CHAPTER **9**

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 (pre-amplifier) mode.

Chapter topics include:

9.1 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 MetroPlanner 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 "Configuring Mesh DWDM Networks" section on page 9-30.

9.1.1 Hub Node

A hub node is a single ONS 15454 node equipped with two TCC2/TCC2P 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 32WSS-L cards and two 32DMX-L cards
- Two 40-WSS-C cards and two 40-DMX-C cards

Note The 32WSS/32WSS-L/40-WSS-C and 32DMX/32DMX-L/40-DMX-C 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 express ports (EXP RX and EXP TX) are not cabled.

A dispersion compensation unit (DCU) can also be added, if necessary. Figure 9-1 shows a hub node configuration with 32MUX-O and 32DMX-O cards installed.

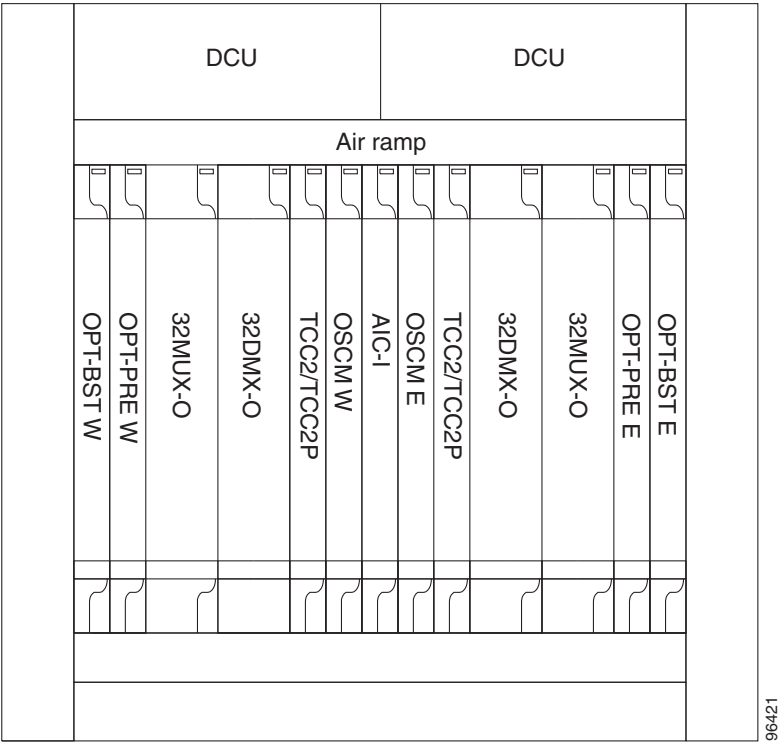*Figure 9-1* **Hub Node Configuration Example with 32-Channel C-Band Cards**

Figure 9-2 shows a 40-channel hub node configuration with 40-WSS-C cards installed.

Figure 9-2   Hub Node Configuration Example with 40-WSS-C Cards

Figure 9-3 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 9-3   Hub Node Channel Flow Example
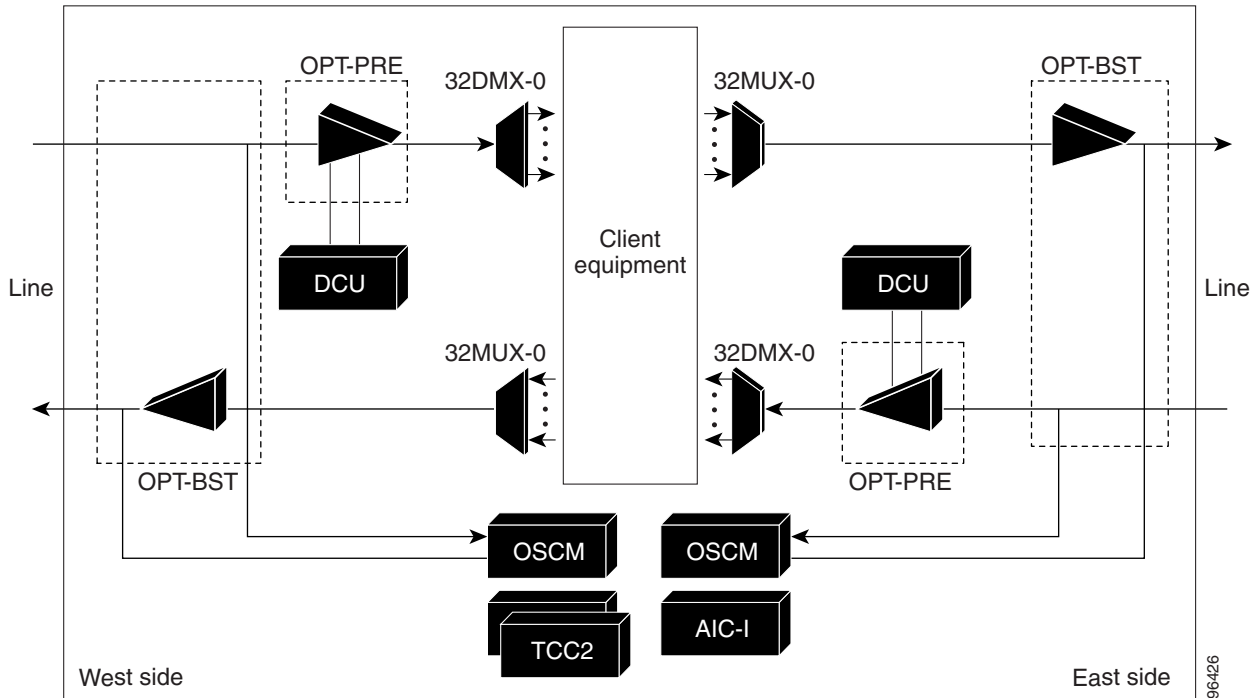
9.1.2 Terminal Node

A terminal node is a single ONS 15454 node equipped with two TCC2/TCC2P 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 32WSS-L card and one 32DMX-L card
- One 40-WSS-C card and one 40-DMX-C card
- One 40-MUX-C and one 40-DMX-C card

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 9-4 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 9-3).

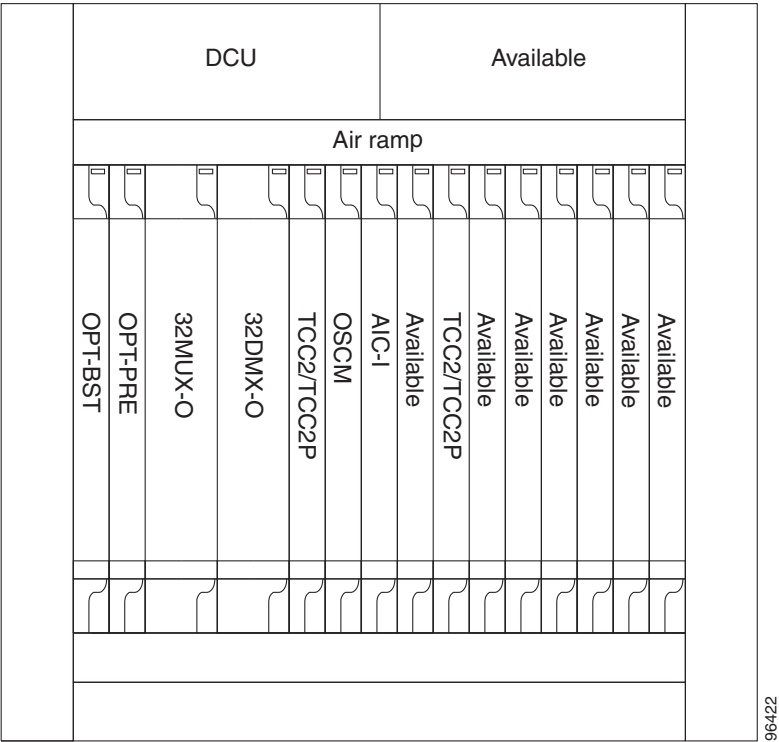**Figure 9-4 Terminal Node Configuration With 32MUX-O Cards Installed**

Figure 9-5 shows an example of a terminal configuration with a 40-WSS-C card installed.

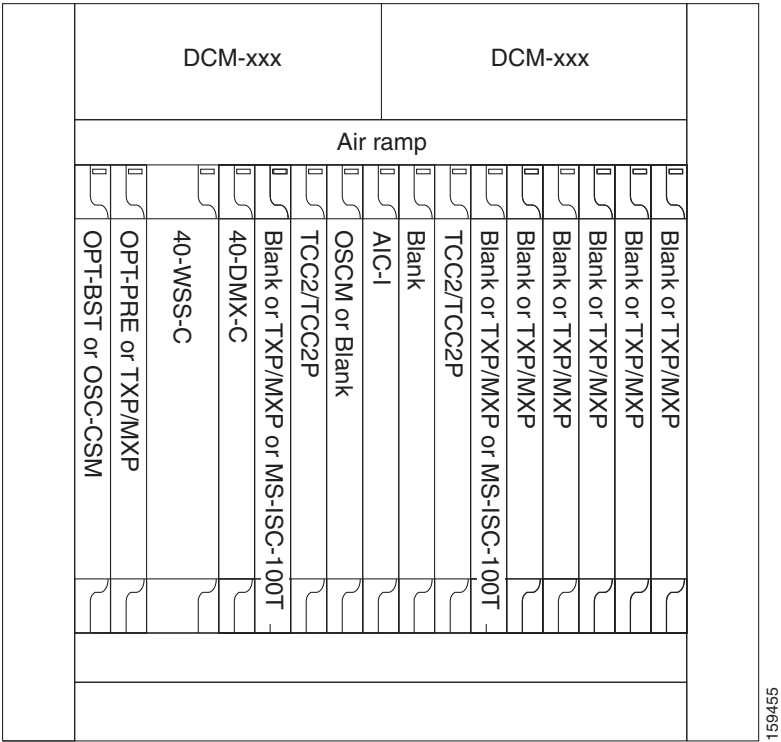**Figure 9-5** *Terminal Node Configuration with 40-WSS-C Cards Installed*
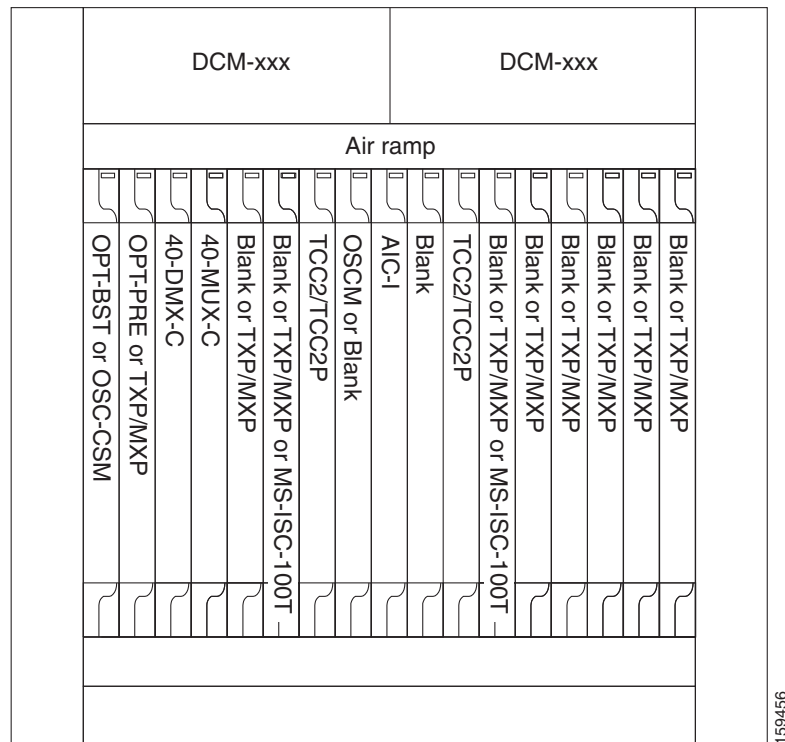

Figure 9-5 shows an example of a terminal configuration with a 40-MUX-C card installed.

Figure 9-6   Terminal Node with 40-MUX-C Cards Installed

9.1.3 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 cards. 32MUX-O/40-MUX-C or 32DMX-O/40-DMX-C cards cannot be installed in an OADM node. 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 MetroPlanner 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 9-7 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.

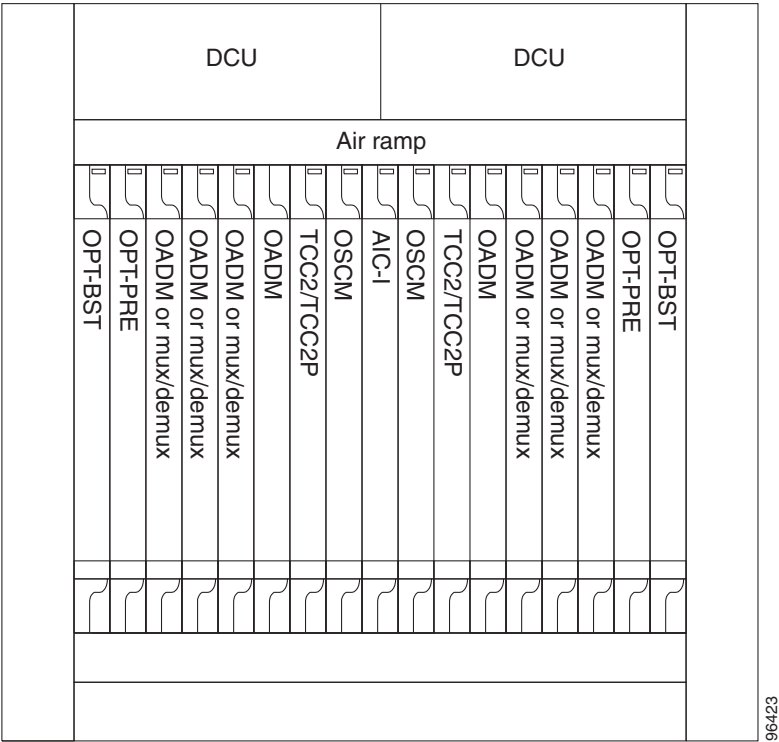**Figure 9-7   Amplified OADM Node Configuration Example**

Figure 9-8 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).

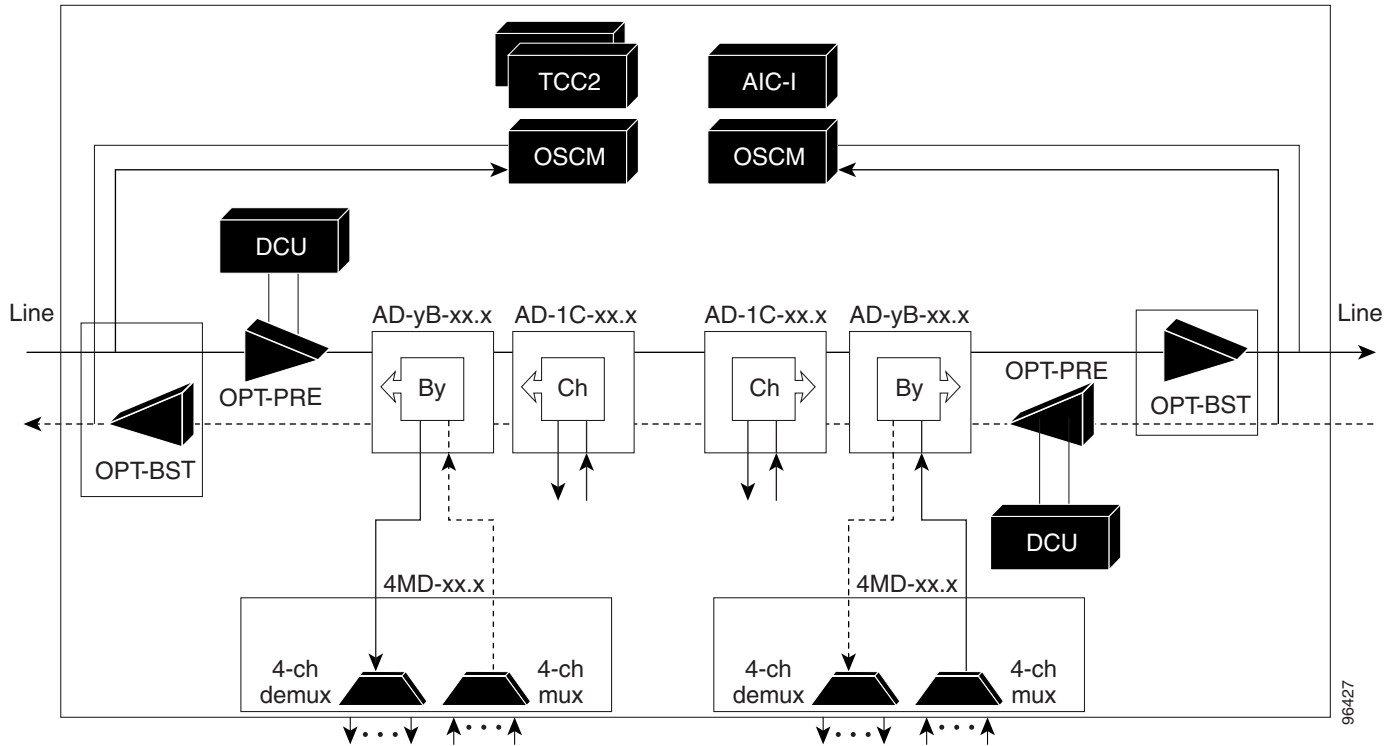*Figure 9-8   Amplified OADM Node Channel Flow Example*

Figure 9-9 shows an example of a passive OADM node configuration. The passive OADM node is equipped with a band filter, one four-channel multiplexer/demultiplexer, and a channel filter on each side of the node.
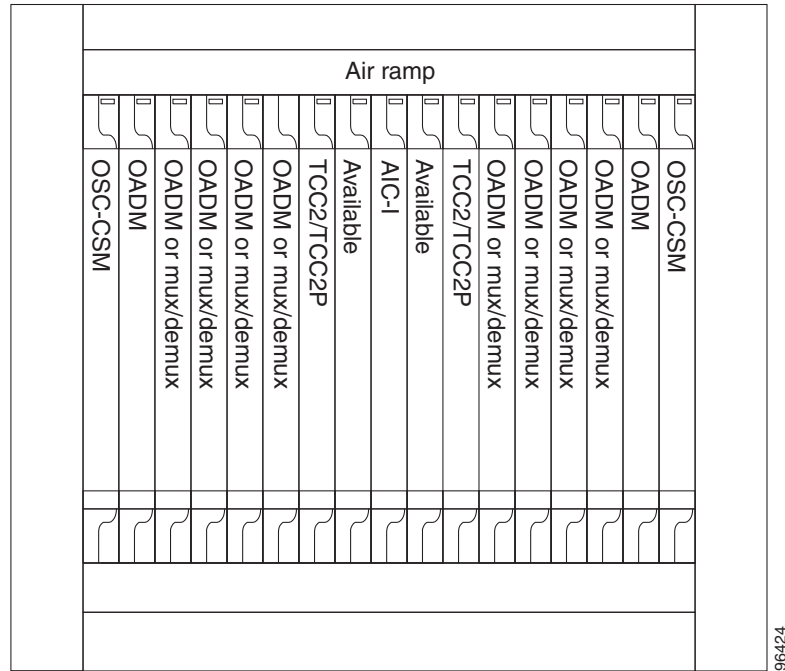
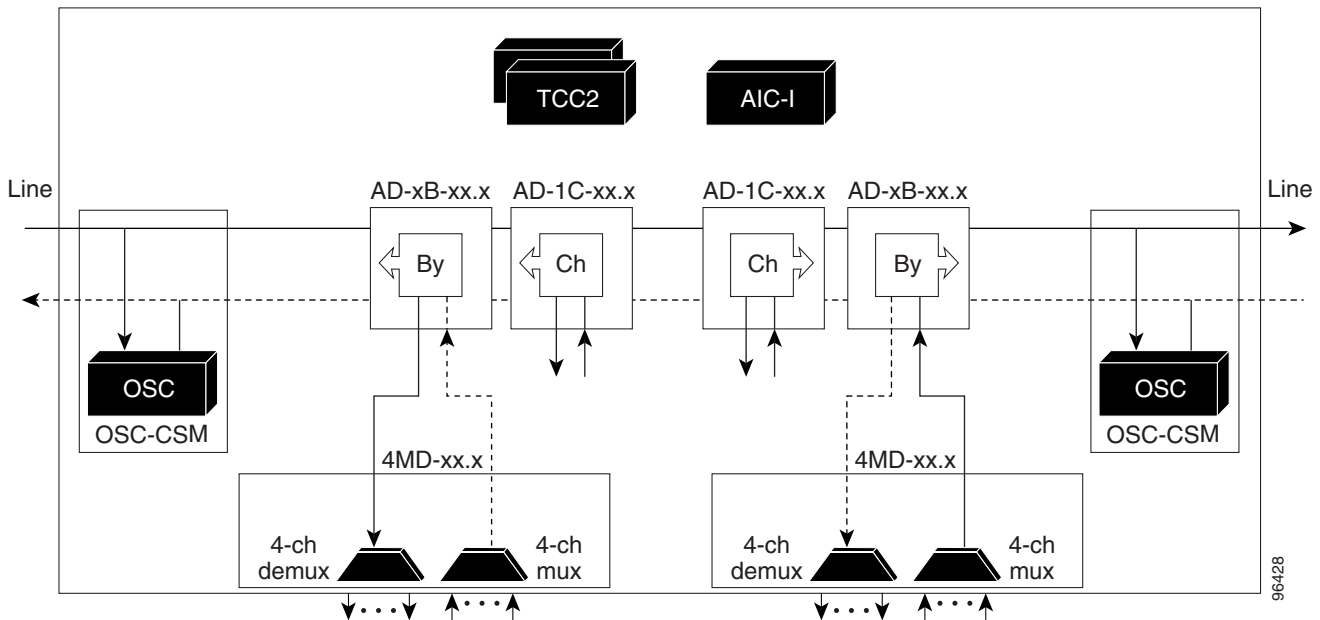*Figure 9-9*   *Passive OADM Node Configuration Example*

Figure 9-10 shows an example of traffic flow on the passive OADM node. The signal flow of the channels is the same as the amplified OADM, except that the OSC-CSM card is used instead of the OPT-BST and OSCM cards.

Figure 9-10   *Passive OADM Node Channel Flow Example*

9.1.4 ROADM Node

A ROADM node adds and drops wavelengths without changing the physical fiber connections. A ROADM node is equipped with two TCC2/TCC2P cards and one of the following combinations:

- Two 32WSS cards and, optionally, two 32DMX or 32DMX-O cards
- Two 32WSS-L cards and, optionally, two 32DMX-L cards
- Two 40-WSS-C cards and, optionally, two 40-DMX-C cards

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 an ROADM node. Cisco MetroPlanner automatically chooses the demultiplexer card that is best for the ROADM node based on the network requirements.

Figure 9-11 shows an example of an amplified ROADM node configuration with 32DMX cards installed.
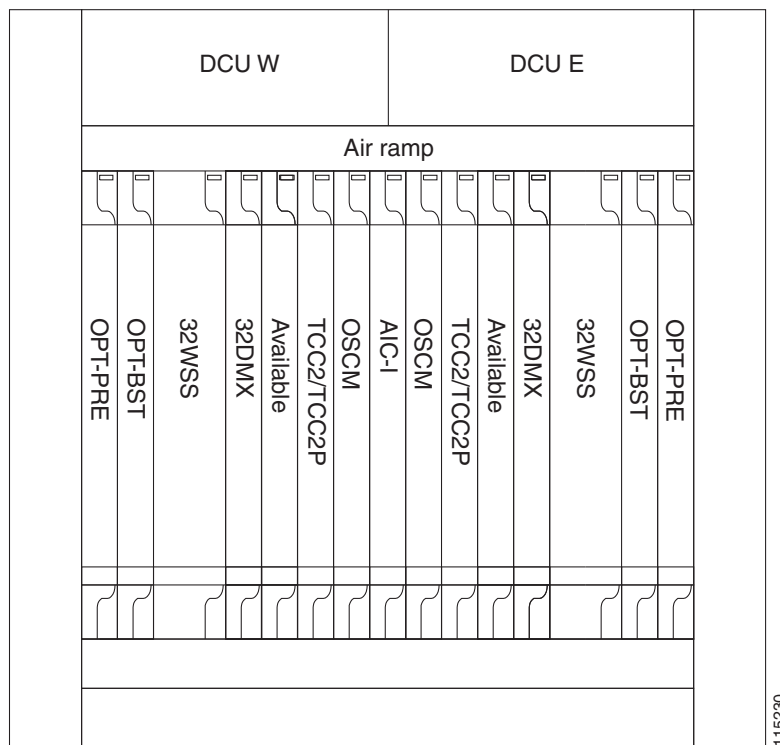
Figure 9-11   ROADM Node with 32DMX Cards Installed

Figure 9-12 shows an example of an amplified ROADM node configuration with 40-WSS-C cards installed.

Figure 9-12 **ROADM Node with 40-WSS-C Cards Installed**
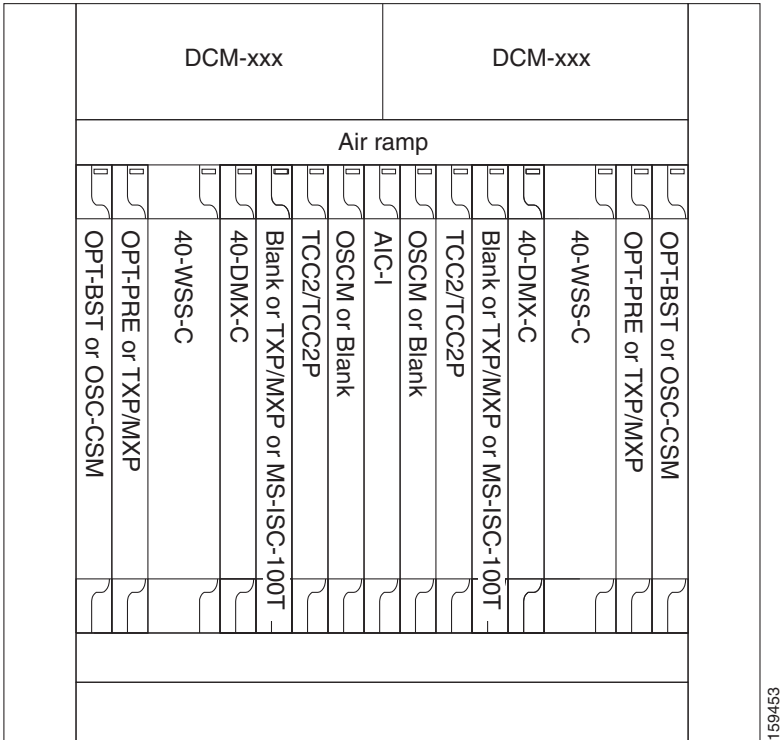
Figure 9-13 shows an example of an ROADM node with 32WSS-L and 32DMX-L cards installed.

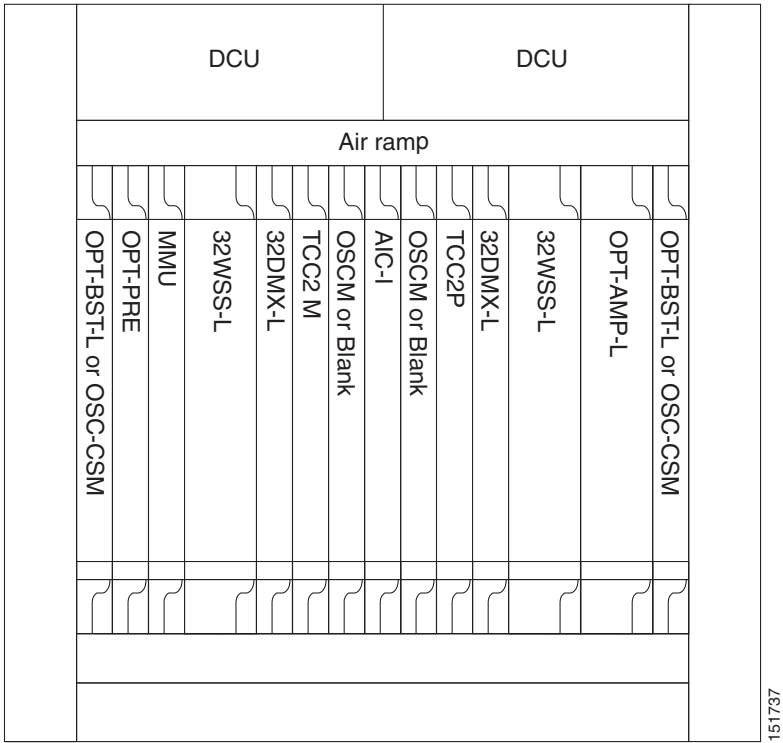*Figure 9-13   ROADM Node with 32WSS-L and 32DMX-L Cards Installed*

Figure 9-14 shows an example of an ROADM optical signal flow from Side A to Side B. 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 so OPT-BSTs are not needed.

Figure 9-14 ROADM Optical Signal Flow Example
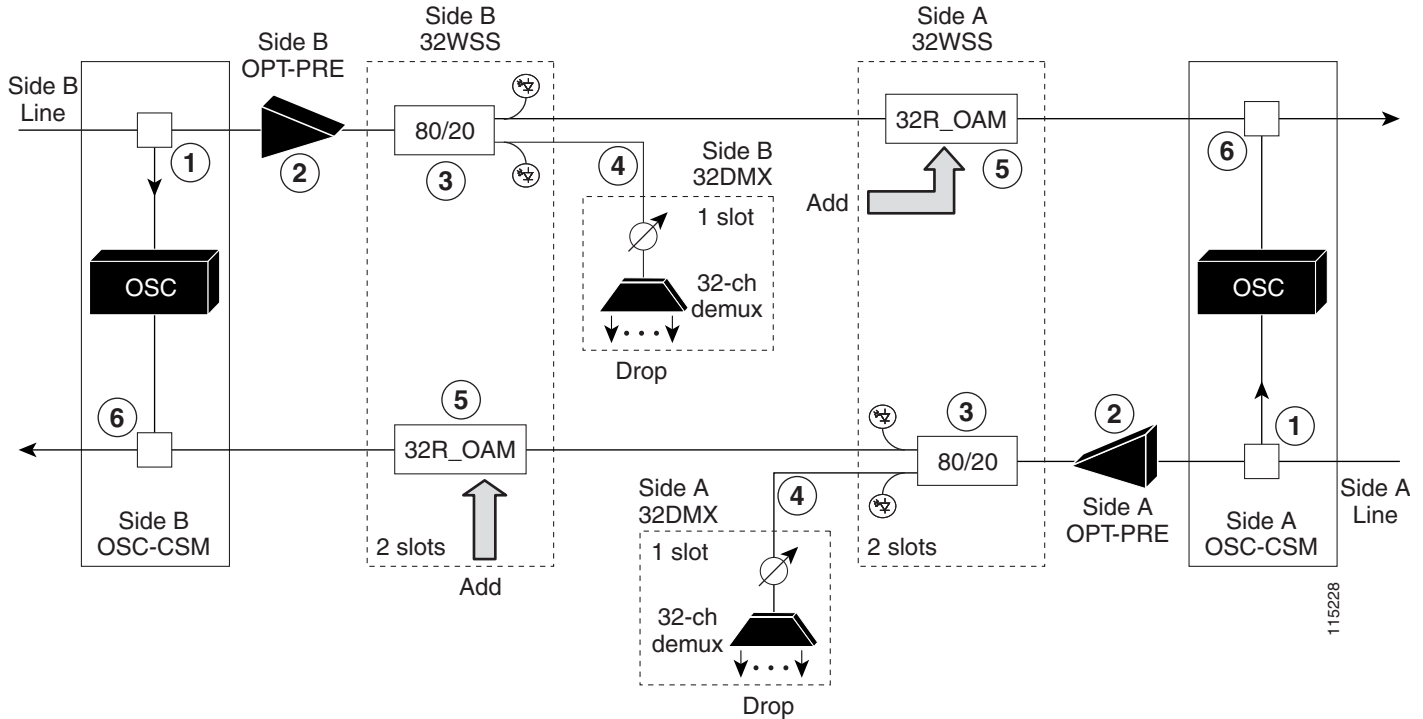
1	The OSC-CSM receives the optical signal. It separates the optical service channel from the optical payload and sends the payload to the OPT-PRE module.
2	The OPT-PRE compensates for chromatic dispersion, amplifies the optical payload, and sends it to the 32WSS or 40-WSS-C.
3	The 32WSS or 40-WSS-C splits 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 or 40-DMX-C where it is demultiplexed and dropped.
5	The express wavelength aggregate signal goes to the 32WSS or 40-WSS-C 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.

9.1.5 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 9-8 on page 9-10.

Figure 9-15 shows an anti-ASE node that uses all wavelengths in the pass-through mode. Use Cisco MetroPlanner to determine the best configuration for anti-ASE nodes.
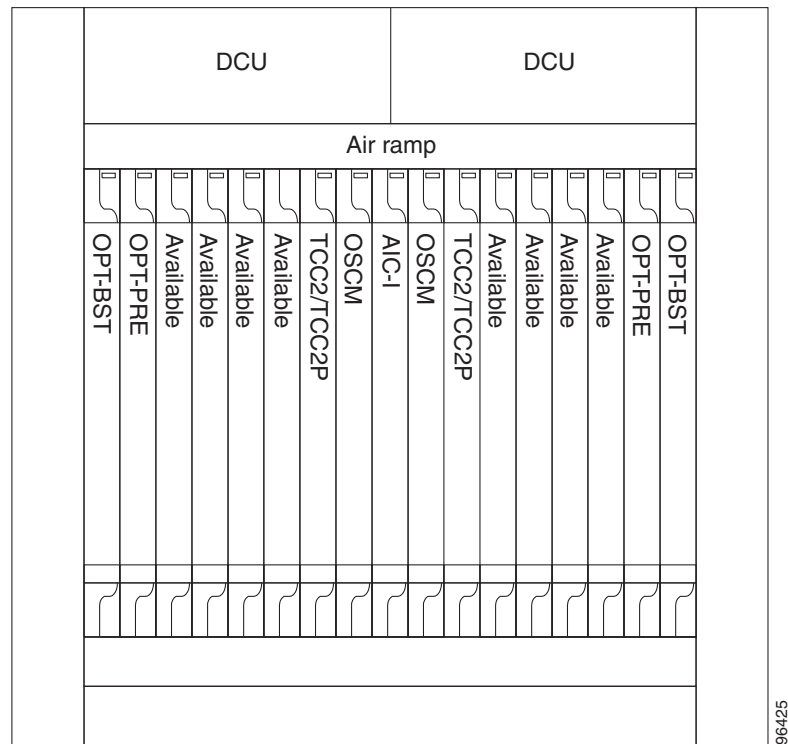
Figure 9-15　　*Anti-ASE Node Channel Flow Example*

9.1.6 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

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 an OPT-BST card, OSC-CSM cards must be installed instead of OSCM cards. Figure 9-16 shows an example of a line amplifier node configuration using OPT-BST, OPT-PRE, and OSCM cards.

Figure 9-16   Line Amplifier Node Configuration Example

9.1.7 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 MetroPlanner 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 9-17. The cards are installed in each side of the shelf.

Figure 9-17   OSC Regeneration Line Node Configuration Example
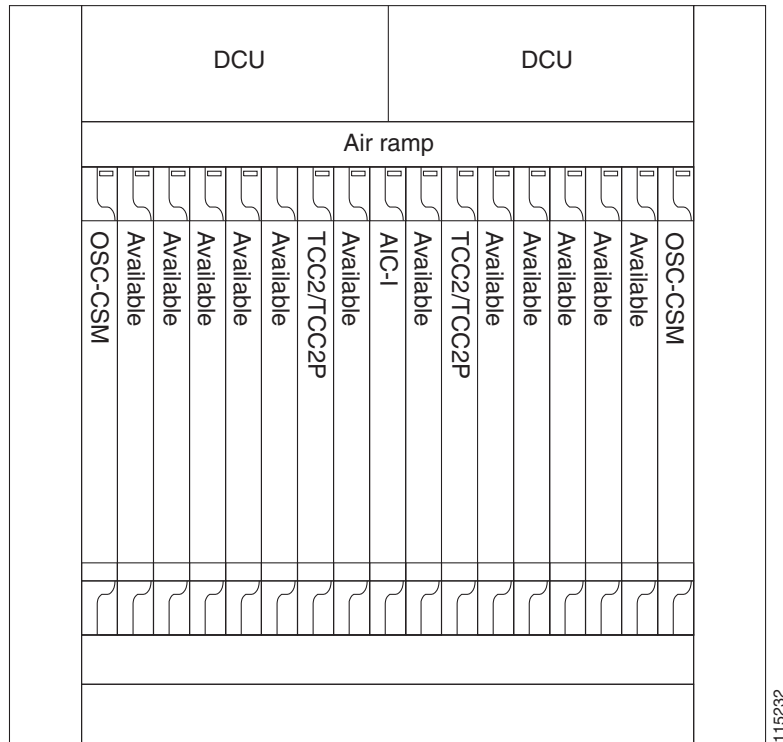
Figure 9-18 shows the OSC regeneration line node signal flow.

Figure 9-18   OSC Regeneration Line Node Flow
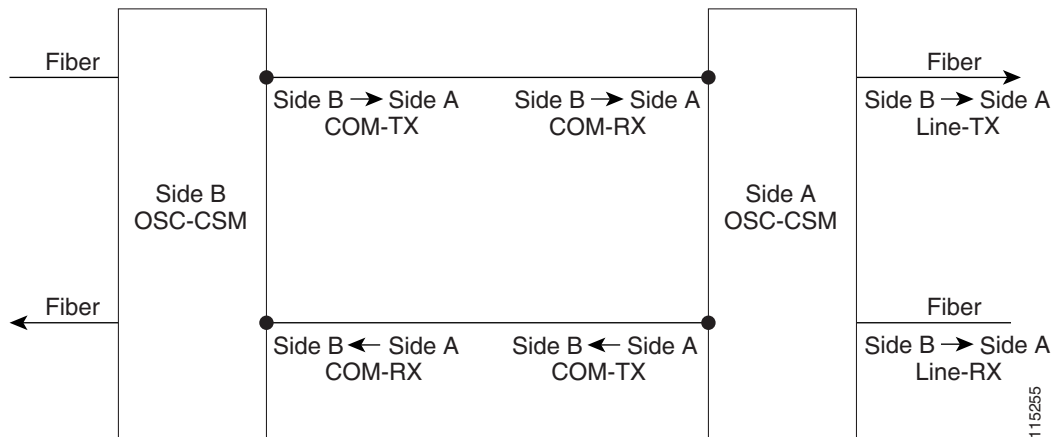
9.2 Multishelf Node

An ONS 15454 node provisioned as a multishelf node can manage up to eight subtending shelves as a single entity. The node controller is the main shelf; its TCC2/TCC2P cards run multishelf functions. Each subtending shelf must be equipped with TCC2/TCC2P 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. Cisco recommends using the MS-ISC-100T cards. If using the Catalyst 2950, it is installed on one of 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 9-19 shows an example of a multishelf node configuration.

Figure 9-19   Multishelf Node Configuration
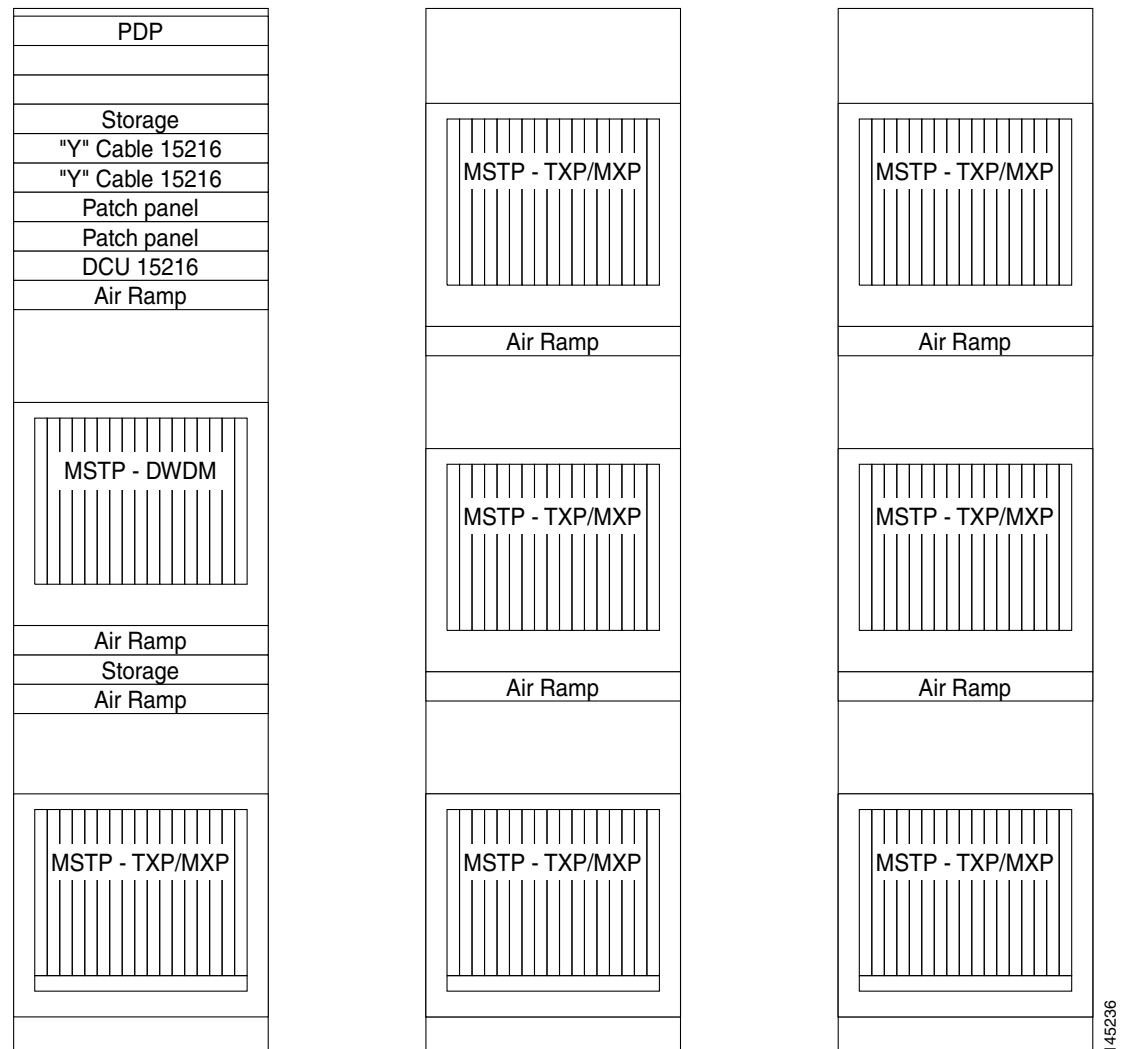
A multishelf node has a single public IP address for all client interfaces (Cisco Transport Controller [CTC], Transaction Language One [TL1], Simple Network Management Protocol [SNMP], and HTTP); a client can only connect to the node controller shelf, not to the subtending shelves. The user interface 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 occur at the node controller level.
- Open Shortest Path First (OSPF) is 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 use as timing source line, TCC/TCC2P clock, or building integrated timing supply (BITS) source lines.

9.2.1 Multishelf Node Layout

Multishelf configurations are configured by Cisco MetroPlanner 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.

9.2.2 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.

9.3 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 9.3.2 Side line ports, page 9-25) 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 span 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, shown in Figure 9-20.

Figure 9-20   Optical Side Tab
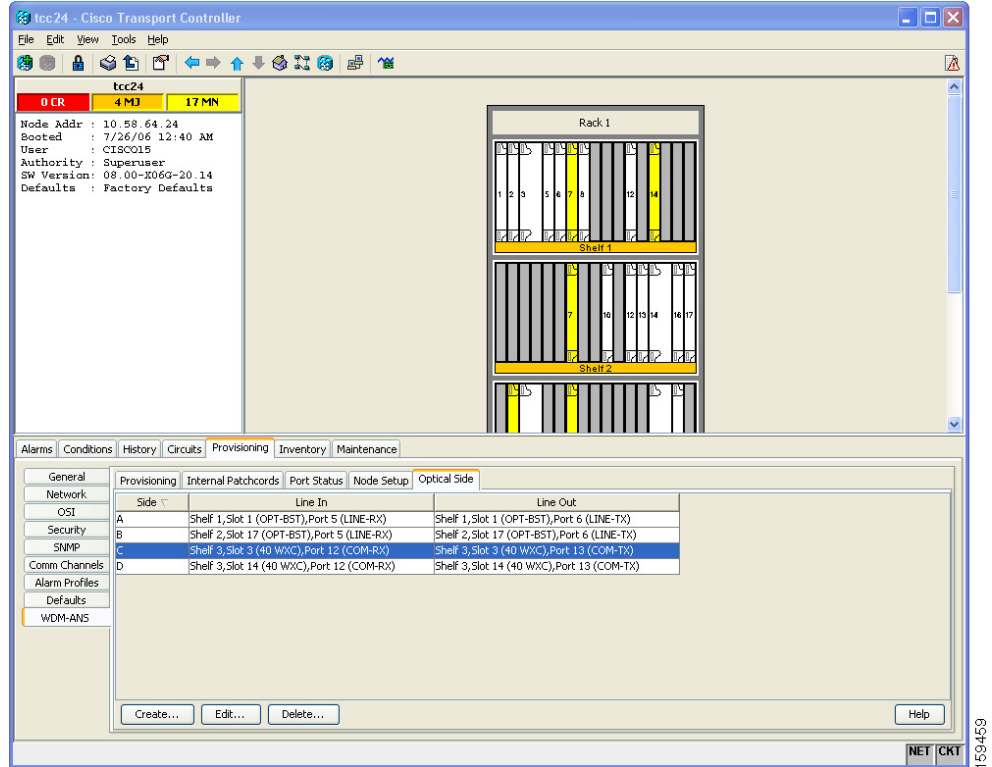
9.3.1 Optical Side Stages

All MSTP nodes can be modelled according to .

Figure 9-21   *Interconnecting Sides Conceptual View*
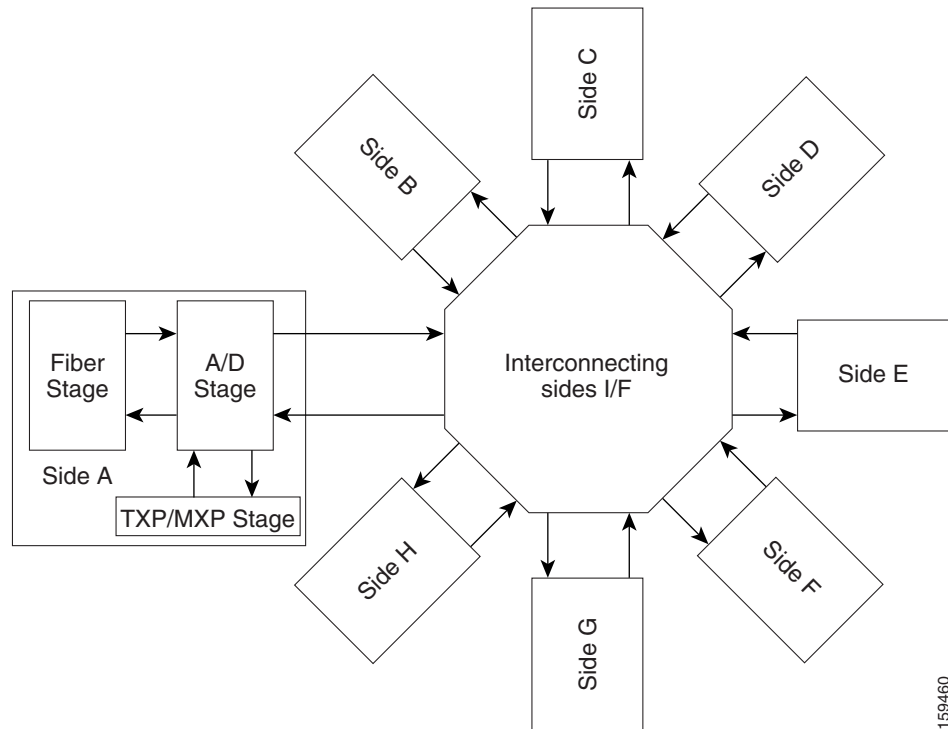
According to Figure 9-21, each MSTP node side includes DWDM units that can be conceptually divided into three stages.

- 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.

9.3.1.1 Fiber Stage

The fiber stage includes DWDM cards that are used to amplify transmitted or received signal and cards that are used to add optical supervision channel. 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

Table 9-1 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 9-1   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)

Table 9-1   Supported Fiber Stage Configurations (continued)

Layout	Cards	Configurations
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)
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)

9.3.1.2 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 9.4 Configuring Mesh DWDM Networks, page 9-30.

- 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.

9.3.2 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
- 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

9.3.3 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 A and B only.
- 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.

Side IDs are assigned automatically by the system when you create default internal patchcords in CTC or 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 "Side line ports" section on page 9-25).
- The side line ports are not connected to an internal patchcord.

Note Cisco does not recommend that you manually create or modify ONS 15454 sides.

The following tables show examples of how Side IDs are automatically assigned by the system for common DWDM layouts.

Table 9-2 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 9-2   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 9-3 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 9-3   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 9-4 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 9-4   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

Table 9-4 **Multishelf Four-Degree Mesh Node Layout Example (continued)**

Shelf	Slots 1–6	Side	Slots 12–17	Side
3	WXC Line Termination	D	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	—

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 9-5 **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	—

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 9-6 **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	—

Table 9-6 Multishelf Four-Degree Protected Mesh Node Layout Example (continued)

Shelf	Slots 1–6	Side	Slots 12–17	Side
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 9-7 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 9-7 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 9-8 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 9-8 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

Table 9-8 Multishelf Eight-Degree Mesh Node Layout Example (continued)

Shelf	Slots 1–6	Side	Slots 12–17	Side
5	WXC Line Termination	H	TXP/MXP	—
6	TXP/MXP	—	TXP/MXP	—
7	TXP/MXP	—	TXP/MXP	—
8	TXP/MXP	—	TXP/MXP	—

Table 9-9 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 9-9 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 9-10 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 9-10 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	—

Table 9-10   Multishelf Four-Degree Mesh Node User-Defined Layout Example

Shelf	Slots 1–6	Side	Slots 12–17	Side
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

9.4 Configuring Mesh DWDM Networks

ONS 15454 shelves can be configured in mesh DWDM networks using the 40-WXC-C wavelength cross-connect cards, multishelf provisioning, and the 40-channel patch panel, four-degree patch panel, and eight-degree patch panels. ONS 15454 DWDM mesh configurations can be up to four degrees (four optical directions) when the four-degree patch panel 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.

9.4.1 Line Termination Mesh Node

The line termination mesh node is installed in native Software Release 8.5 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 40-DMX-C cards can be replaced with 32DMX cards, if a 32WSS is used.
- The 40-MUX-C cards can be replaced with 40-WSS-C or 32WSS cards.
- The OPT-BST cards can be replaced with OPT-AMP-C (in OPT-BST mode), OPT-AMP-17-C (in OPT-BST mode) and/or OPT-BST-E cards.
- The OPT-RAMP-C can be added based on specific network design.
- The OPT-PRE can be replaced with an OPT-AMP-C (in OPT-LINE mode) 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 32DMX) COM-RX port.
- The 40-WXC-C ADD-RX port is connected to the 40-MUX-C (or 40-WSS-C or 32WSS) COM-TX port.
- The 40-WXC-C EXP-TX port is connected to the COM-RX through an LC-LC patchcord.

- The 40-WXC-C EXP-RX port is connected to the EXP-TX patch panel through an MPO-MPO multicable.

Note The PP-MESH interconnects 40-WXC-C cards according to following rule: The EXP-TX port of 40-WXC-C in side "i" is connected to the 40-WXC-C EXP-j-RX port of all the other equipped or provisioned 40-WXC-C cards. The side "i" goes from A to H and side "j" goes from ports 1 to 8 (Side "j" has the same cardinality of the side letter (A<->1, B<->2, ...H<->8). These connections are relevant for routing pourposes or to list the ports that are involved in an OCH-NC network. However, they are not reported in CTC under node view -> Maintenance -> DWDM -> -> Mesh Patch Panel Internal Patchcords.

Figure 9-22 shows one shelf from a line termination node. (Examples of line termination nodes in four-degree and eight-degree mesh networks are shown in Figure 9-29 on page 9-38 and Figure 9-30 on page 9-39.)

Figure 9-22   Line Termination Mesh Node Shelf
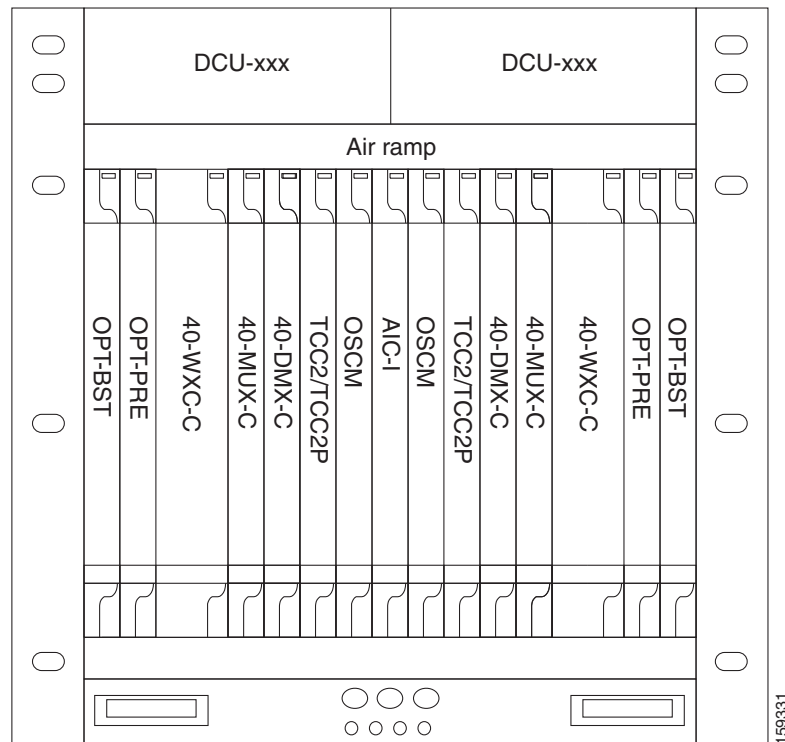
Figure 9-23 shows a functional block diagram of one line termination side using 40-WXC-C and 40-MUX-C cards.

Figure 9-23   Line Termination Mesh Node Side—40-MUX-C Cards
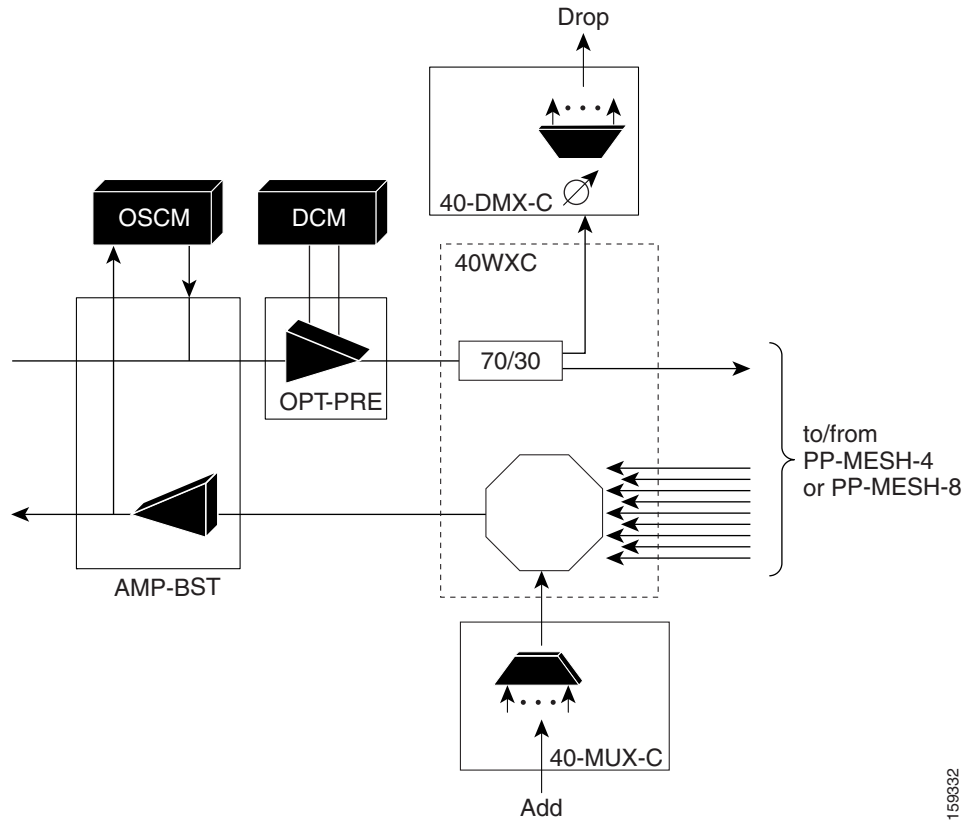
Figure 9-24 shows a functional block diagram line termination side using 40-WXC-C and 40-WSS-C cards.

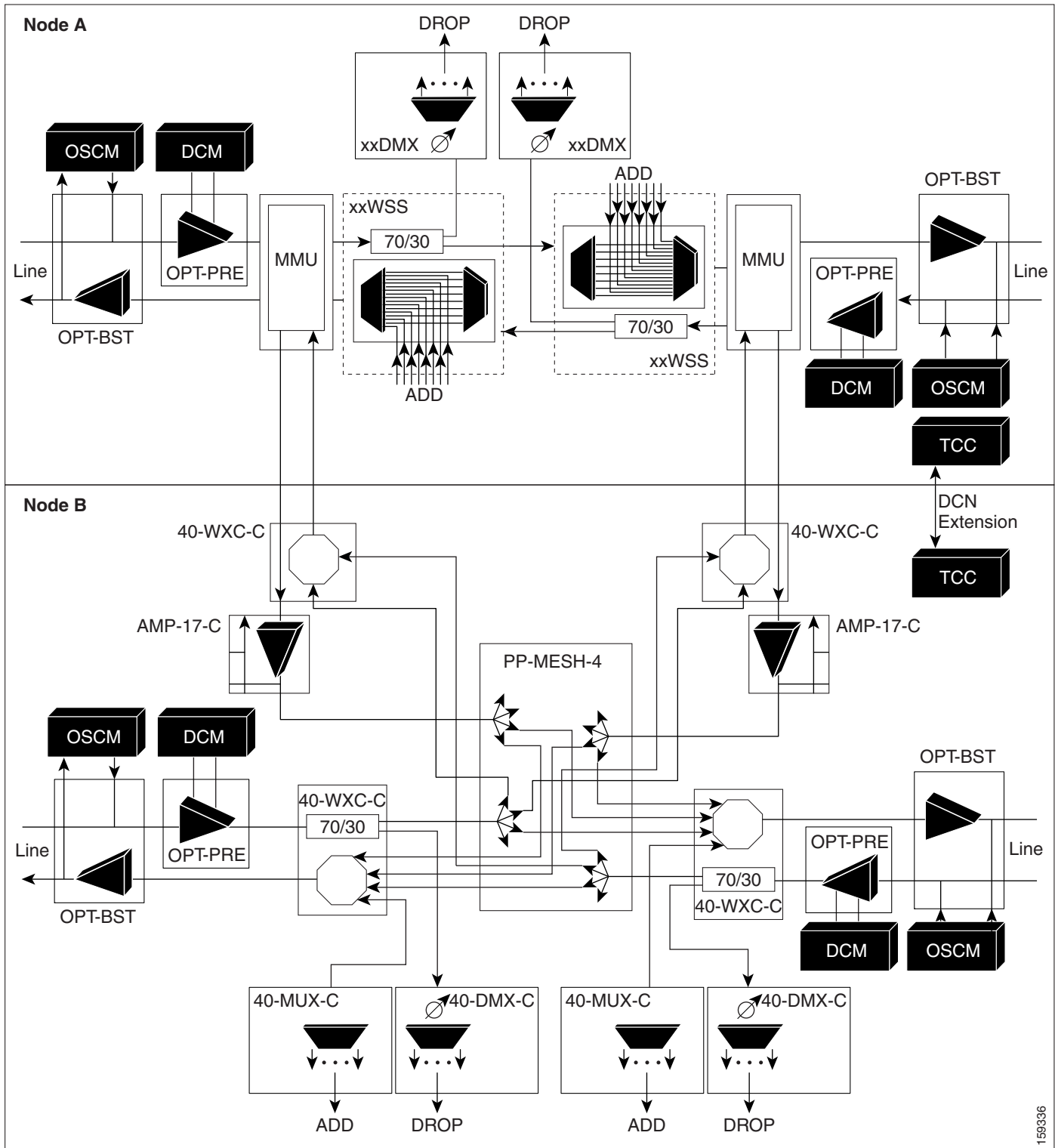*Figure 9-24 Line Termination Mesh Node Side—40-WSS-C Cards*
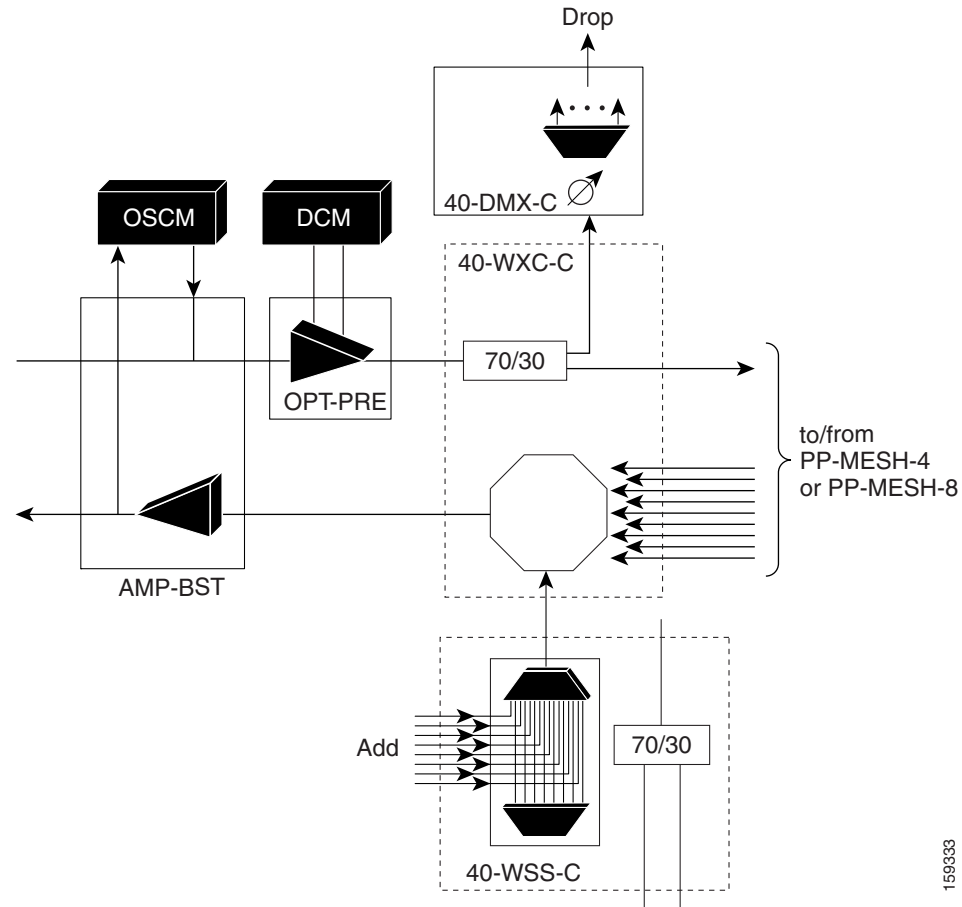
Figure 9-25 shows a functional block diagram of a node that interconnects a ROADM with MMU cards with two native line termination mesh sides.

Figure 9-25   Line Termination Mesh Nodes—ROADM With MMU Cards

9.4.2 XC Termination Mesh Node

The XC termination mesh node, shown in Figure 9-26, 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.
- 40-WXC-C EXP-TX port is connected to the OPT-AMP-17-C COM-RX port.
- 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 9-26   XC Termination Mesh Node Shelf
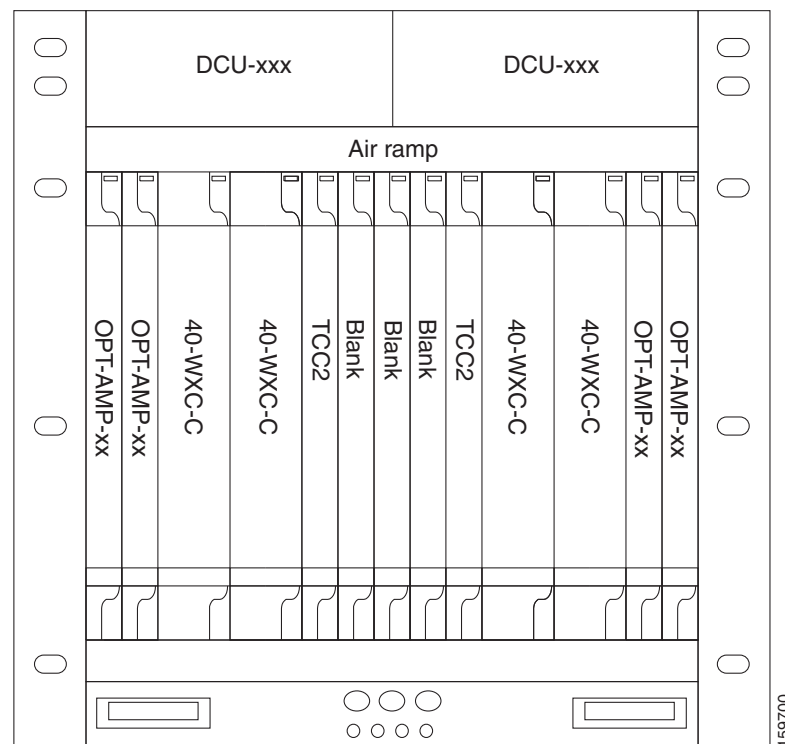

9.4.3 Mesh Patch Panels and Shelf Layouts

ONS 15454 mesh topologies require the installation of a four-degree patch panel (PP-MESH-4) or eight-degree patch panel (PP-MESH-8). If the four-degree patch panel is installed, mesh topologies of up to four degrees can be created. If the eight-degree patch panel 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 9-27 shows a block diagram for the four-degree patch panel.

Figure 9-27   Four-Degree Patch Panel Block Diagram
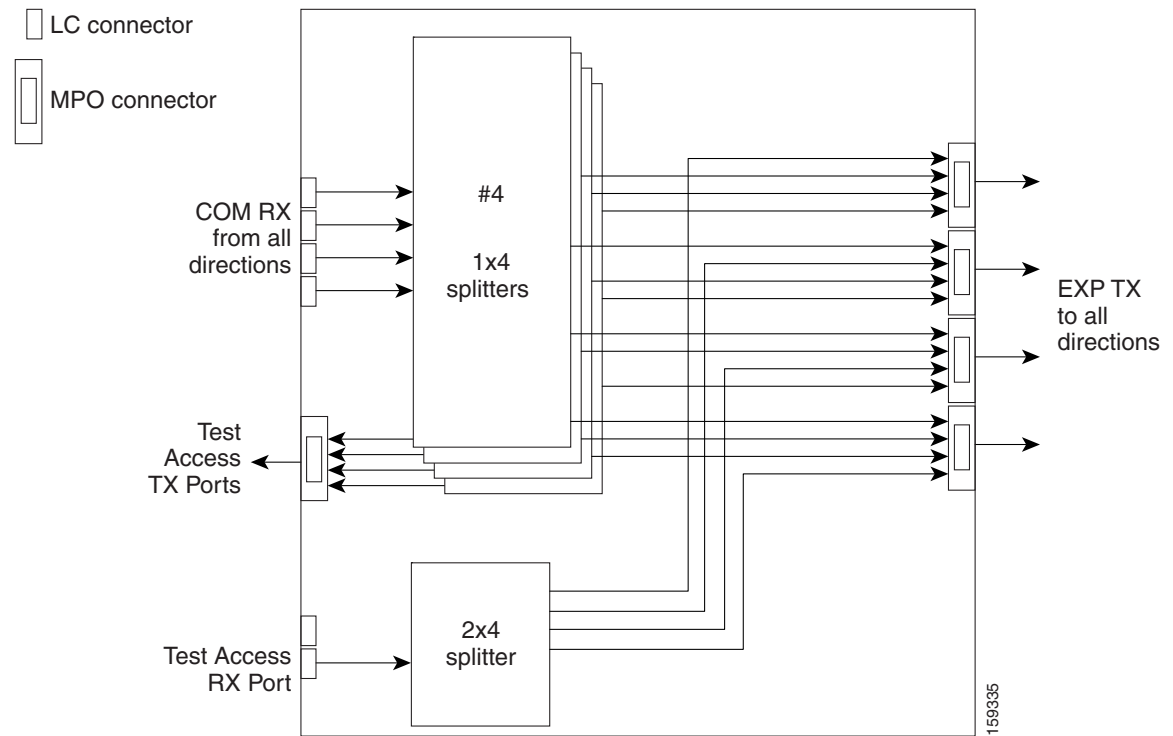
At the mesh patch panel, the signal is split into four signals (if four-degree patch panel is used) or eight signals (if an eight-degree patch panel is used). Figure 9-28 shows the signal flow at the four-degree patch panel. 40-WXC-C cards connect to the four-degree patch panel at the EXP TX and COM RX ports.

Figure 9-28 **Four-Degree Patch Panel Signal Flow**
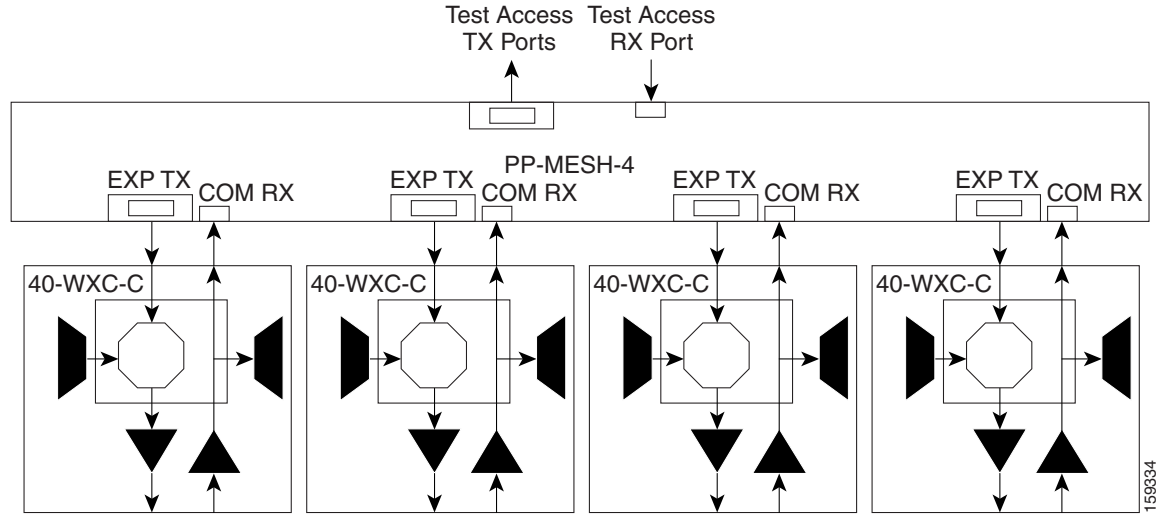
The mesh patch panels interconnect 40-WXC-C cards to create mesh networks, including four-degree and eight-degree mesh topologies. In addition, shelves with 40-WXC-C cards can be configured with mesh patch panels to create multiring, MMU-based mesh nodes. 40-WXC-C cards can be installed in ROADM nodes with MMU cards to upgrade a two-degree MMU-based ROADM node into four-degree or eight-degree mesh nodes. Figure 9-29 shows the ROADM node with MMU cards configuration after it has been upgraded into a four-degree mesh topology.

Figure 9-29   Layout for ROADM Node with MMU Cards and Four-Degree Mesh Topology
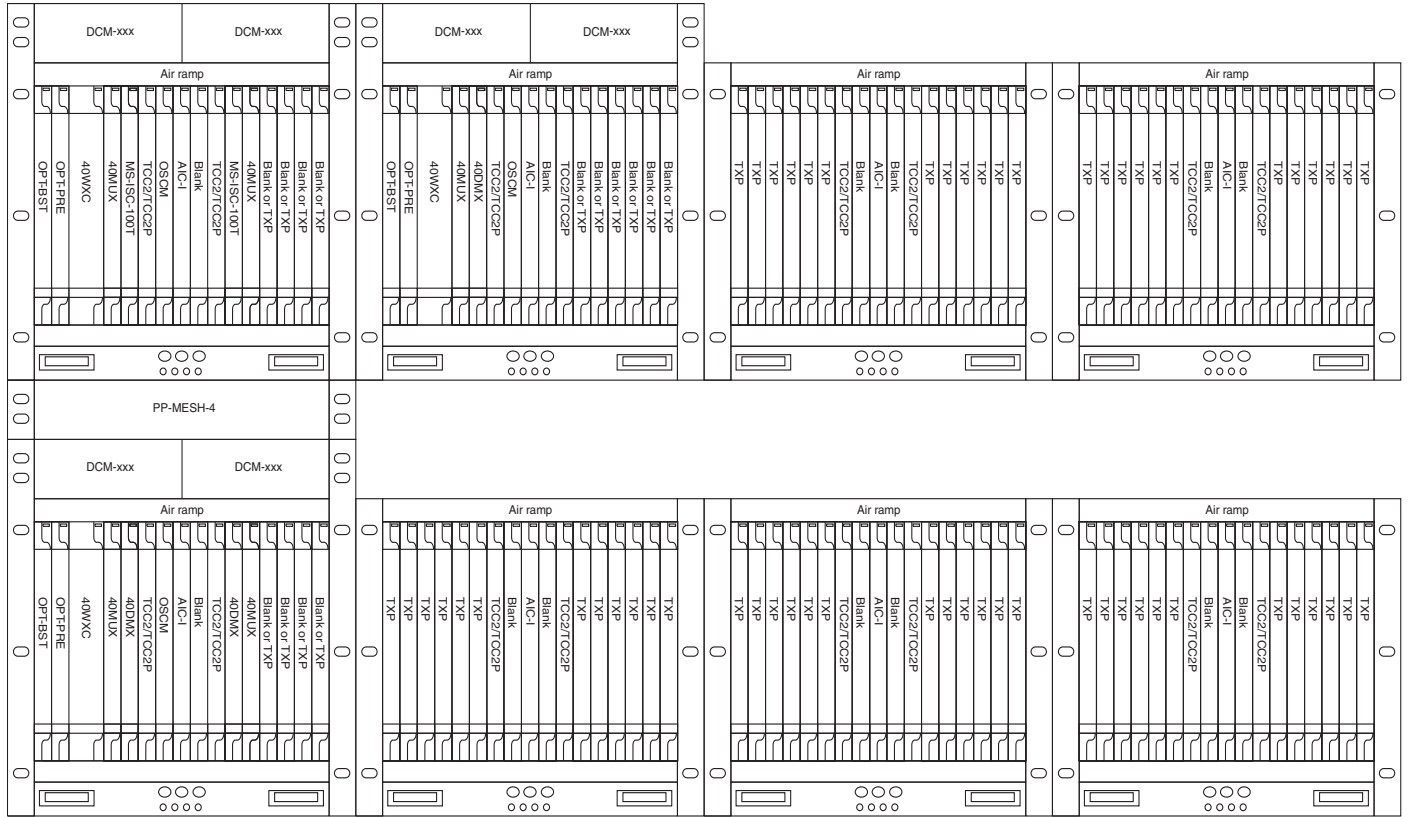

The following figures show different mesh configurations at the shelf level. Figure 9-30 shows a basic four-degree mesh node layout based on the shelf configuration shown in .

Figure 9-30   *Four-Degree Line Termination Mesh Node Layout*
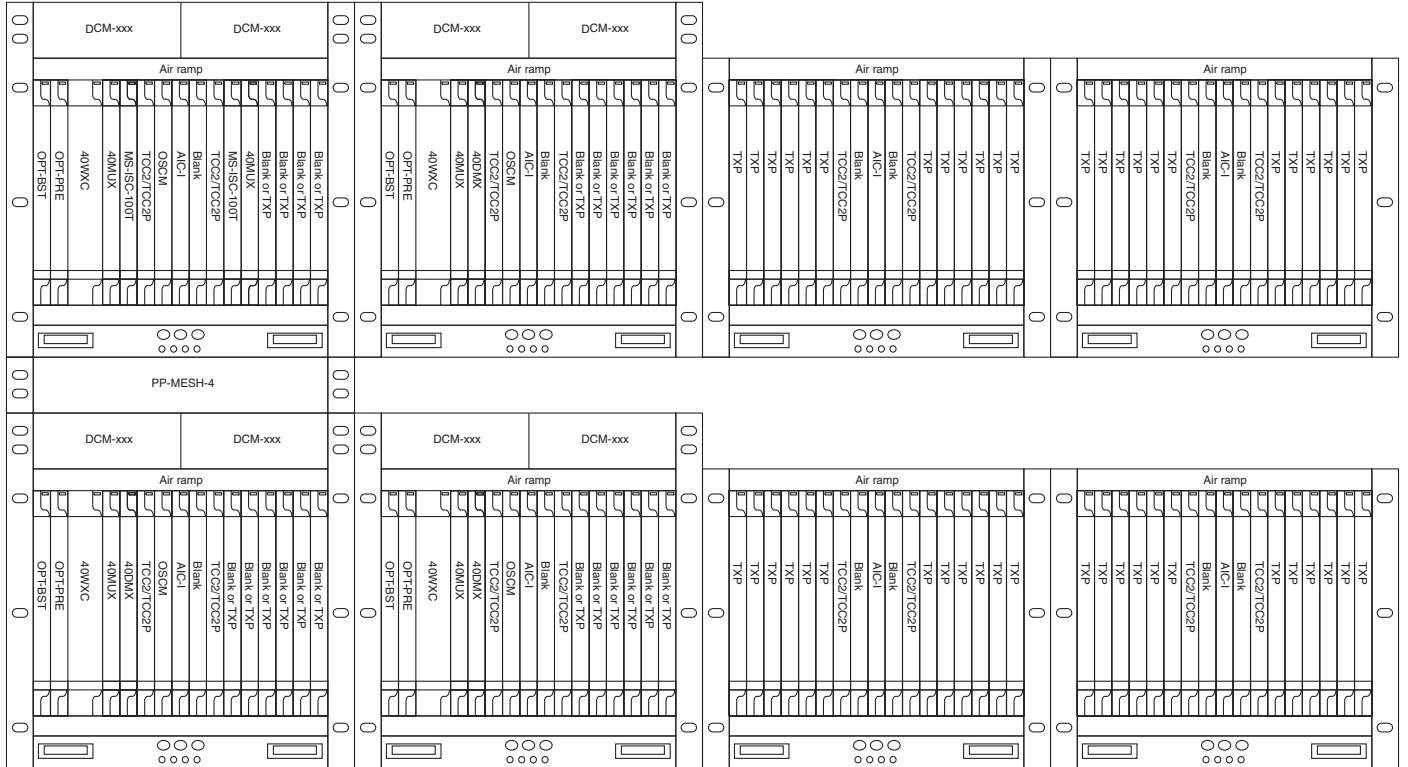
Figure 9-31 shows a protected four-degree mesh node layout based on the shelf configuration shown in Figure 9-22 on page 9-31.

Figure 9-31 **Four-Degree Protected Line Termination Mesh Node Layout**
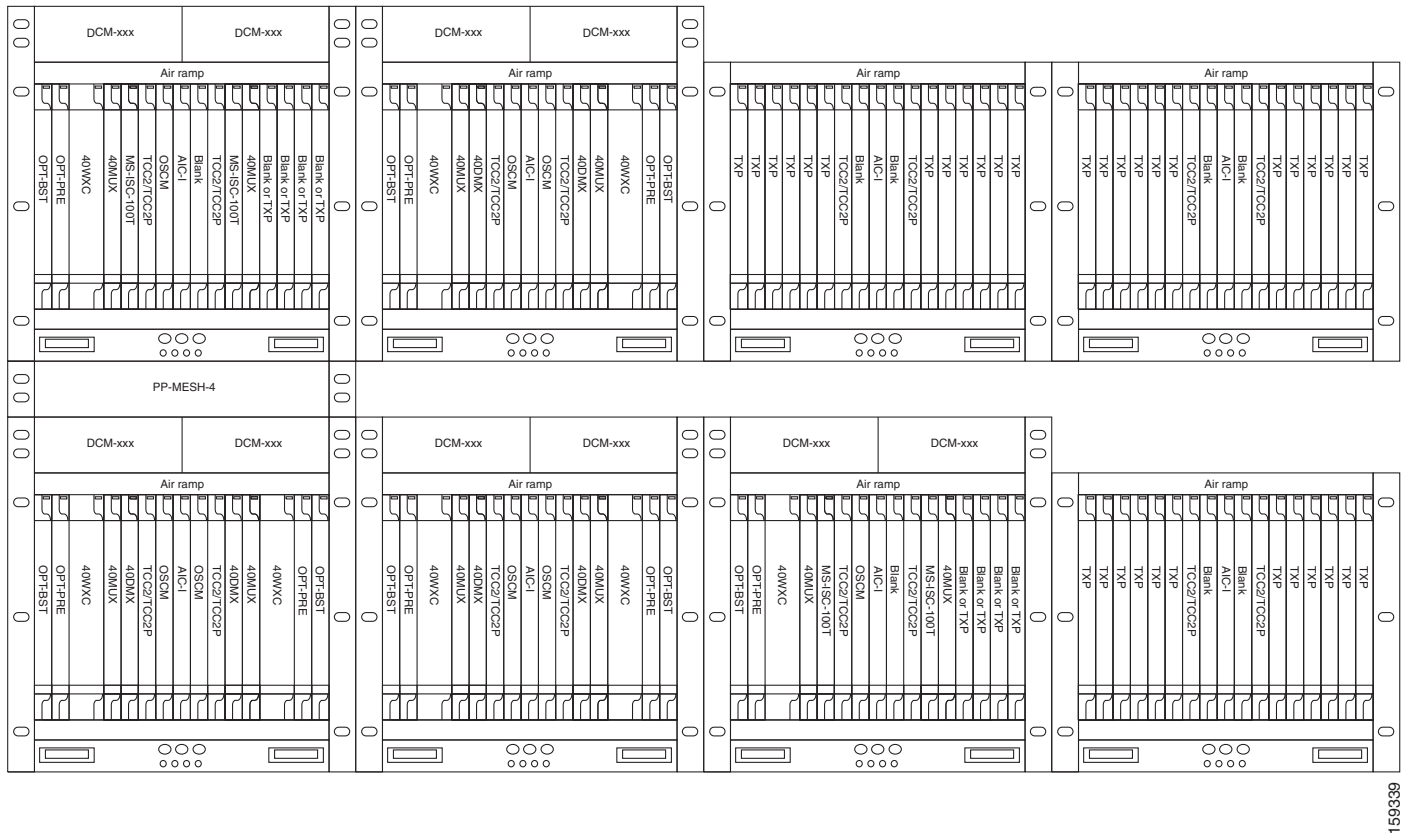
9.5 DWDM Node Cabling

DWDM node cabling is specified by the Cisco MetroPlanner 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 MetroPlanner Internal Connections table for your site.

9.5.1 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 9-32 shows an example of OSC fibering for a hub node with OSCM cards installed.

Figure 9-32 *Fibering OSC Terminations—Hub Node with OSCM Cards*
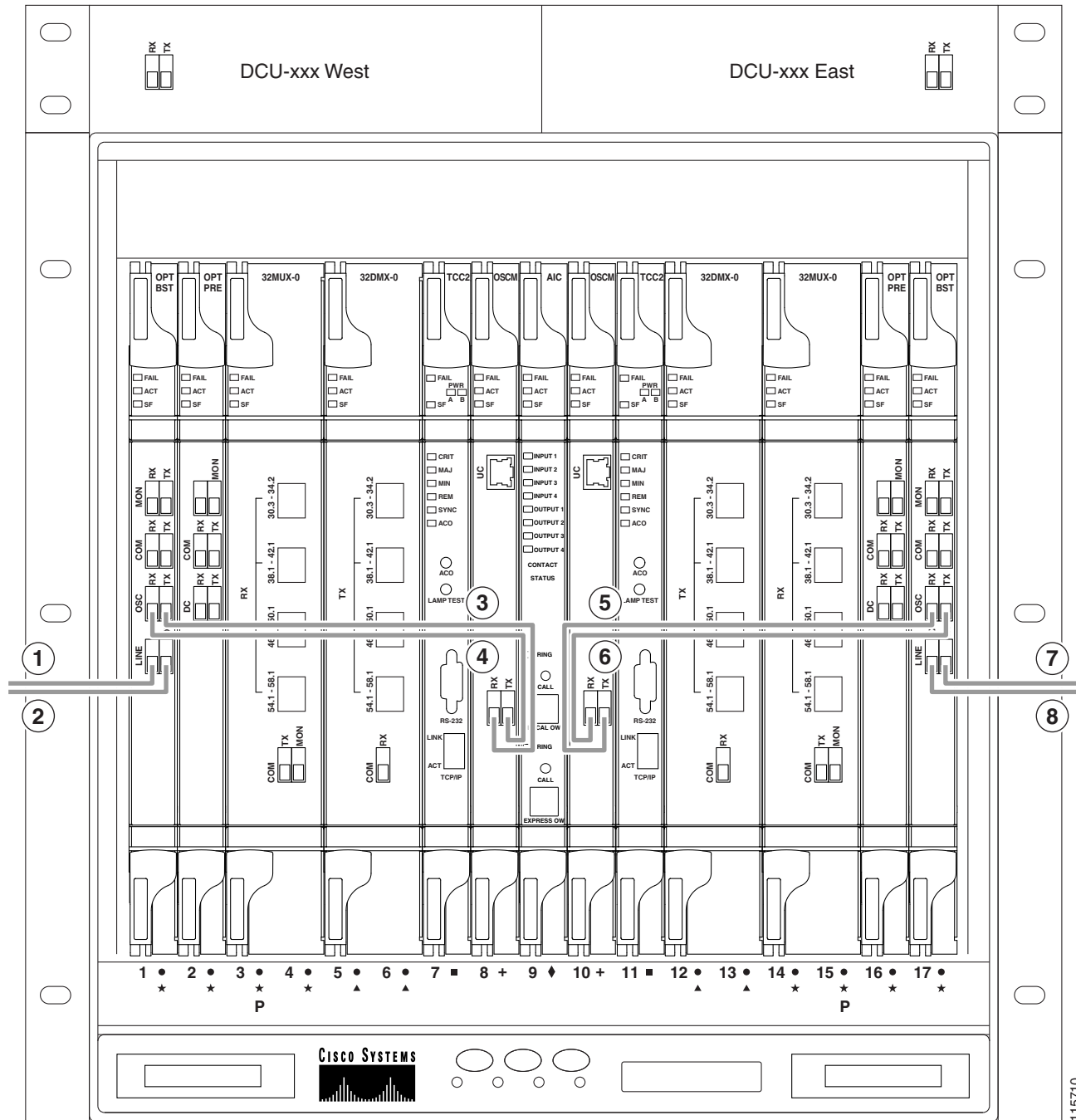
1	Side A OPT-BST LINE RX to Side B OPT-BST or OSC-CSM LINE TX on adjacent node	**5**	Side B OSCM TX to Side B OPT-BST OSC RX

| 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

9.5.2 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 COM RX port.

- The Side A OPT-PRE COM TX port is connected to the Side A 32DMX-O/40-DMX-C 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 9-33 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 9-33   *Fibering a Hub Node*
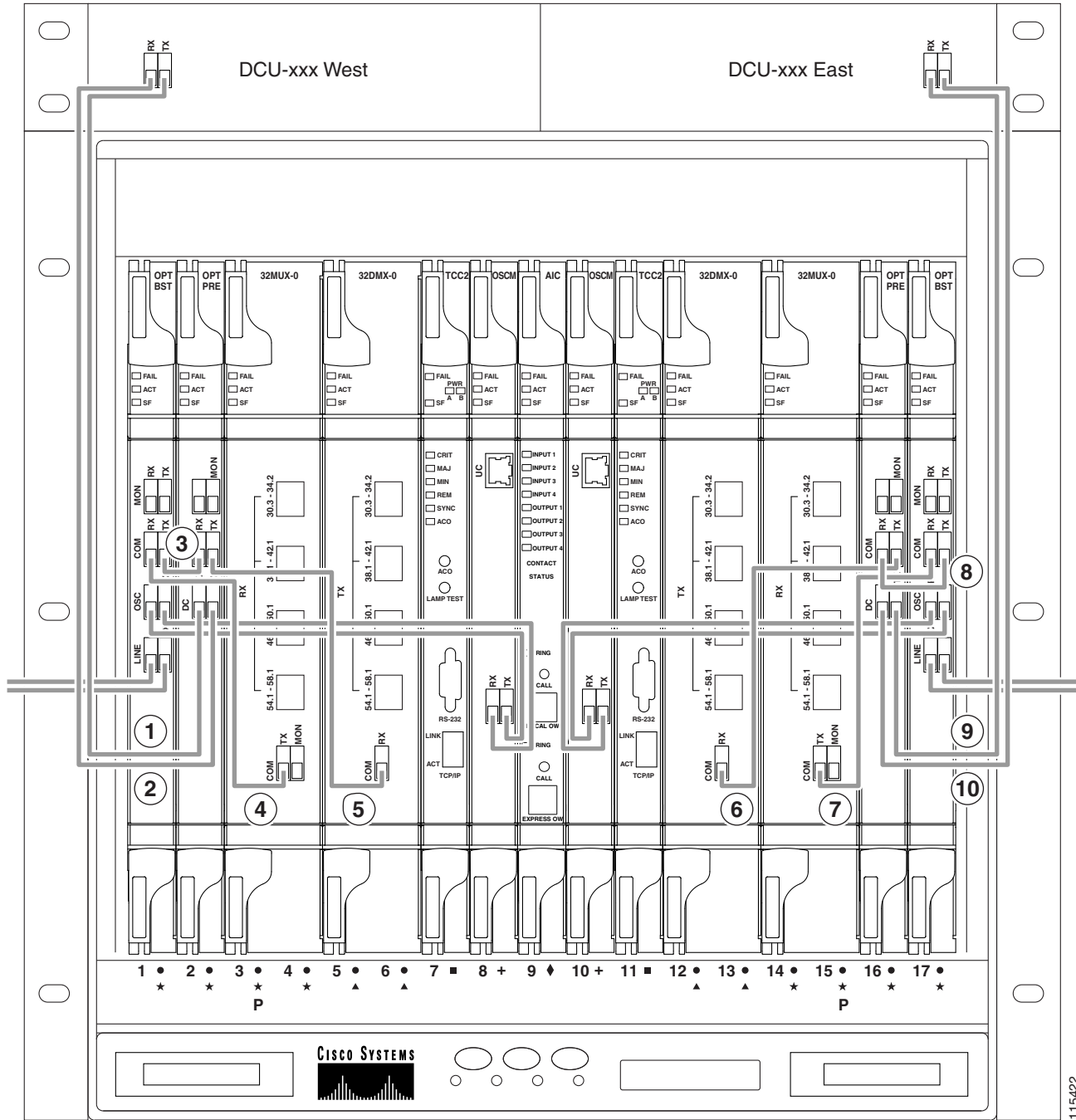
1	Side A DCU TX to Side A OPT-PRE DC RX[1]	6	Side B 32DMX-O COM RX to Side B OPT-PRE COM TX
2	Side A DCU RX to Side A OPT-PRE DC TX[1]	7	Side B 32MUX-O COM TX to Side B OPT-BST COM RX

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.

9.5.3 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 COM RX port.
- The terminal side OPT-PRE COM TX port is connected to the terminal side 32DMX-O/40-DMX-C 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.

9.5.4 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 an 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 9-34 shows an example of a line amplifier node with cabling.

Figure 9-34 **Fibering a Line Amplifier Node**
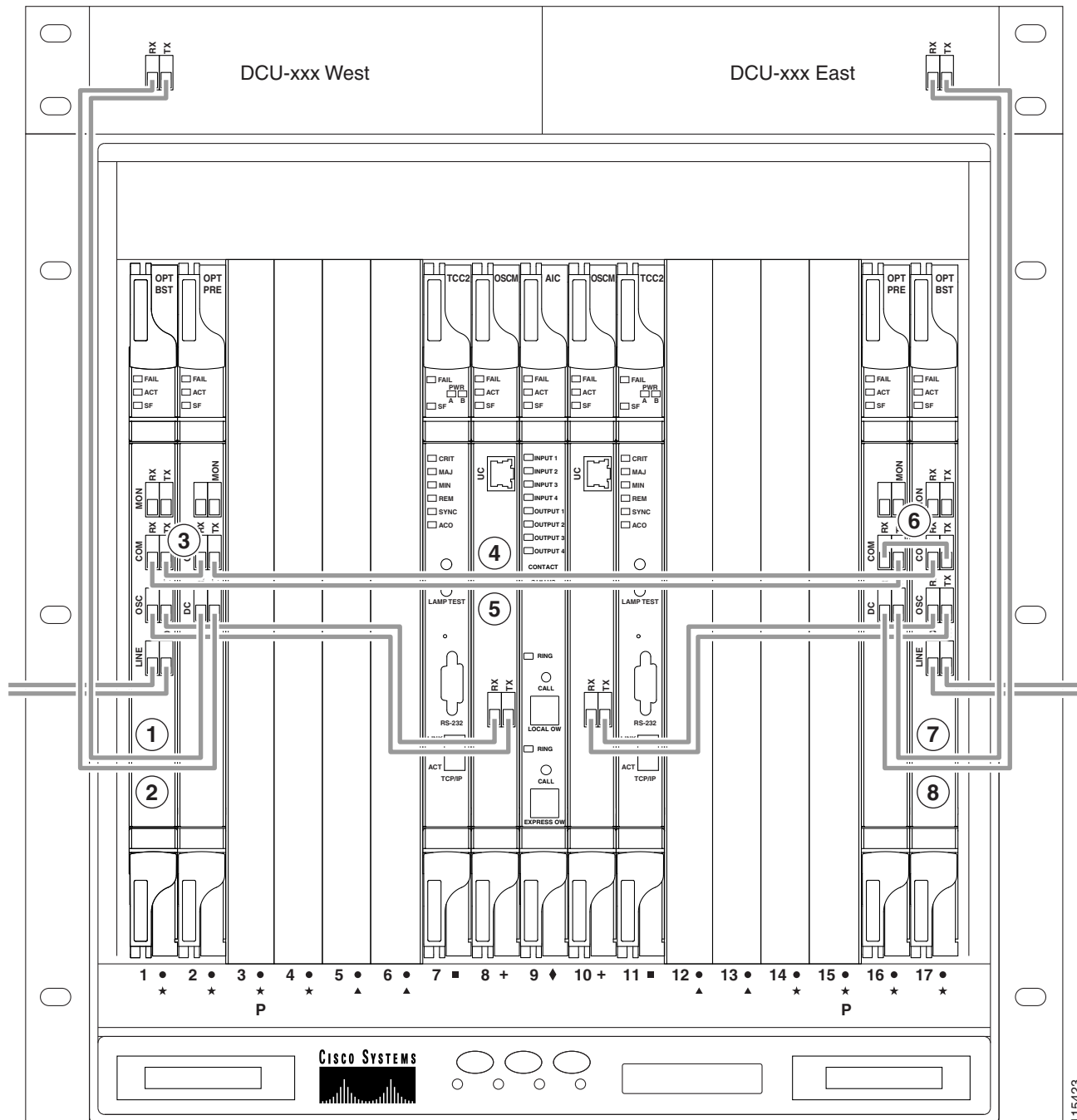
|			
1	Side A DCU TX to Side A OPT-PRE DC RX[1]	**5**	Side A OPT-BST COM RX to Side B OPT-PRE COM TX
2	Side A DCU RX to Side A OPT-PRE DC TX[1]	**6**	Side A OPT-BST COM RX to Side B OPT-PRE COM TX
3	Side A OPT-BST COM TX to Side A OPT-PRE COM RX	**7**	Side B DCU TX to Side B OPT-PRE DC RX[1]
4	Side A 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.

9.5.5 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 9-35 shows an example of an OSC regeneration node with cabling.

Figure 9-35   Fibering an OSC Regeneration Node
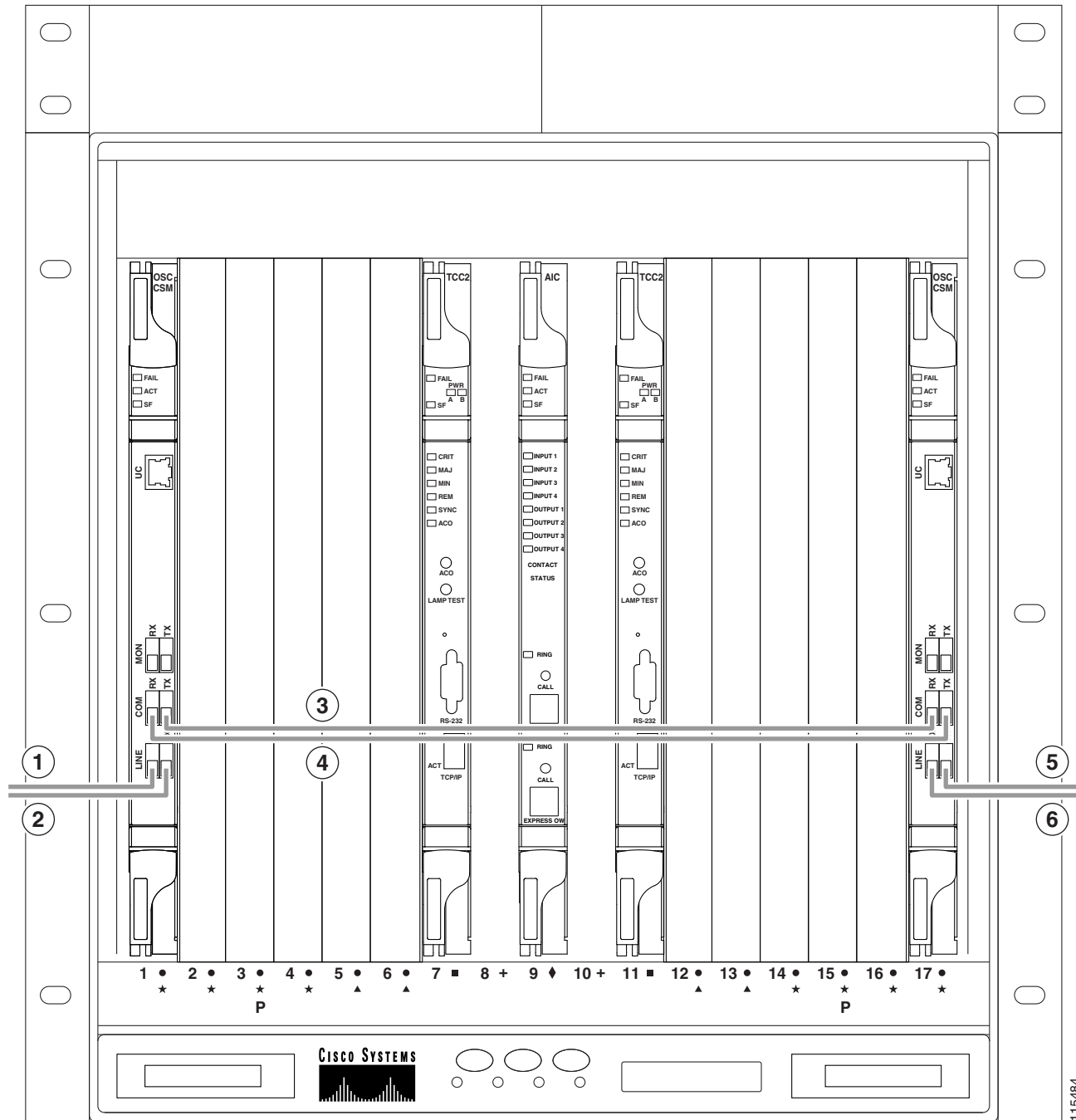
1	Side A OSC-CSM LINE RX to Side B OSC-CSM or OPT-BST LINE TX on adjacent node	4	Side A OSC-CSM COM RX to Side B OSC-CSM COM TX
2	Side A OSC-CSM LINE TX to Side B OSC-CSM or OPT-BST LINE RX on adjacent node	5	Side B OSC-CSM LINE RX to Side A OSC-CSM or OPT-BST LINE TX on adjacent node
3	Side A OSC-CSM 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

9.5.6 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 MetroPlanner 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 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 an 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 9-36 shows an example of an amplified OADM node with AD-1C-xx.x cards installed.

Note Figure 9-36 is an example. Always install fiber-optic cables based on the Cisco MetroPlanner Internal Connections table for your site.

Figure 9-36 **Fibering an Amplified OADM Node**
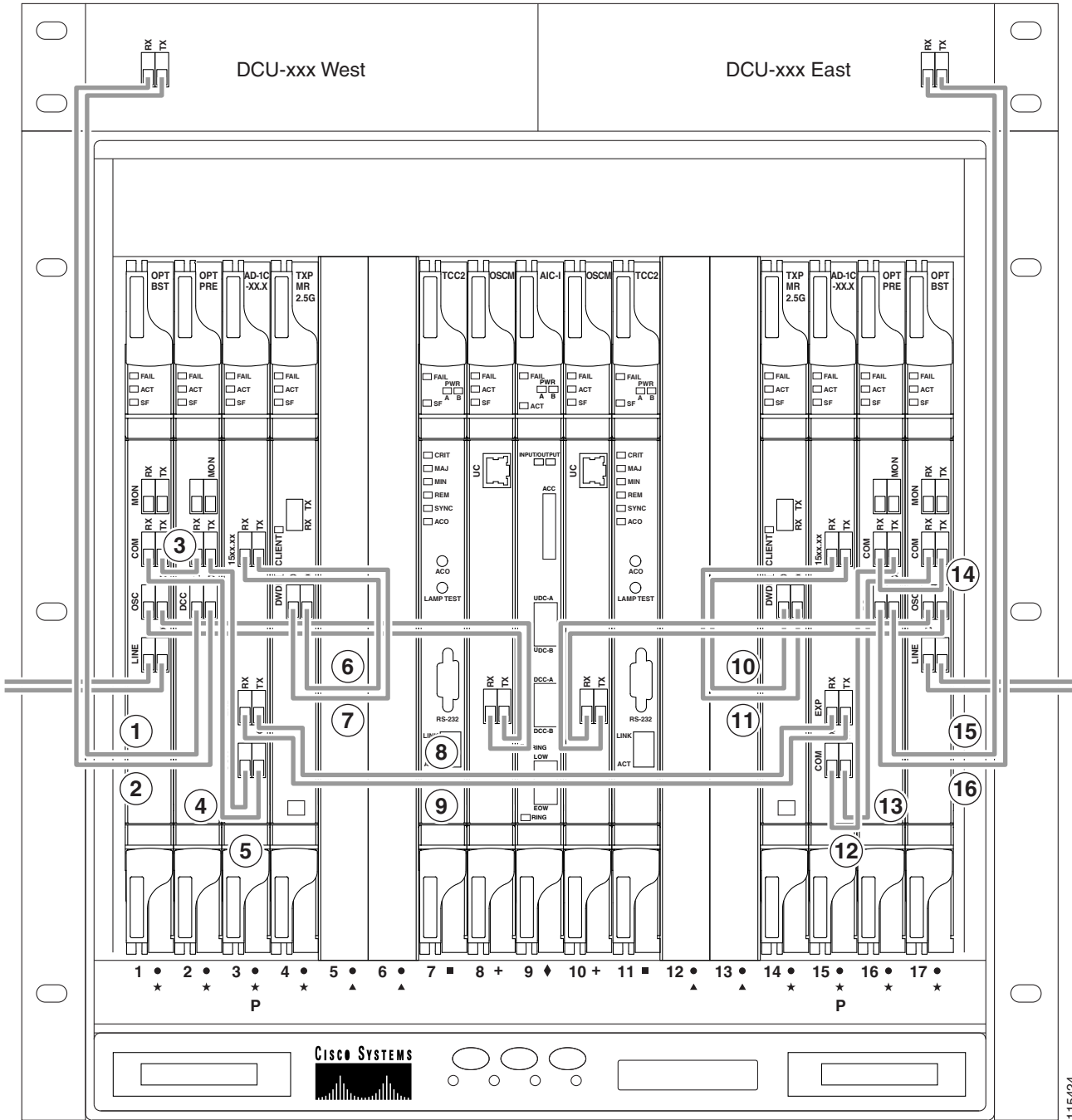
1	Side A DCU TX to Side A OPT-PRE DC RX[1]	**9**	Side A AD-1C-xx.x EXP RX to Side B AD-1C-xx.x EXP TX
2	Side A DCU RX to Side A OPT-PRE DC TX[1]	**10**	Side B TXP_MR_2.5G DWDM RX to Side B AD-1C-xx.x (15xx.xx) TX
3	Side A OPT-BST COM TX to Side A OPT-PRE COM RX	**11**	Side B TXP_MR_2.5G DWDM TX to Side 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 9-37 shows an example of a passive OADM node with two AD-1C-xx.x cards installed.

Figure 9-37   Fibering a Passive OADM Node
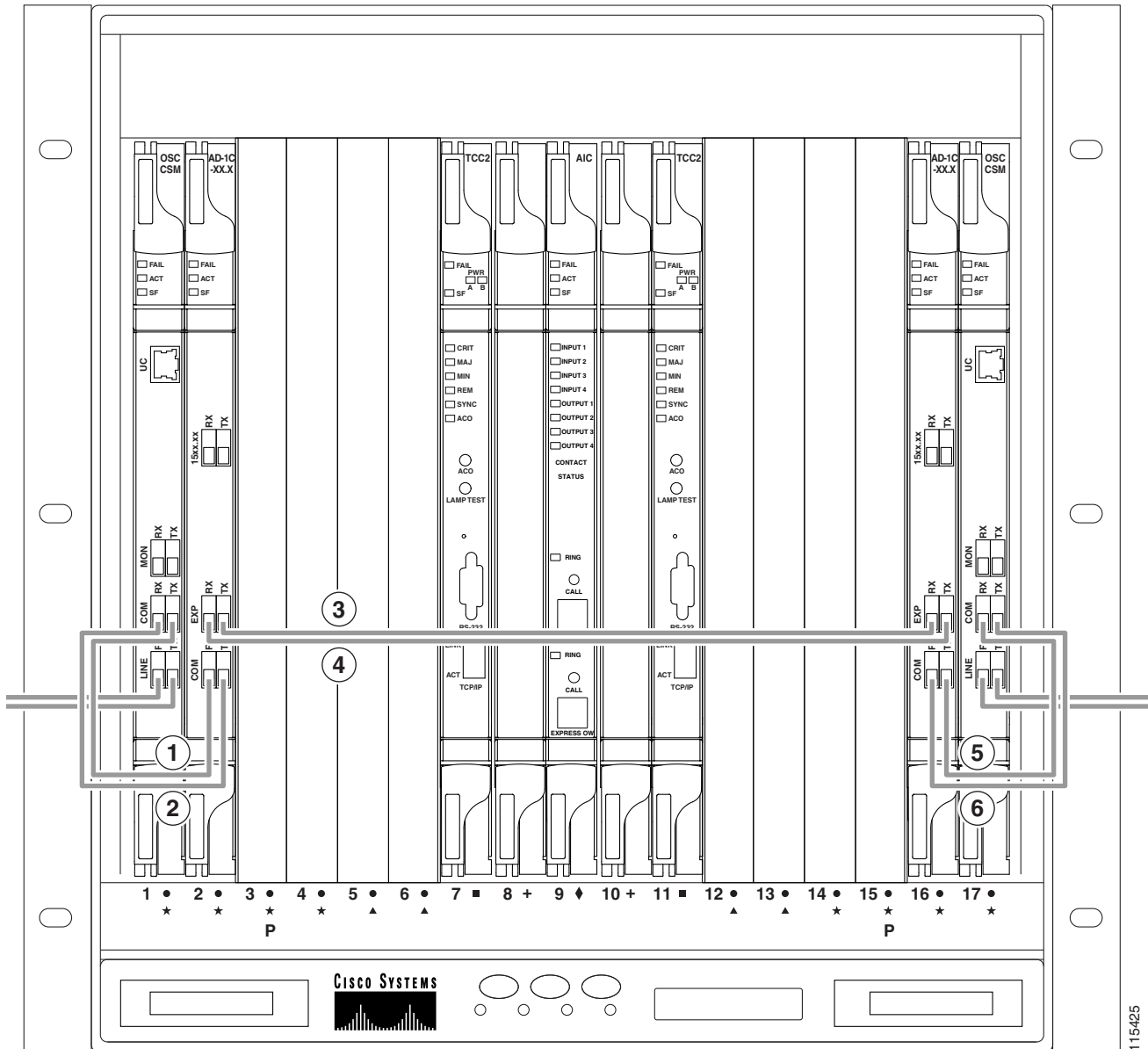
1	Side A OSC-CSM COM TX to Side A AD-1C-xx.x COM RX	**4**	Side A OSC-CSM EXP RX to Side B AD-1C-xx.x EXP TX
2	Side A OSC-CSM COM RX to Side A AD-1C-xx.x COM TX	**5**	Side B AD-1C-xx.x COM TX to Side B OSC-CSM COM RX
3	Side A OSC-CSM EXP TX to Side B AD-1C-xx.x EXP RX	**6**	Side B AD-1C-xx.x COM RX to Side B OSC-CSM COM TX

9.5.7 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 DROP TX port is connected to the Side A 40-DMX-C 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 DROP TX port is connected to the Side B 40-DMX-C COM RX port.

Figure 9-38 shows an example of an amplified ROADM node with cabling.

Note Figure 9-38 is an example. Always install fiber-optic cables based on the Cisco MetroPlanner Internal Connections table for your site.

Figure 9-38 *Fibering a ROADM Node*
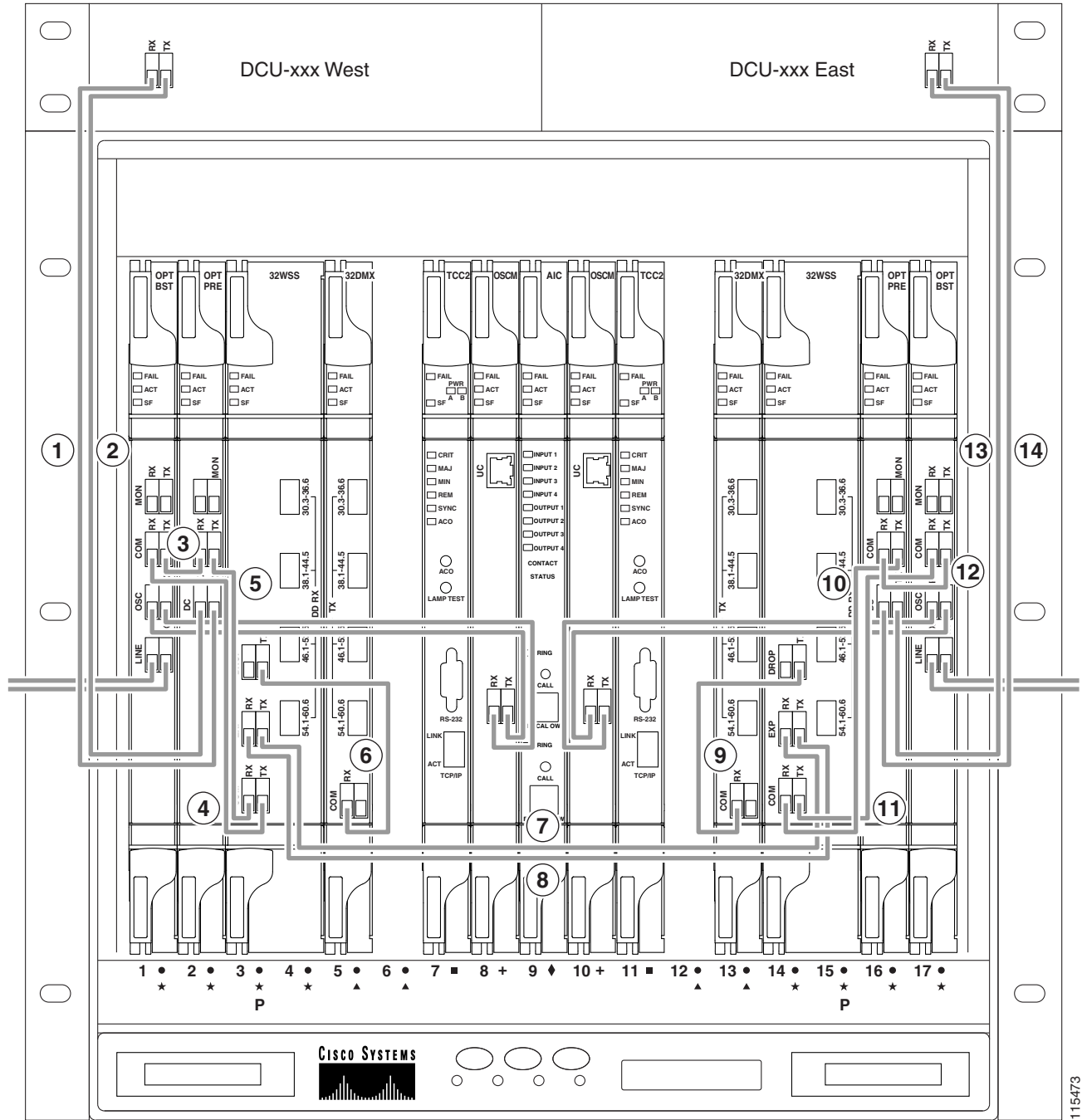
1	Side A DCU TX to Side A OPT-PRE DC RX[1]	**8**	Side A 32WSS EXP RX to Side B 32WSS EXP TX
2	Side A DCU RX to Side A OPT-PRE DC TX[1]	**9**	Side B 32DMX COM RX to Side B 32WSS DROP TX
3	Side A OPT-BST COM TX to Side A OPT-PRE COM RX	**10**	Side B 32WSS COM RX to Side B OPT-PRE COM TX

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.

9.6 Automatic Node Setup

Automatic node setup (ANS) is a TCC2/TCC2P 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 from the input signal on the client interface and independent from 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-WXC-C add and pass through paths
- 32DMX-O card drop paths
- 32DMX, 40-DMX-C card input port
- 40-MUX-C card output port

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 channels 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

To allow you to modify ANS values based on your DWDM network requirements, provisioning parameters are divided into two contributions:

- Reference Contribution—(Display only) This value is set by ANS.
- Calibration Contribution—This value can be set by the user.

To complete the equalization, ANS requires the following information:

- The order in which DWDM cards are connected together on the express paths.
- The number of channels that are add or dropped.
- The number of channels and/or bands that are configured as passthrough.

ANS assumes that every DWDM port is associated to one on the node side. The port-to-side association is based on node layout deriving from provisioned (or automatically calculated) internal patchcords. From CTC or TL1 you can:

- Calculate the default connections on the NE.
- Retrieve the list of existing connections.
- Retrieve the list of free ports.
- Create new connections or modify existing ones.
- Launch ANS.

After you launch ANS, one of the following statuses is provided for each ANS parameter:

- 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 ports in an IS state.
- Not Applicable—The parameter setpoint does not apply to this node type.
- 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 not available.

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 that the new connection is feasible (according to internal connection rules) and returns a denied message if the user connection violates one of the rules. ANS requires the expected wavelength to be provisioned. When provisioning the expected wavelength, the following rules apply:

- The card name is generically characterized by the card family, 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 MetroPlanner calculates the ANS parameters based on the requirements for a planned network. Cisco MetroPlanner exports the parameters to an ASCII, NE Update file. The NE Update file can then

be imported by CTC to automatically provision the node for the network. All ANS parameters can be viewed and manually modified from the node view Provisioning > WDM-ANS > Provisioning tab, shown in Figure 9-39.

Figure 9-39 **WDM-ANS Provisioning**

The Provisioning > WDM-ANS > Provisioning tab presents the following information:

- Selector—Presents the ANS parameters in a tree view. 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. Clicking Rx > Amplifier displays the amplifier receive parameters only.

- Parameter—displays the parameter name.

- Value—Displays the parameter value. Values can be modified manually, although manual modification of ANS parameters is not recommended. If ANS could not calculate a parameter, "Unknown" is displayed in the Value column.

- Origin—Indicates how the parameter was calculated:
  - Default—The value is the default provided with the node.
  - Calculated—The value was calculated by Cisco MetroPlanner.

      – Provisioned—The value was manually provisioned.

- Note—Displays information for parameters that could not be calculated, that is, parameters with Unknown appearing in the Value column.

Table 9-11 shows the following information displayed for ANS parameters on the Provisioning > WDM-ANS > Provisioning tab.

- Side—The optical side, which can be A (Slots 1 through 6) or B (Slots 12 through 17) for DWDM nodes in non-mesh DWDM networks, or A, B, C, D, E, F, G, or H for nodes in DWDM mesh networks.

- Rx/Tx—Indicates whether the parameter is transmit or receive.

- Category—The parameter category as displayed in the ANS parameter tree.

- Min—Minimum value in decibels.

- Max—Maximum value in decibels.

- Def—Default value in decibels. Other defaults include MC (metro core), CG (control gain), U (unknown).

- Optical Type—Parameter optical type: T (Terminal), FC (flexible channel count terminal), O (OADM), H (hub), L (line amplifier), R (ROADM), or U (unknown).

Table 9-11 Provisioning > ANS-WDM > Provisioning Tab Parameters

Side	Rx/Tx	Category	Parameters	Min	Max	Def	Optical Types
i[1]	—	Network Type	Network Type	—	—	MC	U, T, FC, O, H, L, R
	Rx	Amplifier	Side i.Rx.Amplifier.Tilt	0	30	0	T, FC, O, H, L, R
			Side i.Rx.Amplifier.Gain	0	30	0	T, FC, O, H, L, R
			Side i.Rx.Amplifier.Ch Power	–10	17	2	T, FC, O, H, L, R
			Side i.Rx.Amplifier.Working Mode	—	—	CG	T, FC, O, H, L, R
		—	Side i.Rx.Max Expected Span Loss	0	60	60	T, FC, O, H, L, R
			Side i.Rx.Min Expected Span Loss	0	60	60	T, FC, O, H, L, R
		Power	Side i Rx.Power.Far End	–50	30	U	T, FC, O, H, L, R
			Side i Rx.Power.Add&Drop - Input Power	–50	30	14	T, FC, O, H, R
			Side i.Rx.Power.Add&Drop - Drop Power	–50	30	14	T, FC, O, H, R
			Side i.Rx.Power.Band n.Drop Power (where $n = 1$–8)	–50	30	14	FC, O
			Side i.Rx.Power.Channel n.Drop Power Side B (where $n = 1$–32[2] or 1–40[3])	–50	30	14	T, H, R
		Thresholds	Side i.Rx.Threshold.OSC LOS Threshold	–50	30	U	T, FC, O, H, L, R
			Side i.Rx.Threshold.Channel LOS Threshold	–50	30	U	T, FC, O, H, L, R
			Side i Rx Amplifier In Power Fail Th	–50	30		
	Tx	Amplifier	Side i.Tx.Amplifier.Tilt	0	30	0	T, FC, O, H, L, R
			Side i.Tx.Amplifier.Gain	0	30	0	T, FC, O, H, L, R
			Side i.Tx.Amplifier.Ch Power	–10	17	2	T, FC, O, H, L, R
			Side i.Tx.Amplifier.Working Mode	—	—	CG	T, FC, O, H, L, R
		Power	Side i.Tx.Power.Add&Drop - Output Power	–50	30	14	T, FC, O, H, R
			Side i.Tx.Power.Add&Drop - By-Pass Power	–50	30	14	H
		Threshold	Side i.Tx.Threshold.Fiber Stage Input Threshold	–50	30	U	

1. Where i = A, B, C, D, E, F, G, H

2. If 32-channel cards are installed

3. If 40-channel cards are installed