GE_XP, GE_XPE, and 10GE_XPE can be set accordingly:

Table C-2 Setting speed values

Card	Ports	Speed
GE_XP and GE_XPE	Client ports 1 to 20	auto 1000 Mbps
GE_XP and GE_XPE	Trunk ports 21 and 22	10000
10 GE-XP and 10 GE_XPE	Trunk ports 1 to 4	10000

Examples

The following example specifies 1000 Mbps operation:

```
MSTP-176(config-if)# speed 1000
```

flowcontrol on|off

To set a gigabit ethernet interface to send or receive pause frames, use the **flowcontrol** ON or OFF command.

flowcontrol *on|off*

Syntax Description

on	Enables a port to receive and process pause frames from remote ports or send pause frames to remote ports.
off	Prevents a port from receiving and processing pause frames from remote ports or from sending pause frames to remote ports.

Defaults

By default, Gigabit Ethernet and 10 Gigabit Ethernet interface ports are set to off.

Command Modes

Interface configuration

Usage Guidelines

Pause frames are special packets that signal a source to stop sending frames for a specific period of time because the buffers are full.

Examples

This example shows how to enable a port to pause frames:

```
MSTP-176(config-if)# flowcontrol receive on
MSTP-176(config-if)#
```

switchport mode trunk

To set a port as UNI/NNI, use the **switchport mode trunk** command.

switchport mode trunk

Defaults

By default, all client ports are dot1q-tunnel and all trunk ports are trunk.

Command Modes

Interface configuration

Usage Guidelines

The port has to be administratively down to make these settings

Examples

This example shows how to configure a port for trunk mode:

```
MSTP(config-if)# switchport mode trunk
```

To verify your settings enter the show interfaces privileged EXEC command.

switchport mode dot1q-tunnel

These commands set a port as UNI/NNI, use the **switchport mode trunk** command.

switchport mode dot1q-tunnel

Syntax Description

This command has no arguments or keywords.

Defaults

By default, all client ports are dot1q-tunnel and all trunk ports are trunk

Command Modes

Interface configuration

Usage Guidelines

Use the switchport mode trunk command to cause the interface to become a trunk.

Examples

This example shows how to configure a port as an IEEE 802.1Q tunnel port:

```
MSTP-176(config-if)# switchport mode dot1q-tunnel
```

To verify your settings enter the show interfaces privileged EXEC command.

service-policy input *name*

To set the ingress and egress QoS parameters on the port by mapping relevant policies to the port, use the **service-policy input** command.

service-policy input *name*

[no] service-policy input *name*

Syntax Description

name	Name of a service policy map to be attached.

Defaults

No policy maps are attached.

Command Modes

Interface configuration

Usage Guidelines

The port must be administratively down for configuring.

Examples

This example shows how to attach a policy map to an interface:

```
MSTP-176(config-if)# service-policy input pmap1
MSTP-176(config-if)#
```

service-policy output *name*

To set the ingress and egress QoS parameters on the port by mapping relevant policies to the port, use the **service-policy output *name*** command in interface configuration command.

service-policy output *name*

[no] service-policy output *name*

Syntax Description

name	Name of a service policy map to be attached.

Defaults

No policy map is attached.

Command Modes

Interface configuration

Examples

This example shows how to attach a policy map to an output interface:

```
MSTP-176(config-if)# service-policy output policy9
MSTP-176(config-if)#
```

service instance ethernet *name*

To create a service instance on an interface, use the **service instance ethernet *name*** command.

service instance ethernet *name*

Syntax Description

name	Name of a service instance. Maximum characters are 32

Command Modes

Interface configuration

Examples

This example shows how to create a service instance:

```
MSTP-176(config-if)# service instance Ethernet servether1
MSTP-176(config-if)#
```

l2protocol-tunnel

To enable protocol tunneling on an interface, use the **l2protocol-tunnel** command.

l2protocol-tunnel

Syntax Description

This command has no arguments or keywords.

Defaults

No Layer 2 protocol packets are tunneled.

Command Modes

Interface configuration

Examples

This example shows how to enable protocol tunneling:

```
MSTP-176(config-if)# l2protocol-tunnel
MSTP-176(config-if)#
```

[no] switchport port-security mac-address *mac-address*

To configure a secure MAC address for an interface, use the **switchport port-security mac-address** command.

switchport port-security mac-address *mac-address*

[no] switchport port-security mac-address *mac-address*

Syntax Description

mac-address	MAC address of the port. The format is 00:00:00:00:00:00

Defaults

MAC address is not secured on the port.

Command Modes

Interface configuration

Examples

This example shows how to configure a MAC address as secure on the interface:

```
MSTP-176(config-if)# switchport port-security mac-address ff:ee:00:12:30:04
```

ip igmp snooping mrouter

To configure a Layer 2 port as a multicast router port, use the ip igmp snooping mrouter command. Use the no form of this command to remove the configuration.

ip igmp snooping mroute

Command Modes

Interface configuration

Usage Guidelines

Takes effect on SVLANS associated with the port where IGMP is enabled.

Examples

This example shows how to specify the next-hop interface to the multicast router:

```
MSTP-176(config-if)# ip igmp snooping mrouter interface gigabitethernet 5
MSTP-176(config-if)#
```

encapsulation default

To set the encapsulation method used by the interface, use the **encapsulation default** command in service interface configuration mode.

encapsulation default

Syntax Description

This command has no arguments or keywords.

Command Modes

Service instance configuration

Usage Guidelines

Execute the rew ing tag push dot1 <svlan> command to set the port in transparent mode.

Examples

```
MSTP-176(config-if-srv)# encapsulation default
```

encapsulation dot1q *first cvlan last cvlan*

To enable IEEE 802.1Q encapsulation of traffic on a specified subinterface in a virtual LAN (VLAN), use the **encapsulation dot1q *first cvlan last cvlan>*** command in service interface configuration mode or subinterface configuration mode

encapsulation dot1q *first cvlan last cvlan>*

Syntax Description

<*first cvlan*> <*last cvlan*>	Comma must be entered to separate each customer VLAN (CVLAN) ID range from the next range.

This command has no arguments or keywords.

Defaults

By default, IEEE 802.1Q encapsulation is disabled.

Command Modes

Service instance configuration

Usage Guidelines

IEEE 802.1Q encapsulation is configurable on interface GiGe and 10Gige interfaces. IEEE 802.1Q is a standard protocol for interconnecting cards and for defining VLAN topologies.

Examples

```
MSTP-176(config-if-srv)# encapsulation dot1q 1000 1002
```

encapsulation untagged

Defines the matching criteria to be used in order to map untagged Ethernet frames ingress on an interface to the appropriate service instance.

encapsulation untagged

Syntax Description

This command has no arguments or keywords.

Command Modes

Service instance configuration

Examples

```
MSTP-176(config-if-srv)# encapsulation untagged
```

bridge-domain *svlan*

To enable RFC 1490 Frame Relay bridging to map a bridged VLAN to the GE_XP, 10GE_XP, GE_XPE, and 10GE_XPE card, use the **bridge-domain** command in service interface configuration mode.

bridge-domain *svlan*

Syntax Description

svlan	SVLAN ID to be used in the bridging configuration. The valid range is from 1 to 4093.

Defaults

Bridging is disabled.

Command Modes

Service instance configuration

Examples

The following example shows the GE_XP, 10GE_XP, GE_XPE, and 10GE_XPE being configured for IEEE 802.1Q VLAN bridging using a VLAN ID of 99:

```
MSTP-176(config-if-srv)# bridge-domain 99
```

police cir percent % bc *bytes* be *bytes*

To configure traffic policing based on a percentage of bandwidth available on an interface, use the police command in policy-map configuration mode.

police cir percent *%* **bc** *bytes* **be** *bytes*

Syntax Description

cir	Committed information rate. Indicates that the cir will be used for policing traffic.
percent	Specifies that percent of bandwidth will be used for calculating the cir.
%	Specifies the bandwidth percentage. Valid range is a number from 1 to 100.
bc	Conform burst (bc) size used by the first token bucket for policing traffic.
be	Peak burst (be) size used by the second token bucket for policing traffic.

Defaults

By default, traffic policing is disabled.

Command Modes

Policy-map configuration and VLAN profile configuration.

Examples

The following example configures traffic policing using a cir and a pir based on a percentage of bandwidth. In this example, a cir of 20 percent and a pir of 40 percent have been specified. Additionally, an optional bc value and be value (300 ms and 400 ms, respectively) have been specified.

```
MSTP(config-pmap)# police cir percent 20 bc 300 ms be 400 ms
```

set cos *number*

To set the Layer 2 class of service (CoS) value of an outgoing packet, use the set cos command in policy-map class configuration mode.

set cos *number*

Syntax Description

number	Specify the CoS value to be applied to the 802.1Q SVLAN tag. Values 0 through 7 specify constant values for the CoS. Values 8 and 9 mean: 8 = TRUST. This value indicates that the CVLAN CoS value must be trusted, i.e. copied into the SVLAN CoS field. 9 = CVLAN. This value indicates that the SVLAN CoS field is set based on the value of the CVLAN ID. This mapping is provided by an EVC service instance. A service instance on an interface can be defined to match frames with one or more CVLANs. That service instance can also have a policy applied that specifies a CoS. The result is a mapping from CVLAN to CoS on an interface.

Defaults

By default, no CoS value is set for the outgoing packet.

Command Modes

Policy-map configuration.

Usage Guidelines

Enter upto 9 CoS values.

Examples

In the following example, the policy map called "cos-set" is created to assign different CoS values for different types of traffic.

```
MSTP(config)# policy-map cos-set
MSTP(config-pmap-c)# set cos 1
```

wrr-queue cos-map *queue-id cos1 … cosn*

To map CoS values to drop thresholds for a queue, use the wrr-queue cos-map command.

wrr-queue cos-map *queue-id cos1 … cosn*

Syntax Description

queue-id	Queue number; the valid value is 1.
cos1 ... cosn	CoS value; valid values are from 0 to 9.

Command Modes

Policy-map configuration.

Examples

This example shows how to map the CoS values 0 and 1 to standard transmit queue 1

```
MSTP(config-pmap)# wrr-queue cos-map 1 1 0
MSTP(config-pmap)#
```

wrr-queue queue-id w*eight 1-16* bandwidth percent *%*

To allocate bandwidth between standard transmit queue 1 (low priority) and standard transmit queue 2 (high priority), use the **wrr-queue bandwidth** command.

wrr-queue <queue-id> weight <1-16> bandwidth percent <%>

Syntax Description

weight <1-16)	WRR weights; valid values are 1 to 15

Command Modes

Policy-map configuration.

Examples

This example shows how to allocate a three-to-one bandwidth ratio:

```
MSTP(config-pmap)# wrr-queue weight 2 bandwidth 3
```

wrr-queue queue-id weight 1-16 bandwidth percent %

APPENDIX D

Fiber and Connector Losses in Raman Link Configuration

This appendix provides important guidelines to be followed when configuring a Raman link regardless of whether you are configuring the Raman link using the Raman installation wizard or the CiscoTransport Planner (CTP) XML file. Ensuring the desired gain and gain flatness is critical to the success of the configuration.

The Raman installation wizard automatically addresses any deviation in connector and fiber splice loss values by displaying warning messages appropriately, provided they are within the limits detailed in Table D-1 on page D-2. However, configuration of the Raman link using the CTP XML file is based on the algorithms within CTP. Any deviation in the connector and fiber splice losses values leads to unpredictable behavior of the entire system, in terms of Raman tilt and optical signal-to-noise ratio (OSNR). For these reasons, configuring the Raman link using the Raman installation wizard is preferred than configuring using the CTP XML file.

Table D-1 on page D-2 contains the following fields:

- Conditions—Limit for connector losses were measured under the following conditions:
  - No splice losses—Ideal conditions.
  - Splice 0.1 dB every 2 km or 0.2 dB splice every 4 km—The maximum acceptable values that can be considered when configuring Raman link.
  - Splice 0.1 dB every 4 km—The limit for connector losses values shows a realistic situation.
- Fiber type—The various fiber types used are:
  - Single Mode Fiber (SMF)
  - Enhanced large effective area fiber (ELEAF)
  - TrueWave RS (TW-RS)
- Target Gain—Expected Raman gain.
- Minimum Span [dB]—For the Raman link configuration to be successful, the span loss should be equal or greater than the value shown in Table D-1 on page D-2.
- Limit for Connector Losses—Connector losses values that must not exceed for configuration to be successful.

Note Table D-1 on page D-2 shows values that were estimated under ideal test conditions and may differ depending on the actual fiber type used, distance, etc.

Table D-1 Limit for Connector Losses

Conditions	Fiber Type	Minimum Span Loss [dB]		Target Gain [dB]		Limit for Connector Losses [dB]
		OPT-RAMP-C	OPT-RAMP-CE	Min	Max	
No splice loss	SMF	21	15	7	8.5	1.6
	ELEAF	21	15	7	10	1.3
	TW-RS	24	18	9	13.5	1.1
Splice 0.1 dB every 2 km or 0.2 dB splice every 4 km	SMF	21	15	7	8.5	0.7
	ELEAF	21	15	7	10	0.5
	TW-RS	24	18	9	13.5	0.2
Splice 0.1 dB every 4 km	SMF	21	15	7	8.5	1.2
	ELEAF	21	15	7	10	0.9
	TW-RS	24	18	9	13.5	0.6

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