Cisco ONS 15454 40 Gbps Enhanced FEC Full Band Tuneable Muxponder Cards

Product Overview

The Cisco® ONS 15454 Multiservice Transport Platform (MSTP) supports two versions of the Cisco 4-Port 10 Gbps Full-Band Tuneable CP-DQPSK Muxponder Cards, which expand the 10-Gbps interface density of the platform. The cards facilitate the delivery of transparent 10-Gbps–based services for enterprises or service provider optical networks (Figure 1).

Cisco ONS 15454 MSTP Release 9.2.1 extends the overall data bandwidth that the system can transport by a factor of four, allowing transmission across Cisco ONS 15454 MSTP dense wavelength-division multiplexing (DWDM) for up to 320 channels at 10 Gbps over 80 wavelengths at 40 Gbps.

Figure 1. Cisco ONS 15454 40 Gbps Full-Band Tuneable CP-DQPSK Muxponder Card

Challenge and Solution

The bandwidth carried on core and metropolitan (metro) DWDM networks is growing exponentially, but operators' revenues are not growing as quickly. The Cisco ONS 15454 40 Gbps solution can dramatically lower the cost to carry bandwidth, helping maintain and improve customers' profitability. Internet growth is still exponential, mainly because of demand for next-generation services such as quadruple play (data, voice, video, and mobility), video distribution, Internet Protocol Television (IPTV), and other high-bandwidth services.

This growth in data transmission in DWDM networks that require technology advances to support such large bandwidth. Scaling from 10 to 40 Gbps is the perfect solution for this problem; it quadruples the bandwidth that can be transported over existing fiber networks.

New modulation techniques now support ultra-long-haul (ULH) networks with more than 2000 km of unregenerated optical links. The Cisco ONS 15454 MSTP 4-Port 10Gbps Full-Band Tuneable CP-DQPSK Muxponder Card is designed to satisfy the following requirements.

- 40-Gbps signals must work in fully uncompensated networks up to more than 2000 km.
- 40-Gbps signals must work with very low-quality fiber with very high polarization mode dispersion (PMD) coefficients.
- 40-Gbps technology must work on 50-GHz systems with negligible filtering penalty.
- 40-Gbps units must fit mechanically and thermally with existing installed shelves with no effect on existing units, allowing full back-compatibility and no restriction rules for where the units can be placed.

Product Features and Benefits

The Cisco ONS 15454 MSTP 40 Gbps Full-Band Tuneable CP-DQPSK Muxponder Card can transport four OC-192/STM-64/10 Gigabit Ethernet (OC-192/STM-64/10GE) LAN/10 Gigabit Ethernet (LAN/10GE) WAN/8-Gbps (WAN/8G) Fibre Channel/10-Gbps (FC/10G) Fibre Channel Optical Transport Unit Level 2 (FC/OTU2) payloads over a G.709 OTU3-based, 50-GHz spaced, 50-GHz stabilized, ITU-compliant wavelength with selectable enhanced forward error correction (EFEC). The muxponder card is a plug-in module to the Cisco ONS 15454 MSTP, providing a high-density, cost-effective solution for 10-Gbps services transport over a platform capable of low-rate services down to 1.5 Mbps. The muxponder card architecture contains four client interfaces that are mapped to a single line interface, without accessing the Cisco ONS 15454 shelf cross-connect fabric.

Each client interface provides a multiservice (OC-192/STM-64/10GE LAN/10GE WAN/8G FC/10G FC/OTU2) interface through a 10-Gbps Small Form-Factor Pluggable (XFP) optics module with LC connectors, providing the flexibility to support several optical reaches with support for qualified XFP modules. The muxponder card supports any mixture of XFP reach types and also supports in-service insertion or removal without affecting other active ports, allowing superior networking flexibility and reduced preplanning activities.

You can use various types of XFP Pluggables depending on the reach and application needed (Table 1).

Table 1. Supported XFP

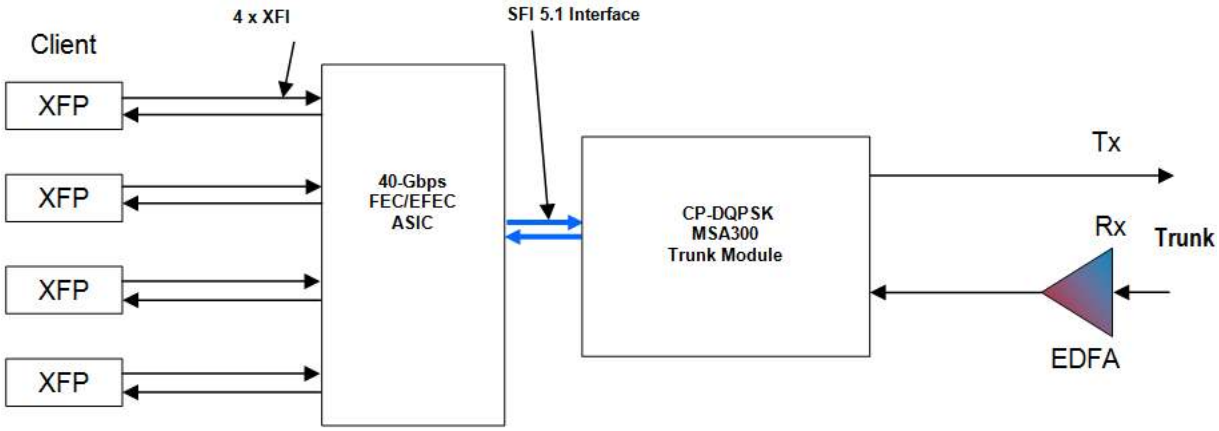
XFP Product Identifier	Supported rate and reach
ONS-XC-10G-S1= (P/N 10-2012-03)	10G-1200-SM-LL-L/10GE BASE-LR/10GE BASE-WR/OC-192 SR1/STM-64 I.64/OTU-2 at 10.7G, 11.05G, and 11.09G
ONS-XC-10G-I1= (P/N 10-2193-02)	10GE BASE-ER/10GE BASE-EW/OC-192 IR2/STM-64 S-64.2
ONS-XC-10G-L2= (P/N 10-2194-02)	10GE BASE-ZR/OC-192 LR2/G959.1 P1L1 2D2
ONS-XC-10G-SR-MM= (P/N 10-2420-01)	1200-MX-SN-I/10GE BASE-SR/OTU-2 at 10.7G, 11.05G, and 11.09
ONS-XC-10G-C= (P/N 10-2480-01)	Full C-Band Tuneable DWDM XFP supporting OC-192/STM-64/10GE/10G FC/OTU2 services
ONS-XC-8G-SM=	800-SMLC-L services
ONS-XC-10G-xxxx (xxxx from 1470 to 1610)	Coarse wavelength-division multiplexing (CWDM) for 10GE LAN PHY, WANPHY , STM-64, OC-192, 10G FC, and OTU2 at 10.7G, 11.05G, 11.09G, and 11.3G

The DWDM line interface provides a configurable 43.018-Gbps/44.570-Gbps G.709 OTU3 digital wrapper, long-reach/long-haul, ITU-compliant, 50-GHz spaced optical interface using LC connectors supporting G.709 OTU3 digital-wrapper interfaces. The DWDM output line interface is tuneable across the full optical C band, dramatically reducing inventories for spares. When operated within the outlined specifications, each card can transport each of the 10-Gbps signals with a maximum bit error rate (BER) of 10E-15.

The muxponder card incorporates the four clients and one DWDM line interface on the same card. The muxponder cards are deployable in any of the 12 multiservice interface card slots of the Cisco ONS 15454 platform, in systems with or without cross-connect cards. The addition of a cross-connect card allows the platform to support hybrid applications, containing transparent 10-Gbps services as well as aggregation of the other services supported by the Cisco ONS 15454 platform. The only other common card required for operation is the timing, communications, and control (TCC) card.

The muxponder card provides many carrier-class features and capabilities necessary to deliver 10-Gbps services, including selectable protocol transparency, wavelength tuneability, flexible protection mechanisms, flexible timing options, and management capabilities (Figure 2).

Figure 2. Cisco 40 Gbps Full-Band Tuneable CP-DQPSK Muxponder Card Block Diagram



Enhanced FEC Capability

The card can support a FEC mechanism on trunk and client interfaces.

The trunk port supports FEC and EFEC, and you cannot disable such mechanisms. The output bit rate does not depend on the selected algorithm, but you can provision the error coding performance.

- FEC: Standard G.975 Reed-Salomon algorithm
- EFEC: Standard G.975.1 (Subclause 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. EFEC provides 2 dB more reach than standard FEC. You can enable this EFEC algorithm in three of the four client ports (port 1 does not support E-FEC). Two different Over-Heads are applied if the trunk is OTU3 or OTU3 overclocked trunk (OTU3e): 10 percent for OTU3e mode and 13 percent for OTU3 mode.

Client ports, pending the support of FEC rate on the pluggable, support a FEC mechanism that can be disabled:

- FEC: Standard G.975 Reed-Salomon algorithm on all four client ports
- EFEC: Standard G.975.1 (Subclause I.7); two orthogonally concatenated BCH super FEC code

Advanced Modulation Scheme

Cisco 4-Port 10 Gbps Full-Band Tuneable CP-DQPSK Muxponders feature an advanced modulation scheme that aims to reach performance levels beyond industry-standard 10-Gbps equivalent units.

Cisco selected a Coherent Polarization Multiplexed Differential Quadrature Phase Shift Keying (CP-DQPSK) modulation format to optimize 40-Gbps transmission in terms of optical signal-to-noise ratio (OSNR), chromatic dispersion robustness, and PMD robustness.

The CP-DQPSK modulation scheme consists of multiplexing two DQPSK signals over two different orthogonal polarizations, as shown in Figures 3 and 4.

Figure 3. CP-DQPSK Tx Domain Scheme and Transmitter Scheme

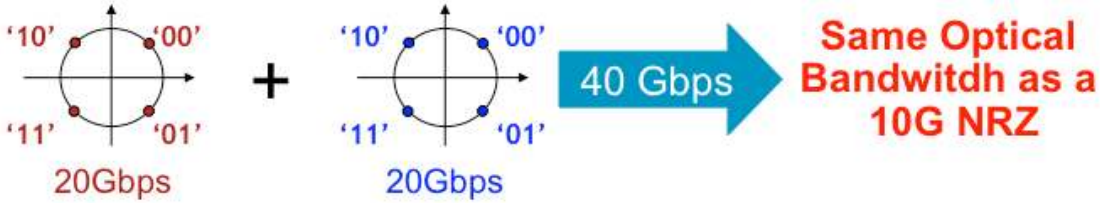
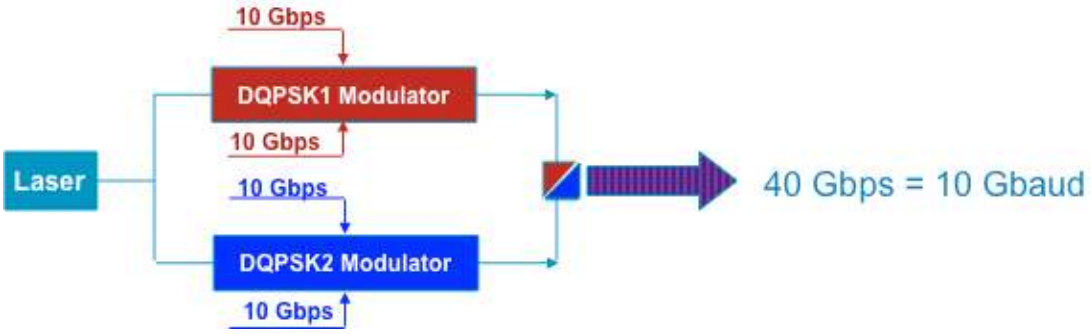
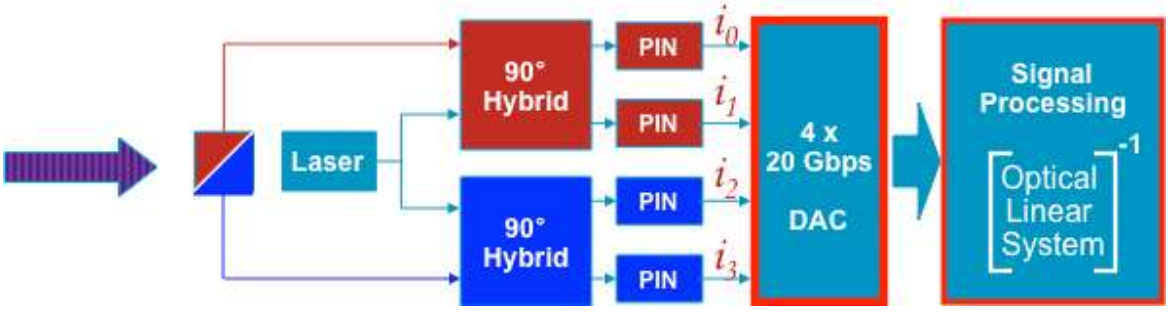


Figure 4. CP-DQPSK Transmitter Scheme



The core of the 40-Gbps CP-DQPSK modulation scheme is the receiver that is based on coherent detection, where a digital signal processor (DSP) calculates the inverse of the optical system matrix, allowing the receiver to recover the original transmitted signals (Figure 5).

Figure 5. CP-DQPSK Receiver Scheme



The main benefits of CP-DQPSK are:

- Strong OSNR performance (better than 10-Gbps units)
- Outstanding chromatic dispersion robustness for performance in a completely uncompensated network
- Very strong PMD robustness (three times better than 10-Gbps units)
- Very good spectral density that allows traffic to cross a long cascade of reconfigurable optical add-drop multiplexers (ROADMs) with negligible penalty

Provisionable Differential Mode

CP-DQPSK shows the best absolute performance, but it is sensitive to the presence of other 10-Gbps signals because the nonreturn to zero (NRZ) signals create an XPhase effect over the phase-sensitive CP-DQPSK signal. This situation encourages the creation of a guard band, an unused region between 10- and 40-Gbps signals that can potentially cause a major limitation in optical mesh networks. Cisco allows you to use a simple software configuration to reduce or delete the guard band to configure the card in differential mode, which is intrinsically much more robust than the 10-Gbps intercorrelation effect.

Muxponder Card Versions

Two versions of the Cisco 40-Gbps Full-Band Tuneable CP-DQPSK Muxponders are offered to support different application requirements:

- An extended-performance version offering full performances targeting ULH application where the network is optimized for CP-DQPSK transmission (no 10-Gbps channels and Dispersion Compensation Units [DCUs])
- A metro edge performance version with differential mode only (CP-DQPSK), cost-optimized for metropolitan application and 10-Gbps installed networks

Protocol Transparency and Card Configuration

The Cisco 40-Gbps Full-Band Tuneable CP-DQPSK Muxponder can deliver transparently any combination of 10-Gbps services for cost-effective, point-to-point networking for the Cisco ONS 15454 platform.

The card can be provisioned in two operational modes: OTU3 or OTU3e. In OTU3 mode, the card can transparently multiplex any mix of STM-64/OC-192, 10GE LAN, 10GE WAN, OTU2, or 8G FC signals. In OTU3e mode, you can combine any mix of 10G FC and OTU2e (G,Sup43 7.1) signals, as shown in Table 2.

Table 2. Muxponder Client Configurations and Mapping

Client Format	Frequency (GHz)	Mapping	Trunk Format	Frequency (GHz) with FEC	Frequency (GHz) with EFEC
8G-FC	8.500	Enhanced OTN mapping (proprietary)	OTU3	43.018	45.548
OC192/STM64/10GeWAN-PHY	9.953	ODTU23 multiplexing			
10GE LAN-phy	10.312	GFP-F (G.SUP43 7.3) or LAN-WAN (G.SUP43 6.1)			
OTU2 (OC192/STM64/10GeWAN-PHY)	10.709	ODTU23 multiplexing			
10G-FC	10.519	512/513 transcoding plus GFP-T	OTU3e	44.570	45.794
OTU2e (10Ge LAN-PHY)	11.096	ODTU23 multiplexing (G.SUP43 7.1)			

The card also can process provisionable SONET/SDH overhead bytes. It is possible to pass the bytes transparently or to terminate the line and section overhead. In transparent mode, client terminal equipment interconnected over a muxponder-based circuit can communicate over the section (or multiplexer section) data communications channel (SDCC/MSDCC), can signal 1+1 and bidirectional line switched ring or multiplex section-shared protection ring (BLSR/MS-SPR) protection switching using the K1 and K2 bytes, and can support provisionable section trace capabilities over the J0 byte. In addition, the muxponder circuit, whether provisioned in transparent or terminating mode, can support client circuits based on unidirectional-path switched ring (UPSR) or subnetwork connection protection (SNCP).

Full transparency is provided by the enhanced multiplex engine that performs the multiplexing of the incoming 10-Gbps signals at the optical transport network (OTN) layer that are no longer in the SONET/SDH domain. Different mapping schemes are used pending the payload to guarantee full transparency of the signal, as indicated in Table 2.

LAN-to-WAN Conversion

The Cisco 40-Gbps Full-Band Tuneable CP-DQPSK Muxponder can convert incoming 10GE LAN PHY signals into 10GE WAN PHY signals at the far-end egress port.

The 10GE LAN PHY-to-WAN PHY conversion is implemented according to the standard defined in IEEE 802.3: WIS (WAN interface sublayer). The 10GE LAN PHY interfaces have an effective line rate of 10.3125 Gbps (10 Gbps of data traffic encoded in a 64B/66B protocol). The 10GE WAN PHY interfaces conform to the SONET/SDH standards to achieve 9.95328 Gbps and allow service providers to use their existing SONET/SDH Layer 1 infrastructure.

WAN PHY is used to transport 10 Gigabit Ethernet across SDH/SONET or WDM systems without having to directly map the Ethernet frames into SDH/SONET first. The WAN PHY variants correspond at the physical layer to 10GBASE-SR, 10GBASE-LR, 10GBASE-ER, and 10GBASE-ZR, respectively, and hence use the same types of fiber and support the same distances.

Wavelength Tuneability

The muxponder cards operate on the 50-GHz ITU grid and are tuneable across 82 adjacent 50-GHz channels for the C-band module and across 80 adjacent 50-GHz channels for the L-band module. The incorporation of tuneability into the muxponder cards reduces the customer's inventory required to cover all of the wavelengths for deployment and spares. Tuneability is software-provisionable.

Flexible Protection Mechanism Support

You can deploy the muxponder card, depending on your network requirements, to support the many protection mechanisms found in optical transport networks. Table 3 outlines the supported protection options that help deliver the service-level agreements (SLAs) that the application requires.

Table 3. Protection Formats

Protection Type	Capabilities
Unprotected	There is no client terminal interface, muxponder card, or DWDM line protection. The client signal is transported over a single unprotected muxponder card.
1 + 1 protection or UPSR/SNCP and BLSR/MSP-SPR	This protection type protects the client terminal interface, muxponder card, and DWDM line through client automatic protection switching (APS) or linear multiplex section protection (LMSP) signaling transported transparently over the muxponder card.
	Similar to unprotected format, protection is provided through client line or path protection through transparent signal transport through a muxponder circuit.

Protection Type	Capabilities
Y-cable protection	This protection provides muxponder card and DWDM line protection without requiring client terminal equipment interface protection. It uses a Y-protection device to optically split a single client interface into two muxponder cards. The Cisco ONS 15454 system controls the muxponder card active or standby status to provide a single signal feed to client equipment.
OCH-trail protection	This type of protection provides protection for DWDM signals through external optical switch units (Protection Switch Module).

Flexible Timing Options

The Cisco 40-Gbps Full-Band Tuneable CP-DQPSK Muxponder Card times the client side and the DWDM line optical transmitter port with the clock derivate by the shelf processor. The Cisco ONS 15454 platform provides the option to recover timing signals for node-timing reference, with synchronization status messaging support, from any of the four client optical interfaces in case of SONET/SDH, Ethernet, and OTN signal, in addition to the standard options of using an external clock derived from a Building Integrated Timing Supply (BITS) clock or another optical interface card on the Cisco ONS 15454 system. The muxponder card can also recover the clock from the trunk when the operational mode is OTU3. In addition, the muxponder card can maintain synchronization from an internal clock even if both the shelf processors (active and standby) fail.

Compact Design

- Double-width card-slot design, ideal for high-density, 4x 10-Gbps solutions
- Up to six muxponder cards per shelf assembly and up to 96 10-Gbps interfaces per bay frame

Flexible restoration options

- Transparent support for UPSR/SNCP, BLSR/MSP, and 1 + 1 APS/MSP
- Client Y-protection
- OCH-trail protection through PSM
- Unprotected (0 + 1)

Management

The Cisco ONS 15454 MSTP provides comprehensive management capabilities for operations, administration, monitoring, and provisioning (OAM&P) accessed through the integrated Cisco Transport Controller craft interface with support from the Cisco Transport Manager element management system The muxponder card incorporates provisionable digital-wrapper (G.709) functions, providing DWDM wavelength performance-management capabilities, especially for services transported transparently across the network. Without the digital-wrapper function, a carrier transporting a service transparently would be unable to identify network impairments that may degrade the transported signal and exceed SLA requirements. The generic communication channel (GCC) of the digital wrapper provides a separate communications channel, other than the SDCC or regenerator SDCC (RSDCC) in SONET/SDH signals, to be used by the platform when transparent signals are transported. This GCC allowss the Cisco ONS 15454 system to extend its advanced network autodiscovery capabilities to DWDM-based services. The integrated Cisco Transport Controller craft manager and the Cisco Transport Manager offer you OAM&P access for the system.

Far-End-Laser-Off Behavior

The Cisco 40-Gbps Full-Band Tuneable CP-DQPSK Muxponder can provision the far-end-laser-off behavior for ONSET/SDH payloads. You can use the Cisco Transport Controller to configure how the remote client interface behaves following a fault condition. You can configure the remote client to squelch or to send an alarm indication signal (AIS).

For data signals (10GE, 10G FC, or 8G FC) the behavior is squelching.

Performance Monitoring

The performance-monitoring capabilities of the muxponder card support both transparent and nontransparent signal transport. For SONET/SDH signals, standard performance monitoring, threshold-crossing conditions, and alarms are supported per Telcordia GR-253, GR-474, and GR-2918; ITU G.828; and ETS 300 417-1 standards. Each digital-wrapper channel is monitored per G.709 (OTN), G.8021. Optical parameters on the client and DWDM line interfaces support loss of signal (LOS), laser bias current, transmit optical power, and receive optical power. Calculation and accumulation of the performance-monitoring data are in 15-minute and 24-hour intervals as per G.7710. Ethernet data is monitored using Remote Monitoring (RMON).

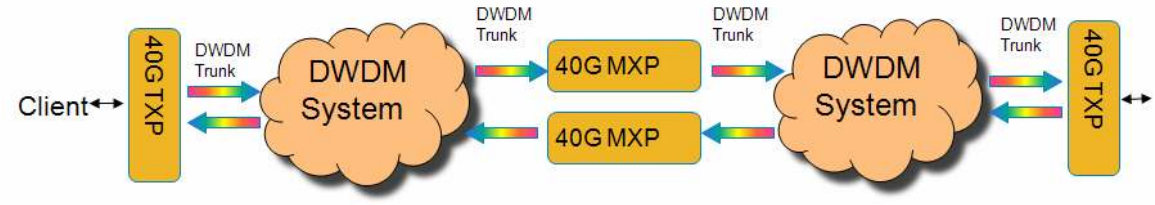
A detailed list of performance monitors is given in Table 9.

The muxponder card incorporates faceplate-mounted LEDs to provide a quick visual check of the operational status of the card. An orange circle is printed on the faceplate, indicating the shelf slot in which you can install the card.

Regenerator Configuration

The Cisco 40-Gbps Full-Band Tuneable CP-DQPSK Muxponder also supports the OTU3 regeneration function. You can configure two cards to work in unidirectional mode, allowing the muxponder to perform the OTN O-E-O regeneration function as depicted in Figure 6.

Figure 6. Unidirectional Configuration for 40-Gbps Muxponder in Regeneration Mode



OTU overhead is terminated and ODU is correctly passed through as required by the G.709 standard, and GCC-1 and GCC-2 are properly passed through while the GCC0 channels are not terminated.

Application Description

The main applications of the Cisco ONS 15454 MSTP 4-Port 10-Gbps Full-Band Tuneable CP-DQPSK Muxponder Extended-Performance Card are for ultra-long-haul/long-haul (ULH/LH) networks and high PMD fibers:

- CP-DQPSK modulation is the best way to provide 2000 km and more unregenerated 40-Gbps lambdas connection for greenfield applications where 10-Gbps wavelengths are not present.
- CP-DQPSK full performance support up to 30 picoseconds of PMD that copes with the vast majority of low-quality fiber networks

The main applications of the Cisco ONS 15454 MSTP 4-Port 10 Gbps Full-Band Tuneable CP-DQPSK Muxponder Metro Edge Performance Card target metro-regional spaces:

- Data center interconnection
- Existing metro 10-Gbps network upgrade

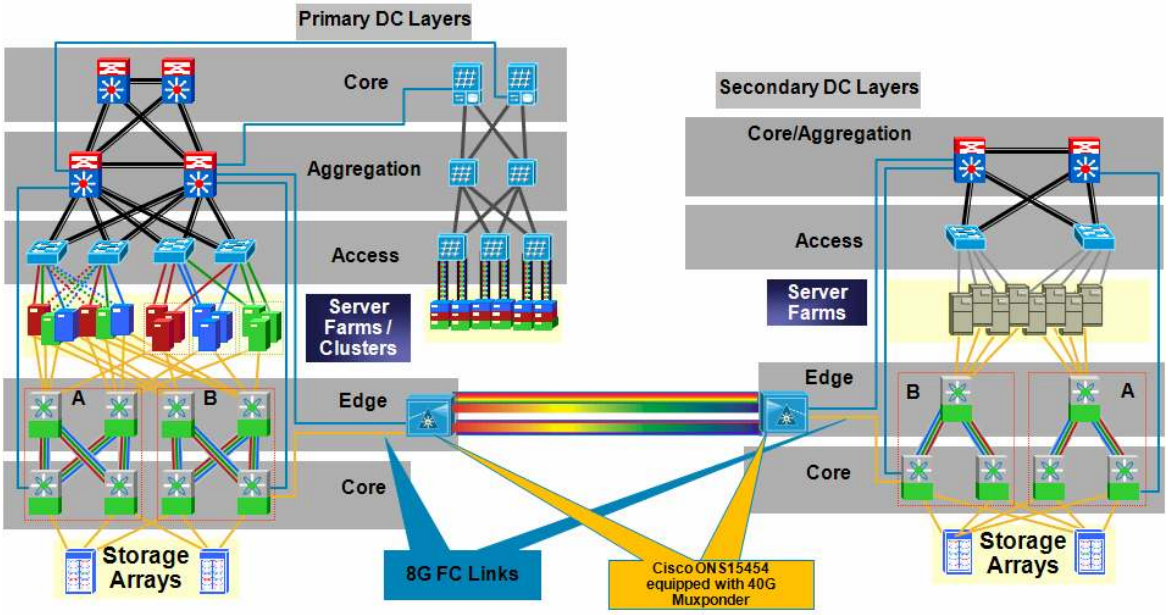
The continued proliferation of data-intensive enterprise services (virtual offices and related services such as video conferencing, and VPNs) and mass-market deployment of high-end consumer applications (such as high-

definition video on demand [VOD] and IPTV) are driving transmission speed through the 10-Gbps–based DWDM transport network. The Cisco 40-Gbps solution aims to quadruple the available fiber transport bandwidth with performance comparable to the 10-Gbps solution.

Fiber relief is one of the primary applications for the Cisco 40-Gbps muxponder solution. Bandwidth transport demand increased in the last 3 years, consuming existing 10-Gbps-wavelength-based DWDM systems. With the 40-Gbps muxponder, it is possible to significantly increase existing DWDM system capacity. With the 40-Gbps Muxponder, Cisco can upgrade an existing 80-channel 10-Gbps network equipped with 64 wavelengths with an additional 16 wavelengths at 40 Gbps that carry an additional 64 10-Gbps signals. The Cisco solution was designed specifically to cope with existing 10-Gbps channels without any need to upgrade the existing optical infrastacture.

Industry trends show that the adoption of 8-Gbps Fibre Channel is becoming a necessity in data center environments because of the increase of storage area network (SAN) services such as server virtualization. The 40-Gbps muxponder offers a hyperdense 8-Gbps Fibre Channel solution, allowing you to transmit up to 320 8-Gbps Fibre Channel signals over a single fiber pair over the C-band (Figure 7).

Figure 7. Data Center 8-Gbps Fibre Channel over 40-Gbps Muxponder Architecture



The LAN-WAN conversion on the Cisco 40-Gbps Full-Band Tuneable CP-DQPSK Muxponder allows service flexibility to handle existing SONET/SDH OC-192/STM-64 facilities that are mapped for 10 Gigabit Ethernet payloads. Important applications include the transport of 10 Gigabit Ethernet over traditional SONET/SDH networks and submarine landing-side translation where a vast majority of the systems are based only on time-division multiplexing (TDM).

Compact Design

- Double-width card-slot design, ideal for high-density, 4x 10-Gbps solutions
- Up to six muxponder cards per shelf assembly and up to 96 10-Gbps interfaces per bay frame
- Flexible restoration options
- Transparent support for UPSR/SNCP, BLSR/MSP, and 1 + 1 APS/MSP

- Client Y-protection
- OCH-trail protection through PSM
- Unprotected (0 + 1)

Features and Product Specifications

Tables 4 and 5 list the regulatory compliance and system requirements for the transponder card. Table 6 lists the DWDM specifications, Table 7 provides DWDM receive-side optical performance information, Table 8 gives card specifications, Table 9 gives performance-monitoring parameters, and Table 10 gives ordering information for the card.

Regulatory Compliance

Note that all compliance documentation may not be completed at the time of product release. Please check with your Cisco sales representative for countries other than Canada, the United States, and the European Union.

Table 4. Regulatory Compliance

ANSI System	ETSI System
Countries Supported	
• Canada • United States • Korea • Japan • European Union	• European Union • Africa • CSI • Australia • New Zealand • China • Korea • India • Saudi Arabia • South America
EMC (Class A)	
• ICES-003, 2004 • GR-1089-CORE Issue 4, NEBS EMC and Safety, June 2006 • FCC 47CFR15, 2007	• ETSI EN 300 386 V1.4.1 (2008-04) Telecommunication network equipment EMC requirements (Note: EMC-1) • CISPR22:2008 and EN55022:2006/A1:2007 Information Technology Equipment (Emissions) (EMC-2) • CISPR24: 1997/ A1:2001/A2:2002 and EN55024:1998/A1:2001/A2:2003: Information Technology Equipment – Immunity characteristics - Limits and Methods of Measurement (test levels)
Safety	
• CSA C22.2 #60950-1 - Edition 7, March 2007 • UL 60950-1 - Edition 2, March 2007 • GR-1089-CORE Issue 4, NEBS EMC and Safety, June 2006	• UL 60950-1 - Edition 2, March 2007 • IEC 60950-1 Information technology equipment Safety Part 1: General requirements - Edition 2, 2005 and National Differences as per CB Bulletin 112A • IEC/EN 60950-1 (2006/10) with Amendment 11:2004 to EN 60950-1:2001, 1st Edition and National Differences as per CB Bulletin 112A. • EN 60950-1, Edition 2 (2006) Information technology equipment – Safety – Part 1: General requirements • CE Safety Directive: 2006/95/EC
Laser	

ANSI System	ETSI System
• UL 60950-1 - Edition 2, March 2007 • IEC 60825-1: 2001 Ed.1.2 (incl. am1+am2) Safety of laser products Part 1: Equipment classification, requirements, and users guide • IEC60825-2 Ed.3 (2004) Safety of laser products Part 2: Safety of optical fiber communication systems + A1:2006	• IEC 60825-1: 2001 Ed.1.2 (incl. am1+am2) Safety of laser products Part 1: Equipment classification, requirements, and users guide • IEC60825-2 Ed.3 (2004) Safety of laser products Part 2: Safety of optical fiber communication systems + A1:2006 • 21CFR1040 (2008/04) (Accession Letter and CDRH Report) Automatic Laser Shutdown and restart (ALS) according to ITU-T G.664 (03/06). Guidance for Industry and FDA Staff (Laser Notice No. 50) June 2007 • Laser Products – Conformance with IEC 60825-1 and IEC 60601-2-22; Guidance for Industry and FDA Staff (Laser Notice No. 50), June 2007
Environmental	
• GR-63-CORE Issue 3, NEBS Physical Protection, March 2006)	• ETS 300-019-2-1 V2.1.2 (Storage, Class 1.1) • ETS 300-019-2-2 V2.1.2 (1999-09): Transportation, Class 2.3 • ETS 300-019-2-3 V2.2.2 (2003-04):Operational, Class 3.1E
Optical	
• GR-253-CORE - Issue 04 • ITU-T G.691	• ITU-T G.709 • ITU-T G.975
Quality	
• TR-NWT-000332, Issue 4, Method 1 calculation for 20-year mean time between failure (MTBF)	
Miscellaneous	
• GR-1089-CORE Issue 4, NEBS EMC and Safety (June 2006) (Note: NEBS-1) • GR-63-CORE Issue 3, NEBS Physical Protection (March 2006) (Note: NEBS-2) • ATT-TP-76200: 2008 • ANSI T1.315-2001 • GR-499: 2004 Transport Systems Generic Requirements (TSGR): Common Requirements	

Table 5. System Requirements

Component	Cisco ONS 15454 ANSI	Cisco ONS 15454 ETSI	Cisco ONS 15454 M6	Cisco ONS 15454 M2
Processor	TCC3/TCC2P/TCC2	TCC3/TCC2P/TCC2	TNC/TSC	TNC/TSC
Cross-connect	All (not required)	All (not required)	–	–
Shelf assembly	15454-SA-HD or 15454-SA-HD-DDR shelf assembly with CC-FTA version fan-tray assembly	15454-SA-ETSI shelf assembly with CC-FTA fan-tray assembly	15454-M6-SA shelf assembly	15454-M2-SA shelf assembly
System software	Release 9.2.1 ANSI or later	Release 9.2.1 ETSI or later	Release 9.2.1 ANSI/ETSI or later	Release 9.2.1 ANSI/ETSI or later
Slot compatibility	1–5, 12–16	1–5, 12–16	2–6	2

Table 6. DWDM Specifications

Specification	DWDM Line Interface
DWDM line interface	
Bit rate	43.018 ±100 ppm (OTU3) 44.570 ±100 ppm (OTU3e)
Automatic laser shutdown and restart	ITU-T G.664 (06/99)
Nominal wavelengths (λ_{Tnom})	Full tuneable from 1529.55 to 1561.83 (C-Band – 50 GHz)
Spectral width @ 3dB ($\lambda\Delta_3$)	<25 GHz
Optical Transmitter	
Type	CP-DQPSK modulation format
Output power (P_{Tmin})	+1 to +6.5 dBm
Required optical return loss, minimum (ORL_{min})	30 dB

Specification	DWDM Line Interface
Laser safety class	1
Optical Receiver	
Type	PIN photodetector
Chromatic dispersion tolerance (DLR_{max}) • Extended performance version • Metro edge performance version	 +/– 29,000 ps/nm +/– 3,000 ps/nm
Minimum BER (BERmin) • FEC on • EFEC on	 10E-15 10E-15
Overload	–8 dBm
Receiver reflectance (maximum)	30 dB
Input wavelength bandwidth (λ_{c_rx})	Full Tuneable from 1529.55 to 1561.83 (C-band – 50 GHz)
Connector type (Tx/Rx)	LC, duplex (shuttered)

Table 7. DWDM Receive-Side Optical Performances

CD Tolerance	FEC Type	Pre-FEC BER	Post-FEC BER	Input Power Sensitivity	DGD	OSNR (0.5nm RWB)
Extended performance						
0 ps/nm	STD 7%	<10E(–5)	<10E(–15)	–8 to –20dBm	-	10 dB
0 ps/nm					100 ps	11 dB
+/- 34,000 ps/nm					100 ps	14 dB
0 ps/nm	ENH 10%	<4.6x10E(–3)	<10E(–15)	–8 to –20 dBm	-	5.2 dB
0 ps/nm					100 ps	5.7 dB
+/- 29,000 ps/nm					100 ps	6.2 dB
0 ps/nm	ENH 13%	<7x10E(–3)	<10E(–15)	–8 to –20 dBm	-	4.7 dB
0 ps/nm					100 ps	5.1 dB
+/- 29,000 ps/nm					100 ps	5.5 dB
Metro edge performance						
0 ps/nm	STD	<10E(–5)	<10E(–15)	–8 to –20 dBm	-	10 dB
+/- 3,000 ps/nm					10 ps	11 dB
0 ps/nm	ENH 10%	<4.6x10E(–3)	<10E(–15)	–8 to –20 dBm	-	5.2 dB
+/- 3,000 ps/nm					10 ps	6.2 dB
0 ps/nm	ENH 13%	<7x10E(–3)	<10E(–15)	–8 to –20 dBm	-	4.7 dB
+/- 3,000 ps/nm					10 ps	5.5 dB

Table 8. Card Specifications

Specification	
Management	
Card LEDs Failure (FAIL) Active/standby (ACT/STBY) Signal fail (SF)	 Red Green/yellow Yellow
Client port LEDs (per port) Active input signal	 Green

Specification	
DWDM port LEDs	
Active input signal	Green
Output wavelength	Green
Power (including worst-case pluggable)	
Typical	100W (with no pluggable)
Maximum	130W (fully loaded)
Physical	
Dimensions	Occupies 2 slots
Weight	2.58 kg (5.8 lb)
Reliability and availability	
Mean time between failures (MTBF)	92,540 hours
Latency (end to end)	
G.709 On – Standard FEC	6 microsecond
G.709 On – Enhanced FEC	50 microseconds
Environmental conditions	
Storage temperature	–40 to 70º C (–40 to 158º F)
Operating temperature	
Normal	0 to 40℃ (32 to 104℉)
Short-term[1]	–5 to 55º C (23 to 131º F) on M6/M2 –5 to 50º C (23 to 131º F) on M12
Relative humidity	
Normal	5% to 85%, noncondensing
Short-term[1]	5% to 90%, but not to exceed 0.024 kg water/kg of dry air

[1] Short-term refers to a period of not more than 96 consecutive hours and a total of not more than 15 days in 1 year (a total of 360 hours in any given year, but no more than 15 occurrences during that 1-year period). The values shown are valid for M6 or M2 chassis. M12 chassis will support 55º C only in case ONS-XC-10G-S1= SFP is used. If a different SFP model is used, maximum allowed temperature for M12 is 50º C.

Table 9. Performance-Monitoring Parameters

Payload	Description		
10 Gigabit Ethernet	etherStatsOctets and comply with RFC-1757 etherStatsPkts and comply with RFC-1757 etherStatsBroadcastPkts and comply with RFC-1757 etherStatsMulticastPkts and comply with RFC-1757 etherStatsUndersizePkts and comply with RFC-1757 etherStatsOversizePkts and comply with RFC-1757 etherStatsFragments and comply with RFC-1757 etherStatsJabbers and comply with RFC-1757 etherStatsPkts64Octets and comply with RFC-1757 etherStatsPkts65to127Octets and comply with RFC-1757 etherStatsPkts128to255Octets and comply with RFC-1757 etherStatsPkts256to511Octets and comply with RFC-1757 etherStatsPkts512to1023Octets and comply with RFC-1757 etherStatsPkts1024to1518Octets and comply with RFC-1757 ifInOctets and comply with RFC-2233 ifInUcastPkts and comply with RFC-2233 ifInErrors and comply with RFC-2233 ifInMulticastPkts and comply with RFC-2233 ifInBroadcastPkts and comply with RFC-2233 Ethernet counts include dot3StatsFCSErrors and comply with RFC-2358		
OTN	OTUk SM counters	ODUk PM counters	Description

Payload	Description		
	BBE-SM	BBE-PM	Number of background block errors
	BBER-SM	BBER-PM	Background block-error ratio
	ES-SM	ES-PM	Number of errored seconds
	ESR-SM	ESR-PM	Errored seconds ratio
	SES-SM	SES-PM	Number of severely errored seconds
	SESR-SM	SESR-PM	Severely errored seconds ratio
	UAS-SM	UAS-PM	Number of unavailable seconds
	FC-SM	FC-PM	Number of failure counts
OC-192	CV-L: Line Coding Violation (CV-L) CV-S: Section Coding Violation (CV-S) ES-L: Line Errored Seconds (ES-L) ES-S: Section Errored Seconds (ES-S) FC-L: Line Failure Count (FC-L) SEF-S: Severely Errored Framing Seconds (SEFS-S) SES-L: Line Severely Errored Seconds (SES-L) SES-S: Section Severely Errored Seconds (SES-S) UAS-L: Line Unavailable Seconds (UAS-L)		
STM-64	MS-BBE: Multiplex Section Background Block Error (MS-BBE) MS-BBER: Multiplex Section Background Block Error Ratio (MS-BBER) MS-EB: Multiplex Section Errored Block (MS-EB) MS-ES: Multiplex Section Errored Second (MS-ES) MS-ESR: Multiplex Section Errored Second Ratio (MS-ESR MS-SES: Multiplex Section Severely Errored Second (MS-SES) MS-SESR: Multiplex Section Severely Errored Second ratio (MS-SESR) MS-UAS: Multiplex Section Unavailable Seconds (MS-UAS) RS-BBE: Regenerator Section Background Block Error (RS-BBE) RS-BBER: Regenerator Section Background Block Error Ratio (RS-BBER) RS-EB: Regenerator Section Errored Block (RS-EB) RS-ES: Regenerator Section Errored Second (RS-ES RS-ESR: Regenerator Section Errored Second Ratio (RS-ESR) RS-SES: Regenerator Section Severely Errored Second (RS-SES) RS-SESR: Regenerator Section Severely Errored Second Ratio (RS-SESR) RS-UAS: Regenerator Section Unavailable Second (RS-UAS)		
FEC	Bit errors: Number of corrected bit errors Uncorrectable words: Number of uncorrectable words		
10G FC and 8G FC	rxTotalPkts: Client RX - Receive frame counter mediaIndStatsRxFramesTruncated: Client RX - mediaIndStatsRxFramesTooLong: Client RX - Receive oversize frame counter mediaIndStatsRxFrameBadCRC: Client RX - Receive frame CRC error counter ifInOctects: Client RX - Receive (frame) octets counter ifInErros: Client RX - Receive Total Errored Frame counter		
Trunk Optical Performance Monitoring	Transmit optical power (OPT) PM Transmitter laser bias current (LBC) Receiver optical power (OPR)		

Table 10. Ordering Information

Part Number	Description
15454-40E-MXP-C=	4x10GE/OC192/STM64/OTU2Muxponder CP-DQPSK Extended Performance
15454-40EX-MXP-C=	4x10GE/OC192/STM64/OTU2Muxponder CP-DQPSK Extended Performance
15454-40ME-MXP-C=	4x10GE/OC192/STM64/OTU2Muxponder CP-DQPSK Metro Edge Performance

Part Number	Description
ONS-XC-10G-C=	10G MultiRate Full C Band Tuneable DWDM XFP, 50 GHz, LC
ONS-XC-10G-S1=	10 Gigabit SFP OC-192/STM-64/10 GE/10-Gbps Fibre Channel , 1310 SR-SM LC connectors
ONS-XC-10G-I2=	XFP – OC192/STM64/10GE – 1550 IR/SH2 – SM LC
ONS-XC-10G-L2=	XFP – OC192/STM64 - 1550 LR2 - SM LC
ONS-XC-10G-SR-MM=	XFP – 10GE/10G FC – 850 SR – MM LC
ONS-XC-8G-SM=	8G FC XFP SM
ONS-XC-10G-1470=	OC192/10GE/OTU2 , CWDM, 1470 nm, XFP C-Temp, 40km range
ONS-XC-10G-1490=	OC192/10GE/OTU2 , CWDM, 1490 nm, XFP C-Temp, 40km range
ONS-XC-10G-1510=	OC192/10GE/OTU2 CWDM, 1510 nm, XFP C-Temp , 40km range
ONS-XC-10G-1530=	OC192/10GE/OTU2 , CWDM, 1530 nm, XFP C-Temp , 40km range
ONS-XC-10G-1550=	OC192/10GE/OTU2 , CWDM, 1550 nm, XFP C-Temp , 40km range
ONS-XC-10G-1570=	OC192/10GE/OTU2 , CWDM, 1570 nm, XFP C-Temp , 40km range
ONS-XC-10G-1570=	OC192/10GE/OTU2 , CWDM, 1590 nm, XFP C-Temp , 40km range
ONS-XC-10G-1610=	OC192/10GE/OTU2 , CWDM, 1610 nm, XFP C-Temp , 40km range
ONS-XC-10G-EP30.3=	10G MR, XFP,Edge Performance 1530.33, 100 GHz, LC
ONS-XC-10G-EP31.1=	10G MR, XFP,Edge Performance 1531.12, 100 GHz, LC
ONS-XC-10G-EP31.9=	10G MR, XFP,Edge Performance 1531.90, 100 GHz, LC
ONS-XC-10G-EP32.6=	10G MR, XFP,Edge Performance 1532.68, 100 GHz, LC
ONS-XC-10G-EP33.4=	10G MR, XFP,Edge Performance 1533.47, 100 GHz, LC
ONS-XC-10G-EP34.2=	10G MR, XFP,Edge Performance 1534.25, 100 GHz, LC
ONS-XC-10G-EP35.0=	10G MR, XFP,Edge Performance 1535.04, 100 GHz, LC
ONS-XC-10G-EP35.8=	10G MR, XFP,Edge Performance 1535.82, 100 GHz, LC
ONS-XC-10G-EP36.6=	10G MR, XFP,Edge Performance 1536.61, 100 GHz, LC
ONS-XC-10G-EP37.4=	10G MR, XFP,Edge Performance 1537.40, 100 GHz, LC
ONS-XC-10G-EP38.1=	10G MR, XFP,Edge Performance 1538.19, 100 GHz, LC
ONS-XC-10G-EP38.9=	10G MR, XFP,Edge Performance 1538.98, 100 GHz, LC
ONS-XC-10G-EP39.7=	10G MR, XFP,Edge Performance 1539.77, 100 GHz, LC
ONS-XC-10G-EP40.5=	10G MR, XFP,Edge Performance 1540.56, 100 GHz, LC
ONS-XC-10G-EP41.3=	10G MR, XFP,Edge Performance 1541.35, 100 GHz, LC
ONS-XC-10G-EP42.1=	10G MR, XFP,Edge Performance 1542.14, 100 GHz, LC
ONS-XC-10G-EP42.9=	10G MR, XFP,Edge Performance 1542.94, 100 GHz, LC
ONS-XC-10G-EP43.7=	10G MR, XFP,Edge Performance 1543.73, 100 GHz, LC
ONS-XC-10G-EP44.5=	10G MR, XFP,Edge Performance 1544.53, 100 GHz, LC
ONS-XC-10G-EP45.3=	10G MR, XFP,Edge Performance 1545.32, 100 GHz, LC
ONS-XC-10G-EP46.1=	10G MR, XFP,Edge Performance 1546.12, 100 GHz, LC
ONS-XC-10G-EP46.9=	10G MR, XFP,Edge Performance 1546.92, 100 GHz, LC
ONS-XC-10G-EP47.7=	10G MR, XFP,Edge Performance 1547.72, 100 GHz, LC
ONS-XC-10G-EP48.5=	10G MR, XFP,Edge Performance 1548.51, 100 GHz, LC
ONS-XC-10G-EP49.3=	10G MR, XFP,Edge Performance 1549.32, 100 GHz, LC
ONS-XC-10G-EP50.1=	10G MR, XFP,Edge Performance 1550.12, 100 GHz, LC
ONS-XC-10G-EP50.9=	10G MR, XFP,Edge Performance 1550.92, 100 GHz, LC
ONS-XC-10G-EP51.7=	10G MR, XFP,Edge Performance 1551.72, 100 GHz, LC
ONS-XC-10G-EP52.5=	10G MR, XFP,Edge Performance 1552.52, 100 GHz, LC
ONS-XC-10G-EP53.3=	10G MR, XFP,Edge Performance 1553.33, 100 GHz, LC

Part Number	Description
ONS-XC-10G-EP54.1=	10G MR, XFP,Edge Performance 1554.13, 100 GHz, LC
ONS-XC-10G-EP54.9=	10G MR, XFP,Edge Performance 1554.94, 100 GHz, LC
ONS-XC-10G-EP55.7=	10G MR, XFP,Edge Performance 1555.75, 100 GHz, LC
ONS-XC-10G-EP56.5=	10G MR, XFP,Edge Performance 1556.55, 100 GHz, LC
ONS-XC-10G-EP57.3=	10G MR, XFP,Edge Performance 1557.36, 100 GHz, LC
ONS-XC-10G-EP58.1=	10G MR, XFP,Edge Performance 1558.17, 100 GHz, LC
ONS-XC-10G-EP58.9=	10G MR, XFP,Edge Performance 1558.98, 100 GHz, LC
ONS-XC-10G-EP59.7=	10G MR, XFP,Edge Performance 1559.79, 100 GHz, LC
ONS-XC-10G-EP60.6=	10G MR, XFP,Edge Performance 1560.61, 100 GHz, LC
ONS-XC-10G-EP61.4=	10G MR, XFP,Edge Performance 1561.43, 100 GHz, LC

For More Information

For more information about the ONS15454 MSTP, visit
http://www.cisco.com/en/US/products/hw/optical/ps2006/ps5320/index.html

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