Node Reference

This chapter explains the ONS 15454 dense wavelength division multiplexing (DWDM) node types that are available for the ONS 15454. The DWDM node type is determined by the type of amplifier and filter cards that are installed in an ONS 15454. The chapter also explains the DWDM automatic power control (APC), reconfigurable optical add/drop multiplexing (ROADM) power equalization, span loss verification, and automatic node setup (ANS) functions.

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

Note In this chapter, "OPT-BST" refers to the OPT-BST, OPT-BST-E, OPT-BST-L cards, and to the OPT-AMP-L and OPT-AMP-17-C cards when they are provisioned in OPT-LINE (optical booster) mode. "OPT-PRE" refers to the OPT-PRE card and to the OPT-AMP-L and OPT-AMP-17-C cards provisioned in OPT-PRE (preamplifier) mode.

Note In this chapter, "RAMAN-CTP" refers to the 15454-M-RAMAN-CTP card. "RAMAN-COP" refers to the 15454-M-RAMAN-COP card.

Note In this chapter, the "NFV view" refers to the "DWDM Network Functional View (NFV)". The "GMPLS view" refers to the "DWDM Network Functional View (GMPLS)".

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 Transport Planner tool creates a plan for amplifier placement and proper node equipment.
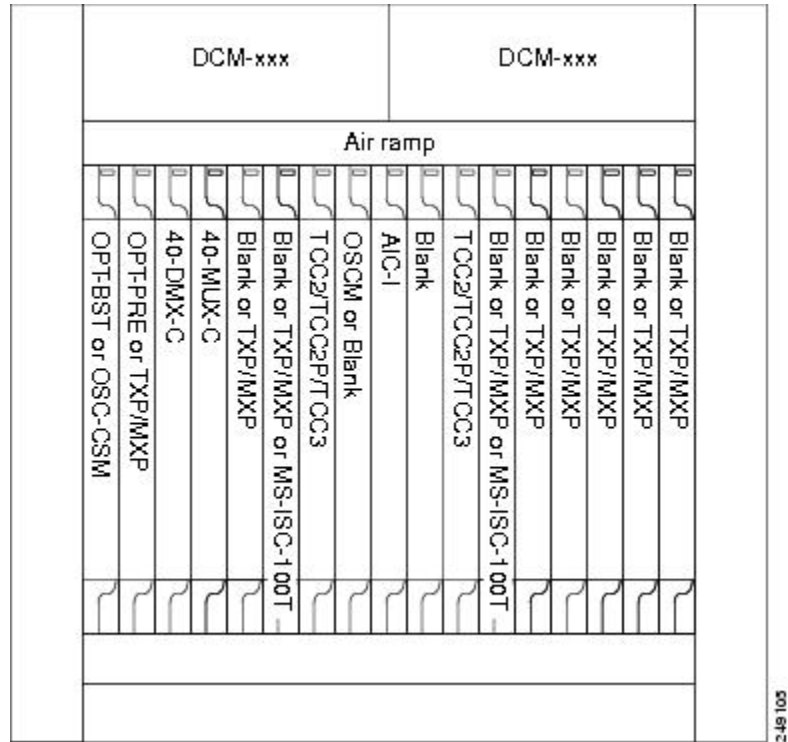
Note To support multiple optical sides in mesh DWDM networks, east and west are no longer used to reference the left and right sides of the ONS 15454 shelf. If a network running a previous software release is upgraded to this release, west will be mapped to A and east to B. In two-sided nodes, such as 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, on page 79

Terminal Node

A terminal node is a single node equipped with two control cards and one of the following combinations:

- One 32MUX-O card and one 32DMX-O card

- One 32WSS card and either a 32DMX or a 32DMX-O card

- One 40-WSS-C or 40-WSS-CE card and one 40-DMX-C or 40-DMX-CE card

- One 40-MUX-C and one 40-DMX-C or 40-DMX-CE card

- One 80-WXC-C card, one 15216-MD-40-ODD, 15216-EF-40-ODD, or 15216-MD-48-ODD patch panel, and one 15216-MD-40-EVEN, 15216-EF-40-EVEN, or 15216-MD-48-EVEN (15216 40 or 48-channel mux/demux patch panel), and 15216-MD-ID-50 or 15216-MD-48-CM

- 16-WXC-FS, MF-MPO-8LC, MF-4x4-COFS, MF-16AD-CFS, MF-DEG-5, MF-UPG-4, OPT-EDFA-xx, RAMAN-CTP (optional), RAMAN-COP, EDRA2-yy

• One 40-SMR1-C and one 15216-MD-40-ODD, 15216-EF-40-ODD, or 15216-MD-48-ODD patch panel

• One 40-SMR2-C and one 15216-MD-40-ODD, 15216-EF-40-ODD, or 15216-MD-48-ODD patch panel

✎

Note Although it is recommended that you use the 15216-MD-40-ODD, 15216-EF-40-ODD, or 15216-MD-48-ODD patch panel along with the 40-SMR1-C and 40-SMR2-C cards, you can alternatively use the 40-MUX-C and 40-DMX-C cards instead of the 15216-EF-40-ODD, or 15216-MD-48-ODD patch panel.

Cards in the terminal nodes can be installed in Slots 1 through 6 or Slots 12 through 17. The side where cards are installed is always assigned as Side A.

The following figure shows an example of a terminal configuration with a 32MUX-O card installed. The channel flow for a terminal node is the same as the hub node.

Figure 1: Terminal Node Configuration With 32MUX-O Cards Installed

The following figure shows an example of a terminal configuration with a 40-WSS-C card installed.

Figure 2: Terminal Node Configuration with 40-WSS-C Cards Installed

The following figure shows an example of a terminal configuration with a 40-MUX-C card installed.

Figure 3: Terminal Node with 40-MUX-C Cards Installed

The following figure shows an example of a terminal configuration with a 40-SMR1-C card installed.
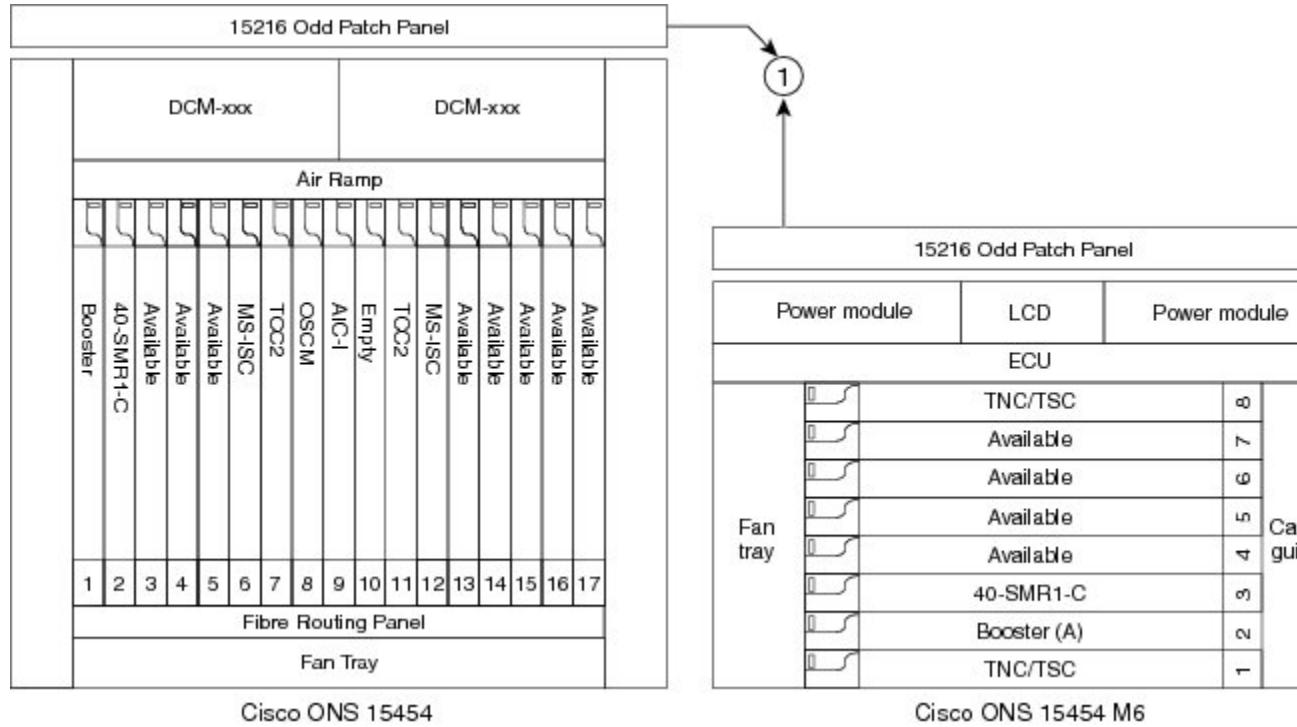
Figure 4: Terminal Node with 40-SMR1-C Card Installed
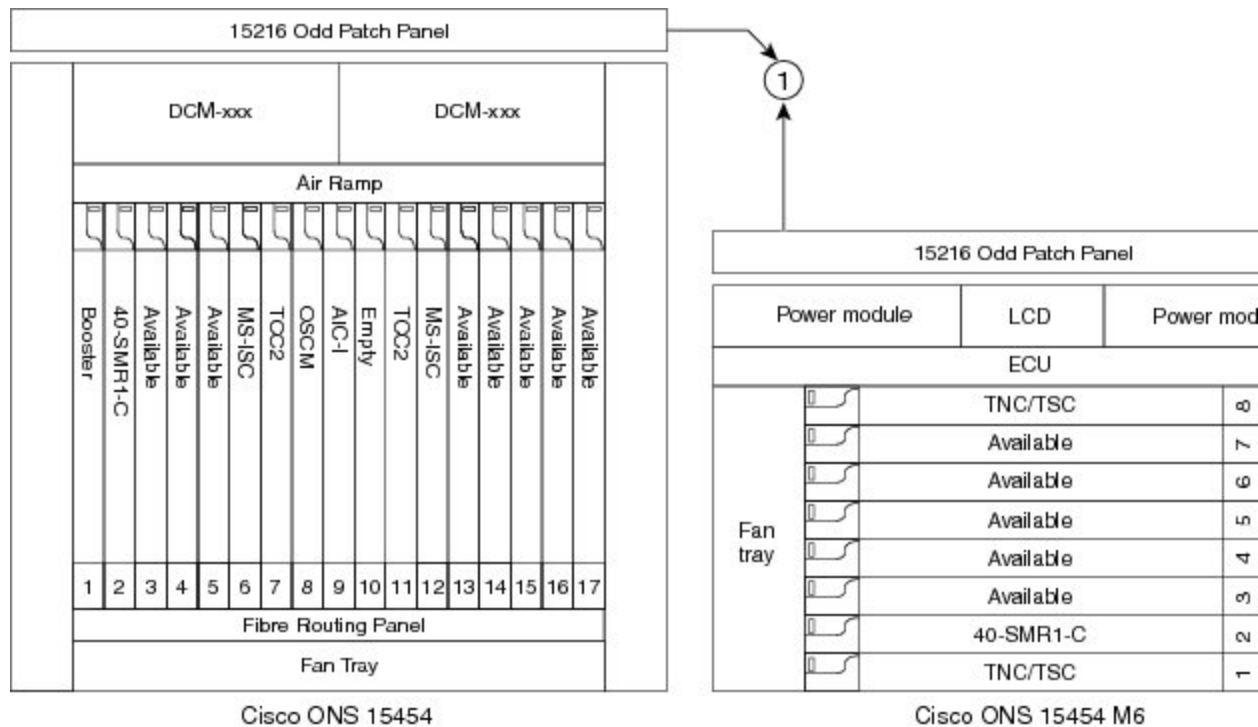
1	15216-MD-40-ODD, 15216-EF-40-ODD, or 15216-MD-48-ODD patch panel

The following figure shows an example of a terminal configuration with 40-SMR1-C and booster amplifier cards installed.

*Figure 5: Terminal Node with 40-SMR1-C and Booster Amplifier Cards Installed*

1	15216-MD-40-ODD, 15216-EF-40-ODD, or 15216-MD-48-ODD patch panel

Note When you use the 40-SMR1-C card along with a booster amplifier, the OSCM card must be connected to the booster amplifier.

The following figure shows an example of a terminal configuration with a 40-SMR2-C card installed.
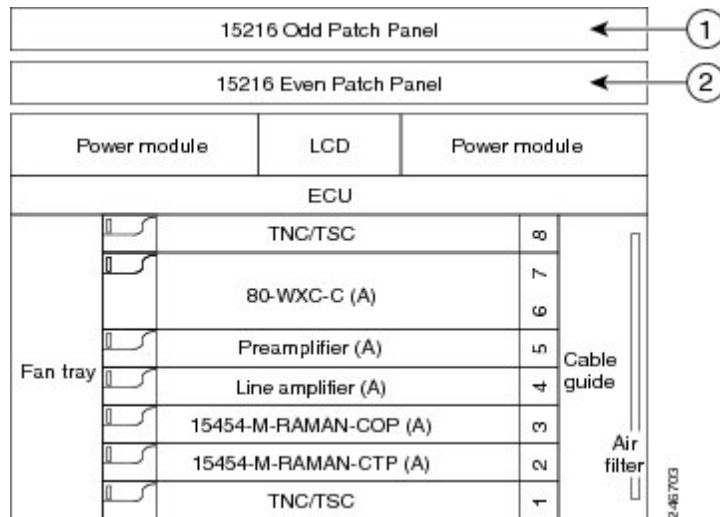
Figure 6: Terminal Node with 40-SMR2-C Card Installed
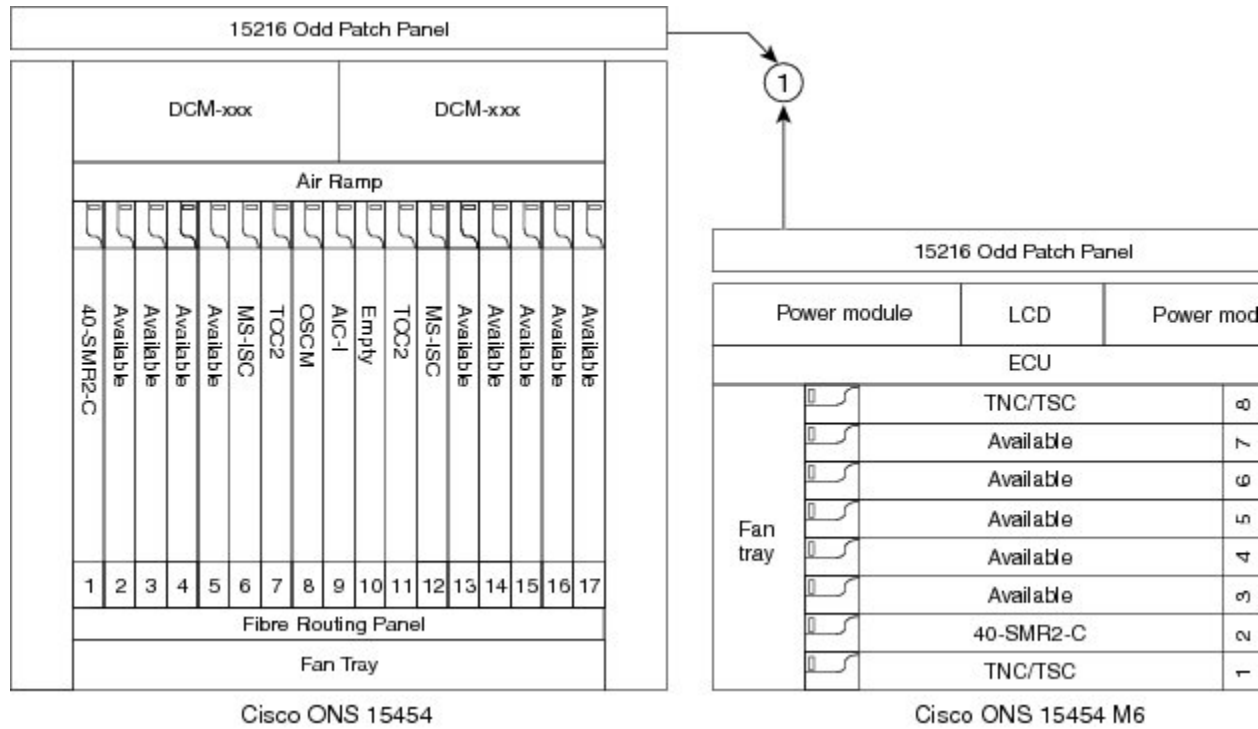
1	15216-MD-40-ODD, 15216-EF-40-ODD, or 15216-MD-48-ODD patch panel

The following figure shows an example of a 80-channel terminal configuration with RAMAN-CTP and RAMAN-COP cards installed.

Figure 7: 80-Channel Terminal Node with RAMAN-CTP and RAMAN-COP Cards Installed

1	15216-MD-40-ODD, 15216-EF-40-ODD, or 15216-MD-48-ODD patch panel

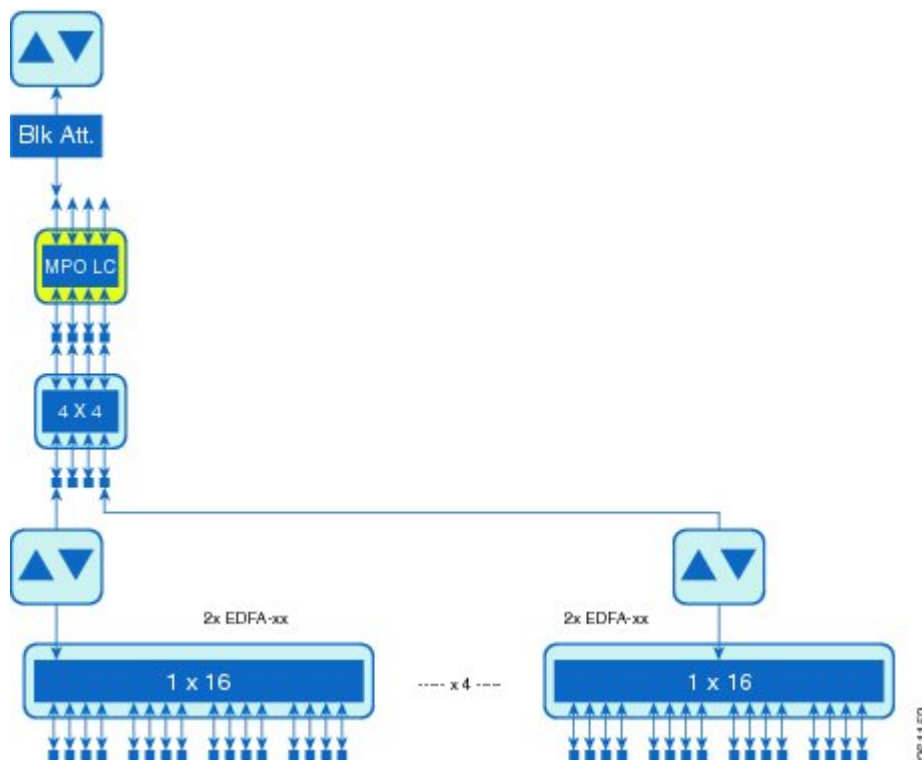| 2	15216-MD-40-EVEN, 15216-EF-40-EVEN, or 15216-MD-48-EVEN patch panel

The following figure shows an example of a 16-channel terminal configuration with16-WXC-FS, amplifiers, MPO connector, and TXP cards.

Figure 8: Terminal Node with 16-WXC-FS Up to 16 Channels

1. Terminal Node with 16-WXC-FS Up to 16 Channels -Cisco ONS 15454 M6

The following figure shows an example of a 64-channel colorless terminal configuration with16-WXC-FS, amplifiers, MPO connector, 4x4-COFS, and 16AD-CFS. In the absence of power regulation in the ADD path, bulk attenuators are needed to fit with EDFA input power dynamic.

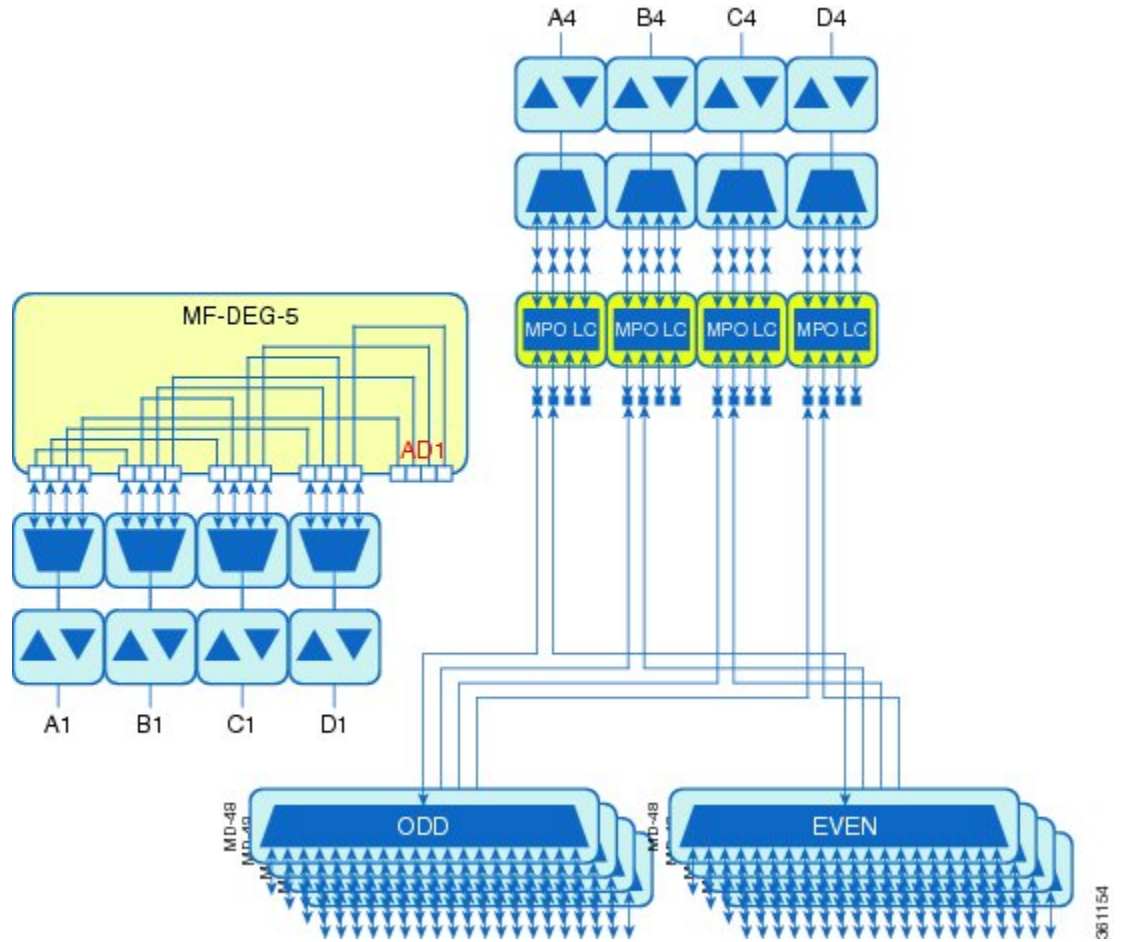*Figure 9: Terminal Node with 16-WXC-FS Up to 64 Channels*

The following figure shows an example of a 96-channel colorless omni-directional terminal configuration with16-WXC-FS, amplifiers, MPO connector, and 16AD-CFS.

Figure 10: Terminal Node with 16-WXC-FS Up to 96 Channels

1. Terminal Node with 16-WXC-FS Up to 96 Channels - Cisco ONS 15454 M6
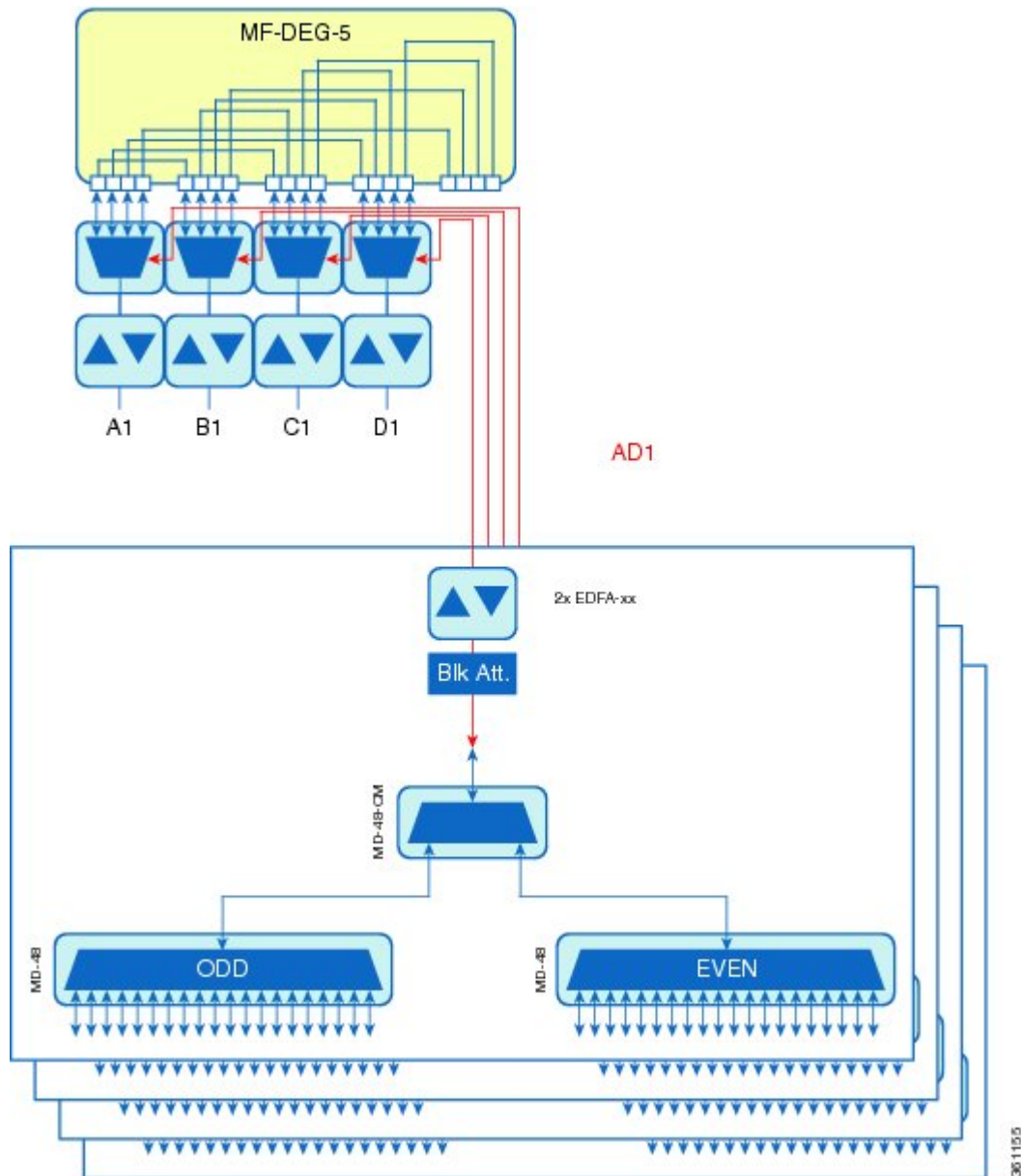
The following figure shows an example of a 4 degree or higher up to 48 or 96 channels with MD-48-Odd/Even. This configuration can also be used with 48 channels at 100GHz spacing deploying only one MD-48-Odd/Even.

Figure 11: Terminal Node with 16-WXC-FS Up to 48 or 96 Channels

The following figure shows an example of a 4 degree omnidirectional terminal node up to 96 channels with MD-48-Odd/Even and 4x4-COFS.

Figure 12: Terminal Node with 16-WXC-FS Up to 96 Channels

The following figure shows an example of a 4 degree colorless omnidirectional terminal node up to 52 channels with 4x4-COFS.

Figure 13: Terminal Node with 16-WXC-FS Up to 52 Channels

1. Terminal Node with 16-WXC-FS Up to 52 Channels - Cisco ONS 15454 M6

The following figure shows an example of a 4 degree colorless omnidirectional terminal node up to 128 channels with two independent add/drop stages.

**Figure 14: Terminal Node with 16-WXC-FS Up to 128 Channels**
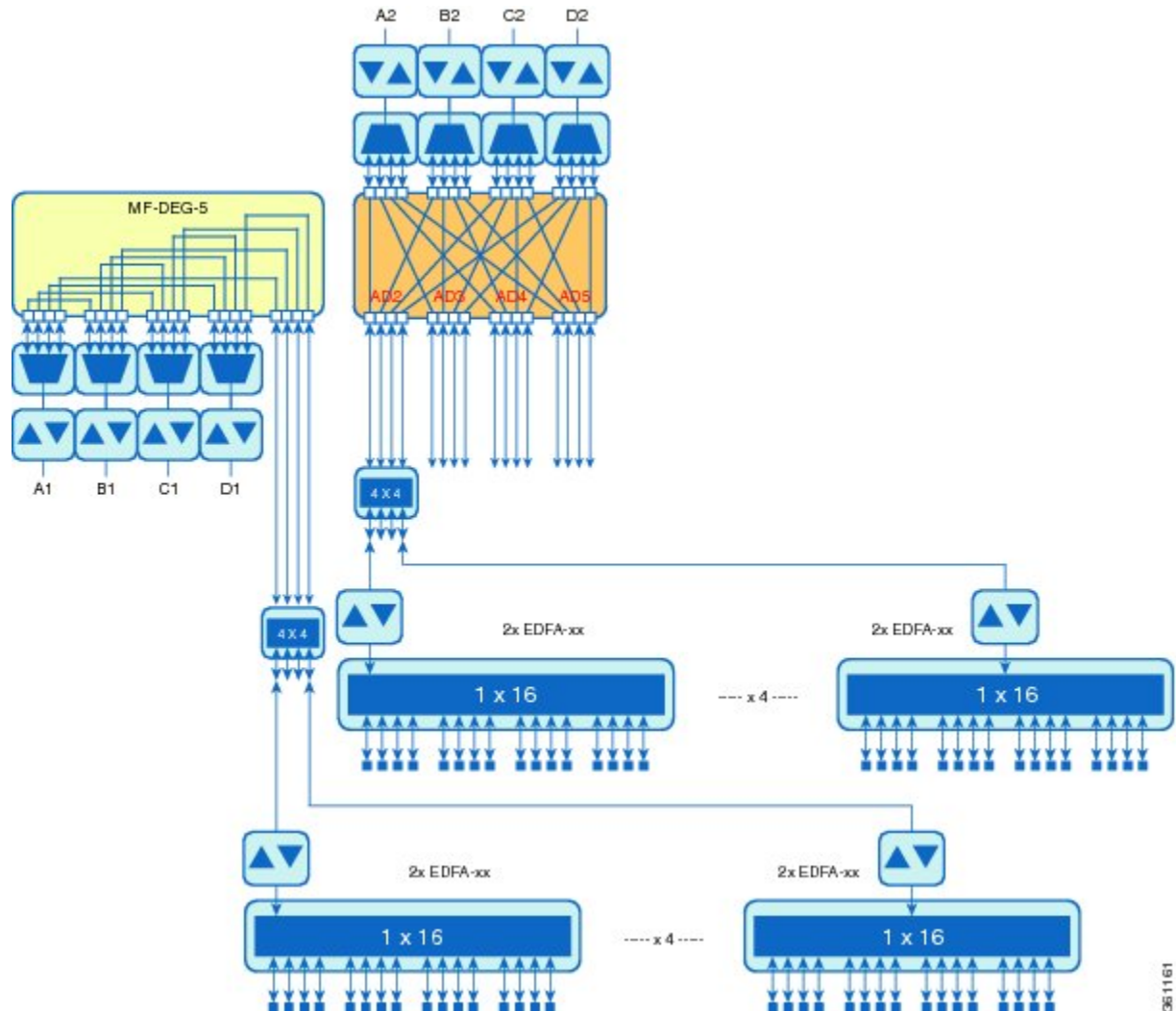
OADM Node

An OADM node is a single node equipped with cards installed on both sides and at least one AD-xC-xx.x (or FLD-4-xx.x) card or one AD-xB-xx.x card (plus their related 4MD-xx.x cards) and two control cards. This configuration supports 32 channels. In an OADM node, channels can be added or dropped independently from each direction and then passed through the reflected bands of all OADMs in the DWDM node (called express path). They can also be passed through one OADM card to another OADM card without using a TDM ITU-T line card (called optical pass-through) if an external patchcord is installed.

Unlike express path, an optical pass-through channel can be converted later to an add/drop channel in an altered ring without affecting another channel. OADM amplifier placement and required card placement is determined by the Cisco TransportPlanner tool or your site plan.

OADM nodes can be amplified or passive. In amplified OADMs, booster and preamplifier cards are installed on bode sides of the node. The following diagram 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 15: Amplified OADM Node Configuration Example
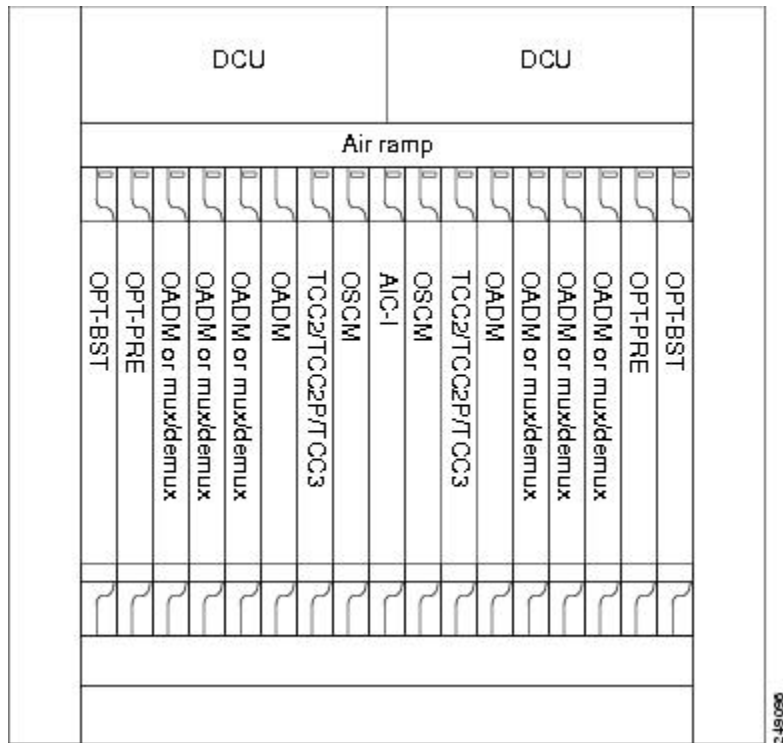
The following diagram shows an example of the channel flow on the amplified OADM node. Since the 32-wavelength plan is based on eight bands (each band contains four channels), optical adding and dropping can be performed at the band level and/or at the channel level (meaning individual channels can be dropped).

Figure 16: Amplified OADM Node Channel Flow Example
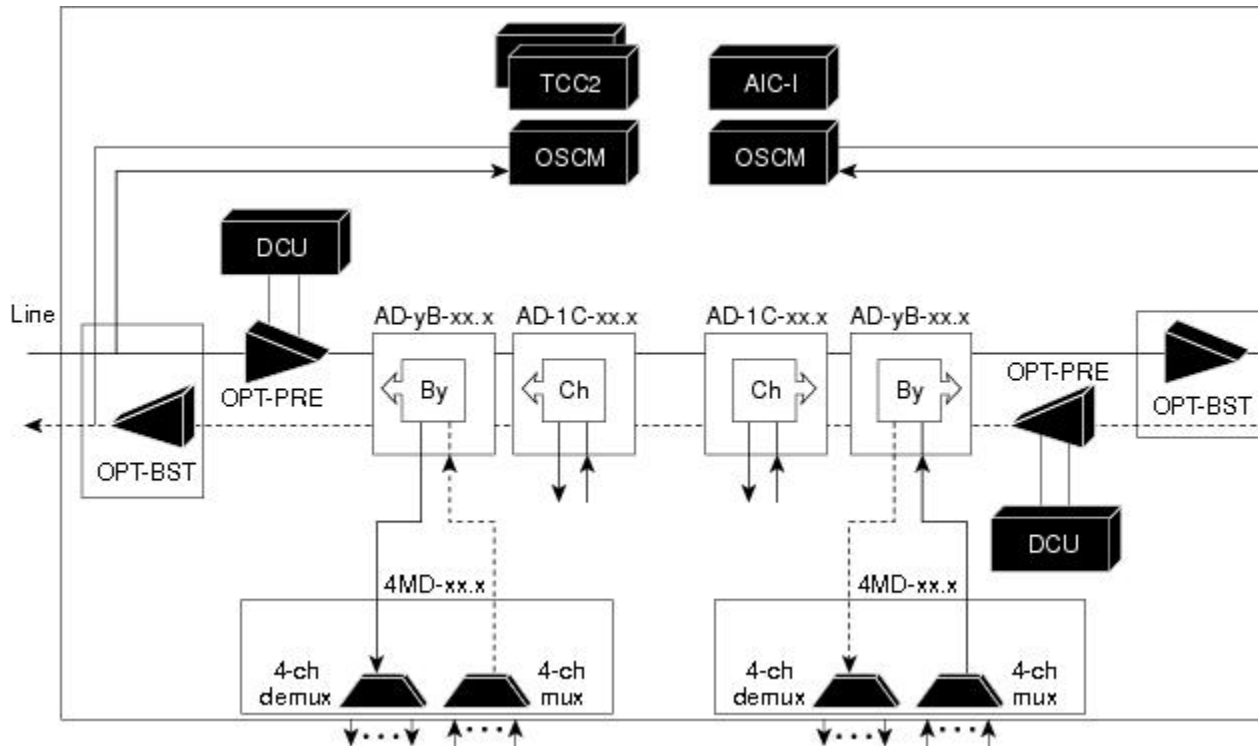
Specifying the number of circuits that are currently present on an amplifier that is receiving the power directly from the 15216-FLD-4 passive units (in case of an OADM node with FLD-4 cards and when an APC domain is in passive state) enables an accurate calculation of the power gain on the amplified port. This also ensures that the amplifier works effectively when the number of circuits is lesser than the actual circuits provisioned (where APC does not run in those domains.

To provision the number of active circuits, in CTC go to the card view, click > **Maintenance** > **Manual Gain Calc** tabs and enter the number of circuits currently active and then click **Apply**. Changing the value forces the system to recalculate the gain in order to obtain a more suitable output power.

You can manually provision the number of active circuits only if one of the following conditions are satisfied:

- The amplified port that belongs to the APC domain is in passive state (an APC domain involving the OADM with 15216-FLD-4 passive modules and the APC is disabled).

- The APC in the active domain where the APC is temporarily disabled by an alarm.

ROADM Node

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

- Two 32WSS cards and either, two 32DMX or 32DMX-O cards

- Two 40-WSS-C or 40-WSS-CE cards and either, two 40-DMX-C or 40-DMX-CE cards

- Two 40-SMR1-C cards and two 15216-MD-40-ODD, 15216-EF-40-ODD, or 15216-MD-48-ODD (ONS 15216 40 or 48-channel mux/demux) patch panels

- Two 40-SMR1-C cards, two line amplifiers (OPT-BST, OPT-BST-E, OPT-AMP-C, or OPT-AMP-17C cards), two OPT-RAMP-C or OPT-RAMP-CE cards, and two 15216-MD-40-ODD, 15216-EF-40-ODD, or 15216-MD-48-ODD patch panels

- Two 40-SMR2-C cards and two 15216-MD-40-ODD, 15216-EF-40-ODD, or 15216-MD-48-ODD patch panels

- Two 80-WXC-C cards and two 15216-MD-40-ODD, 15216-EF-40-ODD, 15216-MD-48-ODD, 15216-MD-40-EVEN, 15216-EF-40-EVEN, or 15216-MD-48-EVEN patch panels

Note Although it is recommended that you use the 15216-MD-40-ODD, 15216-EF-40-ODD, or 15216-MD-48-ODD patch panel along with the 40-SMR1-C and 40-SMR2-C cards, you can alternatively use the 40-MUX-C and 40-DMX-C cards instead of the 15216-MD-40-ODD, 15216-EF-40-ODD, or 15216-MD-48-ODD patch panel.

- 16-WXC-FS, MF-MPO-8LC, MF-4x4-COFS, MF-16AD-CFS, MF-DEG-5, MF-UPG-4, OPT-EDFA-xx, RAMAN-CTP (optional), RAMAN-COP, EDRA2-yy

Note Although not required, 32DMX-O can be used in a ROADM node. Cisco TransportPlanner automatically chooses the demultiplexer card that is best for the ROADM node based on the network requirements.

The following diagram shows an example of an amplified ROADM node configuration with 32DMX cards installed.

Figure 17: ROADM Node with 32DMX Cards Installed
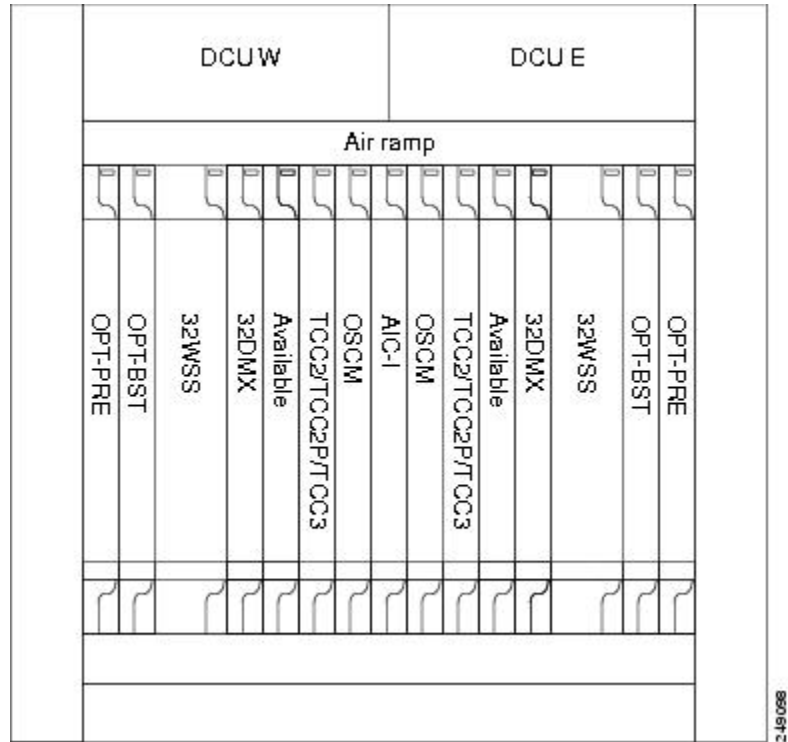
The following diagram shows an example of an amplified ROADM node configuration with 40-WSS-C cards installed.

Figure 18: ROADM Node with 40-WSS-C Cards Installed
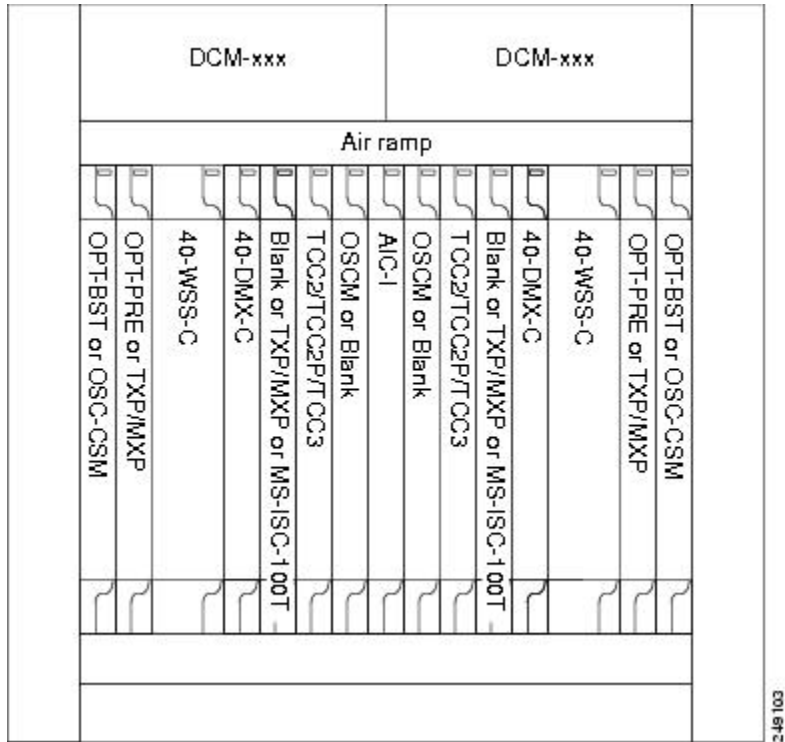
The following diagram shows an example of a ROADM node with 40-SMR1-C cards installed.

Figure 19: ROADM Node with 40-SMR1-C Cards Installed

| 1 | 15216-MD-40-ODD, 15216-EF-40-ODD, or 15216-MD-48-ODD patch panel |

The following diagram shows an example of a ROADM node with 40-SMR1-C and booster amplifier cards installed.

Figure 20: ROADM Node with 40-SMR1-C and Booster Amplifier Cards Installed

1	15216-MD-40-ODD, 15216-EF-40-ODD, or 15216-MD-48-ODD patch panel

Note When you use the 40-SMR1-C card along with a booster amplifier, the OSCM card must be connected to the booster amplifier.

The following diagram shows an example of a ROADM node with 40-SMR1-C and OPT-RAMP-C cards installed.

Figure 21: ROADM Node with 40-SMR1-C and OPT-RAMP-C Cards Installed
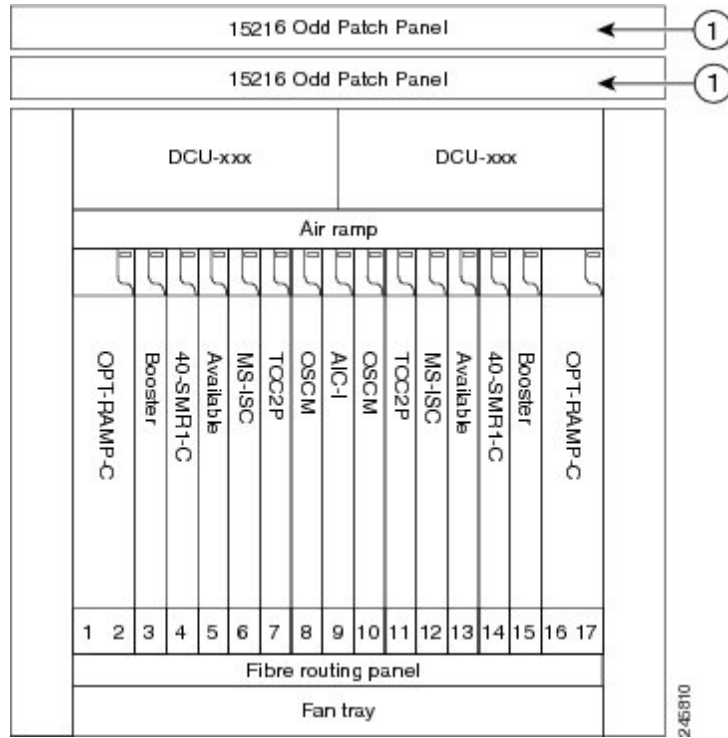
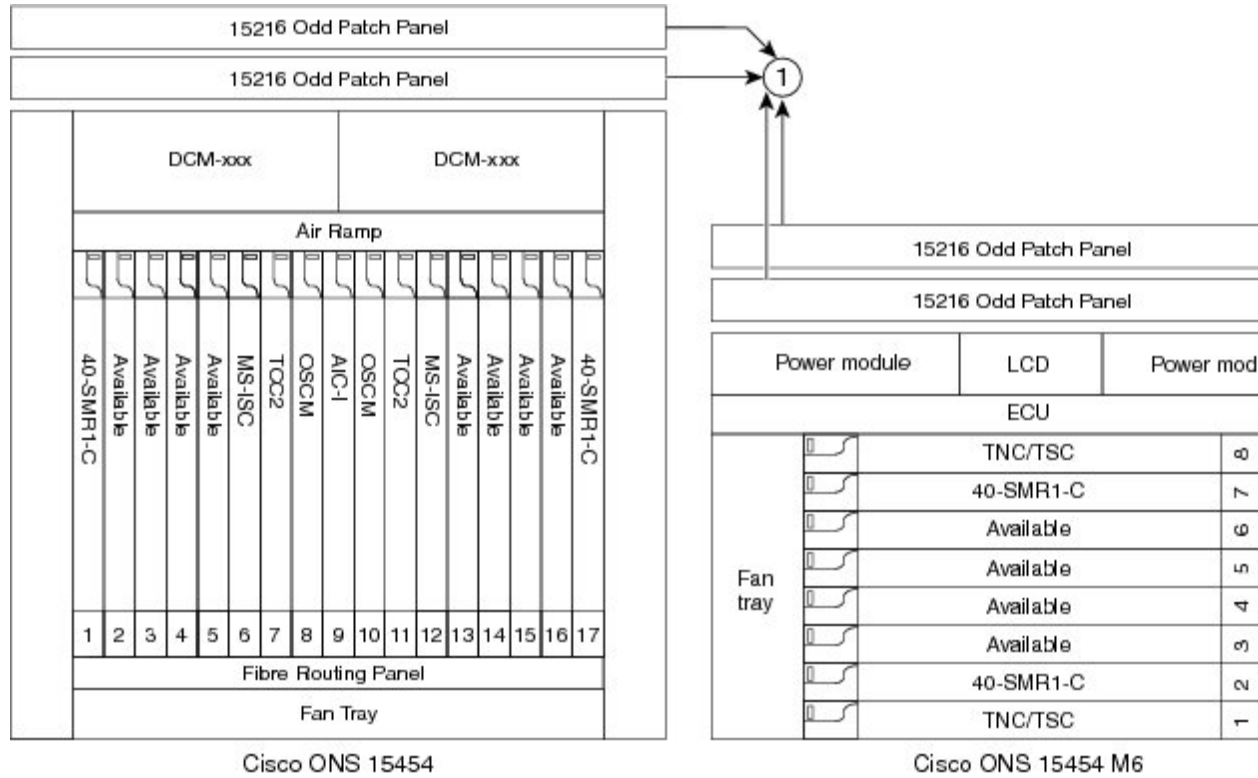| 1	15216-MD-40-ODD, 15216-EF-40-ODD, or 15216-MD-48-ODD patch panel

The following diagram shows an example of a ROADM node with 40-SMR2-C cards installed.
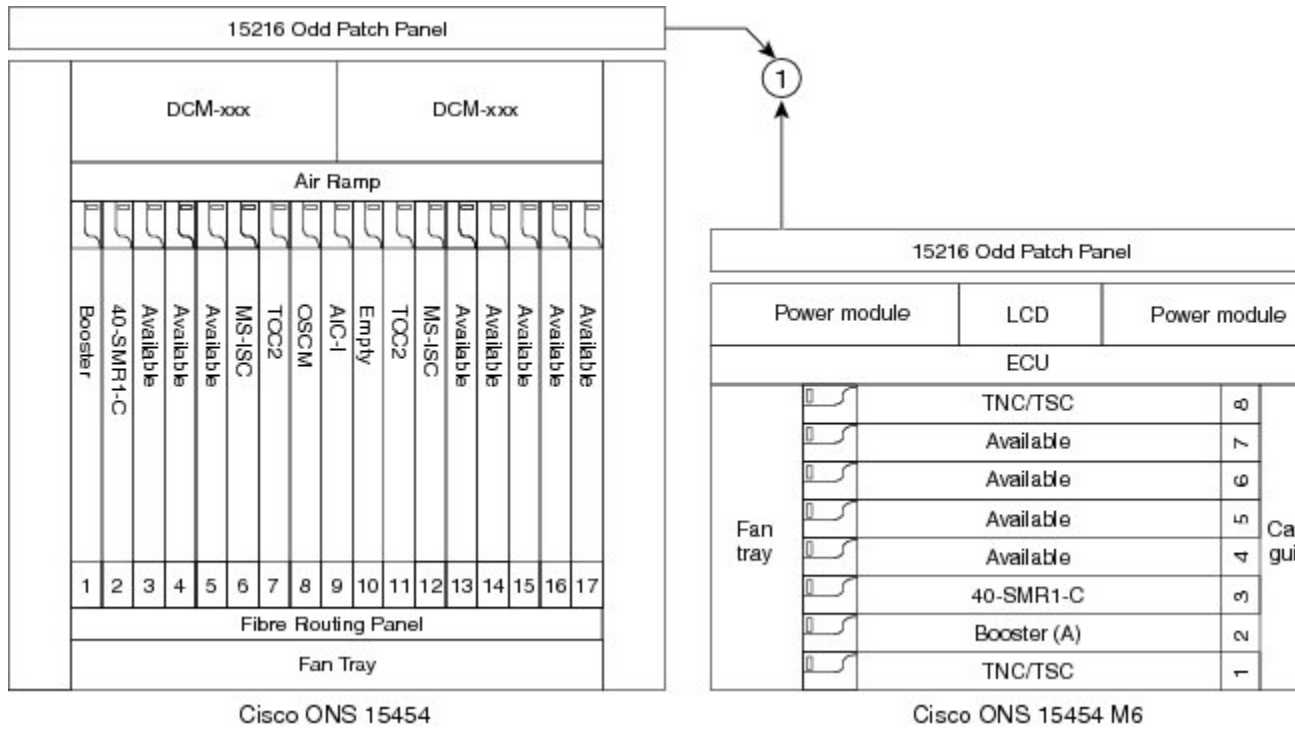
Figure 22: ROADM Node with 40-SMR2-C Cards Installed
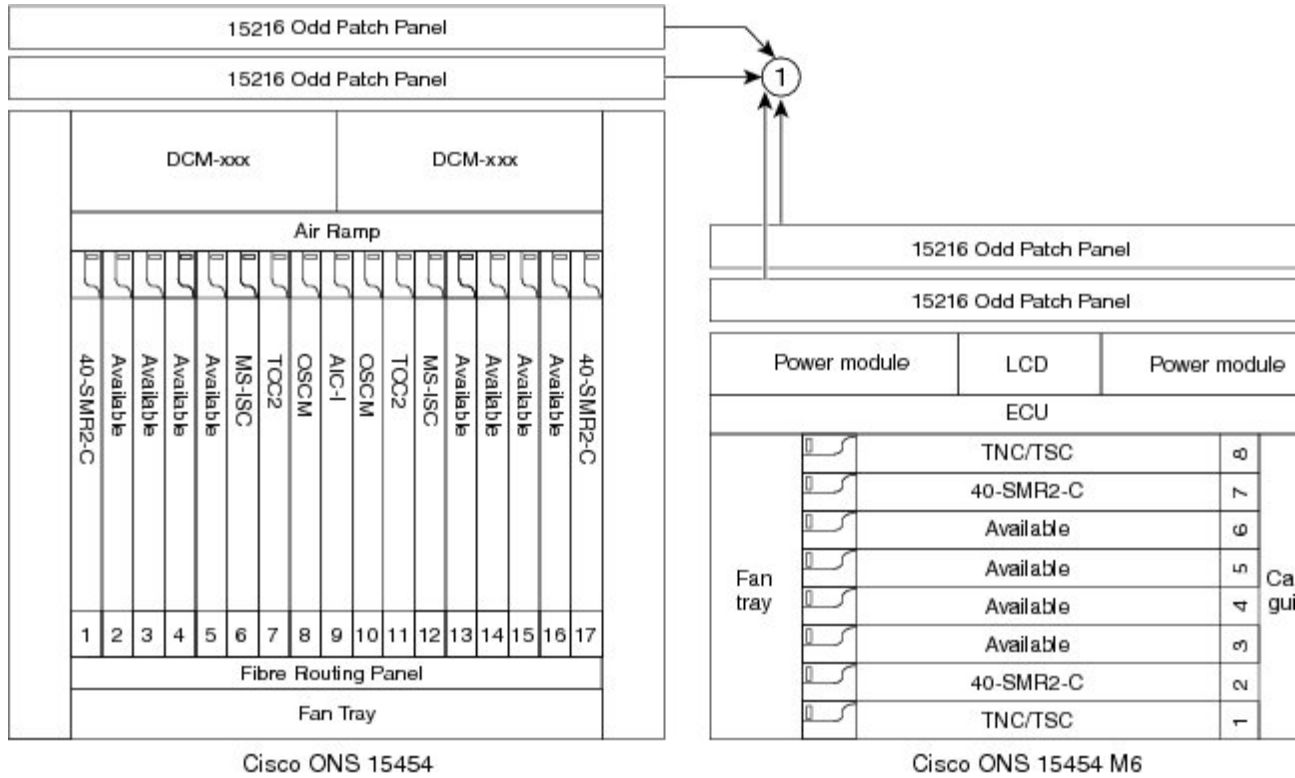
| 1 | 15216-MD-40-ODD, 15216-EF-40-ODD, or 15216-MD-48-ODD patch panel |

The following diagram shows an example of a colored two-degree ROADM node using 80-WXC-C cards with booster and preamplifier cards. The 80-WXC-C cards are inserted in Slots 3 and 14, and function in the bidirectional mode.

Figure 23: Colored Two-Degree ROADM Node with 80-WXC-C, Booster, and Preamplifier Cards
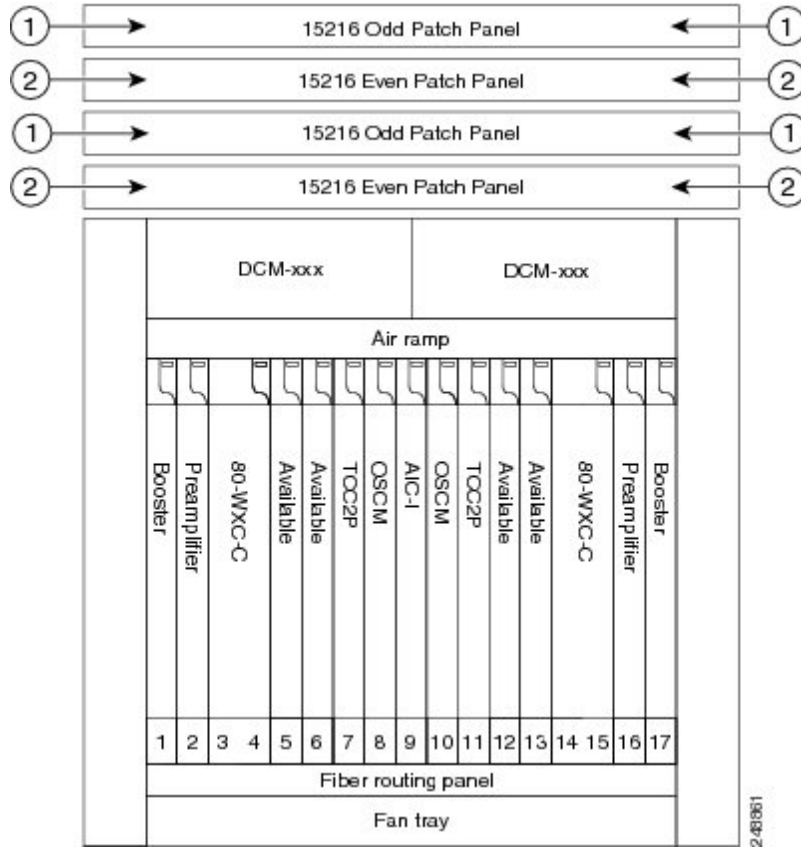
1	15216-MD-40-ODD, 15216-EF-40-ODD, or 15216-MD-48-ODD patch panel
2	15216-MD-40-EVEN, 15216-EF-40-EVEN, or 15216-MD-48-EVEN patch panel

The following diagram shows an example of an 80-channel colored two-degree ROADM node.

Figure 24: 80-Channel Colored Two-degree ROADM Node
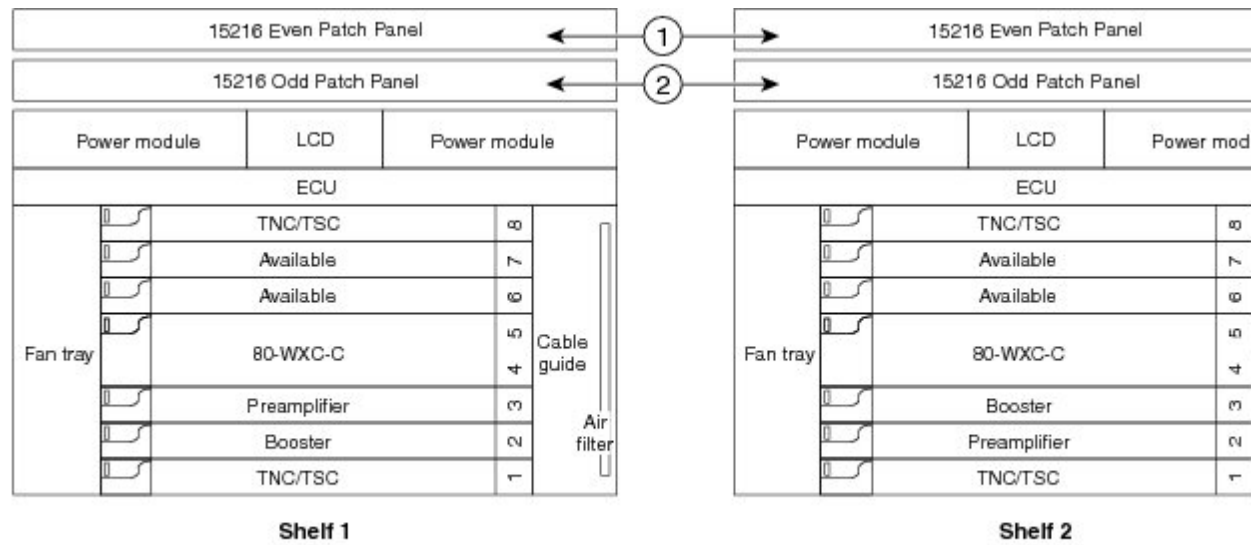
1	15216-MD-40-EVEN, 15216-EF-40-EVEN, or 15216-MD-48-EVEN patch panel
2	15216-MD-40-ODD, 15216-EF-40-ODD, or 15216-MD-48-ODD patch panel

The following diagram shows the layout of an 80-channel n-degree ROADM node with omni-directional side.

Figure 25: 80-Channel n-degree ROADM node with Omni-directional Side
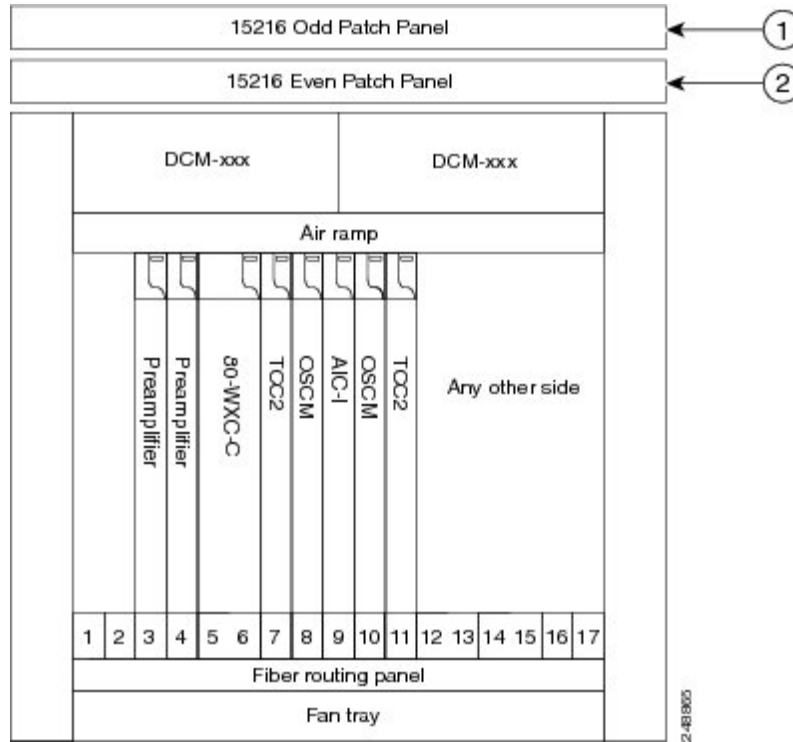
1	15216-MD-40-ODD, 15216-EF-40-ODD, or 15216-MD-48-ODD patch panel
2	15216-MD-40-EVEN, 15216-EF-40-EVEN, or 15216-MD-48-EVEN patch panel

The following diagram shows the layout of an 80-channel n-degree ROADM node with omni-directional side.

Figure 26: 80-Channel n-degree ROADM Node with Omni-directional Side
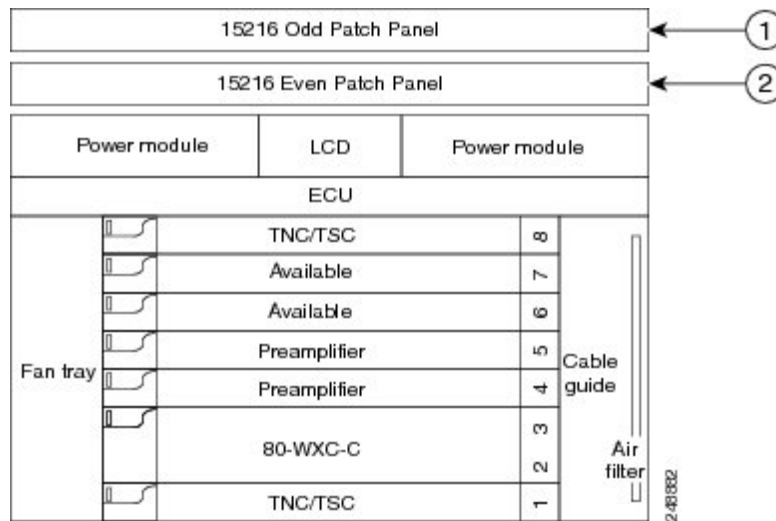
1	15216-MD-40-ODD, 15216-EF-40-ODD, or 15216-MD-48-ODD patch panel
2	15216-MD-40-EVEN, 15216-EF-40-EVEN, or 15216-MD-48-EVEN patch panel

The following diagram shows the layout of a 40-channel n-degree ROADM node with a 40-WXC-C based colorless side.

Figure 27: 40-Channel n-degree ROADM Node with 40-WXC-C Based Colorless Side
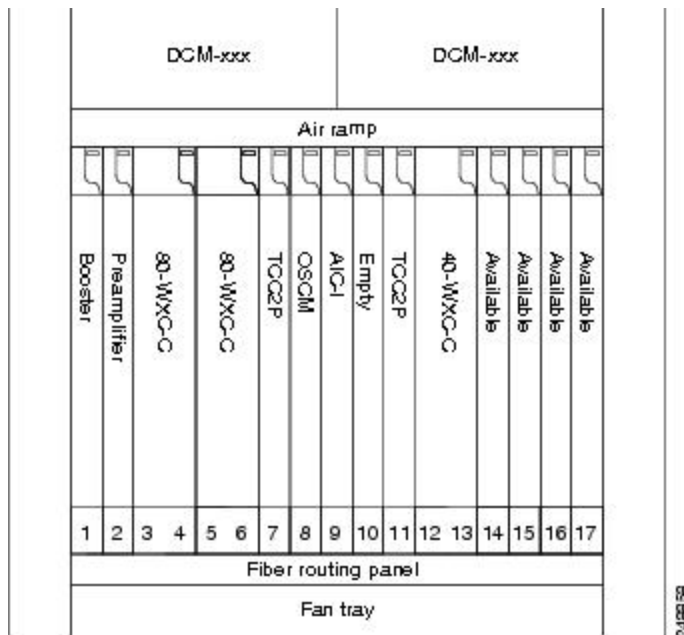
The 80-WXC-C cards are connected to the ADD/DROP ports of the 40-WXC-C card and function as colorless multiplexer and demultiplexer units.

The following diagram shows the layout of a 40-channel four-degree ROADM node with a 40-SMR2-C based colorless side.

Figure 28: 40-Channel Four-degree ROADM Node with 40-SMR2-C Based Colorless Side
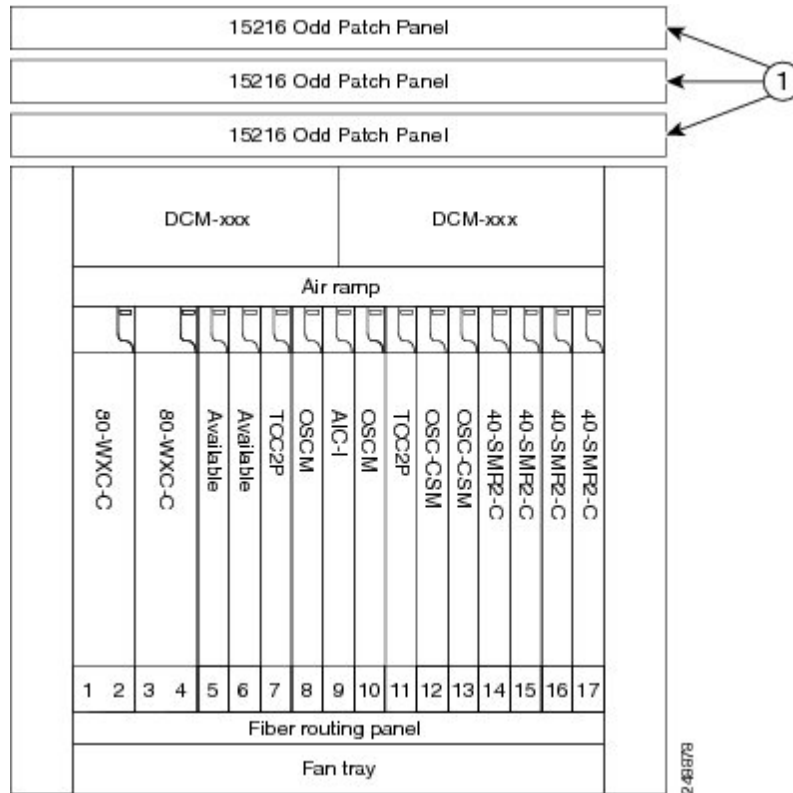
| 1 | 15216-MD-40-ODD, 15216-EF-40-ODD, or 15216-MD-48-ODD patch panel |

The 80WXC-C (multiplexer) card is inserted in Slot 3 and the 80-WXC-C (demultiplexer) card is inserted in Slot 5. The 80-WXC-C cards are connected to the ADD/DROP ports of the 40-SMR2-C card and function as the colorless multiplexer and demultiplexer units.

The following diagram shows the layout for an 80-channel colorless ROADM node.

Figure 29: 80-Channel Colorless ROADM Node
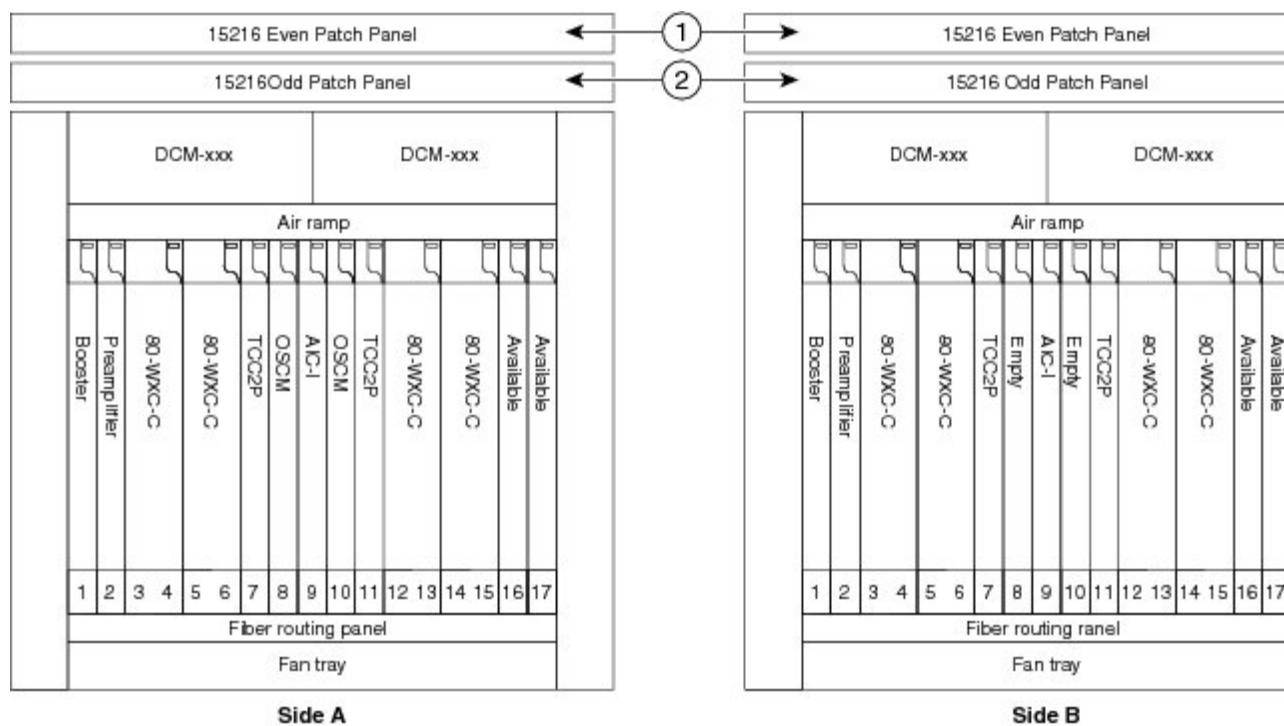
1	15216-MD-40-EVEN, 15216-EF-40-EVEN, or 15216-MD-48-EVEN patch panel
2	15216-MD-40-ODD, 15216-EF-40-ODD, or 15216-MD-48-ODD patch panel

An 80 channel colorless two-degree ROADM node requires the following cards: 80-WXC-C, 15216-MD-40-ODD, 15216-EF-40-ODD, 15216-MD-48-ODD, 15216-MD-40-EVEN, 15216-EF-40-EVEN, 15216-MD-48-EVEN, preamplifiers, and boosters.

The 80-WXC-C cards can be used at two levels; level1 (L1) and level2 (L2).

The L1 80WXC-C (multiplexer) card is inserted in Slot 3 and the L1 80-WXC-C (demultiplexer) card is inserted in Slot 5. The L2 80WXC-C (multiplexer) card is inserted in Slot 12 and the L2 80-WXC-C (demultiplexer) card is inserted in Slot 14.

The following diagram shows an example of the optical signal flow in an 80-channel colorless two-degree ROADM node from Side A to Side B using 80-WXC-C cards. The optical signal flow from Side B to Side A follows an identical path.

Figure 30: 80-Channel Colorless Two-degree ROADM Node

1	The booster on Side A receives the composite optical signal. It separates the optical service channel from the op and sends the payload to the preamplifier on Side A.
2	The preamplifier compensates for chromatic dispersion, amplifies the optical payload and sends it to the L1 80- (demultiplexer).
3	Up to eight colorless ports are available on the L1 80-WXC-C card if no colored wavelength is terminated. The t are connected to 15216-MD-40-ODD, 15216-EF-40-ODD, 15216-MD-48-ODD, 15216-MD-40-EVEN, 15216-1 or 15216-MD-48-EVEN units where the colored odd and even wavelengths are dropped.
4	The L1-80-WXC-C card on Side B sends the composite signal to the booster on Side B.
5	The booster on Side B receives the composite optical signal, adds the optical service channel to the optical paylo it to the transmission line.
6	It is possible to configure more colorless ports by cascading the 80-WXC-C cards at two levels. For example, to g ports connect one of the EAD ports of the L1 80-WXC-C card to another 80-WXC-C cards at level 2. There are ports on the L1 80-WXC-C card and nine colorless ports on the L2 80-WXC-C card. To achieve an 80 channel configuration, connect nine L2 80-WXC-C cards to the nine EAD ports of the L1 80-WXC-C card.

The following diagram shows the layout for an 80-channel colorless ROADM node with OPT-RAMP-C cards.

Figure 31: 80-Channel Colorless ROADM Node with OPT-RAMP-C Card

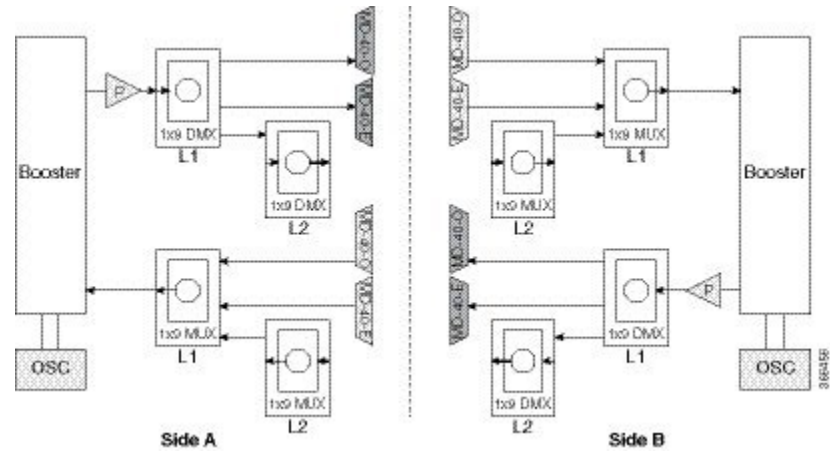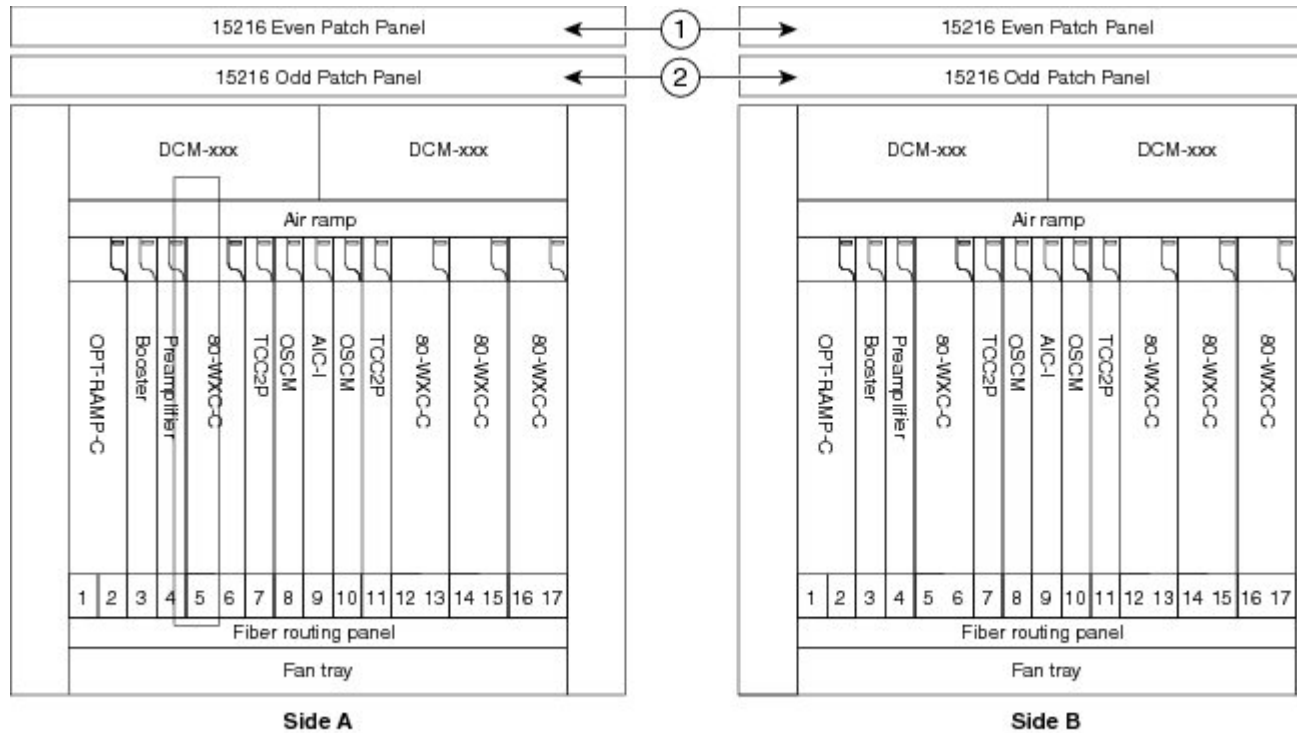| 1	15216-MD-40-EVEN, 15216-EF-40-EVEN, or 15216-MD-48-EVEN patch panel
2	15216-MD-40-ODD, 15216-EF-40-ODD, or 15216-MD-48-ODD patch panel

The following diagram shows an example of an ONS 15454 M6 80-channel two degree colorless ROADM node.

Figure 32: 80-Channel Two-degree Colorless ROADM Node
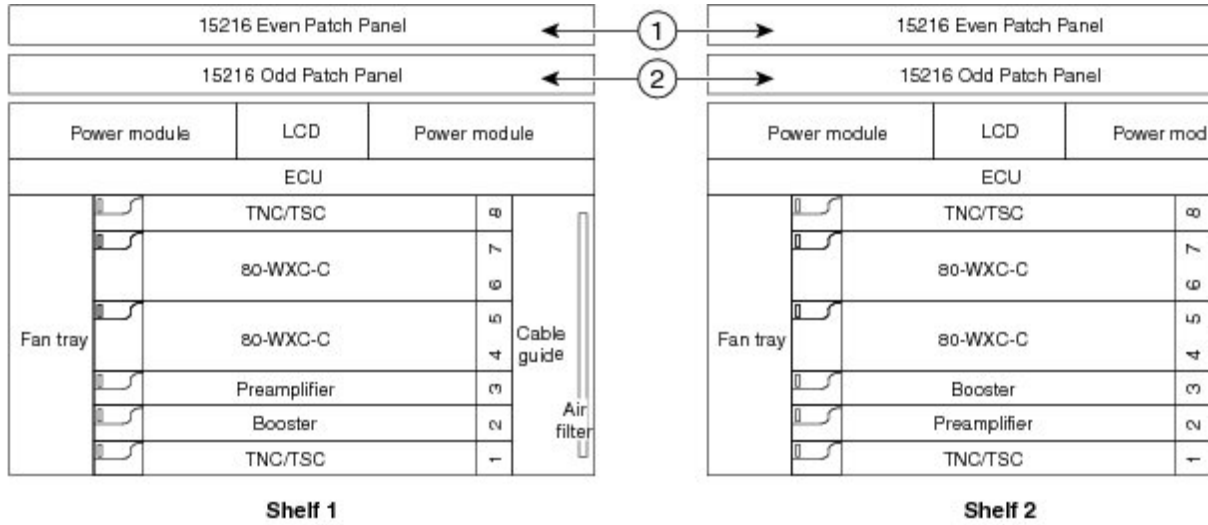
1	15216-MD-40-EVEN, 15216-EF-40-EVEN, or 15216-MD-48-EVEN patch panel
2	15216-MD-40-ODD, 15216-EF-40-ODD, or 15216-MD-48-ODD patch panel

The L1 80WXC-C (multiplexer) card is inserted in Slot 4 and the L1 80-WXC-C (demultiplexer) is inserted in Slot 6. The L2 80WXC-C (multiplexer) card is inserted in Slot 2 and the L2 80-WXC-C (demultiplexer) is inserted in Slot 4.

An example of a ROADM optical signal flow from Side A to Side B using the 32WSS or 40-WSS-C card is shown. The optical signal flow from Side B to Side A follows an identical path through the Side B OSC-CSM and32WSS or 40-WSS-C cards. In this example, OSC-CSM cards are installed, hence OPT-BSTs are not needed.

The following diagram shows an example of an ONS 15454 M6 80-channel ROADM node with RAMAN-CTP cards installed.

Figure 33: 80-Channel ROADM Node Using RAMAN-CTP Cards
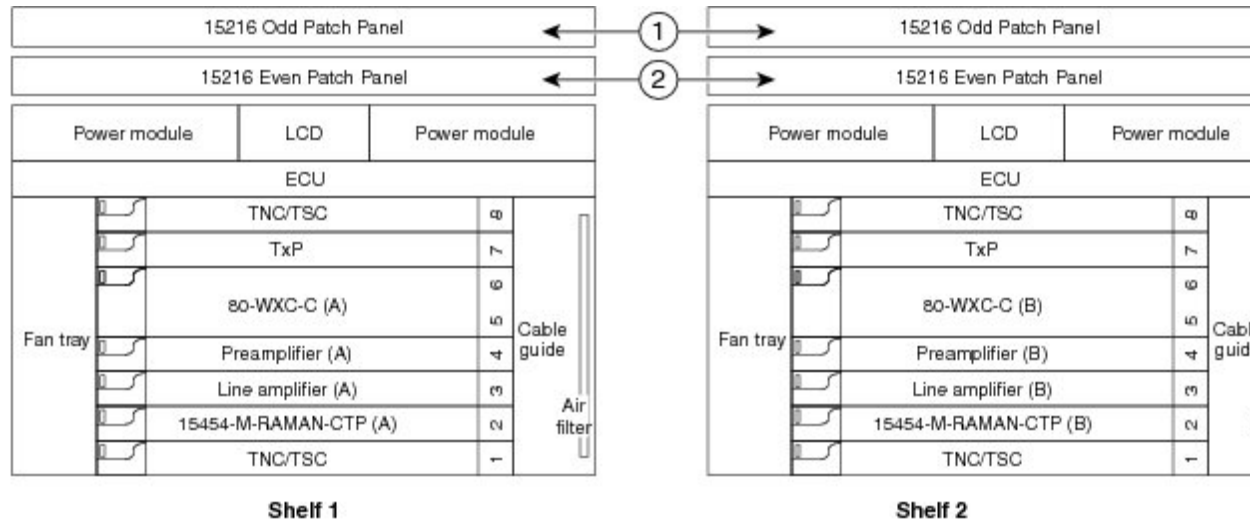
1	15216-MD-40-ODD, 15216-EF-40-ODD, or 15216-MD-48-ODD patch panel
2	15216-MD-40-EVEN, 15216-EF-40-EVEN, or 15216-MD-48-EVEN patch panel

Figure 34: ROADM Optical Signal Flow Example Using 32WSS or 40-WSS-C Card
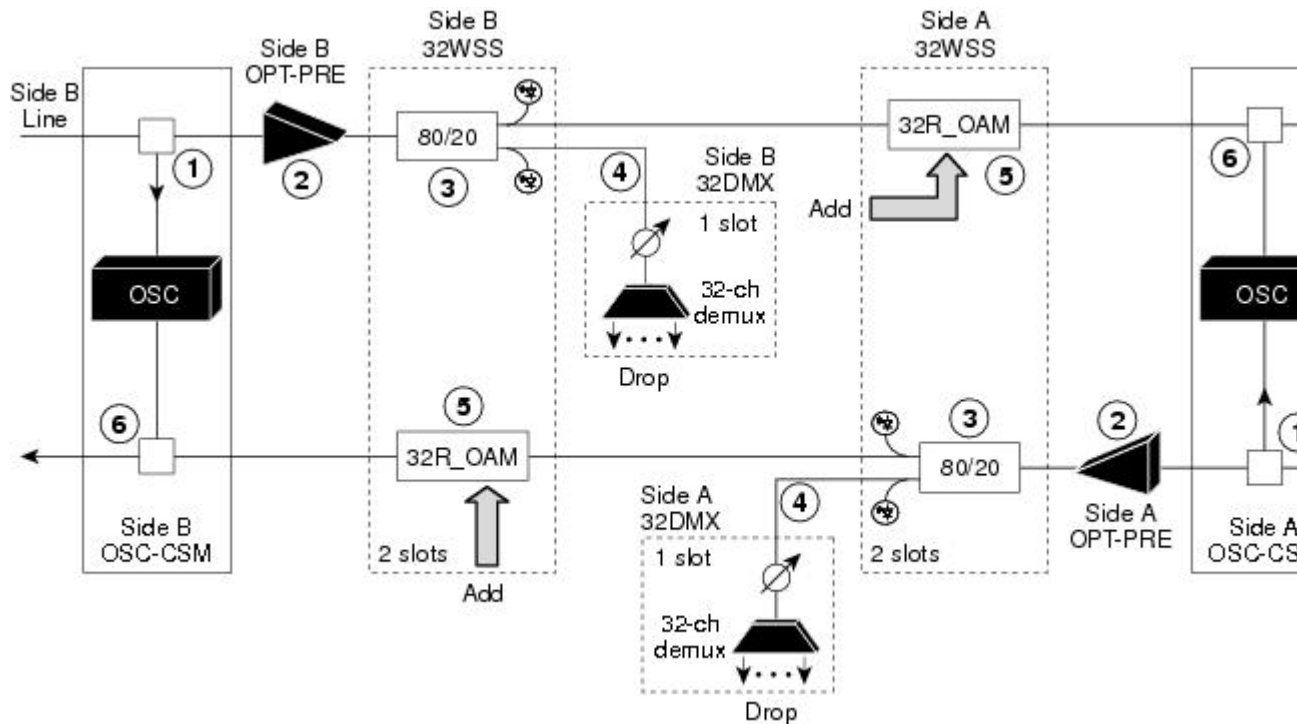
1	The OSC-CSM receives the optical signal. It separates the optical service channel from the optical payload and sen to the OPT-PRE module.
2	The OPT-PRE compensates for chromatic dispersion, amplifies the optical payload, and sends it to the 32WSS 40-WSS-C/40-WSS-CE.
3	The 32WSS or 40-WSS-C/40-WSS-CE splits the signal into two components. The 80 percent component is sent to t port and the 20 percent component is sent to the EXP-TX port.
4	The drop component goes to the 32DMX card or 40-DMX-C/40-DMX-CE card where it is demultiplexed and d
5	The express wavelength aggregate signal goes to the 32WSS or 40-WSS-C/40-WSS-CE on the other side where demultiplexed. Channels are stopped or forwarded based upon their switch states. Forwarded wavelengths are m 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.

The following diagram shows an example of an ROADM optical signal flow from Side A to Side B using the 40-SMR1-C card. The optical signal flow from Side B to Side A follows an identical path through the Side B booster and 40-SMR1-C card.

Figure 35: ROADM Optical Signal Flow Example Using 40-SMR1-C Card
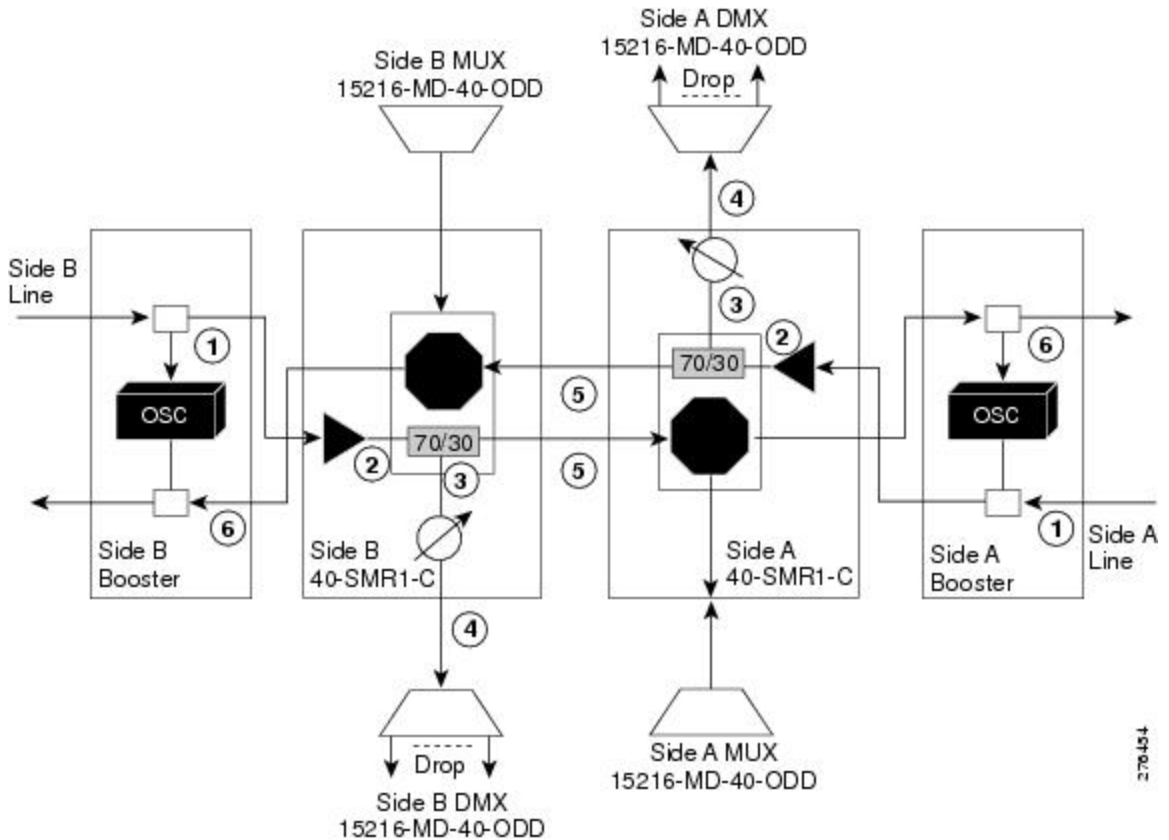
| 1 | The booster receives the optical signal. It separates the optical service channel from the optical payload and sen to the preamplifier module within the 40-SMR1-C card. |

2	The preamplifier module compensates for chromatic dispersion, amplifies the optical payload, and sends it to the 70/ within the 40-SMR1-C card.
3	The 70/30 splitter splits the signal into two components. The 70 percent component is sent to the DROP-TX port an 30 percent component is sent to the EXP-TX port.
4	The drop component goes to the 15216-MD-40-ODD, 15216-EF-40-ODD, or 15216-MD-48-ODD unit where it is dem and dropped.
5	The express wavelength aggregate signal goes to the 40-SMR1-C card on the other side where it is demultiplexed. C are stopped or forwarded based upon their switch states. Forwarded wavelengths are merged with those coming from path and sent to the booster module.
6	The booster combines the multiplexed payload with the OSC, amplifies it, and sends the signal out the transmission

Figure 36: 4-degree ROADM Node Using 16-WXC-FS Card
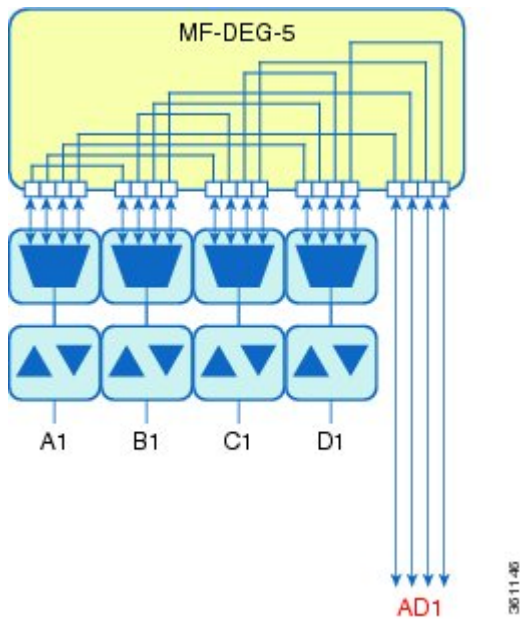
Figure 37: 8-degree ROADM Node Using 16-WXC-FS Card
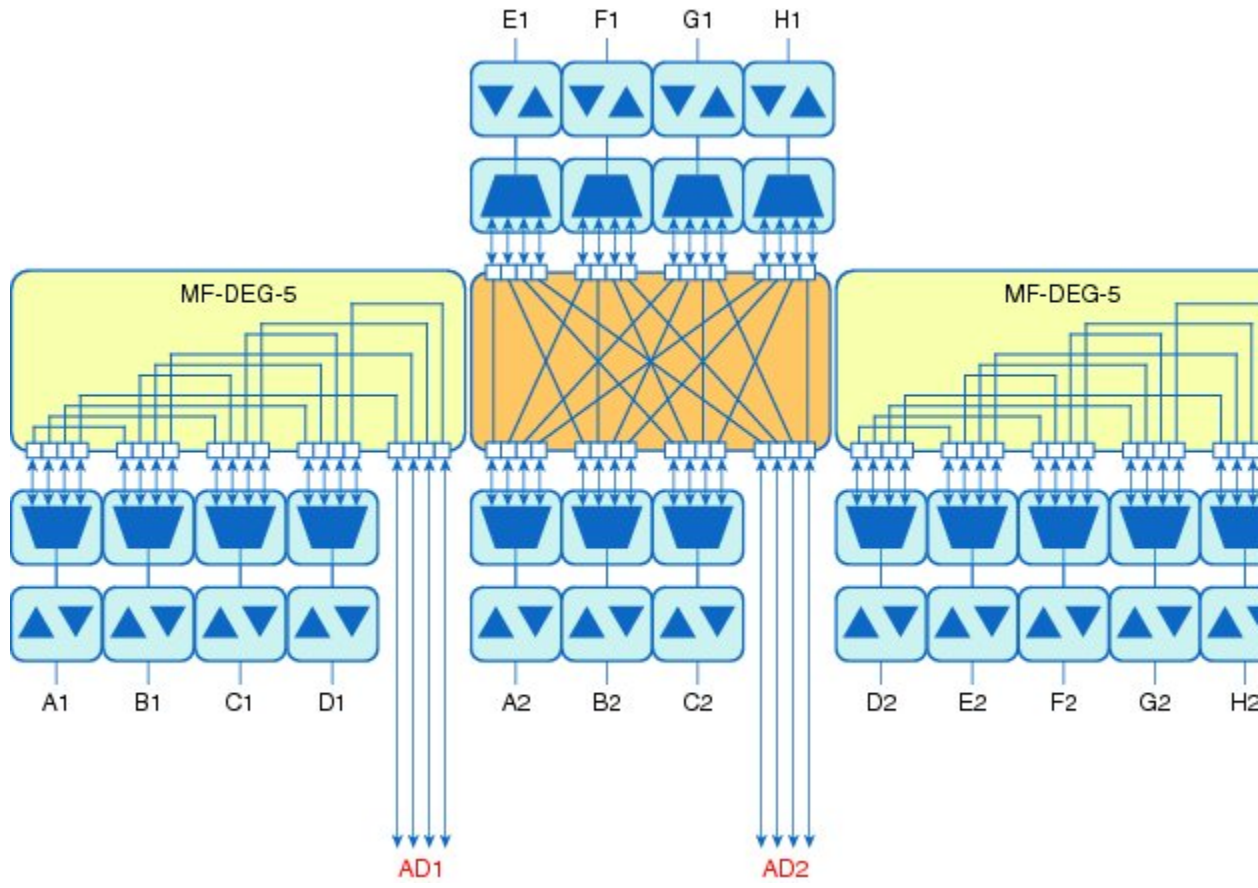
Figure 38: 12-degree ROADM Node Using 16-WXC-FS Card

Figure 39: 16-degree ROADM Node Using 16-WXC-FS Card

The following diagram shows a colored directional A/D ROADM configuration with MD-48 units connected to the UPG-RX or TX port of each 16-WXC-FS card.

Figure 40: Colored Directional A/D ROADM Configuration
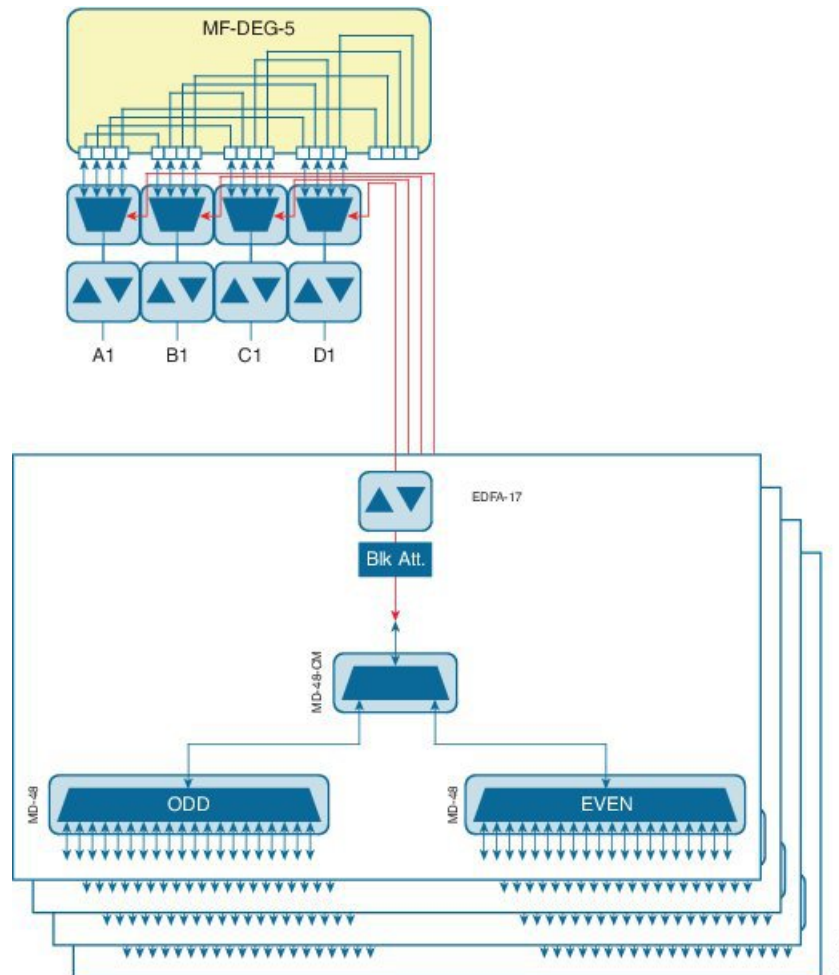
This configuration is used for a directional colored A/D ROADM configuration with more than 12 degrees and for any ROADM configuration that requires PSM-OCH protection. The amplifiers on the drop path are EDFA-17 cards and they work in constant Gain mode with a reference per-channel output power of 0 dBm and are configured in the PRE mode. The 16-WXC-FS card sets the input power of the EDFA-17 cards to obtain a typical gain of 10 dB. A 5 dB bulk attenuator is used to lower the output power of the EDFA -17 cards before it reaches the receiving channels.

The following diagram displays a colored directional 48-channel 100 GHz A/D ROADM configuration.

Figure 41: Colored Directional A/D ROADM Configuration
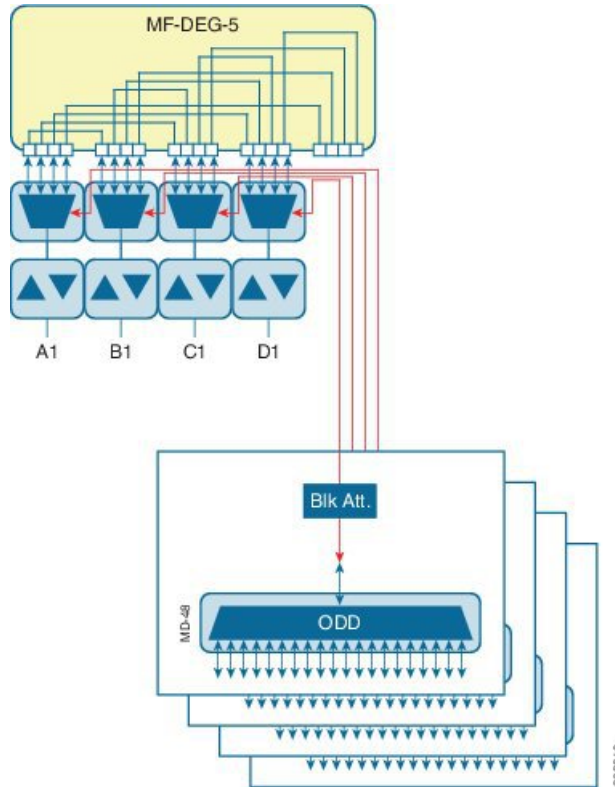
If the network uses only 100GHz channels (both odd and even grids), the MD-48-CM unit is not required and the channels can be inserted through the MD-48 units connected to the UPG TX or RX ports of each 16-WXC-FS card. A/D amplifiers are not required in this configuration. A 3 dB attenuator is recommended on the Add path between the MD-48 COM-TX port and the 16-WXC-FS UPG-RX port to lower the VOA setting requested to 16-WXC-FS card. This configuration is used for all degrees of ROADM (2 to 16) and it supports PSM-OCH protection on the terminated channels.

The following diagram displays a colored omnidirectional 48-channel 100 GHz A/D 4-degree ROADM configuration.

Figure 42: Colored Omnidirectional A/D 4-Degree ROADM Configuration
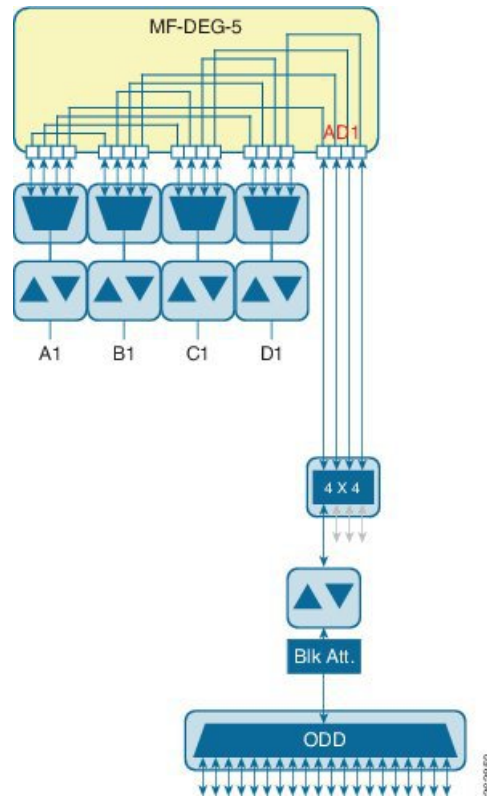
If the network uses only 100GHz channels (both odd and even grids), the MD-48-CM unit is not required on the omnidirectional colored A/D stages. Two EDFA-xx cards are used as additional amplifiers on the MD stage. These amplifiers are configured as PRE and they work in the constant Gain mode. On the Add path an EDFA-17 card is used with a reference per-channel output power of 0 dBm. A 5 dB bulk attenuator is used at the EDFA-17 card input to correctly set the amplifier gain and obtain a typical gain of 8 dB. On the drop path an EDFA-17 card is used with a reference per-channel output power of -2 dBm. The 16-WXC-FS card sets the EDFA input power so that a typical gain of 13 dB is obtained, while at the EDFA-17 output a 5 dB bulk attenuator is used to lower the power of all the received channels.

The following diagram displays a colored omnidirectional 48-channel 100 GHz A/D ROADM configuration with more than 4 degrees.

Figure 43: Colored Omnidirectional A/D ROADM Configuration with More Than 4 Degrees
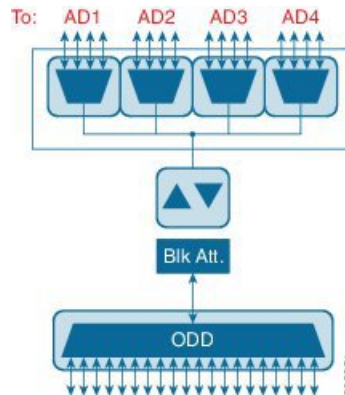
Two EDFA-xx cards are used as additional amplifiers on the MD stage. These amplifiers are configured as PRE and they work in the constant Gain mode. On the Add path an EDFA-17 card is used with a reference per-channel output power of 0 dBm. A 5 dB bulk attenuator is used at the EDFA-17 card input to correctly set the amplifier gain and obtain a typical gain of 8 dB. On the drop path an EDFA-24 card with a target gain of 15 dB is used with a reference per-channel output power of -3 dBm. A 5 dB bulk attenuator is used to lower the power of all the received channels.

The following figure shows a two degree contentionless ROADM node configuration using the SMR9 FS and 12-AD-FS cards.

Figure 44: Two Degrees ROADM Node Configuration with SMR9 FS and 12-AD-FS Cards
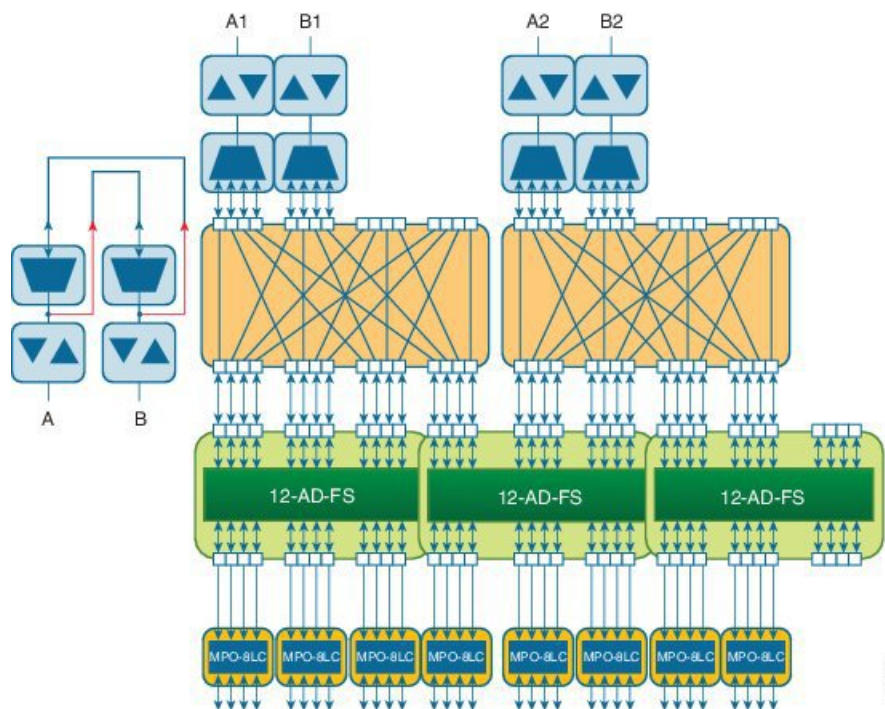
The following figure shows a terminal ROADM node configuration using the SMR20 FS and 16-AD-FS cards.

Figure 45: Terminal ROADM Node Configuration with SMR20 FS and 16-AD-FS Cards
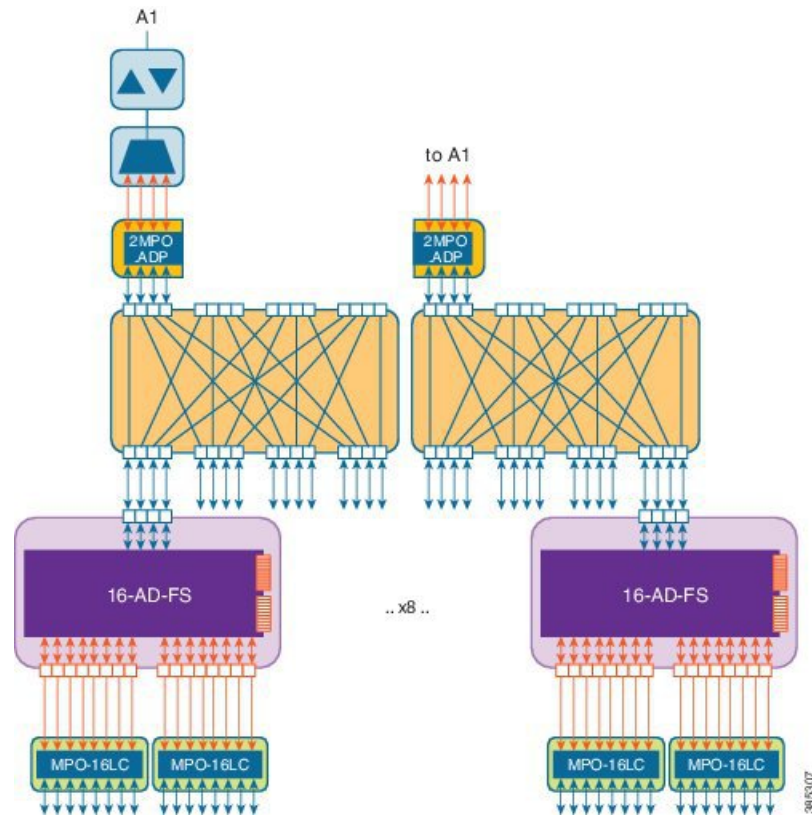
ROADM configuration with SMR20 FS in the omnidirectional side

Omnidirectional colorless A/D with high channel count provides A/D capability for 96 channels.

Figure 46: 4 degrees ROADM with SMR20 FS
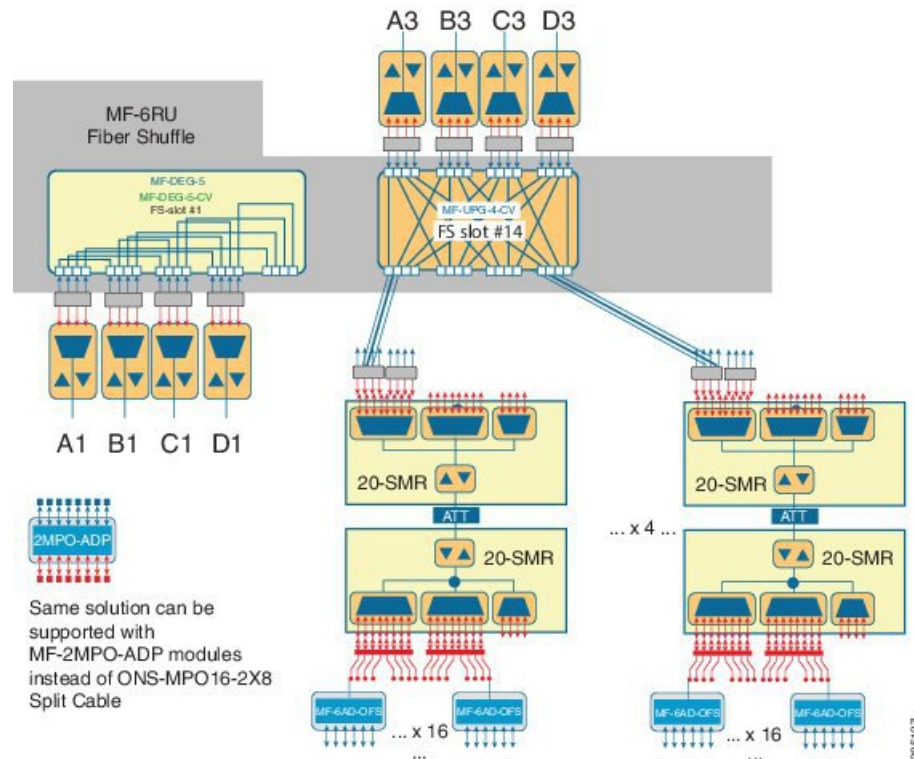
This is a non-contentionless colorless configuration.

Here, two SMR20 FS units are used. The first unit routes traffic to/from different line directions, while the second unit is used as a port-replicator to feed a set of sixteen units of MF-6AD-CFS passive A/D modules. The SMR20 is in the omnidirectional node. The cascaded SMR units are connected using an attenuator as the amplifier input signal is double in the first SMR. The configuration can have 16 A/D per port and a maximum of sixteen passive MF-6AD-CFS cards, where each passive card can add six wavelengths.

✎

Note   Instead of SMR20 FS cards, SMR20 FS CV can also be used.

ROADM configurations with extended A/D capability with cascading SMR20 FS

In a two-layered SMR20 FS units' array, the second layer of SMR20 FS units are subtended on the first layer, using an extension port available on the main PP-MESH. The second Layer SMR20 FS is used to increase the node A/D capacity. One port from SMR (layer 1A) is cascaded to another SMR (layer 2A). This gives more drop capability. Circuits in layer 2 can be added/ dropped only. Layer 2A and 2B are not connected. Express connection is possible only in layer 1. The amplifiers in layer 1 are in gain controller mode; amplifiers in layer 2 are in fixed gain mode.

Figure 47: ROADM with extended A/D capability
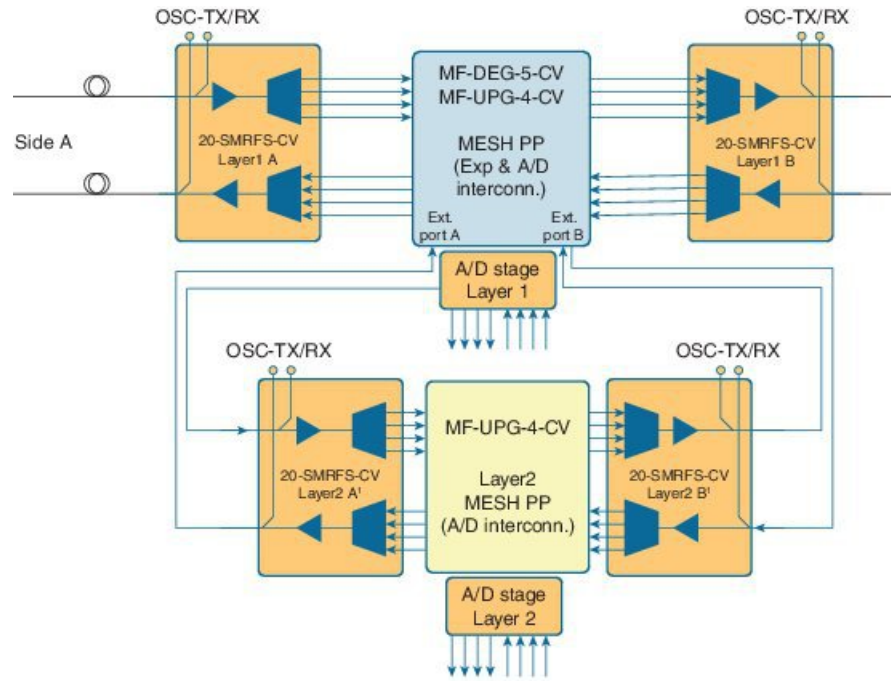
Note Instead of SMR20 FS CV cards, SMR20 FS can also be used.

Optical connections from layer 1 and layer 2 A/D are between the MPO-8 extension ports of the mesh patch-panel passive modules and the LC line ports of the SMR20 FS card. The physical optical adaptations of these interconnections are performed with a MF-MPO-8LC passive card with a special MPO-to-MPO cross cable (ONS-12MPO-XMPO-x) as shown in the following figures, for different ROADM sizes.

Figure 48: Layer 2 A/D extension for ROADM upto 4 degrees
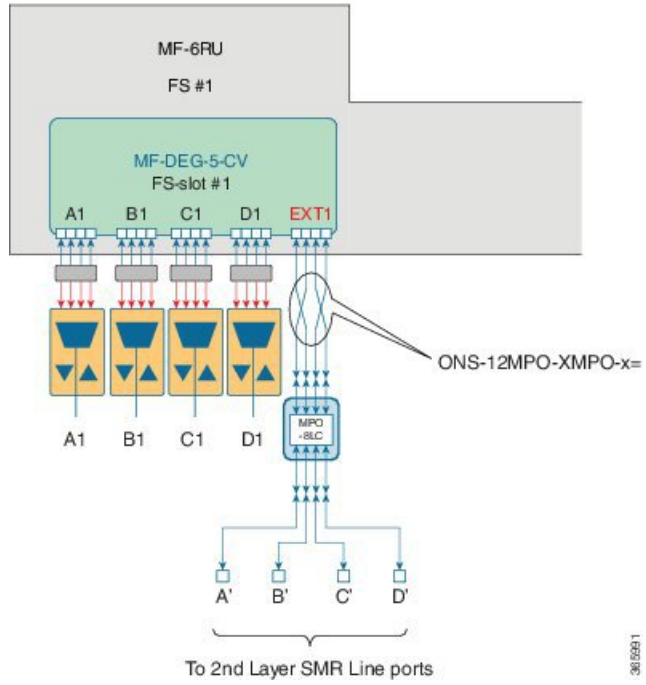
Figure 49: Layer 2 A/D extension for ROADM upto 8 degrees
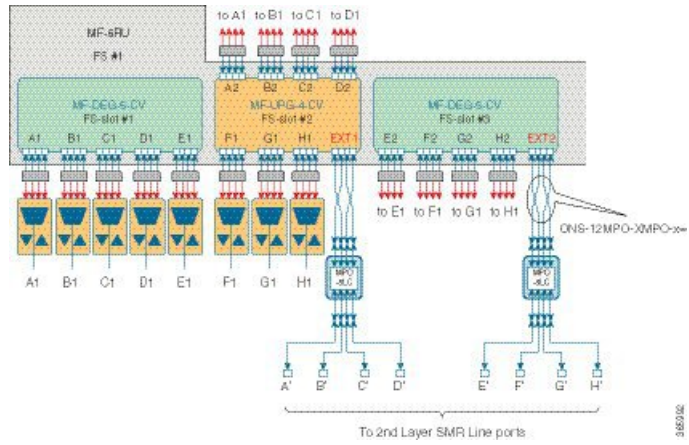
Figure 50: Layer 2 A/D extension for ROADM upto 12 degrees
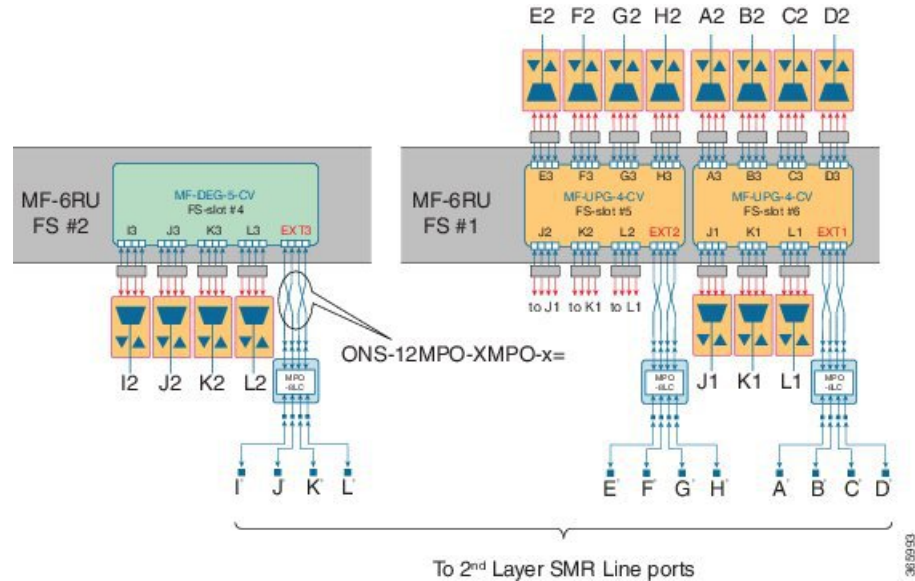
Figure 51: Layer 2 A/D extension for ROADM upto 16 degrees
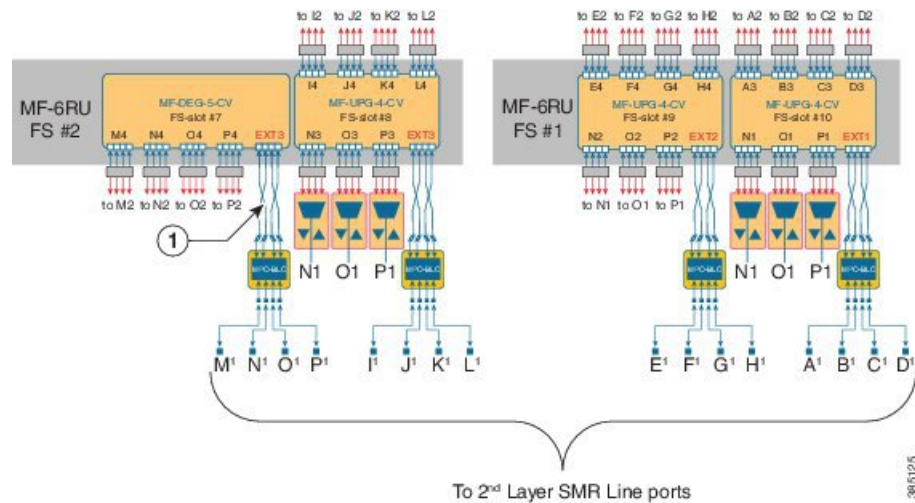
| 1 | MPO crossed cable |

Contentionless ROADM configuration for 16 degrees

Figure 52: ROADM configuration to get 16 degrees by interconnecting the sides

The following figure represents the connections between the omnidirectional side and all the line sides (contentionless A/D stage).
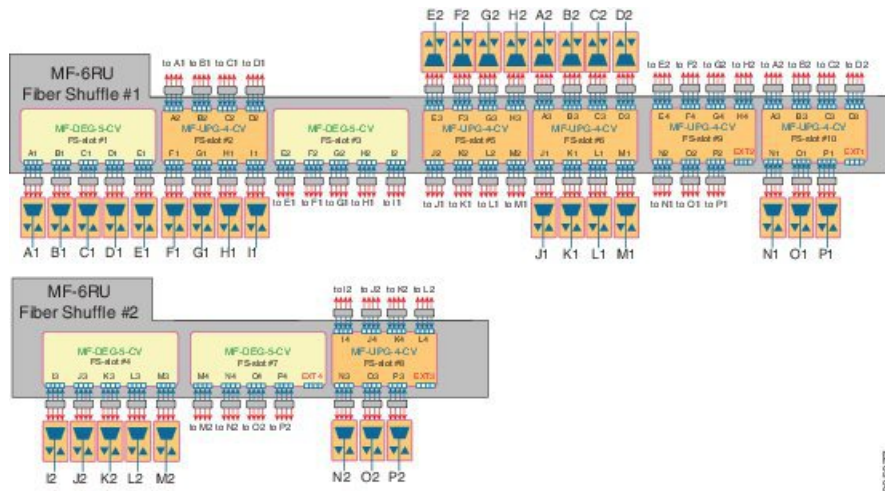
Figure 53: ROADM configuration to get 16 degrees by cascading four 16-ADCCO FS cards
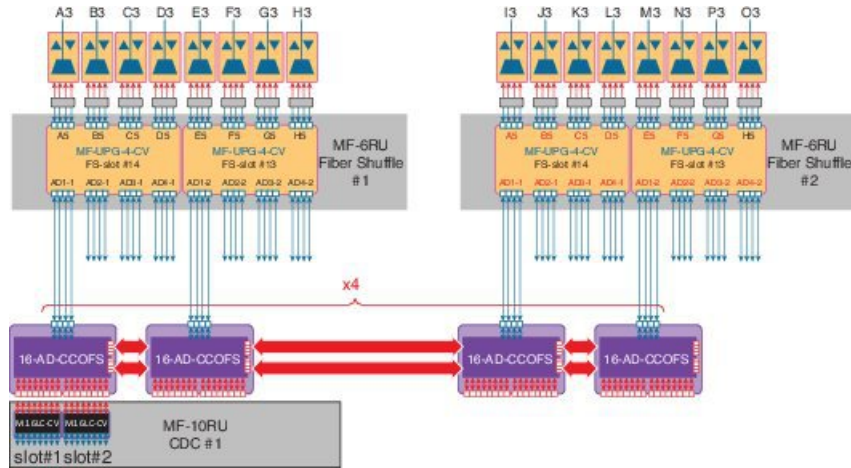
One node can have up to 16 sides (A to P). Four 16-port A/D cards are cascaded in the omnidirectional side. This configuration allows to have a 16 degree node, with at least one contentionless, colorless omnidirectional side by cascading four 16 AD-CCOFS cards.

ROADM Configurations with MF-6AD-CFS

From Release 10.6.2, a new colorless, directional A/D stage is available using the passive A/D module, MF-6AD-CFS. A set of MF-6AD-CFS passive splitter/coupler modules are connected to the SMR-20 EXP-TX/RX ports to obtain a colorless (and gridless) directional A/D stage. The interconnection can be done either with the break-out cable, ONS-MPO-16-LC2= or with the adapter module, MF-MPO-16LC. This A/D stage provides modular A/D capability up to 96 channels (with steps of 6 channels) that can be used to insert/extract colorless channels to or from a specific ROADM direction (side). This A/D stage works only with coherent trunk interfaces.

Figure 54: Colorless Directional A/D
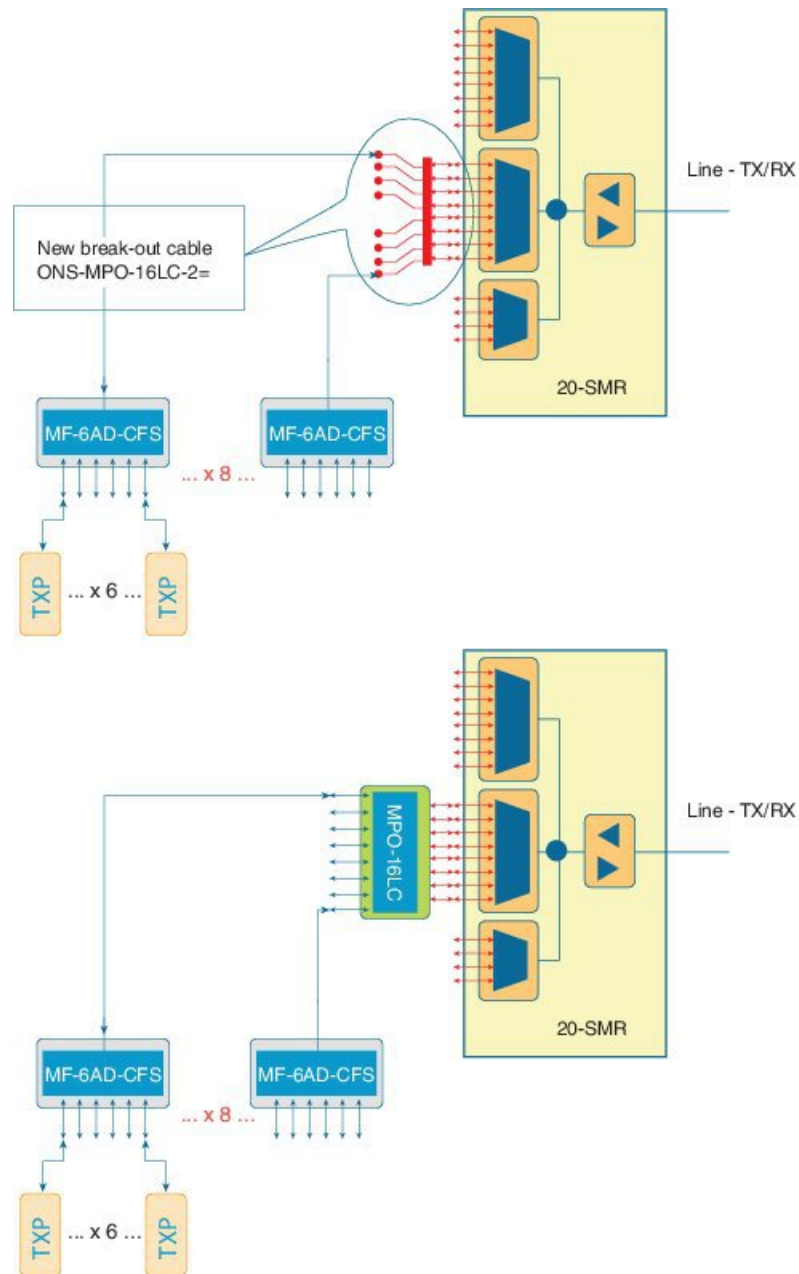
The table below, defines the interconnection between 20-SMR and the different MF-6AD-CFS passive modules with the ONS-MPO-16LC-2 cable.

SMR Signal	LC Label	MF-6AD-CFS	Port
EXP-TX-x-1	1	1	COM-RX
EXP-RX-x-9	9	1	COM-TX
EXP-TX-x-2	2	2	COM-RX

SMR Signal	LC Label	MF-6AD-CFS	Port
EXP-RX-x-10	10	2	COM-TX
EXP-TX-x-3	3	3	COM-RX
EXP-RX-x-11	11	3	COM-TX
EXP-TX-x-4	4	4	COM-RX
EXP-RX-x-12	12	4	COM-TX
EXP-TX-x-5	5	5	COM-RX
EXP-RX-x-13	13	5	COM-TX
EXP-TX-x-6	6	6	COM-RX
EXP-RX-x-14	14	6	COM-TX
EXP-TX-x-7	7	7	COM-RX
EXP-RX-x-15	15	7	COM-TX
EXP-TX-x-8	8	8	COM-RX
EXP-RX-x-16	16	8	COM-TX

Up to 96 channels can be obtained with the colorless terminal configuration.

Figure 55: Colorless Terminal Node
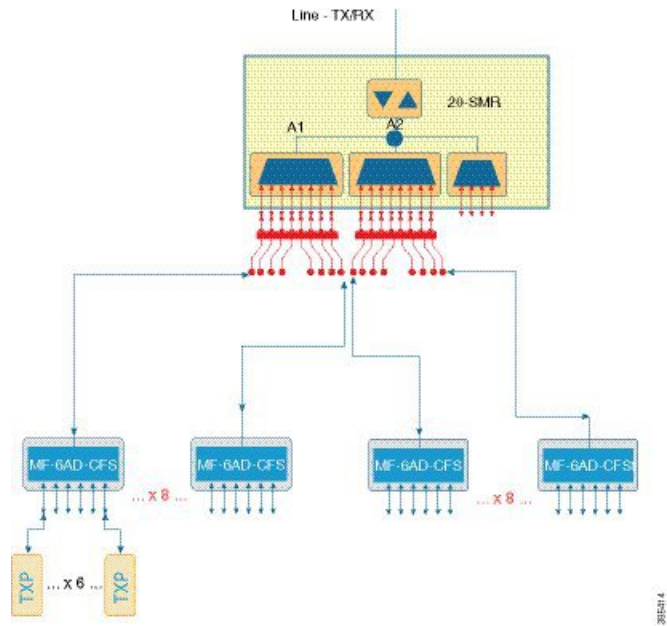
Up tp 96 channels, per side, can be obtained with the 2-degree colorless configuration.

Figure 56: 2-degree colorless
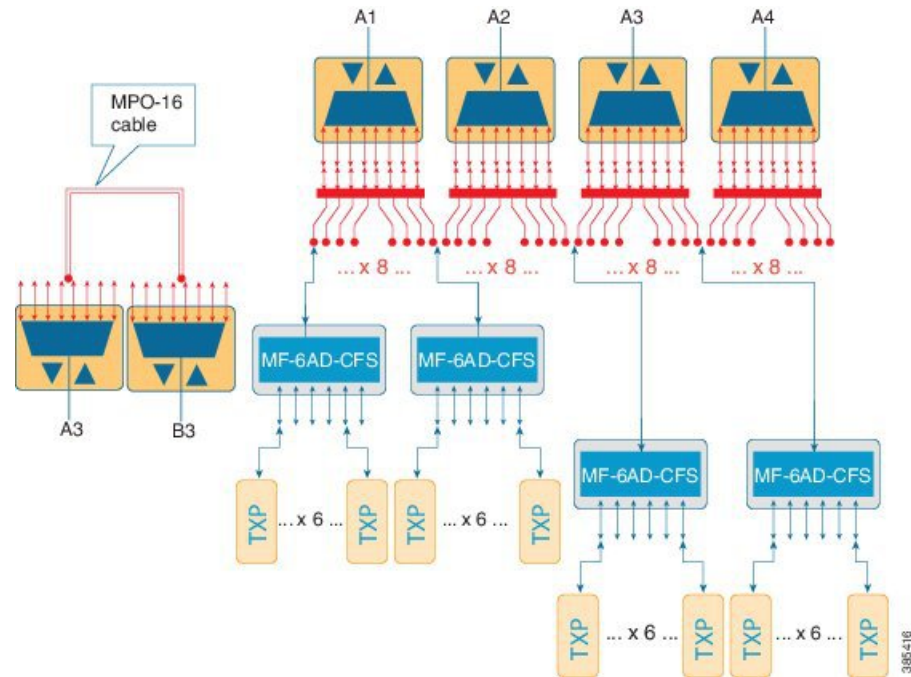
Up to 72 channels, per side, can be obtained with the 8-degree colorless configuration.

Figure 57: 8-degree colorless
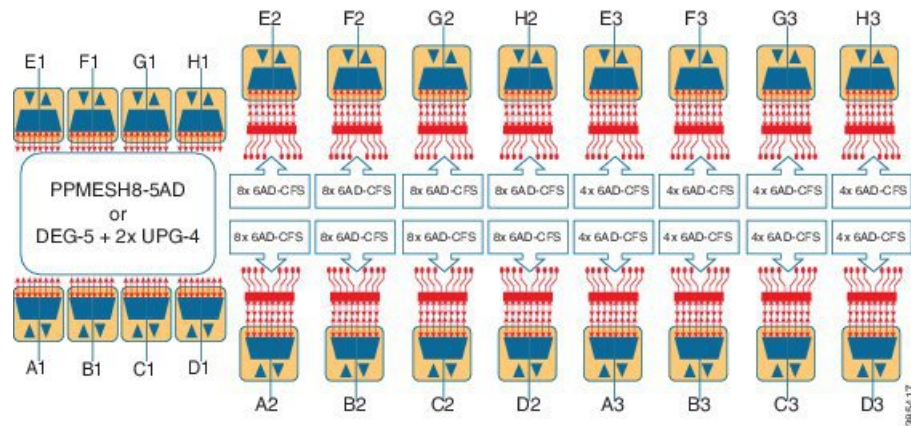
ROADM Split Nodes

Workflow for ROADM Split Nodes

Hub Node

A hub node is a single ONS 15454 node equipped with two control cards and one of the following combinations:

- Two 32MUX-O cards and two 32DMX-O or 32DMX cards

- Two 32WSS cards and two 32DMX or 32DMX-O cards

- Two 40-WSS-C or 40-WSS-CE cards and two 40-DMX-C or 40DMX-CE cards

- Two 40-SMR1-C and two 15216-MD-40-ODD, 15216-EF-40-ODD, or 15216-MD-48-ODD (ONS 15216 40 or 48-channel mux/demux patch panel)

- Two 40-SMR2-C and two 15216-MD-40-ODD, 15216-EF-40-ODD, or 15216-MD-48-ODD

Note   Although it is recommended that you use the 15216-MD-40-ODD, 15216-EF-40-ODD, or 15216-MD-48-ODD patch panel along with the 40-SMR1-C and 40-SMR2-C cards, you can alternatively use the 40-MUX-C and 40-DMX-C cards instead of the 15216-MD-40-ODD, 15216-EF-40-ODD, or 15216-MD-48-ODD patch panel.

Note   The configuration for a hub node using 40-SMR1-C or 40-SMR2-C cards is identical to the ROADM node, except that there is no patchcord connecting the two 40-SMR1-C or 40-SMR2-C cards. For more details on the ROADM node configuration, see the .

Note   The 32WSS/40-WSS-C/40-WSS-CE and 32DMX/32DMX-L/40-DMX-C/ 40-DMX-CE cards are normally installed in ROADM nodes, but they can also be installed in hub and terminal nodes. If the cards are installed in a hub node, the 32WSS/32WSS-L/ 40-WSS-C/40-WSS-CE express ports (EXP RX and EXP TX) are not cabled.

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

Figure 58: Hub Node Configuration Example with 32-Channel C-Band Cards
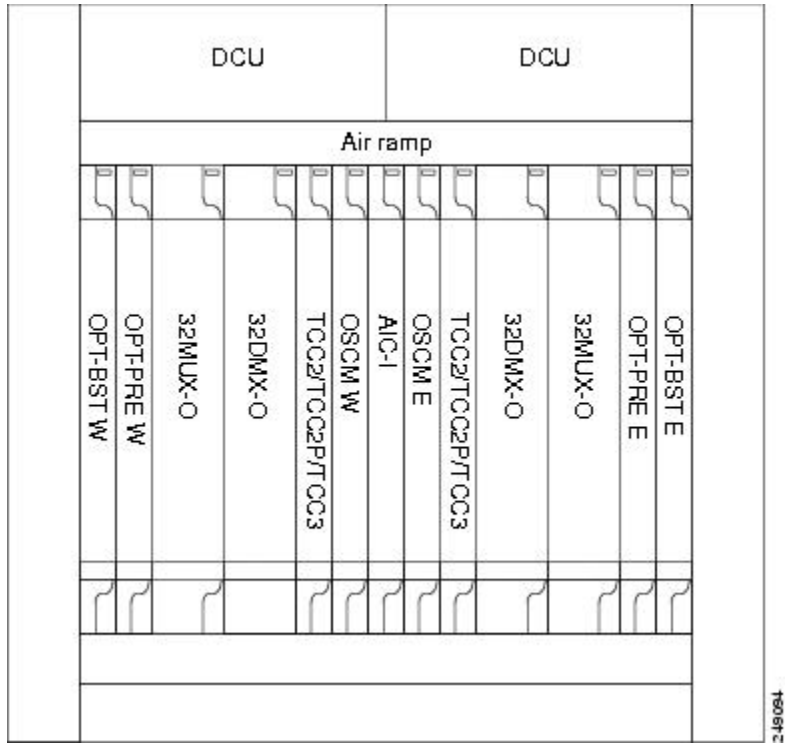
The following diagram shows a 40-channel hub node configuration with 40-WSS-C cards installed.

Figure 59: Hub Node Configuration Example with 40-WSS-C Cards
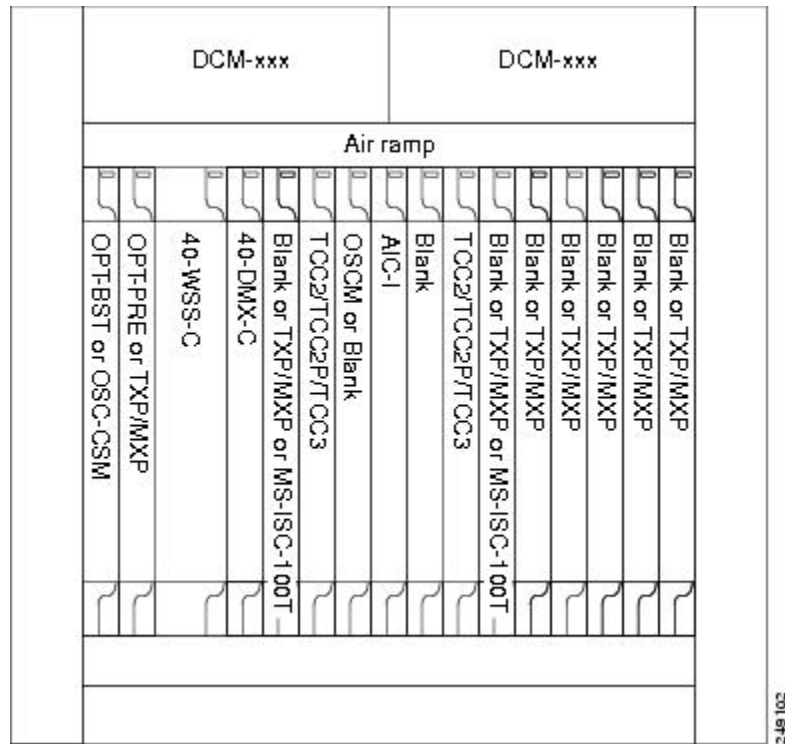
The following diagram shows the channel flow for a hub node. Up to 32 channels from the client ports are multiplexed and equalized onto one fiber. Then, multiplexed channels are transmitted to the OPT-BST amplifier. The OPT-BST output is combined with an output signal from the OSCM card and transmitted 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 60: Hub Node Channel Flow Example
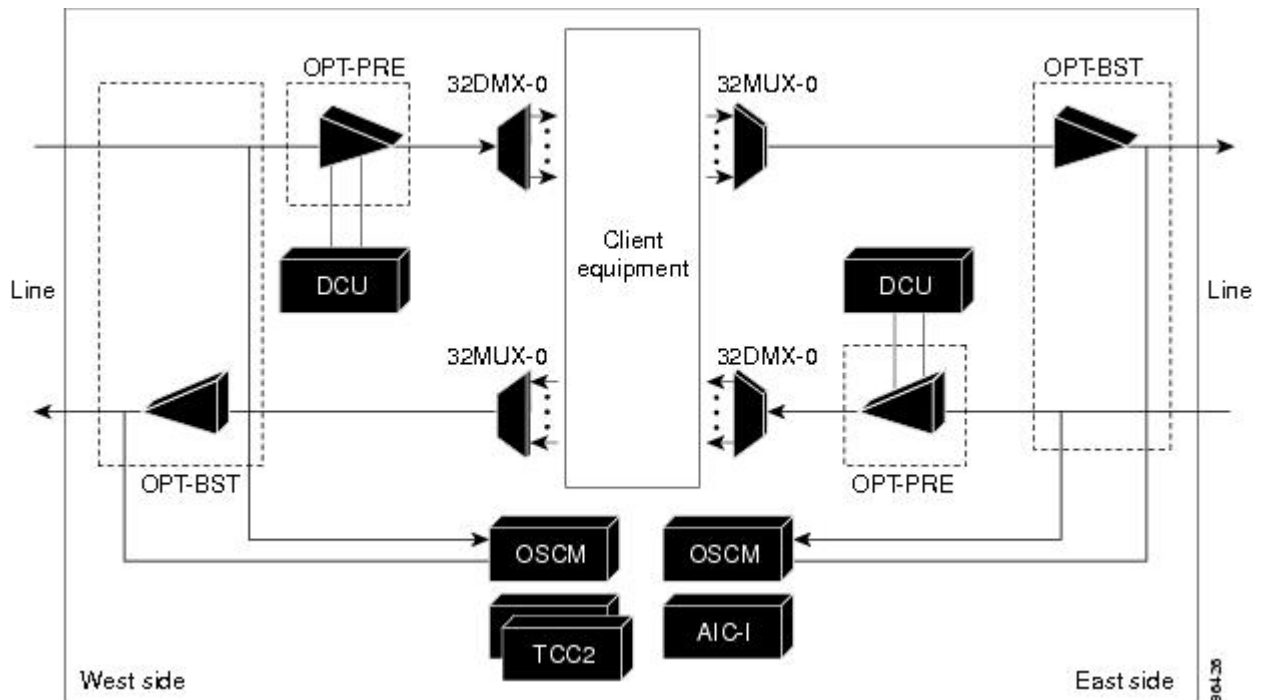
Anti-ASE Node

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.

The following diagram shows an anti-ASE node that uses all wavelengths in the pass-through mode. Use Cisco TransportPlanner to determine the best configuration for anti-ASE nodes.

Figure 61: Anti-ASE Node Channel Flow Example
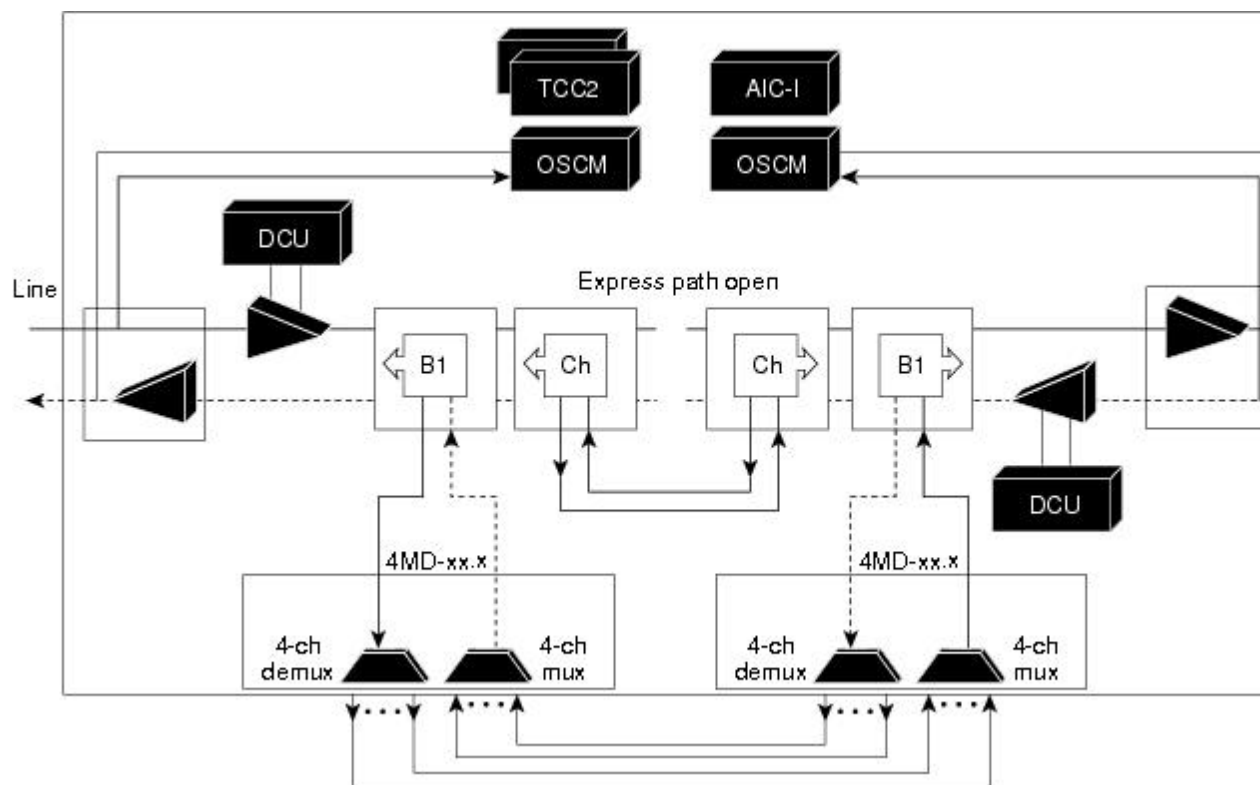
Line Amplifier Node

A line amplifier node is a single ONS 15454 node that is used to amplify the optical signal in long spans. The line amplifier node can be equipped with one of the following sets of cards:

- Two OPT-PRE cards, two OPT-BST cards, and two OSCM cards

- Two OPT-PRE cards and two OSC-CSM cards

- Two OPT-AMP-17-C cards and two OSCM cards

- Two OPT-AMP-C cards and two OSCM cards

Attenuators might also be required between each preamplifier and OPT-BST amplifier to match the optical input power value and to maintain the amplifier gain tilt value.

Two OSCM cards are connected to the OPT-BST cards to multiplex the OSC signal with the pass-though channels. If the node does not contain a booster card, OSC-CSM cards must be installed instead of OSCM cards. The following diagram shows an example of a line amplifier node configuration using OPT-BST, OPT-PRE, and OSCM cards.

Figure 62: Line Amplifier Node Configuration Example
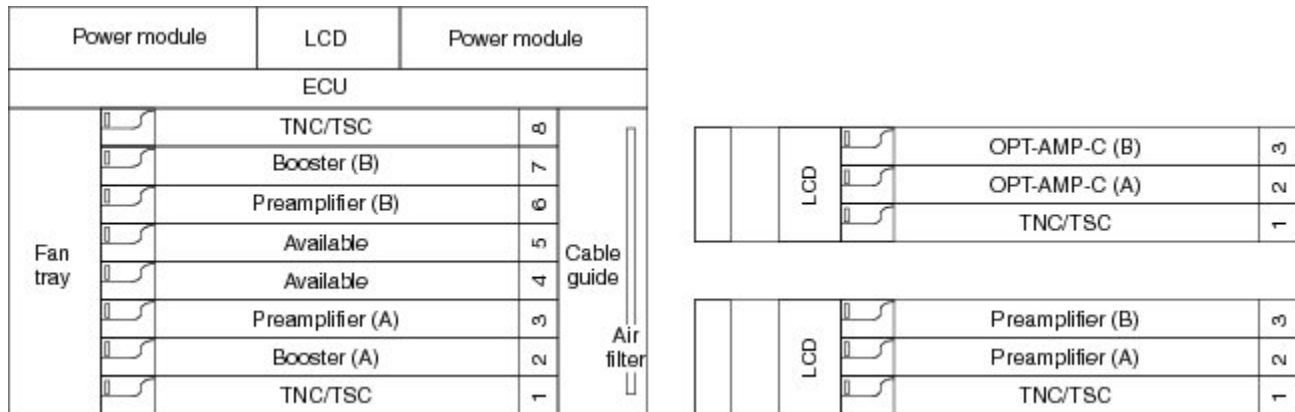
The line amplifier can be equipped with OPT-RAMP-C or OPT-RAMP-CE cards to achieve in fiber amplification. The following diagram shows an example of a line amplifier node with Raman amplification using OPT-RAMP-C cards.

Figure 63: Line Amplifier Node with OPT-RAMP-C Cards
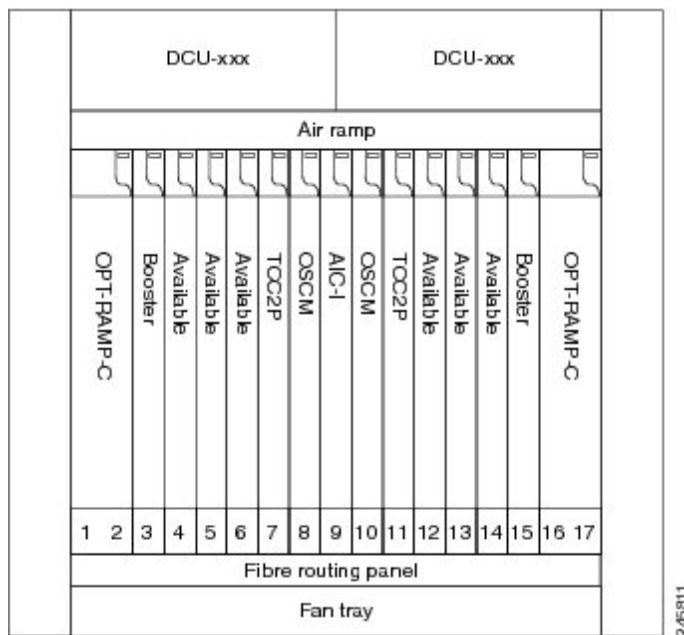
A node layout equipped with OPT-RAMP-C or OPT-RAMP-CE cards without post-amplifiers is used when post-amplification of the optical signal is not required.

This layout is used in the following scenarios:

• The fiber is non-linear with high Raman gain (12.5 dB)

• The span length is 13 to 22 dB

There are three node layouts without post-amplifiers:

1. Line amplifier node equipped with OPT-RAMP-C or OPT-RAMP-CE cards on Side A and Side B.

2. Line amplifier node equipped with OPT-RAMP-C or OPT-RAMP-CE and booster cards on Side A and OPT-RAMP-C or OPT-RAMP-CE cards on Side B and vice-versa.

3. Line amplifier node equipped with OPT-RAMP-C or OPT-RAMP-CE and booster cards on Side A and OSC-CSM cards on Side B and vice-versa.

The following figure shows an example of a line amplifier node with OPT-RAMP-C cards on Side A and Side B.

Figure 64: Line Amplifier Node with OPT-RAMP-C Cards on Sides A and B
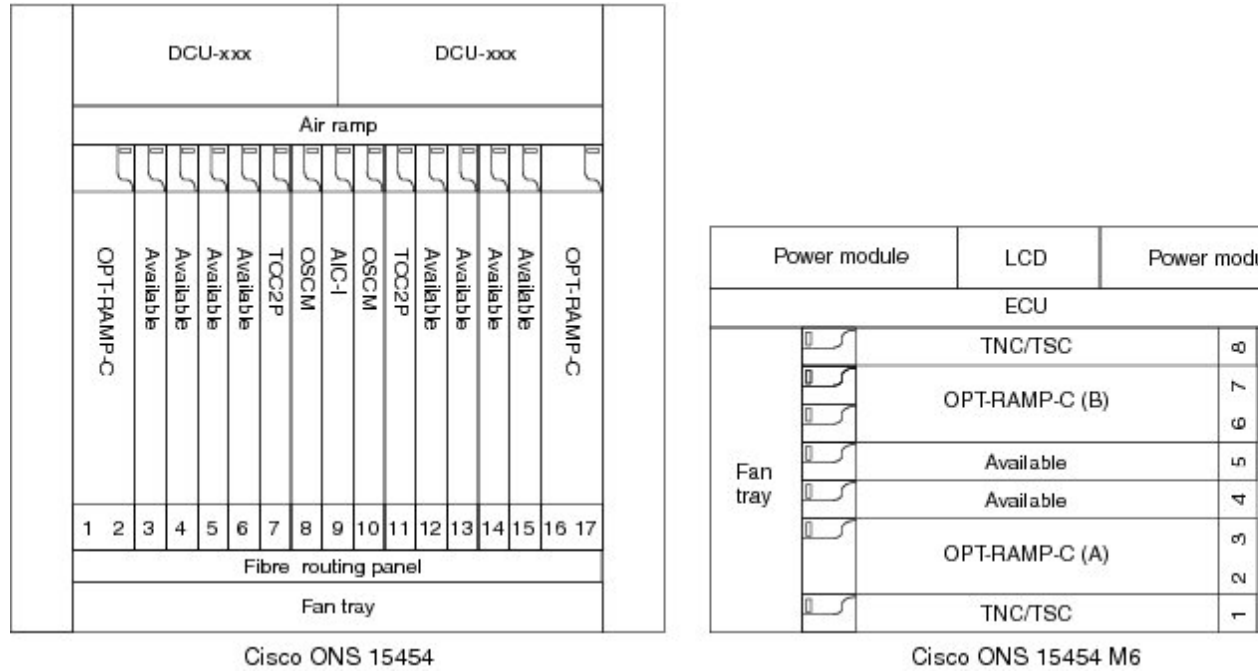
The following diagram shows an example of a line amplifier node with a standard Raman configuration (OPT-RAMP-C or OPT-RAMP-CE and booster cards) on Side A and a Raman only configuration (OPT-RAMP-C or OPT-RAMP-CE cards) on Side B.

Figure 65: Line Amplifier Node with OPT-RAMP-C and Booster Cards (Side A) and OPT-RAMP-C Cards (Side B)
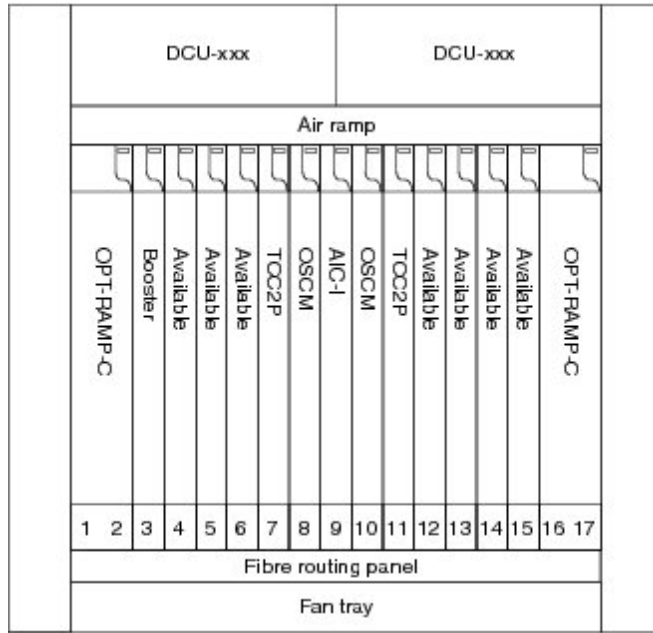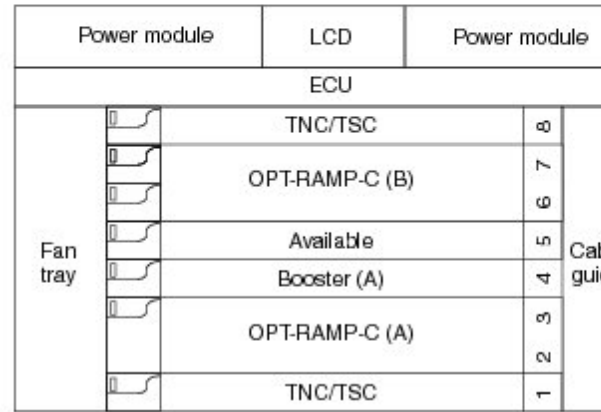
The following diagram shows an example of a line amplifier node with a standard Raman configuration (OPT-RAMP-C or OPT-RAMP-CE and booster cards) on Side A and an OSC-CSM configuration on Side B.

Figure 66: Line Amplifier Node with OPT-RAMP-C and Booster Cards (Side A) and OSC-CSM Cards (Side B)
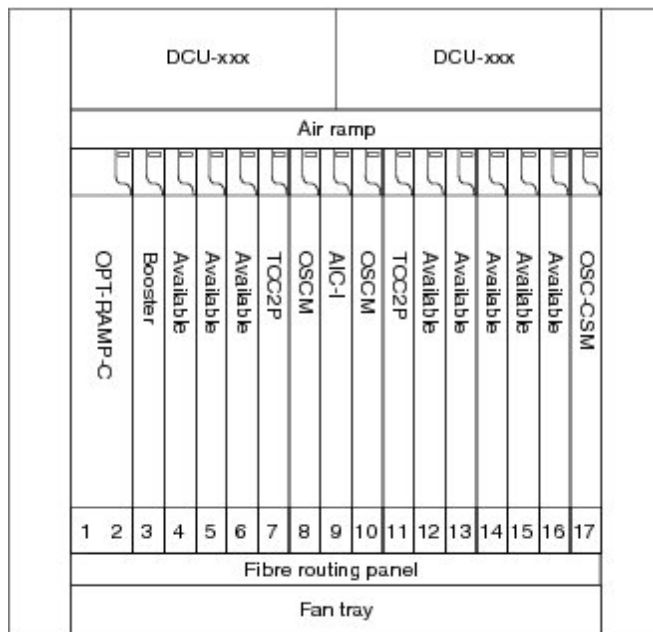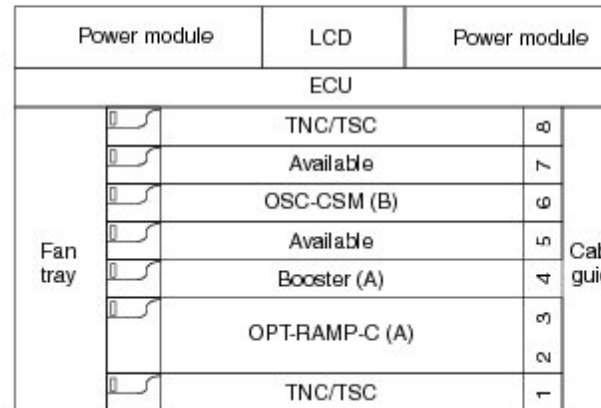
OSC Regeneration Node

The OSC regeneration node is added to the DWDM networks for two purposes:

- To electrically regenerate the OSC channel whenever the span links are 37 dB or longer and payload amplification and add/drop capabilities are not present. Cisco TransportPlanner places an OSC regeneration node in spans longer than 37 dB. The span between the OSC regeneration node and the next DWDM network site cannot be longer than 31 dB.

- To add data communications network (DCN) capability wherever needed within the network.

OSC regeneration nodes require two OSC-CSM cards, as shown in the following figure. The cards are installed in each side of the shelf.

Figure 67: OSC Regeneration Line Node Configuration Example
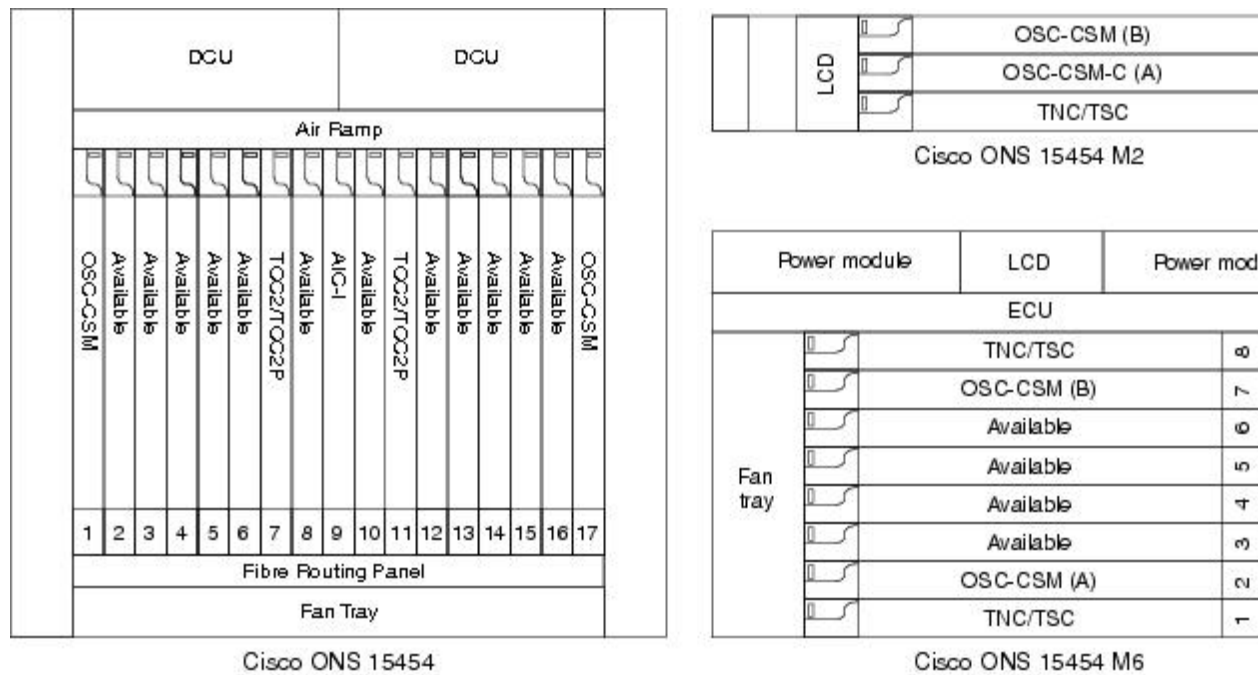
The following figure shows the OSC regeneration line node signal flow.

Figure 68: OSC Regeneration Line Node Flow
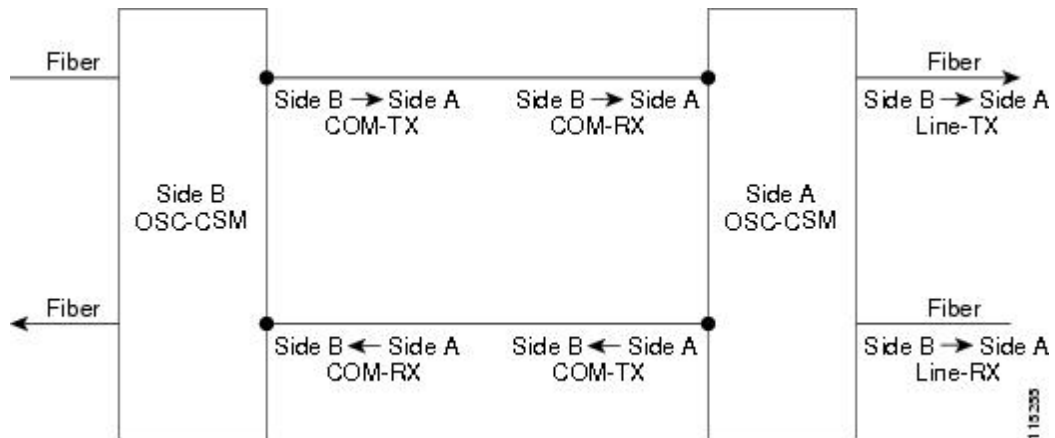
Supported Node Configurations for OPT-RAMP-C and OPT-RAMP-CE Cards

The OPT-RAMP-C and OPT-RAMP-CE cards can be equipped in the following network element type configurations:

- C-band odd systems:
    - C-band terminal site with 32-MUX-O and 32-DMX-O cards
    - C-band hub node with 32-MUX-O and 32-DMX-O cards
    - C-band fixed OADM node
    - C-band line site
    - C-band 32-channel reconfigurable OADM (ROADM)
    - C-band terminal site using a 32-WSS and 32-DMX cards
    - C-band flexible terminal site using AD-xC cards
    - C-band hub node using a 32-WSS and 32-DMX cards
    - C-band 40-channel ROADM
    - C-band terminal site using a 40-WSS-C and 40-DMX-C cards
    - C-band terminal site using 40-MUX-C and 40-DMX-C cards
    - C-band hub node using a 40-WSS-C and 40-DMX-C cards
    - C-band up to 4 degree mesh node
    - C-band up to 8 degree mesh node
    - C-band multiring/mesh with MMU node
    - C-band 4 degree multiring/mesh node (MMU based)

• C-band odd and even systems:

  • C-band 64-channel terminal site

  • C-band 72-channel terminal site

  • C-band 80-channel terminal site

  • C-band 64-channel hub site

  • C-band 72-channel hub site

  • C-band 80-channel hub site

  • C-band 64-channel ROADM site

  • C-band 72-channel ROADM site

  • C-band 80-channel ROADM site

The following amplifier cards are defined as booster or preamplifiers:

• Booster:

  • OPT-BST

  • OPT-BST-E

  • OPT-AMP-17-C

  • OPT-AMP-C

• Preamplifier:

  • OPT-PRE

  • OPT-AMP-C

  • OPT-BST

  • OPT-BST-E

Note When the booster is not needed, it must be replaced with an OSC-CSM card.

OPT-RAMP-C or OPT-RAMP-CE Card in an Add/Drop Node

When the OPT-RAMP-C or OPT-RAMP-CE card is equipped in an add/drop node, the booster amplifier is mandatory and cannot be replaced by an OSC-CSM card. The preamplifier is an OPT-BST, OPT-BST-E, or OPT-AMP-C card, and must be cabled as an unidirectional card. Note that the COM-TX and LINE-RX ports must not be used for any other connections. If a single module ROADM 40-SMR-1-C is used as an add/drop card, a preamplifier is not required. If a single module ROADM 40-SMR-2-C is used as an add/drop card, both the preamplifier and booster are not required.

The following diagram shows the OPT-RAMP-C or OPT-RAMP-CE card in an add/drop node.

Figure 69: OPT-RAMP-C or OPT-RAMP-CE Card in an Add/Drop Node
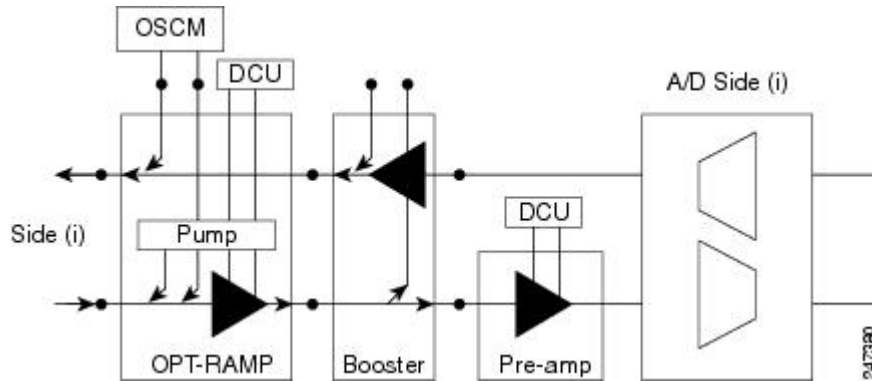
When required, a DCN extension can be used on A/D Side (i).

Side (i) can be equipped with the following cards:

- WSS + DMX

- AD-xC

- 40-WXC-C or 80-WXC-C + MUX + DMX

- Single module ROADM

OPT-RAMP-C or OPT-RAMP-CE Card in a Line Site Node with Booster Amplification

The OPT-RAMP-C or OPT-RAMP-CE card can be equipped in a line site node with a booster amplifier in the following configurations:

- OPT-BST and OPT-BST-E can be used as booster in a line site node with OPT-RAMP-C or OPT-RAMP-CE. The booster cards need to be cabled as bidirectional units. The following figure shows the OPT-RAMP-C or OPT-RAMP-CE card in a line site configuration.

Figure 70: OPT-RAMP-C Card or OPT-RAMP-CE Card in a Line Site Configuration
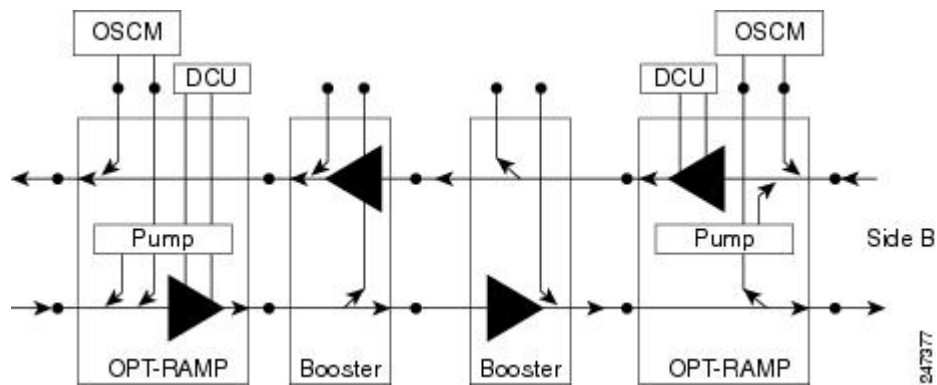
- The OPT-AMP-C can be used as a booster in a line site node with OPT-RAMP-C or OPT-RAMP-CE and needs to be cabled as a bidirectional unit. An additional DCU unit can be equipped between the

OPT-AMP-C DC ports. The following figure shows a line site configured with OPT-AMP-C card and an additional DCU unit.

Figure 71: Line Site Configured with OPT-AMP-C
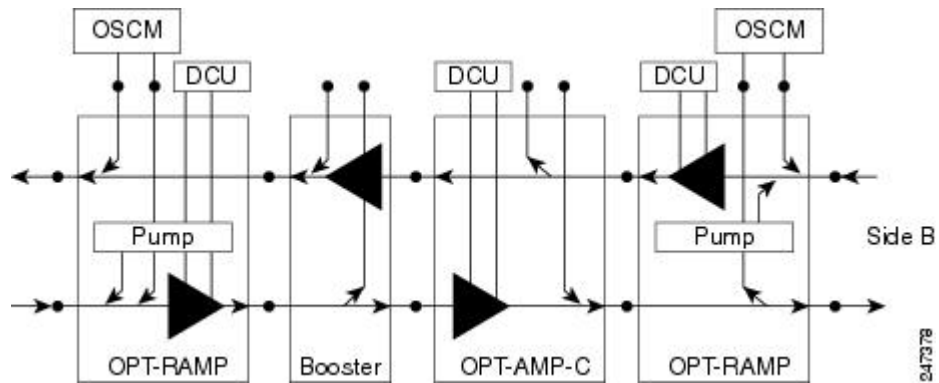
• A line site can be configured with OPT-RAMP-C or OPT-RAMP-CE card on one side only. The following figure shows the line site configured with OPT-RAMP-C or OPT-RAMP-CE on side A only. The booster is configured on side B.

Figure 72: Line Site with OPT-RAMP-C or OPT-RAMP-CE On One Side
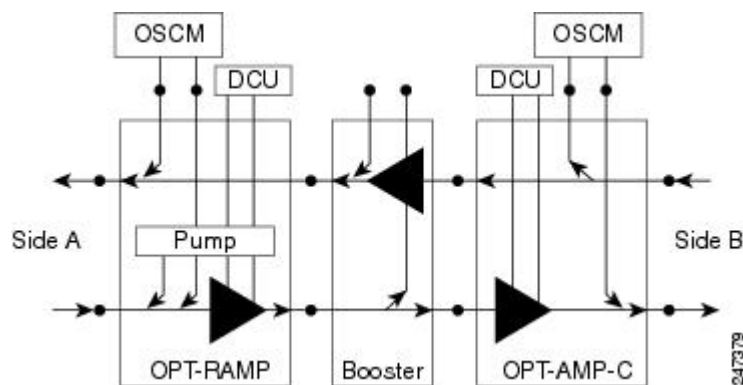
In all configurations, the booster amplifier facing the OPT-RAMP-C or OPT-RAMP-CE card is mandatory for safety reasons.

OPT-RAMP-C or OPT-RAMP-CE Card in a Line Site Node Without Post - Amplification

The OPT-RAMP-C or OPT-RAMP-CE card can be equipped in a line site node in the following configurations:

• A symmetric Raman configuration without post-amplifiers with an OPT-RAMP-C or OPT-RAMP-CE card on Side A and Side B in a line site node (see the following figure). In this configuration, the OPT-RAMP-C or OPT-RAMP-CE cards do not support DCU units.

Figure 73: Symmetric Raman Configuration Without Post-Amplifiers
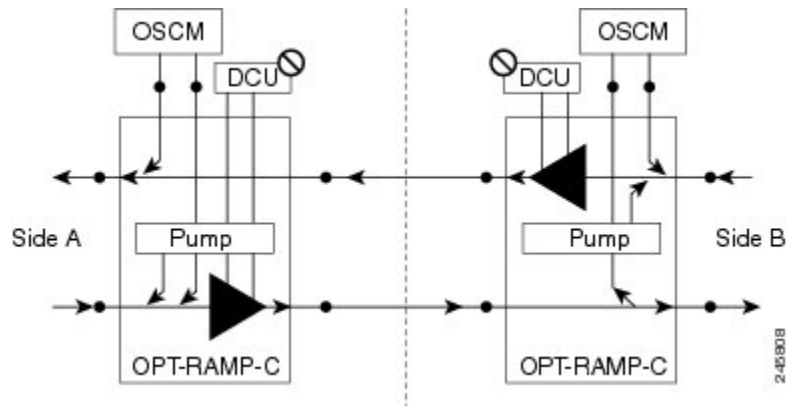
- An asymmetric configuration of a line site node where Side A is a standard Raman configuration equipped with OPT-RAMP-C or OPT-RAMP-CE and booster cards and Side B is a Raman configuration without post-amplifiers and is equipped with OPT-RAMP-C or OPT-RAMP-CE cards (see the following figure). Side B does not support DCU units.

Figure 74: Asymmetric Configuration With Standard Raman on Side A and Raman Without Post-Amplifier on Side B
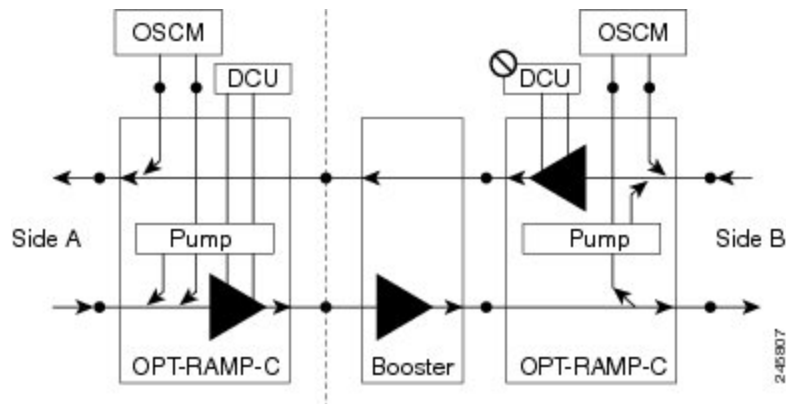
- An asymmetric configuration of a line site node where Side A is a Raman configuration without post-amplifier equipped with OPT-RAMP-C or OPT-RAMP-CE cards (without DCU units) and Side B is configured with OSC-CSM cards (see the following figure).

Figure 75: Asymmetric configuration With One Side Configured as Raman Without Post-Amplifier
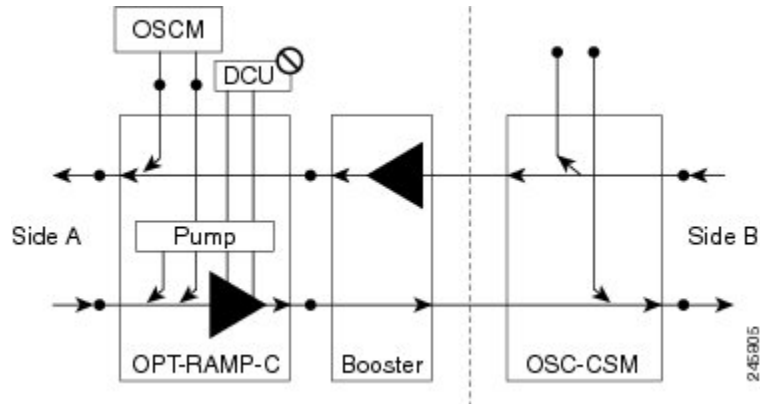
Supported Node Configurations for PSM Card

The PSM card supports the following node configurations:

Channel Protection

In a channel protection configuration, the PSM card is used in conjunction with a TXP/MXP card. The PSM card in a channel protection configuration can be used in any site apart from a terminal site.

The following figure shows the DWDM functional view of a PSM card in channel protection configuration.

Figure 76: PSM Channel Protection Configuration
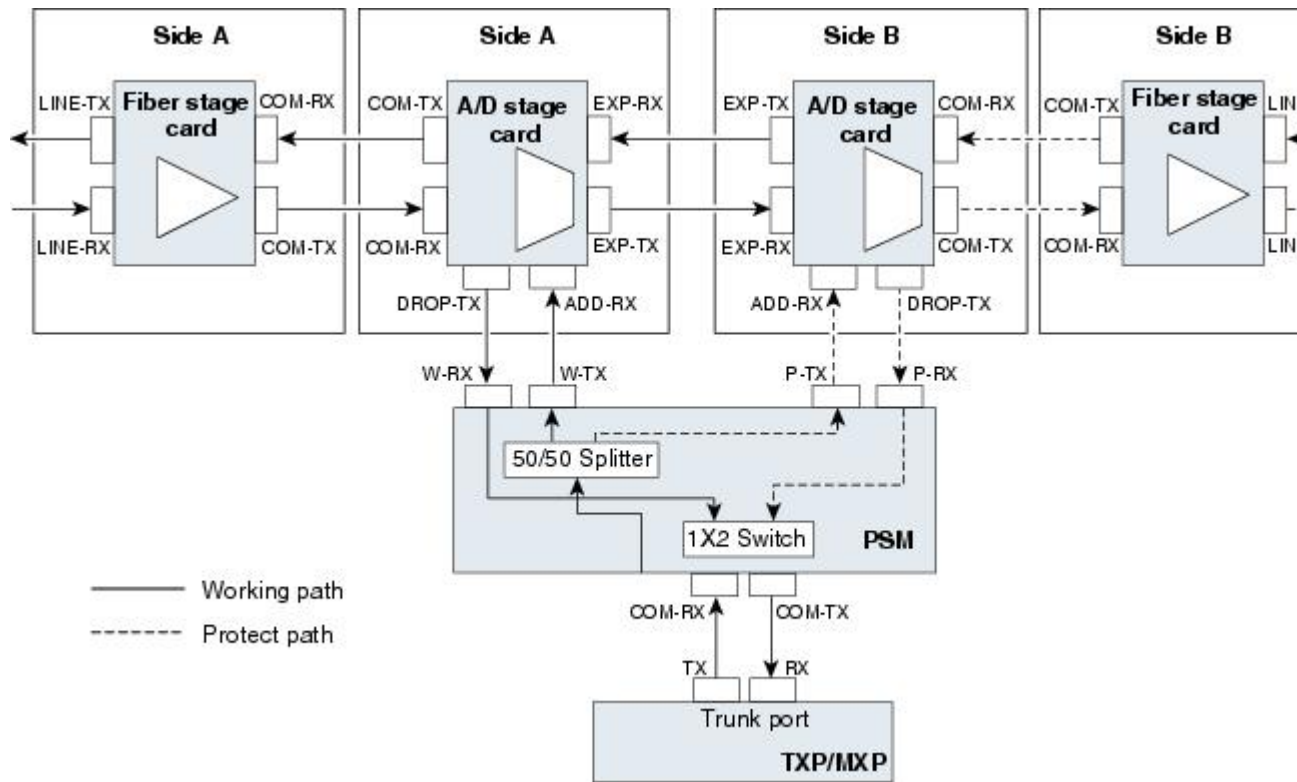
In this configuration, the COM-RX and COM-TX ports of the PSM card are connected to the TXP/MXP trunk ports. This configuration is applicable to an *n*-degree MSTP node, for example, a two-degree ROADM, an *n*-degree ROADM, or an OADM node. The example block diagram shows a two-degree node with Side A and Side B as the two sides. The Side A and Side B fiber-stage block can be DWDM cards that are used to amplify transmitted or received signal (see the Fiber Stage, on page 70 for the list of cards). The Side A and Side B add/drop stage block can be DWDM cards that can add and drop traffic (see the A/D Stage, on page 73 for the list of cards).

In the transmit direction, the traffic originating from a TXP/MXP trunk port is split by the PSM card on to the W-TX and P-TX ports. The W-TX and P-TX ports are connected to the ADD-RX ports of the add/drop stage cards in Side A and Side B respectively. The add/drop stage cards multiplex traffic on Side A and Side B line ports that become the working and protect paths respectively.

In the receive direction, the W-RX and P-RX ports of the PSM card are connected to the DROP-TX ports of the add/drop stage cards on Side A and Side B respectively. The add/drop stage cards demultiplex traffic received from Side A and Side B line ports that are the working and protect paths respectively. The PSM card selects one of the two input signals on the W-RX and P-RX ports to be transmitted to the COM-RX port of the PSM card.

Note   All traffic multiplexed or demultiplexed by the two add/drop stage cards is not protected.

Multiplex Section Protection

The PSM card performs multiplex section protection when connected between a multiplexer/demultiplexer card in a terminal site. The multiplexer/demultiplexer stage can be built using WSS and DMX or 40MUX and 40DMX cards. The terminal sites can be 50/100 Ghz band. The number of supported channels can therefore be 32/40 or 72/80.

The following figure shows the block diagram of a PSM card in multiplex section protection configuration.

Figure 77: PSM Multiplex Section Protection Configuration
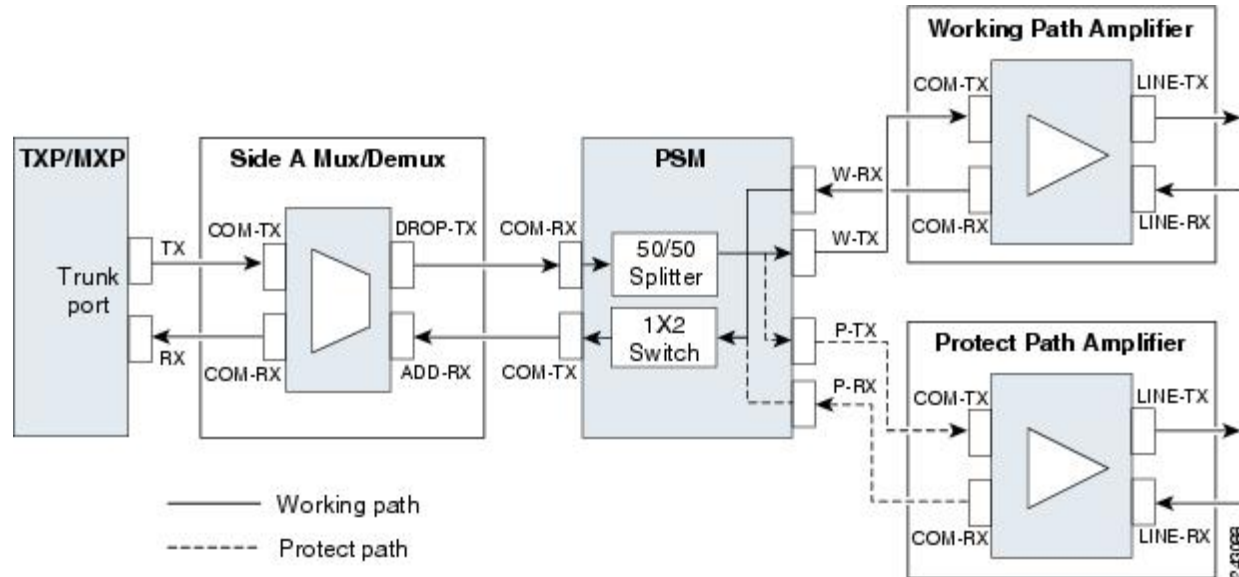
In the transmit direction, the traffic originating from a TXP trunk port is multiplexed by the Side A multiplexer. The PSM card splits traffic on to the W-TX and P-TX ports, which are independently amplified by two separated booster amplifiers.

In the receive direction, the signal on the line ports is preamplified by two separate preamplifiers and the PSM card selects one of the two input signals on the W-RX and P-RX ports to be transmitted to the COM-RX port of the PSM card. The received signal is then demultiplexed to a TXP card.

The presence of a booster amplifier is not mandatory. However, if a DCN extension is used, the W-TX and P-TX ports of the PSM card can be connected directly to the line. The presence of a preamplifier is also not mandatory.

Note   The PSM card cannot be used with Raman amplification in a line protection or section protection configuration.

Line Protection

In a line protection configuration, the working and protect ports of the PSM card are connected directly to the external line. This configuration is applicable to any MSTP node that is configured as a terminal site. The multiplexer/demultiplexer stage can be built using WSS and DMX, 40MUX and 40DMX, 40-SMR1-C and 15216-MD-40-ODD, 15216-EF-40-ODD, or 15216-MD-48-ODD, or 40-SMR2-C and 15216-MD-40-ODD,

15216-EF-40-ODD, or 15216-MD-48-ODD units. The terminal sites can be 50/100 Ghz band. The number of supported channels can therefore be 32/40 or 72/80.

The following figure shows the block diagram of a PSM card in line protection configuration.

Figure 78: PSM Line Protection Configuration
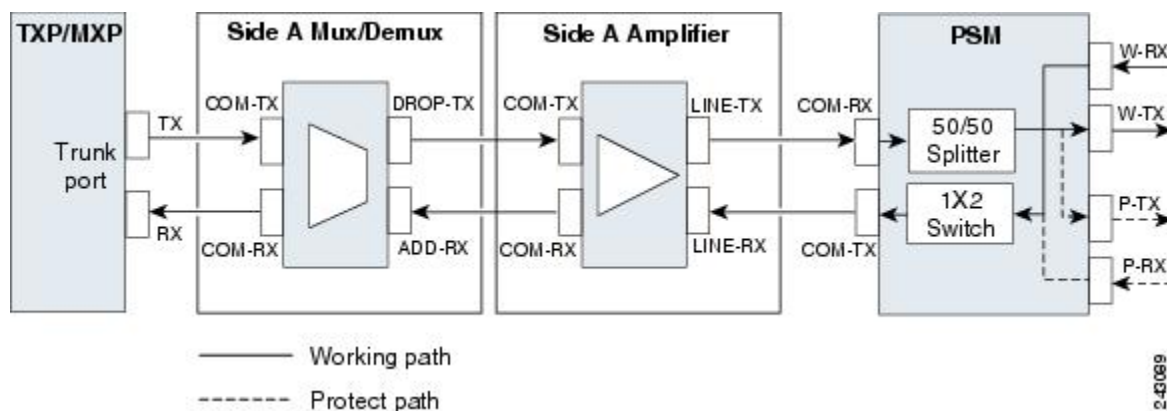
In the transmit direction, the traffic originating from a transponder trunk port is multiplexed by the Side A multiplexer and amplified by a booster amplifier. The Line-TX port of the amplifier is connected to the COM-RX port of the PSM card. The PSM card splits traffic received on the COM-RX port on to the W-TX and P-TX ports, which form the working and protect paths.

In the receive direction, the PSM card selects one of the two input signals on the W-RX and P-RX ports to be transmitted to the COM-RX port of the PSM card. The received signal is then preamplified and demultiplexed to the TXP card.

The presence of a booster amplifier is not mandatory. However, if a DCN extension is used, the COM-RX port of the PSM card is connected to the multiplex section. The presence of a preamplifier is also not mandatory; the COM-TX port of the PSM card can be connected to the demultiplexer.

Note   The PSM card cannot be used with Raman amplification in a line protection or section protection configuration.

Standalone

In a standalone configuration, the PSM card can be equipped in any slot and supports all node configurations. In this configuration, the PSM card provides only basic functionality, such as, protection against a fiber cut, optical safety, and automatic laser shutdown (ALS). It does not provide other functionalities such as, automatic power control (APC), automatic node setup (ANS), network and node alarm correlation, circuit management, and so on.

Multishelf Node

In a multishelf configuration, the ONS 15454 M6 node or the ONS 15454 DWDM node with TCC3 card as the node controller can manage up to 49 subtending shelves as a single entity. The subtending shelves can be ONS 15454 M6 or ONS 15454 DWDM nodes.

The node controller is the main shelf with the control cards running the multishelf functions. Each subtending shelf must be equipped with control 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 cards, external connection unit (ECU), or external connection unit2 (ECU2) modules. As an alternative, the Catalyst 2950 or the Catalyst 3560 switch can be used for internal data exchange between the node controller shelf and subtending shelves. If using the Catalyst 2950 or the Catalyst 3560 switch, it is installed on one of the multishelf racks. All subtending shelves must be located in the same site at a maximum distance of 100 meters or 328 feet from the Ethernet switches used to support the communication LAN.

The following figure shows an example of a multishelf node configuration.

Figure 79: Multishelf Node Configuration
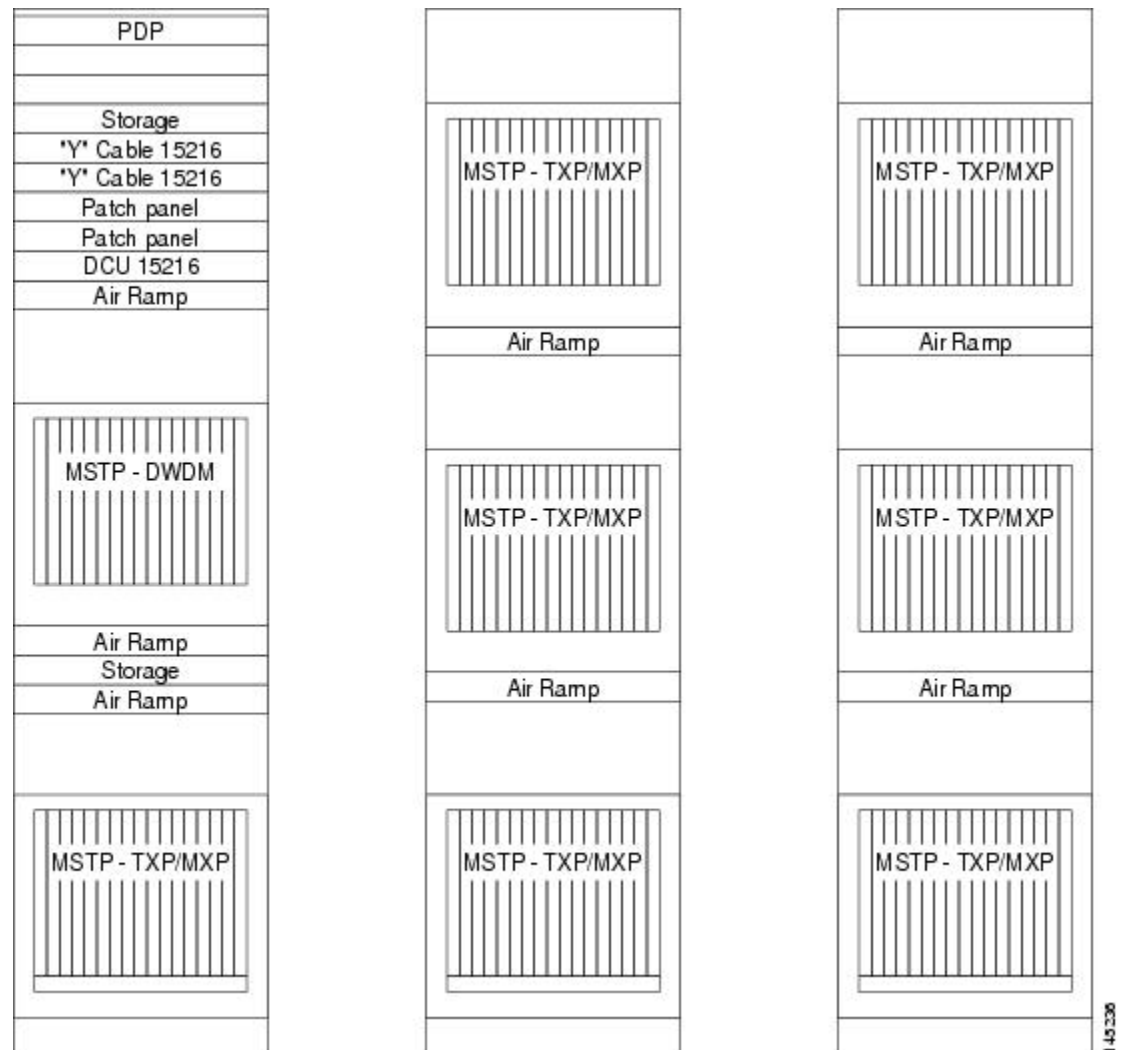
A multishelf node has a single public IP address for all client interfaces (Cisco Transport Controller [CTC], Transaction Language One [TL1], Simple Network Management Protocol [SNMP], and HTTP); a client can only connect to the node controller shelf, not to the subtending shelves. The user interface and subtending shelves are connected to a patch panel using straight-through (CAT-5) LAN cables.

The node controller shelf has the following functions:

- IP packet routing and network topology discovery at the node controller level.

- Open Shortest Path First (OSPF) centralized on the node controller shelf.

The subtending shelves have the following functions:

- Each subtending shelf will act as a single shelf node that can be used as a timing source line, control card clock, or building integrated timing supply (BITS) source line.

Multishelf Node Layout

Multishelf configurations are configured by Cisco TransportPlanner and are automatically discovered by the CTC software. In a typical multishelf installation, all optical units are equipped on the node controller shelf and TXP/MXP cards are equipped in the aggregated subtended shelves. In addition, all empty slots in the node controller shelf can be equipped with TXP/MXP cards. In a DWDM mesh network, up to eight optical sides can be configured with client and optical cards installed in different shelves to support mesh and ring-protected signal output.

Note   When a DWDM ring or network has to be managed through a Telcordia operations support system (OSS), every node in the network must be set up as multi-shelf. OLA sites and nodes with one shelf must be set up as "multi-shelf stand-alone" to avoid the use of LAN switches.

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 node. An OSC link between two nodes cannot be substituted by an equivalent generic communications channel/data communications channel (GCC/DCC) link terminated on the same pair of nodes. OSC links are mandatory and they can be used to connect a node to a gateway network element (GNE).

- GCC/DCC links terminate on TXP/MXP cards.

The maximum number of DCC/GCC/OSC terminations that are supported in a multishelf node is 48.

Note   Optical Service Channel can be created on the OC3 port of the TNC, TNCE, and TNCS cards.

Connecting Passive Modules to a ONS 15454 DWDM Node

The non-volatile flash memory of the passive optical modules store inventory and insertion loss (IL) data of the optical paths. The stored data can be retrieved through the USB port of the passive optical module by connecting it to the transport node controller card (TNC) of the Cisco ONS 15454 DWDM shelf assembly.

You can connect the following passive modules to an USB port of the Cisco ONS 15454 DWDM node:

- 15216-FLD-4

- 15216-MD-40-EVEN

- 15216-EF-40-EVEN

- 15216-MD-48-EVEN

- 15216-MD-40-ODD

- 15216-EF-40-ODD

- 15216-MD-48-ODD

- 15216-MD-ID-50

- 15216-MD-48-CM

- 15216-FBGDCU

- MF-16AD-CFS

- MF-4x4-COFS

- MF-DEG-5

- MF-UPG-4

- MF-MPO-8LC

- MF-MPO-16LC

- MF-2MPO-ADP

- MF-16AE-CFS

- MF-10AD-CFS

- PPMESH8-5AD

- MF-DEG-5-CV

- MF-UPG-4-CV

- MF-M16LC-CV

- MF-MPO-20LC

For the related procedure, see NTP-G319 Connecting a Passive Module to the Cisco ONS 15454 DWDM Node.

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 Side Line Ports, on page 73) that are physically connected to the spans. An MSTP node can be connected to a maximum of 8 different spans. Each side identifies one of the spans the MSTP node is connected to.

Note Side A and Side B replace "west" and "east" when referring to the two sides of the ONS 15454 shelf. Side A refers to Slots 1 through 6 (formerly "west"), and Side B refers to Slots 12 through 17 (formerly "east"). The line direction port parameter, East-to-West and West-to-East, has been removed.

Sides are viewed and managed from the Provisioning > WDM-ANS > Optical Sides tab in CTC.

Optical Side Stages

All MSTP nodes can be modelled according to the following figure.

Figure 80: Interconnecting Sides Conceptual View
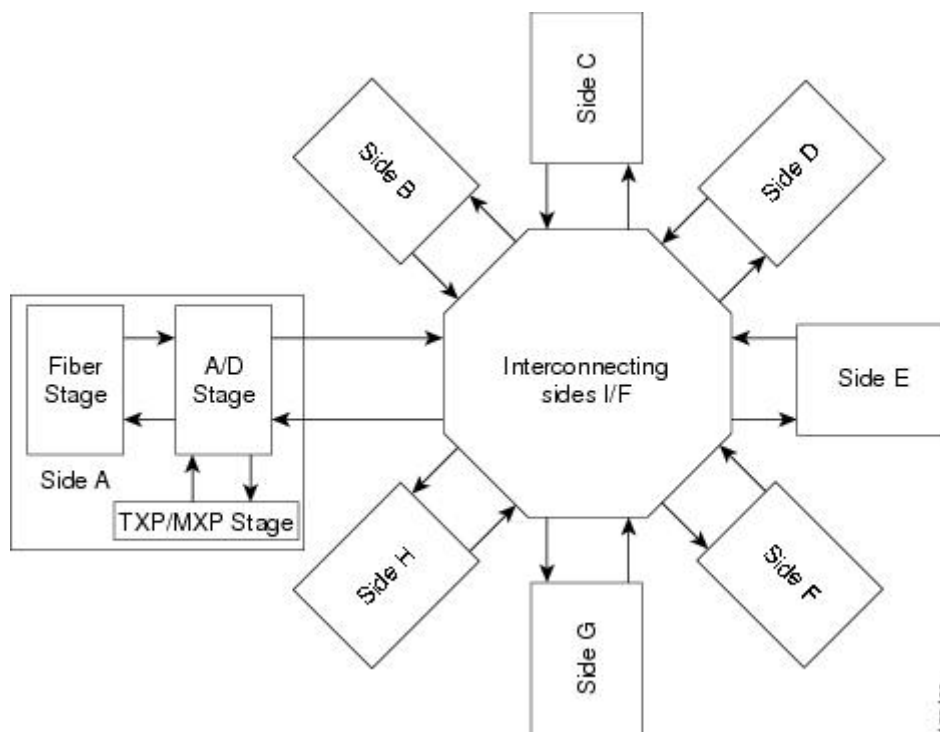
Each MSTP node side includes DWDM units that can be conceptually divided into three stages.

- 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.

Fiber Stage

The fiber stage includes cards that are used to amplify transmitted or received signals and cards that are used to add optical supervision channels. The fiber stage cards are:

- Booster amplifier cards that directly connect to the span, such as:

• OPT-BST

• OPT-BST-E

• OPT-BST-L

• OPT-AMP-C, when provisioned in OPT-LINE (booster amplifier) mode

• OPT-AMP-L, when provisioned in OPT-LINE (booster amplifier) mode

• OPT-AMP-17-C, when provisioned in OPT-LINE (booster amplifier) mode

• Preamplifier cards, such as:

• OPT-PRE

• OPT-AMP-C, when provisioned in OPT-PRE (preamplifier) mode

• OPT-AMP-L, when provisioned in OPT-PRE (preamplifier) mode

• OPT-AMP-17-C, when provisioned in OPT-PRE (preamplifier) mode

• OSC cards, such as:

• OSCM

• OSC-CSM

• OPT-RAMP-C card

The following table 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 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 o LINE ports • OPT-BST LINE ports connected to the span • OPT-BST COM-TX ports connected to OPT-AMP ((mode) or OPT-PRE COM-RX ports • OPT-AMP (OPT-PRE mode) or OPT-PRE LINE-TX ports connected to the next stage (for example, a 40-WSS-C/40-WSS-CE COM-RX port in a ROADM • OPT-BST COM-RX ports connected to the next stage (a 40-WSS-C/40-WSS-CE COM-TX port in a ROAD

Layout	Cards	Configurations
B	OPT-AMP (OPT-BST mode) <-> OPT-PRE/OPT-AMP (OPT-PRE mode)	• OPT-AMP (BST) OSC ports connected to OSCM OSC ports 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 port in a ROADM node) • OPT-AMP (BST) COM-RX port connected to the next stage (for example, a 40-WSS-C/40-WSS-CE COM-TX port in a ROADM node)
C	OSC-CSM <-> OPT-PRE/OPT-AMP(OPT-PRE mode)	• OSC-CSM LINE ports connected to the span • OSC-CSM COM-TX ports connected to OPT-AMP COM-RX ports • OPT-AMP(PRE)/OPT-PRE LINE-TX/COM-TX port connected to the next stage (for example, 40-WSS-C/40-WSS-CE COM 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, 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)

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 .

- 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.

Side Line Ports

Side line ports are ports that are physically connected to the spans. Side line ports can be:

- All ports terminating the fiber stage and physically labeled as LINE, such as ports on the following cards:

  - Booster amplifier (OPT-BST, OPT-BST-E, or OPT-BST-L cards, and the OPT-AMP-C, OPT-AMP-L, or OPT-AMP-17-C cards when provisioned in OPT-LINE mode)

  - OSC-CSM

  - OPT-RAMP-C

- All ports that can be physically connected to the external span using DCN terminations, such as:

  - Booster amplifier LINE-RX and LINE-TX ports

  - OSC-CSM LINE-RX and LINE-TX ports

  - 40-WXC-C COM-RX and COM-TX ports

  - MMU EXP-A-RX and EXP-A-TX ports

- All ports that can be physically connected to the external span using DCN terminations in a line node, such as:

  - Preamplifier (OPT-PRE card and the OPT-AMP-C, OPT-AMP-L, or OPT-AMP-17-C cards when provisioned in OPT-PRE mode) COM-RX and COM-TX ports

  - Booster amplifier COM-TX port

  - OSC-CSM COM-TX port

- All ports that can be physically connected to the external span using DCN terminations in a 40-channel MUX/DMX terminal node, such as:

  - 40-MUX-C COM-TX port

  - 40-DMX-C COM-RX port

- All ports that can be physically connected to the external span when PSM cards implement line protection:

- PSM W-TX and W-RX ports

- PSM P-TX and P-RX ports

Note   PSM card will support two sides A(w) and A(p).

Optical Side Configurations

You can use the following Side IDs depending on the type of node layout:

- In legacy nodes (that is, a node with no provisioned or installed 40-WXC-C cards), the permissible Side IDs are only A and B.

- In four-degree mesh nodes with four or less 40-WXC-C cards installed, the permissible Side IDs are A, B, C, and D.

- In eight-degree mesh nodes with eight or less 40-WXC-C cards installed, the allowed Side IDs are A, B, C, D, E, F, G, and H.

The system automatically assigns Side IDs when you import the CTP XML configuration file into CTC. You can create a side manually using CTC or TL1 if the following conditions are met:

- You use a permissible side identifier, A through H.

- The shelf contains a TX and an RX side line port (see the Side Line Ports, on page 73).

- The side line ports are not connected to an internal patchcord.

Note   We do not recommend that you manually create or modify ONS 15454 optical sides.

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

The following table 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 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	—

Shelf	Slots 1–6	Side	Slots 12–17	Side
6	TXP/MXP	—	TXP/MXP	—
7	TXP/MXP	—	TXP/MXP	—
8	TXP/MXP	—	TXP/MXP	—

The following table 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 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	—

The following table 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 4: Multishelf Four-Degree Mesh Node Layout Example

Shelf	Slots 1–6	Side	Slots 12–17	Side
1	WXC Line Termination	A	TXP/MXP	—
2	WXC Line Termination	B	WXC Line Termination	C
3	WXC Line Termination	D	TXP/MXP	—
4	TXP/MXP	n/a	TXP/MXP	—
5	TXP/MXP	n/a	TXP/MXP	—
6	TXP/MXP	n/a	TXP/MXP	—

Shelf	Slots 1–6	Side	Slots 12–17	Side
7	TXP/MXP	n/a	TXP/MXP	—
8	TXP/MXP	n/a	TXP/MXP	—

The following table 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 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	—

The following table 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 6: Multishelf Four-Degree Protected Mesh Node Layout Example

Shelf	Slots 1–6	Side	Slots 12–17	Side
1	WXC Line Termination	A	TXP/MXP	—
2	WXC Line Termination	B	TXP/MXP	—
3	WXC Line Termination	C	TXP/MXP	—
4	WXC Line Termination	D	TXP/MXP	—
5	TXP/MXP	—	TXP/MXP	—

Shelf	Slots 1–6	Side	Slots 12–17	Side
6	TXP/MXP	—	TXP/MXP	—
7	TXP/MXP	—	TXP/MXP	—
8	TXP/MXP	—	TXP/MXP	—

The following table 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 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	—

The following table 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 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

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	—

The following table 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: 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	—

The following table 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 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	—

Shelf	Slots 1–6	Side	Slots 12–17	Side
2	TXP/MXP	—	WXC Line Termination	C—Unknown
3	WXC Line Termination	D	TXP/MXP	—
4	TXP/MXP	—	TXP/MXP	—
5	WXC Line Termination	User-defined	TXP/MXP	—
6	TXP/MXP	—	TXP/MXP	—
7	TXP/MXP	—	TXP/MXP	—
8	TXP/MXP	—	TXP/MXP	—

Configuring Mesh DWDM Networks

The shelves can be configured in mesh DWDM networks using the 40-WXC-C or 80-WXC-C wavelength cross-connect cards and four-degree patch panel or eight-degree patch panels. Mesh DWDM networks can also be configured using the 40-SMR2-C cards and the four-degree patch panel.

The DWDM mesh configurations can be up to four degrees (four optical directions) when the four-degree patch panel is installed, and up to eight degrees (eight optical directions) when the eight-degree patch panel is installed. Two mesh node types are available, the line termination mesh node and the cross-connect (XC) termination mesh node.

Note Mesh nodes using the 40-WXC-C or 80-WXC-C card requires multishelf management.

Line Termination Mesh Node Using 40-WXC-C Cards

The line termination mesh node is installed in mesh networks. Line termination mesh nodes can support between one and eight line terminations. Each line direction requires the following cards: 40-WXC-C, 40-MUX-C, 40-DMX-C or 40-DMX-CE, a preamplifier and a booster. Within this configuration, the following substitutions can be used:

- The 40-MUX-C cards can be replaced with 40-WSS-C/40-WSS-CE cards.
- The OPT-BST cards can be replaced with OPT-AMP-17-C (in OPT-BST mode) and/or OPT-BST-E cards.
- The OPT-PRE can be replaced with an OPT-AMP-17-C (in OPT-LINE mode) card.

Each side of the line termination mesh node is connected as follows:

- The 40-WXC-C COM-RX port is connected to the preamplifier output port.
- The 40-WXC-C COM-TX port is connected to the booster amplifier COM-RX port.

- The 40-WXC-C DROP TX port is connected to the 40-DMX-C or 40-DMX-CE COM-RX port.

- The 40-WXC-C ADD-RX port is connected to the 40-MUX-C COM-TX port.

- The 40-WXC-C EXP-TX port is connected to the mesh patch panel.

- The 40-WXC-C EXP-RX port is connected to the mesh patch panel.

The following figure shows one shelf from a line termination node.

Figure 81: Line Termination Mesh Node Shelf
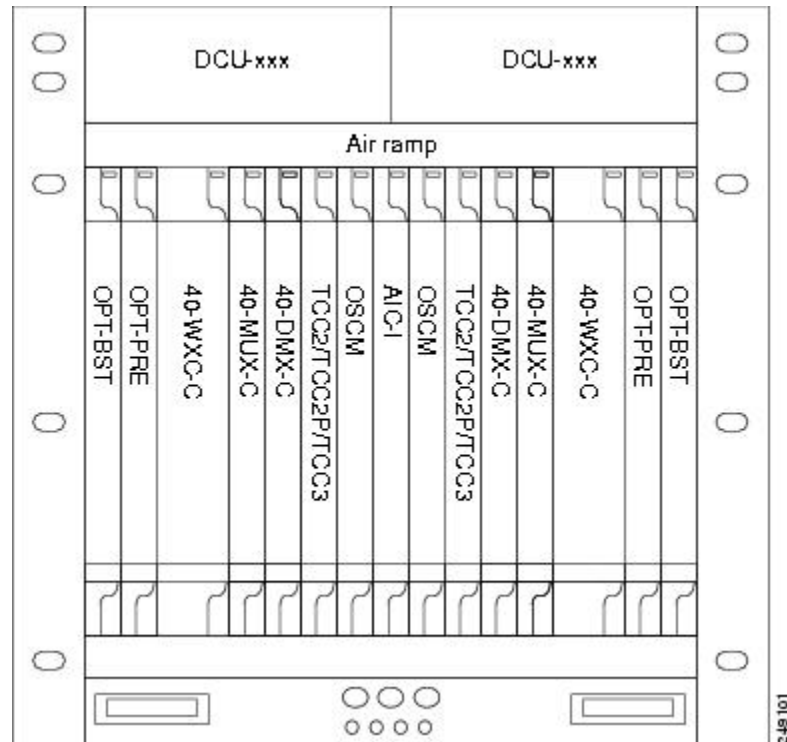
The following figure shows a functional block diagram of one line termination side using 40-WXC-C and 40-MUX-C cards.

Figure 82: Line Termination Mesh Node Side—40-MUX-C Cards
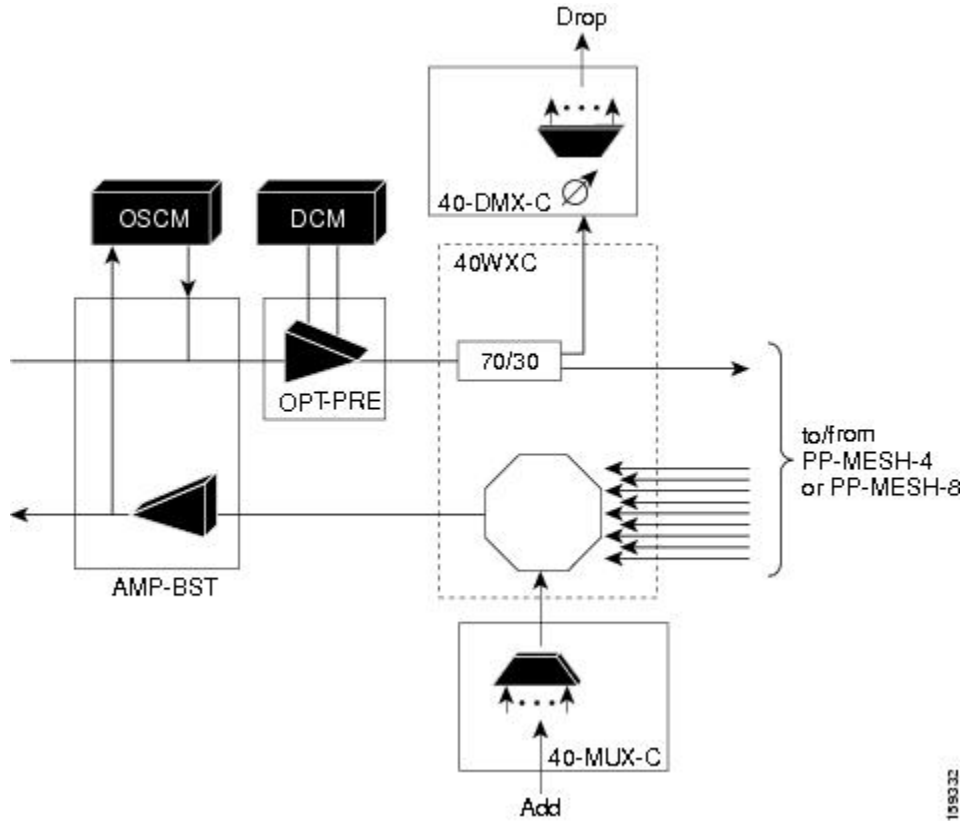
The following figure shows a functional block diagram line termination side using 40-WXC-C and 40-WSS-C cards.

Figure 83: Line Termination Mesh Node Side—40-WSS-C Cards

The following figure shows a functional block diagram of a node that interconnects a ROADM with MMU cards with two native line termination mesh sides.

Figure 84: Line Termination Mesh Nodes—ROADM With MMU Cards
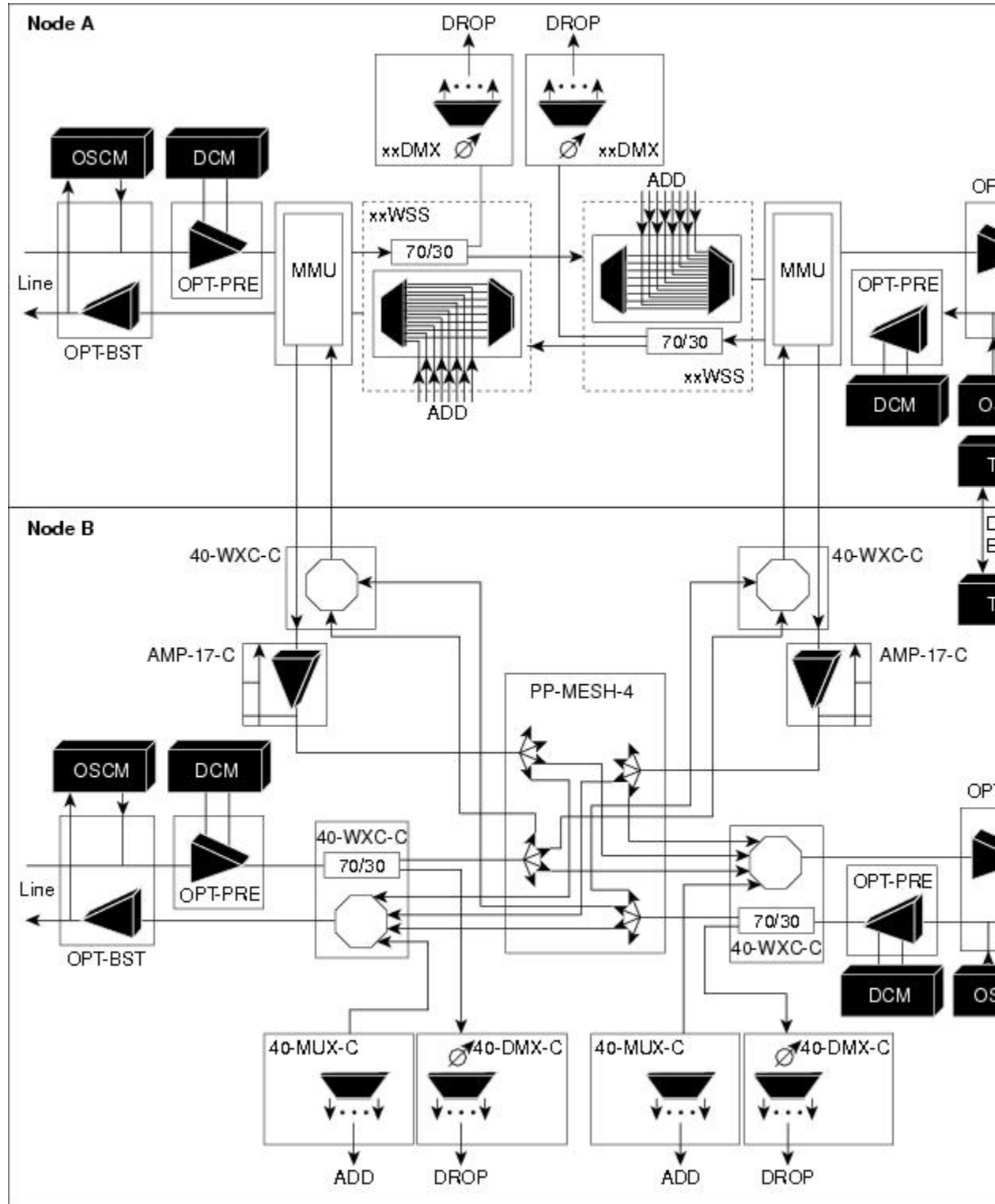
40-Channel Omni-directional n-degree ROADM Node

Any side in the line termination mesh node can be configured as an omni-directional side. The side that is configured as the omni-directional side is connected to a local multiplexer and demultiplexer that can add or drop traffic to or from any of the node directions.

In the following figure, side D is configured as the omni-directional side. Wavelengths from the local multiplexer on side D is routed to sides A, B, or C by the patch panel. Wavelengths from sides A, B, or C can be dropped on side D. The maximum number of omni-directional channels is 40.

Figure 85: 40-Channel Omni-directional Four-Degree ROADM Node

40-Channel Colorless n-Degree ROADM Node

Any side in the line termination mesh node can be configured as a colorless side where any wavelength can be added or dropped. The side that is configured as the colorless side is connected to two 80-WXC-C cards configured as a multiplexer and demultiplexer respectively. In the following figure, side D is configured as the colorless side. The 80-WXC-C cards are connected to the add and drop ports of the 40-WXC-C cards and function as a colorless multiplexer and demultiplexer.

A combination of wavelengths from any of the nine ports is sent to the common output port of the 80-WXC-C card (multiplexer) that is connected to the 40-WXC-C card. The wavelengths entering the 40-WXC-C card are sent to the common input port of the 80-WXC-C card (demultiplexer) and dropped at any of the nine output ports.

Figure 86: 40-Channel Colorless Four-Degree ROADM Node

40-Channel Colorless and Omni-directional n-Degree ROADM Node

Any side in the line termination mesh node can be configured as a colorless and omni-directional side. The side that is configured as the colorless and omni-directional side is connected to a multiplexer (80-WXC-C) and demultiplexer (80-WXC-C) that can add or drop traffic to or from any of the node directions.

The following figure shows the layout of a 40-channel n-degree ROADM node with colorless and omni-directional side.

Figure 87: 40-Channel n-Degree ROADM Node with Colorless and Omni-directional Side
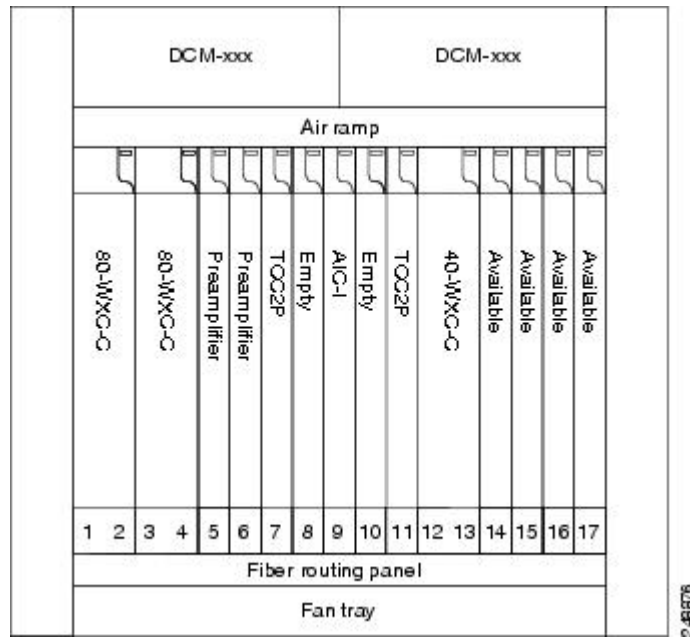
In the diagram below, side D is configured as the colorless and omni-directional side.

A combination of wavelengths from any of the nine ports is sent to the common output port of the 80-WXC-C card (multiplexer) and then routed to the preamplifier. The preamplifier sends the wavelengths to the 40-WXC-C card that is connected to the patch panel. The patch panel routes the wavelengths to sides A, B, or C.

Wavelengths from sides A, B, or C are dropped on side D. The incoming wavelengths from the 40-WXC-C card are sent to the preamplifier. The preamplifier amplifies the signal and sends it to the common input port of the 80-WXC-C card (demultiplexer). The wavelengths are then dropped at any of the nine output ports.

Figure 88: 40-Channel Colorless and Omni-directional Four-Degree ROADM Node
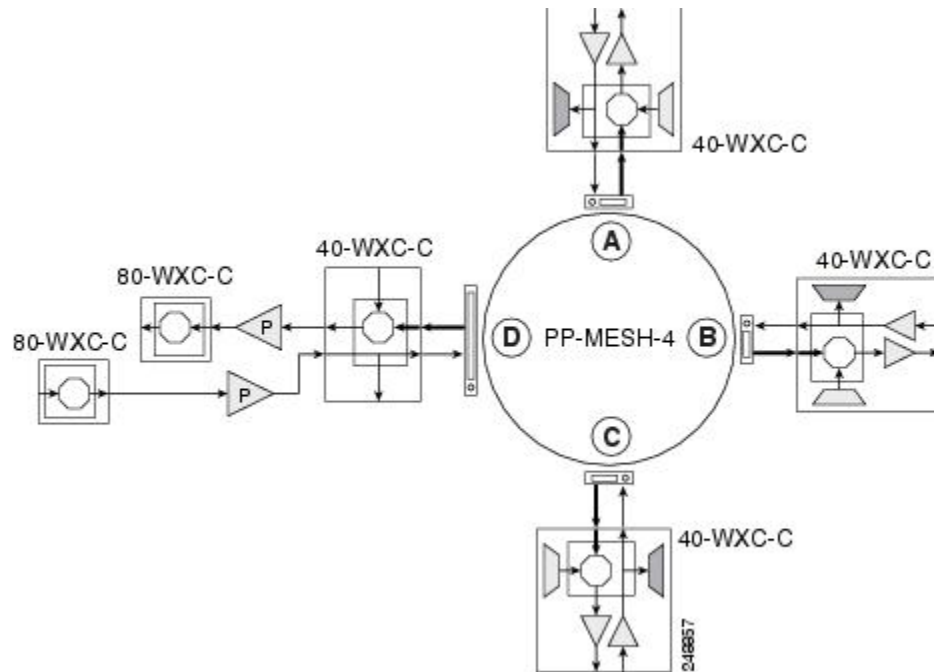
Line Termination Mesh Node Using 80-WXC-C Cards

Line termination mesh nodes using 80-WXC-C cards can support between one and eight line terminations. Each line direction requires the following units: 80-WXC-C, 15216-MD-40-ODD, 15216-EF-40-ODD, or 15216-MD-48-ODD, and 15216-MD-40-EVEN, 15216-EF-40-EVEN, or 15216-MD-48-EVEN, 15216-MD-ID-50 or 15216-MD-48-CM, a preamplifier, and a booster.

- The OPT-BST cards can be replaced with OPT-AMP-17-C (in OPT-BST mode) or OPT-BST-E cards.

- The OPT-PRE can be replaced with an OPT-AMP-17-C (in OPT-LINE mode) card.

Each side of the line termination mesh node is connected as follows:

- The 80-WXC-C COM-RX port is connected to the preamplifier output port.

- The 80-WXC-C COM port is connected to the booster amplifier COM-RX port.

- The 80-WXC-C DROP TX port is connected to the COM-RX (ODD+EVEN-RX) port of 15216-MD-ID-50 or 15216-MD-48-CM. The ODD-TX port of the 15216-MD-ID-50 or 15216-MD-48-CM is connected to the COM-RX port of 15216-MD-40-ODD, 15216-EF-40-ODD, or 15216-MD-48-ODD; and the EVEN-TX port of the 15216-MD-ID-50 or 15216-MD-48-CM is connected to the COM-RX port of 15216-MD-40-EVEN, 15216-EF-40-EVEN, or 15216-MD-48-EVEN.

- The 80-WXC-C AD port is connected to the COM-TX (ODD+EVEN-TX) port of 15216-MD-ID-50 or 15216-MD-48-CM. The ODD-RX port of the 15216-MD-ID-50 or 15216-MD-48-CM is connected to the COM-TX port of 15216-MD-40-ODD, 15216-EF-40-ODD, or 15216-MD-48-ODD; and the EVEN-RX port of the 15216-MD-ID-50 or 15216-MD-48-CM is connected to the COM-TX port of 15216-MD-40-EVEN, 15216-EF-40-EVEN, or 15216-MD-48-EVEN.

- The 80-WXC-C EXP-TX port is connected to the mesh patch panel.

The following figure shows the layout for a line termination node.
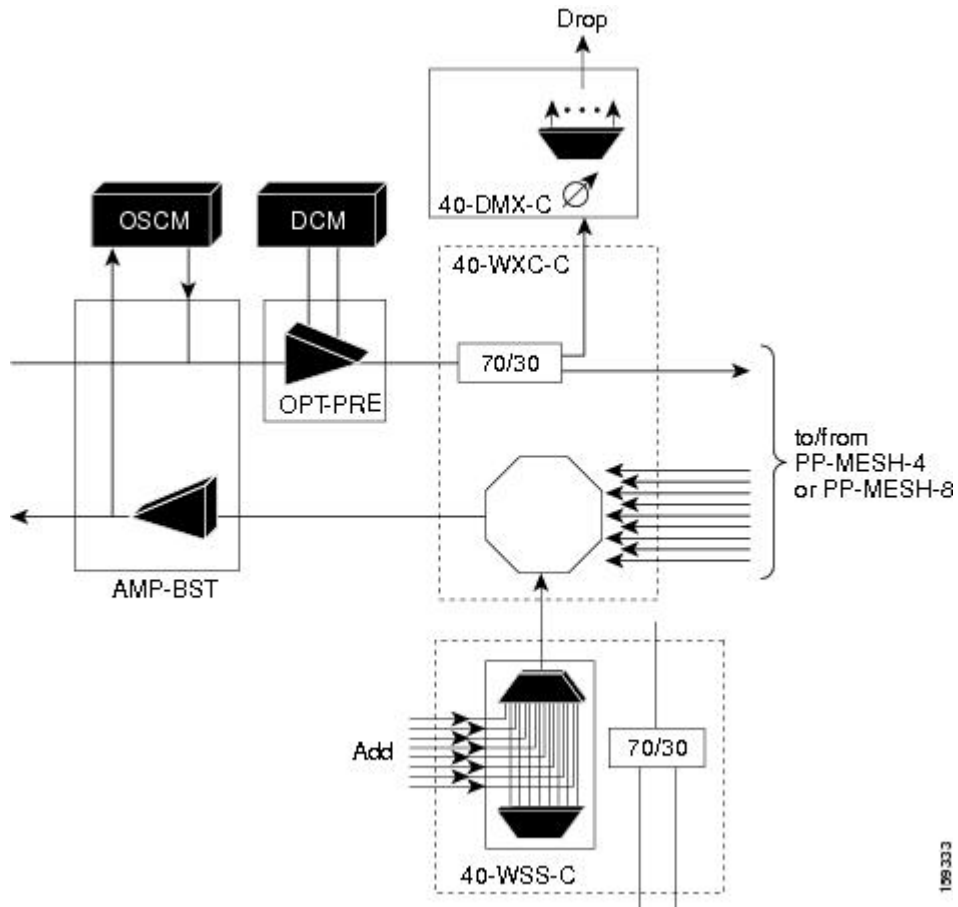
Figure 89: Line Termination Node
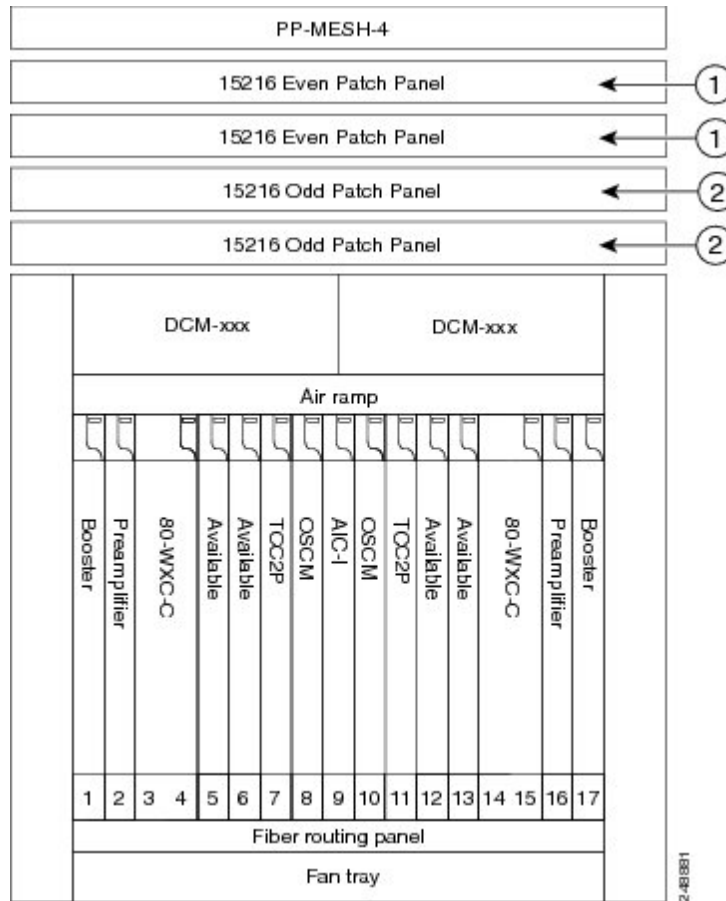
1	15216-MD-40-EVEN, 15216-EF-40-EVEN, or 15216-MD-48-EVEN patch panel
2	15216-MD-40-ODD, 15216-EF-40-ODD, or 15216-MD-48-ODD patch panel

The following figure shows the functional block diagram of a four-degree line termination mesh node using 80-WXC-C, 15216-MD-40-ODD, 15216-EF-40-ODD, 15216-MD-48-ODD, 15216-MD-40-EVEN, 15216-EF-40-EVEN, or 15216-MD-48-EVEN and a PP MESH-4. Wavelengths entering from side(i) can be routed to any of the other n-1 sides where n is defined by the PP MESH type.

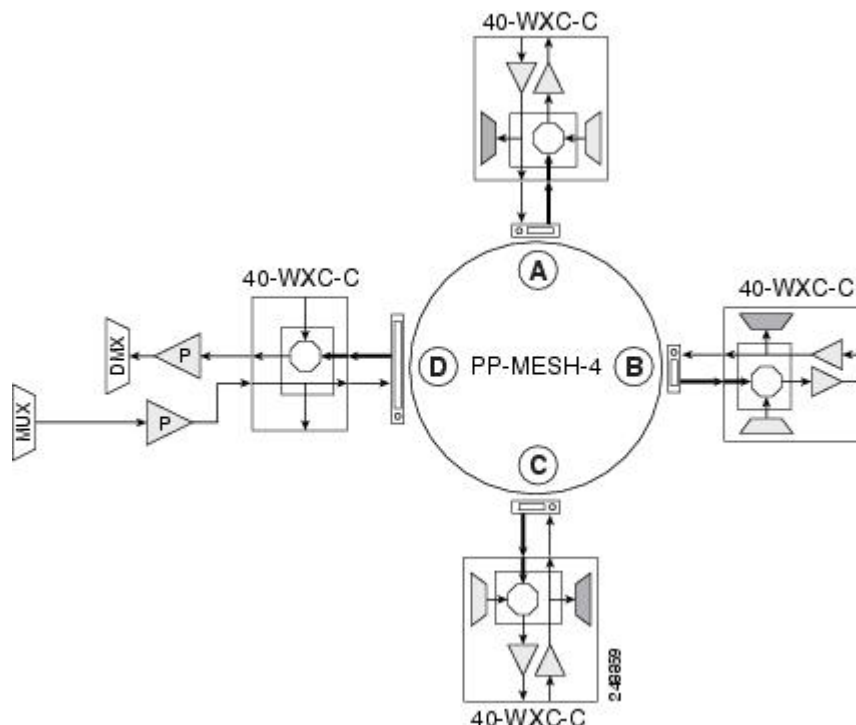Figure 90: Four-Degree Line Termination Mesh Node Functional Diagram
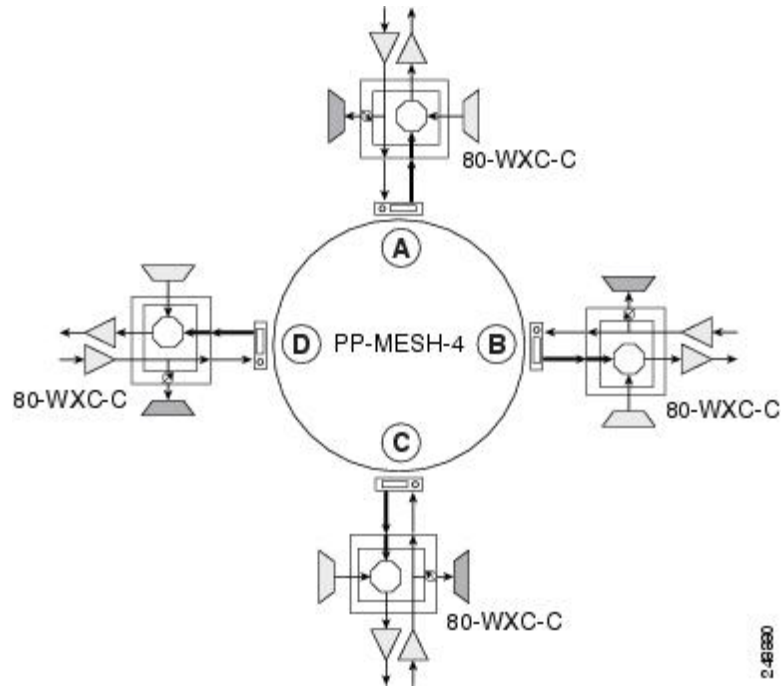
80-Channel Omni-directional n-degree ROADM Node

Any side in the line termination mesh node can be configured as a omni-directional side. The side that is configured as the omni-directional side is connected to a local multiplexer and demultiplexer that can add or drop traffic to or from any of the node directions.

Side D is configured as the omni-directional side. Wavelengths from the local multiplexer on side D are routed to sides A, B, or C by the patch panel. Wavelengths from sides A, B, or C are dropped on side D.

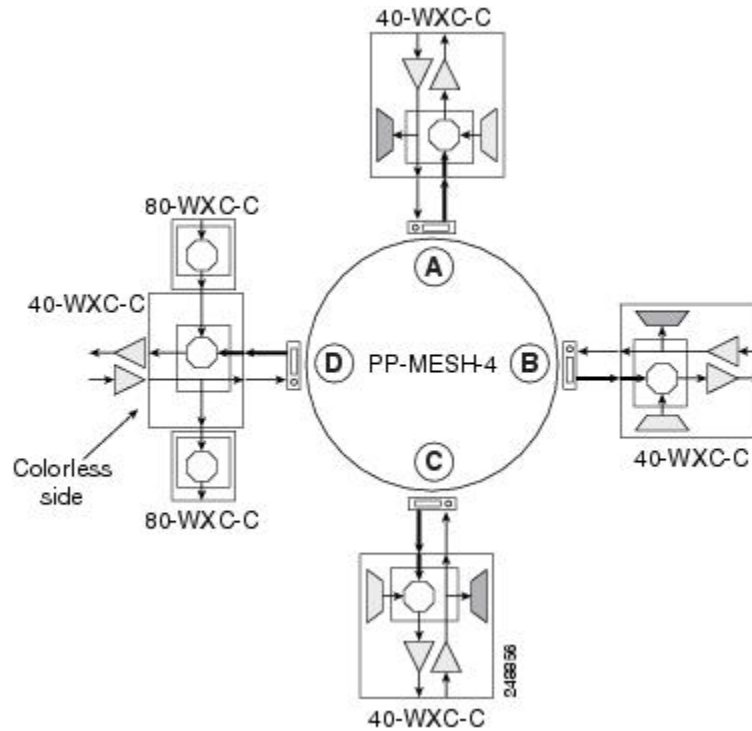*Figure 91: 80-Channel Omni-directional Four-Degree ROADM Node*
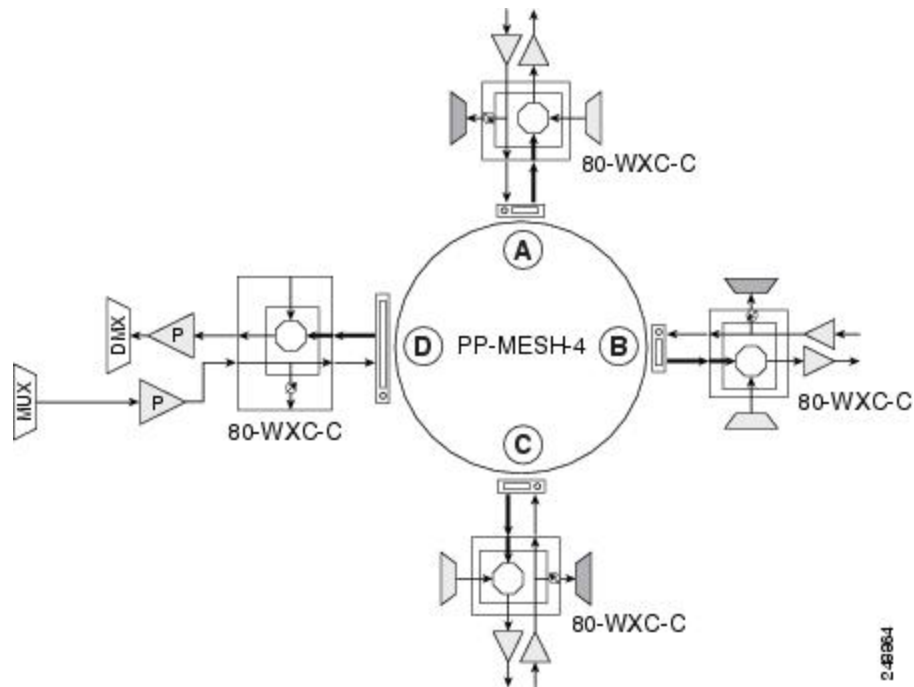
80-Channel Colorless n-degree ROADM Node

Any side in the line termination mesh node can be configured as a colorless side where any wavelength can be added or dropped. The side that is configured as the colorless side is connected to two 80-WXC-C cards configured as a multiplexer and demultiplexer respectively. In the following diagram, side D is configured as the colorless side. The 80-WXC-C cards are connected to the add and drop ports of the 80-WXC-C cards as a colorless multiplexer and demultiplexer.

A combination of wavelengths from any of the nine ports is sent to the common output port of the 80-WXC-C card (multiplexer) that is connected to the 80-WXC-C card. The wavelengths entering the 80-WXC-C card is passed to the common input port of the 80-WXC-C card (demultiplexer) and dropped at any of the nine output ports.

*Figure 92: 80-Channel Colorless Four-Degree ROADM Node*
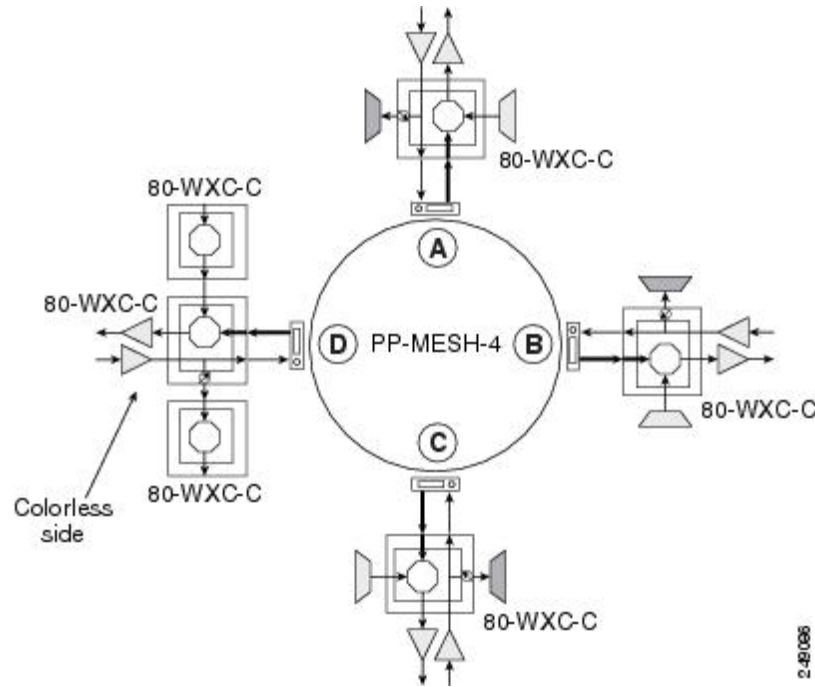
80-Channel Colorless and Omni-directional n-Degree ROADM Node

Any side in the line termination mesh node can be configured as a colorless and omni-directional side. The side that is configured as the colorless and omni-directional side is connected to a multiplexer (80-WXC-C) and demultiplexer (80-WXC-C) that can add or drop traffic to or from any of the node directions.

The following figure shows the layout of a 80-channel n-degree ROADM node with colorless and omnidirectional side.

Figure 93: 80-Channel n-degree ROADM Node with Colorless and Omnidirectional Side
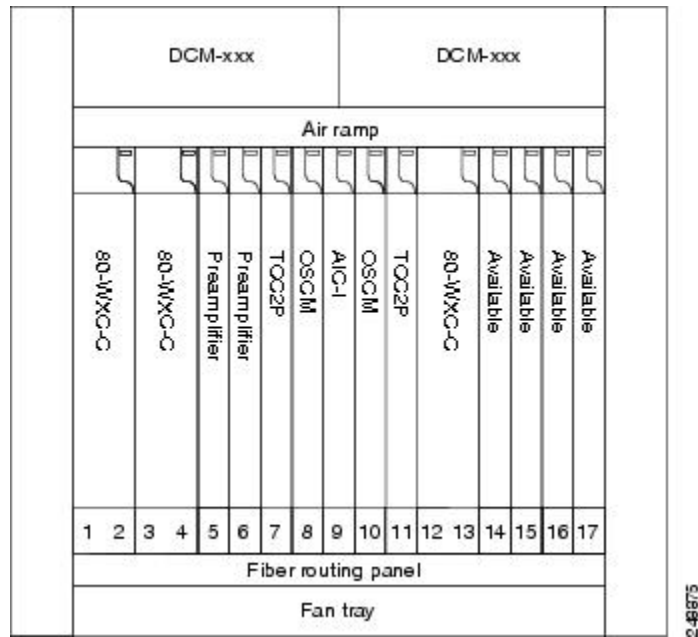

In the diagram below, side D is configured as the colorless and omni-directional side.

A combination of wavelengths from any of the nine ports is sent to the common output port of the 80-WXC-C card (multiplexer) and is then routed to the preamplifier. The preamplifier sends the wavelengths to the 80-WXC-C card that is connected to the patch panel. The patch panel routes the wavelengths to sides A, B, or C.

Wavelengths from sides A, B, or C can be dropped on side D. The incoming wavelengths from the 80-WXC-C card are sent to the preamplifier. The preamplifier amplifies the signal and sends it to the common input port of the 80-WXC-C card (demultiplexer). The wavelengths are then dropped at any of the nine output ports.

Figure 94: 80-Channel Colorless and Omni-directional Four-Degree ROADM Node
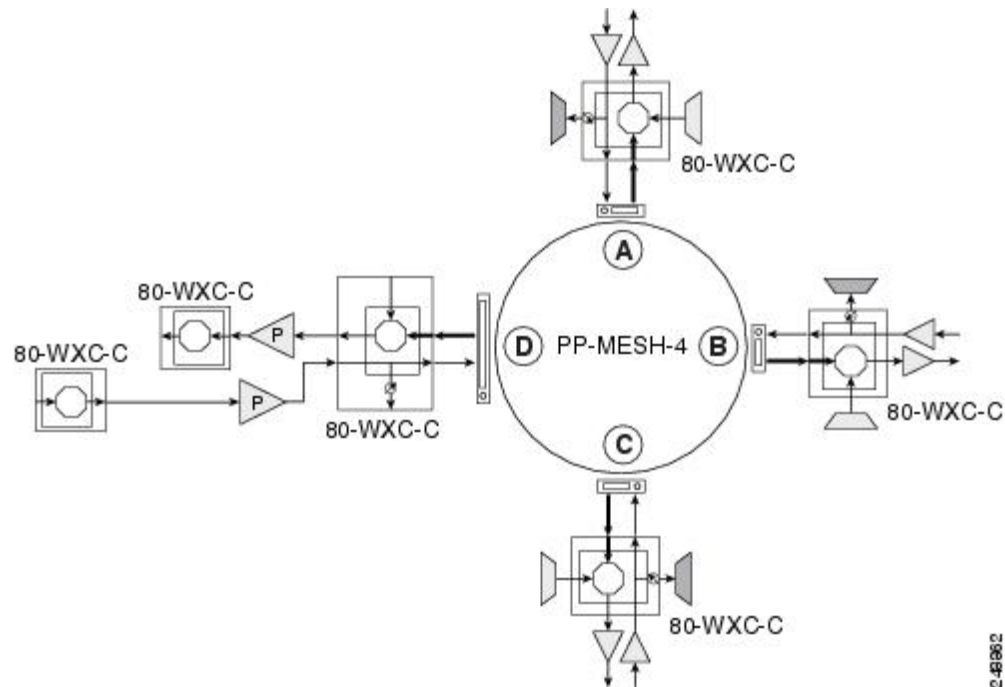
Line Termination Mesh Node Using 40-SMR2-C Cards

Line termination mesh nodes using the 40-SMR2-C cards can support between one and four line terminations. Each line direction requires the 40-SMR2-C and 15216-MD-40-ODD, 15216-EF-40-ODD, or 15216-MD-48-ODD units. Although it is recommended that you use the 15216-MD-40-ODD, 15216-EF-40-ODD, or 15216-MD-48-ODD patch panel along with the 40-SMR2-C card, you can alternatively use the 40-MUX-C and 40-DMX-C cards instead of the 15216-MD-40-ODD, 15216-EF-40-ODD, or 15216-MD-48-ODD patch panel.

Each side of the line termination mesh node is connected as follows:

- The 40-SMR2-C LINE-RX port is connected to the external line.

- The 40-SMR2-C LINE-TX port is connected to the external line.

- The 40-SMR2-C DROP TX port is connected to the 15216-MD-40-ODD, 15216-EF-40-ODD, or 15216-MD-48-ODD (or 40-DMX-C) COM-RX port.

- The 40-SMR2-C ADD-RX port is connected to the 15216-MD-40-ODD, 15216-EF-40-ODD, or 15216-MD-48-ODD (or 40-MUX-C) COM-TX port.

- The 40-SMR2-C EXP-TX port is connected to the mesh patch panel.

- The 40-SMR2-C EXPi-RX (where i = 1, 2, 3) port is connected to the mesh patch panel.

The following figure shows the layout for a line termination node.

Figure 95: Line Termination Mesh Node Shelf
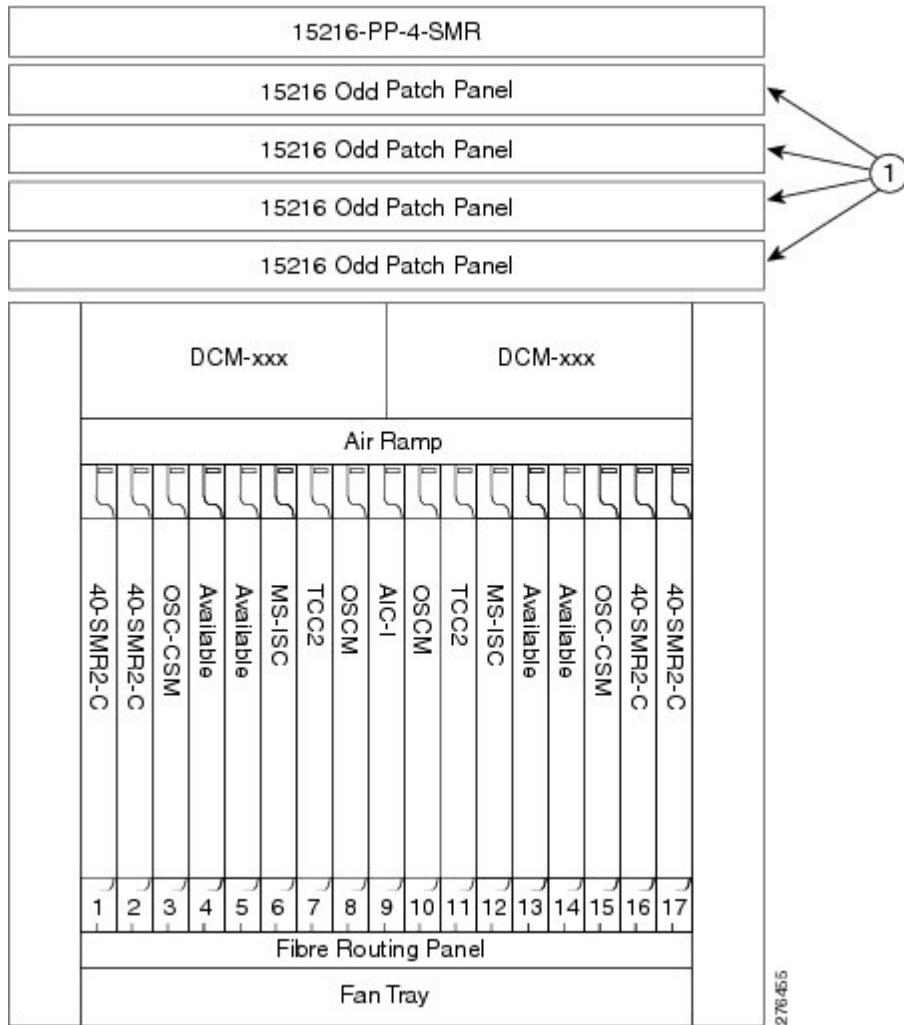
| 1 | 15216-MD-40-ODD, 15216-EF-40-ODD, or 15216-MD-48-ODD patch panel |

The following figure shows the functional block diagram of a four-degree line termination mesh node using 40-SMR2-C, 15216-MD-40-ODD, 15216-EF-40-ODD, or 15216-MD-48-ODD, and PP-4-SMR patch panel.

Figure 96: Four-Degree Line Termination Mesh Node Functional Diagram
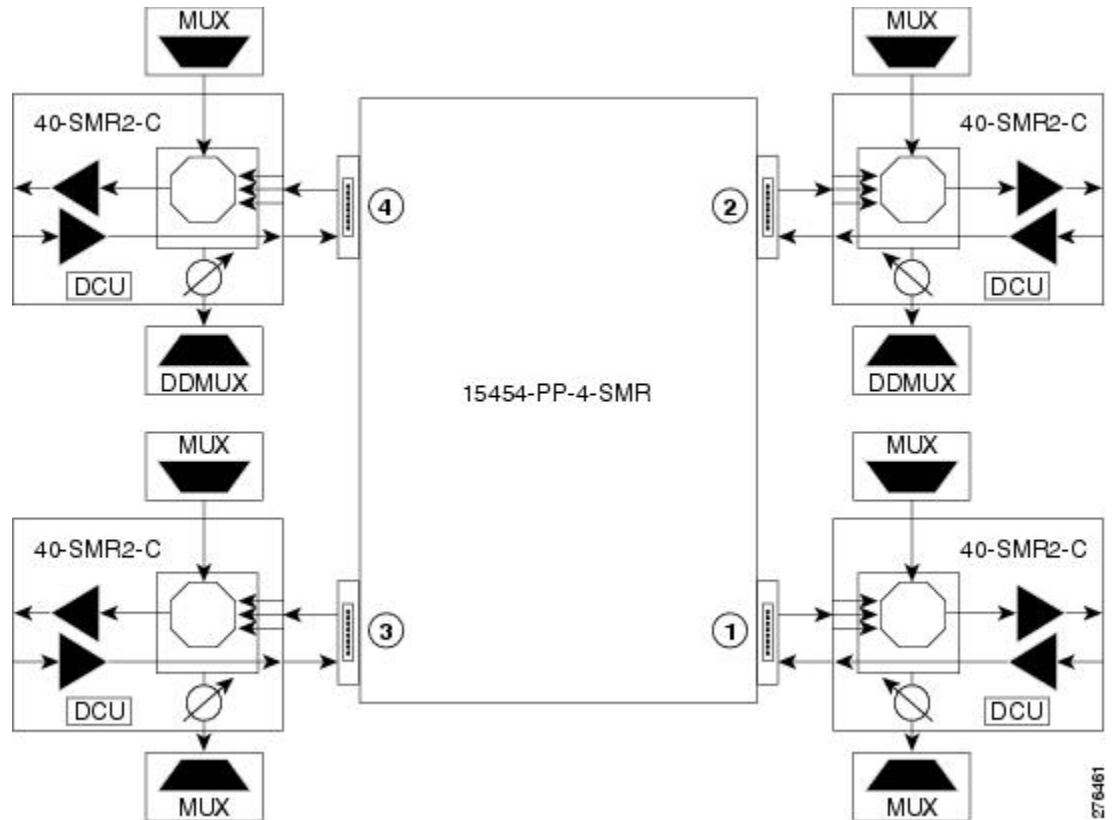
XC Termination Mesh Node

The XC termination mesh node, shown in the following diagram, is the second mesh node type. It is used to upgrade a non-mesh node to a mesh node or to interconnect two non-mesh nodes. The XC termination mesh nodes contain the following cards:

- 40-WXC-C cards

- OPT-AMP-17-C cards configured in OPT-PRE mode

The XC termination mesh node is connected as follows:

- The 40-WXC-C COM-RX port is connected to the MMU EXP-A-TX port.

- The 40-WXC-C COM-TX port is connected to the MMU EXP-A-RX port.

- The 40-WXC-C EXP-TX port is connected to the OPT-AMP-17-C COM-RX port.

- The 40-WXC-C EXP-RX port is connected to the OPT-AMP-17-C COM-TX port.

- The 40-WXC-C EXP-TX port is connected to the mesh patch panel.

- The 40-WXC-C EXP-RX port is connected to the mesh patch panel.

Figure 97: XC Termination Mesh Node Shelf
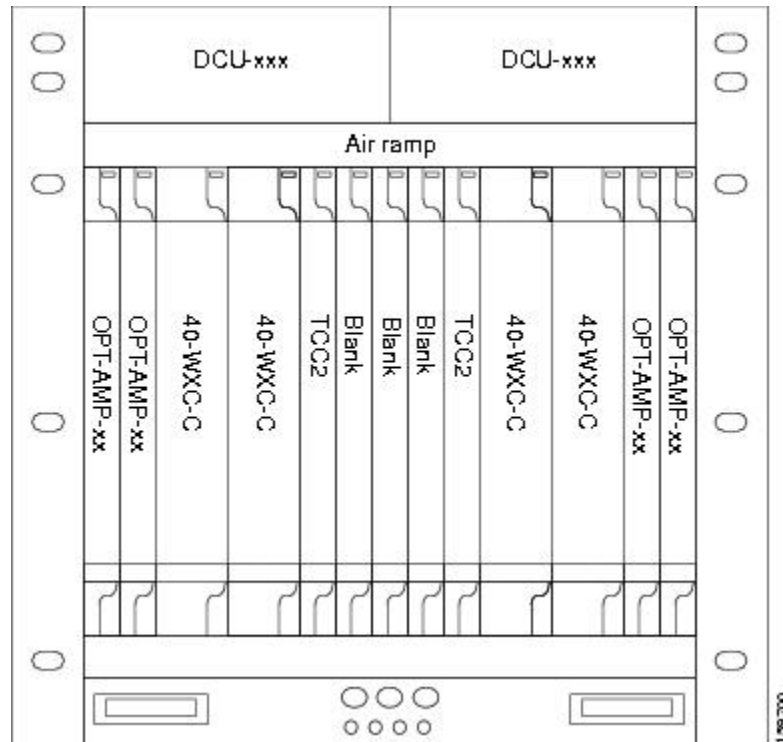
Mesh Patch Panels and Shelf Layouts

Mesh topologies require the installation of a four-degree patch panel, PP-MESH-4 (for 40-WXC-C cards) or PP-4-SMR (for 40-SMR2-C cards) or an eight-degree patch panel, PP-MESH-8 (for 40-WXC-C cards). If the four-degree patch panel is installed, mesh topologies of up to four degrees can be created. If the eight-degree patch panel is installed, mesh topologies of up to eight degrees can be created. The four-degree patch panel contains four 1x4 optical splitters, and the eight-degree patch panel contains eight 1x8 splitters. Each mesh patch panel contains a 2x8 splitter that is used for the test access transmit and receive ports. The following figure shows a block diagram for the PP-MESH-4 patch panel.

Figure 98: PP-MESH-4 Patch Panel Block Diagram
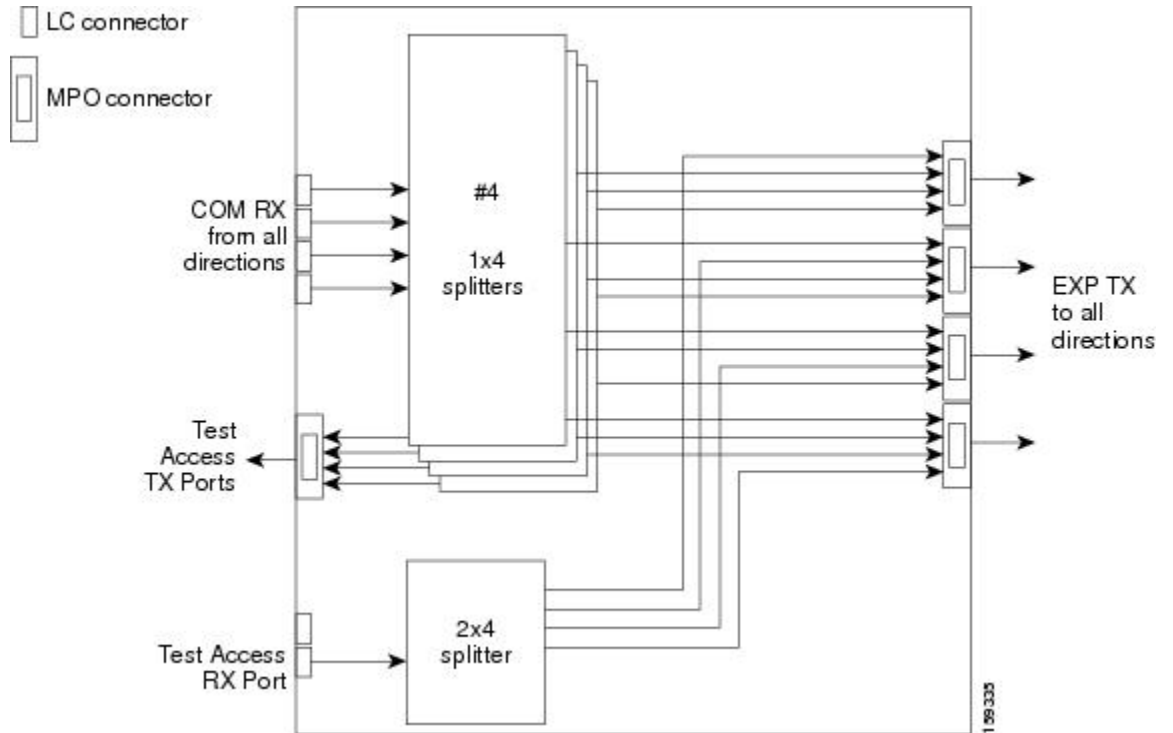
At the mesh patch panel, the signal is split into four signals (if a four-degree patch panel is used) or eight signals (if an eight-degree patch panel is used). The following figure shows the signal flow at the four-degree PP-MESH-4 patch panel. 40-WXC-C cards connect to the four-degree patch panel at the EXP TX and COM RX ports.

Figure 99: PP-MESH-4 Patch Panel Signal Flow
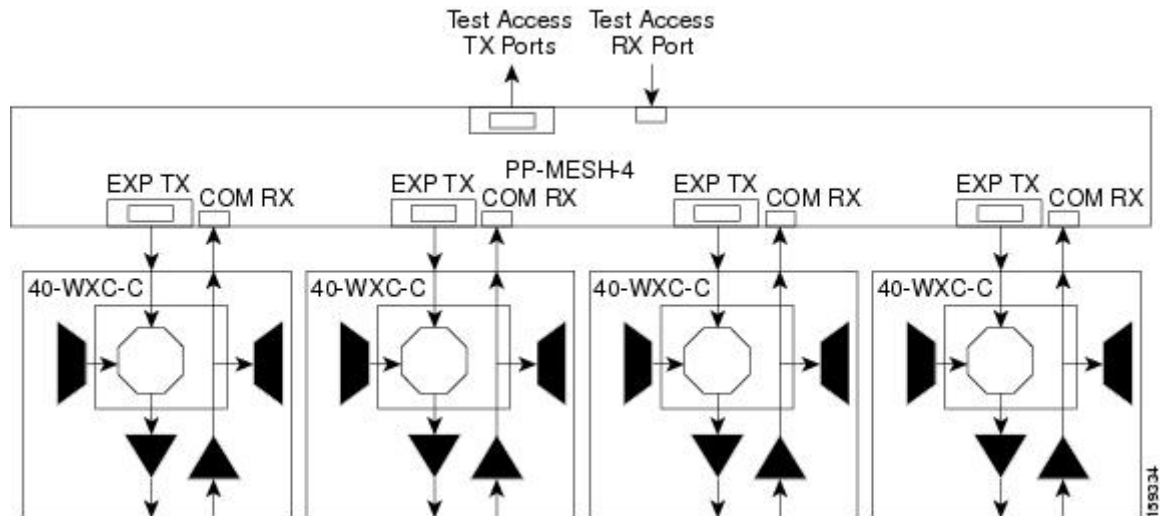
The mesh patch panels interconnect 40-WXC-C cards to create mesh networks, including four-degree and eight-degree mesh topologies. In addition, shelves with 40-WXC-C cards can be configured with mesh patch panels to create multiring, MMU-based mesh nodes. 40-WXC-C cards can be installed in ROADM nodes

with MMU cards to upgrade a two-degree MMU-based ROADM node into four-degree or eight-degree mesh nodes.

The following diagram shows the block diagram of the four-degree PP-4-SMR patch panel connected to one 40-SMR2-C card. The 40-SMR2-C cards connect to the PP-4-SMR patch panel at the EXP RX ports.

Figure 100: PP-4-SMR Patch Panel Block Diagram
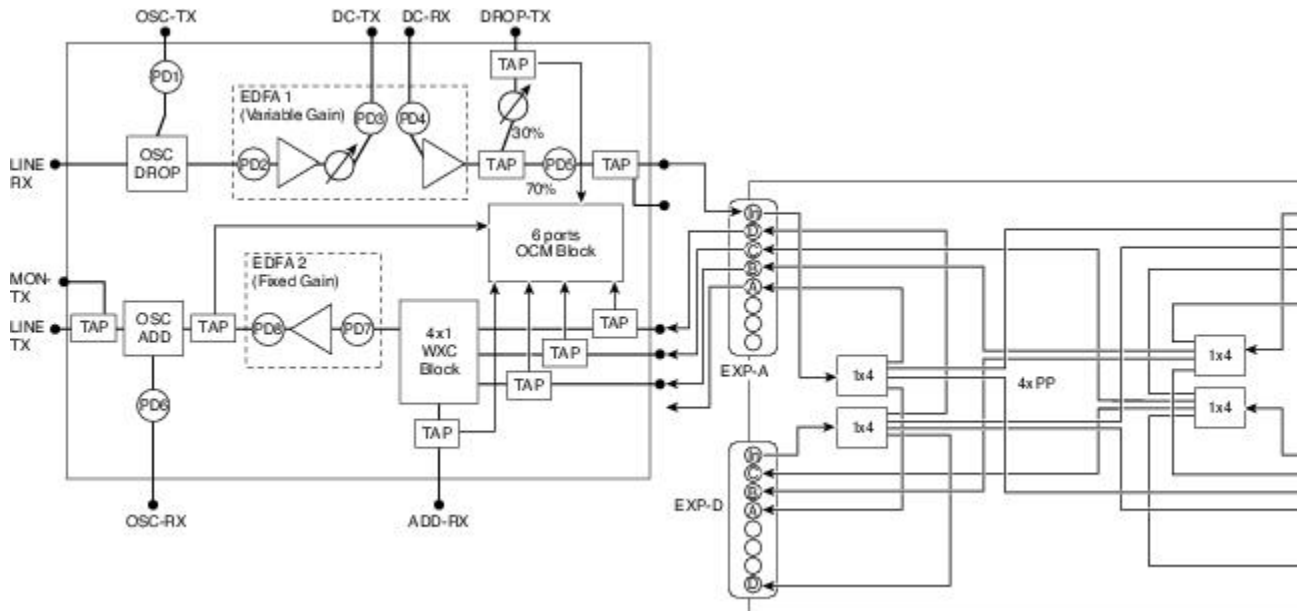
You can use the PP-4-SMR patch panel to connect up to four 40-SMR2-C cards in a four-degree mesh node. The optical splitters inside the patch panel forward the output signal (EXP-TX port) of the 40-SMR2-C card on each side of the mesh node to the input port of the 40-SMR2-C cards on the other three sides of the mesh node. The 4x1 WXC block inside the 40-SMR2-C card selects which wavelength from which side must be propagated at the output of each side. The following figure shows the signal flow at the four-degree PP-4-SMR patch panel. 40-SMR2-C cards connect to the four-degree patch panel at the EXP-TX and EXP-RX ports.

Figure 101: PP-4-SMR Patch Panel Signal Flow
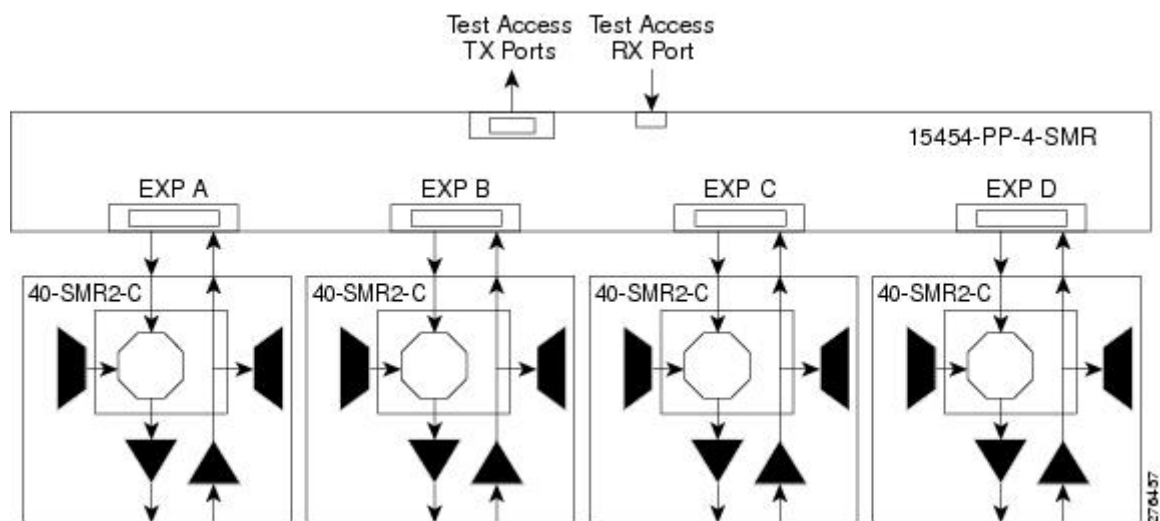
Using a Mesh Node With Omni-Directional Add/Drop Section

Normally, multidegree mesh node use four or eight 40-WXC-C cards and a four-degree or eight-degree patch panel. Each of the 40-WXC-C cards uses a 40-MUX-C card to add wavelengths going to the span and a 40-DMX-C card to drop wavelengths coming in from the span. The 40-MUX-C and 40-DMX-C cards are connected to only one of the node directions. These cards can add/drop traffic only to/from the side that is associated to the 40-WXC-C card. The omni-directional configuration allows you to install a local multiplexer/demultiplexer that can add/drop traffic to/from any of the node directions. The following diagram shows an example of how to set up a omni-directional add/drop configuration.

By setting up a NE as shown in the figure, it is possible to connect the transmit ports of TXP or MXP cards to a 40-MUX-C card and then connect the output of the 40-MUX-C card to an OPT-BST card. The OPT-BST card then connects to a preferred 40-WXC-C card in the four-degree or eight-degree ROADM node (40-WXC-C connected to port 4 of PP-MESH-4, as shown in the figure).

The patch panel splits the traffic coming from the OPT-BST card in all the node directions, through the software configuration. The wavelengths entering the 40-WXC-C cards (ports 1, 2, and 3) can be selectively sent out in any desired outbound direction. In the inbound direction, the patch panel on the preferred 40-WXC-C card, splits any of the wavelengths entering the NE through the 40-WXC-C cards (ports 1, 2, and 3). Through the software configuration, the wavelength can be passed to an OPT-PRE card or stopped. This whole configuration can be managed using a single IP address

An example of using a mesh node for omni-directional add/drop section is shown in the following figure.

Figure 102: Mesh Node With Omni-Directional Add/Drop Section
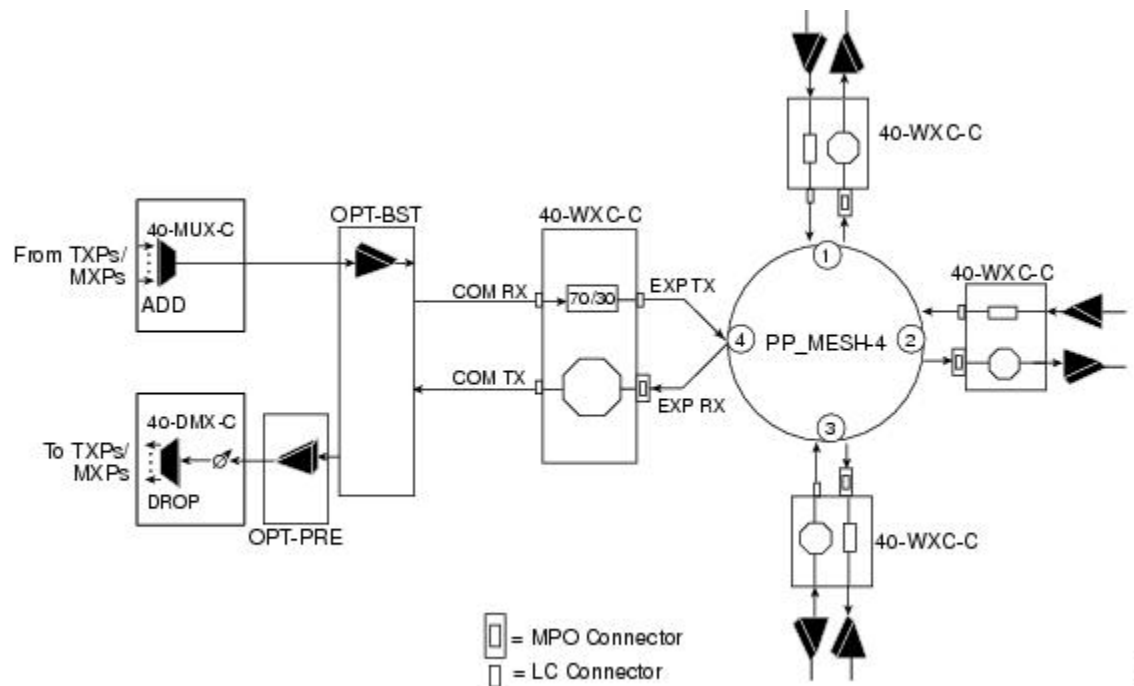
DWDM Node Cabling

DWDM node cabling is specified by the Cisco TransportPlanner Internal Connections table. The following sections provide examples of the cabling that you will typically install for common DWDM node types.

✎

Note   The cabling illustrations shown in the following sections are examples. Always install fiber-optic cables based on the Cisco TransportPlanner Internal Connections table for your site.

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.

The following figure shows an example of OSC fibering for a hub node with OSCM cards installed.

Figure 103: Fibering OSC Terminations—Hub Node with OSCM Cards
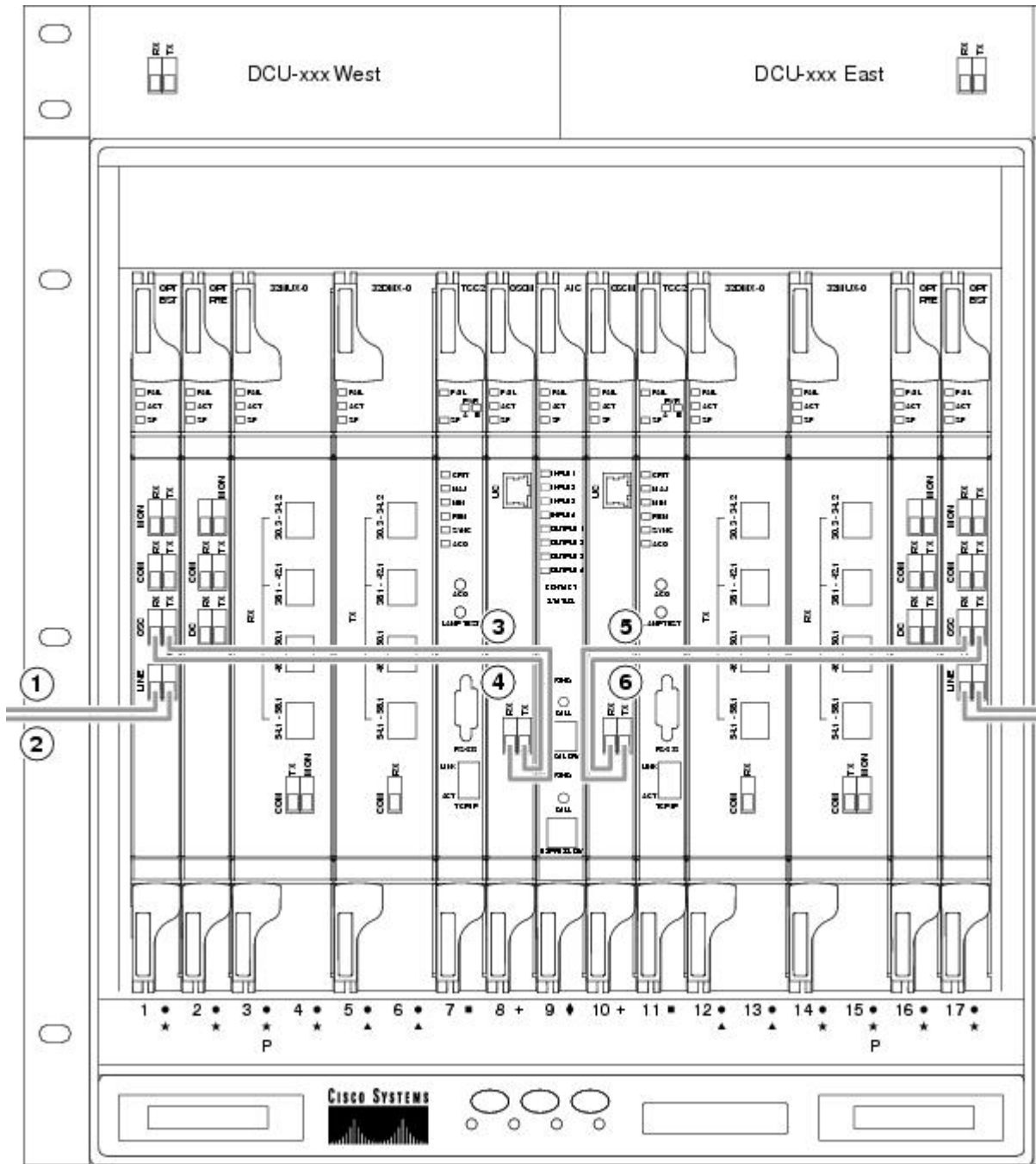
1	Side A OPT-BST LINE RX to Side B OPT-BST or OSC-CSM LINE TX on adjacent node	5	Side B OSCM TX to Side B OPT-BST
2	Side A OPT-BST LINE TX to Side B OPT-BST or OSC-CSM LINE RX on adjacent node	6	Side B OSCM RX to Side B OPT-BST

3	Side A OPT-BST OSC TX to Side A OSCM RX	7	Side B OPT-BST LINE TX to Side A OPT- 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- or OSC-CSM LINE TX on adjacent node

Hub Node Fiber-Optic Cabling

The following rules generally apply to hub node cabling:

- The Side A OPT-BST or OSC-CSM card common (COM) TX port is connected to the Side A OPT-PRE COM RX port or the Side A 32DMX-O/40-DMX-C/40-DMX-CE COM RX port.

- The Side A OPT-PRE COM TX port is connected to the Side A 32DMX-O/40-DMX-C/40-DMX-CE COM RX port.

- The Side A 32MUX-O/32WSS/32WSS-L COM TX port is connected to the Side A OPT-BST or Side A OSC-CSM COM RX port.

- The Side B 32MUX-O/32WSS/32WSS-L COM TX port is connected to the Side B OPT-BST or Side B OSC-CSM COM RX port.

- The Side B OPT-BST or Side B OSC-CSM COM TX port is connected to the Side B OPT-PRE COM RX port or the Side B 32DMX-O/32DMX COM RX port.

- The Side B OPT-PRE COM TX port is connected to the Side B 32DMX-O/32DMX COM RX port.

The following diagram 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 104: Fibering a Hub Node
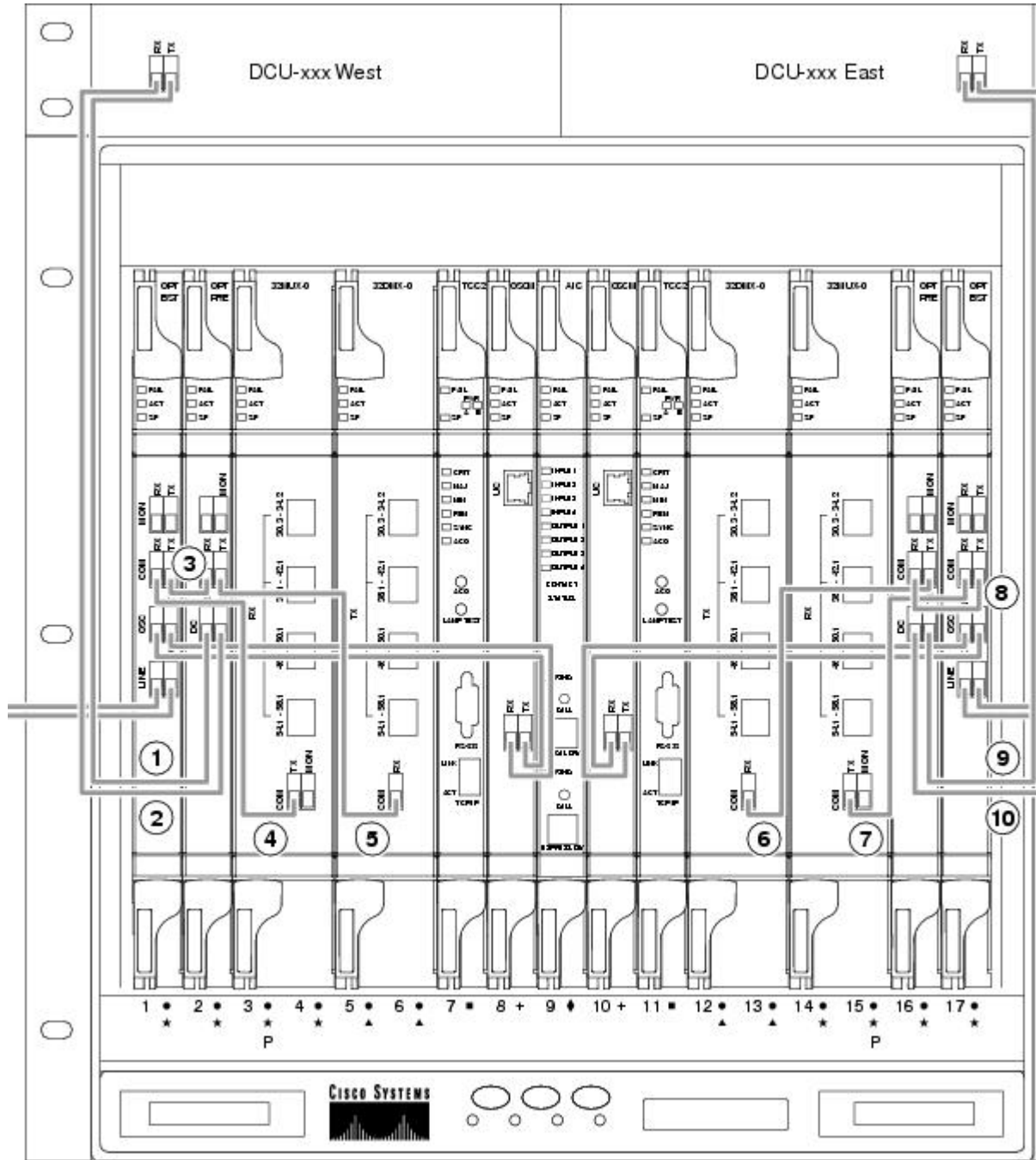
1	Side A DCU TX to Side A OPT-PRE DC RX If a DCU is not installed, a 4-dB attenuator loop, +/− 1 dB must be installed between the OPT-PRE DC ports.	6	Side B 32DMX-O COM RX to Side B OPT TX
2	Side A DCU RX to Side A OPT-PRE DC TX1	7	Side B 32MUX-O COM TX to Side B OPT RX

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-BS 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 RX1
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 TX1

Terminal Node Fiber-Optic Cabling

The following rules generally apply to terminal node cabling:

- A terminal site has only one side (as compared to a hub node, which has two sides). The terminal side can be either Side B or Side A.

- The terminal side OPT-BST or OSC-CSM card COM TX port is connected to the terminal side OPT-PRE COM RX port or the 32DMX-O/40-DMX-C/40-DMX-CE COM RX port.

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

- The terminal side 32MUX-O/40-MUX-C COM TX port is connected to the terminal side OPT-BST or OSC-CSM COM RX port.

Line Amplifier Node Fiber-Optic Cabling

The following rules generally apply to line amplifier node cabling:

- The line amplifier node layout allows all combinations of OPT-PRE and OPT-BST cards and allows you to use asymmetrical card choices in Side A-to-Side B and Side B-to-Side A configurations. For a given line direction, you can configure the four following possibilities:

    - Only preamplification (OPT-PRE)

    - Only booster amplification (OPT-BST)

    - Both preamplification and booster amplification (where a line amplifier node has amplification in at least one direction)

    - Neither preamplification nor booster amplification

- If a Side A OPT-PRE card is installed:

    - The Side A OSC-CSM or OPT-BST COM TX is connected to the Side A OPT-PRE COM RX port.

    - The Side A OPT-PRE COM TX port is connected to the Side B OSC-CSM or OPT-BST COM RX port.

    - If a Side A OPT-PRE card is not installed, the Side A OSC-CSM or OPT-BST COM TX port is connected to the Side B OSC-CSM or OPT-BST COM RX port.

    - If a Side B OPT-PRE card is installed:

        - The Side B OSC-CSM or OPT-BST COM TX port is connected to the Side B OPT-PRE COM RX port.

• The Side B OPT-PRE COM TX port is connected to the Side A OSC-CSM or OPT-BST COM RX port.

• If an Side B OPT-PRE card is not installed, the Side B OSC-CSM or OPT-BST COM TX port is connected to the Side A OSC-CSM or OPT-BST COM RX port.

The following figure shows an example of a line amplifier node with cabling.

Figure 105: Fibering a Line Amplifier Node
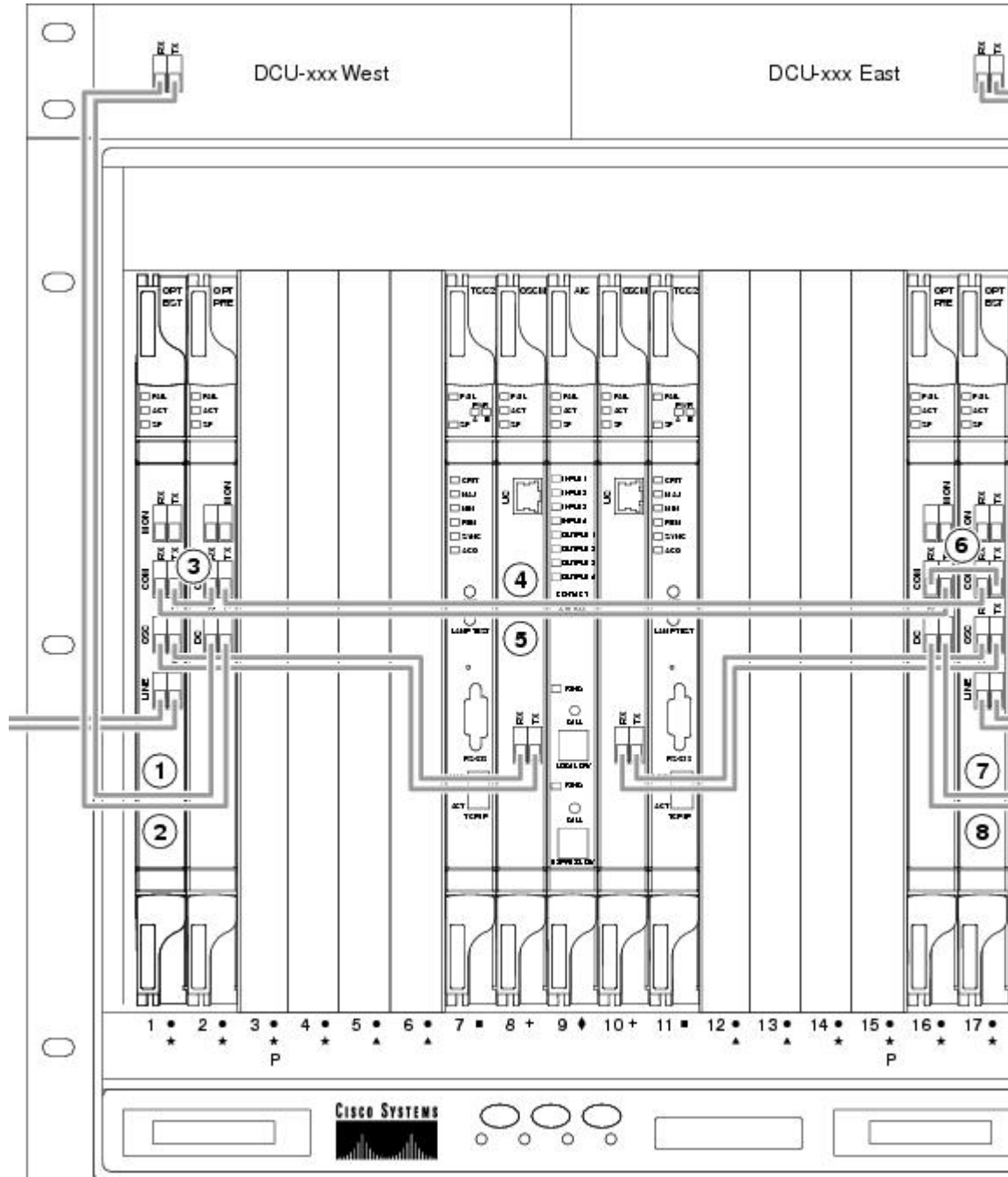
1	Side A DCU TX to Side A OPT-PRE DC RX If a DCU is not installed, a 4-dB attenuator loop, +/– 1 dB, must be installed between the OPT-PRE DC ports.	5	Side A OPT-BST COM RX to Side B OPT-PRE C
2	Side A DCU RX to Side A OPT-PRE DC TX1	6	Side A OPT-BST COM RX to Side B OPT-PRE C
3	Side A OPT-BST COM TX to Side A OPT-PRE COM RX	7	Side B DCU TX to Side B OPT-PRE DC RX1
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 TX1

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.

  The following figure shows an example of an OSC regeneration node with cabling.

Figure 106: Fibering an OSC Regeneration Node
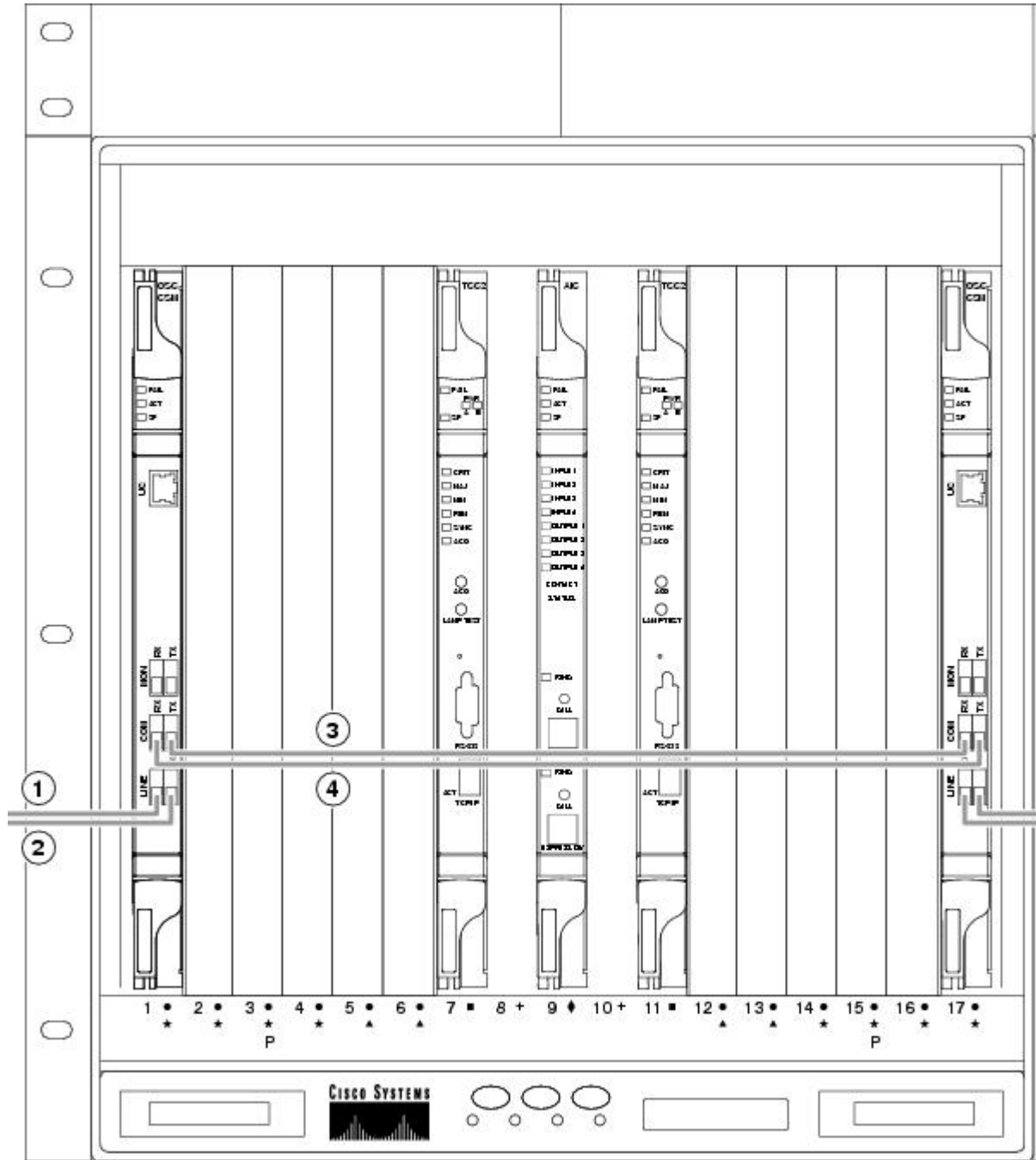
| 1 | Side A OSC-CSM LINE RX to Side B OSC-CSM or OPT-BST LINE TX on adjacent node | 4 | Side A OSC-CSM COM RX to Side B OSC-CSM CO |
| 2 | Side A OSC-CSM LINE TX to Side B OSC-CSM or OPT-BST LINE RX on adjacent node | 5 | Side B OSC-CSM LINE RX to Side A OSC-CSM or OPT-BST LINE TX on adjacent node |

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

# ROADM Node Fiber-Optic Cabling

The following rules generally apply to ROADM node cabling:

- The Side A OPT-BST or OSC-CSM COM TX port is connected to the Side A OPT-PRE COM RX port.

- The Side A OPT-PRE COM TX port is connected to the Side A 32WSS COM RX port.

- The Side A OPT-BST or OSC-CSM COM RX port is connected to the Side A 32WSS COM TX port.

- The Side A OPT-BST (if installed) OSC TX port is connected to the Side A OSCM RX port.

- The Side A OPT-BST (if installed) OSC RX port is connected to the Side A OSCM TX port.

- The Side A 32WSS EXP TX port is connected to the Side B 32WSS EXP RX port.

- The Side A 32WSS EXP RX port is connected to the Side B 32WSS EXP TX port.

- The Side A 32WSS DROP TX port is connected to the Side A 32DMX COM RX port.

- The Side A 40-WSS-C/40-WSS-CE DROP TX port is connected to the Side A 40-DMX-C or 40-DMX-CE COM RX port.

- The Side B OPT-BST or OSC-CSM COM TX port is connected to the Side B OPT-PRE COM RX port.

- The Side B OPT-PRE COM TX port is connected to the Side B 32WSS COM RX port.

- The Side B OPT-BST or OSC-CSM COM RX port is connected to the Side B 32WSS COM TX port.

- The Side B OPT-BST (if installed) OSC TX port is connected to the Side B OSCM RX port.

- The Side B OPT-BST (if installed) OSC RX port is connected to the Side B OSCM TX port.

- The Side B 32WSS DROP TX port is connected to the Side B 32DMX COM RX port.

- The Side B 40-WSS-C/40-WSS-CE DROP TX port is connected to the Side B 40-DMX-C or 40-DMX-CE COM RX port.

The following diagram shows an example of an amplified ROADM node with cabling.

Note This is an example. Always install fiber-optic cables based on the Cisco TransportPlanner Internal Connections table for your site.

Figure 107: Fibering a ROADM Node
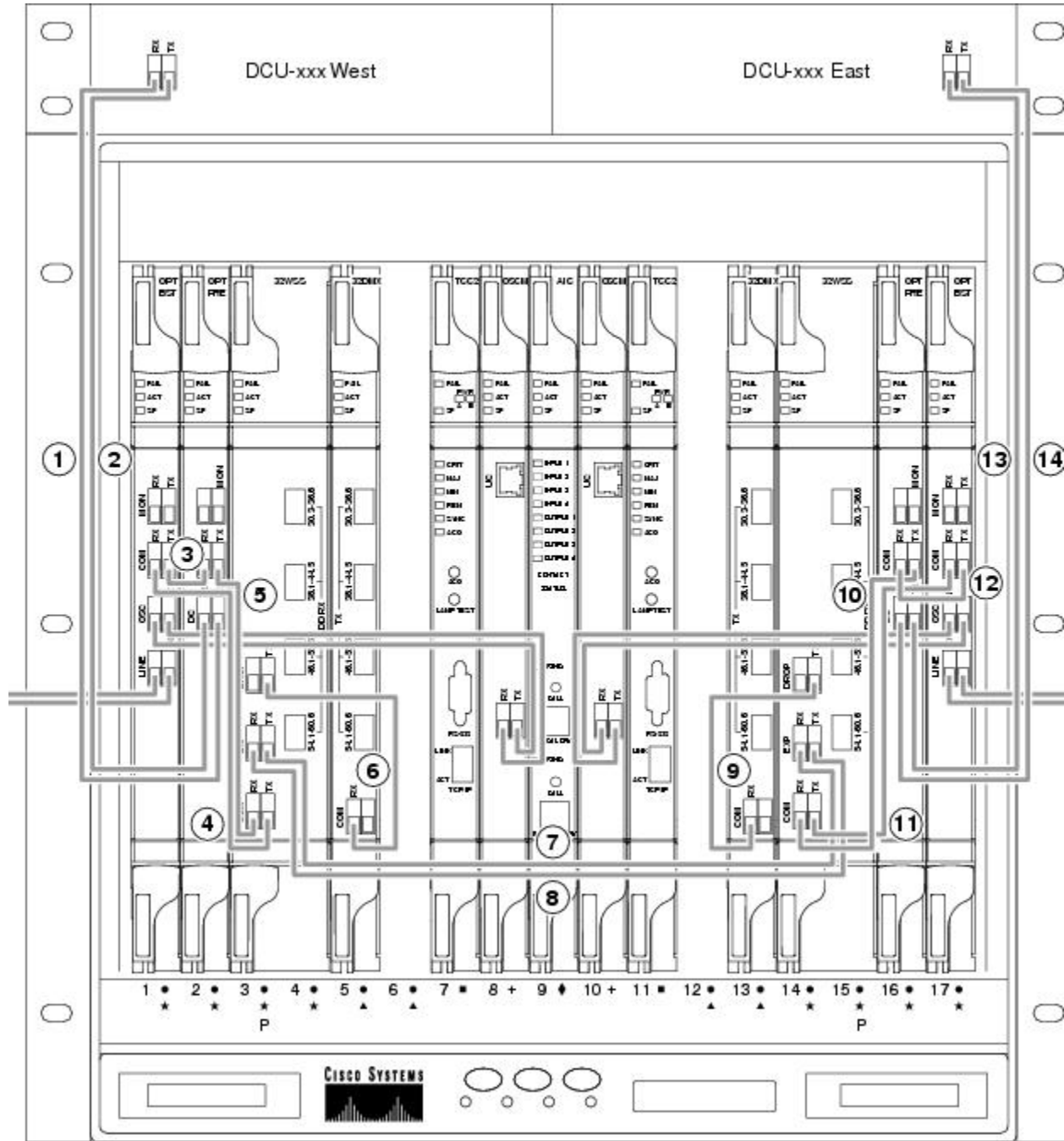
1	Side A DCU TX to Side A OPT-PRE DC RX	8	Side A 32WSS EXP RX to Side B 32WSS E
	If a DCU is not installed, a 4-dB attenuator loop, +/−1 dB must be installed between the OPT-PRE DC ports.		
2	Side A DCU RX to Side A OPT-PRE DC TX1	9	Side B 32DMX COM RX to Side B 32WSS

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 C
4	Side A 32WSS COM TX to Side A OPT-BST COM RX	11	Side B 32WSS COM TX to Side B OPT-BST C
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 C
6	Side A 32DMX COM RX to Side A 32WSS DROP TX	13	Side B DCU RX to Side B OPT-PRE DC TX1
7	Side A 32WSS EXP TX to Side B 32WSS EXP RX	14	Side B DCU TX to Side B OPT-PRE DC RX1

Automatic Node Setup

Automatic node setup (ANS) is a control card function that adjusts values of the variable optical attenuators (VOAs) on the DWDM channel paths to equalize the per channel power at the amplifier input. This power equalization means that at launch, all channels have the same amplifier power, independent of the input signal on the client interface and independent of the path crossed by the signal inside the node. This equalization is needed for two reasons:

- Every path introduces a different penalty on the signal that crosses it.

- Client interfaces add their signal to the DWDM ring with different power levels.

To support ANS, integrated VOAs and photodiodes are provided in the following cards:

- 4MD-xx.x card add paths

- 32MUX-O card add paths

- 32WSS/40-WSS-C/40-WSS-CE/40-WXC-C/80-WXC-C/16-WXC-FS add, drop, and pass through paths

- 32DMX-O card drop paths

- 32DMX, 40-DMX-C, 40-DMX-CE card input port

- 40-MUX-C card output port

- 40-SMR1-C/40-SMR2-C add, drop, and pass through ports

- PSM card input and output ports (both working and protect path)

Optical power is equalized by regulating the VOAs. Based on the expected per channel power, ANS automatically calculates the VOA values by:

- Reconstructing the different channel paths.

- Retrieving the path insertion loss (stored in each DWDM transmission element).

VOAs operate in one of three working modes:

- Automatic VOA Shutdown—In this mode, the VOA is set at maximum attenuation value. Automatic VOA shutdown mode is set when the channel is not provisioned to ensure system reliability in the event that power is accidentally inserted.

- Constant Attenuation Value—In this mode, the VOA is regulated to a constant attenuation independent from the value of the input signal. Constant attenuation value mode is set on VOAs associated to aggregated paths.

- Constant Power Value—In this mode, the VOA values are automatically regulated to keep a constant output power when changes occur to the input power signal. This working condition is set on VOAs associated to a single channel path.

ANS calculates the following VOA provisioning parameters:

- Target attenuation

- Target power

Optical patchcords are passive devices that are modeled by the two termination points, each with an assigned slot and port. If user-provisioned optical patchcords exist, ANS checks if the new connection is feasible according to internal connection rules. If the user connection violates one of the rules, ANS returns a denied message. ANS requires the expected wavelength to be provisioned. When provisioning the expected wavelength, the following rules apply:

- The card family generically characterizes the card name, and not the particular wavelengths supported.

- 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.

ANS parameters set the values required for the node to operate successfully. Cisco Transport Planner calculates the ANS parameters based on the requirements of a planned network. Cisco Transport Planner exports the parameters to NE update file. When the NE update file is imported in CTC, the Provisioning > WDM-ANS > Provisioning tab is populated with the ANS parameters to provision the node for the network. These ANS parameters can be modified even when the card port is in IS state. All the ANS parameters are mapped to the physical ports of the cards. ANS parameters can also be manually added, modified, or deleted in the Provisioning tab. ANS parameters cannot be deleted when the port is in IS state and if any active circuit uses the ANS parameters. If the new or updated value is not within the default range as shown in Table 11: Ranges, Values, and Edit Options for the ANS Parameters, an error message is displayed. For more information on how to add, modify, or delete an ANS parameter, see NTP-G328 Adding, Modifying, or Deleting ANS Parameters procedure.

Note The Provisioning > WDM-ANS > Provisioning tab in CTC is empty if the NE update file is not imported.

Note It is recommended that you use the Cisco Transport Planner NE Update file to provision the ANS parameters instead of manually adding all the parameters in CTC. ANS provisioning parameters must be manually changed by Cisco qualified personnel only. Setting incorrect ANS provisioning (either as preamplifier or booster input power thresholds) may impact traffic.

Note From R11.0, the upgraded NE update XML file imported on the CTC for the respective NCS 2000 node will import the new ANS parameters and settings for the new degree or modules. The existing ANS parameters or module settings are not affected. This prevents unintended changes to the APC corrections to the existing degree and its associations.

Table 11: Ranges, Values, and Edit Options for the ANS Parameters

ANS Parameter	Range/Value	Editable with Port in IS
OSC LOS Threshold	-50.0 to +30.0 dBm	Yes
Channel LOS Threshold	-50.0 to +30.0 dBm	Yes
Amplifier Working Mode	Control Power, Control Gain, Fixed Gain	Yes Per-channel power and tilt can be edited when the Amplifier Working Mode is Control Gain or Control Power and Fixed Gain when Amplifier Working. The Mode is Fixed Gain.
Amplifier Gain	0.0 to 40.0 dB	No
Amplifier Tilt	-15.0 to +15.0 dB	No
OSC Power	-24.0 to 0.0 dBm	No
Raman Ratio	0.0 to 100.0%	Yes
Raman Total Power	100 to 450 mW EDRA: 0.0 to 1000 mW	Yes
Raman Expected Gain Editable only on OPT-RAMP-C and OPT-RAMP-CE cards.	0.0 to 12.0 dB	Yes
Power	-50.0 to +30 dBm	Yes The APC increases or decreases power by 0.5 dB till the new power setpoint is reached. The APC-OUT-OF-RANGE alarm is raised if the updated power setpoint is outside the expected range.
WXC Dithering	0 to 33	No
Min Expected Span Loss	0.0 to 75.0 dB	No

ANS Parameter	Range/Value	Editable with Port in IS
Max Expected Span Loss	0.0 to 75.0 dB	No
VOA Attenuation	0 to 30.0 dB	Yes VOA Attenuation associated with a single channel path can be edited when the working mode is Constant Power Value; VOA Attenuation associated with aggregated paths can be edited when the working mode is Constant Attenuation Value.
Raman Installation Gain (RAMAN-COP and EDRA only)	RAMAN-COP: 30.0 to 8.0 dB EDRA: 0.0 to 40.0 dB	Yes
DFB Power (RAMAN-CTP only)	+6.0 to -5.0 dBm	Yes
DFB LOS Optical Threshold (RAMAN-CTP only)	-20.0 to -70.0 dBm	Yes
Enable LOGO Power Optimisation	Yes, No	Yes
Channel Power Offset	-50.0 to 30.0 dBm	Yes
Total Power	-30.0 to 30.0 dBm	Yes

ANS parameters can be viewed in the node view Provisioning > WDM-ANS > Provisioning tab, as shown in the following figure.

Figure 108: WDM-ANS Provisioning
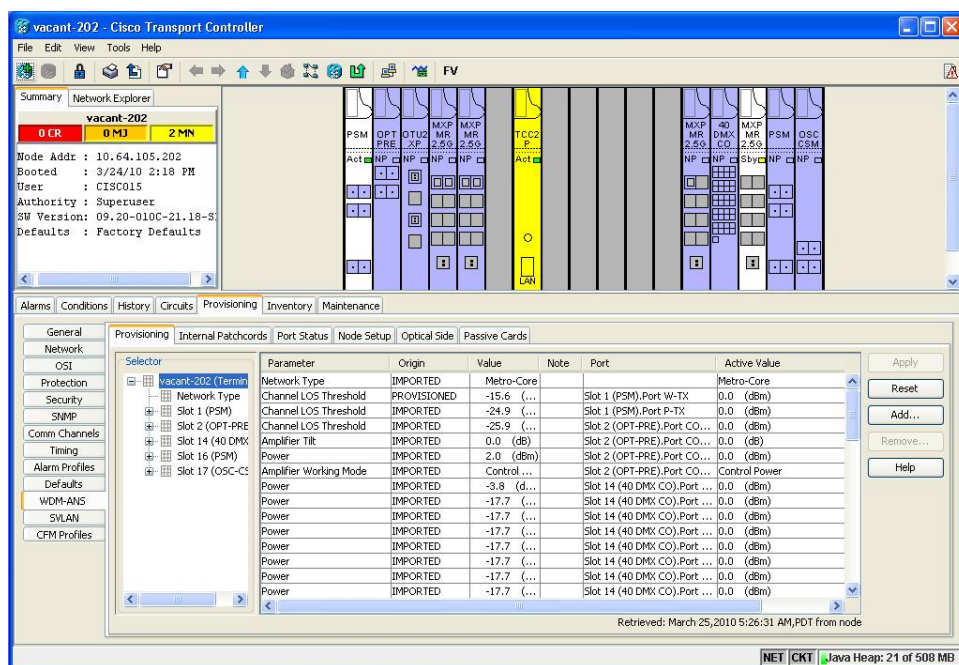
The Provisioning > WDM-ANS > Provisioning tab presents the following information:

- Selector—Presents the ANS parameters in a tree view based on physical position. Clicking the + or – expands or collapses individual tree elements. Clicking a tree element displays the element parameters in the table on the right. For example, clicking the node name at the top displays all the node ANS parameters or clicking Slot 1 (PSM) displays the PSM amplifier parameters only. The ANS parameters can be sorted according to physical position.

- Parameter—Displays the ANS parameter name.

- Origin—Indicates how the parameter was calculated:

    - Imported—The value was set by importing the CTP XML file.

    - Provisioned—The value was manually provisioned.

    - Automatic—The value is automatically calculated by the system using the Raman provisioning wizard. For more information on how to provision using a wizard, see DLP-G468 Configure the Raman Pump Using the Installation Wizard procedure.

- Value—Displays the ANS parameter value. The values can be modified manually, although manually modifying the ANS parameters is not recommended.

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

- Port —Displays the port value. Port is represented as Slot.Port.

- Active Value —Displays the active parameter value. The active value cannot be modified manually. When you modify the parameter value in the Value field, the active value is updated with the modified value after you run ANS.

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

- Port—Displays the port value. The port is represented as Slot.Port.

- Parameter—Displays the ANS parameter name.

- Result—After you run ANS, the status for each ANS parameter in the Results column is provided:

    - Success - Changed—The parameter setpoint was recalculated successfully.

    - Fail - Out of Range—The calculated setpoint is outside the expected range.

    - Fail - Missing Input Parameter—The parameter could not be calculated because the required provisioning data is unknown or unavailable.

    - Not Applicable State—Ports are not in use.

- Value—Displays the parameter value.

A parameter could be set by more than one application. For example, VOA Attenuation parameter could be set by both ANS and APC. In this case, individual entries will be displayed for ANS and APC.

- Last Change—Displays the date and time when the parameter was last modified.

ANS Parameters in a Raman Node With Post-Amplifiers

The following ANS parameters drive the node regulations in the Raman node:

- Power (DC-TX port)—It is the per channel output power level that is allowed on the embedded erbium-doped fiber amplifier (EDFA) amplification stage of the OPT-RAMP-C or OPT-RAMP-CE card. The power can be measured accurately only when the value of the internal VOA is set to 0 dB. During circuit creation, the Power (DC-TX port) setpoint is used to calculate the Gain of the embedded EDFA(GEDFA) in the OPT-RAMP-C or OPT-RAMP-CE card. The GEDFA setpoint has a direct impact on the actual gain tilt that the embedded EDFA generates. If the value of the GEDFA is greater than or less than the optimum Gain (G OPTIMUM) setpoint of the OPT-RAMP-C or OPT-RAMP-CE card, the output spectrum is affected by a positive or negative gain tilt.

    The G OPTIMUM setpoints for the OPT-RAMP-C or OPT-RAMP-CE cards are:

    - OPT-RAMP-C —14 dB

    - OPT-RAMP-CE —11 dB

        The APC automatically calculates the gain tilt. The difference between the G OPTIMUM and GEDFA values of every 1 dB causes a gain tilt of 0.7 dB. Setting an appropriate counter-tilt setpoint on the first amplifier card that is present downstream of the embedded EDFA, compensates the gain tilt.

- Power (COM-TX port)—It is the per channel power level that is allowed on the COM-TX port of the OPT-RAMP-C or OPT-RAMP-CE card. The Power (COM-TX port) setpoint and the DCU insertion loss is used to calculate the attenuation value of the internal VOA of the OPT-RAMP-C or OPT-RAMP-CE card when the first circuit is provisioned. The Power (COM-TX port) setpoint ensures that the power levels at the input port of the amplifier cards (configured in the OPT-PRE or the OPT-LINE mode) downstream are stable. CTP generates the setpoint to suit the optimum Gain range of the amplifier card used.

- Power (LINE-TX port)—It is the per channel power setpoint that is allowed on the LINE-TX output port. The amplifiers that are present downstream of the OPT-RAMP-C card can be configured as OPT-PRE in ROADM nodes or as OPT-LINE in optical line amplifier (OLA) nodes. When the first circuit is provisioned, the Power (LINE-TX port) setpoint is used to automatically calculate the Gain.

- Amplifier Tilt (LINE-TX port)—It is the gain tilt (TILT CTP) that CTP calculates based on the output power of the amplifier configured as OPT-PRE in ROADM nodes or as OPT-LINE in OLA nodes. This is the target value to be reached after circuit creation. The APC dynamically adjusts the tilt reference (TILT REFERENCE) value to meet the target taking into consideration the Raman tilt (TILT RAMAN) that the Raman installation wizard calculates and the EDFA tilt (TILT EDFA) that is calculated by the OPT-RAMP-C or OPT-RAMP-CE card based on its GEDFA value:

  TILT CTP setpoint = TILT RAMAN + TILT EDFA + TILT REFERENCE

ANS Parameters in a Raman Node Without Post-Amplifiers

The TCC automatically identifies the node layout as "Raman Only" and regulates the amplifiers and VOA.

The following ANS parameters drive the node regulations in the Raman node without post-amplifiers:

- Amplifier Tilt (DC-TX port)—CTP configures a predefined tilt value in the range of +/- 1.5 dB on the embedded EDFA, based on the optical characteristics of the fiber downstream of the OPT-RAMP-C or OPT-RAMP-CE card. The embedded EDFA amplifier in OPT-RAMP-C or OPT-RAMP-CE cards work in the fixed gain mode. The GEDFA is equal to the G OPTIMUM setpoint by default and ensures a flat output spectrum.

  The G OPTIMUM setpoints of the OPT-RAMP-C or OPT-RAMP-CE cards are:

  - OPT-RAMP-C—14 dB

  - OPT-RAMP-CE—11 dB

    If the tilt reference value is not equal to zero, it has a direct impact on the GEDFA. The APC changes the tilt reference value and consequently the GEDFA by taking the system tilt contribution accumulated along the transmission line.

- POWER (LINE-TX port)—It is the maximum per channel power level that is allowed on the LINE-TX port of the OPT-RAMP-C, OPT-RAMP-CE, or OSC-CSM card in accordance to the node layout. CTP calculates this setpoint to ensure that the system does not suffer from non-linear effects. The APC can change the power levels based on the traffic pattern and fiber type but never exceeds the setpoint value.

Raman Setup and Tuning

Raman amplification occurs in the optical fiber and the consequent Raman gain depends on the characteristics of the span (attenuator presence, fiber type, junctions, etc.). As two Raman pumps at two different wavelengths are used to stimulate the Raman effect, not only is the total signal power calculation significant, but the right mix of power to ensure gain flatness is crucial. These set points of the total Raman power and Raman ratio can be configured on the OPT-RAMP-C or OPT-RAMP-CE card in three ways:

- Raman installation wizard

- CTP XML file

- CTC/TL1 interface

Raman amplification on OPT-RAMP-C or OPT-RAMP-CE cards depends on the optical fiber installed. Therefore, Raman total power and Raman ratio values calculated using the Raman installation wizard via CTC is more accurate than the values provisioned by loading the CTP XML file. For this reason, the value provisioned using the wizard cannot be overridden by the CTP XML file. However, the values provisioned using the wizard or the CTP XML file can be overriden by manually provisioning the parameters.

When the Raman installation is completed, a report of the status of Raman configuration on a node in the OPT-RAMP-C or OPT-RAMP-CE card can be viewed in the Maintenance > Installation tab when you are in card view.

The Installation tab displays the following fields:

- User—Name of user who configured the Raman pump.

- Date—Date when the Raman pump was configured.

- Status

    - Raman Not Tuned—The OPT-RAMP-C or OPT-RAMP-CE card was provisioned but ANS was not launched.

    - Tuned by ANS—ANS was run successfully and the basic ANS parameters were applied.

    - Tuned by Wizard—The Raman installation wizard was run successfully without errors.

    - Tuned by User Acceptance—The Raman installation wizard was completed with errors and the user accepted the values that the wizard calculated.

    - Raman is Tuning—The Raman installation wizard is running.

- S1Low (dBm)—See Table 12: Example of Raman Power Measurements.

- S1High (dBm)—See Table 12: Example of Raman Power Measurements.

- S2Low (dBm)—See Table 12: Example of Raman Power Measurements.

- S2High (dBm)—See Table 12: Example of Raman Power Measurements.

- Power (mW)—Total Raman power set points.

- Ratio—Raman pump ratio setpoint.

- Gain—Expected Raman gain that the wizard calculated.

- Actual Tilt—Expected Raman tilt that the wizard calculated.

- Fiber Cut Recovery—Status of the fiber cut restoration.

    - Executed—The restore procedure was completed successfully.

    - Pending—The restore procedure is not complete.

    - Failed—The system failed to execute the procedure.

- Fiber Cut Date—Date when the fiber cut occured.

The Raman pump is equipped with two different Raman pumps transmitting powers (P1 and P2) at two different wavelengths Lambda1 and Lambda2. During installation, the two pumps alternatively turn ON and OFF at two different power values. Lambda1 and Lambda2 signals are used as probes at the end of spans to measure Raman gain efficiency of the two Raman pumps separately.

The following diagram shows an example of the Raman gain on an OPT-RAMP-C or OPT-RAMP-CE card in Node B that was measured by setting the wavelength and power measurements as follows:

Lambda1=1530.33 nm signal probe at Node A

Lambda 2=1560.61 nm signal probe at Node A

P1 = 1425 nm power at Node B

P2 = 1452 nm power at Node B

Plow = 100 mW

Phigh = 280 mW

Pmin = 8 mW

Pmax = 450 mW

Figure 109: Raman Gain on Node B
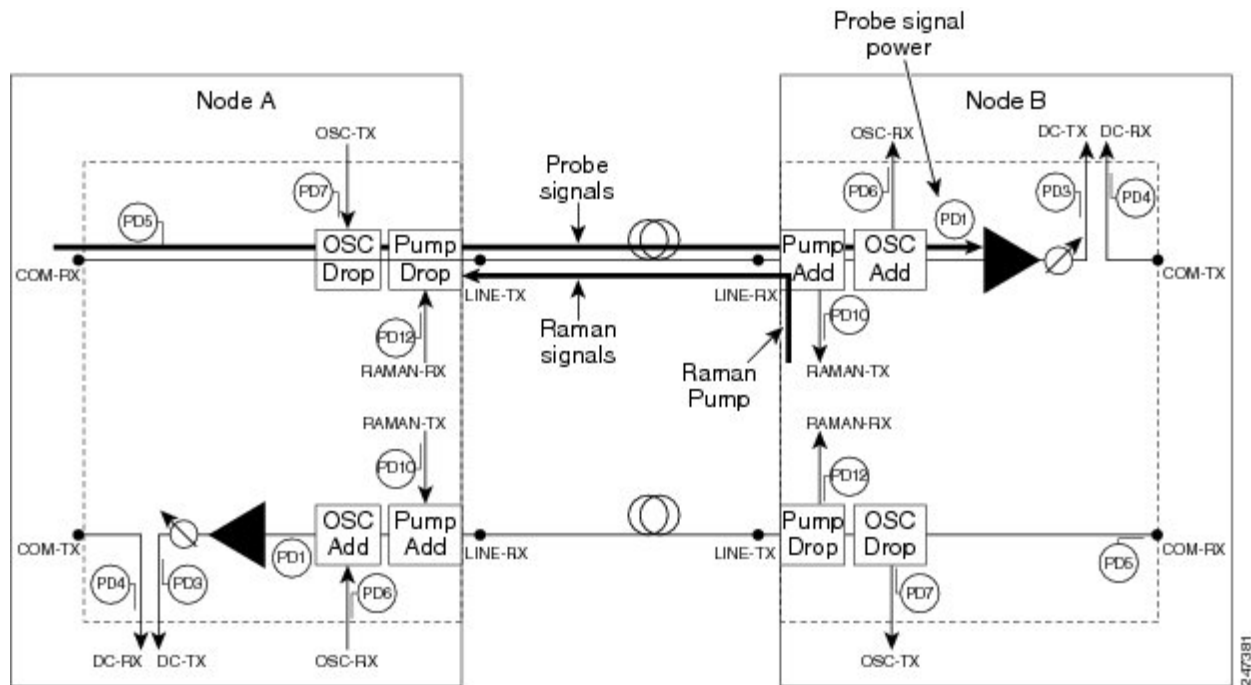
The S1low, S1high, S2low, and S2low values in the Maintenance > Installation tab are based on the power values read on the LINE-RX port of Node B.

Table 12: Example of Raman Power Measurements

Input	P1	P2	Probe Signal Power Received at Node B
Lambda1=1530.33 nm at Node A	Plow = 100 mW	Pmin = 8 mW	S1low
	Phigh = 250 mW	Pmin = 8 mW	S1high

Input	P1	P2	Probe Signal Power Received at Node B
Lambda2=1560.61 nm at Node A	Pmin = 8 mW	Plow = 100 mW	S2low
	Pmin = 8 mW	Phigh = 250 mW	S2low

RAMAN-CTP and RAMAN-COP Card Start Up and Fiber Link Turn Up

The local and remote nodes, equipped with RAMAN-CTP and RAMAN-COP cards, must follow this sequence to startup the card and complete the Raman link turn up.

1. The distributed feedback laser must be enabled—The RAMAN-CTP cards are equipped with embedded distributed feedback (DFB) lasers that operate at 1568.77 nm. The DFB RX port is capable of detecting very low power levels (-55 dBm or -60 dBm). By default, the DFB laser is disabled and the DFB ports are in IS-AINS (ANSI)/Unlocked,automaticInService (ETSI) state. The DFB ports are moved to IS (ANSI)/Unlocked (ETSI) state and the laser is enabled in pulse mode, by performing either one of the following:

   In a DCN Extension layout, ANS is launched. A side-to-side OTS provisionable patchcord (PPC) is created on the side of the node where the RAMAN-CTP card is installed after the DFB ports are successfully regulated (ports are in service). During the creation of the PPC, the TNC card moves the following ports to the IS (ANSI)/Unlocked (ETSI) state:

   • Ports included in the optical path—LINE ports of the RAMAN-CTP card

   • RAMAN-TX and ASE-RX ports of the RAMAN-CTP card

   • RAMAN-TX port of the RAMAN-COP card (if the card is installed)

   ✎

   Note   At this stage, the RAMAN ports do not emit power pulses even though they are in IS (ANSI)/Unlocked (ETSI) state.

   In an OSC based layout, ANS is launched. An OSC termination is created on the side of the node where the RAMAN-CTP card is installed after the DFB ports are successfully regulated. During creation of the OSC termination, the TNC card moves the following ports to the IS (ANSI)/Unlocked (ETSI) state:

   • Ports included in the optical path—LINE and COM ports of the RAMAN-CTP card and the LINE ports of the line amplifier

   • RAMAN-TX and ASE-RX ports of the RAMAN-CTP card

   • RAMAN-TX port of the RAMAN-COP card (if the card is installed)

Note   At this stage, the RAMAN ports do not emit power pulses even though they are in IS (ANSI)/Unlocked (ETSI) state.

The DFB laser from the local node emits a 5-second pulse every 100 seconds and waits for a similar 5-second pulse in response from the DFB laser on the remote node.

Note   For short spans, the DFB optical power level must be regulated by the internal VOA (working in constant power mode) using the provisioned value of the DFB power setpoint. The DFB power setpoint is limited to a maximum of +3 dBm.

2. The DFB laser link continuity is checked—The acknowledgement mechanism between the peer DFB modules works in the following manner:

   • The DFB laser on the local node emits a 5-second pulse.

   • The remote node detects a valid signal (value above the DFB LOS Optical Threshold) on the DFB-RX port and responds with a 9-second DFB laser pulse.

   • The local node detects a signal from the remote DFB laser on the DFB-RX port and starts a counter to check the duration of the remote pulse.

   • If the signal is detected for at least 9 seconds, link continuity is verified and the local node moves the DFB laser to steady (active) state.

   • The remote node performs a similar signal validation and eventually the DFB link is active.

Note   If the DFB-RX port detects a drop in the power below the threshold value before 9 seconds have elapsed, the procedure to check DFB link continuity is restarted.

Note   If one of the fibers is down, the DFB signal must be in OFF state in the opposite fiber too. The acknowledgement mechanism automatically performs this action.

3. A check for short spans is performed—When the DFB signal is active, a point-to-point measurement of the span loss is done. The node measures the loss on the incoming span because the DFB signal is co-propagating. The insertion loss is the difference between the power value on the DFB-TX port of the remote node and the power value on the DFB-RX port of the local node. If the span loss is less than 20 dB, the RAMAN-CTP card raises the PWR-PROT-ON alarm on the RAMAN-TX port and the Raman pumps stop the startup procedure.

4. Excessive back reflection on RAMAN-CTP cards is checked—After the span loss check is complete, the Raman pumps on the RAMAN-CTP card on the local node are turned on in Automatic Power Reduction (APR) mode at reduced power (10 mW) lasting for 200 ms. The RAMAN-CTP cards perform a back reflection power test using an embedded fail threshold, which is configured during card production. The

back reflection test lasts for 500 ms at the maximum. If the back reflection test is successful, the sequence continues with Step 5. If the check fails, the RAMAN-CTP get stuck with the DFB laser in ON state and the Raman pumps do not switch to full power. A Raman Laser Shutdown (RLS) alarm is raised on the RAMAN-TX port, where the failure is detected.

5. Excessive back reflection on RAMAN-COP cards is checked, if the RAMAN-COP cards are installed—The Raman pumps on the RAMAN-CTP card on the local node must shut down after the back reflection test is successful. This allows the same check to be executed by the RAMAN-COP card on the local node without any interference from the RAMAN-CTP card remnant signal.

   When the Raman pumps on the RAMAN-CTP card shut down, a specific command is sent through the backplane lines to the RAMAN-COP card on the local node to turn on the Raman pumps on the RAMAN-COP card to APR mode and perform a back reflection test on the internal connection (RAMAN-TX port of the RAMAN-COP card to the RAMAN-RX port of the RAMAN-CTP card). The back reflection test lasts for a maximum of 500 ms. If the back reflection test is successful, the Raman pumps on RAMAN-COP cards are immediately moved from the APR state to full power using the Total Power setpoint. If the back reflection check fails, the RAMAN-COP pumps get stuck in APR state and a RLS alarm is raised on the RAMAN-TX port, where the failure is detected.

6. The Raman pumps of the RAMAN-CTP card on the local node are moved to full power after the waiting time elapses—When the local RAMAN-CTP card, in Step 5 shuts down its Raman pumps to initiate Raman pump startup of the RAMAN-COP card, it transitions to a waiting mode. After the expiry of 12 seconds, the RAMAN-CTP card must turn up its Raman pumps and move them to full power using the Total Power setpoint irrespective of any alarm that is raised by the RAMAN-COP card in Step 5.

7. The Raman link is tuned—A manual Raman Day 0 tuning procedure must be executed before creating the OCH circuits. The Raman link can also be tuned by the ANS parameters. The Raman amplified span is now ready for traffic provisioning.

8. The OSC link is turned up and the ALS condition is removed on the line amplifiers—When the RAMAN-CTP (and RAMAN-COP, if present) Raman pumps are tuned, the amplification provided in the fiber is sufficient to detect a valid OSC signal, even in very long spans. The OSC detection clears the LOS-O alarm and results in the removal of the ALS condition on the line amplifiers. If an OSC signal is not available, the amplified spontaneous emission (ASE) Raman noise power received at the LINE-RX port of the line amplifier is sufficient to remove the LOS-O alarm and enable the line amplifier startup.

The RAMAN-CTP and RAMAN-COP (if installed) cards on the remote node must perform the same start up sequence (Steps 4 through 8) in asynchronous mode with respect to the local node.

Automatic Raman Pump Calculation

The Raman gain depends on the characteristics of the span (fiber type and span loss). To obtain optimum Raman gain, a correct mix of pump powers must be provisioned. Tuning of the four Raman pumps is crucial before traffic is provisioned.

The tuning procedure is called Automatic Raman Power Calculation (ARPC). This procedure assesses the Raman gain on a C-band signal using pre-defined Raman pump values.

ARPC applies to the RAMAN-CTP and EDRA cards. ARPC is supported only in the NCS Flex package.

ARPC is mandatory during the first installation of the EDRA cards to ensure that the Raman gain can be reached. ARPC can also be used check the success of a fiber restore procedure by measuring the Raman gain reached.

The ARPC target gain is the ANS amplifier gain that is defined on the RAMAN-TX port. This parameter is obtained from the NE update XML file that is imported during installation before ARPC is run.

Whenever ANS is launched, the Raman gain that is obtained is checked against the new Gain setpoint, shown in the ARPC workflow diagram. ANS can be launched again after the value of the ANS amplifier gain is modified, without impacting traffic, even though a C-band payload is provisioned and is active (without alarms).

It is also possible to trigger ARPC manually. To run ARPC manually, go to the card view in CTC and click the Maintenance > Installation Report tabs. Click Run Tuning.

ARPC Workflow

This figure shows the workflow diagram for Automatic Raman Power Calculation (ARPC).

Figure 110: ARPC Workflow Diagram

DWDM Network Functional View

The DWDM network functional view displays a graphical representation of the DWDM cards, internal connections, circuits, optical power, span loss values of the spans, and alarms in the DWDM network. The DWDM network functional view is similar to the DWDM functional view in its graphical layout and behavior at the node level.

The DWDM network functional view consists of two views:

✎

Note   In R10.0.2 and later releases, the GMPLS view is called the Circuit Creation view and the NFV view is called the Circuit Maintenance view.

- Circuit Maintenance view—Enables you to view circuit connections and flow of signals at the network level. This view also enables you to edit existing GMPLS circuits.

- Circuit Creation view—Enables you to create Generalized Multiprotocol Label Switching (GMPLS) circuits that are optically feasible. These circuit connections can be viewed at the network level. The Circuit Creation view also helps to reroute a circuit on an alternate path. For more information about GMPLS circuits, see GMPLS Control Plane, on page 125 section.

✎

Note   In R10.3, all the panes in the DWDM network functional view with the exception of the Overview pane are iconised or hidden. The complete application window is dedicated to the graphic view or network map. The panes are visible on request. If the DWDM functional view is started from the shelf view of a ROADM node, the node FV of the ROADM node is automatically expanded in the graphical view pane.

The DWDM network functional view offers dual options to view the network:

- Graphical view—Displays the circuit connections, optical power, and alarms on a circuit through a graphical representation. To view the graphical display of the circuit connections, select the circuit in the Circuits tab in the Network Data pane. In the toolbar, click the **dB**, **SL**, or **PV** tool to view the optical power in the nodes, span loss values of the spans, or insertion loss of the patchcords, respectively. For more information about the use of the graphical view, see the Graphical View Pane, on page 136 section.

- Tabular format—Displays the circuit connections, optical power, span loss values, and alarms of a circuit in a tabular format in the Network Data pane. For more information about the Network Data pane, see the Network Data Pane, on page 139.

   For information on how to view optical power values and alarms of the circuit selected in the Circuits tab of the Network Data pane, see the NTP-G231 Viewing Optical Power Values and Alarms Using DWDM Network Functional View, on page 152 section.

You can export the DWDM network functional view reports to .html, .csv, or .tsv format. For more information on exporting the reports, see the DLP-G529 Exporting Network Functional View Reports, on page 153 section.

GMPLS Control Plane

This section describes the GMPLS-based control plane. The GMPLS control plane can be used to provision optical channels for the DWDM platform.

When a circuit is created using the Circuit Creation wizard in CTC, the circuit does not get provisioned and cannot carry traffic until it is validated by WSON using non-linear and linear impairments such as:

- Optical Signal-to-Noise Ratio (OSNR)
- Chromatic Mode Dispersion (CMD)
- Polarization Mode Dispersion (PMD)
- Four-Wave Mixing (FWM)
- Self-Phase Modulation (SPM)
- Polarization Dependent Loss (PDL)
- Xtalk
- Chromatic Dispersion (CD)
- Polarization Dependent Gain (PDG)
- Filtering & Frequency Group Delay Ripple (FGDR)

To overcome this problem, a GMPLS-based control plane is now supported that has the capability to validate the optical channel feasibility before a circuit is provisioned. The GMPLS control plane is available with the Cisco ONS 15454DWDM WSON package and is supported on the Cisco ONS 15454, Cisco ONS 15454 M6, and Cisco ONS 15454 M2 platforms. A GMPLS circuit is provisioned only if the optical feasibility is established ensuring transmission of client traffic on the network.

The optical plane uses the GMPLS routing and signalling protocols, such as
Open Shortest Path First - Traffic Engineering (OSPF-TE) and
Resource Reservation Protocol - Traffic Engineering (RSVP-TE) to determine available optical routes.

Bandwidth, network protection, traffic engineering, and optimal utilization of network resources are taken into consideration during path computation, validation, and provisioning.

The functions of the GMPLS control plane are:

- Identifying network topology
- Discovering automatically resources, such as Network Elements (NEs), links, paths, wavelengths, and OCH ports
- Calculating optical paths
- Validating optical circuits taking into account the optical impairments
- Provisioning optical channels (OCHCC, OCHNC, and OCH Trail)
- Rerouting wavelength for traffic restoration

In mesh networks consisting of omnidirectional and colorless ROADM nodes, it is possible to provision a circuit using any path and wavelength, without recabling or physical intervention on the site. The GMPLS

control plane controls and provisions the DWDM optical interfaces installed on routers by defining the appropriate wavelength.

When resources are added to or removed from the network, the control plane can reroute existing connections through an alternate path having optical feasibility to make the best use of the newly available resources.

The following section provides an additional information on the usage of GMPLS control plane:

Card Support

Table 13: Cards Supported by the GMPLS Control Plane

Unit Type	Card Name
TXP/MXPs	All the TXP/MXP cards are supported.
Amplifiers	OPT-PRE, OPT-BST, OPT-BST-E, OPT-EDFA-17, OPT-EDFA-24, OPT-AMP-17-C, OPT-AMP-C, OPT-RAMP-CTP, OPT-RAMP-COP, OPT-RAMP-C, and OPT-RAMP-CE
Filters	32-DMX-C, 40-DMX-C, 40-MUX-C, 15216-MD-40-ODD, 15216-MD-40-EVEN, MD-48-ODD, MD-48-EVEN, MD-48-ODD-E, and MD-48-EVEN-E
Deinterleavers	15216-MD-ID-50, 15216-ID-50, MD-48-CM, and MD-48-CM-E
ROADMs	32-WSS-C, 40-WSS-C, 40-WXC-C, 40-SMR1-C, 40-SMR2-C, and 80-WXC-C
Patch panels	MESH-PP-SMR, PP-MESH-4, and PP-MESH-8

Acceptance Thresholds

The GMPLS control plane validates the optical feasibility of an OCH circuit to ensure that the circuit is operational after provisioning. The optical feasibility is determined based on the optical impairments. The optical feasibility is represented by the following colors:

- Green—Indicates that the channel failure risk is 0%.

- Yellow—Indicates that the channel failure risk is between 0% and 16%.

- Orange—Indicates that the channel failure risk is between 16% and 50%.

- Red—Indicates that the channel failure risk is greater that 50%.

During circuit creation, you can define the acceptance threshold value in the Circuit Parameters pane of the GMPLS view in CTC. The circuit is provisioned only if the evaluated feasibility is greater than or equal to the user-defined threshold.

After the circuit is created, its acceptance threshold and optical feasibility is displayed in the Acpt Threshold and the Opt Valid columns in the Circuits tab in CTC.

Validation Modes

In the DWDM network functional view, the validation mode can be set during circuit creation or circuit maintenance. The validation modes are:

- Full—The circuit gets created when the circuit validation result is greater than or equal to the acceptance threshold value.

- None—The circuit is created without considering the acceptance threshold value. The Opt Valid column in the Circuits tab displays the value, "No Valid".

- Inherited—The restoration circuit inherits the validation and acceptance threshold values from the primary circuit.

GMPLS Optical Restoration

The GMPLS optical restoration feature helps to restore optical circuits from a failed path to a new path using the Generalized Multiprotocol Label Switching (GMPLS) control plane. The optical failure is indicated through any signal alarm such as Loss of Signal (LOS), Loss Of Signal due to absence of payload (LOS-P), and signal failure. The GMPLS control plane initiates restoration after a failure is detected on the circuit. Restoration is supported for OCHNC and OCH trail circuits. The OCHCC restoration is provided by the underlying OCH Trail circuits.

The GMPLS control plane is available with the Cisco ONS 15454 DWDM WSON package and is supported on the Cisco ONS 15454, Cisco ONS 15454 M6, and Cisco ONS 15454 M2 platforms.

Determining an Alternate Path

The GMPLS control plane attempts to determine an alternate path based on the alarm types:

- Link Alarms: The original path constraints, excluding the failed link, are used to determine an alternate path.

- Transponder Alarms: The control plane does not have information about the link or node that degraded the circuit. Links are excluded to determine an alternate path.

The GMPLS control plane attempts to determine an alternate path with the same wavelength. If it fails, it attempts to determine an alternate path using a different wavelength. The alternate path activation takes few minutes depending on the various parameters of the network and therefore affects traffic.

If the GMPLS control plane fails to find an alternate or better path, the original circuit remains in place. The restoration is re-attempted at periodic intervals until a new route is found or the failure in the original working path is fixed.

The circuit restoration is enabled by checking the Restoration check box while creating or editing the circuit in CTC. In case of a failure, if the Restoration check box is not checked, the GMPLS control plane does not attempt to discover the new path to restore traffic that is affected. See NTP-G334 Configuring GMPLS Optical Restoration to configure GMPLS optical restoration for the circuits.

Types of Restoration

- 1+R Restoration—This type of restoration is enabled for an unprotected optical circuit. If the original path fails and restoration is enabled, the GMPLS control plane establishes an alternate restored path and traffic flows on the restored path. If revertive restoration mode is enabled, traffic is switched back to the original path and the restored path is deleted. If non-revertive restoration mode is enabled, the original path is deleted and the restored path becomes the working path.

- 1+1+R Restoration—This type of restoration is enabled for a protected optical circuit. 1+1+R supports the Protection Switching Module (PSM), Y-cable, and splitter protection schemes.

  If the working path fails, traffic is switched to the protect path. If restoration is enabled, the GMPLS control plane establishes an alternate restored path and the restored path becomes the new working path. If revertive restoration mode is enabled, traffic is switched back to the working path and the restored

path is deleted. If non-revertive restoration mode is enabled, the working path is deleted and the restored path becomes the new working path.

If a protect path fails, traffic continues to flow on the working path. If restoration is enabled, the GMPLS control plane establishes an alternate restored path and the restored path becomes the new protect path. Traffic continues to flow on the working path. If revertive restoration mode is enabled, traffic is switched back to the original protect path and the restored protect path is deleted. If non-revertive restoration mode is enabled, the original protect path is deleted and the restored protect path becomes the new protect path.

Restoration Modes

The GMPLS control plane supports the following modes of optical restoration:

Revertive restoration

In revertive restoration mode, the circuit is switched back from the restored path to the original path after the following conditions.

- Failure is fixed on the original path or the alarms listed in the Unverified Alarms tab are acknowledged.

- Soak time expires and one of the above conditions are met.

Revertive restoration can be one of the following types:

- Auto Revert—If the auto revert option is selected, the circuit automatically reverts from the restored path to the original path. The restored path is deleted.

- Manual Revert—If the manual revert option is selected, the circuit does not automatically revert to the original path from the restored path. The circuit must be manually restored on the original path by checking the Manual Revert check box in CTC. The restored path is deleted. The circuit can be reverted manually only when the restoration status of the circuit is REST-REVERTIBLE.

Non-revertive Restoration

In non-revertive restoration, traffic flows on the restored path and does not revert to the original path. In this mode, the restored path becomes the working path even after the failure is fixed on the original working path. The original path is deleted. In case there is a failure on the new path, another path is taken (and at each failure, another new path needs to be found).

No-revertive restoration uses restoration constraints for all the restorations. No-revertive alternative restoration uses restoration and main constraints alternatively, for restorations. The following table indicates the constraints for main activation and the first four restorations in case of no-revertive and no-revertive alternative restoration.

Table 14: Constraints for No-revertive and No-revertive Alternative

Restoration	First Activation	First Restoration	Second Restoration	Third Restoration	Fouth Restoratin
No-revertive	Main Constraint	Restoration Constraint	Restoration Constraint	Restoration Constraint	Restoration Constraint
No-revertive Alternative	Main Constraint	Restoration Constraint	Main Constraint	Restoration Constraint	Main Constraint

Multi-layer Restoration

Multi-layer restoration (MLR) is restoring a network, involving various optical, router and management planes of a network.

MLR can be classified as:

- MLR-O: restoration in the optical domain

- MLR-P: restoration from router port failures

Release 10.6.1 supports MLR-O only, which can be further classified as:

- MLR-O same wavelength - involves the local repair of a failure by the optical network without any change in the wavelength. Although the routers may see loss-of-light until the failure is repaired, there is no signaling involving the routers and from their perspective, the GMPLS-UNI LSP remains unchanged. When the failure occurs, the routers will know that the link is down and layer-3 protection mechanisms are used to minimize traffic loss. The optical network re-routes the GMPLS connection onto an alternative path. This is done without any involvement of the routers.

  A significant limitation in this case is that, the wavelength must be the same along the entire path and cannot be changed. The constraints imposed on the connection during its initial signaling are also unchanged, which may reduce the chance of finding an alternative path.

- MLR-O different wavelength - optical restoration occurs with an associated wavelength change. In this case, the optical network finds an alternative path with the same constraints as were originally signaled, but using a different wavelength. Since the wavelength (and therefore the labels) used by the GMPLS connection need to change, signaling is required.

  The ingress UNI-N sends a path-error message indicating the new wavelength to be used; this has an error code 24 (routing), sub-error 6 (unacceptable label set) and contains a suggested-label sub-object with the new label to be used. The head UNI-C then signals a new LSP with the new wavelength. Although the wavelength in use may change in this case, the constraints used in signaling the original LSP remain unchanged.

Soak Time

After the failure on the original path is resolved, the circuit on the restored path waits until the specified soak time period expires before moving to the original path. The soak time starts after the alarms are acknowledged.

Restoration Status

The restoration status of the circuit can be viewed while editing the circuit. The status of the circuit can be in one of the following states:

- REST_ST_RESTORED—A failure is detected on the original path. A restored path is established to carry traffic only when the Revertive option is selected. When the original path fails, traffic flows on the restored path.

- REST_ST_FAILED—A failure is detected on the original path. The restored path does not exist or is not feasible. Restoration is retried at periodic intervals.

- REST_REVERTIBLE—A failure is detected on the original path and the restored path is established. Traffic flows on the restored path. The failure on the original path is fixed and the traffic can be reverted to the original path after the soak time expires.

- REST_NONE—The circuit does not have a restored path due to the following:

- The circuit was never restored.

- The circuit was restored and reverted to the original path.

- The circuit was restored and reverted to the original path.

- REST_RESTORING—A failure is detected on the original path. The GMPLS control plane attempts to find an alternate feasible path. The status of the circuit becomes REST_ST_RESTORED or REST_ST_FAILED or REST_NONE (if the circuit is non-revertible).

LSP Priority

The control plane supports the Label Switch Path (LSP) priority signaling on the User-Network Interface (UNI). The LSP priority can be set using CTC or TL1 tunnel.

The priority setup is used to resolve a conflict on any network resource when two or more LSP are set at the same time, and requires the same resources. The setup of the LSP priority is critical in circuit creation and restoration.

The LSP priority is implemented according to the RFC 3209 section 4.7.1 4 requirement. The priorities are:

- Setup Priority: The sessions in the network are assigned a priority value from 0 (High) to 7(Low). The session with a value 0 has the highest priority for using the resources in the network. The Setup priority is used to decide whether the session with high priority can preempt another session.

- Holding Priority: The sessions in the network are assigned a priority value from 0 (High) to 7(Low). The session with a value 0 is the highest priority to hold the resources. The Holding priority is used to decide whether this session can be preempted by another session.

Note The Setup priority is supported. However, the Holding priority has a fixed value of 0, and does not affect the control plane.

LSP Setup with Regenerators

The regenerators in the network minimize signal loss, and help to establish an uninterrupted connection between the source and destination. The control plane identifies the availability of regenerators in the network and uses them during circuit setup.

The lambda changes at each regenerator, if the lambda continuity between two end points is not available. A regenerator failure triggers the restoration process.

The workflow diagram depicts the regeneration process with LSP setup.

The control plane (CP) places the regenerator according to the optical validation. If a circuit is not optically feasible, according to the imposed threshold (green, yellow, orange), the CP looks for regenerator availability. If a compatible regenerator(s) is available and the resulting transparent segments are feasible, the circuit is activated using the regenerator(s). In some cases, optical validation is not supported, such as, DS fiber. In such cases, where validation is not supported, pre-validated paths are calculated offline and provided as a constraint to the control plane, while creating the circuit. To support regenerator utilization on the DS fiber type, we need to force the regenerator for a specific path. This inclusion constraint can be on the node that contains the regenerators (CP will decide which regenerator to use) or specific to the regenerator trunk interface. The constraint can be applied on the main or restored path.

To specify the Explicit Route Object (ERO) for the main and restored paths, the following should be considered:

- The path constraints list provisioned by the user must include the main and restored paths.

- The user should be able to add path and regenerator constraints to both the main restored paths.

- For protected paths, the constraints can be provisioned for the main path, protected path and both the restoration paths (one each for the main and protected paths).

Scenario: Circuit with regenerators

In this example, consider a circuit with 7 nodes: N1 to N7. The regenerators are in node N3 and N5.

N1 --- N2 --- N3 --- N4 --- N5 --- N6 --- N7

At node N3, the optical evaluation from N1 to N3 is feasible, and the connection is established between nodes N1 and N3.

At node N5, consider these two scenarios:

- If the optical evaluation from N1 to N5 is successful, the connection proceeds to the next node.
- If the optical evaluation from N1 to N5 fails, the control plane steps back to N3, the previous node with regenerator. A first segment is created between nodes N1 and N3. The control plane restarts evaluation from N3 for the second segment.

At node N7, consider these two scenarios:

- If the optical evaluation from N3 to N7 is successful, the second segment is created between nodes N3 and N7.
- If the optical evaluation from N3 to N7 fails, the control plane steps back to N5, the previous node with regenerator. A second segment is created between nodes N3 and N5. The control plane restarts evaluation from N5 for the third segment. After evaluating the feasibility, a third segment is created between nodes N5 and N7.

Restoration Based on LSP Priority

The LSP priority is used to decide GMPLS restoration in a multiple channel setup, and optimizes the restoration time for an LSP with a higher priority. The automated restoration based on LSP priority reduces the network capex by using the same optical interface for both working and protect modes. The restoration is dynamic, managed by the head node and simplifies network operations.

In a circuit failure, the dynamic optical restoration enables the automatic re-routing of the optical circuit over a new route. This is triggered by a DWDM layer event (no UNI required) or by the client (UNI required). Colorless and omni-directional ROADMs are combined with tunable lasers to allow the optical layer to re-route a circuit.

The WSON intelligence embedded in the circuit enables the DWDM layer to dynamically validate the feasibility of the new route. This ensures a successful network connectivity and eliminates the dependancy on additional design tools.

A restoration delay time is used for efficient restoration of the circuit. The delay can be a fixed value and associated to a priority, or can be a variable value that depends on the traffic and priority matrix. A variable restoration delay is efficient when there are no high-priority circuits that need restoration, because the delay of low-priority circuits is reduced.

Restoration can be triggered by a regeneration failure.

If LSP restoration is started by different Ingress nodes that require the same optical resource, the LSP priority is used to allow or block an LSP. If the circuits have the same priority, the circuit with the lower LSP ID is blocked.

A failure in the network can be restored using these methods:

- Restoration Relative Delay:

    - The Ingress node first restores the LSPs with high priority and then the LSP with low priority.
    - The node that detects the failure signals the loss, and the LSPs are restored after the restoration delay.
    - If a LSP with high priority is not present, the LSP with low priority is restored.
    - When multiple nodes detect a failure and trigger the restoration, the low priority nodes are restored concurrently with high priority nodes.

- Resources Lock:

    - If two LSPs require the same resource simultaneously, the node with high priority uses the resource.
    - If two LSPs have the same priority, the node with a high LSP ID uses the resource.

Scenarios on Restoration with LSP Priority

This section provides scenarios on regeneration with LSP priority.

Scenario 1: Restoration After Network Failure Between Two Nodes

In this example, consider that the network has embedded WSON intelligence in the nodes. The clients are connected via the path shown in red color in the following image.
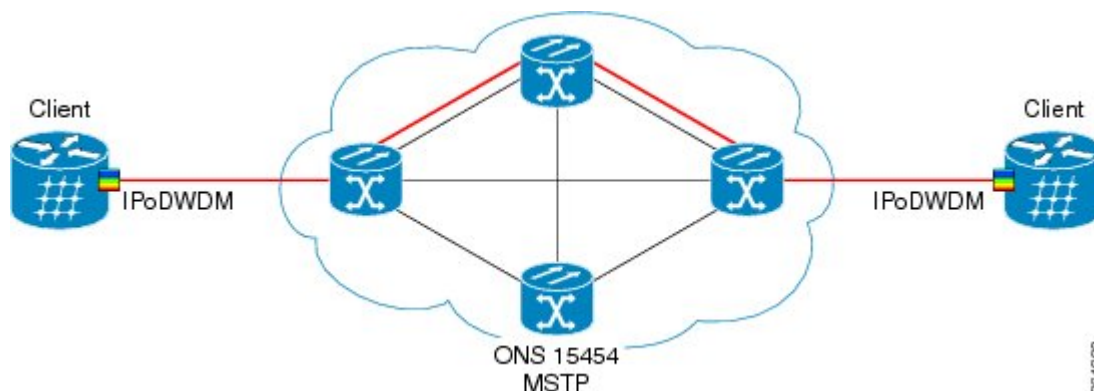
Consider that the network fails because of a fiber cut between two nodes.
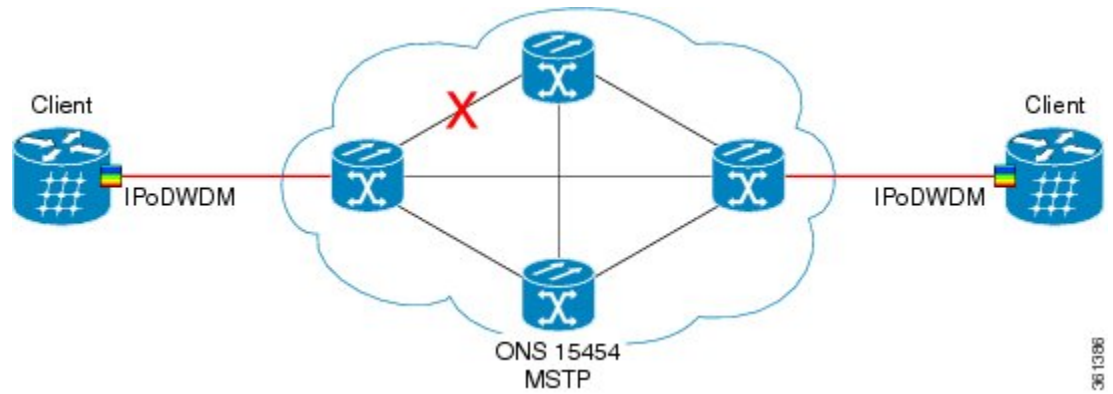
To restore the service, the embedded WSON intelligence in the network calculates an alternate path and verifies the feasibility of this new path. The alternate route is shown in green color in the following image.
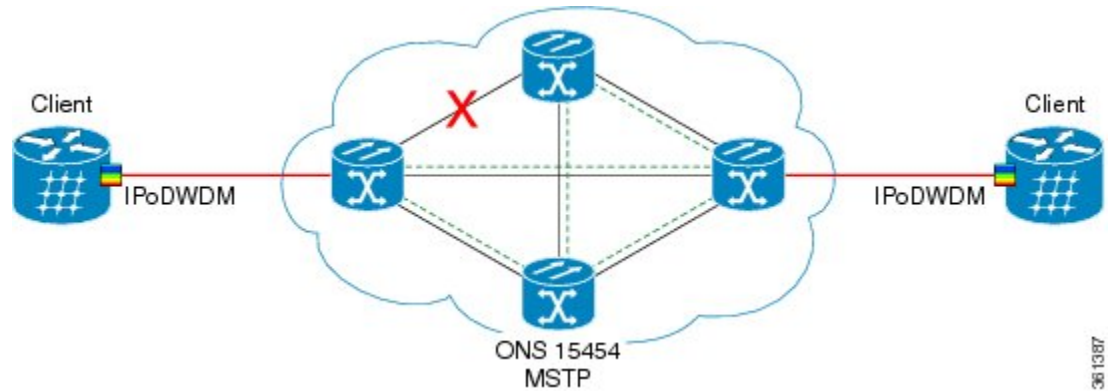
After the alternate route is validated, the edge nodes instruct the client to re-tune the wavelength.
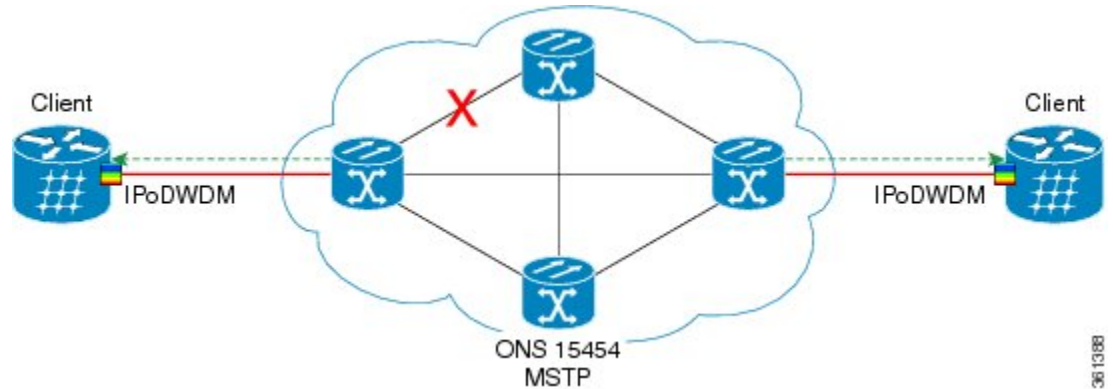
The colorless, omni-directional ROADM switches the path between the source and destination.
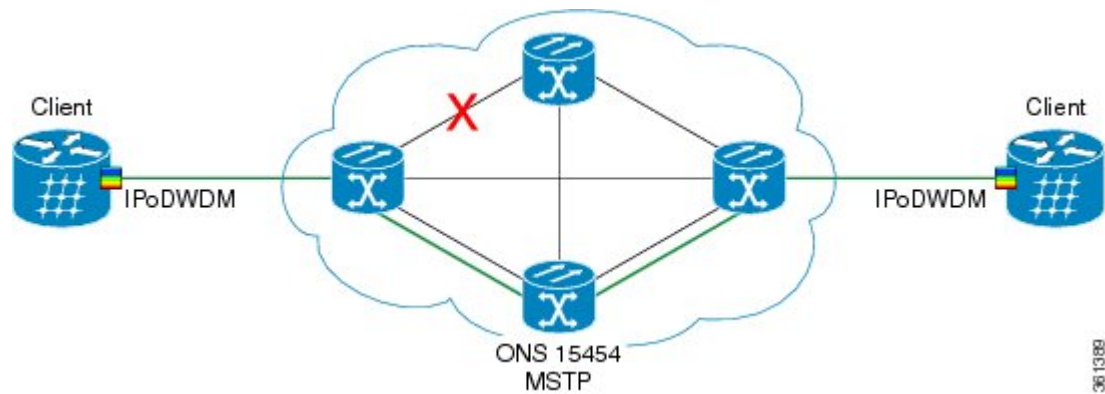
The service is restored using the same client and optical interfaces without manual intervention.

Scenario 2: Multiple restorations triggered at multiple ingress nodes

In this example, consider that the network has embedded WSON intelligence in the nodes. The clients are connected via the path 1, 2 and 3 as shown in the following image. Assume the following priority:

- Circuit 1: Nodes 1 to 2, low priority
- Circuit 2: Nodes 1 to 2, low priority
- Circuit 3: Nodes 3 to 2, high priority
- Circuit 4: Nodes 3 to 2, high priority

Consider a scenario where the connection fails at multiple points; nodes 1 and 2, and nodes 2 and 3. This network failure triggers multiple restorations at multiple ingress nodes. The network with high priority traffic is generated by the ingress node 3, and low priority traffic is generated by node 1. A multiple failure between nodes 1 and 3 triggers the restorations simultaneously. The restore paths use the node 4.
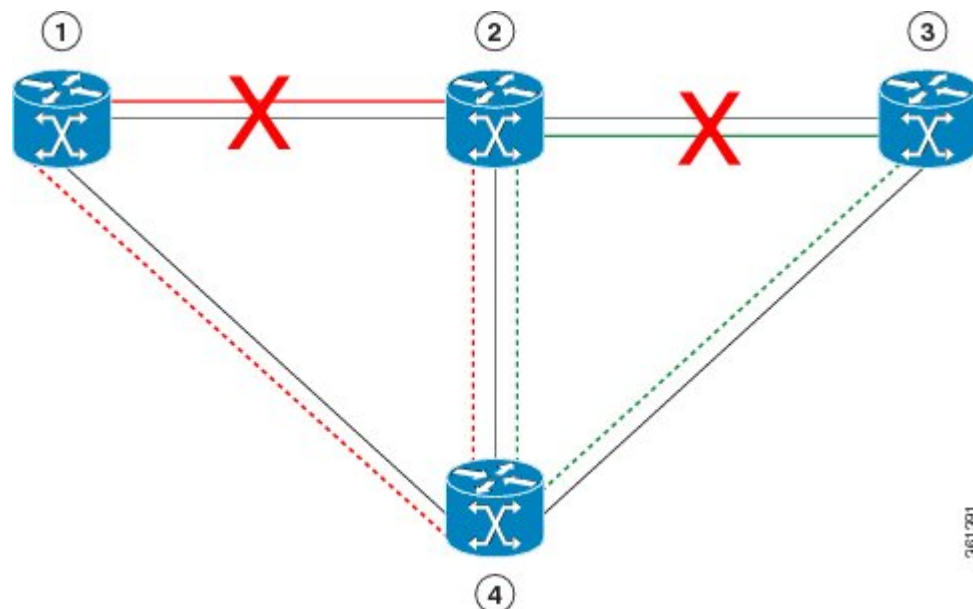
If the low priority traffic restoration at node 1 requests the resources of node 4 before the high priority LSP restoration from node 3, the restoration sequence is:

1. restore the low priority LSP
2. restore the high priority LSP
3. restore the LSP with lowest priority

The connection on node 1 is restored, followed by the connection in node 3.

WSON Full-Coherent Networks Control Plane

This section describes the control plane in a full-coherent network. The optical impairments in full-coherent networks follow the LOGO model (Local Optimization Global Optimization) that is applicable to 100G and beyond full-coherent networks. Linear impairments can be calculated in the full LOGO model, and this enables circuit selection and path validation during the routing process.

LOGO is an optimization method that regulates the per-channel signal power of the amplifiers (in the optical fiber) to obtain the highest possible pre-FEC BER value, for the specific WDM link. The per-channel signal power is regulated according to the pre-provisioned optical parameters of the link(i.e. fiber type and frequency channel spacing) and also in accordance with the derived information, such as, actual span loss value (monitored at system level). LOGO is valid only for links with coherent channels, without dispersion compensation.

The optical impairment is calculated node by node, and the channel optical impairments (non-linear) can be identified by adding the local contribution Penalty of the nodes or spans in the path. The linear impairment is calculated directly from the source node.

The crosstalk between optical channels can be pre-defined in network design phase and considered as a constant by the control plane.

The need to signal the values of all optical parameters to the egress node, to calculate the channel feasibility and the residual margins of existing channels, is eliminated. Each A/D domain is associated with a value that represents the penalty calculated due to signal loss. This operation is done during network setup or network upgrade.

In full coherent networks, the Automatic Power Control (APC) calculates the local optical impairments that are used by the control plane:

1. During network installation, each node calculates the span "non linear noise power" (NLNP) and set the optimal power span for each span.
2. If link values are added to get the A/D domain weight, this value is assigned to the link weight.
3. Open Shortest Path First (OSPF) sends the data to the nodes.
4. The ingress node calculates the routing and lambda between the two points. Ingress node calculates the total NLNP for each LSP.
5. The control pane selects the best path (using shortest path and total NLNP) and starts signalling from the ingress node to the egress node.
6. The control pane reserves the optical LSP and provisions the channel.

The channel is activated.

The user can upgrade an existing GMPLS circuit from the legacy signaling to the new signaling that supports the LOGO and regeneration features on the GMPLS circuit.

WSON Alarms

When there is a failure in the original path of the circuit, alarms are raised to indicate failure. After all the circuits are moved to the restored path, the port on the original path moves to OOS,DSBLD (ANSI) or Locked,disabled (ETSI) state. The alarms disappear on the original path irrespective of whether the failure is fixed. These alarms appear in the WSON tab and are referred to as unverified alarms. These unverified alarms

appear at the network, node, and circuit levels in CTC. Acknowledge these alarms manually to clear them after fixing the failure on the original path.

When the port moves to OOS,DSBLD (ANSI) or Locked,disabled (ETSI) state, the alarms disappear on the original path and the CP-UNVER-CLEARED alarm is raised. This alarm indicates the presence of unverified alarms for the node in the Unverified Alarms tab. After the failure on the original path is fixed, acknowledge the alarms listed in the Unverified Alarms tab. The CP-UNVER-CLEARED alarm is automatically cleared after acknowledging the unverified alarms in the Unverified Alarms tab.

GMPLS UNI

The GMPLS User-Network Interface (UNI) is a signaling interface that is set up between the client such as the Cisco Carrier Routing System (CRS) or the Cisco ASR 9000 series router and the DWDM network. The GMPLS UNI allows the router to request bandwidth from the DWDM network.

The client side of the UNI is called UNI-C and the network side of the UNI is called UNI-N. Typically, UNI-C nodes are the router nodes and UNI-N nodes are the optical nodes. The router and the DWDM network exchange information only through the UNIs.

The GMPLS UNI allows GMPLS circuit created on the router to interact with the DWDM network. The UNI must be configured on both the router and the DWDM network to exchange information.

The GMPLS UNI provides the following benefits:

- If a router needs more bandwidth to connect to another router, the router can signal the request to a DWDM network through the GMPLS UNI and the optical channel is automatically set.

- Service parameters, such as bandwidth, can be easily modified.

When DWDM interfaces such as transponders are located on the router, the UNI-N notifies the UNI-C if a different wavelength (other than the one signaled by the UNI-C) is used after restoration. This allows the router to reconfigure the transponder with the new wavelength.

DWDM Network Functional View (Circuit Maintenance view)

This section describes the Circuit Maintenance view.

To navigate to the Circuit Maintenance view, go to the network view in CTC and click the **DWDM Functional View** icon in the toolbar. The Circuit Maintenance view opens.

The Circuit Maintenance view has the following panes:

Graphical View Pane

The graphical view displays all the nodes and devices in the network. Use the graphical view to gather information on circuits, optical power, and alarms for nodes.

To expand a node, double-click the node in the network functional view map or right-click the node and choose **Open Node FV**. The node opens and the sides of the nodes are displayed showing the various cards and patch panels present on each side. To open only one side of a node, right-click the node and choose Open Side > Side:x from the context menu.

Place the mouse over a card to view the card information. For example, when the mouse is placed over the OPT-BST card of a side, the tooltip text displays OPT-BST: shelf1/s1, indicating that the OPT-BST card is located in Shelf 1, Slot 1. Double-click a card to bring up the CTC card view.

To view the port information, place the mouse over a card port. For example, when the mouse is placed over the first port of the 40-MUX card, the tooltip text displays CARD_PORT-BAND-1-RX, indicating that the port is for the first band of wavelengths (wavelengths 1 to 8) to be added into the optical path on the 40-MUX card. These wavelengths come into the 40-MUX card from a transponder (TXP) or muxponder (MXP) on the patch panel.

Place the mouse over a patchcord to see the state of the output and input port associated with that patchcord.

When you right-click inside a side view, a context menu appears with the options listed in the following table.

Table 15: Side View Context Menu Options

Option	Description
Close Node FV	Closes the node functional view.
Node DoubleZoomIN	Magnifies the node view to double its size.
Node DoubleZoomOUT	Reduces the node view to half of its size.
Node Select all	Selects the complete node.
Rotate Left	Rotates the side 90 degrees counterclockwise (all connections are maintained).
Rotate Right	Rotates the side 90 degrees clockwise (all connections are maintained).
Close Side	Closes the side view.
Open Side	Opens the side view.

Additionally, to zoom-in and zoom-out of the map, press **Ctrl** and scroll up and down with the scroll wheel on your mouse. The keystroke commands provide the keyboard shortcuts for graphical control of the NFV. To access the keystroke commands, click **HelpKeystroke commands**.

When you have multiple node functional views opened, you cannot view the graphical details of the individual nodes due to overlapping. To avoid overlapping of the nodes:

1. Select the entire node by clicking on the title bar of the node and pressing **Ctrl**+**A**. Drag the node away from other nodes.

2. Select the individual side of the node and drag it away from other sides.

DWDM NFV Toolbar Options

The following table lists the tools available in the DWDM NFV toolbar.

Table 16: DWDM NFV Toolbar Options

Tool	Icon	Description
Pan		Enables you to select and move the whole network view.
Select		Enables you to select entities by clicking on them or by dragging a rectangular area around them.

Tool	Icon	Description
Zoom in rect		Enables you to zoom in the area defined by drawing a rectangle.
Zoom in		Zooms in the circuit map.
Zoom out		Zooms out the circuit map.
Reset Nodes Zoom		Resets the graphical view to the default zoom size.
Fit to View		Resizes the view to fit all the nodes in the graphical view.
Print		Prints the functional view data.
Magnifier		Displays a virtual magnifying glass which zooms in the area underneath. Hold the left mouse button to see the magnifying glass.
dB (Show Power)		Displays the optical power (dBm) for the card ports in the form of power balloons. This information is available only for the nodes that have the functional view open. To open the node FV, right-click the node and choose **Open Node FV**. Right-click the internal patchcord link and select the **Flip Power Balloons** option to change the position of power balloon on the selected patchcord. The power balloon is flipped and you can see the power details of the selected patchcord without the power balloons overlapping with each other.
SL (Show Spanloss)		Displays the span loss value on the spans.
PV (Verify Patchcords)		• Displays the insertion loss of the patchcord. The PV calculates the input and output power of the patchcord. You can view the insertion loss of the patchcord only for those nodes that have the FV open. To open the node FV, right-click the node and choose**Open Node FV** . The insertion loss should not exceed 2 dBm. The patchcord lines are colored to indicate the insertion loss: • Red—Indicates that the insertion loss of the patchcords exceeded 2 dBm. • White—Indicates that the system was not able to calculate the insertion loss of the patchcord. • Black—Indicates that the insertion loss of the patchcords is within the limit and not more than 2 dBm.

Tool	Icon	Description
Refresh Power Info		Refreshes the optical power and span loss information. The optical power and span loss information is calculated and is refreshed in the graphical display and optical power table.
Close Expanded Nodes		Closes all the opened nodes in the functional view.
Make node invisible		Hides the nodes that are not part of the selected circuit.
Reset To Default		Restores the panes in the network functional view to its default locations.

Overview Pane

The Overview pane displays the complete network. A rectangle is displayed in the Overview pane. The area enclosed by the rectangle is enlarged and displayed in the graphical view. To view a specific area of the network in the graphical view, move the rectangle to that location in the Overview pane. To zoom in or zoom out the network in the graphical view, resize the rectangle by dragging its corners in the Overview pane.

Network Data Pane

The Network Data pane displays the following three tabs that provide information about circuits:

- Circuits—Displays the list of circuits in the network. Choose the circuit from the list to view the circuit information. A graphical display of the selected circuit and the associated span is visible in the map. Additionally, you can view the general information (type, source, and destination), state (IS,OOS [ANSI] or unlocked, locked [ETSI]), and physical connection details (wavelength, direction, and span) of the selected circuit.

  The circuit can be in any one of the following states:

    - DISCOVERED

    - PARTIAL

    - DISCOVERED_TL1

    - PARTIAL_TL1

    - TO_BE_UPGRADED

    - OCHTRAIL WSON UPGRADEABLE

  When you upgrade from Release 9.21 to Release 9.3 and later releases, some OCHNC circuits do not automatically upgrade during the software activation process. To manually upgrade these circuits, select the **Reconfigure Circuits** option in the CTC **Tools > Circuits** menu. The **Reconfigure Circuits** option is applicable only when the circuit is in the TO_BE_UPGRADED state and not in the OCHTRAIL WSON UPGRADEABLE state. During reconfiguration, CTC reassembles all connections of the selected circuits based on path size, direction, and alignment.

When you switch the selection between the circuits, and if both the circuits are in DISCOVERED_TL1 status, the circuit details of the new selection may not be displayed as the previously selected circuit details are not refreshed.

If you find that the current selection is not refreshed, do either of the following:

- Deselect the selected circuit before selecting the another circuit.

- Update all the selected circuits using the **Reconfigure Circuits** option.

- **Optical Power**—Displays the optical link and span loss of the circuits. This tab lists the aggregated power-in and power-out of all the internal patchcords for the nodes that have the functional view open.

- **Alarms**—Displays all the alarms present on the network. If a card has one or more alarms (that is part of the selected circuit), the node turns either yellow or red, depending on the severity of the alarm. The alarm in red indicates a major alarm and yellow indicates a minor alarm. If there is an alarm present in the card that is not part of the selected circuit, then the node appears gray.

  If a node has alarms that is not part of the selected circuits, then the alarms are not listed in the table, but the node is colored in the map.

DWDM Network Functional View (Circuit Creation view)

This section explains the Circuit Creation view.

The Circuit Creation view uses the GMPLS control plane to provision circuits. For more information about the GMPLS control plane, see the GMPLS Control Plane, on page 125 section.

To navigate to the Circuit Creation view, go to the network view in the CTC and click the **DWDM Functional View** icon in the toolbar. Choose Circuit Creation from the Perspective View drop-down list. The Circuit Creation view opens.

The Circuit Creation view has the following panes:

- Graphical View Pane, on page 136

- Overview Pane, on page 139

- Network Data Pane, on page 139

- **Circuit Parameters** Pane—Options in this pane are used to provision a GMPLS circuit.

- **Working/Protect Port Parameters** Pane—Options in this pane are used to provision working and protect port parameters for the GMPLS circuit.

- Alien Wavelength Selection Pane—Options in this pane are used to provision the alien class wavelength.

- **Wavelength Re-route** Pane—Options in this pane are used to reroute a GMPLS circuit on an alternate path. For more information about wavelength rerouting, see the Wavelength Rerouting, on page 144 section.

- GMPLS/WSON Restoration Configuration Pane—Options in this pane are used to configure the restoration and revertive parameters for the OCHNC or OCH trail circuit. For more information about restoration parameters, see the GMPLS Restoration Configuration, on page 151 section.

Circuit Creation View Toolbar Options

The Circuit Creation view has the same set of tools as the Circuit Maintenance view as listed in Table-15. The additional toolbar options are described in the following table.

Table 17: Circuit Creation View Toolbar Options

Tools	Description
W&P Constraints Config	Displays the list of constraints to be applied on the nodes or links. For information about path constraints, see the GMPLS Path Constraints, on page 141 section .
S/D Configuration	Displays the options to define the source or destination port during GMPLS circuit creation. For more information about configuring the source and destination ports, see the Source and Destination Port Configuration, on page 143 section . This toolbar option is available in releases earlier to R10.3.
Wavelength re-routing	Displays the Wavelength re-routing view that can be used to reroute a GMPLS circuit on an alternate path. For more information about wavelength rerouting, see the Wavelength Rerouting, on page 144 section. This toolbar option is available in the Circuit Maintenance view in R10.3.
Circuit Creation	Displays the types of circuits that can be configured in the circuit creation view. For information about these circuits, see the Circuit Types, on page 144 section. This toolbar option is available in R10.3.

GMPLS Path Constraints

During GMPLS circuit creation or wavelength rerouting, it is possible to force specific nodes and links to be included or excluded in the circuit path by applying specific constraints. The GMPLS circuit is created if a feasible path is found that complies with the specified constraints. In R 10.0.2, you can also modify the constraints of an existing circuit in the circuit maintenance view. The circuit constraints are displayed as icons on the circuit map in the graphical view. The icons also contain an ordinal number that indicates the order in which the constraint will be applied to the link or node.

In the NCS4k-2H-W network functional view, the W&P Constraints Config drop-down list in the toolbar provides the constraint options listed in the following table . Choose the required option and select the node or span in the graphical view to which the constraint must be applied.

Table 18: Working and Protect Path Constraint Options

Option	Description
exclude W Node	The working path does not pass through the selected node.
exclude P Node	The protect path does not pass through the selected node.
exclude W&P Node	The working and protected path do not pass through the selected node.
include W Node	The working path passes through the selected node.
include P Node	The protect path passes through the selected node.
exclude W Link	The working path does not use the selected span.

Option	Description
exclude P Link	The protect path does not use the selected span.
exclude W&P Link	The working and protected path do not use the selected span.
include W Link	The working path uses the selected span.
include P Link	The protect path uses the selected span.

Note You can configure STRICT, LOOSE, or EXCLUDE constraints for a path using the TL1 interface.

- STRICT: The resource (node or span) to be included must be the next resource in the path.

- LOOSE: The resource (node or span) to be included need not be the next resource in the path.

- EXCLUDE: The resource (node or span) must be excluded from the path.

In the Wavelength re-routing view, the Constraints Config drop-down list provides constraint options listed in the following table. Choose the required option and select the node or span in the graphical view to which the constraint must be applied.

Table 19: Reroute Path Constraint Options

Option	Description
Exclude Node	The rerouted path does not pass through the selected node.
Include Node	The rerouted path passes through the selected node.
Include Regen Node	The rerouted path passes through the selected regen node.
Exclude Link	The rerouted path does not use the selected span.
Include Link	The rerouted path uses the selected span.

Table 20: Regen Constraint Options

Option	Description
Include Regen Node in Working Circuit Path	The regenerated node is included in the working circuit path.
Include Regen Node in Working Restored Circuit Path	The regenerated node is included in the working restored circuit path.
Include Regen Node in Protected Circuit Path	The regenerated node is included in the protected circuit path.

Option	Description
Include Regen Node in Protected Restored Circuit Path	The regenerated node is included in the protected restored circuit path.

Note   The constraint options can also be accessed by right-clicking the node or span.

Source and Destination Port Configuration

During GMPLS circuit creation, the source and destination ports at the circuit endpoints must be defined in the map. Depending on the circuit type being created, the circuit endpoints can be channel ports (on line cards), TXP/MXP ports, or router PLIM interfaces (10 G or 100 G ethernet client interface).

Use either of the following methods to define the source and destination ports:

Method 1:

1. From the S/D Configuration drop-down list, choose either of the following:

    • Working S/D—The selected ports are defined as the source and destination ports on the working path.

    • Protected S/D—The selected ports are defined as the source and destination ports on the protect path.

2. Click a node in the map to open the node functional view. The sides of the nodes are displayed showing the various cards and patch panel present on each side. To open only one side of the node, right-click the node and choose Open Side > Side:x from the context menu.

3. Click the patch panel to open it. All the patchcords and cards connected to the patch panel are displayed.

4. Use the zoom tools in the toolbar to manage the graphical view.

5. Click the card port that is associated with the wavelength for which the circuit is being created. A pop-up menu displays the available options:

    • If the port is on a TXP/MXP card, available client and trunk interfaces are displayed. Select the required interface.

    • If the port is an add/drop port, a list of supported wavelengths is displayed. Select the required wavelength.

Method 2:

1. Open the node functional view on the map by using either one of the following:

    • Double-click the node.

    • Right-click the node and select Open Node FV from the context menu.

    • The various cards and patch panel connected to each side are displayed.

2. Use the zoom tools in the toolbar to manage the graphical view.

3. Double-click the patch panel. The patch panel opens displaying all the patchcords and cards connected to it.

4. Click the card port that is associated with the wavelength for which the circuit is being created. A pop-up menu displays the available options:

- If the port is on a TXP/MXP card, available client and trunk interfaces are displayed. Select the required interface.

- If the port is an add/drop port, a list of supported wavelengths is displayed. Select the required wavelength.

5. A pop-up menu appears that displays one of the following pair of options:

- Work. Bid Src/Dst Port—The selected port is the bidirectional source and destination port on the working path.

- Prot. Bid Src/Dst Port—The selected port is the bidirectional source and destination port on the protect path.

- Work. Source Port—The selected port is the source port on the working path.

- Prot. Source Port—The selected port is the source port on the protect path.

- Work. Destination Port—The selected port is the destination port on the working path.

- Prot. Destination Port—The selected port is the destination port on the protect path.

- Select the required option.

Method 3:

Right-click the CRS-1 router and select the 10 G or 100 G ethernet client interface.

After the port is defined as the source or destination, a balloon is displayed on the map. The balloon indicates that the port is the source (S), destination (D), or both (S/D) for the circuit endpoint along with the associated wavelength. If the port is on the working path, the balloon is light blue in color; if the port is on the protect path, the balloon is deep blue in color.

Note During the creation of a Y-cable protected OCHCC circuit, the protected port gets selected automatically when the working port is selected because both the ports are in the same protection group.

Wavelength Rerouting

A GMPLS circuit can be rerouted through an alternate path that adheres to all the parameters that were defined during the circuit creation. Additional path constraints also must be specified based on which alternate route is computed. For more information about reroute path constraints, see Table-18. The wavelength re-routing feature provides an efficient solution for circuit restoration during path failure. For more information on wavelength rerouting, see the DLP-G710 Re-route Wavelength of GMPLS Circuits procedure.

Circuit Types

In R10.3 and later releases, fast circuit creation of protected and unprotected circuits are supported in the Circuit Creation perspective of the DWDM network functional view. The Circuit Creation drop-down list in

the toolbar allows you to select the type of circuit to be created. You can then select the source and destination nodes on the network map. The NFV performs a check for compatible interfaces on both the source and destination nodes. There must be at least one compatible interface on both nodes for circuit creation to take place. A valid interface must satisfy the three conditions:

- The interface must be plugged in.

- The interface must be connected by patchcords to a mux/demux stage.

- The interface must not be part of an already existing circuit.

During the creation of protected circuit using the fast creation method, an extra check is performed by the WSON. The WSON checks if both the source and destination nodes have the same type of protection model before checking for the compatibility of the interfaces. If for example, the source node has a splitter protection and the destination node has a PSM protection configured, the analysis by the WSON is cancelled. The following table displays the circuit types that can be created for each of the protection types.

Table 21: Circuit Types

Protection Type	Circuit Type
PSM	OCHNC, OCHCC
Y-cable	OCHCC
Splitter	OCHCC

A pop up menu displays only those circuit types that are feasible between the selected nodes. When a specific type of circuit is chosen, a new window appears that allows you to select only those interfaces that match the selection and are available on both the nodes. Additional parameters can be configured in the panels on the right. All the changes are applied just before the creation of the circuit.

You can use the pre-route option in the GMPLS/WSON S/D selection window that allows the WSON to detect the probable path of the circuit. When the route is found by the WSON , it is placed in DISCOVERED Preroute state and is highlighted in blue on the map. The circuit is created but placed out of service. All the configuration parameters are disabled except for the circuit action options in the GMPLS/WSON S/D selection window. You can close CTC and continue with the preroute operation at a later point in time.

To continue with the preroute operation, restart CTC. In the Circuit Creation perspective of the DWDM network functional view, select the circuit in the Network Data pane. The circuit is highlighted in blue on the map. Click Continue PreRoute to restart the preroute operation. You can accept the path by clicking the Accept button or can change the constraints using the options in the W & P Constraints config drop-down list. The Accept button changes to Refresh if any of the constraints are applied. On clicking Refresh, the WSON re-computes the path. If the path is acceptable, the user clicks the Accept button and the circuit is placed in service.

The Circuit Creation drop-down list in the Circuit Creation perspective toolbar provides the circuit options listed in the following table.

Table 22: Circuit Creation Options

Option	Description
FastCircuit Unprotected	Allows fast creation of an unprotected circuit.
FastCircuit Protected	Allows fast creation of a protected circuit.

Option	Description
Protected/Unprotected	Allows creation of a protected or unprotected circuit by opening the Node FV.

Video : Learn how to create an unprotected OCHCC circuit using the fast creation method.

GMPLS Optical Configuration Parameters

The following table lists the wavelength attributes that can be set for a GMPLS circuit.

Table 23: GMPLS Optical Configuration Parameters

Item	Description
Ignore Path Alarms	Ignores the path alarms and creates the circuit.
Allow Regeneration	Allows the control plane to find a regenerator deployed in the network. The regenerators are used when an optical LSP between two endpoints is not optical or lambda feasible with a single DWDM channel.
Circuit Diversity	Provisions a diversity path for the circuit. From the circuit pane, choose an existing circuit that will be used as a reference for the LSP diversity. This diverse path that is not taken by the new circuit is displayed in the circuit pane.
Priority	Sets the priority level for the circuit. The priority is used in resolving resource allocation when two or more circuits require the same resource during circuit creation or restoration concurrently. The priority levels are 0 (High) to 7 (Low).

Working and Protect Port Parameters

After a port is selected in the map as the source or destination endpoint, the Working Port Parameters pane, or Protected Port Parameters pane, or both are displayed depending on whether the selected ports are on the working or protect path. The following table lists the port parameters relevant to the selected port that are displayed in these panes.

Note These port parameters are not applicable for MXP-MR-2.5G cards. When you create a circuit using MXP-MR-2.5G cards, the working parameters pane will be empty.

Table 24: Working and Protect Port Parameters

Item	Description
Client Port	Displays the client port information.
ITU-T G709	Sets the ITU-T G.709 monitoring setting on the optical transport network. The available options are Enable or Disable.

Item	Description
FEC Mode (OCHCC and OCH trail only)	Sets the FEC mode for OTN lines. FEC mode can be Disabled, Standard, or Enhanced (provides greater range and lower bit error rate).
Mapping Type	Sets the mapping for the card. The options available are Not used, Asynchronous, Synchronous, ODU Multiplex (client SONET/SDH payload), or No Fixed Stuff. The choices available depend on the card.
MLSE Setting	If checked, sets the maximum likelihood sequence estimation (MLSE) parameter on the trunk port of the MXP_MR_10DME, MXP_MR_10DMEX, TXP_MR_10E, TXP_MR_10EX, MXP_2.5G_10E, and MXP_2.5G_10EX cards. The options available are Enable and Disable.
Overclock Setting	Enables or disables overclock mode on the trunk port.

The working and protect port parameters on the source and destination endpoints must match with each other. Otherwise, the mismatched parameters are displayed in red in the port parameters pane. If feasible, align the parameters by using the various drop-down lists available in this pane. Choose Apply to confirm selection.

Alien Wavelength Parameters

After a port is selected in the network map as the source or destination endpoint, the Alien Wavelength Selection pane is displayed for OCHNC circuits. The following table lists the options for the RX and TX channels at the endpoints of the circuit.

Table 25: Alien Wavelength Selection Parameters

Item	Description
AWL	Sets the alien class for both the RX and TX channels.
FEC Mode	Sets the FEC mode for both the RX and TX channels.

MCH Custom Alien Bandwidth Parameters

Table 26: Feature History

Feature Name	Release	Description
MCH Custom Alien Wavelength and MEDIA CHANNEL OCH NC circuit management through CTC	Cisco NCS 2000 Release 11.12	The feature allows you to create an MCH custom alien wavelength and the associated MEDIA CHANNEL OCH NC circuit specifying the following parameters through CTC: • Signal width • Modulation guard band • Filtering guard band This functionality enables you to create a medial channel of any spectrum size, for example, signal width of 34.20 GHz, modulation GB of 1.71 GHz, and filtering GB of 4.92 GHz.

MCH custom alien provides a way to manage unknown signals entering into the nodes. When you enter values for the signal width, modulation GB, and filtering GB parameters, the system allocates a channel of the required size. Optical validation is not supported on this channel since the characteristics of the signal are not known (apart from the provided size parameters). For this reason, optical validation is automatically set to NONE.

CTC supports the creation of MCH custom alien for which you can specify the spectrum requirement. The special **MCH Custom** alien with the flex option must be used to create the spectrum, which is defined with the following bandwidth parameters.

Table 27: Required Bandwidth Parameters

Item	Description
Signal width (GHz)	Sets the signal bandwidth in GHz.
Modulation GB (GHz)	Sets the modulation guard band in GHz.
Filtering GB (GHz)	Sets the filtering guard band in GHz.

The optical validation is automatically set to none for MCH custom alien.

These bandwidth parameters should satisfy the following condition: **bandwidth + 2 x max(guardbandFiltering, guardbandModulation) <= 4800GHz**

The specified signal width, which is considered in hundreds of GHz, must be even. For example 40.22 is an acceptable value, while 40.23 is not accepted.

Fiber Attributes and Alien Wavelength Provisioning

Choose the Provisioning > WDM-ANS > GMPLS/WSON tab to define and view fiber and alien wavelength parameters to be used during GMPLS circuit creation or upgrade of an a non-GMPLS Circuit to a GMPLS circuit. The GMPLS/WSON tab contains two subtabs, namely Fiber Attributes and Alien Wavelength.

Note   From Release 10.7, Alien Wavelength tab available at Provisioning > WDM-ANS > GMPLS/WSON is read-only. To modify or update Alien Wavelength parameters, see DLP-G800 Create a Link Management Protocol (LMP) Link Using CTC

The parameters available in the Fiber Attributes and Alien Wavelength are populated in CTC after importing the Cisco Transport Planner NE Update configuration file. For more information, see procedure. If required, additional changes can be made to these parameters in the Fiber Attributes and Alien Wavelength tabs.

The Fiber Attributes tab is used to view and define the fiber parameters, which are displayed in a tabular format as shown in the following table.

Table 28: Fiber Attributes Tab Parameters

Parameter	Description
Side	Displays the optical side where the fiber is connected.
Fiber Type	Allows to choose the fiber type from the drop-down list. The following fiber types do not support Nyquist spacing: • Dispersion-Shifted (DS) • True-Wave Classic (TWC) • LS
Topology Direction	Displays whether the link is entering or exiting the node.
Fiber Number	Displays the fiber sequence number. Useful when different types of fiber are present on the span.
Length	Allows to edit the fiber length.
PMD	Displays the Polarization Mode Dispersion fibre coefficient in ps/sqrt(km).
Attenuator In	Displays the input optical attenuation in dB between the node output port (typically LINE-TX port) and the input of the fiber span. The span might include patchcords, attenuators, and patch panels.
Attenuator Out	Displays the output optical attenuation in dB between the node input port (typically LINE-RX port) and the output of the fiber span. The span might include patchcords, attenuators, and patch panels.
Span Validation	Specifies whether the span can be used by GMPLS algorithm for channel routing and validation. The valid values are True and False.

Parameter	Description
Channel Spacing	Displays the minimum frequency spacing between two adjacent channels in the optical grid. The supported values are 100 GHz (up to 48 channels) and 50 GHz (up to 96 channels) and Nyquist. When the Nyquist option is selected, the channel number is denoted as a percentage of the spectral density. It is the ratio of the C-bandwidth used by the carrier, and the total bandwidth. The range for the percentage value is 50 to 91.
Chs Number / Occupancy	Displays the maximum number of channels expected on the span. The channel number and channel spacing must be consistent. For example, there cannot be 80 channels with 100 GHz spacing.
Domain	Displays the algorithm that is active on the span. The valid values are LOGO and LEGACY.

Use the Side drop-down list to choose a side; the attributes of the fibers that are connected to that side are displayed in the table. The Unit drop-down list enables you to choose the measurement unit for the fiber length. If required, the fiber type and the fiber length can be modified in the table. Click Apply to apply the changes.

The Alien Wavelength tab is used to view the port and wavelength parameters for the alien wavelength. The alien wavelength has to be configured for both source and destination ports. The alien wavelength has to be configured for each UNI interface. The following table lists the options available in the Alien Wavelength > Create tab. After making the necessary settings, click OK to apply the changes.

Table 29: Alien Wavelength Tab Options

Option	Description
Type	Choose the type of card where the alien wavelength is configured. The available options are optical card and passive card. The passive card option is available only if there are passive cards available on the network.
Shelf	Choose the shelf where the card resides.
Slot	Choose the slot where the card resides.
Port	Choose the card port where the alien wavelength is configured.
Alien Wavelength	Choose the alien wavelength class.
Lambda	Displays the alien wavelength value.

Option	Description
FEC	Sets the forward error correction (FEC) mode on the alien wavelength channel. The available modes are: • Disabled • Standard • Enhanced • Enhanced I.4 • Enhanced I.7 • 7% High Gain FEC • 20% High Gain FEC • 7% Soft Decision FEC • 20% Soft Decision FEC

GMPLS Restoration Configuration

Choose DWDM Network Functional View (Circuit Creation) in CTC to configure the restoration parameters. The following table lists the GMPLS restoration parameters.

Table 30: GMPLS Restoration Parameters

Option	Description
Restoration	Check this check box to switch the circuit from the original path to an alternate path because of failure in the original path.
Revert	Check this check box to revert the circuit from the restored path to the original path after the failure is fixed.
Mode	Select the mode from the drop-down list. If the mode is set to UNI-C, the reversion of the circuit from the restored path to the original path is triggered by the UNI client that is connected, typically a Cisco CRS router. If the mode is set to UNI-N, the reversion of the circuit is triggered by the DWDM network and can be either a manual revert or an auto revert. This field is displayed when the Revert checkbox is checked.
Auto Revert	Click this radio button to automatically revert the circuit from the restored path to the original path after the failure is fixed, WSON alarms are acknowledged, and the soak time expires.
Manual Revert	Click this radio button to manually revert the circuit from the restored path to the original path after the failure is fixed, the WSON alarms are acknowledged, and the soak time expires.

Option	Description
Soak Time	Enter the time (in hours, minutes, and seconds) in the Soak Time field. Soak time is the period that the circuit on the restored path must wait before switching to the original path after the failure is fixed. The circuit can revert to the original path after the soak time expires. The minimum value of soak time must be 00:00:01.

Related Procedures

- NTP-G151 Creating, Deleting, and Managing Optical Channel Client Connections

- NTP-G59 Creating, Deleting, and Managing Optical Channel Network Connections

- NTP-G353 Creating GMPLS Circuits Using the Fast Circuit Mode

- NTP-G58 Locating and Viewing Optical Channel Circuits

- NTP-G231 Viewing Optical Power Values and Alarms Using DWDM Network Functional View

- NTP-G334 Configuring GMPLS Optical Restoration

NTP-G231 Viewing Optical Power Values and Alarms Using DWDM Network Functional View

Purpose	This procedure enables you to view optical power values and alarms of the circuit selected in the DWDM Network Functional View.
Tools/Equipment	None
Prerequisite Procedures	DLP-G46 Log into CTC
Required/As Needed	As needed
Onsite/Remote	Onsite or remote
Security Level	Superusers only

Procedure

Step 1   From the View menu, choose **Go to Network View** and click the **DWDM Functional View** icon in the toolbar.

Step 2   Click the **Circuits** tab to view the list of circuits present in the network.

Step 3   Select the circuit from the list. A new pane with the Circuit:*circuit name* appears.

Step 4   View the following information in the Circuit:*circuit name* pane.

- General info—Displays circuit type, source, and destination information.

- Status—Displays the circuit protection type, administrative state, and circuit status.

• Physical—Displays the wavelength, number of spans, and circuit direction.

• Span and Power Level tab—Displays **the span loss and node power level**.

• Circuit Alarms tab—Displays alarms.

Step 5 To view the power, span loss, and insertion loss of a circuit in the map, click the following icons on the toolbar:

• **dB**—Displays the power of the circuit.

• **SL**—Displays the loss of signal of the desired span.

• **PV**—Displays the insertion loss of the patch cord.

Step 6 Complete the DLP-G529 Exporting Network Functional View Reports, as needed.

Stop. You have completed this procedure.

DLP-G529 Exporting Network Functional View Reports

Purpose	This task exports the Network Functional View report in .html, .csv, and .tsv formats.
Tools/Equipment	None
Prerequisite Procedures	DLP-G46 Log into CTC
Required/As Needed	As needed
Onsite/Remote	Onsite or remote
Security Level	Superusers only

Procedure

Step 1 From the View menu, choose **Go to Network View** and click the **DWDM Functional View** icon in the toolbar.

Step 2 Click **File** > **Export** to open the Export dialog.

Step 3 You can export the files in any of the following formats:

• As HTML —The exported file is saved as an HTML file. Also, a .png file is saved that provides graphical representation of the site layout.

• AS CSV—The file is saved in the Comma Separated Values (.csv) format. The circuit information is saved in a text file where the data is separated with a comma.

• TSV—The file is saved in a Tab Separated Values (.tsv) file. The circuit information is saved in a file where the data is separated by tabs.

The exported file contains details about the aggregated power and alarms at the network level. If specific circuits are selected in the network before exporting the file, the alarms and power of these circuits are also exported.

Step 4   Click **OK**.

Step 5   Specify the file name and the folder to save the export data and click **Save** .

Stop. You have completed this procedure.

NTP-G319 Connecting a Passive Module to the Cisco ONS 15454 DWDM Node

Purpose	This procedure connects the passive module to the USB port of the Cisco ONS 15454 DWDM node.
Tools/Equipment	Either 15216-FLD-4, 15216-MD-40-EVEN, 15216-MD-40-ODD, 15216-EF-40-ODD, 15216-MD-48-ODD, 15216-MD-40-EVEN, 15216-EF-40-EVEN, 15216-MD-48-EVEN, 15216-MD-ID-50, 15216-MD-48-CM, or 15216-FBGDCU. MF-6AD-CFS, MF-8X10G-FO, MF-16AD-CFS, MF-4x4-COFS, MF-DEG-5, MF-UPG-4, MF-MPO-8LC, MF-MPO-16LC, MF-2MPO-ADP, MF-16AE-CFS, MF-10AD-CFS, PPMESH8-5AD, MF-MPO-20LC
Prerequisite Procedures	DLP-G46 Log into CTC
Required/As Needed	As needed
Onsite/Remote	Onsite or remote
Security Level	Provisioning or higher

Procedure

Step 1   In the multishelf view (multishelf mode), click **Provisioning** > **WDM-ANS** tabs.

Step 2   Click the **Passive Cards** subtab.

Step 3   Click **Create** button. The Create Passive Card dialogue box appears.

Step 4   From the Card Type drop-down list, select the passive module that you want to connect to the USB port of the Cisco ONS 15454 DWDM node. For each passive module, CTC displays a table listing with Passive, Equipment Type, and Locations columns. Selecting the passive module from the Equipment Type column displays the port list of the passive module and its associated wavelength, and MPO.

Note   Perform the above step (Step 4) only if the passive module has not been already provisioned by the CTP xml files).

The available passive modules that can be connected to the USB port are:

- PASSIVE MD 40 ODD

- PASSIVE MD 40 EVEN

- PASSIVE EF 40 ODD

- PASSIVE EF 40 EVEN

- PASSIVE MD 48 ODD

- PASSIVE MD 48 EVEN

- PASSIVE MD ID 50

- PASSIVE 15216 48 CM

- MESH-PPR-SMR

- PASSIVE FBG DCU

- PASSIVE 15126 ID 50

- PASSIVE FLD4 30 3

- PASSIVE FLD4 33 4

- PASSIVE FLD4 36 6

- PASSIVE FLD4 39 7

- PASSIVE FLD4 42 9

- PASSIVE FLD4 46 1

- PASSIVE FLD4 49 3

- PASSIVE FLD4 52 5

- PASSIVE FLD4 55 5

- PASSIVE FLD4 58 9

- MF-16AD-CFS

- MF-4x4-COFS

- MF-DEG-5

- MF-UPG-4

- MF-MPO-8LC

- MF-MPO-16LC

- MF-2MPO-ADP

- MF-16AE-CFS

- MF-10AD-CFS

- PPMESH8-5AD

- MF-6AD-CFS

- MF-8X10G-FO

- MF-MPO-20LC

To connect MF-DEG-5-CV, MF-UPG-4-CV, or MF-M16LC-CV modules to the USB, select the corresponding pre-provisioned passive modules MF-DEG-5, MF-UPG-4, or MF-MPO-16LC.

Step 5 Click **OK**.

Step 6 In the Equipment Type column, select the passive module that you want to connect to the USB port and click **Associate to USB Port**. The Associate USB Port dialogue box appears.

Step 7 From the USB Port drop-down list, select the USB port that is connected to the passive module and click **OK** .

The USB is connected to the selected passive module. The insertion loss (IL) attribute, value, and units values are displayed in a table.

Stop. You have completed this procedure.

Not-DWDM Networks (Enhancements)

Not-DWDM (TDM) Networks take synchronous and asynchronous signals and multiplexes them to a single higher bit rate for transmission at a single wavelength over fiber. When the node is configured as a Not-DWDM Network, the supported MSTP cards are used in the standalone mode. MSTP applications like Circuit Provisioning, NLAC and APC are not supported in amplified TDM networks. For more information on how to configure a node as a Non-DWDM network, see the NTP-G320 Configuring the Node as a Non-DWDM Network.

NTP-G143 Importing the Cisco Transport Planner NE Update Configuration File procedure.

All DWDM cards can be installed in a network element configured as Not-DWDM. The cards must complete the Software Boot and Default Provisioning operations successfully. In NOT-DWDM mode, you must configure significant optical parameters and thresholds before launching the ANS application. For information on how to configure the amplifier, see the DLP-G693 Configuring the Amplifier Card procedure. For information on how to configure the PSM behavior, see the DLP-G694 Configuring the PSM Card procedure.

When the ANS application is launched, the supported cards become optically operative during service and report all the proper alarms. The list of supported cards are:

- OPT-PSM

- All optical amplifiers

- All transponder and muxponder Cards

You can import a standard xml configuration file when the network type is Not-DWDM. Node Layout and Card Parameters list must be populated. Software Patchcords and Optical Sides must not be configured.

Note You cannot transition a node from Metro-Core network type to Not-DWDM, if the circuits, OSC/DCN/GCC links, and Optical Sides have already been provisioned on the node. However, you can transition a node from Metro-Core network type to Not-DWDM if the software patchcords are provisioned on the node.

ANS with ports in IS feature is not applicable to NOT-DWDM networks. For information on how to add, modify, or delete the ANS Parameters, see the NTP-G328 Adding, Modifying, or Deleting ANS Paramteres procedure. The available procedures in Not-DWDM networks for physical shutdown of an active device (like Lasers and VOAs) inside a WDM card are:

- Removing the incoming signal

- Configuring optical thresholds (usually Input Power Fail) values suitable to keep the device off

- Forcing disable conditions (OSRI) via software commands.

For information on the procedure to erase the current card provisioning and to change port state to the default state (IS-AINS), see the DLP-G351 Deleting a Card in CTC procedure. Once deleted, the card can be removed or re-provisioned.

Note PSM Card must be moved to NORMAL state before deleting.

Note OPT-EDFA-17, OPT-EDFA-24, 40-SMR-1C, 40-SMR-2C cards have a different behavior associated to IS-AINS state on input ports (COM-RX, LINE-RX). When the port is in IS-AINS, the amplifier is forced to the OFF state despite the input power level (physical card shutdown).

If you revert the Network Type from NOT-DWDM to METRO-CORE with ports in IS state, TCC recognizes the transition and sets all the ports (of Amplifiers and PSM) to IS-AINS state.

Unnumbered Interface (UNI) Support

Unnumbered Interface (UNI) is the service control interface between the transport network and client equipment. It is used to utilize supported network services. To identify the link between an edge node and a core node, the UNI link assigned to the two interfaces must be specified. The two interfaces must have unnumbered configuration. The unnumbered interface is defined using the router ID and the unnumbered interface index assigned to the optics controller. In case of unnumbered interface support, the interface index is automatically assigned by the node. It eliminates the need of managing IP addresses to identify the interfaces. In case of numbered support, unique IP addresses are assigned manually to identify and manage the interfaces.

In case of unnumbered interface, the router ID and interface index of the local node are not editable. The router ID and interface index for the remote node must be entered manually. These values can be retrieved from **CLI** using *show lmp interface-id dwdm x/y/w/z*.

While creating tunnels, it is not possible to specify one interface on the endpoint directly. It is obtained by reporting the router ID and the interface Index to the Explicit Route Object (ERO) object as loose hop.

To configure the unnumbered interface using CTC, perform these procedures:

1. DLP-G789 Enable RSVP on an Interface

2. DLP-G790 Create a Static LMP Connection

Understanding SLTE

In Submarine Line Terminal Equipment (SLTE) topology, the NCS2K-20-SMRFS= card of NCS 2000 node aggregates channels from transponders, say NCS 1004. If there is more than one channel SMR card, they are connected by the 1*6 AD-CFS passive module. The aggregated channels from this passive module are transmitted to the fan-out module that covers signals from other geographical locations and the SMR card. The channels are then transmitted to the SLTE SMR card that faces the submarine system.

A typical spectrum in a submarine system must be completely occupied. If some channels are empty in the spectrum, they must be filled with dummy channels. ASE SMR card generates these dummy channels.

Figure 111: SLTE Topology
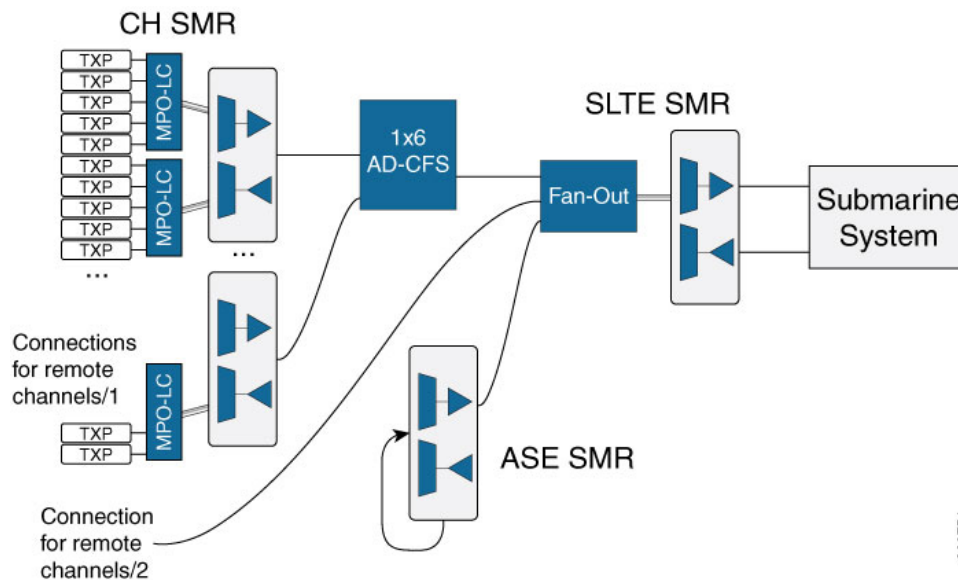
Configurations on the different channel, ASE, and SLTE SMR cards must be manually performed. The user must know the configurations that must be performed based on the type of SMR card. SMR9 FS card must be configured for ASE generation and SMR20 FS card must be configured for the terminal node of the submarine system.

> **Note** The NCS2K-20-SMRFS= card supports SLTE. The licensed version of the card does not support SLTE.

Provision Optical Safety

Before you begin

Install a fixed LC/UPC 1550nm single-mode fiber optical attenuator on the LINE-TX port of each SMR card of the node. The minimum loss of the optical attenuator must be 1dB +/- 0.5dB. The attenuator ensures that the optical power is always within the Class1M limit.

⚠️

Warning   Do not remove the attenuator from the front panel of the SMR card to prevent optical safety class violation.

Procedure

Step 1   In node view (single-shelf mode) or shelf view (multishelf mode), double-click the SMR9 FS or SMR20 FS cards where you want to provision optical safety.

Step 2   Click the **Maintenance** > **ALS** tabs.

Step 3   (For cards in slots 2, 3, 4, and 5) From the ALS Mode drop-down list, choose Disable.

Provision Network Type and Amplifier Working Mode

Procedure

Step 1   In shelf view (multishelf mode), click the **Provisioning** > **WDM-ANS** > **Provisioning** tabs.

Step 2   From the Value drop-down list, choose SLTE for Network Type parameter to specify that this node is used for a specific sub-marine application.

Step 3   (For COM-RX and LINE-TX ports of slot 2) From the Value drop-down list, choose Total Output Power for Amplifier Working Mode parameter.

Step 4   (For COM-RX port of slot 3) From the Value drop-down list, choose Total Output Power for Amplifier Working Mode parameter.

Provision ANS Parameters

Procedure

Step 1   In shelf view (multishelf mode), click the **Provisioning** > **WDM-ANS** > **Provisioning** tabs.

Step 2   Provision the values of the ANS parameters as described in the following tables.

Table 31: ANS Parameters for SLTE SMR Card

ANS Parameter	Value
ALS	Disabled
BST Working Mode	Total Output Power
PRE Working Mode	Total Output Power
BST Total Power	19

ANS Parameter	Value
PRE Total Power	19
BST Tilt	0
PRE Tilt	0
PRE Gain Range	1
COM-TX Power	-14
EXP-TX-1 Power	-25
EXP-TX-2 Power	-13
BST Power	-3
PRE Power	-3
EXP-RX-xyz Power	-6
LINE-RX LOS Threshold	-xxx (span loss dependent)

Table 32: ANS Parameters for ASE SMR Card

ANS Parameter	Value
ALS	Disabled
BST Working Mode	Fixed Gain
PRE Working Mode	Total Output Power
BST Gain	19
PRE Total Power	-10
PRE Tilt	0
PRE Power	-10
BST Power	0 (channel power)
BST Tilt	0
EXP-9-TX Power	-20
EXP-9-RX Power	-17
COM-TX Power	-21

Table 33: ANS Parameters for AD1 and AD2 SMR Cards

ANS Parameter	Value
ALS	Disabled
BST Working Mode	Fixed Gain
PRE Working Mode	Fixed Gain
PRE Gain Range	1
PRE Gain	21
BST Gain	16
BST Power	7
PRE Power	-2
BST Tilt	0
PRE Tilt	0
EXP-i-TX Power	−10
EXP-i-RX Power	1 dB lower than the TXP output power at SMR input port (scaled over 32GHz)
COM-TX Power	-12
LINE-RX LOS Threshold	-28

Create Channels for SLTE

Procedure

Step 1	In node view (single-shelf mode) or shelf view (multishelf mode), double-click the SMR9 FS or SMR20 FS card where you want to create channels.
Step 2	Click the **Provisioning** > **SLTE** > **Configuration** tabs.
Step 3	Click **Channel Create**. The SLTE Channel Creation dialog box appears.
Step 4	From the Port In drop-down list, choose the port where you want to create the channel.
Step 5	From the Carrier Frequency drop-down list, choose a frequency from C-band. This frequency is expressed in GHz or THz depending on the CTC settings.
Step 6	From the Channel Bandwidth drop-down list, choose a bandwidth expressed in GHz.
Step 7	Enter the target carrier power in the Mux PSD Config dBm field.

Step 8	Enter the Mux WXC VOA value in the Mux VOA Config dB field.
Step 9	Check the **Mux PSD Mode** check box to configure the working mode of the channel in the ADD direction.
Step 10	Enter the target carrier power in the Dmux PSD Config dBm field.
Step 11	Enter the Demux WXC VOA value in the Dmux VOA Config dB field.
Step 12	Check the **Dmux PSD Mode** check box to configure the working mode of the channel in the DROP direction.
Step 13	Click **OK** to close the SLTE Channel Creation dialog box.
Step 14	Click **Apply** in the SLTE Configuration dialog box to create channels.