

**NTRN10AN**

Nortel Networks

# **OPTera Metro 3500 Multiservice Platform**

## **Release 12.1 Planning and Ordering Guide—Part 1 of 2**

Standard Issue 1 April 2004

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### ***What's inside...***

#### **Overview**

**Operation, administration, and maintenance (OAM) features**

**Hardware feature descriptions**

### ***See Part 2 for the following...***

**Technical specifications**

**Engineering rules**

**Cable and connector details**

**Shelf mounting guidelines**

**Ordering information**

**Terms and conditions**

**Glossary**

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# Contents

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<b>About this document</b>	<b>ix</b>
Supported software	ix
Supported hardware	x
Technical support and information	xii
<b>Overview</b>	<b>1-1</b>
Network element overview	1-1
Release 12.1 features	1-4
Release 12.1 Hardware Compatibility Matrix	1-16
Supported configurations	1-19
Interworking	1-25
Supported upgrade paths	1-26
<b>Operation, administration, and maintenance (OAM) features</b>	<b>2-1</b>
Gigabit Ethernet Drop and Continue	2-3
Alarm provisioning	2-5
Alarm flow control	2-6
Environmental alarms	2-7
External controls	2-7
ACO switch — clearing audible alarms and performing lamp tests	2-7
Bandwidth management	2-7
Tributary, DWDM, BLSR, UPSR, and 1+1 linear point-to-point	2-8
BLSR	2-9
Connection editing	2-9
In-service traffic rollover	2-9
BLSR networks (2-fiber)	2-10
Protection	2-11
'Infinite wait-to-restore' parameter	2-12
BLSR Line Protection Oscillation Control	2-13
BLSR single span fiber cut scenario	2-13
BLSR nodal / multi-span failure scenario (involves squelching)	2-25
BLSR configurations	2-29
BLSR configuration and connection audit	2-30
Traffic flow over OC-48 BLSR	2-31
Traffic flow over OC-192 BLSR	2-32
Provisioning rules	2-34
OAM supported on BLSR	2-43
Channelized DS3 service (DS3VTx12 mapper)	2-44

- Common Language Location Identifier 2-44
- Connection ID 2-45
- Consolidated load 2-45
- Dense wavelength division multiplexing (DWDM) 2-46
  - OMX module 2-48
  - Network sites 2-49
  - DWDM configurations 2-50
- Facility attributes 2-54
- Loopbacks 2-54
  - Terminal loopback 2-54
  - Facility loopback 2-54
  - Optical loopback 2-55
- Network surveillance 2-58
  - Extended network processor (NPx) 2-58
  - Telemetry byte-oriented serial (TBOS) 2-59
  - Path trace 2-60
  - Section trace 2-61
  - TID address resolution protocol (TARP) 2-61
- OPTera Packet Edge System (Resilient Packet Ring) - Ethernet 2-62
  - Connectors 2-62
  - Resilient packet ring (RPR) object 2-63
  - Optical Ethernet / Layer 2 (OE/L2) on OPTera Packet Edge System 2-64
  - RPR configuration alert 2-65
  - Auto save notification 2-65
  - NNI Filters increased to 2048 2-66
- Optical Ethernet-Private Line (OE-PL) services using 10/100 Ethernet 2-66
  - 2x100BT-P2P circuit pack 2-66
  - PPP over SONET 2-67
  - PPP and HDLC 2-67
  - Bridge Control Protocol 2-69
  - Network protection using UPSR, 1+1 linear and BLSR 2-69
  - OAMP support 2-70
  - Ethernet Operational Measurements 2-70
- Optical Ethernet-Private Line (OE-PL) service using 2x1000 SX/LX OPE circuit packs 2-71
  - Distributed multilink trunking 2-72
  - Bandwidth Reservation Protocol (BRP) 2-72
  - 1024 TDIs on a mapped UNI 2-72
- Optical Ethernet - Private Line (OE-PL) and Storage applications 2-73
  - 2xGigE/FC-P2P circuit pack 2-73
  - Alarm management 2-74
  - Bandwidth management 2-84
  - Facility attributes 2-85
  - Ethernet Operational Measurements 2-90
  - Performance Monitoring 2-95
  - Fibre Channel Extended Reach 2-95
  - Generic Framing Procedure and Virtual Concatenation support 2-99
- Optical interoperability of OPTera Metro 3500 2-102
- Performance monitoring 2-102
  - SONET line, section, and path parameters 2-102
  - Threshold values 2-103

- Retrieving performance monitoring counts 2-110
- Physical PMs 2-111
- Performance monitoring threshold crossing alerts (TCA) 2-114
  - TCA summary alarms 2-114
- Site Manager support 2-116
  - Preside Software Upgrade Management support 2-116
- Preside Applications Platform and Multiservice MOA support 2-117
- Protection switching 2-118
  - Protection hierarchy 2-119
  - Protection performance monitoring parameters for optical facilities 2-120
- Security and administration 2-122
  - Local account user authentication 2-122
  - Local 'challenge-response' user authentication 2-123
  - Centralized Security Administration (CSA) 2-124
  - Centralized user administration and authentication through RADIUS 2-125
  - SecurID support 2-128
  - Secure storage of authentication data 2-128
  - Saving and restoring provisioning data 2-129
  - Local TL1 of provisioning data 2-129
  - Save and restore of shelf processor or span of control data to a remote management entity through an IP connection 2-129
  - Application of TL1 commands from a TL1 script file 2-130
  - Security levels 2-130
  - Third Level 5 User Support/Increased NPx SOC visibility to 16 NEs 2-131
  - System identifier (SID) 2-131
  - Remote login 2-132
  - Multiple login sessions 2-132
  - Enhanced Intrusion Detection 2-133
  - Intrusion attempt handling 2-134
  - Password management 2-135
  - Customer managed networks 2-137
  - Security log audit trail 2-138
  - General Broadcast tool 2-139
  - Modifiable Login Banner 2-140
- STS Managed DSM 2-142
- Support for 12 DSM 2-146
- Synchronization 2-146
  - Internal timing 2-147
  - External timing 2-147
  - Line timing 2-147
  - Timing modes 2-149
  - Stratum clocks 2-150
  - Synchronization hierarchy 2-150
  - Hierarchy violations 2-151
  - Timing loops 2-151
  - Building-integrated timing supply (BITS) 2-153
  - Network element synchronization modes 2-153
  - Timing sources and timing distribution 2-155
  - External timing reference input signals to STX and VTX-series circuit packs 2-156

- Synchronization-status messages 2-156
- User-specified quality levels for timing sources 2-158
- BITS output with VTX-series or STX-192 circuit packs 2-158
- User-initiated synchronization switches 2-158
- Test Access 2-160
  - Test Access Ports (TAPs) 2-161
  - Test access configurations 2-162
  - Monitoring test access 2-162
  - Split test access 2-165
  - Loss of association and auto recovery 2-167
  - User interface 2-168
- Time of day synchronization 2-169
- TL1 Changes to Cross Connect AID parameter 2-172
- TL1 event exerciser 2-173
- TL1 event / log feature 2-173
  - Database change events 2-174
  - Log events 2-174
  - Inventory events 2-174
  - ATAG sequence numbers 2-175
- Topology enhancements 2-175
- VT management option on STX equipped OPTera Metro 3500 2-175
  - VT management on a UPSR 2-175
  - VT grooming on a UPSR 2-181
  - Collocated OPTera Metro 3000 NE and dedicated STS at each site 2-184
  - Collocated OPTera Metro 3000 NE and shared VT-managed STS 2-186
  - UPSR planning guidelines summary 2-189
  - General guidelines 2-189
  - Physical subtending rings 2-189
  - Virtual rings across the STS-managed OPTera Metro 3500 backbone network 2-189
  - VT grooming at an STS-managed OPTera Metro 3500 site 2-189

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## Hardware feature descriptions

3-1

- Extended Reach (ZX) Small Form Factor Pluggable (SFP) 3-3
- OPTera Metro 3500 Shelf and the OPTera Metro 3500 Universal Shelf 3-4
  - Shelves equipped with VTX-48 or VTX-48e circuit packs 3-4
  - Shelves equipped with STX-192 circuit packs 3-5
- Replaceable I/O modules 3-26
- Common modules 3-37
  - Left OAM (LOAM) 3-37
  - Left interface (LIF) 3-38
- OPTera Metro 3500 cooling unit assembly and cooling unit fan modules 3-40
- Universal cooling unit assembly and cooling unit fan modules for extended temperature applications 3-41
- 20 A (Universal) power module 3-42
- OPTera Metro 3000 breaker interface panel (BIP) 3-42
- OPTera Metro 3500 BIP (European deployment) 3-44
- STX-192 circuit pack 3-51
  - Equipping rules 3-51
- VTX-48 circuit pack 3-54
  - Equipping rules 3-55

- VTX-48e circuit pack 3-55
  - Equipping rules 3-56
- Extended shelf processor (SPx) 3-56
  - TL1 sessions 3-56
  - Alarms and TBOS 3-57
  - Reset button 3-57
  - Section data communication channel (SDCC) 3-57
    - Equipping rules 3-57
- Extended network processor (NPx) 3-57
  - TL1 sessions 3-58
  - Alarms and provisioning data 3-58
  - Reset button 3-58
  - Equipping rules 3-59
- ILAN interface 3-59
  - Equipping rules 3-59
- OC-192 optical interface circuit pack 3-59
  - STS-1 path trace for OC-192 3-60
  - Section trace for OC-192 3-60
  - Section data communication channel (SDCC) 3-60
  - Forward Error Correction (FEC) 3-60
  - Equipping rules 3-62
  - OC-192 protection switching 3-62
- OC-192 DWDM G.709 FEC optical interface circuit pack 3-64
  - Section data communication channel (SDCC) 3-64
  - Forward Error Correction (FEC) 3-64
  - Equipping rules 3-65
- OC-48 optical interface circuit pack 3-65
  - STS-1 path trace for OC-48 3-65
  - Section trace for OC-48 3-66
  - Section data communication channel (SDCC) 3-66
  - Equipping rules 3-66
  - OC-48 protection switching 3-67
- OC-48 STS optical interface circuit pack 3-68
  - STS-1 path trace for OC-48 3-69
  - Section trace for OC-48 3-69
  - Section data communication channel (SDCC) 3-69
  - Equipping rules 3-70
  - OC-48 protection switching 3-70
- OC-48 DWDM circuit pack 3-71
  - Section data communication channel (SDCC) 3-71
  - Equipping rules 3-72
- OC-12 optical interface circuit pack 3-72
  - Equipping rules 3-73
  - OC-12 Protection switching 3-73
  - Section data communication channel (SDCC) 3-74
- OC12x4 STS IR optical interface circuit pack 3-75
  - Multimode Interworking 3-75
  - Equipping rules 3-76
  - Section data communication channel (SDCC) 3-77
- OC-3 optical interface circuit pack 3-77
  - Equipping rules 3-78

OC-3 Protection switching	3-78
Section data communication channel (SDCC)	3-79
OC-3x4 optical interface circuit pack	3-80
Multimode Interworking	3-80
Equipping rules	3-81
Section data communication channel (SDCC)	3-82
EC-1x3 circuit pack	3-82
Equipping rules	3-83
Protection switching	3-83
Section data communication channel (SDCC)	3-83
EC-1x12 circuit pack	3-84
Equipping rules	3-84
Protection switching	3-85
Section data communication channel (SDCC)	3-85
DS1 mapper	3-86
Equipping rules	3-86
DS3x3 mapper	3-87
Equipping rules	3-87
Protection switching	3-88
DS3x12 / DS3x12e mapper	3-89
Equipping rules	3-89
DS3VTx12 mapper	3-90
Equipping rules	3-91
DS3/VT protection switching	3-91
2x100BT-P2P circuit pack	3-91
Equipping rules	3-92
OPTera Packet Edge System 4x100BT circuit pack	3-94
Equipping rules	3-94
OPTera Packet Edge System 4x100FX circuit pack	3-96
Equipping rules	3-96
OPTera Packet Edge System 2xGigE (2x1000SX, 2x1000LX) circuit pack	3-97
Equipping rules	3-97
2xGigabit Ethernet/Fibre Channel - Point-to-Point circuit pack	3-98
Equipping rules	3-98
Protection switch controller (PSC)	3-100
Equipping rules	3-100
Protection switch extender (PSX)	3-101
Equipping rules	3-101
OMX + Fiber Manager 4CH	3-101
Enhanced OMX + Fiber Manager 4CH	3-102
OMX shelf (not required with OMX + Fiber Manager 4CH)	3-103
Equipping rules	3-103
Fiber Manager (not required with OMX + Fiber Manager 4CH)	3-104
DS1 service module (DSM) shelf	3-107
Equipping rules	3-107
Multiple IS	3-107
DSM DS1x84 termination module (TM)	3-111
Equipping rules	3-111
Protection switching	3-112



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# About this document

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**ATTENTION**

This document is presented in two parts: Part 1 and Part 2. Each part has its own table of contents. The table of contents in Part 1 contain topics found in Part 1 only. The table of contents in Part 2 contain topics found in Part 2 only. Part 2 continues sequential chapter numbering from Part 1.

You are reading Part 1 of Nortel Networks *OPTera Metro 3500 Multiservice Platform Release 12.1 Planning and Ordering Guide*, NTRN10AN.

Part 1 of *OPTera Metro 3500 Multiservice Platform Release 12.1 Planning and Ordering Guide*, NTRN10AN covers a network element overview and new features in Release 12.1, operation, administration, and maintenance (OAM) features, and hardware description features.

Part 2 of *OPTera Metro 3500 Multiservice Platform Release 12.1 Planning and Ordering Guide*, NTRN10AN covers technical specifications, engineering rules, cable and connector details, shelf mounting guidelines, ordering information, terms and conditions, and a glossary.

## Standards

The Telecommunications Industry Association (TIA) and the Electronics Industries Alliance (EIA) accepted RS-232 as a standard in 1997 and renumbered this standard as TIA/EIA-232. In this document, RS-232 is used to reflect current labels on the hardware and in the software for the OPTera Metro 3500 Multiservice Platform.

## Supported software

This document supports the software release for OPTera Metro 3500 Release 12.1.

## Supported hardware

This document supports the OPTera Metro 3500 shelves (NTN476AA, NTN476DA) and the Universal OPTera Metro 3500 shelf (NTN476AH).

*Note:* The OPTera Metro 3500 shelf NTN476AA must be upgraded using the power module and cooling upgrade kit (NTN458MW) to support OC-192 optical interfaces.

## Hardware naming conventions

The following naming conventions are used throughout this document to identify the OPTera Metro 3500 hardware:

- The extended shelf processor (SPx) is referred to as the shelf processor.
- The extended network processor (NPx) is referred to as the network processor.

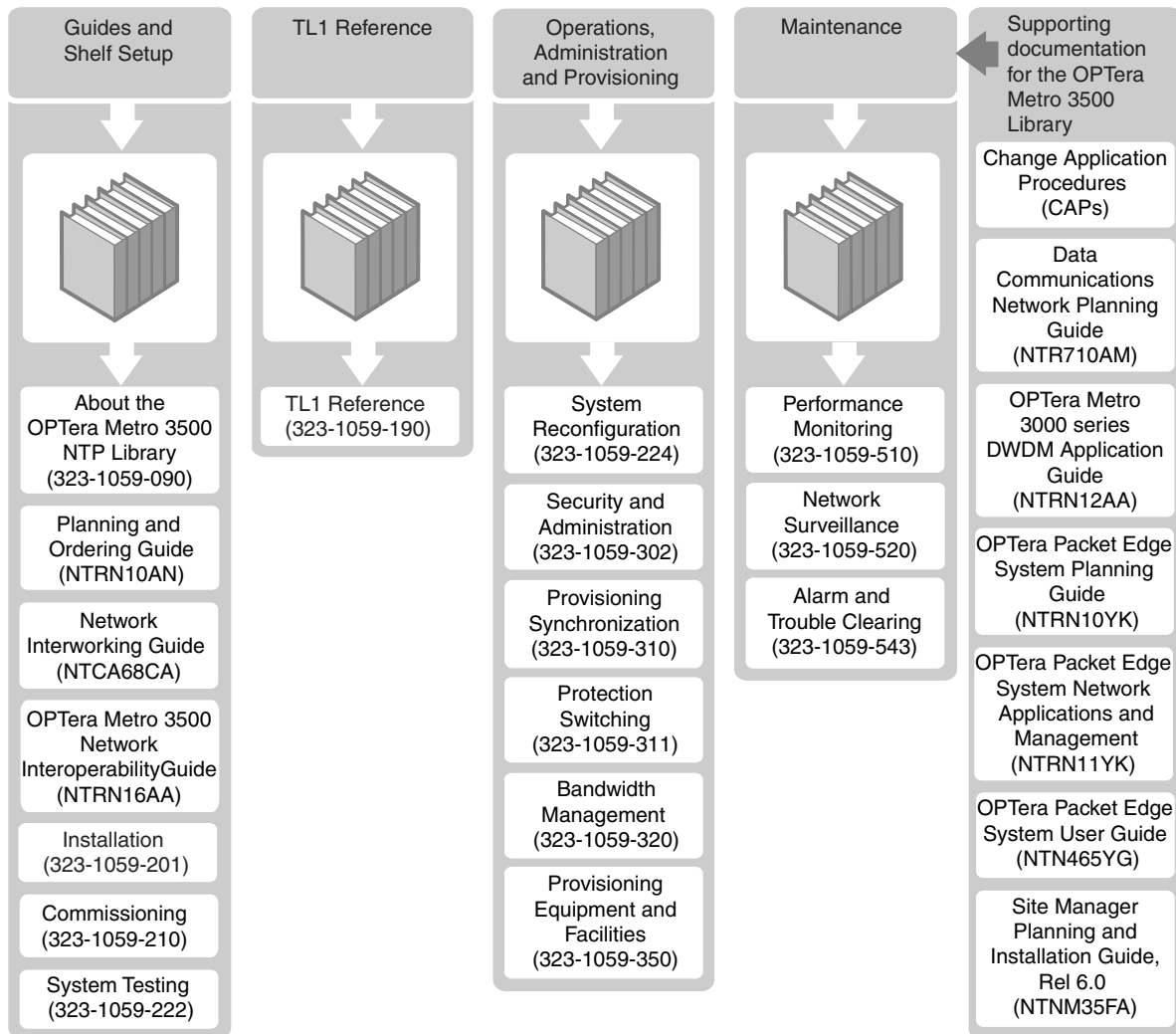
## Audience

The following members of your company are the intended audience of this Nortel Networks technical publication (NTP):

- planners
- provisioners
- network administrators
- transmission standards engineers

# OPTera Metro 3500 NTP library

EX1541p



## Technical support and information

For technical support and information from Nortel Networks, refer to the following table.

<b>Technical Assistance Service</b>	
<p><b>For service-affecting problems:</b> For 24-hour emergency recovery or software upgrade support, that is, for:</p> <ul style="list-style-type: none"> <li>• restoration of service for equipment that has been carrying traffic and is out of service</li> <li>• issues that prevent traffic protection switching</li> <li>• issues that prevent completion of software upgrades</li> </ul>	<p><b>North America:</b> 1-800-4NORTEL (1-800-466-7835)</p> <p><b>International:</b> 001-919-992-8300</p>
<p><b>For non-service-affecting problems:</b> For 24-hour support on issues requiring immediate support or for 14-hour support (8 a.m. to 10 p.m. EST) on upgrade notification and non-urgent issues.</p>	<p><b>North America:</b> 1-800-4NORTEL (1-800-466-7835)</p> <p><b>Note:</b> You require an express routing code (ERC). To determine the ERC, see our corporate Web site at <a href="http://www.nortelnetworks.com">www.nortelnetworks.com</a>. Click on the Express Routing Codes link.</p> <p><b>International:</b> Varies according to country. For a list of telephone numbers, see our corporate Web site at <a href="http://www.nortelnetworks.com">www.nortelnetworks.com</a>. Click on the Contact Us link.</p>
<p><b>Global software upgrade support:</b></p>	<p><b>North America:</b> 1-800-4NORTEL (1-800-466-7835)</p> <p><b>International:</b> Varies according to country. For a list of telephone numbers, see our corporate Web site at <a href="http://www.nortelnetworks.com">www.nortelnetworks.com</a>. Click on the Contact Us link.</p>

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# Overview

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## Network element overview

The Nortel Networks OPTera Metro 3500 network element is a multiservice platform offering dense wavelength division multiplexing (DWDM) with a wide variety of services: DS1, DS3, Channelized DS3, EC-1, OC-3, OC-12, OC-48, OC-192, 10/100BASE-T Ethernet, 100BASE-FX Ethernet, Gigabit Ethernet and Fibre Channel.

OPTera Metro 3500 is a next generation SONET multiservice platform. It provides full OC-192 connectivity to customer premise locations.

On the physical layer (layer 1), an OPTera Metro 3500 network can be configured as a unidirectional path-switched ring (UPSR), a 1+1 linear configuration, a 2-fiber bidirectional line-switched ring (BLSR), or as an unprotected fiber optic run.

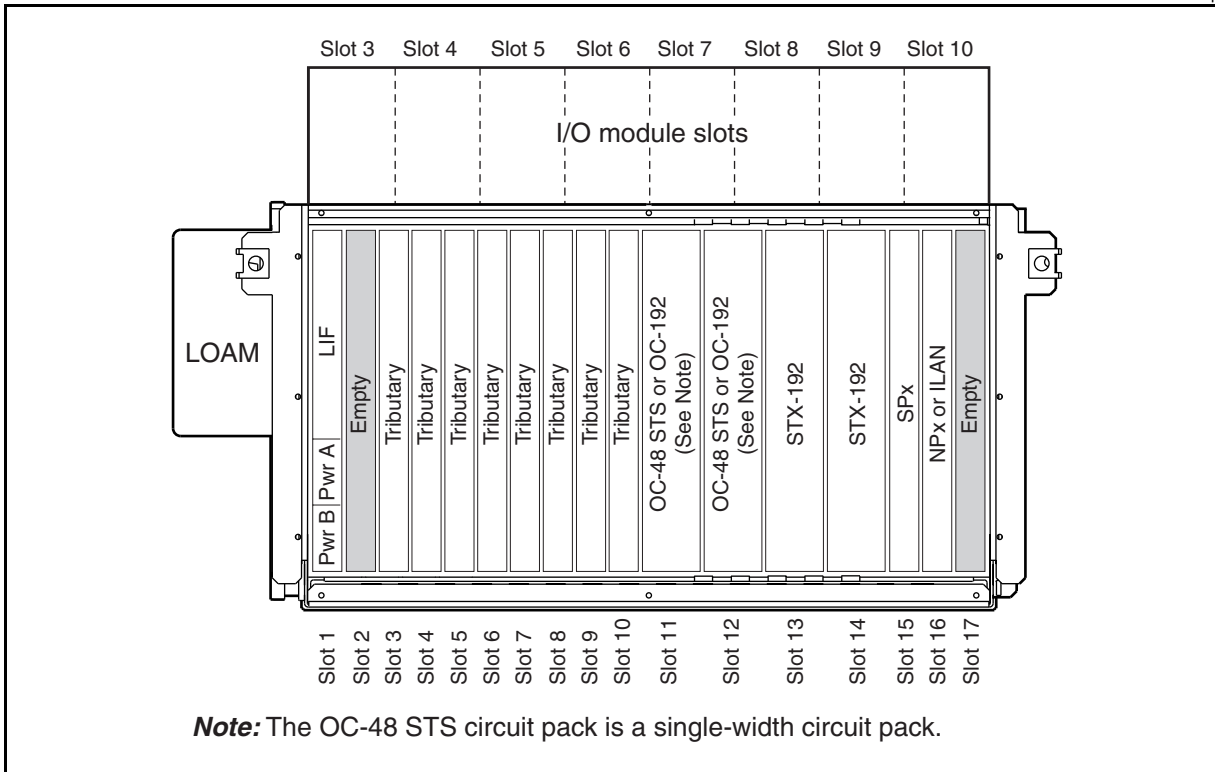
On the data link layer (layer 2), an OPTera Metro 3500 network can be configured as an OPTera Packet Edge ring with layer 2 protection, in accordance with Resilient Packet Rings (RPR) currently being defined by the IEEE 802.17 working group.

OPTera Metro Release 12.0 introduced a new STX-192 switch matrix circuit pack. The STX-192 circuit pack is a fully non-blocking STS switch matrix and clocking module providing switching capability for 40 Gbit/s. The STX-192 provides support for 10 Gbit/s links to the line slots 11 and 12 and up to 2.5 Gbit/s links to slots 3 through 10.

For STX based configurations, the OPTera Metro 3500 is optimized for broadband services, namely Gigabit Ethernet, Storage Area Networking, and switched Ethernet services using Resilient Packet Ring. When configured for STX based configurations, the platform supports full TDM services as well, with full fill OC12 and OC48 densities. Furthermore, DS1 services are still possible via the DS1 Service Module (DSM). For STX based configurations where VT1.5 level management is required, a dual node configuration can be used where by a VTX based OPTera Metro 3500 is subtended from a STX based OPTera Metro 3500. Both nodes are managed via Site Manager, which provides end-to-end connection management capability.

**Figure 1-1**  
**OPTera Metro 3500 slot assignments (STX-192 installed in shelf)**

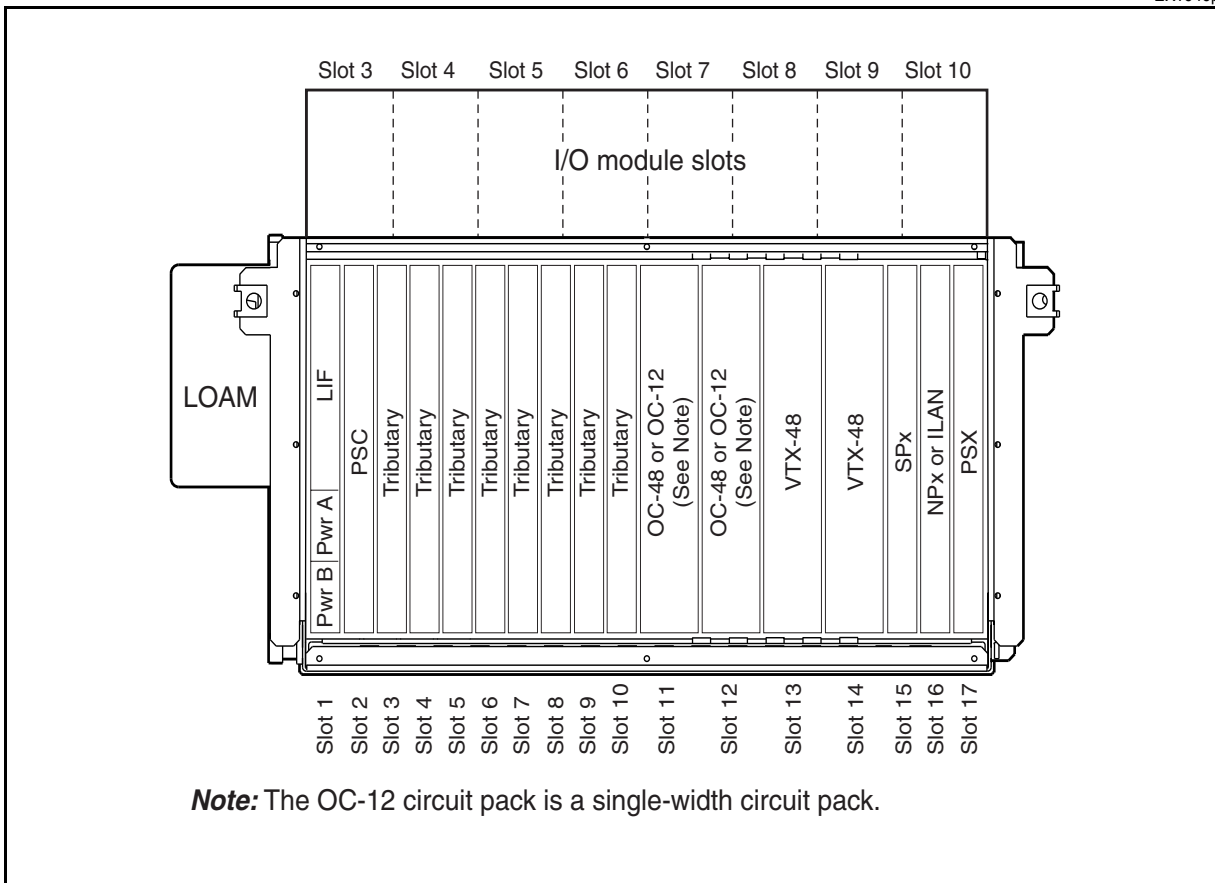
EX1470p



For VTX based configurations, the OM3500 is optimized for OC48 based TDM and Optical Ethernet applications, supporting full densities for all TDM services. Furthermore, with the completely non-blocking VT1.5 switch matrix, the platform is ideally suited for hybrid digital cross connect and add/drop multiplexer applications.

**Figure 1-2**  
**OPTera Metro 3500 slot assignments (VTX-48/VTX-48e installed in shelf)**

EX1040p



**Note:** The OC-12 circuit pack is a single-width circuit pack.

## Release 12.1 features

The Release 12.1 OPTera Metro 3500 system offers the following new and enhanced features:

- Gigabit Ethernet Drop and Continue support on 2xGigE/FC-P2P interface
- Support for extended reach (ZX) small-form factor pluggable (SFP)

This document describes the applications and functionality available in Release 12.1. See the following chapters for more detail:

- Chapter 1, [Overview](#), gives a high level description of what is supported in this release.
- Chapter 2, [Operation, administration, and maintenance \(OAM\) features](#), gives a high level description of OAM&P functionality.
- Chapter 3, [Hardware feature descriptions](#), describes both shelves and their components.
- Chapter 4, [Technical specifications](#) (in Part 2 of this guide), lists the technical specifications for all circuit packs and equipment.
- Chapter 5, [Engineering rules](#) (in Part 2 of this guide), lists special engineering rules for interworking, DWDM, and Preside.
- Chapter 6, [Cable and connector details](#) (in Part 2 of this guide), lists the cables and components used on the shelf.
- Chapter 7, [Shelf mounting guidelines](#) (in Part 2 of this guide), describes typical installations.
- Chapter 8, [Ordering information](#) (in Part 2 of this guide), provides procedures and tables to simplify the ordering process.
- Chapter 9, [Terms and conditions](#) (in Part 2 of this guide), provides contacts to set up an order.

See [Table 1-1](#) for a complete list of supported features in Release 12.1.

**Table 1-1**  
**Feature compatibility for Release 12.1**

Feature	Supported on platforms with VTX-series circuit packs	Supported on platforms with STX circuit packs
<b>Network configurations</b>		
Bidirectional line switched ring (BLSR) (2-fiber) at OC-192 rate	No	Yes
Bidirectional line switched ring (BLSR) (2-fiber) at OC-48 rate	Yes	No
BLSR with linear spur	Yes	Yes
BLSR with subtending UPSR	Yes	Yes



**Table 1-1 (continued)**  
**Feature compatibility for Release 12.1**

Feature	Supported on platforms with VTX-series circuit packs	Supported on platforms with STX circuit packs
Uni-directional Path switched Ring at OC3, OC-12, OC-48 or OC-192 rates	Yes except OC-192	Yes
Dual-homed subtending rings (on UPSR)	Yes	Yes
Linear add/drop multiplexer OC-3, and OC-12, OC-48, and OC-192 rates	Yes except OC-192	Yes except OC-192
Linear point-to-point at OC-3, OC-12, OC-48, and OC-192 rates	Yes except OC-192	Yes
Matched nodes (on UPSR)	Yes	Yes
Mixed RPR and TDM traffic over BLSR	Yes	Yes
Mixed RPR and TDM traffic over UPSR (and above UPSR variants)	Yes	Yes
Optical hubbing	Yes	Yes
Path-in-line (virtual ring) (across UPSR or BLSR)	Yes	Yes
RPR over BLSR (working and protection channels)	Yes	Yes
RPR over UPSR (and above UPSR variants)	Yes	Yes
Single-homed subtending rings (on UPSR)	Yes	Yes
UPSR to non-OPTEra Metro 3500 BLSR interconnection	Yes	Yes
<b>In-service reconfigurations</b>		
Adding a network element to an OC-48 or OC-192 BLSR	Yes except OC-192	Yes except OC-48
Adding a network element to a UPSR	Yes except OC-192	Yes
Adding an OMX shelf to an in-service DWDM network	Yes	Yes
Adding an OPTera Metro 3500 network element to an OC-48 UPSR over DWDM	Yes	Yes
Adding an OPTera Metro 3500 network element to an OC-48 BLSR over DWDM	Yes	No
Converting an OC-48 UPSR to an OC-48 UPSR over DWDM	Yes	Yes
Converting an OC-48 BLSR to an OC-48 BLSR over DWDM	Yes	No

**Table 1-1 (continued)**  
**Feature compatibility for Release 12.1**

Feature	Supported on platforms with VTX-series circuit packs	Supported on platforms with STX circuit packs
Converting an OC-48 linear point-to-point network to an OC-48 linear point-to-point network over DWDM	Yes	Yes
Adding an OPTera Metro 3500 network element to an OC-192 UPSR over DWDM	No	Yes
Converting an OC-192 UPSR to an OC-192 UPSR over DWDM	No	Yes
Converting an OC-192 linear point-to-point network to an OC-192 linear point-to-point network over DWDM	No	Yes
Converting a UPSR to a BLSR	Yes See Note 3	Yes See Note 3
Converting a 1+1 linear point-to-point configuration to a 2-node UPSR	Yes	Yes
Converting a 2-node UPSR to a 1+1 linear point-to-point configuration	Yes	Yes
Moving a synchronization boundary	Yes	Yes
Removing a network element from an OC-48 or OC-192 BLSR	Yes except OC-192	Yes except OC-48
Removing a network element from a UPSR	Yes	Yes
Removing an OPTera Metro 3500 network element from an OC-48 BLSR over DWDM	Yes	No
Removing an OPTera Metro 3500 network element from an OC-48 UPSR over DWDM	Yes	Yes
Replacing a DS3x3 mapper with a DS3x12 / DS3x12e mapper	Yes	Yes
Replacing an EC-1x3 circuit pack with an EC-1x12 circuit pack	Yes	Yes
Replacing the ILAN circuit pack with a network processor	Yes	Yes
Replacing the network processor with an ILAN circuit pack	Yes	Yes
Upgrading a fiber span from an OC-3 to an OC-12 rate (See Note 2)	Yes	Yes
Upgrading a fiber span from an OC-12 to an OC-48 rate (See Note 2)	Yes	Yes

**Table 1-1 (continued)**  
**Feature compatibility for Release 12.1**

Feature	Supported on platforms with VTX-series circuit packs	Supported on platforms with STX circuit packs
Upgrading a fiber span from an OC-48 to an OC-192 rate	No	Yes See Note 3
Converting a VT-assigned BLSR connection to a Full VT BLSR connection	Yes	No
Converting a Full VT BLSR connection to a VT-assigned BLSR connection	Yes	No
<b>Services</b>		
DS1	Yes	Yes
DS3	Yes	Yes
DS3 (Channelized)	Yes	No
EC-1	Yes	Yes
OC-3	Yes	Yes
OC-12	Yes	Yes
OC-48	Yes	Yes
OC-192	No	Yes
Optical Ethernet - Private Line service using 10/100 Ethernet	Yes	Yes
Optical Ethernet - Private Line using Gigabit Ethernet	Yes	Yes full rate support
OPTera Packet Edge System See: <ul style="list-style-type: none"> <li>• OPTera Metro 3000 OPTera Packet Edge System User Guide (NTN465YG)</li> <li>• OPTera Packet Edge System Planning Guide (NTRN10YK)</li> <li>• OPTera Packet Edge System Network Applications and Management (NTRN11YK)</li> </ul>	Yes	Yes
Resilient Packet Ring (RPR)	Yes	Yes
Storage Network (Fibre Channel (FC100) & FICON)	Yes	Yes
Test Access Electrical and Optical TAPS (monitor and split states)	Yes	Yes
<b>Hardware</b> (See Note 2)		

**Table 1-1 (continued)**  
**Feature compatibility for Release 12.1**

Feature	Supported on platforms with VTX-series circuit packs	Supported on platforms with STX circuit packs
OPTera Metro 3500 Shelf Assembly (NTN476AA)	Yes	Yes See Note 4
OPTera Metro 3500 Shelf Assembly (NTN476DA)	Yes	Yes
OPTera Metro 3500 Universal Shelf Assembly (NTN476AH)	Yes	Yes
2x100BT-P2P circuit pack (NTN433AA)	Yes	Yes
4x100FX (NTN4333EA, NTN433FA)	Yes	Yes
4x100BT (NTN433BB)	Yes	Yes
2x1000SX (NTN438AA)	Yes	Yes
2x1000LX (NTN438BA)	Yes	Yes
2xGigE/FC-P2P (NTN438DA)	Yes	Yes
1000-BaseSX 850 nm SFP (NTTP51AA)	Yes	Yes
1000-BaseLX 1310 nm SFP (NTTP51BD)	Yes	Yes
1000-BaseZX 1550 nm SFP (NTTP51DZ)	Yes	Yes
DS1 mapper (1:N protection)	Yes	No
DS1 service module (DSM) (up to 12 protected or unprotected DSM on an NE)	Yes	Yes
DS3 mapper See Note 5	No	No
DS3VTx12 mapper	Yes	No
DS3x12 mapper (1+1 protection)	Yes	Yes
DS3x12e mapper (1+1 protection)	Yes	Yes
DS3x3 mapper (1+1 protection) (NTN437AA)	Yes	Yes
DSM DS1x84 termination module (TM)	Yes	Yes
EC-1 circuit pack See Note 5	No	No
EC-1x12 circuit pack (1+1 protection)	Yes	Yes
EC-1x3 circuit pack (1+1 protection) (NTN436AA)	Yes	Yes

**Table 1-1 (continued)**  
**Feature compatibility for Release 12.1**

Feature	Supported on platforms with VTX-series circuit packs	Supported on platforms with STX circuit packs
OC-3 circuit pack in slots 11 and 12 (UPSR, 1+1 linear point-to-point and 1+1 linear ADM)	No	No
OC-3 circuit pack in slots 3 through 10 (UPSR, 1+1 linear point-to-point and 1+1 linear ADM)	Yes	Yes
OC-3x4 circuit pack in slots 11 and 12 (UPSR, 1+1 linear point-to-point and 1+1 linear ADM)	No	No
OC-3x4 circuit pack in slots 3 through 10 (UPSR, 1+1 linear point-to-point and 1+1 linear ADM)	Yes	Yes
OC-12 circuit pack in slots 11 and 12 (UPSR, 1+1 linear point-to-point and 1+1 linear ADM)	Yes	No
OC-12 circuit pack in slots 3 through 10 (UPSR, 1+1 linear point-to-point and 1+1 linear ADM)	Yes	Yes
OC-12x4 STS circuit pack in slots 11 and 12 (UPSR, 1+1 linear point-to-point and 1+1 linear ADM)	No	No
OC-12x4 STS circuit pack in slots 3 through 10 (UPSR, 1+1 linear point-to-point and 1+1 linear ADM)	No	Yes
OC-48 circuit pack in slots 11 and 12 (BLSR, UPSR, 1+1 linear point-to-point)	Yes	No
OC-48 circuit pack in slots 3 through 10 (UPSR, 1+1 linear point-to-point)	No	No
OC-48 STS circuit pack in slots 3 to 12 (UPSR, 1+1 linear point-to-point)	No	Yes
OC-48 DWDM circuit pack in slots 11 and 12 (BLSR, UPSR, 1+1 linear point-to-point)	Yes	No
OC-48 DWDM circuit pack in slots 3 through 10 (UPSR, 1+1 linear point-to-point)	No	No
OC-192 circuit pack in slots 11 and 12 (BLSR, UPSR, 1+1 linear point-to-point)	No	Yes
OC-192 circuit pack in slots 3 through 10 (UPSR, 1+1 linear point-to-point)	No	No
STM-0 optical interface (1+1 protection) (in J-SDH mode) See Note 5	No	No

**Table 1-1 (continued)**  
**Feature compatibility for Release 12.1**

Feature	Supported on platforms with VTX-series circuit packs	Supported on platforms with STX circuit packs
STM-1 optical interface (1+1 protection) (in J-SDH mode) See Note 5	No	No
STM-1x4 optical interface (in J-SDH mode) (in Slots 3 through 10)	Yes	Yes
Intershelf LAN (ILAN) circuit pack	Yes	Yes
Network Processor circuit pack (NP circuit pack) (NTN422AA) See Note 5	No	No
Network Processor circuit pack - extended (NPx circuit pack) (NTN424Bx)	Yes	Yes
Shelf Processor circuit pack - terminal (SP circuit pack) (NTN420AA) See Note 5	No	No
Shelf Processor circuit pack - enhanced (SPe circuit pack) (NTN421BA) See Note 5	No	No
Shelf Processor circuit pack - extended (SPx circuit pack) (NTN423Bx)	Yes	Yes
OMX shelf	Yes	Yes
<b>Performance monitoring</b>		
DS1 line and path	Yes	Yes See Note 6
DS1e far-end line and path	Yes	Yes See Note 6
DS1e far-end line and path with F bit generation	Yes	Yes See Note 6
DS3 line and path	Yes	Yes
DS3/VT line and path	Yes	No
EC-1 section and line	Yes	Yes
Path PMs on DS3x12e circuit pack	Yes	Yes
OC-12 section and line	Yes	Yes
OC-3 section and line	Yes	Yes

**Table 1-1 (continued)**  
**Feature compatibility for Release 12.1**

<b>Feature</b>	<b>Supported on platforms with VTX-series circuit packs</b>	<b>Supported on platforms with STX circuit packs</b>
OC-48 section and line	Yes	Yes
OC-192 section and line	No	Yes
Physical performance monitoring for OC-48 DWDM ER and ELR circuit pack-receiver	Yes	No
Physical performance monitoring for OC-48 STS and OC-192 circuit pack-receiver	No	Yes
STM-0 section and line (in J-SDH mode) See Note 5	No	No
STM-1 section and line (in J-SDH mode) See Note 5	Yes	Yes
STS-1 path	Yes	Yes
STS-3c path	Yes	Yes
STS-12c path See Note 7	Yes	Yes
STS-24c path	No	Yes
STS48c path	No	Yes
Ethernet Operational Measurements	Yes	Yes
<b>Security and administration</b>		
User account creation	Yes	Yes
Network element / network processor naming	Yes	Yes
Time zone, date and time setting	Yes	Yes
Maintenance and updating of accounts and network element parameters	Yes	Yes
Intrusion attempt handling on the SPx and NPx	Yes	Yes
Password management on the SPx and NPx	Yes	Yes
Customer managed networks on the SPx and NPx	Yes	Yes
Security log / audit trail	Yes	Yes
Multiple authentication methods	Yes	Yes

**Table 1-1 (continued)**  
**Feature compatibility for Release 12.1**

<b>Feature</b>	<b>Supported on platforms with VTX-series circuit packs</b>	<b>Supported on platforms with STX circuit packs</b>
Challenge / Response authentication	Yes	Yes
Centralized authentication through a RADIUS server	Yes	Yes
Third span of control surveillance	Yes	Yes
General Broadcast tool	Yes	Yes
<b>Bandwidth management</b>		
In-service traffic rollover for TDM traffic	Yes	Yes
In-service traffic rollover for RPR traffic	No	No
STS-1 traffic	Yes	Yes
STS-3c traffic	Yes	Yes
STS-12c traffic	Yes	Yes
STS-24c traffic	No	Yes
STS-48c traffic	No	Yes
STS-48c, STS24c, STS-12c, STS-3c, STS-1 time slot assignment (TSA) on pass-through nodes on BLSR	Yes except STS24c & STS-48c	Yes
STS-48c, STS-24c, STS-12c, STS-3c, STS-1, VT1.5 broadcast on 1+1 linear, UPSR	Yes except STS24c & STS-48c	Yes except VT1.5
STS-48c, STS-24c, STS-12c, STS-3c, STS-1, VT1.5 drop-and-continue on 1+1 linear, UPSR	Yes except STS24c & STS-48c	Yes except VT1.5
STS48c, STS-24c, STS-12c, STS-3c, STS-1, VT1.5 drop-and-continue on BLSR	No	No
STS-48c, STS-24c, STS-12c, STS-3c, STS-1, VT1.5 hairpinning	Yes except STS24c & STS-48c	Yes VT1.5
STS-48c, STS-24c, STS-12c, STS-3c, STS-1, VT1.5 time slot assignment (TSA) on 1+1 linear, UPSR	Yes except STS24c & STS-48c	Yes VT1.5
STS-48c, STS-24c, STS-12c, STS-3c, STS-1, VT1.5 time slot assignment (TSA) on add/drop nodes on BLSR	Yes except STS-48c	Yes VT1.5



**Table 1-1 (continued)**  
**Feature compatibility for Release 12.1**

Feature	Supported on platforms with VTX-series circuit packs	Supported on platforms with STX circuit packs
STS-48c, STS-24c, STS-12c, STS-3c, STS-1, VT1.5 time slot interchange (TSI) on 1+1 linear, UPSR	Yes except STS24c & STS-48c	Yes VT1.5
STS-48c, STS-24c, STS-12c, STS-3c, STS-1, VT1.5 time slot interchange (TSI) on BLSR	Yes except STS24c & STS-48c	Yes VT1.5
TU11, TU21, AU32, AU4 cross-connects (in J-SDH mode)	Yes	Yes supports AU32 and AU4
VT1.5/ time slot assignment (TSA) on pass-through nodes on BLSR	Yes	No
VT6 cross-connects (in J-SDH mode)	Yes	No
<b>Miscellaneous</b>		
6.312-MHz clock (in J-SDH mode)	Yes	Yes
Alarm provisioning	Yes	Yes
Composite clock timing (in J-SDH mode)	Yes	Yes
Consolidated load	Yes	Yes
DS1 ESF BITS synchronization status messaging	Yes	Yes
DS1 automatic in-service (AINS)	Yes	Yes
DS1 loopback	Yes	No
DS3 automatic in-service (AINS) on T3 facilities	Yes	Yes
DS3 loopback	Yes	Yes
DS3/VT automatic in-service (AINS) on T3 facilities	Yes	No
External building-integrated timing supply (BITS) input/output	Yes	Yes
Full TARP	Yes	Yes
Hitless timing reference switching	Yes	Yes
Independent synchronization and bandwidth management switching	Yes	Yes
Mixed tributaries	Yes	Yes

**Table 1-1 (continued)**  
**Feature compatibility for Release 12.1**

Feature	Supported on platforms with VTX-series circuit packs	Supported on platforms with STX circuit packs
NP/SP version checking	Yes	Yes
OC-3 1+1 high speed exerciser	Yes	Yes
OC-12 1+1 high-speed exerciser	Yes	Yes
OC-48 1+1 high-speed exerciser	Yes	Yes
OC-192 1+1 high-speed exerciser	No	Yes
Optical Facility loopbacks for OC-3, OC-12, EC1x12, OC-3x4, STM-1x4, OC-12x4 STS, OC-48, OC-48 STS, OC-192, 2xGigE/FC-P2P	Yes except OC-192	Yes
Optical Terminal loopbacks for OC-3, OC-12, EC1x12, OC-3x4, STM-1x4, OC-12x4 STS, OC-48, OC-48 STS, OC-192, 2xGigE/FC-P2P	Yes except OC-192	Yes except OC-192
OSI 7 layer	Yes	Yes
Path trace	Yes	Yes
Site Manager Rel 6.0.1 See Note 8	Yes	Yes
Remote save and restore	Yes	Yes
S1 byte synchronization status messaging	Yes	Yes
Section trace	Yes	Yes
Shelf timing (internal, line/loop, tributary, external)	Yes	Yes
Stratum 3 internal clock	Yes	Yes
SP spare management enhancements	Yes	Yes
SSbit functionality at OC-3, OC-12, OC-48 and OC-192 rates	Yes except OC-192	Yes
STS-1 path trace for DS3, OC-3, OC-12, OC-48 and OC-192	Yes except OC-192	Yes See Note 9

**Table 1-1 (continued)**  
**Feature compatibility for Release 12.1**

Feature	Supported on platforms with VTX-series circuit packs	Supported on platforms with STX circuit packs
Time of day synchronization	Yes	Yes
VT1.5 group alarm	Yes	No
<p><b>Note 1:</b> See <a href="#">Table 1-2 on page 1-16</a> for a list of optical circuit packs supported by each STX and VTX-series circuit packs.</p> <p><b>Note 2:</b> See <a href="#">Table 1-2 on page 1-16</a> for a list of optical circuit packs supported by each STX and VTX-series circuit packs.</p> <p><b>Note 3:</b> This is an out-of service procedure.</p> <p><b>Note 4:</b> The OPTera Metro 3500 Shelf assembly (NTN476AA) must be upgraded using power module and cooling upgrade kit (NTN458MW) to support OC-192 optical interfaces.</p> <p><b>Note 5:</b> This interface is below the hardware baseline for OPTera Metro Release 12.1 and it is not supported.</p> <p><b>Note 6:</b> DS1 PMs are available through DSM connected to OPTera Metro 3500 equipped with STX-192 circuit pack.</p> <p><b>Note 7:</b> Supported on all new Release 12.1 circuit packs (OC12x4 STS, OC-48 STS and OC-192) along with all OC-48 circuit packs and selected OC-12 circuit packs (NTN404JA, NTN404KA, NTN404LA, NTN404MA).</p> <p><b>Note 8:</b> Site Manager Release 6.0.1 is backward compatible to the following releases:</p> <ul style="list-style-type: none"> <li>— OPTera Metro 3500 Releases 10.1, 10.3, 10.31, 11.01, 11.02, 12.0 and 12.1</li> <li>— OPTera Metro 3300/3400 Releases 9.12, 11.11 and 11.12</li> <li>— OPTera Metro 3100 Release 4.01 and 4.02</li> </ul> <p><b>Note 9:</b> For OPTera Metro 3500 equipped with STX-192 circuit packs (STS-managed), path trace must be monitored on the path terminating equipment such as DSM module, DS3, 2x100BT- P2P, 2xGigGE/FC circuit packs.</p>		

## Release 12.1 Hardware Compatibility Matrix

For a list of supported electrical and optical interfaces by STX and VTX-series circuit packs in Release 12.1, see [Table 1-2](#).

**Table 1-2**  
**Hardware Compatibility Matrix for Release 12.1**

Card Type	Supported on platform with STX- 192 circuit packs	Supported on platforms with VTX-series circuit packs	Notes
OC-192	Yes	No	<ul style="list-style-type: none"> <li>• Dual slot circuit packs supported in slots 11 and 12.</li> <li>• Supported only with STX-192 circuit pack.</li> </ul>
OC-48 STS	Yes	No	<ul style="list-style-type: none"> <li>• Single slot circuit packs supported in slots 3 to 12.</li> <li>• Supported only with STX-192 circuit pack.</li> </ul>
OC-48	No	Yes	<ul style="list-style-type: none"> <li>• Dual slot circuit packs supported in slots 11 and 12.</li> <li>• Supported only with VTX-series circuit pack.</li> </ul>
OC-12x4 STS	Yes	No	<ul style="list-style-type: none"> <li>• Single slot circuit packs supported in slots 3 through 10.</li> <li>• Supported with STX-192 circuit pack.</li> </ul>
OC-12	Yes	Yes	<ul style="list-style-type: none"> <li>• Single slot circuit packs not supported in slots 11 and 12 with STX-192 or VTX-48 circuit packs.</li> <li>• Single slot circuit packs supported in slots 3 through 10 with STX-192 or VTX-48 circuit packs.</li> <li>• Single slot circuit packs supported in slots 3 through 12 with VTX-48e circuit pack.</li> </ul>

**Table 1-2 (continued)**  
**Hardware Compatibility Matrix for Release 12.1**

<b>Card Type</b>	<b>Supported on platform with STX-192 circuit packs</b>	<b>Supported on platforms with VTX-series circuit packs</b>	<b>Notes</b>
OC-3x4	Yes	Yes	Single slot circuit packs supported in slots 3 through 10.
OC-3	Yes	Yes	<ul style="list-style-type: none"> <li>• Single slot circuit packs supported in slots 3 through 10.</li> </ul>
STM-1x4	Yes	Yes	<ul style="list-style-type: none"> <li>• Single slot circuit packs supported in slots 3 through 10.</li> </ul>
2xGigE/FC-P2P	Yes	Yes	<ul style="list-style-type: none"> <li>• Single slot circuit pack supported in slots 3 through 10.</li> <li>• Maximum bandwidth of 12xSTS1 per card when equipped with VTX-series circuit packs.</li> <li>• Maximum bandwidth of 2xSTS24 per card when equipped with STX-192 circuit packs.</li> </ul>
2xGigE (OPE)	Yes	Yes	<ul style="list-style-type: none"> <li>• Dual slot circuit pack supported in slots 3 through 10.</li> <li>• Maximum bandwidth assignable to a RPR is STS12c with both VTX-series and STX-192 circuit packs.</li> </ul>
4x100FX (OPE)	Yes	Yes	<ul style="list-style-type: none"> <li>• Single slot circuit pack supported in slots 3 through 10.</li> <li>• Maximum bandwidth assignable to a RPR is STS12c with both VTX-series and STX-192 circuit packs.</li> </ul>

**Table 1-2 (continued)**  
**Hardware Compatibility Matrix for Release 12.1**

Card Type	Supported on platform with STX- 192 circuit packs	Supported on platforms with VTX-series circuit packs	Notes
4x100BT(OPE)	Yes	Yes	<ul style="list-style-type: none"> <li>• Single slot circuit pack supported in slots 3 through 10.</li> <li>• Maximum bandwidth assignable to a RPR is STS12c with both VTX-series and STX-192 circuit packs.</li> </ul>
2x100BT-P2P (Private Lines)	Yes	Yes	<ul style="list-style-type: none"> <li>• Single slot circuit pack supported in slots 3 through 10.</li> </ul>
EC-1x12	Yes	Yes	<ul style="list-style-type: none"> <li>• Single slot circuit pack supported in slots 3 through 10.</li> </ul>
DS3x12	Yes	Yes	<ul style="list-style-type: none"> <li>• Single slot circuit pack supported in slots 3 through 10.</li> </ul>
EC-1x3	Yes	Yes	<ul style="list-style-type: none"> <li>• Single slot circuit pack supported in slots 3 through 10.</li> </ul>
DS3VTx12	No	Yes	<ul style="list-style-type: none"> <li>• Single slot circuit pack supported in slots 3 through 10.</li> </ul>
DS3x3	Yes	Yes	<ul style="list-style-type: none"> <li>• Single slot circuit pack supported in slots 3 through 10.</li> </ul>
12xDS1	No	Yes	<ul style="list-style-type: none"> <li>• Single slot circuit pack supported in slots 3 through 10.</li> </ul>
84xDS1 (DSM)	Yes	Yes	<ul style="list-style-type: none"> <li>• Support for 12 DSM per shelf.</li> <li>• DSM is only STS-1 managed with STX-192.</li> </ul>

## Supported configurations

For network element configurations supported in Release 12.1, see [Table 1-3](#) through [Table 1-6](#).

[Table 1-3](#) provides a summary of all network topologies supported when main optical interfaces (slots 11 and 12) are configured as BLSR.

[Table 1-4](#) provides a summary of all network topologies supported when main optical interfaces (slots 11 and 12) are configured as UPSR.

[Table 1-5](#) provides a summary of all network topologies supported when main optical interfaces (slots 11 and 12) are configured as Linear point-to-point or Linear ADM

[Table 1-6](#) provides a summary of various network topologies supported on the OPTera Metro 3500,

**Table 1-3**  
**Summary of network topology supported - main optical interfaces configured as BLSR**

Shelf platform (VTX or STX)	Line rate of BLSR optical interfaces (Slots 11 & 12)	Supported subtending configurations	Line rate of subtending configurations (Slots 3 - 10)
VTX-48	OC-48 (requires dual slot circuit pack)	Linear Spur	OC-12
			OC-3
		UPSR	OC-12
			OC-3
VTX-48e	OC-48 (requires dual slot circuit pack)	Linear Spur	OC-12
			OC-3
		UPSR	OC-12
			OC-3
STX-192	OC-192	Linear Spur	OC-48 (requires OC-48 STS circuit packs)
			OC-12
			OC-3
		UPSR	OC-48 (requires OC-48 STS circuit packs)
			OC-12
			OC-3



**Table 1-4**  
**Summary of network topology supported - main optical interfaces configured as UPSR**

Shelf platform (VTX or STX)	Line rate of UPSR optical interfaces (slots 11 & 12)	Supported subtending configurations	Line rate of subtending configurations (Slot 3 - 10)
VTX-48	OC-48 (requires dual slot circuit pack)	Linear Spur	OC-12
			OC-3
		UPSR	OC-12
			OC-3
VTX-48e	OC-48 (requires dual slot circuit pack)	Linear Spur	OC-12
			OC-3
		UPSR	OC-12
			OC-3
	OC-12	Linear Spur	OC-12
			OC-3
		UPSR	OC-12
			OC-3

**Table 1-4 (continued)**  
**Summary of network topology supported - main optical interfaces configured as UPSR**

Shelf platform (VTX or STX)	Line rate of UPSR optical interfaces (slots 11 & 12)	Supported subtending configurations	Line rate of subtending configurations (Slot 3 - 10)
STX-192	OC-192	Linear Spur	OC-48 (requires OC-48 STS circuit pack)
			OC-12
			OC-3
		UPSR	OC-48 (requires OC-48 STS circuit pack)
			OC-12
			OC-3
	OC-48 (requires OC-48 STS circuit pack)	Linear Spur	OC-48 (requires OC-48 STS circuit pack)
			OC-12
			OC-3
		UPSR	OC-48 (requires OC-48 STS circuit pack)
			OC-12
			OC-3

**Table 1-5**  
**Summary of network topology supported - main optical interfaces configured as Linear (pt-to-pt or ADM)**

Shelf platform (VTX or STX)	Line rate of Linear optical interfaces (Slots 11 & 12)	Supported subtending configurations	Line rate of subtending configurations (Slots 3 - 10)
VTX-48	OC-48 (requires dual slot circuit pack)	Linear (pt-to-pt or ADM chain)	OC-12
			OC-3
		UPSR	OC-12
			OC-3

**Table 1-5 (continued)**  
**Summary of network topology supported - main optical interfaces configured as Linear (pt-to-pt or ADM)**

Shelf platform (VTX or STX)	Line rate of Linear optical interfaces (Slots 11 & 12)	Supported subtending configurations	Line rate of subtending configurations (Slots 3 - 10)
VTX-48e	OC-48 (requires dual slot circuit pack)	Linear (pt-to-pt or ADM chain)	OC-12
			OC-3
		UPSR	OC-12
			OC-3
	OC-12	Linear (pt-to-pt or ADM chain)	OC-12
			OC-3
		UPSR	OC-12
			OC-3
STX-192	OC-192	Linear (pt-to-pt or ADM chain)	OC-48 (requires OC-48 STS circuit pack)
			OC-12
			OC-3
		UPSR	OC-48 (requires OC-48 STS circuit pack)
			OC-12
			OC-3
	OC-48 (requires OC-48 STS circuit pack)	Linear (pt-to-pt or ADM chain)	OC-48 (requires OC-48 STS circuit pack)
			OC-12
			OC-3
		UPSR	OC-48 (requires OC-48 STS circuit pack)
			OC-12
			OC-3

**Table 1-6**  
**Summary of network topology line rates**

Network topology	Supported on platforms with VTX-series circuit packs			Supported on platforms with STX circuit packs	
	OC-3	OC-12	OC-48	OC-48	OC-192
Dual-homed subtending rings (UPSR)	Yes	Yes	Yes	Yes	Yes
Linear add/drop multiplexer	Yes	Yes	Yes	Yes	No
Linear point-to-point	Yes	Yes	Yes	Yes	Yes
Matched nodes (UPSR)	Yes	Yes	Yes	Yes	Yes See Note 1
Mixed RPR and TDM traffic over BLSR	No	No	Yes	No See Note 2	Yes
Mixed RPR and TDM traffic over UPSR	Yes	Yes	Yes	Yes	Yes
Optical hubbing	Yes	Yes	Yes	Yes	Yes
Path-in-line ring (virtual ring) (on BLSR)	No	No	Yes	No See Note 2	Yes
Full VT BLSR	No	No	Yes	No See Note 3	No See Note 3
VT-assigned BLSR	No	No	Yes	No See Note 3	No See Note 3
STS-1 assigned BLSR	No	No	Yes	No See Note 2	Yes
Path-in-line ring (virtual ring) (on UPSR)	Yes	Yes	Yes	Yes	Yes
RPR over BLSR (working and protection channels)	No	No	Yes	No See Note 2	Yes
RPR over UPSR	Yes	Yes	Yes	Yes	Yes
Single-homed subtending rings (UPSR)	Yes	Yes	Yes	Yes	Yes
UPSR	Yes	Yes	Yes	Yes	Yes
UPSR to non-OPTer Metro 3500 BLSR interconnection	Yes	Yes	Yes	Yes	Yes
<p><b>Note 1:</b> If interconnecting two mixed traffic rings (VT and STS traffic), STS traffic must be used at the gateway network element.</p> <p><b>Note 2:</b> OC-48 BLSR is supported on OPTera Metro 3500 equipped with VTX-series switched matrix in slots 13 and 14.</p> <p><b>Note 3:</b> STX-192 circuit pack is an STS-managed switch matrix in slots 13 and 14.</p>					

The following DWDM wavelength topologies are also supported:

- meshed ring
- hubbed ring
- point-to-point

## Interworking

- OPTera Metro 5000-series Multiservice Platform (Release 6.1)
  - Note:* UPSR, BLSR, and 1+1 linear protection schemes for OPTera Metro 3500 signals pass through OPTera Metro 5000 network segments transparently. Logical UPSRs, BLSRs and 1+1 linear configurations are possible across both OPTera Metro 3000 and 5000 DWDM networks.
  - OPTera Metro 3500 Gigabit Ethernet and Fibre Channel services (GFP mapped) to OPTera Metro 5200 and OPTera Metro 5100.
  - OPTera Metro 3500 aggregated signal (Gigabit Ethernet, OC-3, OC-12, OC-48) to OPTera Metro 5000 OCI to OPTera Metro 5000 DWDM network.
  - OPTera Metro 3500 DWDM to OPTera Metro 5000 DWDM
  - OPTera Metro 3500 DWDM to OPTera Metro 5200 OFA to OPTera Metro 3500 DWDM
  - OPTera Metro 3500 DWDM to OPTera Metro 5200 OFA to OC-48 Classic DWDM
- OPTera Connect DX (Release 5 and higher):
  - 1+1 linear point-to-point at OC-3, OC-12, OC-48 and OC-192 line rates
  - UPSR at OC-3, OC-12 and OC-48 line rates
  - BLSR at OC-48 and OC-192 line rates
  - virtual ring at OC-3, OC-12 and OC-48 line rates
- Optical Cross Connect HDX (formally OPTera Connect HDX) (Release 2):
  - 1+1 linear point-to-point at OC-3, OC-12, OC-48 and OC-192 line rates
  - BLSR at OC-48 and OC-192 line rates
- Optical Cross Connect HDXc (formally OPTera Connect HDXc) (Release 2.1):
  - 1+1 linear point-to-point at OC-3, OC-12, OC-48 and OC-192 line rates
  - BLSR at OC-48 and OC-192 line rates

- TransportNode OC-12 TBM (Release 14):
  - 1+1 linear point-to-point at OC-3, and OC-12 line rates
  - virtual ring at OC-3 line rate
- TransportNode OC-48 (Release 17):
  - 1+1 linear point-to-point at OC-3, OC-12 and OC-48 line rates
  - virtual ring at OC-3 and OC-12 line rates
  - matched nodes at STS-1, OC-3 and OC-12 line rates
  - OC-48 Regenerator
  - BLSR at OC-48 line rate
- OPTera Long Haul 1600 (Release 7 and higher):
  - OC-48 and OC-192 line rates
- TransportNode OC-192 (Release 7.0):
  - 1+1 linear point-to-point at OC-3, OC-12, OC-48 and OC-192 line rates
  - virtual ring at OC-3, OC-12 and OC-48 line rates
- for OPE interworking, see *OPTera Packet Edge System Planning Guide* (NTRN10YK).

**Note:** For Nortel Networks interworking and multi-vendor network scenarios, DCC interoperability can be achieved with the appropriate provisioning. See *Optical Networks Data Communications Network Planning Guide*, NTR710AM.

## Supported upgrade paths

Supported upgrade paths for OPTera Metro 3500 Release 12.1 are 10.1, 10.3, 10.31, 11.01, 11.02 and 12.0.

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# Operation, administration, and maintenance (OAM) features

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This section describes the operations, administration, and maintenance (OAM) features of Release 12.1 software.

[Table 2-1](#) lists new OAM features in Release 12.1, and [Table 2-2](#) lists OAM features Release 12.1 continues to support.

**Table 2-1**  
New or enhanced OAM features in OPTera Metro 3500 Release 12.1

Feature	Page
<a href="#">Gigabit Ethernet Drop and Continue</a>	<a href="#">2-3</a>

**Table 2-2**  
OPTera Metro 3500 OAM features

Feature	Page
<a href="#">Alarm provisioning</a>	<a href="#">2-5</a>
<a href="#">Bandwidth management</a>	<a href="#">2-7</a>
<a href="#">BLSR networks (2-fiber)</a>	<a href="#">2-10</a>
<a href="#">Channelized DS3 service (DS3VTx12 mapper)</a>	<a href="#">2-44</a>
<a href="#">Common Language Location Identifier</a>	<a href="#">2-44</a>
<a href="#">Connection ID</a>	<a href="#">2-45</a>
<a href="#">Consolidated load</a>	<a href="#">2-45</a>
<a href="#">Dense wavelength division multiplexing (DWDM)</a>	<a href="#">2-46</a>
<a href="#">Facility attributes</a>	<a href="#">2-54</a>
<a href="#">Loopbacks</a>	<a href="#">2-54</a>
<a href="#">Network surveillance</a>	<a href="#">2-58</a>
<a href="#">OPTera Packet Edge System (Resilient Packet Ring) - Ethernet</a>	<a href="#">2-62</a>

## 2-2 Operation, administration, and maintenance (OAM) features

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**Table 2-2 (continued)**  
**OPTera Metro 3500 OAM features**

<b>Feature</b>	<b>Page</b>
Optical Ethernet / Layer 2 (OE/L2) on OPTera Packet Edge System	2-64
Optical Ethernet-Private Line (OE-PL) services using 10/100 Ethernet	2-66
Optical Ethernet-Private Line (OE-PL) service using 2x1000 SX/LX OPE circuit packs	2-71
Optical Ethernet - Private Line (OE-PL) and Storage applications	2-73
Optical interoperability of OPTera Metro 3500	2-102
Performance monitoring	2-102
Site Manager support	2-116
Preside Applications Platform and Multiservice MOA support	2-117
Protection switching	2-118
Security and administration	2-122
STS Managed DSM	2-142
Support for 12 DSM	2-146
Synchronization	2-146
Test Access	2-160
Time of day synchronization	2-169
TL1 Changes to Cross Connect AID parameter	2-172
TL1 event exerciser	2-173
TL1 event / log feature	2-173
Topology enhancements	2-175
VT management option on STX equipped OPTera Metro 3500	2-175

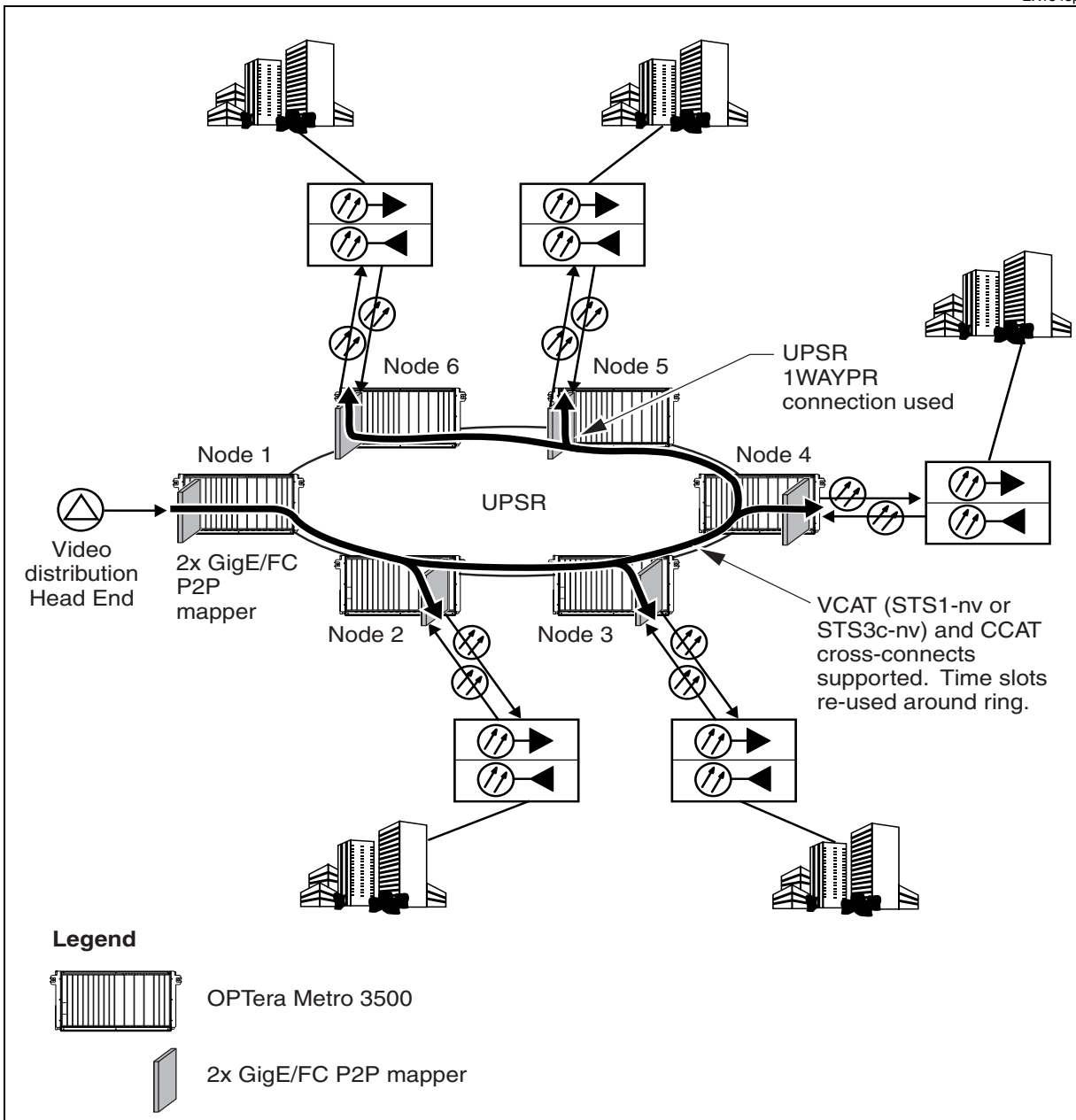


## Gigabit Ethernet Drop and Continue

OPTera Metro 3500 Release 12.1, extends its Unidirectional Multi-Node Drop and Continue capability to support unidirectional Gigabit Ethernet (GE) traffic. Unidirectional Multi-Node Drop and Continue provides the ability to drop a time slot, either SONET contiguous (STS-1, STS-3c, STS-12c and STS24c) or Virtual concatenation (STS-1-nv, n = 1 through 21 or STS-3c-nv, n = 1 through 7), at a single or on a continuing series of nodes in an UPSR ring or linear chain using a single timeslot on the ring or the linear chain. Gigabit Ethernet unidirectional drop and continue connections are supported by the 2xGigE/FC-P2P interface for UPSR rings. [Figure 2-1 on page 2-4](#), illustrates an application where a video signal is inserted on a 2xGigE/FC-P2P interface at one node and dropped on 2xGigE/FC-P2P interfaces at 5 subsequent nodes using a unidirectional CCAT or VCAT timeslot(s).

**Figure 2-1**  
**Gigabit Ethernet drop and continue application**

EX1543p



Because the connection is unidirectional the other direction (timeslot) can be reused for another circuit. Unidirectional drop & continue on OPTera Metro 3500 can be used to provide applications such as; video broadcast, Multi-Media conferencing and Distance Learning, for residential, business, research and educational services.

At the GE unidirectional add node, local client failures are propagated to the far end using Client Signal Fail (CSF) client management frames. Refer to [Table 2-11 on page 2-78](#) for list of ingress LAN alarms. If subrate GE WAN bandwidth is provisioned, enabling PAUSE flow control maybe required if the connected equipment can not properly send the GE traffic to match the provisioned WAN bandwidth.

### Engineering rules

- Unidirectional Gigabit Ethernet traffic is supported on Linear and UPSR rings.
- Gigabit Ethernet Drop and Continue traffic is supported for UPSR rings only.
- A valid Gigabit Ethernet signal must be connected to the receiver interface of the 2xGigE/FC-P2P at each drop node, otherwise GE idles will be transmitted.

*Note:* An external optical splitter can be used to loop back the GE signal from the Tx port to the Rx port of 2xGigE/FC-P2P, if the connected equipment can not provide a valid GE signal.

- A "Link down" alarm will be raised if you re-provision a bidirectional connection to unidirectional. To prevent this alarm from being raised the following steps must be performed:
  - Delete all cross-connections to the WAN port
  - Delete the Ethernet facility (DLT-ETH)
  - Add the Ethernet facility (ENT-ETH)
  - Re-enter the unidirectional cross-connection(s)

*Note:* Refer to Bandwidth Management, 323-1059-320, Equipment and Facility Provisioning, 323-1059-350 and Alarm and Trouble Clearing, 323-1059-543.

- Auto-negotiation (AN) can be enabled, however both the receive (Rx) and transmit (Tx) fibers must connect to the same partner otherwise auto-negotiation will not complete properly.
- It is recommended to disable auto-negotiation (AN) and Pause transmit (PAUSETX) frames at the drop nodes in this configuration.

### Alarm provisioning

Alarm provisioning allows you to disable or enable notification of an alarmed condition for any SONET alarm point on a network element. You can enable or disable alarm notification for one alarm or for a group of alarms with no effect on the alarm function. Disable an alarm to prevent that alarm from being reported to the user in any way (including alarm reports, TBOS, LEDs, or

audible and visible office alarm outputs). The network element, whether the alarm point is disabled or enabled, records all alarms when the conditions that cause an alarm occur.

Alarms are not lost after they are activated, whether enabled or disabled, and can be retrieved when they are enabled. OPTera Metro 3500 stores a maximum of 3000 active alarms, including both enabled and disabled alarms. The Active Alarms window of Site Manager does not identify active disabled alarms. You can retrieve a list of all disabled alarms from the Alarm Provisioning window, by clicking the Alarms on Disabled Points tab.

Alarm profiles allow you to enable or disable defined groups of alarm points. These groups are defined as Alarm classes. Alarm points are grouped by facility type or equipment.

Each group of alarm points has two profiles defined by the system: All Alarms ON and All Alarms OFF. At start-up, every group of alarm points has a default profile of All Alarms ON, which becomes the active profile. You can create up to three profiles for any group of alarm points. Each profile has a distinct name and contains status information for each alarm or event that applies to that profile. Profile names can contain an ASCII string of up to 20 characters that cannot include quotation marks (") or backslashes (\).

You can create, edit, and delete profiles. You can change all profiles, except the two profiles defined by the system. However, you cannot delete or edit a profile that is set as the default profile, or edit or delete the active profile if it is in use. A new profile can be added to take care of additional requirements.

### **Alarm flow control**

When a major fault occurs within a network, significant numbers of alarms are raised on each shelf processor over a sustained period of time. The alarm flow control (AFC) feature avoids situations in which Site Manager sessions log out automatically due to TL1 request timeouts.

If the alarm rate is four alarms / second or greater, in a given ten minute period, then this condition is considered excessive alarming and the 'Alarm and Event Throttling Active' alarm is generated to warn users that further alarms will not be reported.

When the system initiates alarm flow control, applications can continue to generate alarms. The AFC feature only disables the reporting of alarms to the screen or to file. User-initiated retrievals will continue to display all the alarms.

When the number of alarms being generated falls below the provisioned threshold, the 'Alarm and Event Throttling Active' alarm is cleared and alarm reporting resumes.

## Environmental alarms

Both the OPTera Metro 3500 and DS1 service module (DSM) support environmental alarms. Each OPTera Metro 3500 shelf and DS1 service module have 16 pairs of contacts that detect environmental alarms. The contacts are on the environmental alarms connector of the left OAM (LOAM) and on the DSM connected to the OAM power module. Set up environmental alarms during provisioning.

The cooling fans on the OPTera Metro 3500 are detectable through pins available from the backplane to the shelf processor. They are not connected to an environmental alarm input for monitoring.

Alarm messages broadcast to all active user sessions.

## External controls

The OPTera Metro 3500 network elements and DSM support external controls. The external controls allow you to operate or release up to four relays from any part of the network element or DSM. Connect the relays to external equipment and program each relay with a control type attribute.

## ACO switch — clearing audible alarms and performing lamp tests

The OPTera Metro 3500 network element and the DSM have an alarm cut-off (ACO) button. The ACO button for the network element is on the left interface (LIF) and the ACO button for the DSM is located on the fan faceplate of the DSM. The alarm subsystem turns off the audible office alarm relay(s) when you press the ACO button once.

*Note:* The ACO button on the network element also cuts off alarms and performs lamp tests on connected DSMs.

The DSM has its own alarm cut-off button (ACO) because the DSM, although connected to the shelf, can be located in another area that is far from the shelf. You can turn off the audible alarms on both the network element and the DSM from the Site Manager interface.

You can perform a lamp test on the network element or DSM by pressing the ACO button twice.

## Bandwidth management

OPTera Metro 3500 supports a built-in, fully non-blocking switching matrix. OPTera Metro 3500 is capable of routing up to 192 STS-1 signals, 5376 VT1.5 channels when equipped with VTX-48 or VTX-48e modules. See [Figure 2-2 on page 2-10](#). With the introduction of new STS-192 circuit pack the OPTera Metro 3500 is now capable of routing 768 STS-1 signals. See [Figure 2-3 on page 2-10](#). This eliminates the need for adjunct cross-connect facilities in most applications.

OPTera Metro 3500 supports bandwidth management capabilities that include time slot assignment (TSA), time slot interchange (TSI), hairpinning, broadcast, drop-and-continue, path protection, unidirectional services, connection editing, and in-service rollover. This bandwidth management capability is available at VT1.5, STS-1, STS-3c, STS-12c, STS-24c and STS-48c levels.

Features such as hairpinning between tributaries permit a single OPTera Metro 3500 shelf to be used instead of multiple colocated network elements.

### **Tributary, DWDM, BLSR, UPSR, and 1+1 linear point-to-point**

- up to 48 STS-1s and 1344 VT1.5s (with VTX-series circuit pack)
- up to 192 STS-1s (with STX-192 circuit pack)
- slots 3 through 10 can each access up to 2.48 Gbit/s (with STX-192 circuit pack)
- slots 3 through 10 can each access up to 622 Mbit/s (with VTX-series circuit pack)
- optical slots 11 and 12 access up to 10 Gbit/s (with STX-192 circuit pack)
- optical slots 11 and 12 access up to 622 Mbit/s/2.48 Gbit/s (with VTX-series circuit pack)
- the OPTera Metro 3500 shelf supports electrical and optical services and interfaces from DS1, DS3s, EC-1, OC-48, OC-12, OC-3, 10/100BT, GE and Fibre Channel. See [Table 3-7 on page 3-52](#) for a complete list of supported interfaces.

**Note:** In a configuration of 12 protected DSM shelves connected to a single OPTera Metro 3500 shelf, up to 1008 DS1s are supported.

- full VT/STS management is supported

**Note:** VT management is supported with VTX-48 or VTX-48e circuit packs in slots 13 & 14 only.
- each OPTera Metro 3500 shelf with two OC-48 or OC-192 DWDM optical interface circuit packs can support one wavelength per circuit pack
- each OPTera Metro 3500 shelf supports up to twelve protected DS1 service module shelves or twelve unprotected DS1 service module shelves. Each DS1 service module shelf supports 84 protected or unprotected DS1 facilities
- For a complete list of electrical and optical interfaces supported by VTX-48, VTX-48e and STX-192 circuit packs equipped OPTera Metro 3500 shelf, refer to [Table 3-7 on page 3-52](#).

## BLSR

- supports BLSR protocol on OC-192 circuit packs equipped with STX-192 circuit packs in slots 13 and 14.
- supports BLSR protocol on OC-48 circuit packs equipped with VTX-series circuit packs in slots 13 and 14.
  - BLSR is not supported on OC-48 STS circuit packs equipped in slots 11 and 12.
- VT1.5, STS-1, STS-3c, and STS-12c, connections supported on the OC-48 BLSR ring equipped with VTX-series circuit pack.
- STS-1, STS-3c, STS-12c, STS-24c and STS-48c connections supported on the OC-192 BLSR ring equipped with STX-192 circuit pack.
- supports In service Channel Rollover and In service Route Rollover of VT1.5, STS-1, STS-3c, STS-12c and STS-24c.

**Note 1:** VT1.5 connections require VTX-series circuit pack.

**Note 2:** STS-24c connections are supported on 2xGigE/FC-P2P, OC-48 STS and OC-192 circuit packs.

- supports OPE connections (RPR rings) at STS-1, STS-3c and STS-12c over OC-48 or OC-192 BLSR.

## Connection editing

Connection editing for the optical interface allows the user to change traffic configurations through single or multiple connection type editing, while maintaining live traffic. A forced switch or lockout may be required before the edit to ensure that traffic is maintained.

## In-service traffic rollover

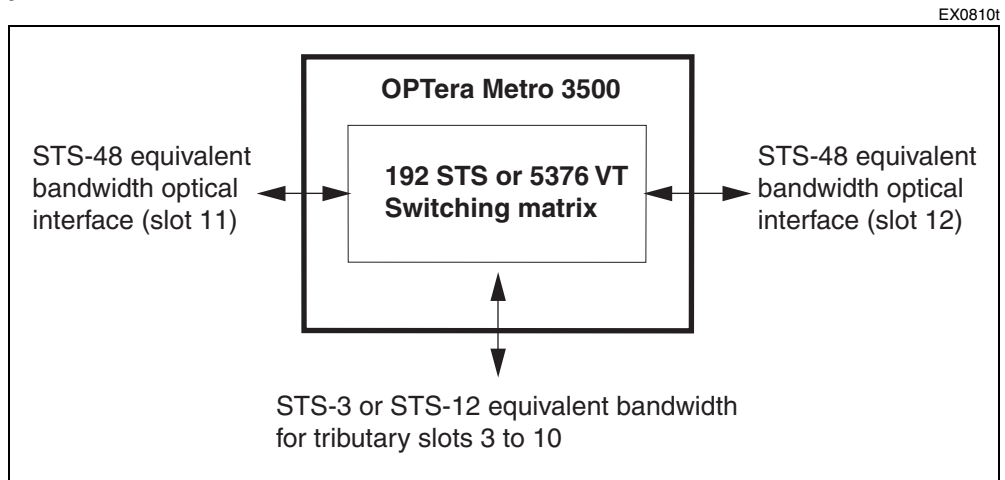
In-service traffic rollover allows you to migrate live traffic within the transport network. You can migrate any cross-connect end point to any other end point capable of servicing the cross-connect rate, independent of the protection scheme at the end point.

This operation is also supported to provide reconfigurations, such as merging two UPSRs. This can be done on path-switched connections (1WAYPR and 2WAYPR) to move traffic from one cross-connect termination to a new termination without disrupting service.

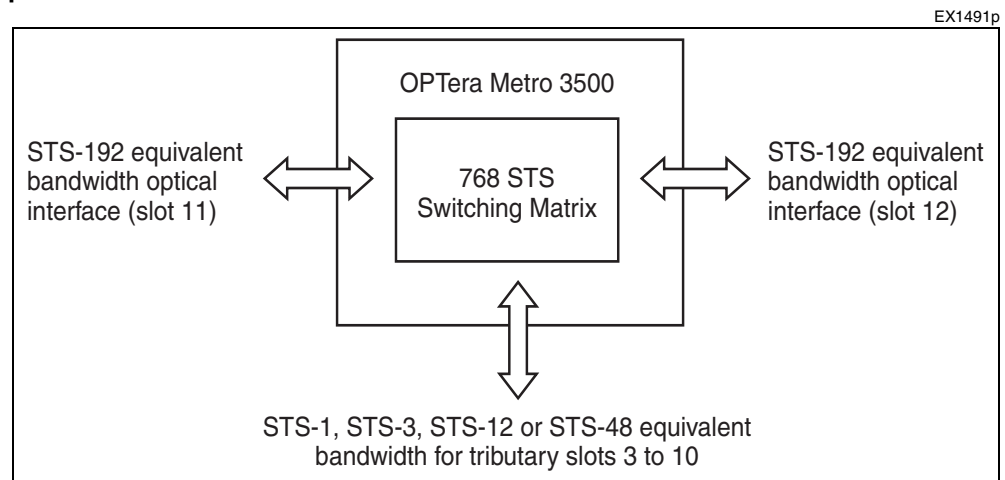
In service Channel Rollover in BLSR networks is the act of moving VT or STS channels across time slots within a span. In service Route Rollover in BLSR networks is the act of moving VT or STS channels from the short path to the long path.

**Note:** In-service traffic rollover is not supported over RPR.

**Figure 2-2**  
**OPTera Metro 3500 bandwidth management architecture with VTX-series circuit pack**



**Figure 2-3**  
**OPTera Metro 3500 bandwidth management architecture with STX-192 circuit pack**



## BLSR networks (2-fiber)

OPTera Metro 3500 supports 2-Fiber BLSR networks in its protection scheme and configuration portfolios.

A 2-Fiber bidirectional line-switched ring (BLSR) is a ring network of nodes interconnected by a pair of fibers. Like the unidirectional path-switched ring (UPSR), the BLSR provides 100% restoration of restorable traffic for single failures by reserving 50% of the ring's capacity for protection. Consequently, a 2-Fiber OC-48 or OC-192 ring effectively has a span capacity of STS-24 and STS-96 respectively.



A BLSR offers a network-level protection capability, and differs from a UPSR in that the nodes in a BLSR are aware of the larger configuration. In a BLSR, switching nodes communicate to each other through K-bytes. A UPSR node has no network knowledge and does not rely upon any APS communication with other nodes.

## Protection

Protection in a BLSR is provided by using a time slot select function. The network elements adjacent to the protected span bridges the working time slots in the failed direction to the preassigned protection time slots in the direction away from the failure. The network element where the signal is dropped from the ring receives (selects) from the protection time slots on the side away from the failure.

A BLSR bridge request can be initiated either by an operator or autonomously.

*Note:* All user-initiated protection switching commands are signaled on the APS channels (K1 and K2 bytes).

### User-initiated BLSR switching commands

- Forced switch
  - This command performs the ring switch from the working to the protection channels for the span between the node at which the command is initiated and the adjacent node to which the command is destined. This switch occurs regardless of the state of the protection channels, unless the protection channels are satisfying a higher priority request.
- Manual switch
  - This command performs the ring switch from the working to the protection channels for the span between the node at which the command was initiated and the node to which the command was destined. This occurs if the protection channels to be used are operating at a BER better than the signal degrade threshold and are not satisfying an equal or higher priority request (including failure of the protection channels).
- Lockout of working/protection
  - These command performs a lockout (working or protection) which prevents the working line from switching to the protection line. When you perform a lockout, you prevent traffic from switching to the protection line. If traffic is on the protection line, it returns to the working line regardless of the condition of the working line. After you initiate a lockout request, the lockout request remains active until you release it. The lockout command has the highest priority.

Lockout of working: prevents a protection switch of the working line to the protection line.

Lockout of protection: prevents any of the channels from switching to the protection line.

**Automatically initiated BLSR switching requests**

- Signal fail (SF)
  - SF is a hard failure caused by a Loss of Signal, Loss of Frame, a line BER exceeding a preselected threshold, a line AIS, or some other protectable hard failure. All channels with the SF condition are protected using the ring switch.
- Signal degrade (SD)
  - SD is a soft failure caused by a BER exceeding a preselected threshold. It can be used to detect gradual degradation of service to perform preventive maintenance. All degraded lines are protected using the ring switch.
- Reverse request (RR)
  - RR is transmitted to the tail-end network element on the Short Path as an acknowledgement for receiving the Short Path ring bridge request.
- Wait to restore (WTR)
  - WTR is issued when working channels meet the restoral threshold after an SD or SF condition. This request is used to maintain the current state during the WTR period unless it is pre-empted by a higher priority request.

When a failure occurs in the ring, the ring switches are performed by the nodes immediately adjacent to the failed segment. It should be noted that a failed segment may be a single span or many spans with multiple nodes.

For a 2-Fiber BLSR operating at an OC-48 rate, time slot numbers 1 through 24 at the multiplex input are reserved for working channels. Time slot number 'X' of the first fiber is protected using time slot number 'X + 24' of the second fiber in the opposite direction, where X is an integer between 1 and 24.

Similarly, for a 2-Fiber BLSR operating at an OC-192 rate, time slot numbers 1 through 96 at the multiplex input are reserved for working channels. Time slot number 'X' of the first fiber is protected using time slot number 'X + 96' of the second fiber in the opposite direction, where X is an integer between 1 and 96.

**'Infinite wait-to-restore' parameter**

OPTera Metro 3500 allows users to provision an infinite wait-to-restore period in BLSR-protected optical interfaces. This effectively allows users to provision BLSRs to autonomously switch non-revertively.

### **BLSR Line Protection Oscillation Control**

OPTera Metro Release 12.0 introduced a line protection oscillation control mechanism for BLSR systems. If 3 signal failures (SF) are detected on a line within 12 seconds of each other the line protection oscillation control mechanism is activated and protection will be in a lockout condition for 12 seconds. The OPTera Metro 3500 will raise an “Auto Switch Complete - Oscillation” alarm. The lockout condition is released only after 12 seconds have elapsed without a signal fail (SF) transition.

This feature is not provisionable and is always on.

### **BLSR single span fiber cut scenario**

A fiber cut - and any other cause of signal degradation or signal failure on a span - causes a BLSR autonomous switch. A fiber degradation scenario is described in the following example. See [Figure 2-4 on page 2-17](#) to [Figure 2-11 on page 2-24](#) to see the following order of events after a signal degradation between Node 3 and Node 4 occurs.

*Note:* The following steps correspond to the step numbers in the graphics.

**BLSR single span Fiber cut example**

---

<b>Step</b>	<b>Action</b>
1	The BLSR ring is clean. Tributaries are added/dropped at Nodes 1 and 4.
2	The signal from Node 4 to Node 3 is degraded. <ul style="list-style-type: none"><li>• Node 3 detects failure.</li><li>• Node 4 is unaware there is a problem.</li></ul>
3	Node 3 sends K-byte messages to Node 4 on the Short and Long paths. The K-byte messages are 2 bytes in the SONET overhead that contain: <ul style="list-style-type: none"><li>• source node (Node 3)</li><li>• destination node (Node 4)</li><li>• type of switch request (Signal Degrade)</li><li>• path direction (Long, Short)</li><li>• node status (Short Path sends '<i>RDI</i>'; Long Path sends '<i>Idle</i>')</li></ul>
4	Node 4 receives the message on the Short Path. Node 4 sends a Signal Degrade switch request back to Node 3 on the Long Path. <ul style="list-style-type: none"><li>• source node (Node 4)</li><li>• destination node (Node 3)</li><li>• type of switch request (Signal Degrade)</li><li>• path direction (Long)</li><li>• node status ('<i>Idle</i>')</li></ul> Node 4 sends a Reverse Request message back to Node 3 on the Short Path, acknowledging the receipt of the Short Path bridge request (the Signal Degrade, RDI message). <ul style="list-style-type: none"><li>• source node (Node 4)</li><li>• destination node (Node 3)</li><li>• type of switch request (Reverse Request)</li><li>• path direction (Short)</li><li>• node status ('<i>Idle</i>')</li></ul>
5	Nodes 1 and 2 enter into a ' <i>Passthrough</i> ' state after receiving the message from Node 3 to Node 4 on the Long Path. <b>Note:</b> Nodes 1 and 2 check the 'Destination Node' attribute of the message to see if it is addressed to them. They send the message unchanged to the next node in the ring in the same direction.

—continued—

**BLSR single span Fiber cut example**

<b>Step</b>	<b>Action</b>
<b>6</b>	<p>Node 4 receives the message on the long path, and enters into a <i>'Bridged'</i> state. Node 4 bridges traffic from the incoming working channels to the opposite direction, outgoing protection channels. Node 4 acknowledges receipt of the message by sending a <i>'Bridged'</i> message back to Node 3 on the Long Path.</p> <ul style="list-style-type: none"> <li>• source node (Node 4)</li> <li>• destination node (Node 3)</li> <li>• type of switch request (Signal Degrade)</li> <li>• path direction (Long)</li> <li>• node status (<i>'Bridged'</i>)</li> </ul> <p><b>Note:</b> Nodes 1 and 2 remain in the <i>'Passthrough'</i> state.</p>
<b>7</b>	<p>Node 3 receives the <i>'Signal Degrade'</i> request from Node 4, and enters into a <i>'Bridged'</i> state. Node 3 bridges traffic from the working to the protection channels and acknowledges receipt of the message by sending a <i>'Bridged'</i> message back to Node 4 on the Long Path.</p> <ul style="list-style-type: none"> <li>• source node (Node 3)</li> <li>• destination node (Node 4)</li> <li>• type of switch request (Signal Degrade)</li> <li>• path direction (Long)</li> <li>• node status (<i>'Bridged'</i>)</li> </ul>
<b>8</b>	<p>Node 4 receives the <i>'Bridged'</i> status indication from Node 3. Node 4 enters into the <i>'Bridged and Switched'</i> state. Traffic received on the protection channels are then routed as if they were received from the failed working link. Node 4 then sends a message to Node 3 indicating that it has entered into the <i>'Bridged and Switched'</i> state.</p> <ul style="list-style-type: none"> <li>• source node (Node 4)</li> <li>• destination node (Node 3)</li> <li>• type of switch request (Signal Degrade)</li> <li>• path direction (Long)</li> <li>• node status (<i>'Bridged and Switched'</i>)</li> </ul> <p><b>Note:</b> Depending on the cross-connects provisioned, Node 4 will then either drop traffic at the add/drop multiplexer or route traffic back out onto the working channels of the ring.</p>

—continued—

**BLSR single span Fiber cut example**

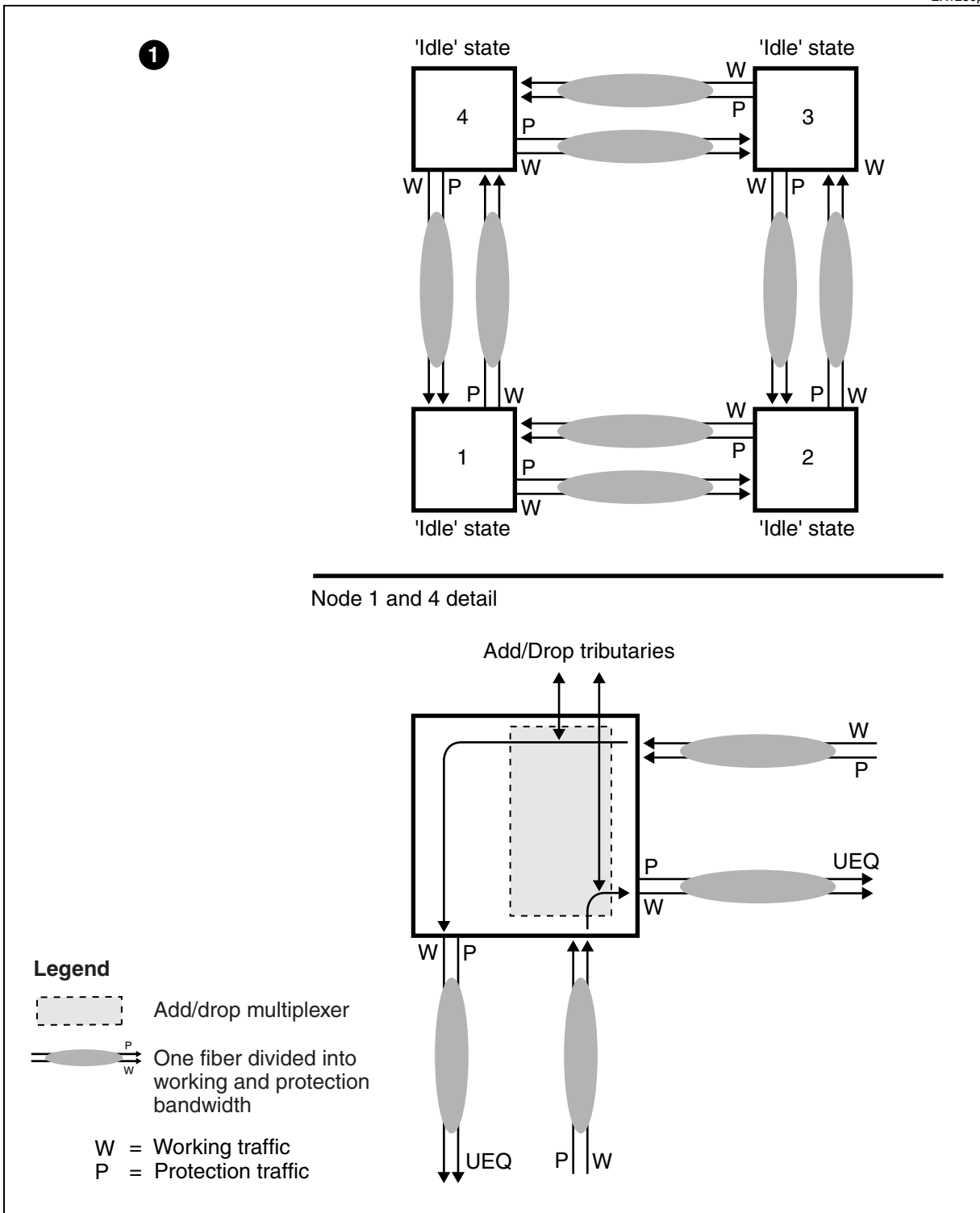
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<b>Step</b>	<b>Action</b>
<b>9</b>	<p>Node 3 receives the <i>'Bridged'</i> status indication from Node 4. Node 3 enters into the <i>'Bridged and Switched'</i> state. Traffic received on the protection channels are then routed as if they were received from the failed working link. Node 4 then sends a message to Node 3 indicating that it has entered into the <i>'Bridged and Switched'</i> state.</p> <ul style="list-style-type: none"><li>• source node (Node 3)</li><li>• destination node (Node 4)</li><li>• type of switch request (Signal Degrade)</li><li>• path direction (Long)</li><li>• node status (<i>'Bridged and Switched'</i>)</li></ul> <p><b>Note:</b> Depending on the cross-connects provisioned, Node 3 will then either drop traffic at the add/drop multiplexer or route traffic back out onto the working channels of the ring.</p>
<b>10</b>	Switch is complete.

—end—

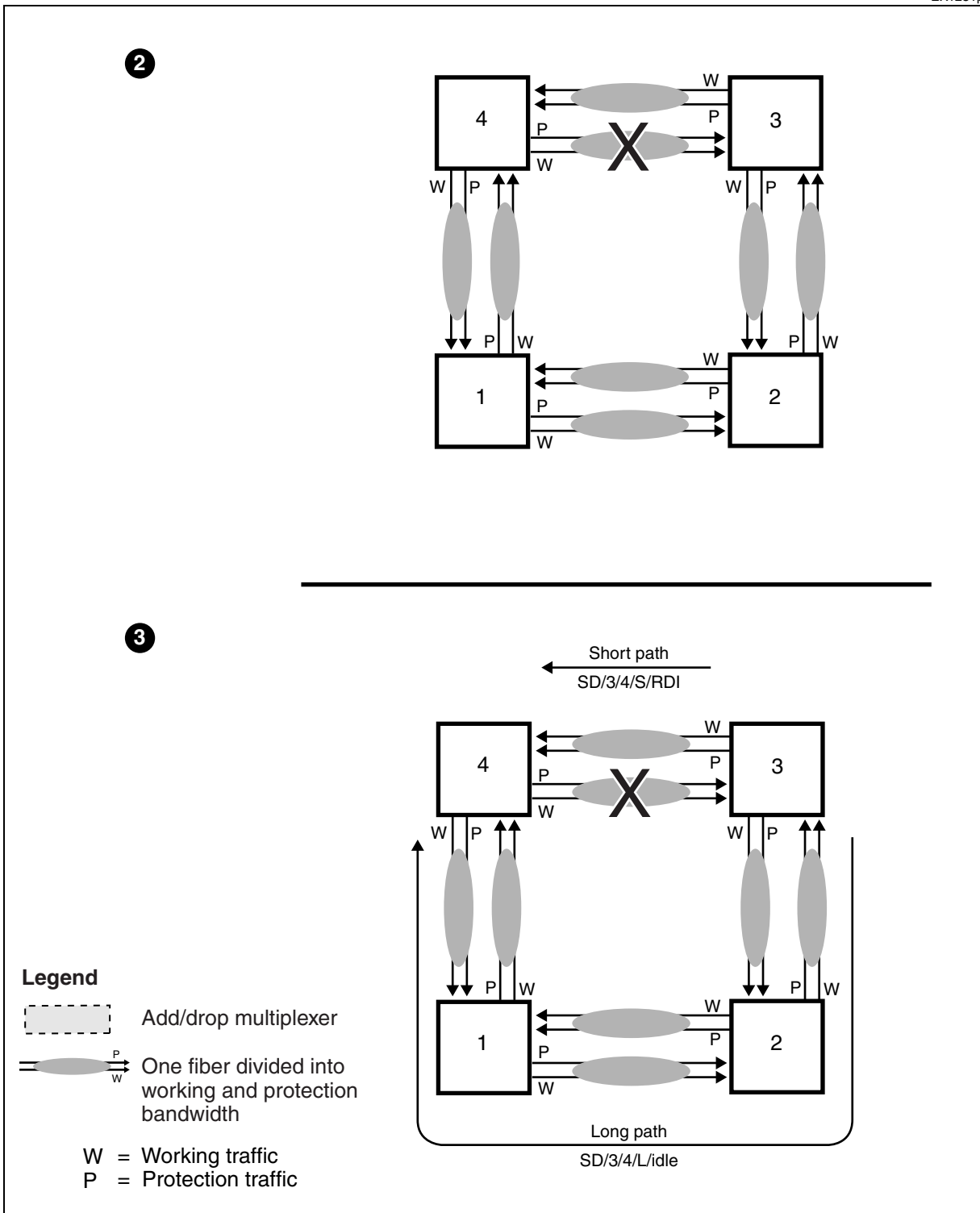
**Figure 2-4**  
**BLSR ring switch example**

EX1230p



**Figure 2-5**  
**BLSR ring switch example**

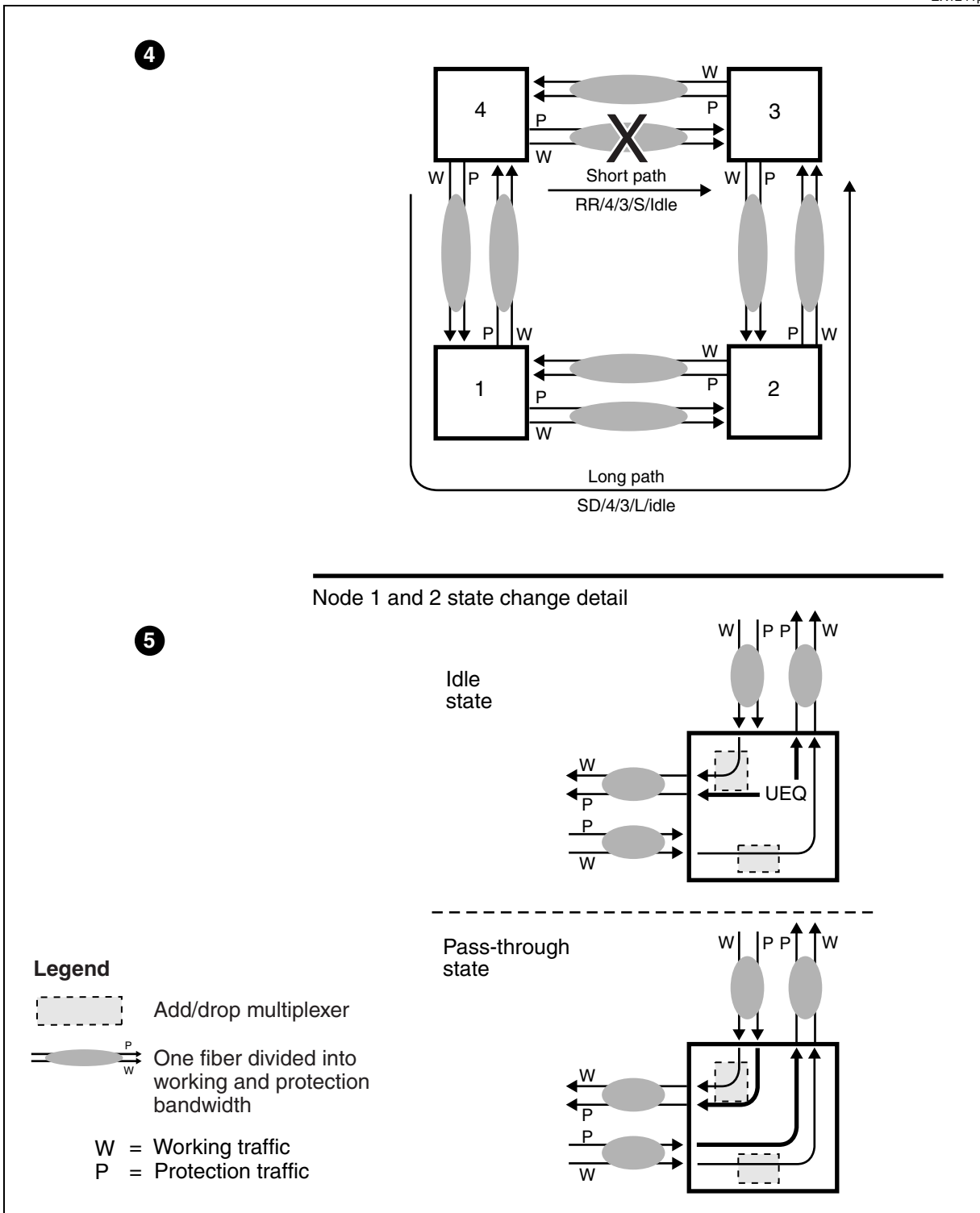
EX1231p





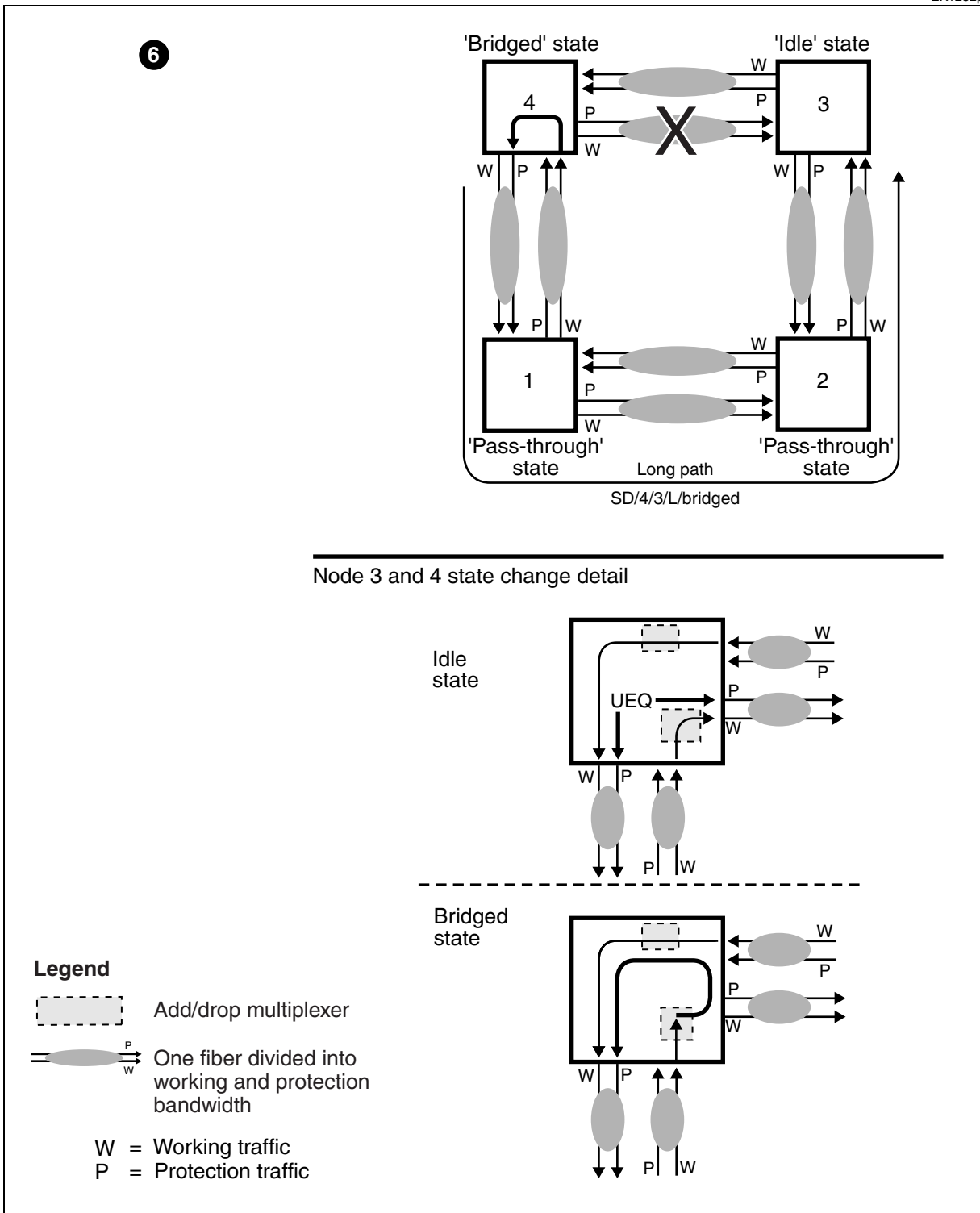
**Figure 2-6**  
**BLSR ring switch example**

EX1241p



**Figure 2-7**  
**BLSR ring switch example**

EX1232p



**Figure 2-8**  
**BLSR ring switch example**

EX1242p

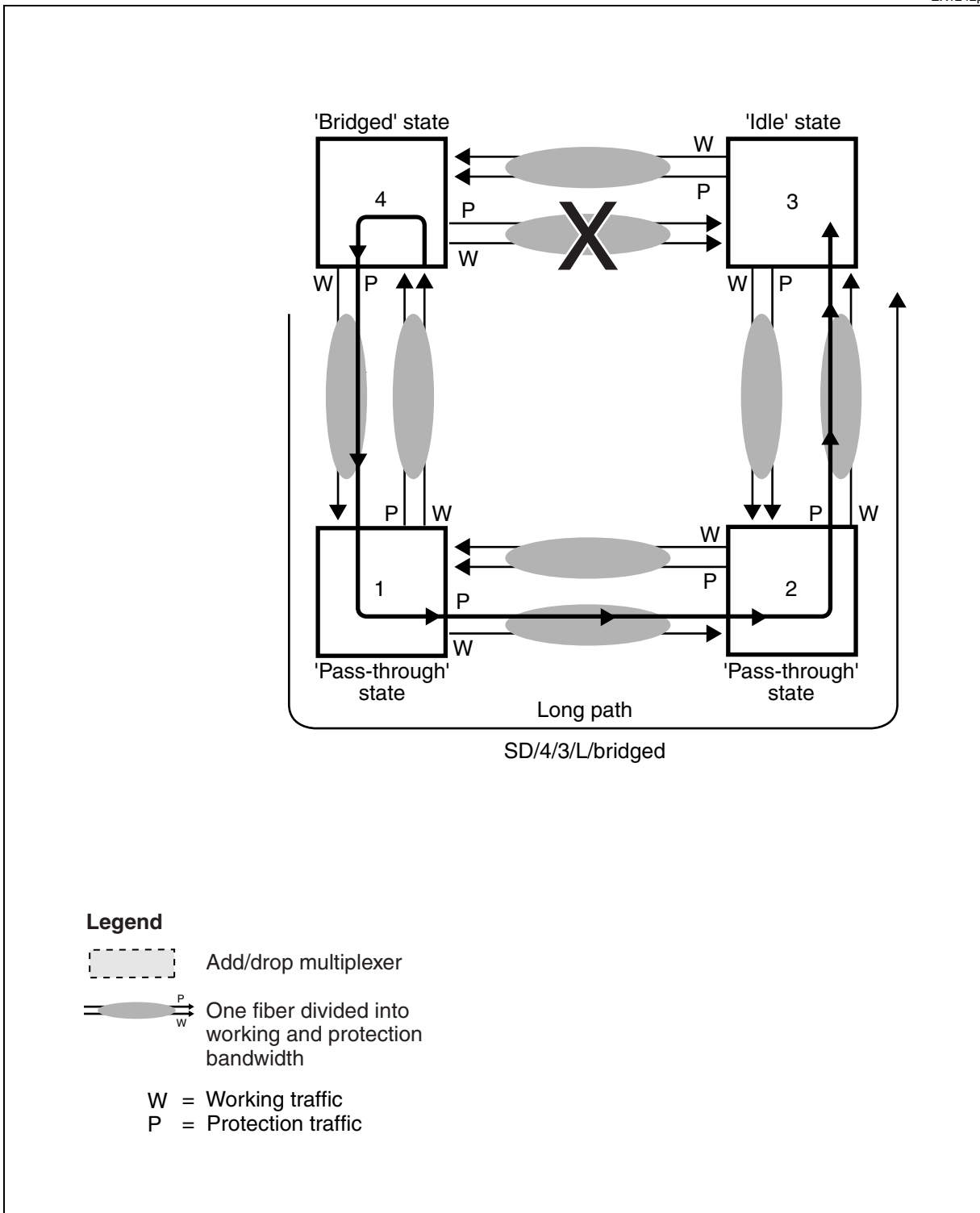
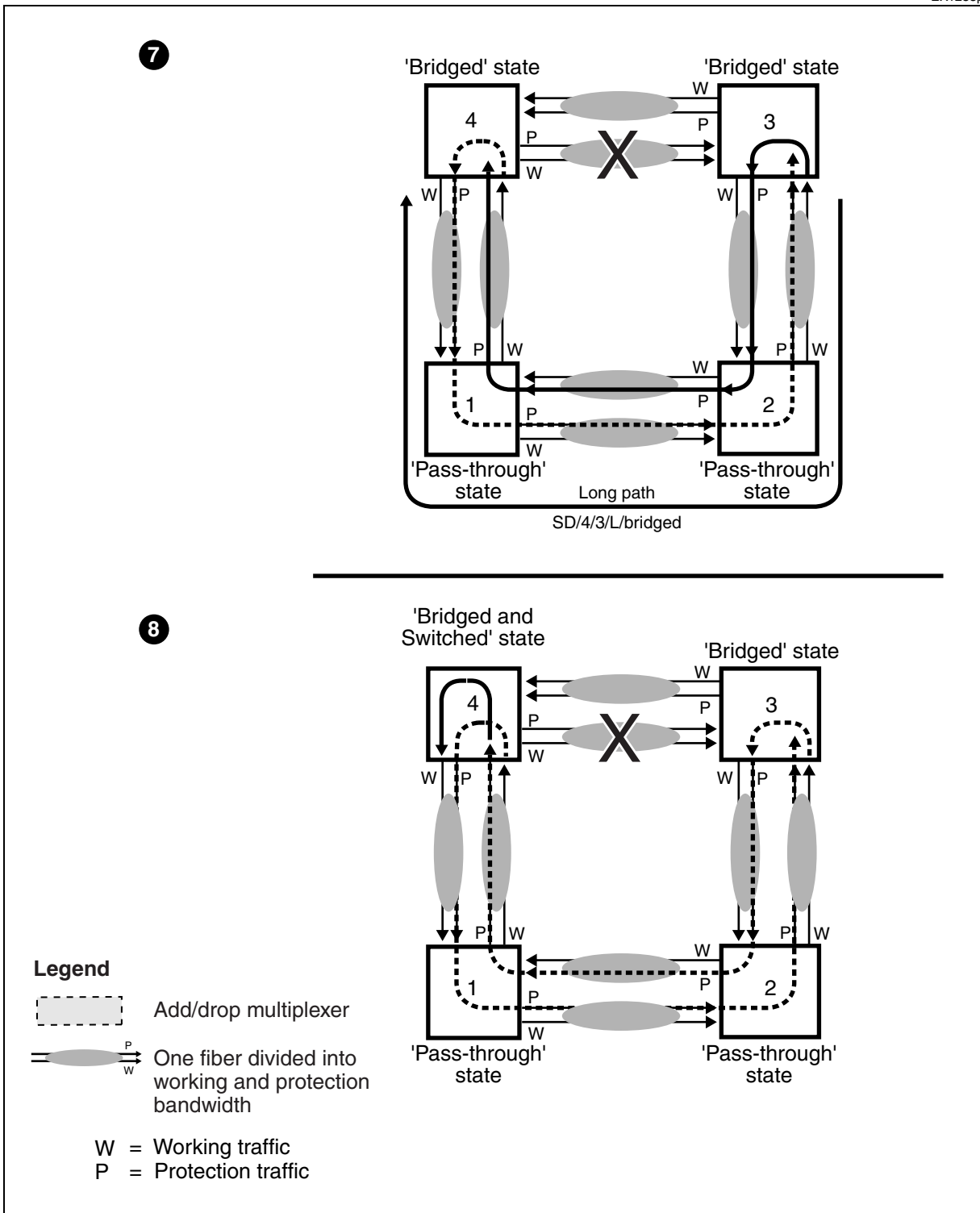


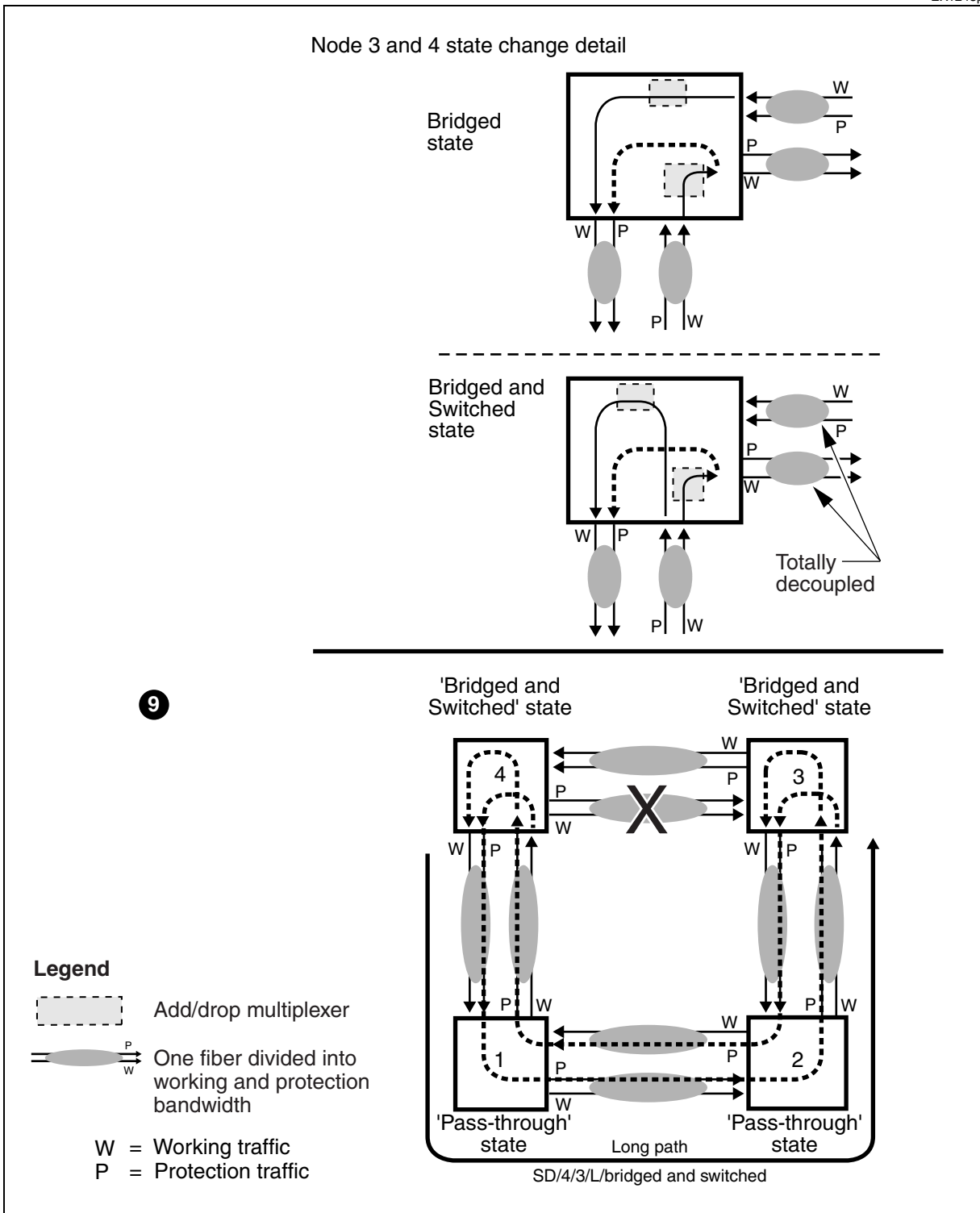
Figure 2-9  
BLSR ring switch example

EX1233p



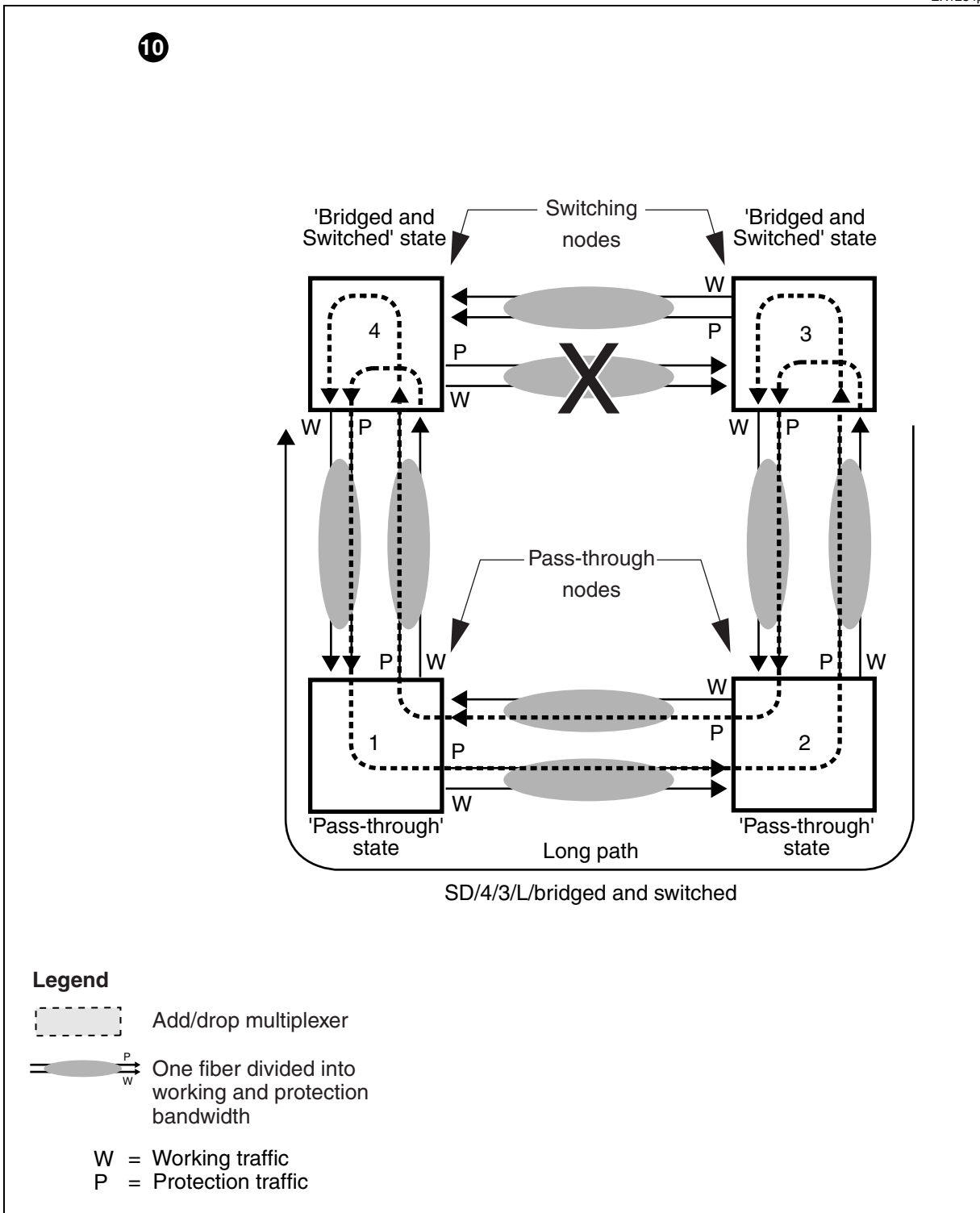
**Figure 2-10**  
**BLSR ring switch example**

EX1243p



**Figure 2-11**  
**BLSR ring switch example**

EX1234p



**BLSR nodal / multi-span failure scenario (involves squelching)**

In the instance in which one or more nodes becomes disconnected because of multiple line failures and/or nodal failures, a BLSR network enters into a bidirectional protected state of operation. The protection operation is much the same as for the loss of a span, except that add-drop traffic at the affected node is lost.

[Figure 2-12 on page 2-27](#) and [Figure 2-13 on page 2-28](#) illustrate failure in Node C for OC-48 and OC-192 BLSR respectively. Traffic normally intended to pass through Node C is looped back to the appropriate protection timeslots at Nodes B and D. The traffic is then routed to the intended destinations as described for link failures. The nodes performing the protection switch are termed switch nodes.

During protection switching, traffic that normally exits the ring at the lost node has the potential to be misconnected to another path termination. To ensure that this does not happen, the nodes adjacent to the failed node (in the example, Nodes B and D) squelch the appropriate working and protection paths by inserting into them a path AIS (alarm indication signal) before completing the protection switch. These paths continue to be given path AIS until the ring returns to normal operation.

The squelching is performed by the switch nodes on the basis of a squelch map that is automatically derived from the node map and STS-1 cross-connection map when these maps are provisioned. The squelch map has an entry for each STS-1 cross-connection provisioned at the ADM node. Each entry contains the APS IDs of the nodes providing the service access point (SAP) and end node for that STS-1.

If a node loses communication with the SAP or end node for a particular STS-1 (for example, because of a failure of the SAP or end node or because of a ring segmentation isolating the SAP or end node), it can then squelch the path. Pass-through connections at the failed node are not squelched, as these can be successfully rerouted over the protection path. [Figure 2-14 on page 2-29](#) shows an example of a four-node ring with four STS-1 paths (a, b, c, and d). The arrows indicate the direction of each path, from the originating node (SAP) to the end node.

[Table 2-3 on page 2-26](#) specifies the squelch map for Node D.

**Table 2-3**  
**Node D squelch map (example)**

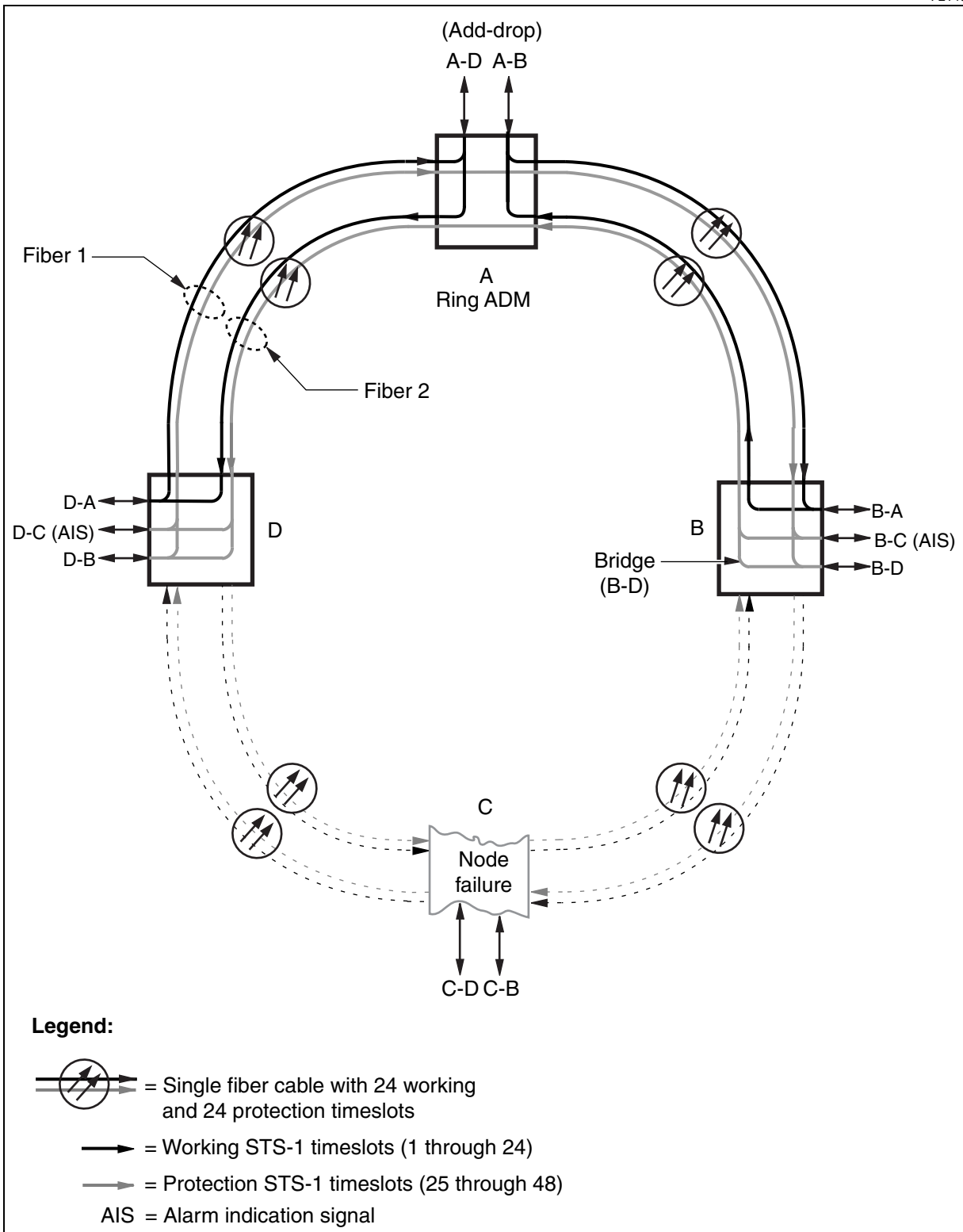
Connection	SAP node ID	End node ID
b	A	B
c	D	A
d	C	D

If Node D fails, path c is squelched at Node A and path d is squelched at Node C. Path b is not squelched, as the path is rerouted from Node A to Node B by the protection switch. Path a is unaffected by the protection switch, as it does not route through the failed node.



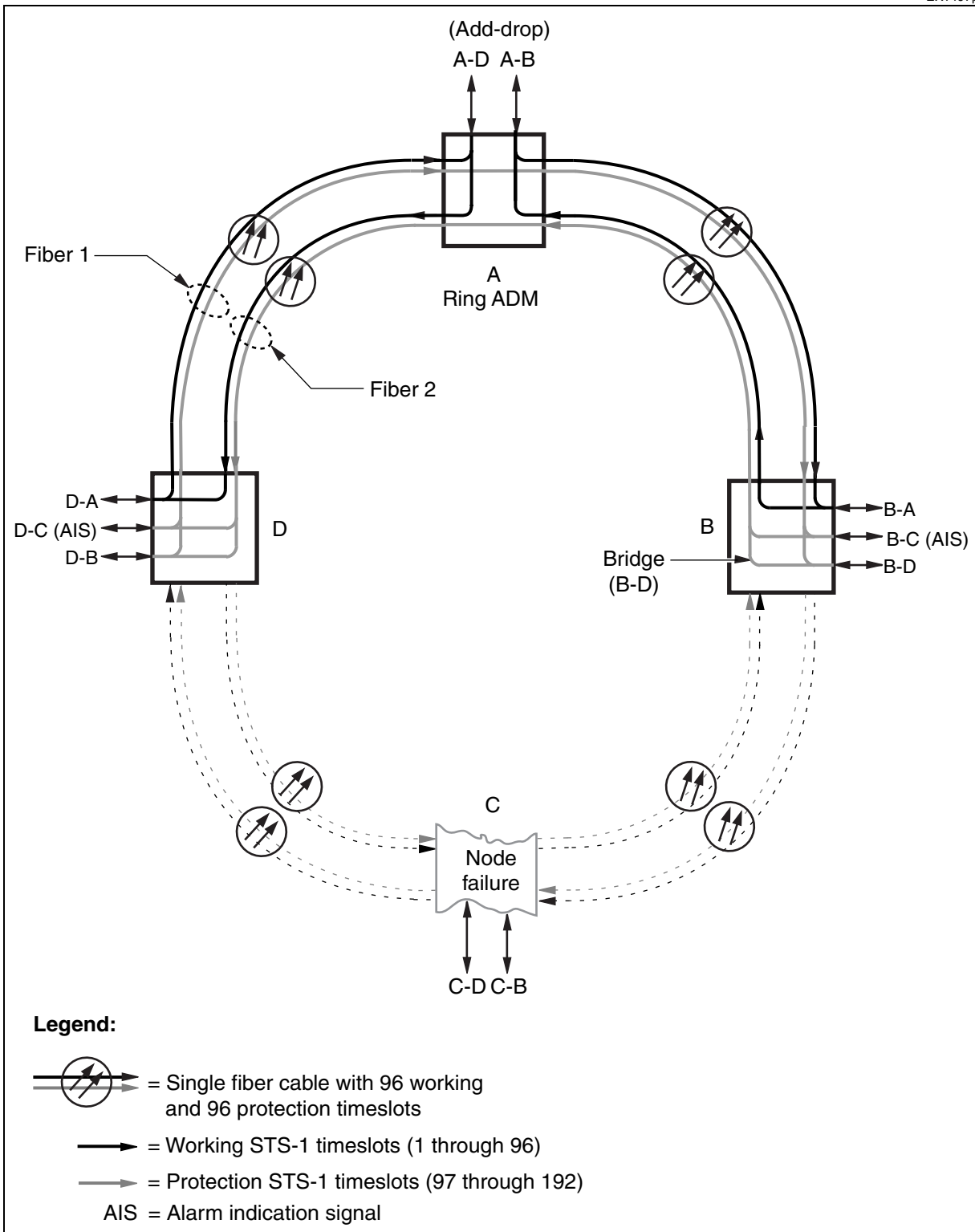
**Figure 2-12**  
**OC-48 BLSR node failure example**

F2140

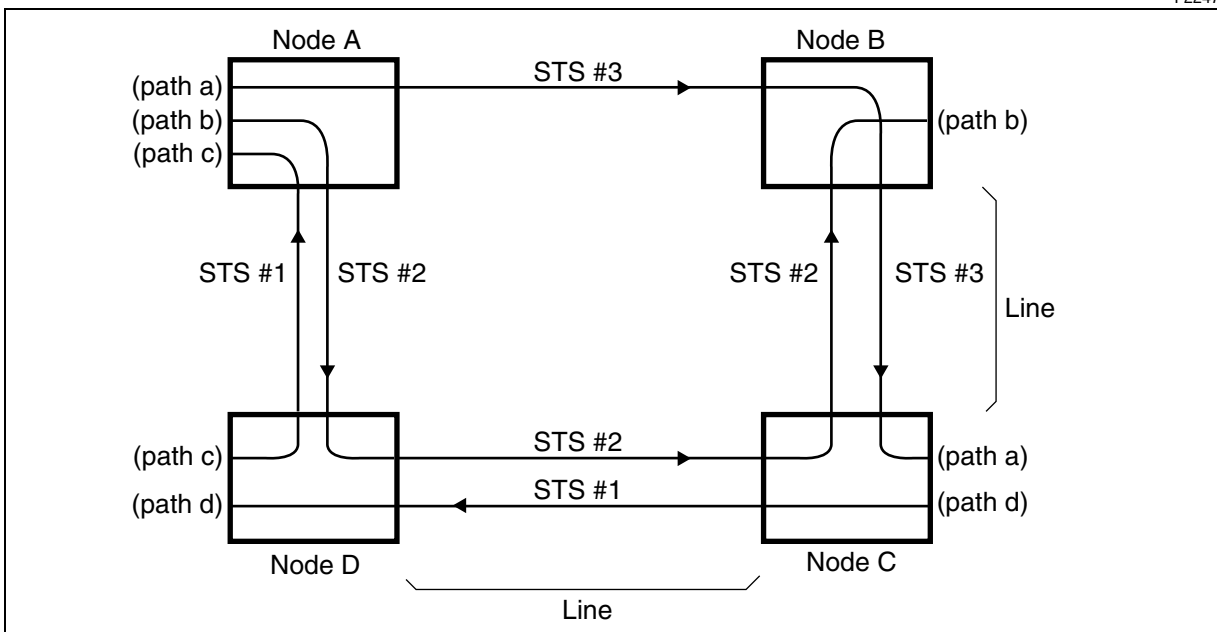


**Figure 2-13**  
**OC-192 BLSR node failure example**

EX1497p



**Figure 2-14**  
**STS paths and squelch map for a four-node 2-Fiber BLSR ring**



### BLSR configurations

The configuration of the BLSR ring is recorded in a BLSR configuration, which is created on the NPx and then propagated to all the SPx circuit packs in the BLSR ring.

#### BLSR configuration attributes

A BLSR configuration contains the following information:

- Ring name
- Optical interfaces involved in the ring (for each node in the ring)
- The associated automatic protection switching (APS) IDs of the involved optical interfaces (for each node in the ring)
- The adjacent nodes' APS IDs and TIDs (for each node in the ring)

**Note 1:** The allowable string characters are "0-9", "A-Z", and "-".

**Note 2:** The allowable range for an APS ID is between 0 and 15.

#### **BLSR configuration distribution**

The distribution process of a BLSR configuration from the NPx to the other nodes in the BLSR is controlled by the combinations of results arising from the following user-initiated actions:

- creating/deleting/editing a BLSR ring
- creating/deleting a BLSR configuration
- checking/loading/invoking/committing a BLSR configuration
- canceling a BLSR configuration (valid at any point before 'commit')

When a new BLSR configuration is provisioned, a 'temporary' BLSR configuration is created. This BLSR configuration is activated when the 'Invoke' button is clicked in Site Manager. Any prior BLSR configuration is deleted after the 'Commit' button is clicked in Site Manager.

#### **BLSR configuration and connection audit**

The BLSR configuration and connection audit feature is enabled by default. Both audits are run by the system once every 1440 minutes (24 hours) by default. This period is provisionable with a range of 15 minutes to 10080 minutes (7 days) in 15 minute increments.

The BLSR configuration and connection audit feature performs two tasks:

- The BLSR configuration audit function determines if the working BLSR configuration on the NPx (master copy) is the same as the BLSR configurations on the SPx circuit packs around the BLSR ring.
- The BLSR connection audit function determines if pass-through connections in the BLSR have the proper End NE A and End NE Z information provisioned.

#### **BLSR configuration audit**

If there is a discrepancy discovered in the configuration audit, the "BLSR Configuration Audit Fail" alarm is raised on the SPx. At this time, the user is able to force down the master copy of the BLSR configuration from the NPx to the faulty SPx by going through the loading, invoking, and committing steps on the NPx.

**BLSR connection audit**

If there is a discrepancy discovered in the connection audit, the "BLSR Connection Audit Failed" alarm is raised against the pass-through node with the inconsistency.

BLSR connection audit behaviour is as follows:

- The BLSR connection audit feature resides on the NPx.
- The audit period is user-provisionable.
- If the audit cannot connect to a node's SPx, the NPx will output the autonomous message "BLSR Connection Audit could not connect to SP"
- The audit will determine the correct End NE A and End NE Z information of a path by looking at the Add/Drop points of the existing path.
- When an audit is complete, the NPx will output the autonomous message "BLSR Connection Audit completed".
- The "BLSR Connection Audit Failed" alarm is cleared upon the next successful BLSR connection audit.
- The BLSR connection audit feature can only raise an alarm if the entire path is provisioned. For partial paths (for example, during the provisioning of a path), an alarm is not raised.

**Traffic flow over OC-48 BLSR**

All traffic types previously supported on the OPTera Metro 3500 shelf are supported in Release 12.1.

OC-48 BLSR is supported on OPTera Metro 3500 shelves equipped with VTX-series circuit packs in slots 13 and 14.

**STS BLSR with VT assignment**

In VT assigned BLSRs, users must provision STS connections at pass-through nodes. This gives a number of distinct advantages to the user:

- There are fewer connections for the user to manage.
- There are fewer, therefore quicker, connection retrievals on pass-through nodes.

*Note:* The number of fewer connections can be estimated to be:  
16 nodes x 24 available STS/node x 1/2 used for passthrough x 28 VT/STS  
= 5376 fewer possible connections.

- The BLSR topology of OPTera Metro 3500 supports interoperability with STS-based products like OPTera Connect HDX, OPTera Connect DX and TransportNode OC-48 subtended BLSRs.

VT assigned end-to-end connections necessarily possess the following characteristics:

- For any given end-to-end VT connection, add and drop nodes must be provisioned with VT connections and pass-through nodes must be provisioned with STS connections
- If one VT end-to-end connection within an STS is provisioned as VT assigned, then all of the VTs within that STS must be VT assigned
- All VT assigned end-to-end connections within an STS channel must terminate (add/drop) at the same node
- All of the VTs within an STS channel must terminate (add/drop) at the same node

**VT BLSR with full VT access**

OPTera Metro 3500 supports full VT access (Full VT mode) in a BLSR. When an end-to-end connection is provisioned as Full VT, all nodes along the length of the connection (add, drop, and pass-through) are VT connections. In addition, VTs in a given STS can be added and dropped to and from any where in the network. This optimizes bandwidth efficiency and provisioning flexibility.

*Note:* Full VT mode is only supported in OC-48 BLSR rings wherein all the nodes are OPTera Metro 3500 network elements equipped with VTX-series circuit packs.

**Traffic flow over OC-192 BLSR**

OC-192 BLSR is supported on OPTera Metro 3500 shelves equipped with OC-192 circuit packs in slots 11 and 12 and with STX-192 circuit packs in slots 13 and 14.

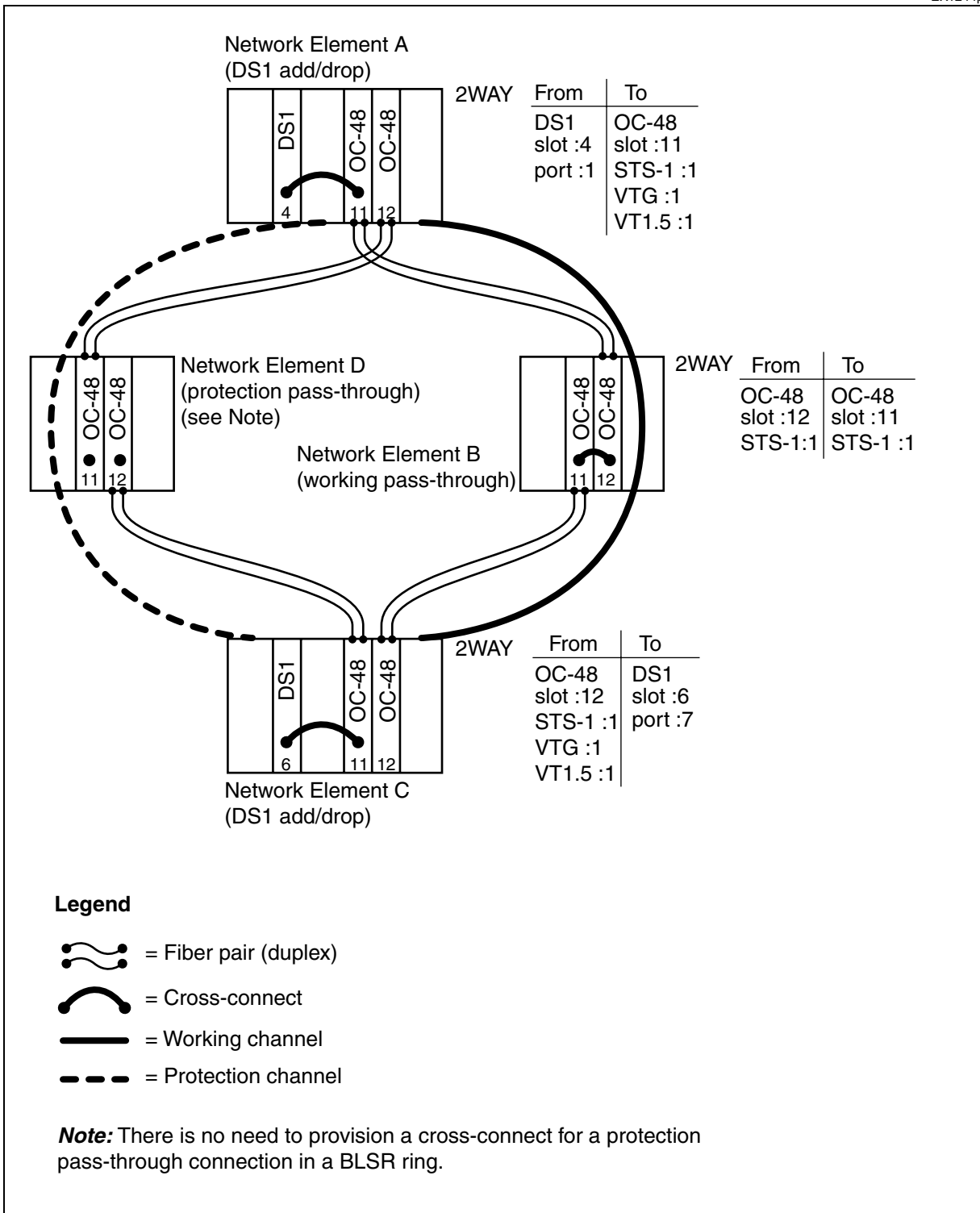
**STS BLSR**

The STX-192 circuit pack supports STS-managed traffic only,

The BLSR topology of OPTera Metro 3500 supports interoperability with OPTera Connect DX at the OC-192 line rate.

**Figure 2-15**  
**STS BLSR with VT assignment support with VTX-48 or VTX-48e circuit pack (example)**

EX1244p



### Provisioning rules

The following BLSR provisioning rules represent the sum of engineering rules - as enforced by system software - plus provisioning recommendations.



#### CAUTION

##### Risk of traffic loss

Blocking of provisioning is performed only at a nodal level. Channel reserving / blocking does not span more than one section. After using the provisioning rules to determine which channels are reserved / blocked on the east and west fiber sections adjacent to an add / drop node, users should ensure they respect these 'reserved' and 'blocked' time slot assignments in all downstream fiber sections until the far-end add / drop node. Provisioning over these time slot assignments downstream may result in dropped traffic if a protection switch occurs.

**Table 2-4**  
**OC-48/OC-192 BLSR provisioning rules**

Rule #	Description
1	<p>Only the working channels may be provisioned as non-RPR connections</p> <p><b>Note 1:</b> For OC-48 BLSR the working channels are any of the STS-1 #1 through #24.</p> <p><b>Note 2:</b> For OC-48 BLSR, STS-1 #25 through #48 are reserved for non-RPR protection and may not be provisioned as unprotected channels for non-RPR traffic.</p> <p><b>Note 3:</b> For OC-192 BLSR the working channels are any of the STS-1 #1 through #96.</p> <p><b>Note 4:</b> For OC-192 BLSR, STS-1 #97 through #192 are reserved for non-RPR protection and may not be provisioned as unprotected channels for non-RPR traffic</p>
2	RPR traffic may be provisioned on STS-1 #1 through #48 for OC-48 BLSR or STS-1 #1 through #192 for OC-192 BLSR
3	<p>Mixed scenarios (both RPR and non-RPR traffic sharing the same BLSR fiber span) may be provisioned.</p> <ul style="list-style-type: none"> <li>— Provisioning rules #1 and #2 apply in mixed scenarios for their respective traffic types.</li> <li>— If a working channel is provisioned for non-RPR traffic, its protection channel is committed to being protection and may not be used for RPR traffic.</li> <li>— If a protection channel is provisioned for RPR traffic, its working channel may not be provisioned as a non-RPR connection.</li> <li>— If an East working channel (any of STS-1 #1 through #24 for OC-48 BLSR or STS-1 #1 through #96 for OC-192 BLSR) is provisioned for RPR traffic, the West working channel with the same time slot assignment is reserved for RPR provisioning.</li> </ul> <p><b>Note:</b> The same is true if the West working channel is provisioned as an RPR connection before the East working channel.</p>
4	RPR connections on the East side of a ring must have the same signal rate as the RPR connection (on the same time slot assignment) on the West side of the same ring.



**Table 2-4 (continued)**  
**OC-48/OC-192 BLSR provisioning rules**

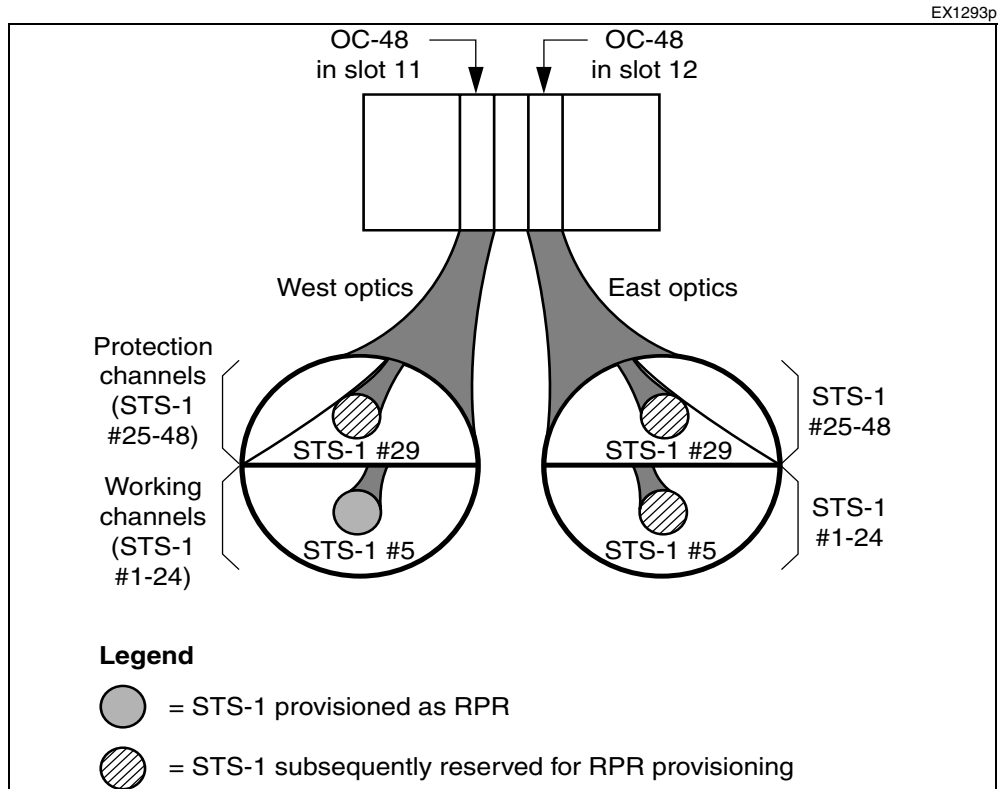
5	<p>In the following types of RPRs, it is recommended that only the working channels may be provisioned for RPR connections:</p> <ul style="list-style-type: none"> <li>— RPRs with subtending UPSRs</li> <li>— Virtual RPRs</li> </ul>
6	<p>VT-assigned connections within the same STS-1 channel must have the same Aend/Zends (Add/Drop points).</p> <p><b>Note:</b> VT-assigned connections are only supported on shelves equipped with VTX-series circuit packs.</p>
7	<p>VT-assigned connections must not be provisioned in the same STS as Full VT connections.</p> <p><b>Note:</b> VT-assigned connections are only supported on shelves equipped with VTX-series circuit packs.</p>

**Example of provisioning rules for OC-48 BLSR (RPR provisioned on working channel)**

In [Figure 2-16 on page 2-36](#), a user provisions STS-1 #5 on the West optical interface (OC-48 in slot 11) as an RPR connection. See [Table 2-4 on page 2-34](#) for provisioning rules.

- STS-1 #29 on the East side is reserved for RPR provisioning because non-RPR connections may not be provisioned in the designated protection channels (any of STS-1 #25 through #48).
- STS-1 #29 on the East side cannot be a non-RPR protection channel because the working channel on the West side has already been provisioned as an RPR connection.
- STS-1 #5 on the East side is reserved for RPR provisioning because STS-1 #5 on the West side has been provisioned as an RPR connection. (See provisioning rule #3)
- STS-1 #29 on the West side is reserved for RPR provisioning because non-RPR connections may not be provisioned in the designated protection channels (any of STS-1 #25 through #48).
- STS-1 #29 on the West side cannot be a non-RPR protection channel because the working channel on the East side is already reserved for RPR provisioning. (See third bullet of this example, provisioning rule #3).

**Figure 2-16**  
**Example of BLSR provisioning rules OC-48 (RPR connection provisioned)**

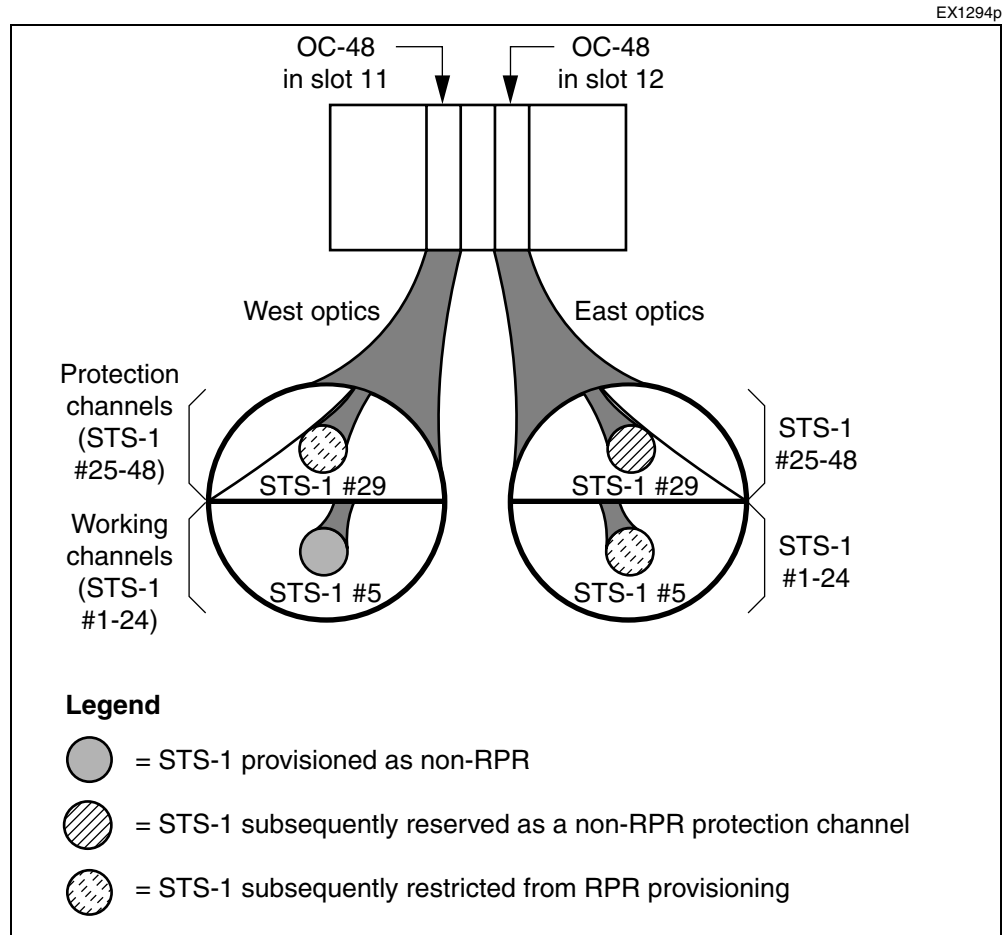


**Example of provisioning rules for OC-48 BLSR (non-RPR provisioned on working channel)**

In Figure 2-17 on page 2-37, a user provisions STS-1 #5 on the West optical interface (OC-48 in slot 11) as an non-RPR connection. See Table 2-4 on page 2-34 for provisioning rules.

- STS-1 #29 on the East side is reserved as a non-RPR protection channel. (See provisioning rule #1, provisioning rule #3)
- STS-1 #5 on the East side is reserved for non-RPR provisioning because RPR provisioning rules over BLSR conflict with STS-1 #5 on the West side and STS-1 #29 on the East side. (See provisioning rule #3)
- STS-1 #29 on the West side is reserved as a non-RPR protection channel because STS-1 #5 on the East side is non-RPR. (See last bullet of this example, provisioning rule #3).

**Figure 2-17**  
**Example of BLSR provisioning rules OC-48 BLSR (non-RPR connection provisioned)**

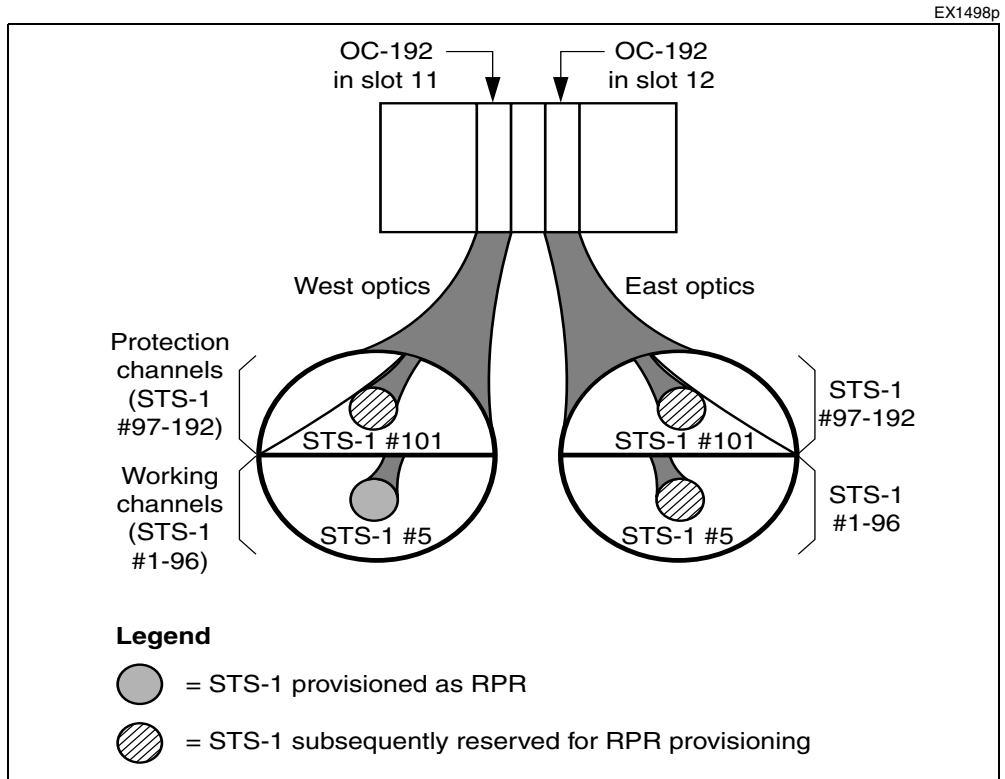


**Example of provisioning rules for OC-192 BLSR (RPR provisioned on working channel)**

In [Figure 2-18 on page 2-38](#), a user provisions STS-1 #5 on the West optical interface (OC-192 in slot 11) as an RPR connection. See [Table 2-4 on page 2-34](#) for provisioning rules.

- STS-1 #101 on the East side is reserved for RPR provisioning because non-RPR connections may not be provisioned in the designated protection channels (any of STS-1 #97 through #192).
- STS-1 #101 on the East side cannot be a non-RPR protection channel because the working channel on the West side has already been provisioned as an RPR connection.
- STS-1 #5 on the East side is reserved for RPR provisioning because STS-1 #5 on the West side has been provisioned as an RPR connection. (See provisioning rule #3)
- STS-1 #101 on the West side is reserved for RPR provisioning because non-RPR connections may not be provisioned in the designated protection channels (any of STS-1 #97 through #192).
- STS-1 #101 on the West side cannot be a non-RPR protection channel because the working channel on the East side is already reserved for RPR provisioning. (See third bullet of this example, provisioning rule #3).

**Figure 2-18**  
**Example of BLSR provisioning rules OC-192 (RPR connection provisioned)**

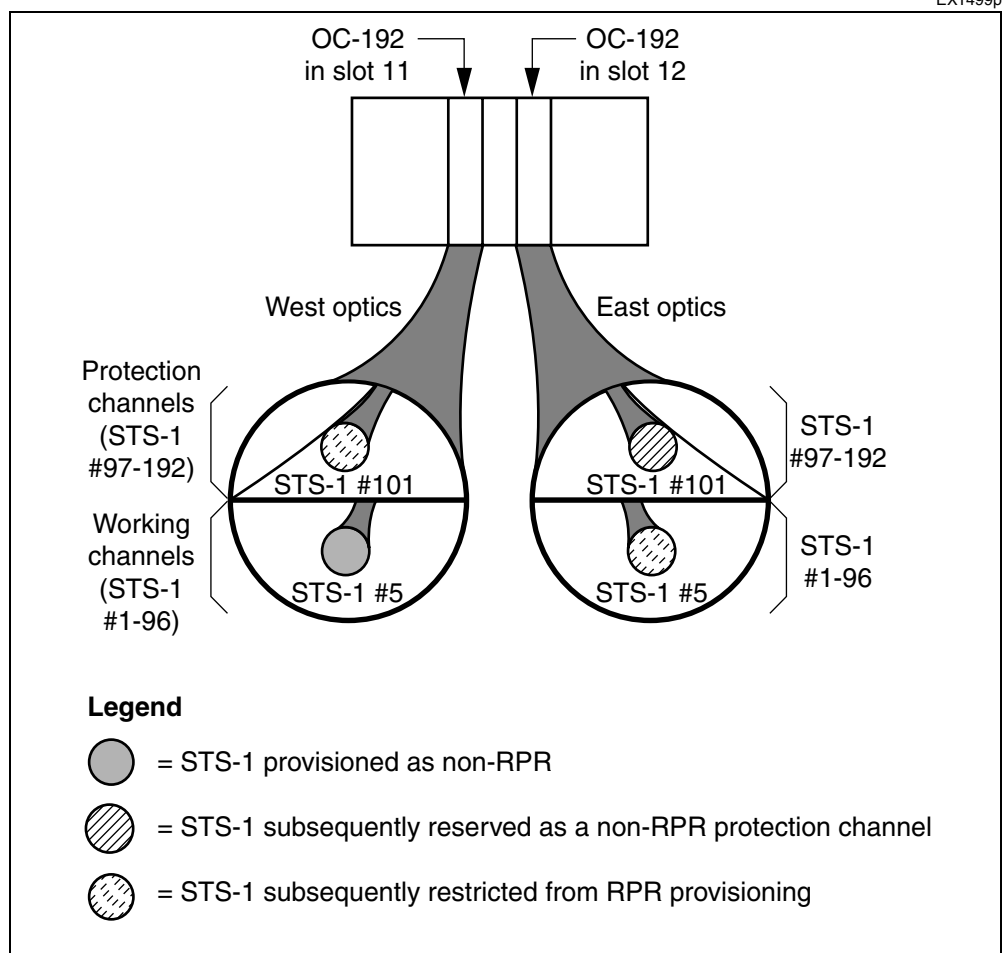


**Example of provisioning rules for OC-192 BLSR (non-RPR provisioned on working channel)**

In Figure 2-19 on page 2-39, a user provisions STS-1 #5 on the West optical interface (OC-192 in slot 11) as a non-RPR connection. See Table 2-4 on page 2-34 for provisioning rules.

- STS-1 #101 on the East side is reserved as a non-RPR protection channel. (See provisioning rule #1, provisioning rule #3)
- STS-1 #5 on the East side is reserved for non-RPR provisioning because RPR provisioning rules over BLSR conflict with STS-1 #5 on the West side and STS-1 #99 on the East side. (See provisioning rule #3)
- STS-1 #101 on the West side is reserved as a non-RPR protection channel because STS-1 #5 on the East side is non-RPR. (See last bullet of this example, provisioning rule #3).

**Figure 2-19**  
**Example of BLSR provisioning rules OC-192 BLSR (non-RPR connection provisioned)**



**Special provisioning considerations for inter-ring hub node of OPE virtual rings or OPE ring spanning Layer 1 subtending rings**

In the case where you provision an RPR spanning multiple Layer 1 (SONET) rings (see [Figure 2-20 on page 2-41](#) and [Figure 2-21 on page 2-42](#)), the hub node will require the use of two IPTR ring names for each RPR, to distinguish the two pass-through connections from one another. Two different provisioning scenarios and their cross-connect provisioning rules are listed in [Table 2-5](#) and [Table 2-6](#).

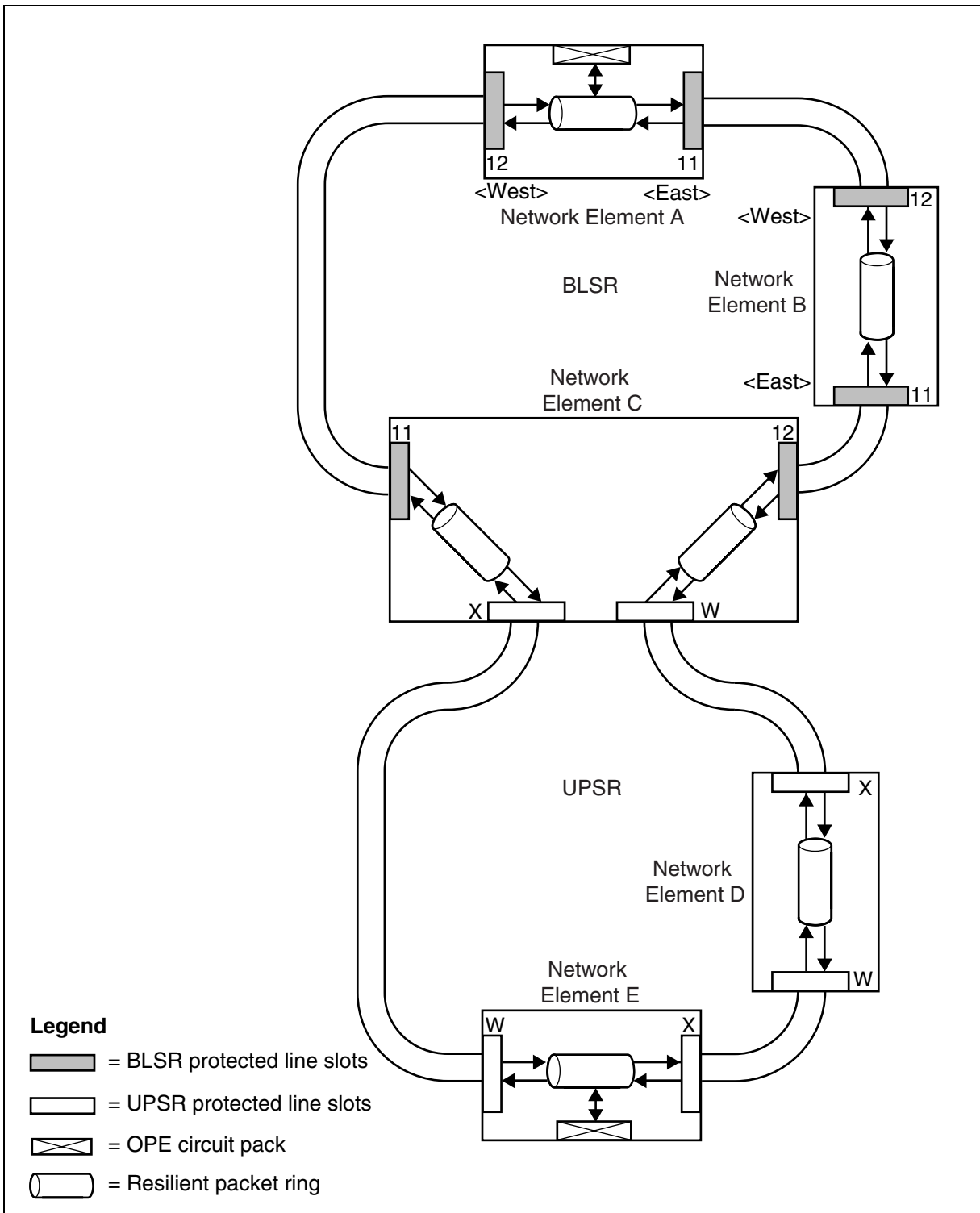
**Table 2-5**  
**Scenario 1: there are already RPRs provisioned on the hub node**

RPR	Nodal IPTR ring name (example names)	Side 1 Optic	Side 2 Optic
first RPR (see Note)	IPTR-1 (see Note)	slot 11 or 12 optical facility	tributary optical facility
	IPTR-2	slot 11 or 12 optical facility	tributary optical facility
second RPR	IPTR-3	slot 11 or 12 optical facility	tributary optical facility
	IPTR-4	slot 11 or 12 optical facility	tributary optical facility
•	•	•	•
•	•	•	•
•	•	•	•
N <sup>th</sup> RPR	IPTR-n	slot 11 or 12 optical facility	tributary optical facility
	IPTR-n+1	slot 11 or 12 optical facility	tributary optical facility
<b>Note:</b> "first RPR" and "IPTR-1" represent the next time you provision an RPR on the hub node.			

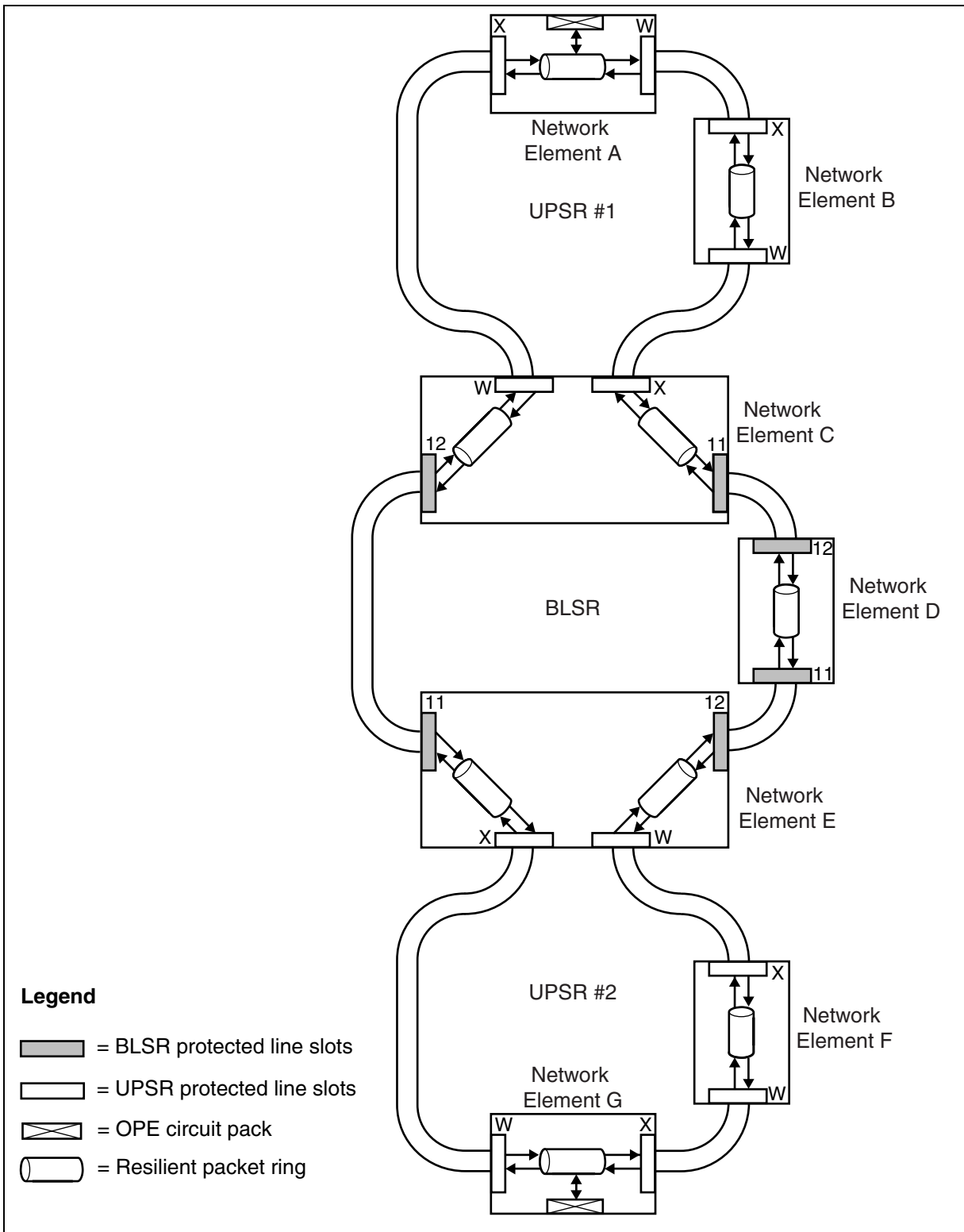
**Table 2-6**  
**Scenario 2: there are no prior RPRs provisioned on the hub node**

RPR	Nodal IPTR ring name (example names)	Side 1 Optic	Side 2 Optic
first RPR	IPTR-1	slot 11 or 12 optical facility	tributary optical facility
	IPTR-2	tributary optical facility	slot 12 or 11 optical facility
second RPR	IPTR-3	slot 11 or 12 optical facility	tributary optical facility
	IPTR-4	slot 11 or 12 optical facility	tributary optical facility
•	•	•	•
•	•	•	•
•	•	•	•
N <sup>th</sup> RPR	IPTR-n	slot 11 or 12 optical facility	tributary optical facility
	IPTR-n+1	slot 11 or 12 optical facility	tributary optical facility

**Figure 2-20**  
**RPR over a BLSR and subtending UPSR (example)**



**Figure 2-21**  
**Virtual RPR over BLSR and subtending UPSRs: no OPE circuit packs in core BLSR (example)**





**OAM supported on BLSR****In service channel rollover**

A user can move VT or STS channels within the same span.

*Note:* VT management is supported with VTX-series circuit packs in slots 13 & 14 only.

**In service route rollover**

A user can move VT or STS channels onto an alternate span.

*Note:* VT management is supported with VTX-series circuit packs in slots 13 & 14 only.

**Retrieving, adding, editing and deleting BLSR protection**

A user can provision and deprovision an optical facility to be BLSR-protected.

**Retrieving, adding, editing, deleting a non-RPR nodal cross-connect**

A user can add, edit or delete a non-RPR cross-connect involving BLSR-protected optical facilities as AIDs.

**Retrieving, adding and deleting an End-to-End Connection over BLSR**

Site Manager Release 6.0 supports end-to-end connection provisioning over BLSR. Users can choose 'Long' or 'Short' path around the ring.

*Note:* OPE end-to-end connections are not supported.

**Adding and deleting a BLSR configuration**

A user can add or delete a BLSR Configuration to/from the NPx.

The operation of adding involves the creation of a 'temporary configuration' to which a user may add or edit BLSR configuration attributes. At any point before 'committing' a BLSR configuration to the NPx, a user may 'cancel' the operation, thereby backing out of the entire procedure. When the user is comfortable with the provisioned attributes of a 'temporary configuration', the user may then 'commit' that configuration to the NPx and to the remaining nodes (SPx circuit packs) in the BLSR ring. The BLSR configuration stored on the NPx is considered by the system to be the master copy.

The operation of deleting requires that the user:

- delete all connections
- remove the entire BLSR configuration

**Forcing a BLSR configuration / connection audit**

BLSR configuration / connection audits can be run on demand from the NPx. Audits can only take place if the NPx Provisioning State is IDLE.

#### **Changing the BLSR configuration / connection audit period**

A user can edit the BLSR configuration / connection audit period. The range is between 15 minutes to 10080 minutes (7 days). The default is 1440 minutes (1 day).

### **Channelized DS3 service (DS3VTx12 mapper)**

The DS3VTx12 circuit pack accommodates 12 channelized DS3 signals, demultiplexing each of them into 28 DS1s which are in turn mapped into VT1.5s. As a result, each DS3VTx12 circuit pack gives full visibility and access to 336 VT1.5/s.

In keeping with the commitment of OPTera Metro 3500 supporting full digital cross-connect capabilities (DCS), users are able to cross-connect all and any VT1.5s from the DS3VTx12 circuit pack to VT1.5 paths of any other kind supported by this network element, such as OC-48, OC-12, OC-3, EC-1, DS1, DSM, and other DS3VTx12s.

AINS, loopback, and manual facility provisioning are supported at both the DS3 and DS1 facility levels. Full bandwidth management and In-Service Traffic Rollover (ISTR) capabilities are supported at the STS-1 (DS3) level down to the VT1.5 (DS1) level for the DS3VTx12 circuit pack.

The DS3VTx12 circuit pack supports some but not all performance monitoring parameters that are supported on other DS3 and DS1 circuit packs. [Table 2-23 on page 2-108](#) and [Table 2-24 on page 2-109](#) illustrate the supported parameters on the DS3VTx12 circuit pack for DS3 and DS1 PMs.

**Note 1:** The DS3VTx12 mapper supports M13 and ASYNC mapping only.

**Note 2:** VT management is supported with VTX-series circuit packs in slots 13 & 14 only.

**Note 3:** The DS3VTx12 mapper is not supported on OPTera metro shelves equipped with STX-192 circuit packs.

For more information about the DS3VTx12 mapper, see [DS3VTx12 mapper on page 3-90](#).

### **Common Language Location Identifier**

OPTera Metro 3500 supports an 11 character alphanumeric Common Language Location Identifier (CLLI), that assigns a unique identification code to each location and to each coded telephone plant item. The CLLI number is user-provisionable and the code structure is: CCCCSSBBUUU

- CCCC is the geographical or place code
- SS is the geographical or state/country code
- BB is the network site code

- UUU is the network entity code.

The combination of these codes comprise a unique place, a unique building and a specific entity. If lower case characters or a mixture of upper and lower case characters are desired, the CLI may be enclosed in quotations.

## Connection ID

Connection ID is a 40 character string used to identify specific connections across an OPTera Metro 3000 network. This feature allows users to label network connections in a more meaningful way to make the identification of connections less complicated.

**Note:** The backslash (/), double quotation mark ("), and percentage sign (%) characters are not supported in the Connection Id string.

Connection ID can be added or modified through any of the following interfaces:

- TL1
- Site Manager
- Trail Manager

Connection ID can be added, modified, or deleted to or from an existing SONET cross-connect while carrying traffic. A Connection ID can be provisioned for a resilient packet ring (RPR) cross-connect type when provisioning an end-to-end connection but it cannot be edited or deleted afterwards. Connection ID for RPR connections require you to provision both the east and west cross-connects first.

**Note:** Connection ID is preserved over in-service rollover.

Connection ID is supported for all connection types on the OPTera Metro 3500. For RPR connections, Connection ID is stored on the optical interfaces associated with the resilient packet ring (RPR) but cannot be edited after its initial set-up.

## Consolidated load

OPTera Metro 3500 Release 12.1 is a consolidated load, with support for J-SDH (Japan Synchronous Digital Hierarchy) and SONET (Synchronous Optical Network) payload and frame formats.

You can use Site Manager or the TL1 interface to switch from SONET mode to a Superset (SONET and J-SDH) mode. You can also use these interfaces to retrieve the current mode. Refer to the Release 12.0 Japan Specific Supplement for more information.

**Note 1:** You cannot switch from Superset mode to SONET mode.

**Note 2:** Switching from SONET mode to Superset mode results in a warm restart of the shelf processor.

## Dense wavelength division multiplexing (DWDM)

OPTera Metro 3500 supports dense wavelength division multiplexing (DWDM) technology. Information is multiplexed over specific wavelengths called optical channels. Users can combine the supported wavelengths (listed in [Table 2-7 on page 2-47](#)) over a single optical fiber using passive optical couplers.

OPTera Metro 3500 Release 12.1 supports:

- nine OC-48 extended reach (ER) DWDM circuit packs operating in the C-Band, with a dispersion of up to 360km.
- sixteen OC-48 long reach (LR) DWDM circuit packs operating in the C-Band
- sixteen OC-48 long reach (LR) DWDM circuit packs operating in the L-Band.

**Note:** Additional wavelengths for OC-48 DWDM extended and long reach circuit packs may be introduced in the future. See [OC-48 DWDM circuit pack on page 3-71](#).

- nine OC-192 long reach (LR) DWDM circuit packs operating in the C-Band.

**Note 1:** Additional wavelengths for OC-192 DWDM long reach circuit packs may be introduced in the future. See [OC-192 DWDM G.709 FEC optical interface circuit pack on page 3-64](#).

**Note 2:** There are four wavelengths (channels) in each band. Each OMX accommodates one band. Combined, the 8 OMX's can accommodate 32 wavelengths on a single fiber.

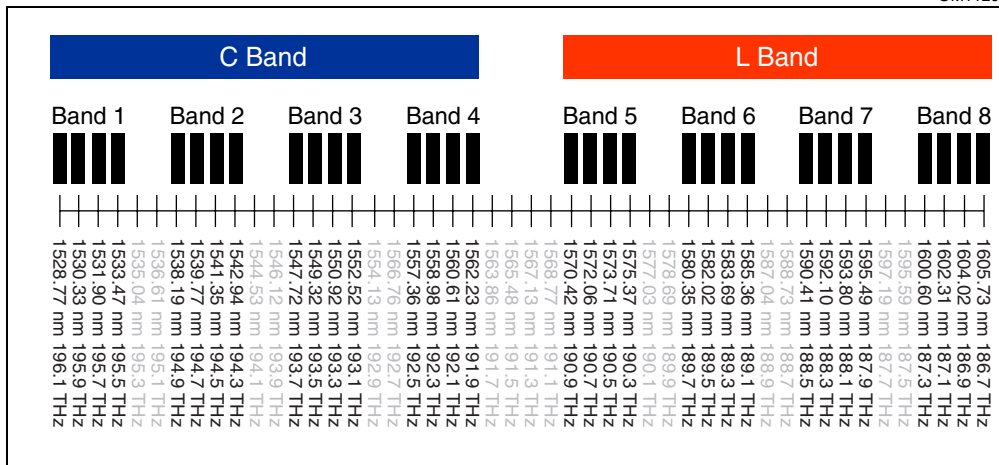
**Note 3:** The OPTera Metro OMX does not support OC-48 DWDM 1535.04 nm, OC-48 DWDM 1555.75 nm, OC-48 DWDM 1596.34 nm, or OC-48 DWDM 1578.69 nm wavelengths.

**Note 4:** Wavelengths and tolerances of the DWDM circuit packs are in compliance with ITU-T G.692 and ITU-T G.694 specifications.

The channels follow ITU-T G.692 and ITU-T G.694 recommendations. The wavelength grid is identical to the wavelength grid that is used for the Nortel Networks OPTera Metro 5200 Multiservice Platform and Nortel Networks TransportNode OC-48 products. See [Figure 2-22](#) for ITU-T grid details.

**Figure 2-22**  
**OPTera Metro 3500 bands**

OM1120t



The 32 wavelengths are divided into eight bands of four channels each, all of which are transmitted over a single optical fiber and can be managed separately.

Sixteen C-Band wavelengths and sixteen L-Band wavelengths along with four additional wavelengths 1534.04 nm, 1555.75 nm, 1578.69 nm and 1596.34 nm wavelengths are supported for the OC-48 DWDM circuit packs. See [Table 2-7](#) for wavelength details.

**Table 2-7**  
**Supported wavelengths for OPTera Metro 3500 OC-48 DWDM circuit pack**

Band	Wavelengths (nm)			
	Channel 1	Channel 3	Channel 2	Channel 4
<b>C Band</b>				
Band 1	1528.77	1530.33	1533.47	1531.90
Band 2	1538.19	1539.77	1542.94	1541.35
Band 3	1547.72	1549.32	1552.52	1550.92
Band 4	1557.36	1558.98	1562.23	1560.61
<b>L Band</b>				
Band 5	1570.42	1572.06	1575.37	1573.71
Band 6	1580.35	1582.02	1586.35	1583.69
Band 7	1590.41	1592.10	1595.49	1593.80
Band 8	1600.60	1602.31	1605.73	1604.02

**Table 2-7 (continued)**  
**Supported wavelengths for OPTera Metro 3500 OC-48 DWDM circuit pack**

Band	Wavelengths (nm)			
	Channel 1	Channel 3	Channel 2	Channel 4
<b>Additional wavelengths</b>				
1535.04	NA	NA	NA	NA
1555.75	NA	NA	NA	NA
1578.69	NA	NA	NA	NA
1596.34	NA	NA	NA	NA
<b>Note 1:</b> The OMX does not support the wavelengths 1535.04nm, 1555.75nm, 1578.69nm and 1596.34nm.				

Eight C-Band wavelengths along with 1534.04 nm wavelength are supported for the OC-192 DWDM G.709 FEC circuit packs. See [Table 2-8](#) for wavelength details.

**Table 2-8**  
**Supported wavelengths for OPTera Metro 3500 for OC-192 DWDM G.709 FEC circuit pack**

Band	Wavelengths (nm)			
	Channel 1	Channel 2	Channel 3	Channel 4
<b>C Band</b>				
Band 1	1528.77	1533.47	1530.33	1531.90
Band 2	1538.19	1542.94	1539.77	1541.35
1535.04	NA	NA	NA	NA
<b>Note 1:</b> The OMX does not support the wavelengths 1535.04nm.				
<b>Note 2:</b> Additional wavelengths for DWDM C-Band may be introduced in the future.				

**OMUX module**

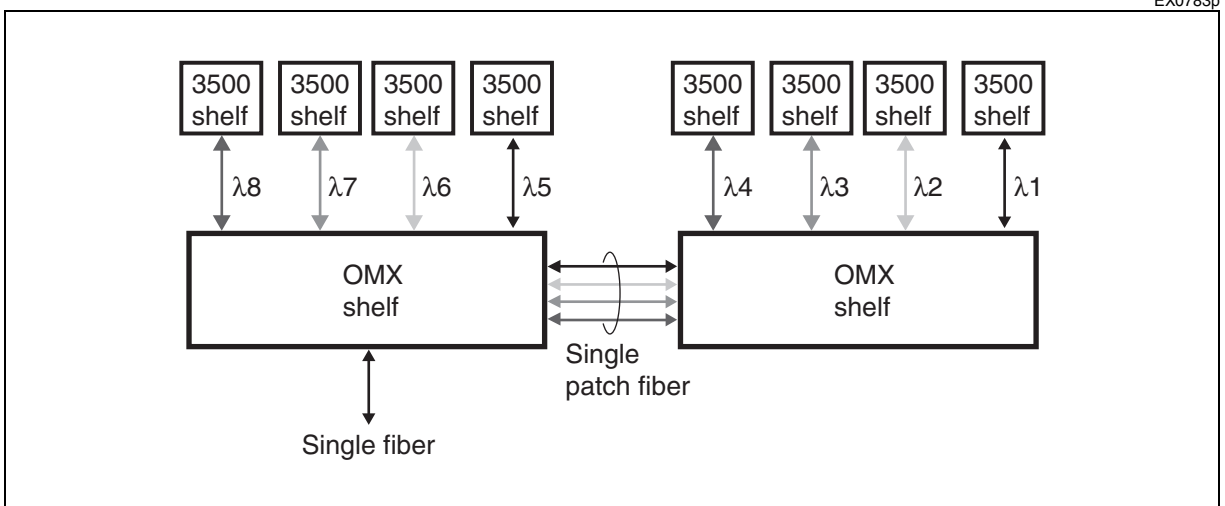
The optical multiplexer (OMUX) module is a multiplexer and demultiplexer capable of supporting up to four wavelengths (one band).

Each OMX module contains passive optical filters that add and drop up to four channels in the assigned wavelength band. The OMX module can multiplex four wavelengths (channels) into an optical band. The bands can then be optically combined into a single optical fiber and can be added to other bands in an optical fiber path. See [Figure 2-23](#).

Additional OMX modules are required for each DWDM band. The DWDM bands can be multiplexed onto one optical fiber to daisy-chain the OMX modules together.

OMX modules can be interconnected within the OMX shelf to provide a working and protection traffic path. A single OMX module supports unprotected traffic.

**Figure 2-23**  
**OPTera Metro 3500 and OMX interconnect**



**Note:** Site Manager and Preside Network Manager do not support wavelength and OMX module visibility in Release 12.1.

### Network sites

There are two types of sites in an OPTera Metro 3500 network:

- terminal sites
- optical add/drop multiplexer sites (OADM)

Terminal sites consist of OPTera Metro 3500 shelves that are provisioned as terminal shelves. At a terminal site, there must be a terminal shelf for every wavelength channel used in the network. Wavelengths must be added or dropped at a terminal location. Terminal sites are sometimes called hub sites when used in hubbed-ring configurations.

At an OADM site, single or multiple OPTera Metro 3500 shelves are placed to gain access to specific wavelengths in the system, so that some wavelengths are terminated, and some are optically passed through at that location. OADM sites are sometimes called remote sites.

## DWDM configurations

The following OMX configurations are supported:

- hubbed-ring
- a meshed-ring
- linear point-to-point

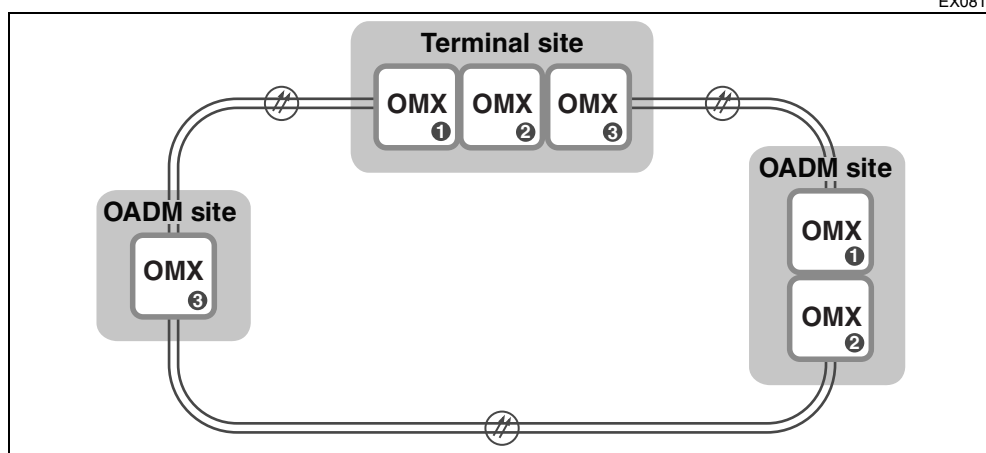
### Hubbed-ring configuration

The hubbed-ring configuration is optimized for traffic flows that are characteristic of access networks. For an example of a hubbed-ring configuration, see [Figure 2-24](#) and [Figure 2-25](#).

Each OPTera Metro 3500 shelf can support one fully protected optical channel between the OADM shelf and the terminal, or two unprotected channels. More than one OPTera Metro 3500 shelf can be installed at an OADM site to provide additional add/drop capacity as required.

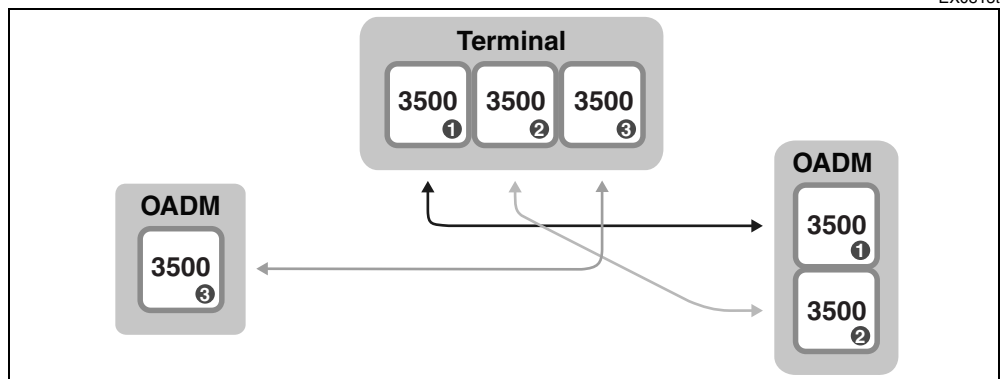
Multiple OPTera Metro 3500 shelves are installed at the terminal, one for each OADM shelf in the hubbed ring. Four wavelengths are grouped into one band. The same wavelength band is assigned to the terminal shelf and the corresponding OADM shelf.

**Figure 2-24**  
Physical connections in a hubbed-ring configuration





**Figure 2-25**  
**Logical connections in a hubbed-ring configuration**



### Meshed-ring configuration

The meshed-ring configuration is optimized for traffic flows that are characteristic of interoffice networks. For an example of a meshed-ring configuration, see [Figure 2-26](#) and [Figure 2-27](#).

Individual wavelengths can be added or dropped at different locations. You can also reuse wavelengths.

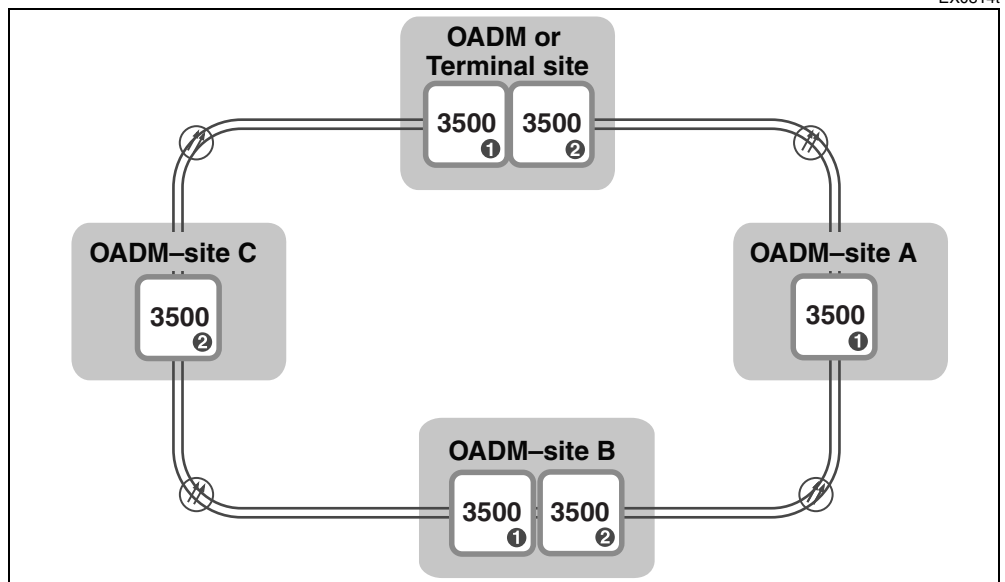
Band meshing and channel meshing are both supported.

Band meshing allows the system to drop and add all wavelengths of a given band at one node or at multiple nodes in the network. Other bands can be passed through the system.

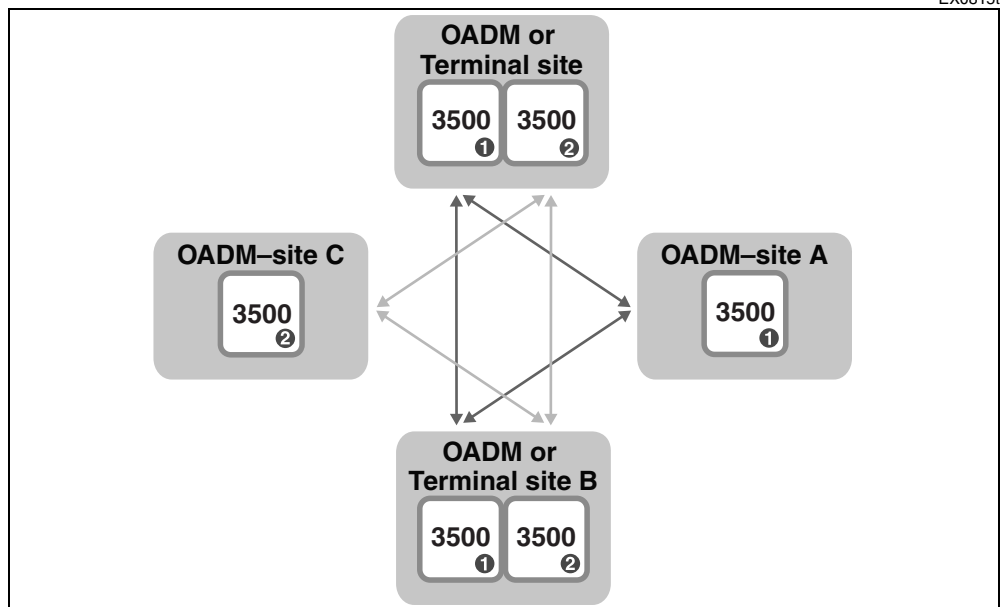
Channel meshing provides the capability for any channel from one node in the network to be terminated (added or dropped) at any other node in the network and at multiple nodes in the network.

Each OPTera Metro 3500 shelf can support one fully protected optical channel or two unprotected channels. More than one OPTera Metro 3500 shelf can be installed at a terminal or OADM site to provide additional add/drop capacity as required.

**Figure 2-26**  
Physical connections in a meshed-ring configuration



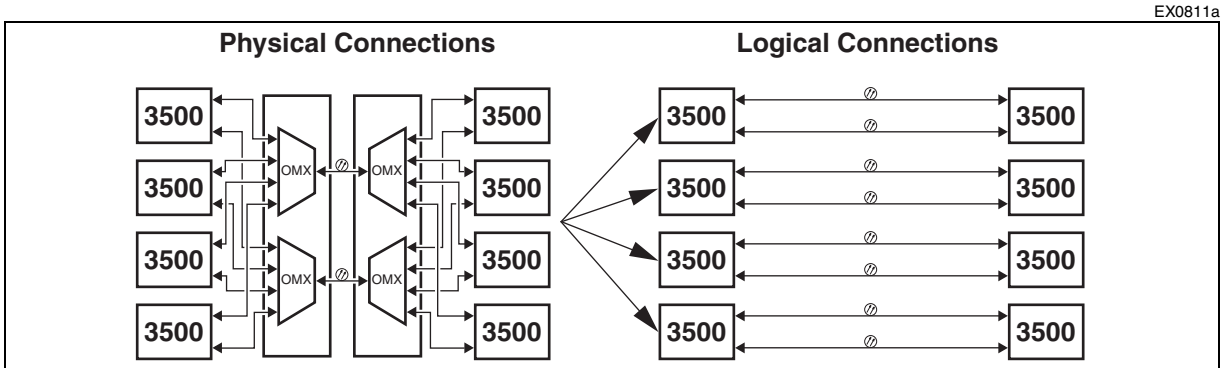
**Figure 2-27**  
Logical connections in a meshed-ring configuration



**Linear point-to-point**

A point-to-point configuration transports traffic between two sites on a protected OMX DWDM system. Two fiber spans between the sites in a DWDM point-to-point configuration have the same functionality as up to 32 fiber spans in a non-DWDM point-to-point configuration. An OMX shelf is required at both sites. The fiber connects to the OTS OUT on the OMX module at one site, and the OTS IN on the OMX module at the other site. See [Figure 2-28](#) for an example of a point-to-point configuration for four channels.

**Figure 2-28**  
**DWDM point-to-point configuration**



## Facility attributes

Visible and provisionable facility attributes include the following:

- Signal degrade threshold (SDTH)
- Auto in service (AINS)
- Section trace
- Path trace
- Equalization (DS1)
- Frame Format (DS1)
- Line build out (DS3, EC-1)
- DS1, DS3, and EC-1 loopbacks

All supported facility attributes (except loopbacks) are default provisioned when equipment is provisioned.

## Loopbacks

### Terminal loopback

A terminal loopback routes an incoming signal towards the backplane. An alarm indication signal (AIS) is generated in the outward direction of the signal.

### Facility loopback

During a facility loopback, a signal received on the optical or electrical side of the facility is looped back towards the associated return transmitter. An alarm indication signal (AIS) is generated in the onward direction of the signal. To operate a facility loopback, the facility must be manually put out of service (OOS).

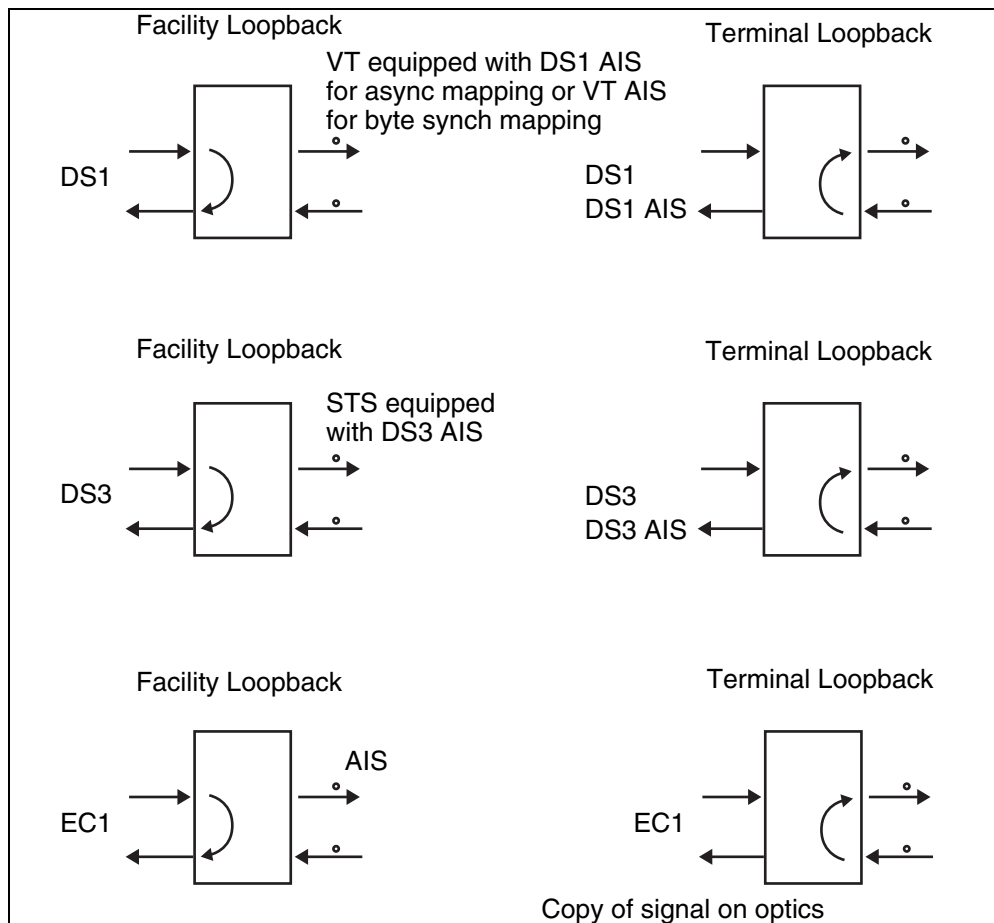
**Note:** The facility must be out-of-service before a loopback is permitted and both types of loopback cannot be active for a given facility at the same time.

Facility loopback implementation complies with the latest issues of:

- GR-253-CORE, Synchronous Optical Network (SONET) Transport Systems: Common Generic Criteria
- GR-819-CORE, Network maintenance: Access and Testing - Special Services (SS) and SS-like networks

Refer to [Figure 2-29](#) for details on electrical loopback types.

**Figure 2-29**  
**Electrical Loopback types**



## Optical loopback

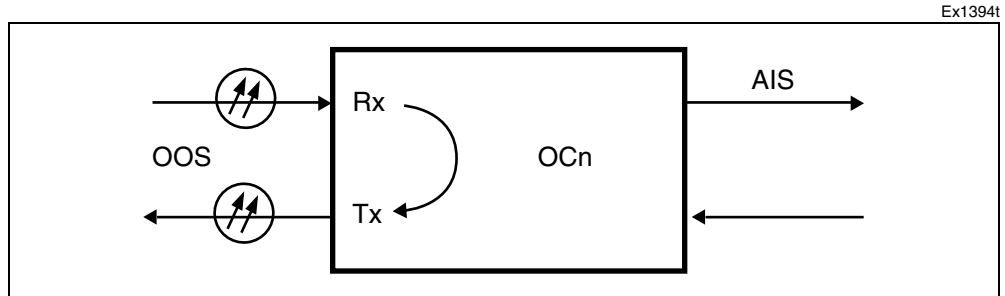
### Optical facility loopbacks

Optical loopback functionality provides maintenance personnel the capability to test portions of optical circuits for signal continuity by having the OC-n circuit packs loopback test signals that are sent to them on either the terminal or facility side of the connection. Sectioning of a SONET path facilitates remote fault isolation.

*Note:* Site Manager supports provisioning of optical loopbacks.

Figure 2-30 illustrates an optical facility loopback.

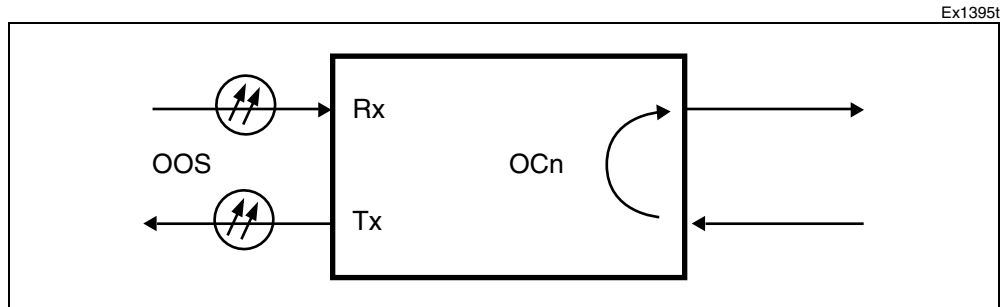
**Figure 2-30**  
**Facility loopback**



**Optical terminal loopbacks**

During a terminal loopback, a signal received on the switch card (STX-192 or VTX-series) side of the facility is looped back towards the associated incoming transmitter. To operate a terminal loopback, the facility must be manually put out of service (OOS). Figure 2-31 illustrates an optical terminal loopback.

**Figure 2-31**  
**Terminal loopback**



**Engineering rules**

- Facility and terminal loopbacks are supported on DS1, DS3x3, DS3x12, DS3VTx12, EC-1x3, EC-1x12, 2x10/100BT, OC-3, 2xGigE/FC-P2P, OC-3x4, OC-12, OC-12x4 STS, and OC-48, OC-48 STS and OC-192 circuit packs.

*Note:* Terminal loopback is not supported on the OC-192 circuit packs.

- Terminal and facility loopbacks can not be performed at the same time on the same optical facility.
- Terminal and facility loopbacks for multi-port optical circuit packs are done on a per port basis. Only one loopback is allowed per port at any one time.
- Terminal and facility loopbacks are maintained during;
  - circuit pack restarts (warm/cold) if a shelf processor is present in the shelf

- shelf processor restarts
- software upgrades
- Terminal and facility loopbacks are not maintained;
  - during network element power cycles
  - during brownouts
  - when a restart is performed on a circuit pack in a shelf not containing a shelf processor
- A facility with a loopback cannot be put in-service and it cannot be deleted.
- In-service roll-overs should not be performed on a card with a loopback operated.
- A facility loopback cannot be operated if;
  - the circuit pack is not physically present
  - the facility state is in-service
  - the facility is provisioned as a TAP
- A data communications channel (DCC) connection to a network element should not be used to initiate a SONET loopback if the loopback interrupts communication between the network element and the user. If DCC communications are interrupted, there will be no way to release the loopback.

**Note 1:** If at least one DCC remains active on the network, the user may still communicate with the network element.

**Note 2:** GR-253-CORE recommends that facility loopbacks be positioned at the point immediately following the optical-to-electrical interface. This is not supported on all circuit packs.

- To operate a loopback, the facility must be OOS-MA.
- Loopbacks are only to be operated for facility testing. Loopbacks are not to be operated at any other time.

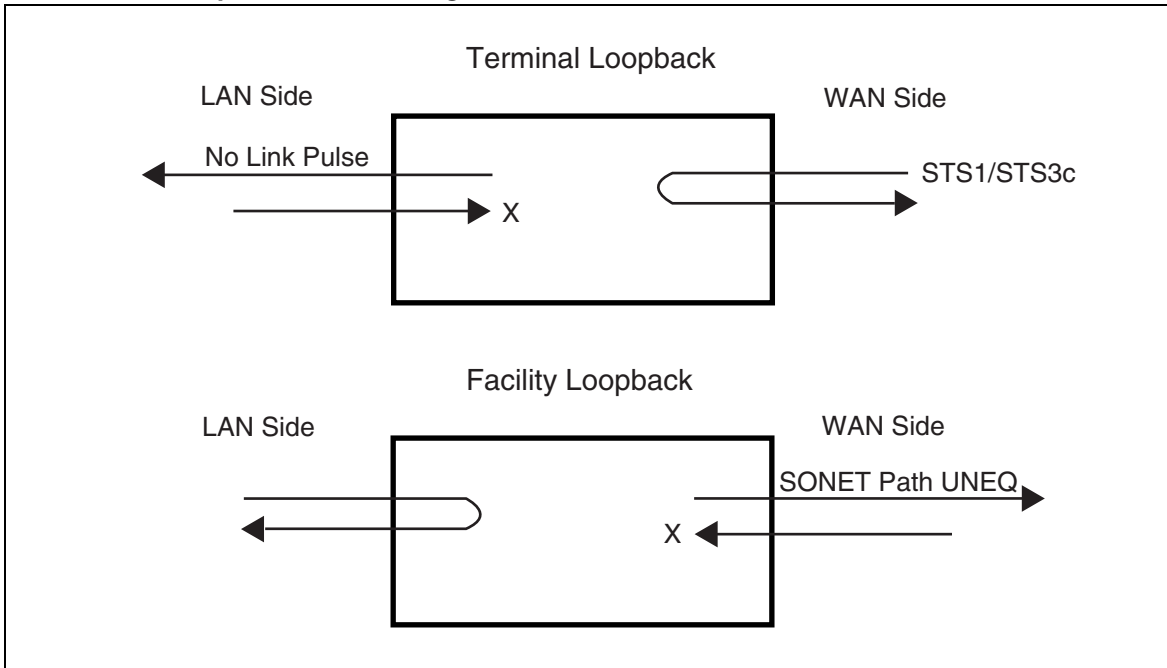
The 2x100BT-P2P and 2XGigE/FC-P2P circuit packs supports both terminal and facility loopbacks for testing purposes. The loopback can be performed on a per-channel basis.

Refer to [Figure 2-32 on page 2-58](#) for details on 2x100BT-P2P loopback types.

**Note:** For descriptive and procedural information about Ethernet loopbacks, see:

- *OPTera Packet Edge System Planning Guide*, NTRN10YK
- *OPTera Packet Edge System Network Applications and Management Guide*, NTRN11YK

**Figure 2-32**  
**2x100BT-P2P loopback conditioning**



## Network surveillance

### Extended network processor (NPx)

The NPx supports TCP/IP, X.25, and a seven-layer OSI stack. The NPx communicates with Site Manager and the Multiservice Managed Object Agent (MOA) over TCP/IP. It supports TL1 communication over X.25 with other operations support systems (OSS). The NPx communicates with the co-located extended shelf processor (SPx) through the backplane over Ethernet. The NPx also allows up to 16 nodes with network processors or ILAN cards to be daisy-chained through the intershelf local area network (ILAN).

The NPx supports three user accounts with a level 5 UPC for network surveillance purposes. Each level 5 user has visibility to NPx's span of control of up to 16 network elements. Logging in to the NPx using a user account with a level 5 UPC from a local connection, you can retrieve alarms and events from all network elements in the network processor span of control. The NPx can have up to 16 network elements in its span of control.

The NPx supports file transfer to and from Preside and Multiservice MOA for electronic software delivery, and to and from a PC to install files on the system. The NPx also allows other network processors or shelf processors to retrieve new software loads for upgrade purposes.



### **Telemetry byte-oriented serial (TBOS)**

The OPTera Metro 3500 network element is equipped with a telemetry byte-oriented serial (TBOS) subsystem that facilitates display of alarms at remote network elements. The TBOS subsystem determines the location of the network element that triggered the alarm.

When a remote alarm is detected by the TBOS system, the remote LED illuminates at the network element defined as the TBOS head-end.

When the network element that has raised the alarm is identified, you can log in to that network element and identify the fault details.

The OPTera Metro 3500 network element supports TBOS monitoring through a dedicated TBOS port and a subset of TBOS information through the Site Manager. OPTera Metro 3500 supports TBOS through a four-wire, half duplex, 2400 baud, RS-422 port on the Left OAM (LOAM). Remote telemetry can be performed using the TBOS port and an E2A monitor. A TBOS status matrix can also be displayed using the Site Manager interface.

TBOS data is transmitted using 8 bytes containing 4 bits of data each. These 32-bit displays represent alarm conditions on a network element.

The TBOS standard states the following:

- There must be 64 bits assigned to represent alarm conditions on a network element.
- There must be a total of eight such displays.

#### **Single-ended TBOS**

The OPTera Metro 3500 allows a single TBOS link to monitor several interconnected network elements such as those in a UPSR or in a linear system. (A linear system has no limit on chain size. However, the head-end only monitors 16 network elements from the head-end.) The monitored network elements are in what is called a monitored span. Network elements in the monitored span communicate their alarm status to each other. This communication allows TBOS to obtain alarm information about all the other network elements in the monitored span.

TBOS mapping assignments are set up at one network element in each monitored span. This network element is called the TBOS head end. Any node can be selected as the head-end network element.

Protocol problems occur if more than one network element is configured as a TBOS head end. If a second head end is set up, the TBOS remote flag becomes erroneous.

**Note:** Although TBOS mapping assignments are set from the head-end network element, you can retrieve TBOS from any remote network element.

The other network elements in the monitored span are mapped to TBOS display positions of the head-end network element. The order in which network elements are assigned to the TBOS numbers is arbitrary. All display numbers, including number one, can be assigned at any time.

The TBOS display is retrieved from the TBOS head-end network element only. If you try to retrieve the TBOS display from another network element, the display is blank.

#### **Remote alarm LED indicator**

The remote alarm LED at the TBOS head-end network element indicates an alarm at another network element in the TBOS monitored span. The remote alarm LED does not turn on if an alarm is raised at a network element that has not been mapped into the TBOS display.

All network elements in a network should be included in the TBOS display mapping.

#### **TBOS report format**

The report generated by opening the TBOS dialog box shows the TBOS mapping assignments and the current alarm status of all assigned elements in the monitored span. In the screen, adjacent to each network element (NE), are columns containing periods (.), asterisks (\*), or question marks (?).

- A period indicates normal status.
- The asterisks under the display header row symbols CR, MJ, MN, E1, E2, E3, E4, and RM, correspond to alarm conditions at each network element. These represent critical, major, and minor alarms, the first four environmental alarms in numeric order, and the remote alarm indicator, respectively.
- Question marks show that the network element has not been found in the TBOS traffic flow. This can mean:
  - the network element is not functioning
  - the network element cannot be reached
  - the NE name has been changed but not updated in the TBOS display page

#### **Path trace**

Path trace is a 64-byte ASCII string transmitted through the J1 byte of the STS path overhead (POH). The 64-byte format provides the user the ability to input a 62-byte ASCII character string.

Path trace is used by an STS path terminating equipment (PTE) to verify its continuous connection to the intended transmitting STS PTE. Path trace can be monitored on a DS3 STS-1 path facility. It can also be monitored on an OC-3, OC-12, or OC-48 STS-1 path facility if the STS is virtual tributary (VT)-managed. For OPTera Metro 3500 equipped with STX-192 circuit packs (STS-managed), path trace must be monitored on the path terminating equipment such as DSM module, DS3, 10/100BT- P2P, 2xGigE/FC-P2P circuit packs.

**Note 1:** The following special characters are not supported:

! " # \$ % ' ( ) \* + - . / < = > @ [ ] ^ \_ { | } ~

**Note 2:** Path trace can be monitored on the 2x100BT-P2P circuit pack WAN port for STS-1 and STS-3c path facilities.

**Note 3:** Path trace can be monitored on the 2xGigE/FC-P2P circuit pack for STS-1 STS-3c, STS12c and STS-24c path facilities.

### Section trace

Section trace is a user-provisionable message transmitted so that a receiving terminal in a section can verify its continued connection to the intended transmitter. Section trace is a user-provisionable message in one of two formats:

- STRING - 15 bytes long printable alphanumeric ASCII string

**Note:** The following special characters are not supported:

! " # \$ % ' ( ) \* + - . / < = > @ [ ] ^ \_ { | } ~

- NUMERIC - any value from 0 through 255 in decimal integer form

Use either of these formats to verify proper fiber connections or detect reflections from optical couplers. When the section trace function is not supported or if no value has been programmed, a numerical value of 01 is transmitted.

### TID address resolution protocol (TARP)

The TID address resolution protocol (TARP) is used by TL1-based network elements to convert target identifiers (TIDs) into network service access points (NSAPs). An NSAP is used internally in a SONET communications network as a means of addressing a network element.

TARP is a propagation protocol. TARP uses this propagation method with a distributed database of learned TID/network entity title (NET) mappings. TARP allows network elements to translate between TID and NET by automatically exchanging mapping information with other TL1-based network elements without the need for craftsperson intervention. No additional address provisioning is required at the network element to support TARP.

TARP transparency is required for operations, administration, and maintenance (OAM) interoperability between OPTera Metro 3500 network elements and network elements that are not based on TL1.

## **OPTera Packet Edge System (Resilient Packet Ring) - Ethernet**

The OPTera Packet Edge System - Ethernet provides a way of delivering data services in a wide area network (WAN). Service providers use Ethernet interfaces (10/100/1000 Mbit/s) for WAN connections. The OPTera Packet Edge System handles the multiplexing and virtual connections across the optical network. OPTera Metro 3500 OPE cards provide STS-1, STS-3c, and STS-12c Resilient Packet Ring (RPR) bandwidth.

OPTera Packet Edge is a set of distributed switch / bridge circuit packs that support connectionless, statistically multiplexed packet traffic on a carrier grade transport platform. The shared bandwidth OPTera Packet Edge switching is suitable for interconnecting LANs, routers, switches, virtual private networks, and servers on SONET topology networks for carrier and service provider applications.

OPTera Packet Edge in Rel 12.0 supports the following circuit packs

- 4x100BT
- 4x100FX-MM
- 4x100FX-SM
- 2x1000SX (2xGigE over multimode fiber)
- 2x1000LX (2xGigE over single mode fiber)

### **Connectors**

4x100FX circuit packs have MT-RJ connectors on the faceplate. Use 1310 nm, single mode fiber-optic cables to interface to the 4x100FX (NTN433FA) circuit pack. Use 850 nm, multimode fiber-optic cables to interface to the 4x100FX (NTN433EA) circuit pack. If necessary, use a patch panel to convert between the MT-RJ connection and SC, ST, or FC connections.

The 4x100BT circuit pack requires a 8xRJ-45 I/O module for connectivity. Connect using ports 1 to 4 of the 8xRJ-45 I/O, ports 5 to 8 are for future use.

The 2x1000SX circuit pack has duplex SC connectors on the faceplate. Use 850 nm, multimode fiber-optic cables to interface to the 2x1000SX circuit pack.

The 2x1000LX circuit pack has duplex SC connectors on the faceplate. Use 1310 nm, single mode fiber-optic cables to interface to the 2x1000LX circuit pack.

### Resilient packet ring (RPR) object

A resilient packet ring (RPR) object is a SONET bandwidth pipe. See [Figure 2-33 on page 2-63](#). The graphic shows a RPR object at the shelf level.

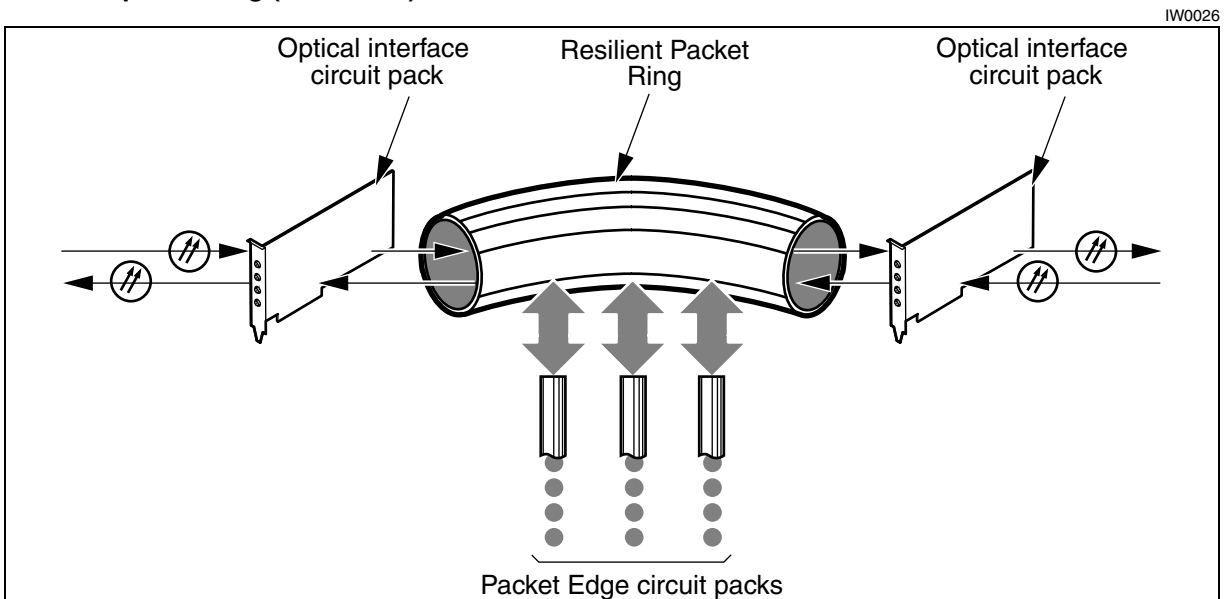
Bandwidth is allocated to the ring object from each of the optical circuit packs. In this example, Packet Edge circuit packs are attached to the RPR object and share its bandwidth.

The maximum number of nodes provisionable on a RPR ring is:

- 16 for RPR ring consisting only of 2xGigE
- 12 for RPR rings consisting of a mix of 2xGigE with 4x100FX and/or 4x100BT cards.

If the maximum number of nodes on the ring is exceeded a “Max OPE Nodes On Ring Exceed” alarm is raised. For more information on this new alarm, see [RPR configuration alert on page 2-65](#).

**Figure 2-33**  
Resilient packet ring (shelf level)



The OPTera Packet Edge System provides the following features:

- optimized use of transport network bandwidth
- reduced port costs
- lower network operation cost
- easy network management
- the ability to support a mix of packet and non-RPR traffic over the same network
- high-speed connectivity with low delay

- flexible Ethernet access and network bandwidth allocation
- ability to support enhanced and competitive SLAs
- ability to support ICMP Ping
- ability to support traffic management features such as static routing, load sharing, and Bandwidth Reservation Protocol
- ability to support NE slot awareness
- ability to support FPGA upgrades
- ability to support software upgrades
- transparent LAN service/layer 2 (TLS/L2) tunneling mode
- optical Ethernet/Layer 2 (OE/L2) tunneling mode
- point-to-point connections (in OE/L2 mode)
- point-to-multi-point connections (in OE/L2 mode)
- multi-point-to-multi-point connections
- TD connectivity tests and internal card loopback tests
- traffic filtering at ports that connect separate rings (NNI filtering)
- redundancy between rings through trunk groups (NNI redundancy)
- station over provisioning notification
- save provisioning notification
- 2048 NNI filters

### **Optical Ethernet / Layer 2 (OE/L2) on OPTera Packet Edge System**

OPTera Packet Edge System provides configurable packet tunneling modes: transparent LAN service Layer 2 (TLS/L2) and Optical Ethernet Layer 2 (OE/L2). The OE/L2 mode provides optimized traffic service through point-to-point and point-to-multipoint tunnels. You can configure your network from TLS/L2 to OE/L2 or from OE/L2 to TLS/L2 without impacting traffic.

For more information, see:

- *OPTera Packet Edge System Planning Guide*, NTRN10YK
- *OPTera Packet Edge System OPTera Metro 3000 User Guide*, NTN465YG

### RPR configuration alert

OPTera Metro 3500 will generate an alarm and trap notifying users when the maximum number of nodes on the RPR ring is exceeded.

The maximum number of nodes provisionable on a RPR ring are:

- 16 for RPR ring consisting only of 2xGigE.
- 12 for RPR rings consisting of a mix of 2xGigE with 4x100FX and/or 4x100BT cards.

An alarm and trap is sent following:

- the addition of the 17 node to the RPR ring which consists only of 2xGigE.
- the addition of the 13 node to RPR ring which consists of a mix of 2xGigE with 4x100FX and/or 4x100BT cards.

All nodes which have their IP and trap receivable provisioned will send a trap along with corresponding TL1 alarm. The trap and alarm clear when the number of nodes on the RPR ring decreases:

- to 16 nodes or less for RPR ring which consists only of 2xGigE.
- to 12 or less RPR ring which consists of a mix of 2xGigE with 4x100FX and/or 4x100BT cards.

### Auto save notification

New traps were introduced in Release 12.0 informing user that unsaved changes have been made to the provisioning of an OPE card.

#### Traps

- `provDataSaveRequiredTrap`  
This trap will be sent after any provisioning change. It will provide notification to the Network Management tools that some data has been modified and has not been saved to NVRam.
- `provDataLostTrap`  
This trap will be sent after there was a provisioning change, which was not saved and either a cold or warm restart occurred. In this case the unsaved provisioning data will be lost. It will provide notification to the Network management tools that some data was lost.

A new variable “Provisioning Data” was added to the “System Device Info” field to reflect the status of the provisioning data. This allows the user to query the provisioning data status at anytime and perform the correct actions depending on the data status. The data statuses are:

- default: provisioning data is the default data
- saved: the provisioning data was saved
- save required: unsaved changes to provisioning date have been made
- data lost: provisioning data is lost

### **NNI Filters increased to 2048**

- OPTera Metro Release 12.0 augmented the number of individual NNI filters to 2048. The 2048 filters are shared across any Ethernet ports on the 4x100BT, 4x100FX and 2xGigE cards which are configured as NNI.

### **Optical Ethernet-Private Line (OE-PL) services using 10/100 Ethernet**

One of the key services within Optical Ethernet is the Private Line (OE-PL) Service. An Ethernet private line has the same service characteristics as a traditional TDM based DS1, DS3 or OC-n private line service but uses Native Ethernet as the interface. Ethernet frames are relayed transparently between two Ethernet ports. The Ethernet frames are mapped into circuits either at full or partial rate.

End users can benefit from Native Ethernet interfaces and no longer require any adaptation to traditional WAN interfaces (T1/DS1, T3/DS3, OC-n). This simplifies the co-ordination of interfaces between the Carrier and Enterprise, and moves to a simple 'plug-and-play' model for WAN services based on Ethernet 802.3.

The 2x100BT-P2P circuit pack available on OPTera Metro 3500 are used to offer OE-PL service.

### **2x100BT-P2P circuit pack**

The 2x100BT-P2P circuit pack has the following functionality:

- Dedicated private point-to-point Layer 1 connectivity using standard STS-1 or STS-3c connections
- Same look and feel as other OPTera Metro 3500 TDM tributaries such as DS3 or EC-1
- 2 x 10/100 LAN ports independently configurable as 10BASE-T or 100BASE-TX
- Capability to interconnect back-to-back the Ethernet interfaces of the 2x100BT cards
- Network protection using UPSR, BLSR, and 1+1 linear
- Fully managed through Site Manager (does not support SNMP/ BCC as in the case of OPE circuit packs)
- Ethernet and WAN Operational Measurements

**Note:** The 2x100BT-P2P circuit pack only supports far-end link conditioning at 100 Mb/s (100BASE-TX).

The 2x100BT-P2P circuit pack separately maps two 10/100BASE-T ports into STS-1/STS-3c SONET signals for transport across a SONET domain. The 2x100BT-P2P circuit pack has two logical sides to its interface: the LAN side, which contains the Ethernet ports; and the WAN side, which interfaces with the STX and VTX-series circuit packs at the SONET level. Four MAC addresses are allocated for each 2x100BT-P2P circuit pack.



There is no flow control support on the LAN and the WAN, and no policing and shaping is performed. Received PAUSE frames are discarded or passed through, depending on the value of the PASSCTRL attribute. By default, PAUSE frames are discarded.

### **PPP over SONET**

The Point-to-Point Protocol (PPP) was designed as a standard method of communicating over point-to-point links. PPP is defined in RFC 1661 and RFC 1662. RFC 2615 specifies POS (PPP over SONET/SDH), the method for encapsulating PPP in SONET. PPP is comprised of three main components:

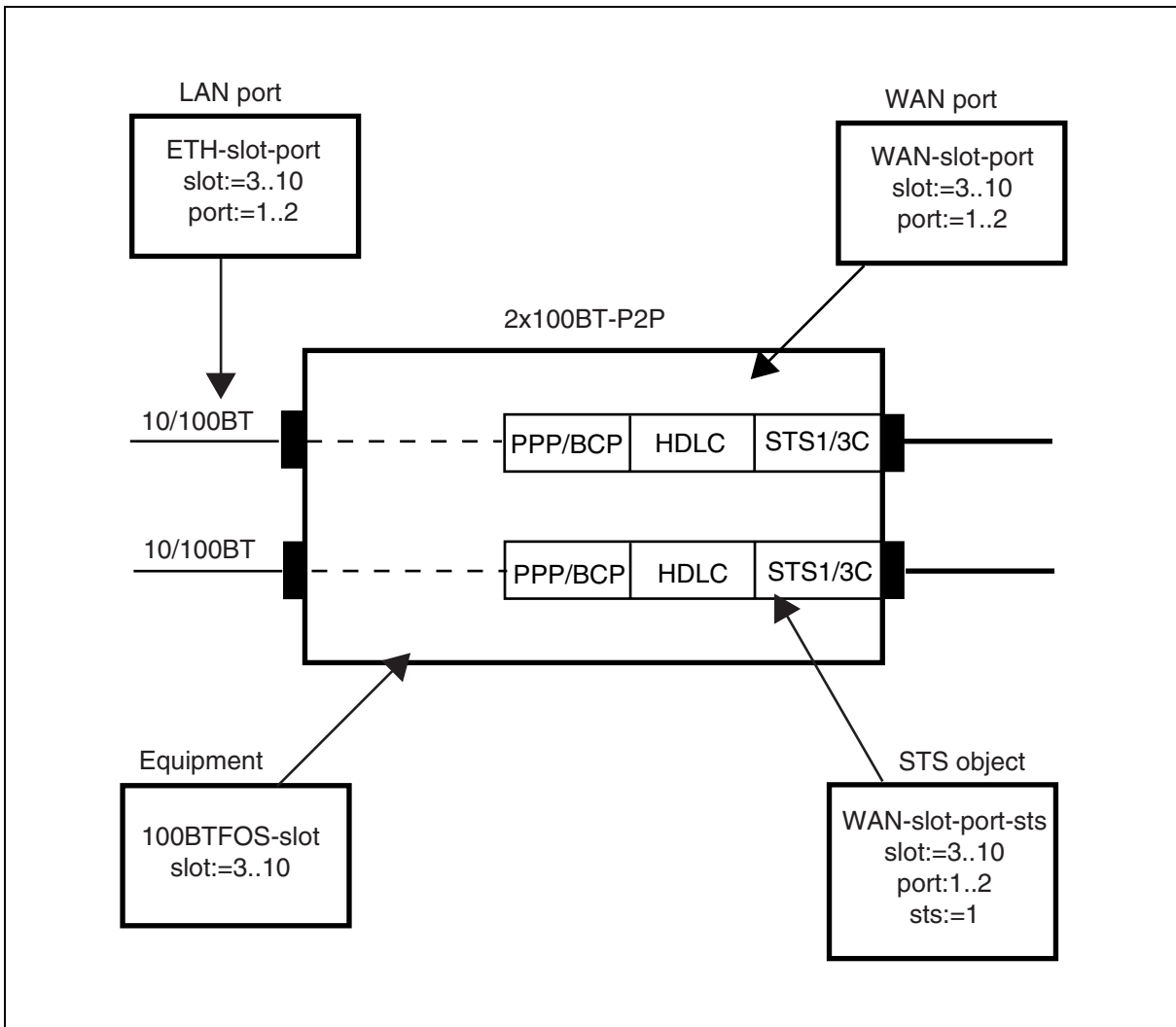
- A method for encapsulating multi-protocol datagrams.
- A Link Control Protocol (LCP) for establishing, configuring, and testing the data-link connection.
- A family of Network Control Protocols (NCPs) for establishing and configuring different network-layer protocols.

### **PPP and HDLC**

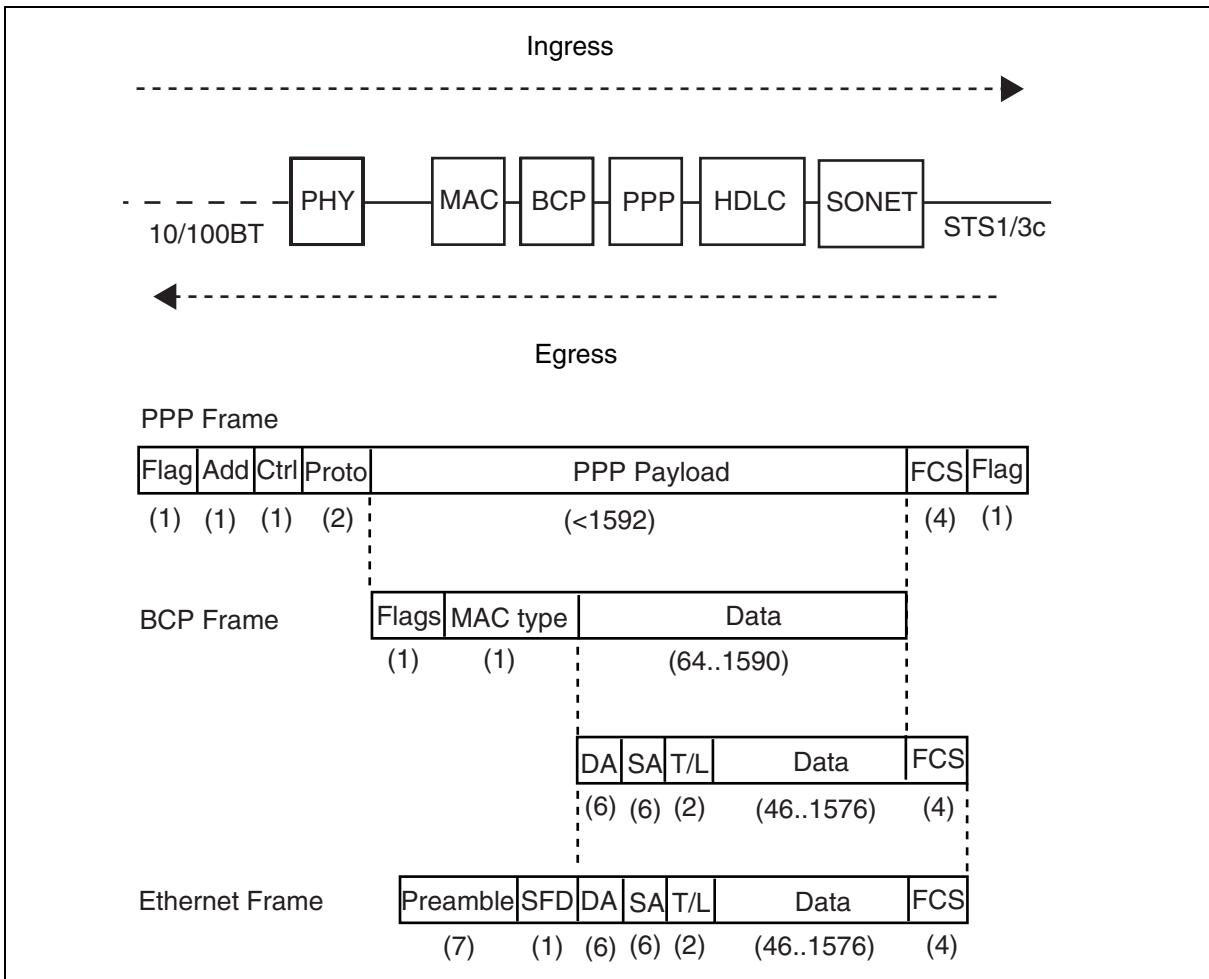
PPP is built from a subset of the standard HDLC protocol. HDLC supports configurable 'Address' and 'Control' fields but PPP is restricted to fixed values in the 'Address' and 'Control' fields. For an illustration of the PPP packet format, please see [Figure 2-35 on page 2-69](#).

The Information Field of the PPP frame will have a maximum size of 1592 bytes.

**Figure 2-34**  
**2x100BT-P2P circuit pack model**



**Figure 2-35**  
**2x100BT-P2P logical datapath overview**



### Bridge Control Protocol

The Bridge Control Protocol (BCP) is negotiated when packets for transport are Ethernet. BCP is responsible for configuring, enabling and disabling the bridge protocol modules on both ends of the link. Negotiation of BCP will not start until LCP negotiation has been completed and the NCP negotiation phase has been reached.

### Network protection using UPSR, 1+1 linear and BLSR

Bandwidth management refers to the method in which the signal from the 100BT-P2P card interfaces with the OPTera Metro 3500 SONET paths. Generally an STS connection is formed between the 2x100BT-P2P circuit pack and another circuit pack on the shelf.

When connecting to OCn circuit packs, the following protection schemes supported by the OCn circuit pack can be used.

- UPSR: 2WAY (unprotected), 2WAYPR, 1WAY (unprotected), 1WAYPR
- 1+1 linear: 1WAY, 2WAY

*Note:* 1WAY protection schemes support another 1WAY connection to travel back from the same circuit pack.

- BLSR: 2WAY (protected), 2WAYPR(for interconnecting BLSR or UPSR rings)

### **OAMP support**

Similar to traditional TDM service, the following features are supported:

- Connection Identifier (CID) is supported.
- STS1 and STS3c path trace are supported.

### **Ethernet Operational Measurements**

The Ethernet Operational Measurements collected by the 2x100BT-P2P circuit packs can be divided into two groups: Generic Interface Operational Measurements (based on the Interfaces Group MIB, RFC 1213, RFC 2233, RFC 2863) and Ethernet Specific Operational Measurements (based on RFC 2665 Ethernet-Like MIB).

The 2x100BT-P2P circuit packs collect Generic Interface Operational Measurements (Generic Interface OMs) which contain a set of counters not specific to any interface type. It is also used for the WAN side of the card. It consists of 64 bit octet and packet counters for all interface speeds. The counters are combined for unicast, multicast, and broadcast packets.

[Table 2-16 on page 2-91](#) defines the generic interface Operational Measurements (OM) for LAN interface supported on the 2x100BT-P2P a circuit pack.

[Table 2-17 on page 2-92](#) defines the generic interface Operational Measurements (OM) for WAN interface supported on the 2x100BT-P2P circuit packs.

[Table 2-18 on page 2-93](#) defines the Ethernet specific Operational Measurements (OM) supported by the 2x100BT-P2P circuit packs

*Note:* Dribble bit errors are not counted.

For a description of the 2x100BT-P2P circuit pack, see [2x100BT-P2P circuit pack on page 3-91](#).

## Optical Ethernet-Private Line (OE-PL) service using 2x1000 SX/LX OPE circuit packs

OPTera Metro 3500 allows you to provision 2xGigE circuit packs in a point-to-point configuration using only SONET interfaces. You first use the ED-SYS TL1 command to specify 2xGigE point-to-point mode for each shelf involved in the configuration. When a 2xGigE circuit pack is provisioned on the shelf (either manually or by installing the circuit pack in a valid and unprovisioned slot), the circuit pack is automatically configured with the data parameters required to enable point-to-point mode. The point-to-point configuration is established by provisioning a Resilient Packet Ring (RPR) cross-connect between the two circuit packs in point-to-point mode across a ring (UPSR or BLSR). You can provision the RPR cross-connect through TL1 or through Site Manager.

The following lists the data parameters of a 2xGigE circuit pack that are auto-provisioned when point-to-point mode is enabled:

- The CPU port of the circuit pack is set to Optical Ethernet layer 2 (OE/L2) mode, configured with a default gateway address of 0.0.0.0, and configured with an IP address of 10.a.b.c., where a.b.c. are the three least significant bytes of the CPU port media access control (MAC) address
- LAN port 1 is set to OE/L2 mode and configured with an IP address of 10.a.b.c+1, where a.b.c. are the three least significant bytes of the CPU port MAC address
- LAN port 1 is configured as a transparent user-to-network interface (UNI) port with a transparent domain identifier (TDI) of 100
- TDI 100 on LAN port 1 is enabled and set to a connectivity type of point-to-point
- LAN port 1 is enabled
- Token bucket is disabled on LAN port 1. Flow control is therefore based on WAN bandwidth. See the *OPTera Packet Edge System Planning Guide* (NTN465YG) for more information.
- The IEEE 802.1p priority mapping for TDI 100 on LAN port 1 is disabled, that is, set to 0:0:0:0:0:0:0

**Note 1:** All other data parameters are unchanged from their default values. In particular, auto-negotiation is enabled, pause frames are enabled, and LAN port 2 is disabled. Refer to the *OPTera Packet Edge System User Guide* (NTN465YG) for a list of default settings.

**Note 2:** A 2xGigE circuit pack auto-provisioned for point-to-point mode operates in the same way as any other 2xGigE circuit pack. For example, you can change any data parameter of the circuit pack using the existing

interfaces for data management, such as the Bay Command Console command line interface (BCC CLI) and Simple Network Management Protocol (SNMP).

### **Distributed multilink trunking**

OPTera Metro 3500 supports network-to-network interface (NNI) redundancy through trunk groups. A trunk group is a logical group of two NNI ports in the same ring that are on separate 2xGigE circuit packs. Ports in a trunk group share traffic according to a hashing algorithm. In case of a failure on one port in a trunk group, all traffic is switched to the other port until the failure clears. Trunk groups enable redundancy between Resilient Packet Rings (RPR) by providing two NNI links between RPRs instead of one. The extra NNI link protects traffic between rings.

For more information, see:

- *OPTera Packet Edge System Planning Guide*, NTRN10YK
- *OPTera Packet Edge System User Guide*, NTN465YG

### **Bandwidth Reservation Protocol (BRP)**

OPTera Packet Edge rings support a bandwidth reservation protocol (BRP) algorithm that allows you to provision a guaranteed bandwidth rate, called the reserved rate, for each node in the ring. The BRP algorithm attempts to provide access to the ring at or above the reserved rate of the node. The BRP algorithm works by sending credit packets from a source node to a downstream node when the source node is exceeding its reserved rate such that the downstream node cannot access the ring at its reserved rate. The credit packets are dropped by the downstream node, creating "holes" (gaps in the data stream) that allow the downstream node to increase the rate at which it adds traffic to the ring. The source node sends enough credit packets to allow the downstream node to access the ring at or above its reserved rate.

For more information about OPTera Packet Edge services, see:

- [OPTera Packet Edge System \(Resilient Packet Ring\) - Ethernet on page 2-62](#)
- *OPTera Packet Edge System Planning Guide*, NTRN10YK
- *OPTera Packet Edge System OPTera Metro 3000 User Guide*, NTN465YG

### **1024 TDIs on a mapped UNI**

You can have up to 1024 TDI values for each 2xGigE circuit pack and up to 256 TDI values for each port of the 4x100BT or 4x100FX circuit pack. You can configure up to 1024 TDI to VLAN ID mappings for each circuit pack. You must limit the number of mappings on each port of the 4x100BT or 4x100FX circuit pack to 256. On the 2xGigE circuit pack, there is no limit to the number of mappings on a port, as long as the total number of mappings on both ports does not exceed 1024.

For more details, see the

- *OPTera Packet Edge System Planning Guide*, NTRN10YK
- *OPTera Packet Edge System User Guide*, NTN465YG

## Optical Ethernet - Private Line (OE-PL) and Storage applications

OPTera Metro 3500 supports efficient point-to-point Ethernet services and Fibre Channel Storage Area Network Extension services with the introduction of a new 2xGigabit Ethernet/Fibre Channel- Point-to-Point (2xGigE/FC-P2P) circuit pack and through the Generic Framing Procedure (GFP) and Virtual Concatenation (VCAT) standards.

**Note:** For information on GFP and VCAT, please refer to [Generic Framing Procedure and Virtual Concatenation support on page 2-99](#).

### 2xGigE/FC-P2P circuit pack

The 2xGigE/FC-P2P circuit pack provides cost-efficient and flexible transport of “leased line” type services across an OPTera Metro 3500 and/or SONET network. The 2xGigE/FC-P2P circuit pack also provides 2 independent LAN ports allowing for transport of Gigabit Ethernet or Fibre Channel signals across a SONET network where the traffic can be groomed, switched and monitored by the network.

The 2xGigE/FC-P2P circuit pack circuit pack supports the following features:

- 2 LAN ports independently configurable as Gigabit Ethernet or Fibre Channel
  - each LAN port can be configured to Gigabit Ethernet, or
  - each LAN port can be configured to Fibre Channel (FC100)/FICON, or
  - one LAN port configured Gigabit Ethernet and the other to Fibre Channel (FC100)/FICON
- Ethernet Services - dedicated private point-to-point layer 1 transport
- Fibre Channel Services - dedicated private point-to-point layer 1 transparent transport (full-rate or sub-rate extended reach)
- Network connectivity
  - SONET contiguous (STS-1, STS-3c, STS-12c and STS24c)
  - Virtual concatenation (STS-1-nv, n = 1 through 21 or STS-3c-nv, n = 1 through 7)
- Generic Framing Procedure - Frames (GFP-F) of Ethernet frames into SONET
- Generic Framing Procedure - Transparent (GFP-T) encapsulation of Fibre Channel frames into SONET
- Network protection using UPSR, BLSR, and 1+1 linear

- Fully managed through Site Manager (does not support SNMP/ BCC as in the case of OPE circuit packs)
- Ethernet, WAN and Fibre Channel Operational Measurements (OMs) and Performance Monitoring (PMs)
- Supports auto-negotiation, flow control and jumbo frame (9600 bytes) on the Ethernet LAN port(s)
- Supports Small Form-factor Pluggable (SFP) optical interface offering 1000Base-SX(850 nm), 1000Base-LX (1310nm) and 1000Base-ZX (1550nm) reaches

The 2xGigE/FC-P2P circuit pack complies with the following industry standards and recommendations:

- ITU-T Draft New Recommendation G.7041, Generic Framing Procedure (GFP)
- ITU-T Draft Revised Recommendation G.707, Network node interface for SDH
- ANSI X3.230-1994 Fibre Channel Physical and Signalling Interface (FC-PH) and for FC-0 (Physical) and FC-1 (Transmission protocol) layers

*Note:* 2xGigE/FC-P2P circuit pack does not adhere to the Fibre Channel Arbitrated Loop (FC-AL) standard and therefore does not support Fibre Channel Arbitrated Loop devices.

### **Alarm management**

The following section describes new alarms specific to the 2xGigE/FC-P2P. For a detailed description of alarms and clearing procedures, refer to OPTera Metro 3500 Release 12.0 Alarm and Trouble Clearing NTPs (323-1059-543.1 and 323-1059-543.2).



**Equipment alarms**

The 2xGigE/FC-P2P circuit pack supports the standard OPTera Metro 3500 equipment alarms. [Table 2-9 on page 2-75](#), lists the 2xGigE/FC-P2P configuration and equipment alarms.

**Table 2-9**  
**2xGigE/FC-P2P configuration and equipment alarms**

Alarm	Description	Severity
Configuration mismatch	This alarm is raised when: <ul style="list-style-type: none"> <li>the circuit pack is inserted into an unprovisioned empty odd slot and the mate even slot has been provisioned for a incompatible service.</li> </ul>	Minor, non-service affecting, (mn,nsa)
Autoprovisioning mismatch	This alarm is raised when: <ul style="list-style-type: none"> <li>a circuit pack is inserted into a shelf that does not support that specific type of circuit pack</li> </ul>	Minor, non-service affecting, (mn,nsa)
Circuit Pack Unknown	This alarm is raised in the following situations: <ul style="list-style-type: none"> <li>when the on-board processor of a circuit pack cannot communicate with the shelf processor after you insert the circuit pack into the shelf</li> <li>when an unknown circuit pack is inserted into an unprovisioned slot</li> <li>when a circuit pack is in the wrong slot</li> </ul>	Minor, non-service affecting, (mn,nsa)
Circuit Pack Missing	This alarm is raised when the following occurs: <ul style="list-style-type: none"> <li>circuit pack is not in the designated slot</li> <li>circuit pack failure makes the circuit pack undetectable</li> </ul>	Critical, service affecting (C,SA) Minor, non service affecting, (mn,nsa) See <a href="#">Note</a>
Circuit Pack Mismatch	This alarm is raised when one of the following conditions apply: <ul style="list-style-type: none"> <li>circuit pack is in a slot provisioned for a circuit pack of another type</li> <li>PSX is inserted before the PSC</li> </ul>	Critical, service affecting (C,SA) Minor, non service affecting, (mn,nsa) See <a href="#">Note</a>
Circuit Pack Fail	This alarm is raised in the following situation: <ul style="list-style-type: none"> <li>the trouble detection circuits of a circuit pack detect a failure on the module</li> </ul>	Critical, service affecting (C,SA) Minor, non service affecting, (mn,nsa) See <a href="#">Note</a>

**Table 2-9 (continued)**  
**2xGigE/FC-P2P configuration and equipment alarms**

<b>Alarm</b>	<b>Description</b>	<b>Severity</b>
Intercard Fail	This alarm is raised when the shelf processor or the circuit pack reports communications bus failures (clock, parity, or interprocess communication)	Critical, service affecting (C,SA) Minor, non service affecting, (mn,nsa) See <a href="#">Note</a>
Intercard Suspected	This alarm is raised when the shelf processor or the circuit pack reports suspected communications bus (clock, parity, or interprocessor communication) failures.	Minor, non service affecting, (mn,nsa)
<b>Note:</b> The severity of the alarm becomes a minor, non-service affecting (mn, nsa) if there are no connections provisioned on the card.		

**Small Form Factor Pluggables (SFP) alarms**

Table 2-10 on page 2-77, lists equipment alarms associated to the small form factor pluggables (SFP) modules.

**Table 2-10**  
**Small Form Factor Pluggable (SFP) alarms**

Alarm	Description	Severity
Circuit Pack Missing - Pluggable	This alarm is raised when a provisioned Small Form Factor Pluggable (SFP) optical transceiver module is not physically installed in the 2xGigE/FC-P2P circuit pack.	Critical, service affecting (C,SA) Minor, non service affecting, (mn,nsa) See <a href="#">Note</a>
Circuit Pack Mismatch - Pluggable	This alarm is raised when an unsupported Small Form Factor Pluggable (SFP) optical transceiver module is installed in a provisioned subslot on a 2xGigE/FC-P2P circuit pack.	Critical, service affecting (C,SA) Minor, non service affecting, (mn,nsa) See <a href="#">Note</a>
Circuit Pack Unknown - Pluggable	This alarm is raised when an unsupported Small Form Factor Pluggable (SFP) optical transceiver module is installed in a unprovisioned subslot of a 2xGigE/FC-P2P circuit pack.	Critical, service affecting (C,SA) Minor, non service affecting, (mn,nsa) See <a href="#">Note</a>
Circuit Pack Fail - Pluggable	This alarm is raised when a Small Form Factor Pluggable (SFP) optical transceiver module provisioned on a 2xGigE/FC-P2P circuit pack fails.	Critical, service affecting (C,SA) Minor, non service affecting, (mn,nsa) See <a href="#">Note</a>
<b>Note:</b> The severity of the alarm becomes a minor, non-service affecting (mn, nsa) if there are no connections provisioned on the card.		

**Ingress LAN port alarms**

Table 2-11 on page 2-78, lists the ingress LAN port alarms which apply to both the Ethernet and Fibre Channel.

Figure 2-36 on page 2-80, provides a graphical representation of the ingress LAN port alarms.

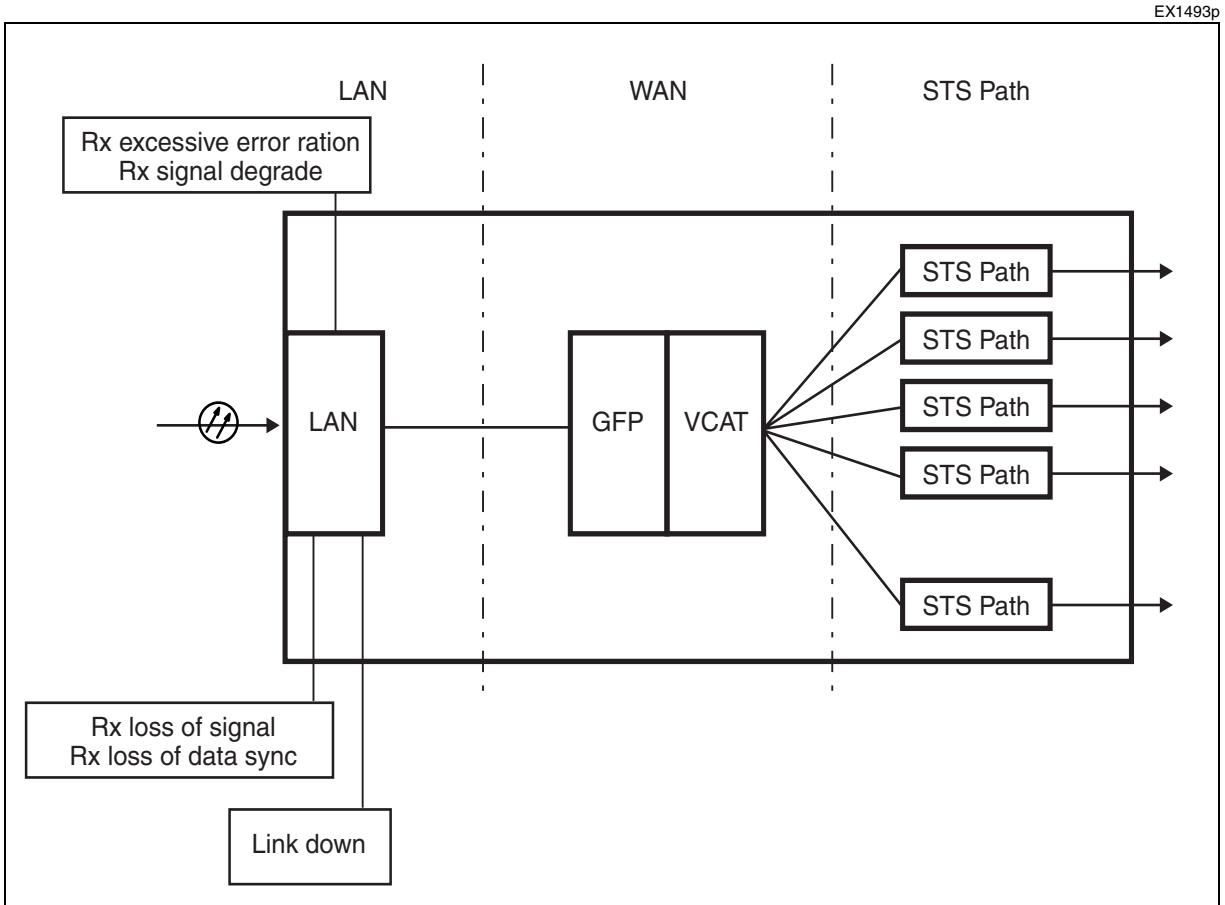
**Table 2-11**  
**Ingress LAN port alarms**

Alarm	Description	Severity
Rx Loss of signal	This alarm is raised against the LAN port on a 2xGigE/FC-P2P circuit pack when the circuit pack cannot detect an input signal.	Critical, service affecting (C,SA)
Rx Loss of data Sync (See <a href="#">Note 1</a> )	<p>This alarm is raised against the LAN port of the 2xGigE/FC-P2P circuit pack when one of the following conditions occurs:</p> <ul style="list-style-type: none"> <li>• the circuit pack cannot establish bit synchronization or transmission word synchronization</li> <li>• the Small Form Factor Pluggable (SFP) optical transceiver module is the wrong type (SX or LX)</li> <li>• the client service provisioned on the subtending transmit equipment does not match the client service provisioned on the 2xGigE/FC-P2P circuit pack</li> </ul>	Critical, service affecting (C,SA)
Link Down	<p>This alarm is raised against the <b>LAN Ethernet</b> port when one of the following conditions occurs:</p> <ul style="list-style-type: none"> <li>• auto-negotiation between the 2xGigE/FC-P2P circuit pack and the local link partner does not complete successfully</li> <li>• auto-negotiation is enabled on the 2xGigE/FC-P2P circuit pack but is disabled on the local link partner</li> <li>• the administrative state of the LAN port on a 2xGigE/FC-P2P circuit pack is up but the operating state of the port is down</li> </ul> <p>This alarm is raised against the <b>LAN Fibre Channel</b> port when the Fibre Channel link state is not active.</p>	Critical, service affecting (C,SA)
Rx Signal Degrade	<p>This alarm is raised against the LAN port when the following occurs:</p> <ul style="list-style-type: none"> <li>• For <b>Ethernet facilities</b>, this alarm is raised when at least 1 percent of the received frames are errored per second, for 3 consecutive seconds.</li> <li>• For <b>Fibre Channel facilities</b>, this alarm is raised when at least one symbol or disparity error occurs per second, for 3 consecutive seconds.</li> </ul>	Minor, service affecting (mn,SA)

**Table 2-11 (continued)**  
**Ingress LAN port alarms**

Alarm	Description	Severity
Rx Excessive Error ratio	<p>This alarm is raised against the LAN port when one of the following conditions occurs:</p> <ul style="list-style-type: none"> <li>• For <b>Ethernet facilities</b>, this alarm is raised when at least 20 percent of the received frames are errored per second, for 3 consecutive seconds.</li> </ul> <p>For <b>Fibre Channel facilities</b>, this alarm is raised when at least 20 percent of the received 8B/10B codes are errored (including symbol or disparity errors) per second, for 3 consecutive seconds.</p>	Major, service affecting (Mj,SA)
Ethernet Loopback Active	This alarm is raised when a user executes a loopback command on an Ethernet facility of a 2xGigE/FC-P2P circuit pack. The alarm notifies other users that a loopback is active.	Minor, non service affecting, (mn,nsa)
Fibre Channel Loopback Active	This alarm is raised when a user executes a loopback command on a Fibre Channel facility of a 2xGigE/FC-P2P circuit pack. The alarm notifies other users that a loopback is active.	Minor, non service affecting, (mn,nsa)
<p><b>Note 1:</b> When connected to a pair of Fibre Channel devices that support the auto negotiation (AN) of 1G and 2G link speeds, the speed of the ports connected to the 2xGigE/FC -P2P card must be manually set to 1G (FC-100).</p> <p><b>Note 2:</b> 2xGigE/FC-P2P circuit pack does not adhere to the Fibre Channel Arbitrated Loop (FC-AL) standard and therefore Fibre Channel Arbitrated Loop devices are not supported.</p>		

**Figure 2-36**  
**LAN Ingress Alarms**



**Egress WAN port and service alarms**

[Table 2-12 on page 2-81](#), lists the egress WAN port and service alarms which apply to both the WAN and STS Path.

[Figure 2-37 on page 2-84](#), provides a graphical representation of the egress WAN port and service alarms.

**Table 2-12**  
**Egress WAN port and service alarms**

Alarm	Description	Severity
STS Rx Loss of Multiframe	This alarm is raised when the multiframe indicator for an STS member of a virtually concatenated group cannot be located. This alarm is raised against an STS that connects to the WAN port of a 2xGigE/FC-P2P circuit pack.	Critical, service affecting (C, SA)
STS Rx Loss of Sequence	This alarm is raised when the received sequence number of an STS in a virtually concatenated group does not match the expected sequence number. This alarm is raised against an STS that connects to the WAN port of a 2xGigE/FC-P2P circuit pack.	Critical, service affecting (C, SA)
STS Rx Loss of Alignment	This alarm is raised when the STS members in a virtually concatenated group cannot be aligned because of excessive differential delay between the STS members. This alarm is raised against the slowest STS in the virtually concatenated group that connects to the WAN port of a 2xGigE/FC-P2P circuit pack.	Critical, service affecting (C, SA)
Rx Loss of Frame Delineation	This alarm is raised against the WAN port of a 2xGigE/FC-P2P circuit pack when the GFP layer cannot detect valid GFP frames.  This alarm only applies to GFP-T and GFP-F mapping	Critical, service affecting (C, SA)
Insufficient Link Capacity	This alarm is raised against the WAN port on the 2xGigE/FC-P2P circuit pack when the bandwidth assigned to the WAN port is insufficient to carry the provisioned Fibre Channel service. This alarm is applicable to full-rate Fibre Channel service.  Full-rate Fibre Channel service requires: <ul style="list-style-type: none"> <li>• STS-24c of bandwidth for concatenated signals</li> <li>• STS1-19v or STS3c-6v of bandwidth for virtually concatenated signals</li> </ul> This alarm applies only when the service is FC100 or FICON with SUBRATE=DISABLE.	Critical, service affecting (C, SA)

**Table 2-12 (continued)**  
**Egress WAN port and service alarms**

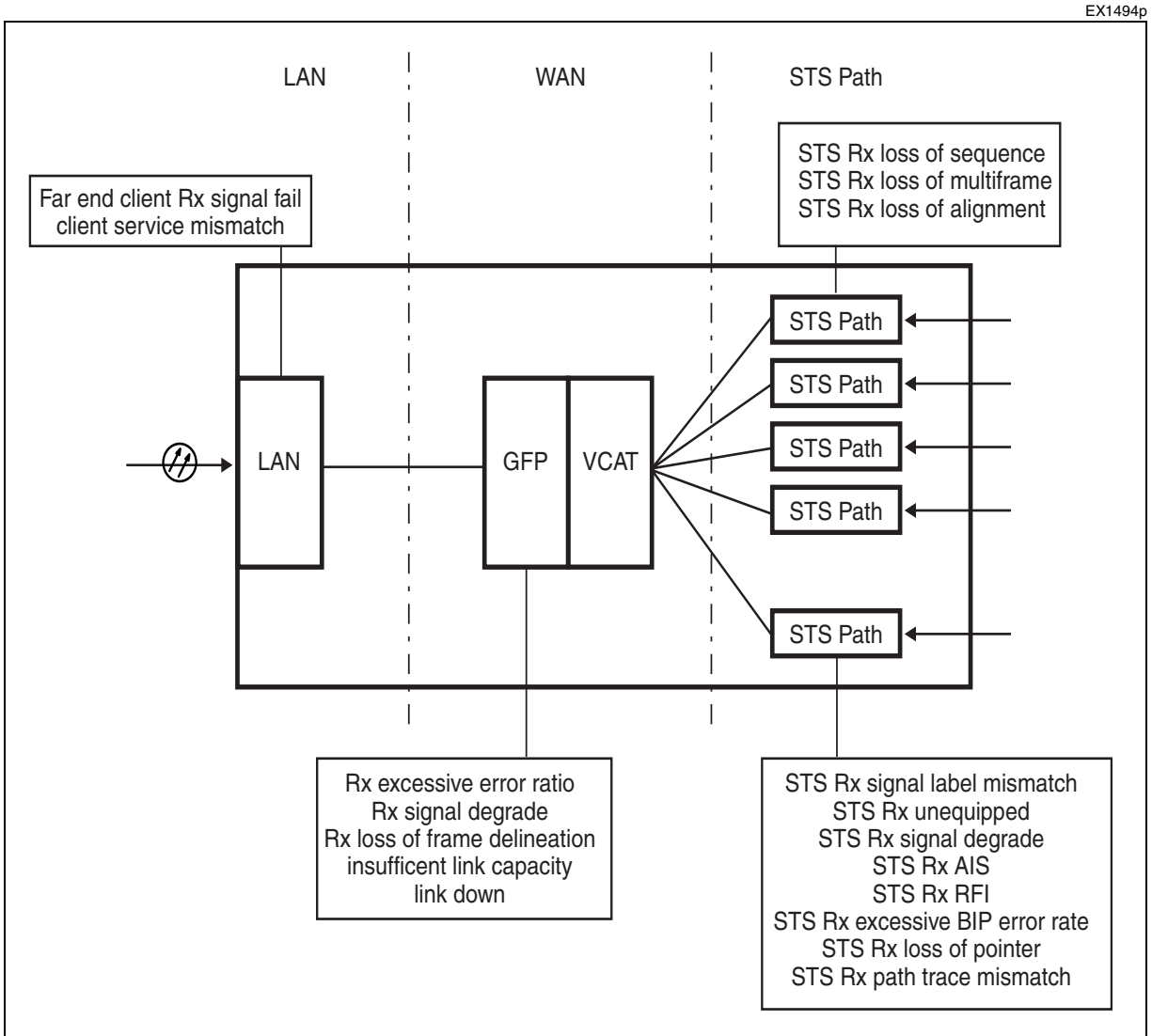
Alarm	Description	Severity
Link Down (See <a href="#">Note</a> )	This alarm is raised against the WAN port when the administrative state of the WAN port on a 2xGigE/FC-P2P circuit pack is up but the operating state of the port is down.	Critical, service affecting (C, SA)
Rx Signal Degrade	This alarm is raised against the WAN port when the following occurs: <ul style="list-style-type: none"> <li>• For GFP-F, this alarm is raised when at least 1 percent of the received frames are errored per second, for 3 consecutive seconds.</li> <li>• For GFP-T, this alarm is raised when at least 1 percent of the received superblocks are errored per second, for 3 consecutive seconds.</li> </ul>	Minor, service affecting (mn,SA)
Rx Excessive Error ratio	This alarm is raised against the WAN port when one of the following conditions occurs: <ul style="list-style-type: none"> <li>• For GFP-F, this alarm is raised when at least 20 percent of the received frames are errored per second, for 3 consecutive seconds.</li> <li>• For GFP-T, this alarm is raised when at least 20 percent of the received superblocks are errored per second, for 3 consecutive seconds.</li> </ul>	Major, service affecting (Mj,SA)



**Table 2-12 (continued)**  
**Egress WAN port and service alarms**

Alarm	Description	Severity
Client Service Mismatch	This alarm is raised against the LAN port of a 2xGigE/FC-P2P circuit pack when one of the following conditions occurs: <ul style="list-style-type: none"> <li>• the client service provisioned on the remote 2xGigE/FC-P2P circuit pack does not match the client service provisioned on the local 2xGigE/FC-P2P circuit pack.</li> <li>• the Sub-rate and Extended reach parameters for a Fibre Channel facility are not provisioned to the same setting.</li> </ul>	Critical, service affecting (C, SA)
Far End Client Rx Signal Fail	This alarm is raised against a 2xGigE/FC-P2P circuit pack when a problem occurs at the far-end 2xGigE/FC-P2P circuit pack that terminates the service.	Critical, service affecting (C, SA)
<p><b>Note:</b> Refer to <a href="#">Gigabit Ethernet Drop and Continue</a> feature description for more details on this alarm. If the alarm is raised against the WAN port of 2xGigE/FC interface and no other WAN and/or SONET related alarms are active, the following must be performed to clear the alarm:</p> <ul style="list-style-type: none"> <li>— Delete all cross-connections to the WAN port</li> <li>— Delete the Ethernet facility (DLT-ETH)</li> <li>— Add the Ethernet facility (ENT-ETH)</li> <li>— Re-enter the unidirectional cross-connection(s)</li> </ul> <p>Refer to <i>Bandwidth Management</i>, 323-1059-320, <i>Equipment and Facility Provisioning</i>, 323-1059-350 and <i>Alarm and Trouble Clearing</i>, 323-1059-543.</p>		

**Figure 2-37**  
**Egress WAN port and service alarms**



**Bandwidth management**

The 2xGigE/FC-P2P circuit pack supports both contiguous and virtual concatenation bandwidth provisioning.

**Contiguous concatenation**

When the VCAT attribute in the WAN port is set to DISABLE, only one connection (STS-1, STS-3c, STS-12c or STS-24c) can be cross connected to a 2xGigE/FC-P2P WAN port.

- SONET contiguous (STS-1, STS-3c, STS-12c and STS24c)

**Virtual concatenation**

When the VCAT attribute in the WAN port is set to ENABLE, up to 7 STS3c or 21 STS1 connections can be cross connected to a 2xGigE/FC-P2P WAN port.

- STS-1-nv, n = 1 through 21 or,
- STS-3c-nv, n = 1 through 7

**Engineering rules**

The following engineering rules apply to the bandwidth management capabilities of the 2xGigE/FC-P2P circuit packs:

- When the VCAT attribute of the WAN port 1 and port 2 is set to DISABLE, if a STS1 granularity connection is made against one of these ports, the only valid connection that can be made against the other WAN port is STS1 connections.
- When the VCAT attribute of the WAN port 1 and port 2 is set to DISABLE, if an STS-nc (STS3c, STS12c or STS24c) connection is made against one of these ports, the only valid connection that can be made against the other WAN port is STS-nc connections.
- When the VCAT attribute of WAN port 1 and port 2 is set to ENABLE, both ports must have the same RATE attribute.

**Facility attributes**

The 2xGigE/FC-P2P circuit pack supports Ethernet, FC and WAN facilities.

**Ethernet facility**

[Table 2-13 on page 2-85](#), lists facility parameters supported by the 2xGigE/FC-P2P Ethernet port.

**Table 2-13**  
**2xGigE/FC-P2P Ethernet port facility signal attributes**

Signal Attribute	Definition	Values (See Note 1)	Access (see Note 2)
AN (Auto-Negotiation)	Auto-Negotiation	Enable, Disable	R/W
ANSTATUS (Auto-Negotiation Status)	Auto-Negotiation Status	InProgress, Completed, Disabled	R/O
ANETHDPX (Negotiated Duplex Operation)	Negotiated Duplex Operation, when AN is enabled	Full	R/O
ANSPEED (Negotiated Speed)	Negotiated speed, when AN is enabled	1000	R/O

**Table 2-13 (continued)**  
**2xGigE/FC-P2P Ethernet port facility signal attributes**

Signal Attribute	Definition	Values (See Note 1)	Access (see Note 2)
ADVETHDPX (LPA duplex)	Link partner advertised Duplex capabilities. Only valid when ANSTATUS is Completed.	Full, Unknown (See Note 3)	R/O
ADVSPEED (LPA speed)	Link partner advertised speed capabilities. Only valid when ANSTATUS is Completed.	1000, Unknown	R/O
ADVFLOWCTRL (LPA flow control)	Link partner advertised flow control capabilities. Only valid when ANSTATUS is Completed	None, Asym, Sym, Both, Unknown (See Note 4)	R/O
ETHDPX (Advertised duplex operation)	Advertised duplex operation capabilities indicates the advertised or current duplex capabilities.	Full	R/O
SPEED (Advertised link speed)	Advertised link speed (in Mb/s) capabilities if AN is enabled. IF AN is disabled, this indicates the current setting.	1000	R/O
PASSCTRL (Pass control frames)	Determines whether received pause control frames (T/L=8808) are passed transparently (ENABLE), or removed from the flow (DISABLE). Note that PAUSE frame is the only currently defined control frame. Other Ethernet control frames (for example, type 0x8809) are not affected by this attribute, and will always be transparently passed through.	Enable, <b>Disable</b>	R/W
ANPAUSERX (Negotiated pause receive)	Negotiated PAUSE receive, when AN is enabled.	Enable, Disable, Unknown (See Note 3)	R/O
ANPAUSETX (Negotiated pause transmit)	Negotiated PAUSE transmit, when AN is enabled.	Enable, Disable, Unknown (See Note 3)	R/O
FLOWCTRL (Advertised flow control)	Advertised flow control capabilities. Ignored if AN is disabled.	None, <b>Asym</b> , Sym (See Note 4)	R/W
PAUSETX (Pause transmission)	Controls PAUSE transmission when AN is disabled. Ignored when AN is enabled.	<b>Enable</b> , Disable (See Note 5)	R/W
PAUSERX (Pause reception)	Controls PAUSE reception when AN is disabled. Ignored when AN is enabled.	Disable	R/O

**Table 2-13 (continued)**  
**2xGigE/FC-P2P Ethernet port facility signal attributes**

Signal Attribute	Definition	Values (See Note 1)	Access (see Note 2)
MTU (Maximum Transfer Unit)	Maximum Ethernet frame size supported. Packets above the MTU will be dropped and counted (LAN ingress) or truncated and sent with CRC error (WAN ingress).	<b>1600</b> , 9600	R/W
PHYSADDR (Ethernet MAC address)	Ethernet MAC address. Used as SA in PAUSE frames.	48-bit value	R/O
PAUSERXOVERRIDE (Pause Receive Override)	When auto-negotiation is enabled, the Pause Receive Override is used to override (disable) the negotiated PAUSE receive.	Enable	R/O

**Note 1:** Values in **bold** indicate defaults.  
**Note 2:** R/O = Read Only, R/W = Read & Write (provisionable)  
**Note 3:** When auto-negotiation is Disabled or In Progress, the attributes return Unknown.  
**Note 4:** Asym = Pause frames sent only, Sym = Pause frames sent and received.  
**Note 5:** For Gigabit Ethernet unidirectional drop and continue connections, at the "drop" nodes, if auto-negotiation (AN) is disabled, PAUSETX should be set to DISABLE. If auto-negotiation (AN) is enabled, FLOWCTRL should be set to "NONE". the 2xGigE/FC interface may cause PAUSE frames (if PAUSE TX = Enabled) to be transmitted if valid Ethernet frames are received by the "drop" nodes.

#### Fibre Channel facility

[Table 2-14 on page 2-87](#), lists facility parameters supported by the 2xGigE/FC-P2P Fibre Channel LAN port.

**Table 2-14**  
**2xGigE/FC-P2P Fibre Channel port signal attributes**

Signal Attribute	Definition	Values (See Note 1)	Access (see Note 2)
SUBRATE (Subrate) (See Note 4)	Indicates whether the service can be carried over a sub-rate bandwidth.	<b>Disable</b> , Enable	R/W
EXTREACH (Extend reach) (See Note 3 & Note 4)	Indicates whether the extended reach mode of operation is used or not.	<b>Disable</b> , Enable	R/W
SERVICE (Service)	Indicates which service is carried	<b>FC100</b> , FICON	R/W

**Table 2-14 (continued)**  
**2xGigE/FC-P2P Fibre Channel port signal attributes**

Signal Attribute	Definition	Values (See Note 1)	Access (see Note 2)
BBCOVERRIDE (BBC override)	Use this BBC value instead of the snooped (non-intrusively monitored) value (BBC). A value of 0 means to use the snooped (non-intrusively monitored) value (BBC). Only applicable when EXTREACH=ENABLE. Only required if directly connecting F or N-ports (e.g. Fibre Channel Host (HBA), Disk array) to the 2xGE/FC -P2P card. When connecting FC switch E-ports, the BBC value will be snooped (non-intrusively monitored) (i.e. default value of 0 disables Override).	0, 1, 2, 4, 8, 16, 32, 64, 128, 256	R/W
FCLINKSTATE (Link State)	Indicates the current FC Link State (snooped (non-intrusively monitored)). These correspond to the standard FC link states (as per FC-PH). Only available when EXTREACH=ENABLE (UNKNOWN returned when EXTREACH=DISABLE).	Active, LinkRecovery, LinkFailure, Offline, Unknown	R/O
BBC (Buffer-to-Buffer credit)	Snooped (non-intrusively monitored) Buffer-to-Buffer Credit. Only available when EXTREACH=ENABLE (UNKNOWN returned when EXTREACH=DISABLE).	1..255, Unknown (See Note 5)	R/O
<p><b>Note 1:</b> Values in <b>bold</b> indicate defaults.</p> <p><b>Note 2:</b> R/O = Read Only, R/W = Read &amp; Write (provisionable).</p> <p><b>Note 3:</b> Refer to <a href="#">Table 2-20 on page 2-98</a>, for list of supported distances</p> <p><b>Note 4:</b> Both the Subrate and Extreach attributes must have the same values. Both attributes must be either enabled or disabled. If these values are not identical for both of these attributes, the "Client Service Mismatch" alarm is raised.</p> <p><b>Note 5:</b> "Unknown" will be displayed when EXTREACH = DISABLE or BBC value is greater than 255.</p>			

**WAN facility**

[Table 2-15 on page 2-89](#), lists facility parameters supported by the 2xGigE/FC-P2P WAN interface.

**Table 2-15**  
**2xGigE/FC-P2P WAN port signal attributes**

Signal Attribute	Definition	Values (See Note 1)	Access (see Note 2)
RATE (Basic rate)	Is used to indicate the basic rate assigned to that facility.	None, STS1, STS3C, STS12C, STS24C	R/O
PROVUNITS (Bandwidth units)	Is used to indicate the number of provisioned bandwidth units in the SONET/SDH transmit direction. The unit is specified by the RATE attribute. Possible values when VCAT=ENABLE are 0..7 (when RATE is STS3c) or 0..21 (when RATE is STS1).	Possible values when VCAT=DISABLE are 0 or 1. Possible values when VCAT=ENABLE are 0..7 (when RATE is STS3c) or 0..21 (when RATE is STS1).	R/O
ACTUALUNITS (Units carrying traffic)	Is used to indicate the number bandwidth unit actually carrying traffic in the SONET/SDH transmit direction.	Possible values when VCAT=DISABLE, or VCAT=ENABLE and LCAS=DISABLE are either 0 or PROVXUNITS. It will return UNKNOWN is the card is not present in the shelf	R/O
MAGICNUM (Magic number) (See Note 6)	Enables or disables the use of a magic number to distinguish between two peers and detect error conditions. Can be used to determine whether trying to establish a link with one self.	Disable (See Note 3)	R/O
FCS (Frame checksum size) (See Note 6)	Size of the FCS to be used to transmit packets.	0, 32 (See Note 4)	R/W
LCM (Link connectivity monitor) (See Note 6)	Is used to control the Link Connectivity Monitor functionality.	Disable (See Note 3)	R/O
MAPPING (Mapping protocol) (See Note 6)	Client signal to SONET mapping protocol	GFP-F (default when LAN facility is Ethernet), GFP-T (default and only option when LAN facility is Fibre Channel)	R/W
MODE (Mode)	Identifies if the port operates in SONET or SDH mode.	Sonet, SDH	R/O
VCAT (Virtual Concatenation)	Indicates if Virtual Concatenation is enabled or not on this port. Can only be edited if there are no cross-connections.	Enable, <b>Disable</b> (See Note 5)	R/W

**Table 2-15 (continued)**  
**2xGigE/FC-P2P WAN port signal attributes**

Signal Attribute	Definition	Values (See Note 1)	Access (see Note 2)
LCAS (Link Capacity Adjustment Scheme)	Link Capacity Adjustment Scheme (applicable to virtual concatenation only).	Disable	R/O
SCRAMBLE (Scramble)	Enables X <sup>43</sup> +1 scrambler.	Enable	R/O
NCP (Network control protocol)	Indicates the Network Control Protocol used.	None	R/O
LANFCS (Encapsulated frame) (See Note 6)	Indicates whether the LAN FCS is included in the encapsulated frame (for both the ingress and egress direction). ENABLE indicates the LAN FCS is included.	Enable (See Note 3)	R/O
RTDELAY (Round trip delay)	Round trip delay (in microseconds). Only available when mapping is GFP-F or GFP-T.	0..220000, Unknown	R/O
<p><b>Note 1:</b> Values in <b>bold</b> indicate defaults.</p> <p><b>Note 2:</b> R/O = Read Only, R/W = Read &amp; Write (provisionable).</p> <p><b>Note 3:</b> For MAPPING=GFP-F or GFP-T, only possible value is ENABLE.</p> <p><b>Note 4:</b> For MAPPING=GFP-F possible values are 0 or 32. For MAPPING=GFP-T, only possible value is 0.</p> <p><b>Note 5:</b> If another WAN port is already created, the VCAT attribute defaults to the value of the existing WAN port.</p> <p><b>Note 6:</b> You must edit the mapping protocol, frame check sum size, magic number and link connectivity monitor attributes at the same time. The system rejects any invalid combination of values for these attributes.</p>			

### Ethernet Operational Measurements

The Ethernet Operational Measurements collected by the 2xGigE/FC-P2P circuit packs can be divided into two groups:

- Generic Interface Operational Measurements (based on the Interfaces Group MIB, RFC 1213, RFC 2233, RFC 2863).
  - Applies to all types of interfaces:
    - LAN (Ethernet, Fibre Channel)
    - WAN (GFP)
- Ethernet Specific Operational Measurements (based on RFC 2665 Ethernet-Like MIB).
  - Applies to Ethernet interfaces only.



The 2xGigE/FC-P2P circuit packs collect Generic Interface Operational Measurements (Generic Interface OMs) which contain a set of counters not specific to any interface type. It is also used for the WAN side of the card. It consists of 64 bit octet and packet counters for all interface speeds. The counters are combined for unicast, multicast, and broadcast packets.

[Table 2-16 on page 2-91](#) defines the generic interface Operational Measurements (OM) for LAN interface supported on 2xGigE/FC-P2P circuit packs.

[Table 2-17 on page 2-92](#) defines the generic interface Operational Measurements (OM) for WAN interface supported on 2xGigE/FC-P2P circuit pack.

*Note:* Dribble bit errors are not counted.

**Table 2-16**  
**Generic Interface Operational Measurements - LAN interface**

Counter	Definition	
	Ethernet	Fibre Channel (supported on 2xGigE/FC-P2P circuit pack)
INFRAMES (In frames)	All frames received (OK, errored, discarded, PAUSE, control, etc.).	Number of Class 2, 3 and framed F FC frames received
INFRAMESERR (In errored frames)	Frames received that contained a LAN FCS errors preventing them from being delivered. This includes fragments and jabbers, but excludes undersize and oversized frames.	NA
INFRAMESDISCDS (In discarded frames)	Valid frames received and discarded due to ingress buffer overflow.	Number of FC frames discarded due to ingress buffer overflow. (always 0 when EXTREACH/SUBRATE=DISABLE)
INOCTETS (In octets)	All data octets received on the interface (in good and errored frame). Includes DA/SA/TL/FCS for Ethernet. This measurement is incremented for valid-length unerrored frames only.	Octets received on the interface. (Rx Data bytes - (Rx Control *3) + INFRAMES*8 + Rx Symbol errors)
INOCTETSEERR (In errored octets)	NA	Rx Disparity errors + Rx Symbol errors
OUTFRAMES (Out frames)	Frames transmitted on this interface.	Number of Class 2, 3 and framed F FC frames transmitted.
OUTFRAMESERR (Out errored frames)	Frames that could not be transmitted because of errors or that were transmitted with errors.	NA

**Table 2-16 (continued)**  
**Generic Interface Operational Measurements - LAN interface**

Counter	Definition	
	Ethernet	Fibre Channel (supported on 2xGigE/FC-P2P circuit pack)
OUTFRAMESDISCDS (Out discarded frames)	NA	Number of FC frames discarded due to egress buffer overflow. (always 0 when EXTREACH/SUBRATE=DISABLE)
OUTOCTETS (Out octets)	Octets transmitted out of the interface. Includes DA/SA/TL/FCS for Ethernet.	Octets transmitted out of the interface (Tx Data bytes - Tx Control bytes*3) + OUTFRAMES*8 + Tx 10B_ERR.
OUTOCTETSERR (In errored octets)	NA	Number of 10B_ERR code transmitted.

**Table 2-17**  
**Generic Interface Operational Measurements - WAN interface**

Counter	Definition	
	GFP-F (Supported on 2xGigE/FC-P2P circuit pack)	GFP-T (Supported on 2xGigE/FC-P2P circuit pack)
INFRAMES	All client data frames received (including FCS/tHEC errors frames, but excluding Client Management Frames).	Number of superblocks received on this interface
INFRAMESERR (In errored frames)	Client data frames received that contained a payload FCS errors. Also includes frames received with an uncorrectable tHEC. Does not include cHEC errors.	Number of superblocks received that contain uncorrectable CRC-16 errors.
INFRAMESDISCDS (In discarded frames)	0	0
INOCTETS (In octets)	All data octets received on the interface (in good or errored frames). Includes GFP/HEC headers and payload FCS. Does not include octets from Client Management Frames (CMF)	NA
INOCTETSERR (In errored octets)	NA	NA
OUTFRAMES (Out frames)	Frames transmitted on this interface (excluding CMF).	Number of superblocks transmitted on this interface
OUTFRAMESERR (Out errored frames)	0	0

**Table 2-17 (continued)**  
**Generic Interface Operational Measurements - WAN interface**

Counter	Definition	
	GFP-F (Supported on 2xGigE/FC-P2P circuit pack)	GFP-T (Supported on 2xGigE/FC-P2P circuit pack)
OUTFRAMESDISCDS (Out discarded frames)	0	0
OUTOCTETS (Out octets)	Octets transmitted out of the interface. Includes GFP headers and payload FCS.	NA
OUTOCTETSERR (In errored octets)	0	NA

Table 2-18 on page 2-93 defines the Ethernet specific Operational Measurements (OM) supported by the 2xGigE/FC-P2P circuit pack. The 2xGigE/FC-P2P circuit pack supports full duplex mode only, all half duplex parameters will returned a value of “NA”

**Table 2-18**  
**Ethernet Specific Operational Measurements**

Name	Duplex	Definition
ALIGNERR (Align errors)	Both	The number of frames received that were not an integral number of octets in length and do not pass the FCS check. This parameter is not applicable to Gigabit Ethernet, as such is not supported by the 2xGigE/FC-P2P circuit pack. A value of “0” is always returned.
FCSERR (FCS errors)	Both	The number of frames received that were an integral number of octets in length and do not pass the FCS check.
SINGLECOLLFR (Single collision frames)	Half	The number of times frames were successfully transmitted after one collision. This parameter is not applicable to the 2xGigE/FC-P2P circuit pack, a value of “0” is always returned.
MULTICOLLFR (Multi collision frames)	Half	The number of times that frames were transmitted after multiple collisions (2 to 15 collisions of the frame). This parameter is not applicable to the 2xGigE/FC-P2P circuit pack, a value of “0” is always returned.
SQETESTERR (SQE Test Error)	Half	Count of times the SQE test error message is generated by the PLS sublayer. This parameter is not applicable to the 2xGigE/FC-P2P circuit pack, a value of “0” is always returned.

**Table 2-18 (continued)**  
**Ethernet Specific Operational Measurements**

Name	Duplex	Definition
DEFERTRANS (Delayed Transmission)	Half	Count of frames for which the first transmission attempt is delayed because the medium is busy. This parameter is not applicable to the 2xGigE/FC-P2P circuit pack, a value of "0" is always returned.
LATECOLL (Late Collision)	Half	Number of times that a collision is detected later than 512 bit-times into the transmission of a packet. This parameter is not applicable to the 2xGigE/FC-P2P circuit pack, a value of "0" is always returned.
EXCESSCOLL (Excess collisions)	Half	The number of times that frames failed to transmit because of excessive collisions (more than 15 collisions of the frame). This parameter is not applicable to the 2xGigE/FC-P2P circuit pack, a value of "0" is always returned.
INTERNALMACRXERR (Internal MAC Receive Error)	Both	Count of frames for which the reception fails because of an internal MAC sublayer receive error.
CARSENERR (Carrier Sense Error)	Half	Number of times that the carrier sense condition was lost or never asserted when attempting to transmit a frame. This parameter is not applicable to the 2xGigE/FC-P2P circuit pack, a value of "0" is always returned.
FRTOOLONGS (Frames too long)	Both	The number of frames received at the port that exceed 1518 bytes (and have valid FCS).
FRTOOSHORTS (Frames too short)	Both	The number of frames received at the port that are smaller than the allowed 64-byte frame size.
INTERNALMACTXERR (Internal MAC Transmit Error)	Both	Count of frames for which the reception fails because of an internal MAC sublayer transmission error.
SYMBOLERR (Symbol Error)	Both	Count of invalid data symbol (100M), or GMII Data reception error (1000M).
INPAUSEFR (In pause frames)	Full	The number of pause frames received at the port.
OUTPAUSEFR (Out pause frames)	Full	The number of pause frames transmitted by the port.

## Performance Monitoring

Performance monitoring (PM) refers to the in-service, non-intrusive monitoring of transmission quality. The 2xGigE/FC-P2P circuit pack will support the PM counts shown in [Table 2-19 on page 2-95](#). These counts will be monitored and binned for Ethernet and WAN signals.

Binning is supported for counts:

- 15 minute (current and previous 32)
- 1 day (current and previous)
- Untimed

Various counters are also binned:

- INFRAMES
- INFRAMESERR
- INFRAMESDISCDS
- OUTFRAMES

**Table 2-19**  
**Performance Monitoring Service counts**

PM parameter	Ethernet and WAN Interface	Fibre Channel
ES (Errored Seconds)	A second where at least one INFRAMESERR occurs	A second where at least one INOCTETERR occurs
SES (Severely Errored Seconds)	Seconds where INFRAMESERR/INFRAME > 0.01	Seconds where INOCTETSERR > 500
UAS (Unavailable Seconds)	Ten consecutive SES counts	

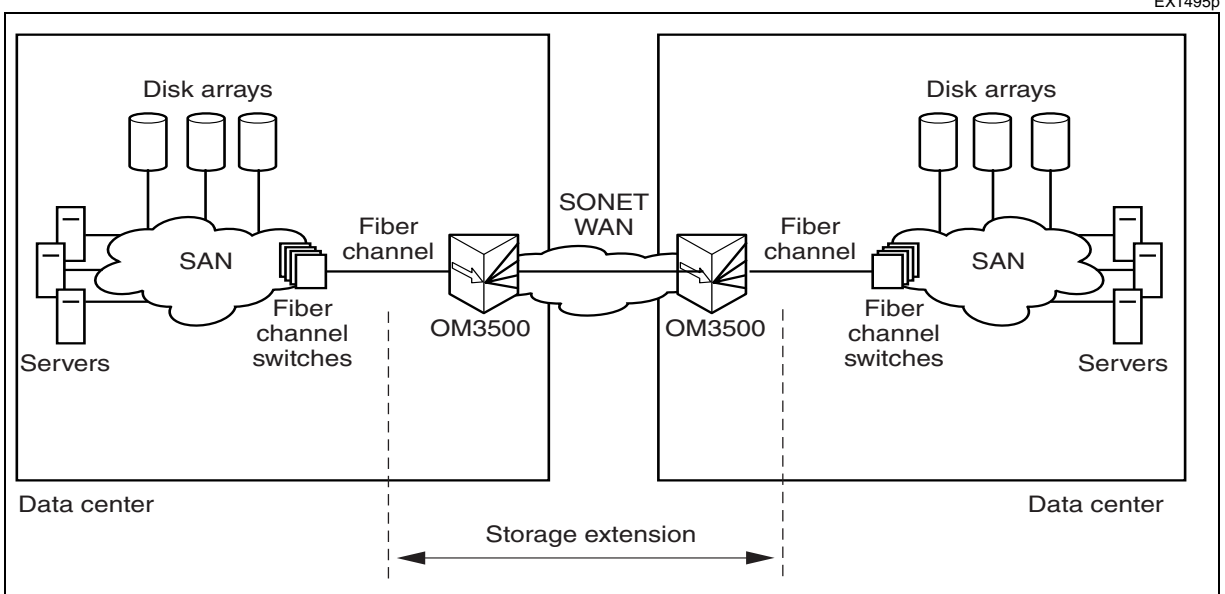
**Note:** LAN PMs ES, SES, and UAS on the 2xGigE/FC-P2P do not count properly if defects are also present on the WAN port.

For additional information on 2xGigE/FC-P2P circuit pack, please refer to [2xGigabit Ethernet/Fibre Channel - Point-to-Point circuit pack on page 3-98](#).

## Fibre Channel Extended Reach

Fibre Channel extended reach avoids throughput degradation for distances up to approximately 980 kilometers (kms) at full rate or about 18000 kilometers (kms) at sub-rate (STS1), see [Figure 2-38 on page 2-96](#). For sub-rate, this means the ability to use 100% of the available WAN bandwidth.

**Figure 2-38**  
**Storage over Sonet**



Storage networks cannot tolerate data discard. Fibre Channel devices employ a credit-based flow control mechanism to guarantee delivery between storage devices in the network and to ensure that the rate at which the data is sent by the source does not exceed that at which it can be received at the destination.

To establish a link by link flow control, ports of the two connected storage devices first exchange and agree on the number of frames each can receive. This is called the Buffer-to-Buffer Credit (BBC). Whenever the source device sends out a frame, it increments the credit counter (or BBC counter) by 1. The receiving device will send back an acknowledgement message, called R\_RDY, upon receipt of each transmitted frame. Once the source device receives the R\_RDY, it lowers the BBC counter by 1. If the BBC counter reaches the previously agreed credit threshold, the source device simply stops sending frames until the BBC counter is lowered below its threshold by receiving another R\_RDY from the destination.

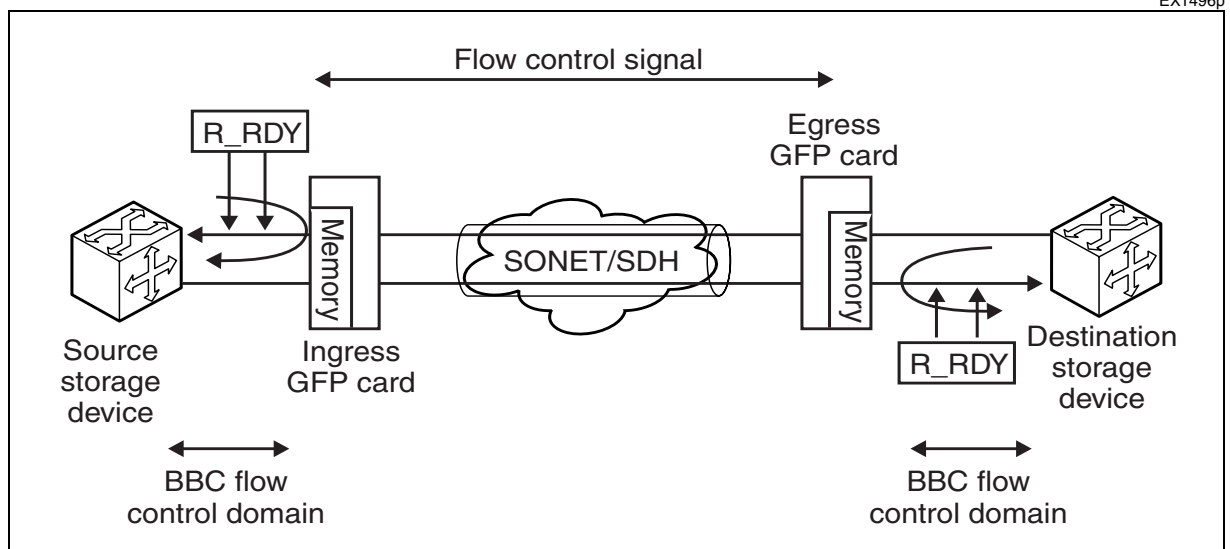
When storage needs to be extended over distance, the storage devices need to provide a sufficient number of buffer credits to compensate for the latency introduced by the link so that the system can still achieve maximum link efficiency.

OPTera Metro 3500 storage extension solution offers the ability to transport Fibre Channel traffic over 1,000's of kilometers. OPTera Metro 3500 solution enables service providers to offer a fully managed service, independent of the end user devices. Fibre Channel client traffic can be mapped into both full-rate and sub-rate SONET signal.

To support storage extension over very long distances, the OPTera Metro 3500 platform is equipped with buffering and flow control functionality to ensure high throughput without requiring large buffer credits from the storage devices. The implementation is illustrated in [Figure 2-39 on page 2-97](#). In this solution, BBC Flow control is implemented between a source storage device and the ingress OPTera Metro 3500 as well as between the egress OPTera Metro 3500 and the destination storage device. Flow control signals are used for flow control between the Nortel Networks network elements.

This solution is transparent to the source and destination storage devices. The OPTera Metro 3500 intercepts login and other messages from the source storage device and transmits them to the destination storage device. As far as they are concerned, the storage devices believe they are connected to each other. This is important for service providers to be able to offer a Storage Private Line service with an effective demarcation point.

**Figure 2-39**  
**GFP and Flow Control Enable Distance Extension**



As the source storage device sends a Fibre Channel frame, the ingress OPTera Metro 3500 transmits it over the WAN connection and then returns an R\_RDY to the source device. This mechanism ensures the source storage device never reaches its maximum allowed BBC count, and so enables it to maintain full throughput even at very long distances.

On egress, the OPTera Metro 3500 will send frames to the destination storage device only at the rate at which this device sends out R\_RDY. This will ensure that the rate at which the data is sent by the egress OPTera Metro 3500 does not exceed that at which it can be received by the destination storage device.

If congestion should occur at the destination storage device, it would begin withholding R\_RDYs from the egress OPTera Metro 3500. All transmitted Fibre Channel frames are buffered in the egress OPTera Metro 3500 card memory. When a certain memory threshold is reached, a flow control signal is sent to the ingress OPTera Metro 3500 to stop the transmission of Fibre Channel frames. Upon receipt of these flow control messages, the ingress OPTera Metro 3500 would in turn withhold R\_RDYs from the source storage device. This mechanism ensures that downward pressure is cascaded upstream to the source of the traffic until congestion abates.

Table 2-20 on page 2-98, lists the sample distances based on the available WAN bandwidth.

**Table 2-20**  
**Fibre Channel extended reach sample distances**

STS1-nv	Round Trip Delay ( $\mu$ s) See Note 1	Distance (kms) See Note 2	STS3c-nv	Round Trip Delay ( $\mu$ s)	Distance (kms) See Note 2
19 See Note 3	9870	987	6 See Note 3	9870	987
18	10160	1016	5	11820	1182
17	10760	1076	4 See Note 3	14770	1477
16	11430	1143	3	19690	1969
15	12190	1219	2	29540	2954
14	13060	1306	1 See Note 3	59080	5908
13	14070	1407			
12	15240	1524			
11	16620	1662			
10	18290	1829			
9	20320	2032			
8	22860	2286			
7	26120	2612			
6	30480	3048			
5	36570	3657			
4	45710	4571			



**Table 2-20 (continued)**  
**Fibre Channel extended reach sample distances**

STS1-nv	Round Trip Delay ( $\mu$ s) See Note 1	Distance (kms) See Note 2	STS3c-nv	Round Trip Delay ( $\mu$ s)	Distance (kms) See Note 2
3	60950	6095			
2	91430	9143			
1 See Note 3	182860	18286			

**Note 1:** When measuring round trip delay, please be aware that round trip latency measurement (RTDELAY) returns the network latency to an accuracy of +/- 1 ms.

**Note 2:** Approximation assuming no network element propagation delays and a 5 microsecond / kilometer fiber propagation delay.

**Note 3:** For Contiguous Concatenation the extended reach supported distances are:  
 STS1 = 18266 kms  
 STS3c = 5908 kms  
 STS12c = 1477 kms  
 STS24c = 987 kms

### Generic Framing Procedure and Virtual Concatenation support

The OPTera Metro 3500-based implementation for point-to-point Ethernet and storage connectivity services uses the GFP and VCAT standards.

#### Generic Framing Procedure (GFP)

GFP (Generic Framing Procedure) is an ITU standard (G.7041) which describes a flexible mapping technique for transparent transport of multiple protocols in SONET.

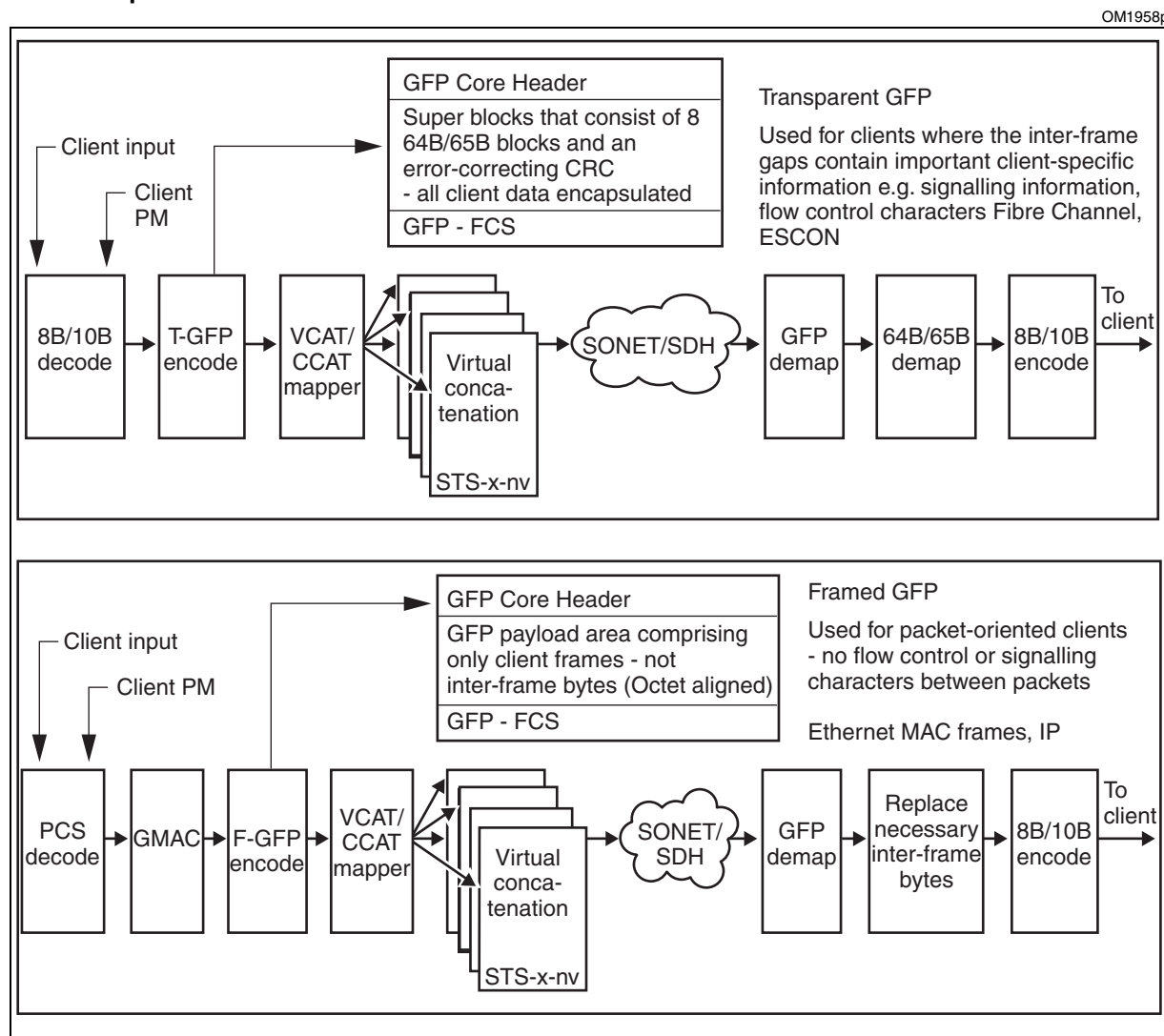
The GFP provides an efficient mechanism for Gigabit Ethernet (GE) and Fibre Channel (FICON and FC-100) transport over a SONET core network via efficiently mapping varying client signals into SONET STS frames.

GFP defines two different implementations: Transparent GFP (GFP-T), for byte-oriented data streams that require low latency transmission, and Framed-mapped GFP (GFP-F), which maps one frame or packet of client signal in one GFP frame. The GFP-T mapping scheme is transparent, as control characters are not interpreted but generally encoded and transmitted. The far-end GFP client must however have knowledge of the client signal type in order to correctly handle client-specific issues. GFP-T is recommended for SAN service. GFP-F processes client signal data streams on a Protocol Data Unit (PDU) basis and maps these streams into GFP-F frames one packet at a time. GFP-F is recommended for Ethernet services as it provides flow control capability as well as performance monitoring (Operational Measurements (OM) and Performance Monitoring (PM)).

In GFP-T, client signals are decoded and mapped into GFP-T frames; these frames can be transmitted immediately without waiting for the reception of an entire client data frame. In GFP-F and GFP-T, idle frames are inserted as necessary to fill the transport payload. Multiple GFP-F frames can be aggregated in a single SONET payload.

Figure 2-40 on page 2-100 shows how GFP encapsulation is executed for Transparent and Frame-mapped GFP.

**Figure 2-40**  
**GFP Encapsulation**



The OPTera Metro 3500 also supports Virtual Concatenation (ITU-T G.707 compliant) with support at the STS-1-nv and STS-3c-nv SONET rates. Up to 14ms of differential delay is supported between each VCAT path.

The OPTera Metro 3500 2xGigE/FC-P2P circuit pack maps Gigabit Ethernet client signals via GFP-F frames and maps FC100/FICON clients signals via GFP-T frames.

**Virtual Concatenation (VCAT)**

Virtual Concatenation (VCAT) is not a new transport protocol but a provision in existing ITU-T standards (G.707 & G.783) and ANSI standards (T1.105). Although it has not been widely adopted as mainstream networking technology, the protocol enables a more efficient support of packet data services through a more efficient use of the traditional coarse concatenation SONET TDM bandwidth. VCAT enables the operator to take existing SONET provisioning paths and map the new packet data service into an arbitrary number of STS-1 or STS-3c units within these paths. The transport capacity is therefore decoupled from the service bandwidth, resulting in less stranded bandwidth for a given link.

VCAT services are available in different virtual containers:

- STS-1-nv, where n is 1 through 21
- STS-3c-nv, where n is 1 through 7

VCAT provides an efficient transport of data-oriented services, by grouping a number (n) of virtual container (STS-1/3c SPEs), by using the combined payload (STS-x-nv) to match the required bandwidth. [Table 2-21 on page 2-101](#), highlights the efficient network resource utilization achieved with VCAT.

**Table 2-21**  
**Contiguous versus virtual concatenation efficiency**

Service	Client Rate	Contiguous Concatenation		Virtual Concatenation	
		Rate	Efficiency	Rate	Efficiency
Fibre Channel (FC-100) See <a href="#">Note</a>	850 Mbit/s	STS-24c	69%	STS-3c-6v	95%
Gigabit Ethernet	1 Gbit/s	STS-24c	81%	STS-1-21v	95%
		STS-48c	42%	STS-3c-7v	95%
<b>Note:</b> When connected to a pair of Fibre Channel devices that support the autonegotiation (AN) of 1G and 2G link speeds, the speed of the ports connected to the 2xGigE/FC -P2P card must be manually set to 1G (FC-100).					

## Optical interoperability of OPTera Metro 3500

- The OPTera Metro 3500 shelf supports OC-3, OC-12, OC-48 and OC-192 UPSR interoperability with other GR1400 compliant vendors for the purpose of passing traffic, routing, and network management data.
- The OPTera Metro 3500 shelf supports OC-3, OC-12, OC-48 and OC-192 1+1 interoperability with other vendors for the purpose of passing traffic, routing, and network management data.
- Interoperability with the OPTera Metro 3500 OC-192 Long reach (LR) G.709 FEC and OC-192 DWDM G.709 FEC optical interfaces requires G.709 compatible optics.
- OPTera Metro 3500 does not support BLSR interoperability, as the standards have not been defined.

## Performance monitoring

OPTera Metro 3500 network elements support a performance monitoring subsystem that uses traffic performance to help identify transmission problems.

The network element supports several types of surveillance mechanisms including alarms, performance statistics, and messages generated by alarm conditions. Supported alarms include environmental, traffic trouble, light-emitting diode indicators, and automatically generated messages.

The performance monitoring subsystem allows threshold levels to be preset for different parameters and manual retrieval of data.

## SONET line, section, and path parameters

Performance monitoring parameters for traffic-carrying facilities include near-end and far-end line, section and path parameters, such as errored seconds and coding violations.

The performance monitoring subsystem reads and analyzes the performance monitoring data every second. Performance monitoring counts accumulate for the following time intervals:

- current 15 minutes
- current one day
- current untimed interval
- 32 15-minute intervals prior to the current interval
- 1 day prior to the current interval

## Threshold values

There are three performance monitoring threshold values:

- hard-coded default threshold values (facility type)
- default threshold values defined by the user (facility type)
- threshold values defined by the user (facility type)

### **Hard-coded default threshold values (facility type)**

Each facility type has a set of hard-code default performance monitoring threshold values. You cannot edit these values. You can, however, define your own performance monitoring threshold values.

### **User defined default threshold values (facility type)**

Each facility type has a set of default values that the user can define. The initial default values are derived from the hard-coded factory default threshold values. However, you can change these default values at any time.

### **User defined threshold values (facility)**

You can set a facility slot or port to

- specific threshold values
- the default threshold values defined for that facility type

The threshold values for each specific facility are initially derived from the default threshold values for the matching facility types.

If you delete a facility with customized threshold values and add the facility again, the threshold values specific to the facility revert to the default threshold values. When you replace threshold values that you program, the programmed values stay with the network element.

If you replace a circuit pack other than the shelf processor, the threshold values are recovered from the shelf processor.

If you replace the shelf processor, the threshold values are recovered from other circuit packs in the network element.

See [Table 2-22](#) for a list of performance monitoring parameter definitions. For a list of DS3 performance monitoring parameters supported on the DS3 circuit packs, see [Table 2-23](#). For a list of DS1 performance monitoring parameters supported on the DS1 and DS3VTx12 circuit packs, see [Table 2-24](#).

**Table 2-22**  
**Performance monitoring parameter definitions**

Parameters		Definitions
<b>Section</b>		
CV-S	Coding violations, section	<ul style="list-style-type: none"> <li>SONET: Count of BIP-8 errors (B1) byte</li> </ul>
ES-S	Errored seconds, section	<ul style="list-style-type: none"> <li>SONET: Count of one second intervals with BIP-8 errors (B1) <math>\geq 1</math> or LOF <math>\geq 1</math> or LOS <math>\geq 1</math></li> </ul>
SES-S	Severely errored seconds, section	<ul style="list-style-type: none"> <li>SONET: Count of one second intervals with BIP-8 errors (B1) <math>\geq K</math> (where K is 155 for OC-3, 616 for OC-12, 2392 for OC-48, 8854 for OC-192) or SEF <math>\geq 1</math> or LOS <math>\geq 1</math></li> </ul>
SEFS-S	Severely errored frame seconds, section	<ul style="list-style-type: none"> <li>SONET: Count of one second intervals with any LOF <math>\geq 1</math></li> </ul>
<b>Line</b>		
CV-L	Coding violations, line	<ul style="list-style-type: none"> <li>SONET: Count of BIP-8 errors (B2 byte)</li> <li>DS1 / DS3x3 / DS3x12 / DS3x12e: Count of BPV + EXZ BPVs which are part of the B3ZS code are not counted, receive only</li> </ul>
CV-LFE	Coding violations, line, far-end	<ul style="list-style-type: none"> <li>SONET: Count of FEBE-L (Bits 2-8 of Z2 byte of STS-1 No. 3)</li> </ul>
ES-L	Errored seconds, line	<ul style="list-style-type: none"> <li>SONET: Count of one second intervals with BIP-8 errors (B2) <math>\geq 1</math> or AIS-L <math>\geq 1</math></li> <li>DS1 / DS3: Count of one second intervals with (BPV + EXZ) <math>\geq 1</math> or LOS <math>\geq 1</math>, receive only</li> </ul>
ES-LFE	Errored seconds, line, far-end	<ul style="list-style-type: none"> <li>SONET: Count of one second intervals with FEBE-L <math>\geq 1</math> or RDI-L <math>\geq 1</math></li> <li>DS1-ESF: Count of one second PRM intervals with LV=1 in the PRM, receive and transmit</li> </ul>
SES-L	Severely errored seconds, line	<ul style="list-style-type: none"> <li>SONET: Count of one second intervals with BIP-8 errors (B2) <math>\geq K</math> (where K is 154 for OC-3, 615 for OC-12, 2459 for OC48, 9835 for OC-192) or AIS-L <math>\geq 1</math></li> <li>DS3: Count of one second intervals with (BPV + EXZ) <math>\geq 44</math> or LOS <math>\geq 1</math>, receive only</li> <li>DS1: Count of one second intervals with (BPV + EXZ) <math>\geq 1544</math> or LOS <math>\geq 1</math>, receive only</li> </ul>

**Table 2-22 (continued)**  
**Performance monitoring parameter definitions**

Parameters		Definitions
SES-LFE	Severely errored seconds, line	<ul style="list-style-type: none"> <li>SONET: Count of one second intervals with FEBE-L <math>\geq</math> K (where K is 154 for OC-3, 615 for OC-12, 2459 for OC-48, 9835 for OC-192) or RDI-L <math>\geq</math> 1</li> </ul>
UAS-L UAS-LFE	Unavailable seconds, line Unavailable seconds, Line, far-end	<ul style="list-style-type: none"> <li>SONET: Count of the seconds during which the Line was considered unavailable</li> </ul>
FC-L	Failure count, line	<ul style="list-style-type: none"> <li>SONET: Count of near-end line failure (AIS-L) events</li> </ul>
FC-LFE	Failure count, line far-end	<ul style="list-style-type: none"> <li>SONET: Count of far-end line failure (RFI-L) events</li> </ul>
<b>Path</b>		
CV-P	Coding violations, path	<ul style="list-style-type: none"> <li>SONET: Count of BIP-8 errors (B3 byte)</li> <li>DS3x3 / DS3x12e: Count of P-bit parity errors C-bit application not supported, receive and transmit</li> <li>DS3x12: Count of P-bit parity errors C-bit application not supported, transmit only</li> <li>DS1-SF: Count of Frame synchronization bit errors (FE), receive and transmit</li> <li>DS1-ESF: Count of CRC-errors, receive and transmit</li> </ul>
CSS-P	Controlled slip seconds, path	<ul style="list-style-type: none"> <li>DS1: Count of one second PRM intervals with LV=1 in the PRM, receive and transmit</li> </ul>
CV-PFE	Coding violations, path, far-end	<ul style="list-style-type: none"> <li>SONET: Count of FEBE-P (bits 1-4 in G1 byte)</li> <li>DS1: ESF: 0, 1, 5, 10, 100, 319, or 333 based on G1-G6 bit value in the PRM, receive and transmit</li> </ul>

**Table 2-22 (continued)**  
**Performance monitoring parameter definitions**

Parameters		Definitions
ES-P	Errored seconds, path	<ul style="list-style-type: none"> <li>• SONET: Count of one second intervals with BIP-8 errors (B3) <math>\geq 1</math> or LOP-P <math>\geq 1</math> or AIS-P <math>\geq 1</math></li> <li>• DS3x3 / DS3x12e: Count of one second intervals with P-bit parity errors <math>\geq 1</math> or SEF <math>\geq 1</math> or AIS <math>\geq 1</math>, receive and transmit</li> <li>• DS3x12: Count of one second intervals with P-bit parity errors <math>\geq 1</math> or SEF <math>\geq 1</math> or AIS <math>\geq 1</math>, transmit only</li> <li>• DS1-SF: Count of one second intervals with SEF <math>\geq 1</math>, AIS <math>\geq 1</math> or FE <math>\geq 1</math>, receive and transmit</li> <li>• DS1-ESF: Count of one second intervals with CRC <math>\geq 1</math>, SEF <math>\geq 1</math> or AIS <math>\geq 1</math>, receive and transmit</li> </ul>
ES-PFE	Errored seconds, path, far-end	<ul style="list-style-type: none"> <li>• SONET: Count of one second intervals with FEBE-P <math>\geq 1</math> or RDI-P <math>\geq 1</math></li> <li>• DS1-ESF: Count of one second PRM intervals with (G1-G6=1 or SE=1 or SL=1) in the PRM or RAI signal, receive and transmit</li> </ul>
SES-P (See <a href="#">Note</a> )	Severely errored seconds, path	<ul style="list-style-type: none"> <li>• SONET: Count of one second intervals with BIP-8 errors (B3) <math>\geq 2400</math> or AIS-P= or LOP-P <math>\geq 1</math></li> <li>• DS1-SF: Count of one second intervals with FE<math>\geq 8</math> or SEF <math>\geq 1</math> or AIS <math>\geq 1</math>, receive and transmit</li> <li>• DS1=ESF: Count of one second intervals with CRC <math>\geq 320</math> or SEF <math>\geq 1</math> or AIS <math>\geq 1</math>, receive and transmit</li> <li>• DS3x3 / DS3x12e: Count of one second intervals with P-bit parity errors <math>&gt; 44</math> or SEF 1 or AIS, receive and transmit</li> <li>• DS3x12: Count of one second intervals with P-bit parity errors <math>&gt; 44</math> or SEF 1 or AIS, transmit only</li> <li>• STS-3c: Count of one second intervals with BIP-8 errors (B3) <math>\geq 2400</math></li> <li>• STS-12c: Count of one second intervals with BIP-8 errors (B3) <math>\geq 2400</math></li> <li>• STS-24c: Count of one second intervals with BIP-8 errors (B3) <math>\geq 2400</math></li> <li>• STS-48c: Count of one second intervals with BIP-8 errors (B3) <math>\geq 2400</math></li> </ul>



**Table 2-22 (continued)**  
**Performance monitoring parameter definitions**

Parameters		Definitions
SES-PFE	Severely errored seconds, path, far-end	<ul style="list-style-type: none"> <li>• SONET: Count of one second intervals with FEBE-P <math>\geq</math>2400 or RDI-P <math>\geq</math>1</li> <li>• DS1-ESF: Count of one second PRM intervals with (G6=1 or SE=1) in the PRM or RAI signal, receive and transmit</li> </ul>
SEFS-PFE	Severely errored frame, path, far-end	<ul style="list-style-type: none"> <li>• SONET: Count of one second intervals with FEBE-P <math>\geq</math>2400 or RDI-P <math>\geq</math>1</li> <li>• DS1-ESF: Count of one second PRM intervals with (G6=1 or SE=1) in the PRM or RAI signal</li> </ul>
SAS-P	Severely errored frame / alarm indication signal (AIS) seconds, path	<ul style="list-style-type: none"> <li>• DS3: Count of one second intervals with any SEF <math>\geq</math>1 or AIS <math>\geq</math>1, receive and transmit</li> <li>• DS1: Count of one second intervals with SEF <math>\geq</math>1 or AIS <math>\geq</math>1, receive and transmit</li> </ul>
SEFS-P	Severely errored frame, path	<ul style="list-style-type: none"> <li>• DS1-ESF: Count of one second PRM intervals with SE bit=1 in the PRM, receive and transmit</li> </ul>
ALS-P	AIS / LOP seconds, path	<ul style="list-style-type: none"> <li>• SONET: Count of one second intervals with AIS-P <math>\geq</math>1 or LOP-P <math>\geq</math>1</li> </ul>
ALS-PFE	AIS / LOP seconds, path, far-end	<ul style="list-style-type: none"> <li>• SONET: Count of one second intervals with RDI-P <math>\geq</math>1</li> </ul>
UAS-P	Unavailable seconds, path	<ul style="list-style-type: none"> <li>• SONET: Count of the seconds during which the STS Path was considered unavailable</li> <li>• DS3x3 / DS3x12e: Count of the seconds during which the STS Path was considered unavailable, receive and transmit</li> <li>• DS3x12: Count of the seconds during which the STS Path was considered unavailable, transmit only</li> <li>• DS1: Count of the seconds during which the STS Path was considered unavailable, receive and transmit</li> </ul>
UAS-PFE	Unavailable seconds, path, far-end	<ul style="list-style-type: none"> <li>• SONET, DS1-ESF: Count of the seconds during which the STS Path was considered unavailable, receive and transmit</li> </ul>

**Table 2-22 (continued)**  
**Performance monitoring parameter definitions**

Parameters		Definitions
FC-P	Failure count, path	<ul style="list-style-type: none"> <li>• SONET: Count of near-end STS path failure (LOP-P or AIS-P) events</li> <li>• DS1: Count of near-end path failure (LOF or AIS) events, receive and transmit</li> </ul>
FC-PFE	Failure count, path, far-end	<ul style="list-style-type: none"> <li>• SONET: Count of far-end STS path failure (RFI-P) events</li> <li>• DS1: Count of far-end path failure (RAI) events, receive and transmit</li> </ul>
<p><b>Note:</b> The SESP parameter does not count frame errors for DS-1 facilities on DS-1 circuit packs.</p>		

**Table 2-23**  
**DS3 performance monitoring - supported parameters for DS3VTx12**

PM parameter	DS3x3, DS3x12, DS3x12e circuit packs	DS3VTx12 circuit pack See <a href="#">Note</a>
CVL Near End Rx	√	√
ESL Near End Rx	√	√
SESL Near End Rx	√	√
CVP Near End Rx	√	√
CVP Near End Tx	√	
FCP Near End Rx	√	√
ESP Near End Rx	√	√
ESP Near End Tx	√	
SESP Near End Rx	√	√
SESP Near End Tx	√	
SASP Near End Rx	√	√
SASP Near End Tx	√	
UASP Near End Rx	√	√
UASP Near End Tx	√	
<p><b>Note:</b> DS3/VTx12 circuit pack is not supported on shelves equipped with STX-192 circuit packs.</p>		

**Table 2-24**  
**DS1 performance monitoring - supported parameters for DS3VTx12**

PM parameter	DS1/DS1e and DS1TM circuit packs	DS3VTx12 circuit pack See <a href="#">Note</a>
CVL Near End Rx	√	
ESL Near End Rx	√	
ESL Far End Rx	√	
ESL Far End Tx	√	
SESL Near End Rx	√	
CVP Near End Rx	√	√
CVP Far End Rx	√	
CVP Near End Tx	√	
CVP Far End Tx	√	
FCP Near End Rx	√	√
ESP Near End Rx	√	√
ESP Far End Rx	√	
ESP Near End Tx	√	
ESP Far End Tx	√	
SESP Near End Rx	√	√
SESP Far End Rx	√	
SESP Near End Tx	√	
SESP Far End Tx	√	
SASP Near End Rx	√	√
SASP Near End Tx	√	
SEFSP Far End Rx	√	
SEFSP Far End Tx	√	
CSSP Far End Rx	√	
CSSP Far End Tx	√	
UASP Near End Rx	√	√
UASP Far End Rx	√	

**Table 2-24 (continued)**  
**DS1 performance monitoring - supported parameters for DS3VTx12**

PM parameter	DS1/DS1e and DS1TM circuit packs	DS3VTx12 circuit pack See <a href="#">Note</a>
UASP Near End Tx	√	
UASP Far End Tx	√	
<b>Note:</b> DS3/VTx12 circuit pack is not supported on shelves equipped with STX-192 circuit packs.		

### Retrieving performance monitoring counts

OPTera Metro 3500 Release 11.0 introduced enhancements for retrieving performance monitoring (PM) counts.

- A faster retrieval method is used to retrieve PM counts for DS1 service module (DSM) facilities and for protected DS1 facilities.

**Note:** DSM facilities include DS1, OC-3, and STS-1 facilities that carry traffic on a DSM.

- A continuation message mechanism is implemented in the response block for RTRV-PM TL1 commands.

PM retrieval uses a continuation message mechanism, as described below.

- A TL1 response is displayed within two minutes after you issue a RTRV-PM command.
- If no PM data is available within 2 minutes, a continuation message is sent to the TL1 session. The continuation message is sent at regular intervals (1 minute and 40 second intervals), until PM data is available. The continuation message mechanism indicates that additional time is required for reporting PM data and prevents the MOA or Site Manager from timing out.

**Note:** The MOA or Site Manager times out if no response is received in two minutes.

- If partial or complete PM data is available in under two minutes, it is reported to the TL1 session. The termination character in the response message indicates whether the data is incomplete or complete (see [Table 2-25](#)).
- When all PM data has been reported, the termination character in the last response indicates that the process is complete.

**Note:** A time change on the network element does not affect the operation of the continuation message timer.

Table 2-25 describes the termination characters for the RTRV-PM response messages.

**Table 2-25**  
**Termination characters supported in the RTRV-PM response message**

Termination character	Description
semi-colon (;)	Indicates the termination of the response. All PM data has been reported and the process is complete.
greater than (>)	If the current response does not include PM data (in a response block), then the termination character indicates that the current response is a continuation message. PM data will be reported in subsequent response messages.  If the current response includes PM data, then the termination character indicates that this response contains partial data. Additional PM data will be reported in subsequent response messages.

### Physical PMs

The physical PMs feature measures the received optical power on various OC-48 and OC-192 circuit packs. See Table 2-26 on page 2-111 for list of circuit packs supporting receive optical power measurement.

**Table 2-26**  
**OC-48 and OC-192 circuit packs supporting receive optical power**

Description	PEC
OC-48 STS SR circuit pack	NTN440HA
OC-48 STS IR circuit pack	NTN440KA
OC-48 STS LR circuit pack	NTN440LA
OC-48 ELR interface circuit (1550nm)	NTN440FA
OC-48 ER DWDM circuit pack (1535.04nm)	NTN408AS
OC-48 ER DWDM circuit pack (1555.75nm)	NTN408CW
OC-48 ER DWDM circuit pack (1528.77nm)	NTN408AA
OC-48 ER DWDM circuit pack (1533.47nm)	NTN408AN
OC-48 ER DWDM circuit pack (1530.33nm)	NTN408AE
OC-48 ER DWDM circuit pack (1531.90nm)	NTN408AJ
OC-48 ER DWDM circuit pack (1552.52nm)	NTN408CN
OC-48 ER DWDM circuit pack (1550.92nm)	NTN408CJ

**Table 2-26**  
**OC-48 and OC-192 circuit packs supporting receive optical power**

Description	PEC
OC-48 STS SR circuit pack	NTN440HA
OC-48 STS IR circuit pack	NTN440KA
OC-48 STS LR circuit pack	NTN440LA
OC-48 ELR interface circuit (1550nm)	NTN440FA
OC-48 ER DWDM circuit pack (1557.36nm)	NTN408DA
OC-192 IR circuit pack	NTN445CB
OC-192 LR G.709 FEC circuit pack	NTN445DA
OC-192 DWDM G.709 FEC circuit pack (1535.04nm)	NTN445JA
OC-192 DWDM G.709 FEC circuit pack (1528.77nm)	NTN445EA
OC-192 DWDM G.709 FEC circuit pack (1533.47nm)	NTN445EB
OC-192 DWDM G.709 FEC circuit pack (1530.33nm)	NTN445EC
OC-192 DWDM G.709 FEC circuit pack (1531.90nm)	NTN445ED
OC-192 DWDM G.709 FEC circuit pack (1538.19nm)	NTN445FA
OC-192 DWDM G.709 FEC circuit pack (1542.94nm)	NTN445FB
OC-192 DWDM G.709 FEC circuit pack (1539.77nm)	NTN445FC
OC-192 DWDM G.709 FEC circuit pack (1541.35nm)	NTN445FD

Physical PMs are gauge type readings that can go up or down during a collection period.

Two parameters are used to evaluate received optical power performance:

- optical power received un-normalized (OPR)
- optical power received normalized (OPRN)

**OPR**

OPR is a measurement of the received optical signal in dBm. In Site Manager, OPR is displayed in exponential form. OPR values are collected and recorded every second and are un-normalized. OPR is used to calculate OPRN.

**OPRN**

OPRN is the deviation from the receivers midpoint operational range. This value is expressed as a percentage and is derived from the following formula:

$$\text{OPRN} = 2 \left( \frac{(\text{OPR} - \text{OPR}_{\text{nominal}})}{(\text{OPR}_{\text{max}} - \text{OPR}_{\text{min}})} \right) 100$$

Where:

- **OPR<sub>nominal</sub>** is the midpoint operational range of the receiver
- **OPR<sub>max</sub>** is the maximum received optical power
- **OPR<sub>min</sub>** is the minimum received optical power

OPRN is 0% when the received power is equal to the nominal value (mid-range value), 100% when the received power is at the maximum level of the operational range, and -100% when the received power is at the minimum level of the operational range.

**Storage and retrieval of physical PMs**

For the physical PMs, the following PM registers are stored and can be retrieved:

- untimed (taken every second), OPR parameter only
- current 15-minute interval, OPRN parameter only
- current day, OPRN parameter only
- last 32 15-minute intervals, OPRN parameter only
- previous day, OPRN parameter only

*Note:* The OPRN current 15-minute and current day bins are updated once at the start of each interval (15-minutes or 1-day).

**Resetting registers and invalid data flag**

Both OPR and OPRN registers can be reset. Resetting the OPRN register causes that value to be recalculated.

The physical PM OPR and OPRN parameters will have an invalid data flag (IDF) value when the measured value is beyond the minimum or maximum values.

### **Performance monitoring threshold crossing alerts (TCA)**

This feature groups together TCAs to minimize the number of alarms raised from a particular facility. Summary alarms are reported per facility and are raised when one or more TCAs have been raised for the facility within a collection period (15-min. or 1-day).

When monitored performance monitoring (PM) counts exceed their provisioned thresholds, the system generates a threshold crossing report. You can provision the report type to one of the following options:

- threshold crossing alert (TCA) (default report type)
- TCA summary alarm
- both TCA and TCA summary alarm
- no reporting

Report type provisioning is supported for the following facilities: OC-3, OC-12, OC-48, OC-192, STS-1, STS-3c, STS-12c, STS24c, STS48c, WAN, FC, ETH and EC-1.

*Note 1:* TCA summary alarms will not be supported on DS1 and DS3 facilities.

*Note 2:* TCA summary alarms for OC3 facilities is supported on the OC3x4 cards only.

You provision the report type for each facility type and location based on the collection period (15-minute or 1-day). Report type provisioning is not valid for untimed PMs.

*Note:* Physical PMs do not generate TCA summary alarms. Protection PMs do not support thresholds and therefore do not generate TCAs or TCA summary alarms.

### **TCAs**

When TCA reporting is enabled, the system raises a TCA when the provisioned threshold of a monitored parameter is exceeded during a collection period. Multiple TCAs can be raised against a facility within a single collection period. For example, two separate TCAs for two section PM parameters can be raised during a single collection period for the same facility.

### **TCA summary alarms**

The TCA summary alarms provide a first alert notification to maintenance personnel that a TCA has been generated. The TCA summary alarms can enable maintenance personnel to troubleshoot and avoid potentially service-affecting problems.



When TCA summary alarm reporting is enabled, the system raises a TCA summary alarm at the first occurrence of a section, line, or path PM threshold crossing for a given facility and location, within a single collection period. The alarm is raised one time during the collection period, and it clears automatically at the end of the collection period. If the problems causing the threshold crossings are not corrected, then the alarm will be raised against the facility in subsequent collection periods at the first occurrence of a PM threshold crossing.

## Alarms

The new TCA summary alarms are as follows:

- Section PM Threshold Exceeded
- Line PM Threshold Exceeded
- Path PM Threshold Exceeded

The severity for these alarms is minor, non service affecting (mn, nsa).

**Note 1:** If you disable TCA summary alarm reporting, any active summary alarms will clear immediately and an alarm cleared notification is generated in the list of active alarms.

**Note 2:** If you disable all thresholds for a facility (by setting the threshold values to zero), any active summary alarms will clear at the end of the collection period. In this case, an alarm cleared notification is not generated immediately.

**Note 3:** If you change a threshold value such that a threshold is no longer exceeded, any active summary alarms will clear at the end of the collection period. In this case, an alarm cleared notification is not generated immediately.

## Engineering rules

The following engineering rules apply to the performance monitoring threshold crossing alerts enhancements feature:

- A TCA summary alarm will survive an SPx restart or replacement
- A TCA summary alarm provisioning data is preserved over an SPx restart or replacement.
- A TCA summary alarm will clear;
  - if the equipment or facility that a summary alarm is raised against is deleted.
  - if it was raised for a PM point and the reporting mode for this facility is disabled.
  - if INIT-REG command is issued against a PM bin
  - at the end of a collection period.

- TCA summary alarms will not clear if;
  - the equipment or facility that a summary alarm is raised against is put out-of-service (OOS).

the equipment or facility that a summary alarm is raised against is removed without first deleting the equipment of facility.

## Site Manager support

Site Manager Release 6.0.1 is used to operate, administer, maintain, and provision network elements at a nodal level. For more information, refer to the *Site Manager Planning and Installation Guide*, NTN35FA.

Site Manager incorporates data applications, which manages OPE provisioning, and the TL1 Command Builder.

When you log in to Site Manager, the main window is displayed. See [Figure 2-41 on page 2-117](#).

## Preside Software Upgrade Management support

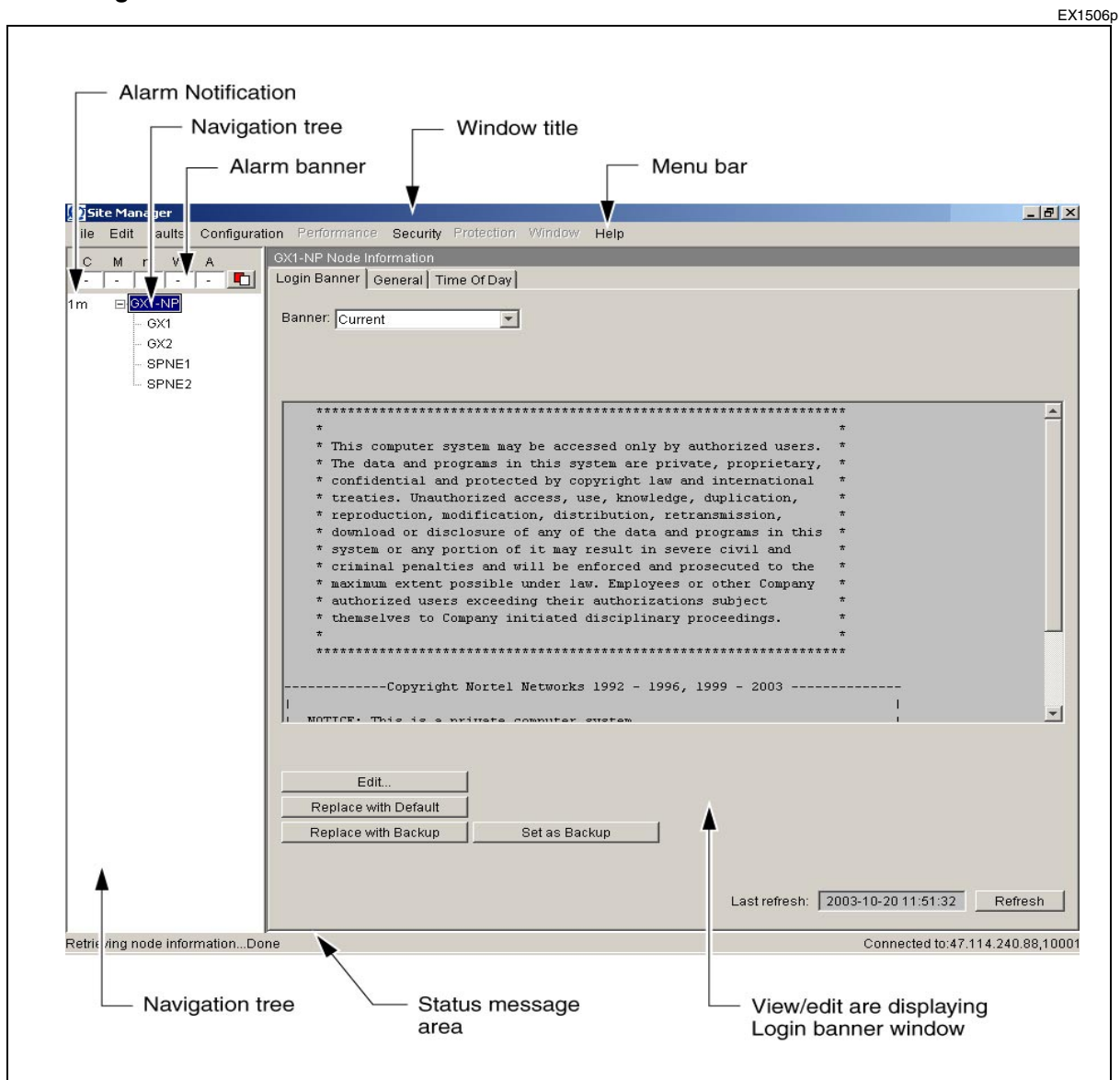
The purpose of Preside Software Upgrade Management (PSUM) is to deliver new software to the processors of one or more network elements (NE), and to upgrade the circuit pack cards on these network elements.

Preside SUM is a network-level application installed on the Preside Applications Platform. Preside SUM provides fast, simple, and reliable software upgrade deployment across a network, from a single location.

Preside SUM Release 3.0 supports the upgrade of OPTera Metro 3500 network elements controlled by a network processor (NP).

For more information on Preside Software Upgrade Management capability, refer Preside Software Upgrade Management Release 3.0 documentation (NTNM26DA).

**Figure 2-41**  
**Site Manager main window**



## Preside Applications Platform and Multiservice MOA support

Preside Applications Platform Rel. 9.2 with Preside Multiservice MOA Rel. 12.0 provide support for OPTera Metro 3500 Multiservice Platform and the Site Manager user interface.

For detailed information, refer to the *Preside Multiservice MOA Planning Guide* (NTNM43CA) and the *Preside Applications Platform Planning Guide* (NTNM51FAGA).

## Protection switching

At the OC-48 line rate, an optical fiber cut could result in 1344 VT1.5s being switched to an alternate path. The system is required to meet the 60-ms switch time for multiple path failures on a single optical interface only.

For more information about protection switching behaviour for specific circuit packs:

- [OC-192 optical interface circuit pack on page 3-59](#)
- [OC-48 optical interface circuit pack on page 3-65](#)
- [OC-48 STS optical interface circuit pack on page 3-68](#)
- [OC-12 optical interface circuit pack on page 3-72](#)
- [OC12x4 STS IR optical interface circuit pack on page 3-75](#)
- [OC-3 optical interface circuit pack on page 3-77](#)
- [OC-3x4 optical interface circuit pack on page 3-80](#)
- [EC-1x3 circuit pack on page 3-82](#)
- [EC-1x12 circuit pack on page 3-84](#)
- [DS1 mapper on page 3-86](#)
- [DS3x3 mapper on page 3-87](#)
- [DS3x12 / DS3x12e mapper on page 3-89](#)
- [DS3VTx12 mapper on page 3-90](#)

**Note 1:** If multiple simultaneous path failures, such as an optical fiber cut, occur on different optical interfaces such as an OC-3, OC-12, OC-48 or OC-192, the 60 ms switch time may not be met. Protection of simultaneous path failures on multiple OC-n optical interfaces will complete in less than 200 ms.

**Note 2:** VT1.5 management is not supported on OPTera Metro 3500 shelves equipped with STX-192 circuit packs.

The Wait to Restore time and Signal Degrade Threshold are provisionable for OC-48 and OC-192 optical interface pairs and DS1 circuit packs.

**Note:** DS1 user protection switch requests (including manual, forced and lockouts) are automatically cleared after a network element power failure/recovery.

On BLSR rings, user-initiated switches are supported as follows:

- Lockout on working channel on a span. This prevents a span from switching. The node can still go into pass-through mode.
- Lockout on protection channel on a span. This prevents the use of the span for any protection switching. It also prevents ring switches anywhere in the ring.

- Forced switch on working channel of a span. This switches traffic from the working channels on a span to the protection channels around the ring.
- Manual switch on a working channel of a span. This switches traffic from the working channels on a span to the protection channels around the ring.

In BLSR, squelching is the application of AIS-P to avoid misconnection when the source node or the destination node for connection is involved in a node failure, node isolation, or ring segmentation. Each node maintains a squelch table which holds the source and destination ID for each working connection that the node is terminating (adding/dropping) or passing through.

For BLSR configurations, Site Manager does not display squelch maps.

### Protection hierarchy

Switch requests are not preempted. When a higher priority switch request is made, the lower priority switch request is dropped. If the higher priority switch request is released, the lower priority switch request is not reestablished.

*Note:* An exception to this is in the case of a Lockout of a working in a BLSR. The Lockout of the working optical interface pre-empts any pending forced or manual switches.

See [Table 2-27](#) for the protection request priority for circuit packs.

**Table 2-27**  
**Services protection priority**

Circuit pack	Protection priority
DS1 (1:N, revertive) (see Note)	<ul style="list-style-type: none"> <li>• Lockout</li> <li>• Forced</li> <li>• Autonomous (equipment failure)</li> <li>• Manual</li> </ul>
DS3x3, DS3VTx12, DS3x12, DS3x12e, EC-1x3, EC-1x12, DSM DS1x84 TM (1+1 nonrevertive)	<ul style="list-style-type: none"> <li>• Forced</li> <li>• Autonomous (equipment failure)</li> <li>• Manual</li> </ul>
OC-3, OC-3x4, OC-12, OC-12x4, OC-48, OC-192 (UPSR, VT1.5, STS-1, STS-3c, STS-12c, STS-24c, STS-48c, path nonrevertive)	<ul style="list-style-type: none"> <li>• Forced</li> <li>• Autonomous (path failures)</li> <li>• Manual</li> </ul>

**Table 2-27 (continued)**  
**Services protection priority**

Circuit pack	Protection priority
OC-3, OC-3x4, OC-12, OC-12x4, OC-48, OC-192 (1+1 unidirectional, bidirectional line nonrevertive)	<ul style="list-style-type: none"> <li>• Lockout</li> <li>• Autonomous (line failures on protection)</li> <li>• Forced</li> <li>• Autonomous (line failures on working)</li> <li>• Manual</li> <li>• High-speed exerciser</li> </ul>
OC-48 (2-Fiber BLSR) (revertive) OC-192 (2-Fiber BLSR) (revertive)	<ul style="list-style-type: none"> <li>• Lockout (protection/working)</li> <li>• Forced Switch of Working - Ring</li> <li>• Signal Failed on Working - Ring</li> <li>• Signal Degraded on Protection</li> <li>• Signal Degraded on Working - Ring</li> <li>• Manual Switch of Working - Ring</li> <li>• Wait to Restore</li> <li>• Exerciser - Ring</li> <li>• Reversed Request - Ring</li> </ul>
<p><b>Note:</b> DS1 user protection switch requests (including manual, forced and lockouts) are automatically cleared after a network element power failure/recovery.</p>	

### Protection performance monitoring parameters for optical facilities

The OPTera Metro 3500 network elements support the following protection performance monitoring (PM) parameters for OC-3, OC-12, OC-48 and OC-192 facilities:

- protection switch count-working (PSC-W)
- protection switch count-protection (PSC-P)
- protection switch duration (PSD)

The protection PM parameters are available for OC-3, OC-12, OC-48 and OC-192 facilities (see [Note](#)). When the facilities are not protected, the protection PM parameters are fixed at 0.

**Note:** Protection PM parameters are not available for the OC-3 optical interface, EC-1x3, and EC-1x12 circuit packs. For these circuit packs, the protection PM parameters are fixed at 0.

The PSC-W, PSC-P, and PSD parameters are defined as follows:

- PSC-W—For a working line, PSC-W is the number of times that service switched from the working line to the protection line, plus the number of times that service switched back to the working line.
- PSC-P—For a protection line, PSC-P is the number of times that service switched from the working line to the protection line, plus the number of times service switched back to the working line.
- PSD—For a working line, PSD is the number of seconds that service was carried on the protection line. For a protection line, PSD is the number of seconds that the line was used to carry service. The PSD parameter is applicable only if the protection scheme is revertive.

**Note:** You cannot set thresholds for the protection PM parameters.

**Protection PM in a linear 1+1 configuration**

Protection PM parameters are applicable to OC-3, OC-12, OC-48 and OC-192 facilities in a linear 1+1 configuration.

The working and the protection facilities in a linear 1+1 configuration are on separate lines. Therefore, the PSC-P parameter on the working line and the PSC-W parameter on the protection line are fixed at 0.

The linear 1+1 configuration is non-revertive. Therefore, the PSD parameter for facilities in a linear 1+1 configuration is fixed at 0.

**Protection PM in a BLSR configuration**

Protection PM parameters are applicable to OC-48 and OC-192 facilities in a BLSR configuration. Protection PM parameters increment on switching nodes only and not on pass-through nodes.

Because each line in a BLSR configuration includes both working and protection facilities, the PSC-P and the PSC-W parameters increment independently on each line.

For the BLSR configuration, the PSD parameter increments only if the protection switch is revertive. The PSD parameter is not applicable in the following cases:

- revertive operation is disabled (by setting the wait-to-restore period to infinite)
- a manual switch or a forced switch is activated
- In these two cases, the PSD parameter is fixed at 0.

## Security and administration

OPTera Metro 3500 Release 12.1 offers the following security and administration features:

- User account creation
- Network element / network processor naming
- Time zone, date and time setting
- Time of Day synchronization (see [Time of day synchronization on page 2-169](#))
- Maintenance and updating of accounts and network element parameters
- Intrusion Attempt Handling on the SPx and NPx
- Password Management on the SPx and NPx providing
  - enhanced restrictions on passwords
  - restricted password reuse
  - password aging
  - temporary account feature
- Customer Managed Networks on the SPx and NPx
- Security log/audit trail
- Local user authentication (see [Local account user authentication on page 2-122](#))
- Challenge / Response authentication (see [Local 'challenge-response' user authentication on page 2-123](#))
- Centralized RADIUS authentication (see [Centralized Security Administration \(CSA\) on page 2-124](#))

### Local account user authentication

This method of user authentication employs the use of a user ID and password and is the default method on the OPTera Metro 3000 series platforms. Local account user authentication is the method that has been implemented in all past releases of OPTera Metro 3000. A userID and password is managed individually at each network element and network processor.

**Note 1:** This method of user authentication is not available for network elements enabled with Centralized Security Administration (CSA) (see [Centralized Security Administration \(CSA\) on page 2-124](#)) but for which the alternative authentication method is provisioned as challenge-response.

**Note 2:** This is the default authentication mode for network elements.

For more information about local accounts, see [Security and administration on page 2-122](#).



### Local 'challenge-response' user authentication

When logging in locally with 'challenge-response' as the specified domain, users will be given a challenge for which they must provide a response.

Challenge / Response addresses many security issues associated with sending authentication information over unsecured links:

- When a user attempts to authenticate, they are presented with a challenge. This challenge is changed at each login attempt, regardless of whether it is successful or not.
- A local shared secret is used to calculate a response for a given challenge. This local shared secret is never transmitted as part of the authentication process.

**Note:** User ability to provision the Challenge-Response local shared secret is restricted to those individuals with administrative access (default ADMIN, UPC 4). To change the local shared secret, you will require knowledge of the old local shared secret.

- A response calculator (in the Login application of Site Manager) is used to generate a response for a given challenge using the local shared secret. The network element uses the same shared secret to validate if the response is correct for the given challenge.

If an intruder is able to gather challenge and response pairings, these pairings cannot be replayed to gain access to the equipment. The intruder may attempt to collect a number of challenge/response pairings and perform some brute force attacks in an attempt to compromise the shared secret, however for properly chosen shared secrets, this is computationally infeasible at the present time.

The challenge generator and response validator will be present on the network processor and shelf processor. The local shared secret is provisioned on each network processor and shelf processor. The provisioned local shared secret is stored locally on each network processor and shelf processor in such a way that it is not visible in clear text.

**Note 1:** The challenge-response login mechanism is always available to the user

**Note 2:** If a challenge-response login is successful, the UPC level granted to the user is derived from the level encoded into the response from the response calculator (found in the Login application of Site Manager).

**Note 3:** It is very important to note that an NP will still Save & Restore all provisioning information for **every node** provisioned in its SOC.

**Note 4:** Because of the power granted by the Challenge / Response Authentication Protocol, the local shared secret must be kept secure and must not be lost. There is no way to recuperate or change a lost local shared secret. If the local shared secret is lost, contact your Nortel Networks support group.

**Note 5:** If the response for a challenge-response login includes lowercase characters, you must enter the response in double quotes (“”) when you log in through TL1.

**Note 6:** The default local shared secret is ‘nortelnetworks’ (all in lower case). The local shared secret can be provisioned through Site Manager or TL1 and must be between 8 and 20 alphanumeric characters. To maintain case sensitivity when you provision the secret through TL1, you must enclose the secret in double quotes (“”). The double quotes are not included in the length of the secret.



**CAUTION**

**Risk of unauthorized access**

Be sure to change the default local shared secret to something only the administrative-level user knows.

### Centralized Security Administration (CSA)

OPTera Metro 3500 Release 11.0 introduced a new centralized authentication mechanism that provided additional security when accessing OPTera Metro 3500 network elements and network processors.

System administrators can provision access to be based on any one of three methods:

- Centralized user administration and authentication through RADIUS
- Local account user authentication
- Local ‘challenge-response’ user authentication

**Note:** Local account user authentication and RADIUS authentication require a user identifier and password. See [Password management on page 2-135](#) for information on password restrictions.

For information about enhanced security logs, see [TL1 event / log feature on page 2-173](#).

## Centralized user administration and authentication through RADIUS

OPTera Metro 3500 supports a Remote Access Dial-In User authentication Service (RADIUS) as a centralized authentication solution. The RADIUS Protocol is an IETF Draft Standard (RFC 2865) widely used to support remote access protocols (for example, SLIP, PPP, telnet, and rlogin). The RADIUS Protocol is a UDP-based client-server protocol. OPTera Metro 3500 implementation provides support for three messages from this protocol:

- Access-Request - message sent from the network processor to the authentication server providing user information (user ID, password, etc.)
- Access-Reject - message sent from the authentication server to the network processor refusing access to the user
- Access-Accept - message sent from the authentication server to the network processor granting access to the user

Designated network processors in an OPTera Metro 3500 network operate as RADIUS clients, responsible for passing user information to RADIUS servers, and then acting on the response which is returned. This remote authentication feature is user-provisionable, allowing system administrators to enable or disable RADIUS. When RADIUS is enabled, all user authentications are processed through the RADIUS server (that is, local account user authentication is unavailable). When RADIUS servers are unavailable or down, users will be able to log in with either local account user authentication (if provisioned as the alternate) or local challenge-response user authentication (always available).

**Note 1:** Network elements with CSA interoperate seamlessly with OPTera Metro 3000 network elements that do not support CSA or have not enabled CSA.

**Note 2:** If a user is connected by RS-232 to a shelf processor, that user will be authenticated through Centralized Authentication. If the RADIUS server is down, then the user will be prompted to select between retrying with CSA, Challenge Response or Local authentication. Local authentication will only be available if it was provisioned as the alternate authentication method.

The login-retry strategy is as follows:

- The RADIUS client on the network processor sends up to three requests to the primary server, followed by up to three requests to the secondary.
- The provisioned timeout value specifies the maximum amount of time it will take to send and wait for responses for each server. For example, with 30 seconds as the provisioned primary RADIUS server timeout value, and 20 seconds for the secondary timeout value, the requests will be sent as follows:

Time (s)	Server
T0	Primary
T0 + 10	Primary
T0 + 20	Primary
T0 + 30	Secondary
T0 + 35	Secondary
T0 + 40	Secondary

- The minimum timeout is one second. However, the minimum timeout per request is also one second. So it will take at most three seconds for RADIUS authentication to complete for each server.

**'Access-Request'**

When a network processor is configured to use RADIUS, all users of that network processor or the network element must present authentication information to the network processor. Once the network processor has obtained such information, it will create an "Access-Request" if the authentication mode was provisioned as Centralized. The network processor acting as the RADIUS gateway sends the following four parameters to the RADIUS server:

- NAS IDENTIFIER. This is the TID of the network element or network processor a user is trying to log into.
- NAS IP ADDRESS. This is the IP address of the network processor serving as the RADIUS gateway.
- user ID
- password (encrypted)

The password is encrypted through a server shared secret. The server shared secret is the key for decrypting the password, and must be provisioned separately on the network processor (through Site Manager or TL1) and on the RADIUS server.

**Note 1:** The user need only provide a user name and password. See [Password management on page 2-135](#) for information on password restrictions.

**Note 2:** There is no requirement for the user account of the RADIUS server to exist on any of the network elements or network processor.

**Note 3:** The server shared secret can be between 8 and 20 alphanumeric characters. To maintain case sensitivity when you provision the secret through TL1, you must enclose the secret in double quotes (""). The double quotes are not included in the length of the secret.

The Access-Request is submitted to the RADIUS server through the network. If no response is returned within a length of time, the request is re-sent a number of times.

Once the RADIUS server receives the request, it validates the sending network processor. If the network processor is valid, the RADIUS server consults a database of users to find the user whose name matches the request. The user entry in the database contains a list of requirements which must be met to allow access for the user.

**'Access-Reject'**

If any condition is not met, the RADIUS server sends an "Access-Reject" response indicating that this user request is invalid.

**'Access-Accept'**

Transactions between the network processor and RADIUS server are authenticated through the use of a server shared secret. Users must provision on the RADIUS server, the user's UPC level (OM3000\_UPC) and the idle time out period (Idle-Timeout). These values are returned to the gateway network processor, which is then forwarded to the network element, in the Access-Accept message from the RADIUS server. At this point, the user is granted access to the network element or network processor.

There is one RADIUS shared secret that is separately provisionable: the server shared secret. The user enters a user name and password, and the RADIUS protocol authenticates.

Users are able to provision on the NPx:

- a primary RADIUS server's IP address and port number (on the gateway network processor)
- a secondary RADIUS server's IP address and port number (on the gateway network processor)
- the primary and secondary server shared secret (on the gateway network processor)
- timeout period for each RADIUS server (on the gateway network processor)
- state of the RADIUS feature (enabled / disabled) (on the gateway network processor)
  - RADIUS feature must be enabled prior to enabling CSA feature.
- state of the CSA feature (enabled / disabled) (on the gateway network processor and the network element)
- alternate login method on the gateway network processor

Users are able to provision on the SPx:

- a network processor as the primary authentication gateway (on the network element)
- optionally, a network processor as the secondary authentication gateway (on the network element)

*Note:* A secondary authentication server is supported only if the shelf processor using this server is a member of the spans of control of both network processors acting as authentication gateways (primary and secondary).

- state of the CSA feature (enabled / disabled) (on the gateway network processor and the network element)
- alternate login method on the network element

The centralized authentication provisioning data on the network processor and shelf processors is included in database save and restore operations. The centralized authentication provisioning data on the network processor and shelf processors will survive circuit pack restarts and replacements.

*Note:* It is possible for the network elements in a span of control to be the gateway network processor to have its CSA feature enabled but for a network element in the span of control provisioned for local authentication only. This will allow a network element to interwork with other network elements running a software release that does not support CSA.

### **SecurID support**

To log in to a network processor or shelf processor using remote authentication, you must have a valid user identifier (UID) and password identifier (PID). You can use RSA Security's SecurID system to generate dynamic passwords. SecurID uses a token card to generate a pseudo-random number called the token code every 60 seconds. To log in to a network processor or shelf processor, use the 4-digit alphanumeric PIN and the 6-digit token code as the PID. The information is verified by an RSA Security ACE/Server authentication server. This ACE server must be the backend to the network processor/shelf processor Radius server or the Radius server itself.

You must send the authentication request to the ACE server during the 60 second interval when the token code displayed on the SecurID token card is valid. This feature allows for clock drift between the SecurID token card and the ACE server.

### **Secure storage of authentication data**

All local storage of authentication data is on the network element. The network element can store authentication information for up to 100 accounts. All passwords are stored in a one-way encrypted form. The network element does

not store or retain any clear text passwords in non-volatile storage. Encrypted password storage employs the DES and is stored in non-volatile memory for survival of restarts and network processor / shelf processor replacements.

**Note 1:** Any clear text representation of a password on the data entry device is suppressed by the network element. Passwords in clear text are not available to any user, including appropriate administrators. An appropriate administrator may be allowed to retrieve encrypted passwords.

**Note 2:** The network element does not support the ability to change passwords on the RADIUS server. RADIUS passwords are changed through a mechanism supplied by the RADIUS server.

### **Saving and restoring provisioning data**

OPTera Metro 3500 supports the saving and restoring of provisioning data:

- on the shelf circuit packs to and from the shelf processor
- on the shelf processor to and from the STX or VTX-series circuit packs
- on the shelf processor to and from the controlling network processor
- on the network processor to and from an external repository
- on the network processor from multiple shelf processor in the span of control
- on the shelf processor to and from a remote IP address

### **Local TL1 of provisioning data**

You can save shelf processor provisioning data to, and restore provisioning data from, the disk of a local PC running Site Manager. You can execute this procedure only through a PC connected to the shelf processor through an RS-232 or a modem connection.

### **Save and restore of shelf processor or span of control data to a remote management entity through an IP connection**

#### **Span of control**

Save and Restore functionality provides users the capability to:

- save each individual network element's backup data to the repository located on the network processor.
- transfer of a copy of each file to a given remote location immediately after the files become available following a successful backup to the network processor. Files are transferred to a remote location of destination type TID or IP.

#### **Individual shelf processor**

Users are able to target a single shelf processor for backup from the network processor's span of control. Subsequently, files are transferred automatically to a remote location of destination type TID or IP.

The existence of any blocking conditions on the shelf processor and/or the network processor can block the Save and Restore application from executing any further actions. Users are able to check for the existence of Save and Restore blocking conditions.

A Save and Restore activity can be terminated at any point before the action is complete. Users can also recommence the Save and Restore application after the application has been arrested.

### **Application of TL1 commands from a TL1 script file**

A TL1 script file is a collection of TL1 commands which by their nature impact the configuration of a network element. These TL1 commands are captured by logging the Data Base Changes commands for all individual network elements and storing them on a remote database. During a TL1 Script Load, a script file is created from the logged database TL1 commands, downloaded from the remote location, and temporarily stored on the network processor's file system. Once the file is successfully stored, each TL1 command contained in the script file is issued on the target network element following a 'commit'.

The user is able to apply TL1 scripts to a single network element after the Restore process by issuing a TL1 Script-specific set of commands to Load and Commit TL1SCRPT to that specific network element. This process is similar to the Restore and Commit Provisioning data applications. TL1 commands issued to the targeted network element from the TL1 script that did not complete successfully are logged onto that targeted network element.

### **Security levels**

OPTera Metro 3500 network elements and network processors support multiple security access levels. This feature reduces accidental or intrusive interruption of service.

There are five UPC security levels that allow a range of task execution capabilities:

#### **Level 5**

- Surveillance allows surveillance of all network elements in the network processor span of control. A user account with a level 5 UPC can only be used to log into a network processor using a local connection. A user account with a level 5 UPC is valid only under the following circumstances:
  - a login to the network processor from Preside or a managed object agent (MOA)
  - a login to the network processor, if the network processor is the gateway to the network



**Level 4**

- Administration allows complete access to all commands, except for automatic surveillance of all network elements in the network processor span of control. It is recommended that levels 1 through 4 are used to log in to a network element.

**Level 3**

- Provisioning allows access to provision, test, edit, and retrieve commands.

**Level 2**

- Control allows access to control and retrieve commands but not to provisioning.

**Level 1**

- Retrieve allows the user to execute retrieve and report related commands. Because of its limits, level 1 is appropriate for monitoring purposes.

The network processor and shelf processor come programmed with two default accounts named SURVEIL (level 5 access) and ADMIN (level 4 access).

Up to 100 accounts can be created for one network element but only six user sessions using these accounts can be active at one time on one network element.

Up to 99 accounts can be created for one network processor, but only 34 user sessions using these accounts can be active at one time on the network processor. Only two of these accounts can have a level 5 UPC.

**Third Level 5 User Support/Increased NPx SOC visibility to 16 NEs**

OPTera Metro 3500 supports three surveillance user (level 5) with each users having visibility of NPx's span of control up to 16 network elements.

**Engineering rules**

The following engineering rules apply to the third level 5 user feature:

- A maximum of 16 network elements can be managed by any active level 5 user within the NPx span of control.

A unique user account ID (UID) is required for each level 5 user if there are more than one active level 5 user logged in to the NPx.

**System identifier (SID)**

Each network element and network processor has a unique name, called a system identifier (SID). The SID is set up during the provisioning process and indicates the position and function of a network element or network processor in a network.

The SID must be between 1 and 20 characters (inclusive). It cannot contain spaces or the following symbols:

\:

OPTera Metro 3500 MSP MOA does not support the following symbols in the SID:

<;

### **Remote login**

Commands cannot be sent to a network element or network processor until an account is activated on that node. The network processor is considered to be a remote login.

Because network elements are normally in different geographic locations, remote maintenance and fault identification is not possible without remote login.

When addressing a command to a local or remote network element or network processor, the SID to which the command is addressed is called the target identifier (TID).

### **Multiple login sessions**

Several user accounts can be active at the same time. When several sessions are active, commands can be sent to any network element on which the sessions are active.

Alarms, events and performance monitoring reports are displayed for all network elements or logged in network processors.

The network element and network processor allow multiple concurrent login sessions through local or remote connections.

A local connection includes:

- connecting to an RS-232 port
- connecting to an NPx over X.25
- connecting to an NPx over TCP/IP
- setting up an rlogin session from an OC-12 TBM, OC-48, OC-192, Connect DX or OPC, to a shelf processor or network processor.

A remote connection is a login session from a local connection to any other available network element or network processor.

**SPx login sessions**

The maximum number of incoming login sessions to the network element is six. The login maximum of six is broken down into the following login max restrictions:

- maximum two physical (local) connections
- maximum one direct debug (local) connection
- maximum three remote connections (for example, ACT-USER from Connect DX)

*Note:* There is no limit on the number of sessions for each user ID. The same user ID can be used to log in up to six times.

The maximum number of outgoing login sessions from a network element is 20.

**NPx login sessions**

The network processor allows the following multiple concurrent login sessions through local or remote connections:

- two rlogin sessions from a network element or network processor
- the recommended maximum number of TCP/IP sessions is five
- 16 X.25 sessions
- 16 OSI connections for the span of control. For maintenance purposes, this capability allows simultaneous control and surveillance of a full network processor span of control or 16 network elements.
- the maximum number of logins to a network processor (a combination of local and remote) is 34.
- a maximum of three remote connections (for example, ACT-USER from Connect DX)
- a maximum of three level 5 user accounts can be active at the same time.

**Enhanced Intrusion Detection**

OPTera Metro 3500 provides the capability to detect and report the true originating address of any access attempts to the NP or SP. These access attempts include remote login, from one NE to another, or a local login (telnet, X.25, RS232 or passthrough). In the case of remote logins, the originating address and connection type of each login request is sent to the remote network element.

Once the intrusion threshold for an address has been reached, the intrusion detection feature shall prevent any further access attempts from the same originating address.

For remote login, for example, a remote login from telnet port 10001, the intrusion detection feature will not block the intermediate nodes, instead the IP address from the telnet connection from which the request was initiated will be blocked.

For more information about intrusion detection feature, please see [Intrusion attempt handling on page 2-134](#).

### **Intrusion attempt handling**

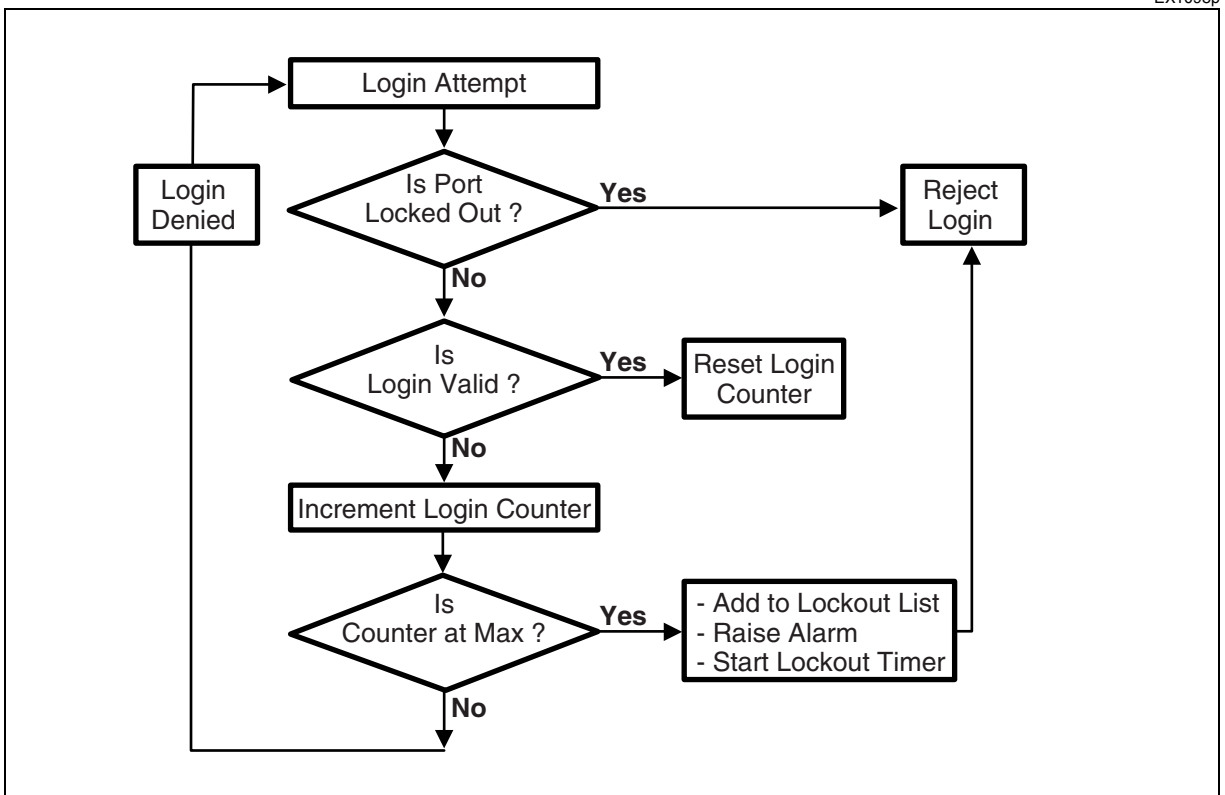
Intrusion attempts on the OPTera Metro 3500 network elements are alarmed and displayed when incoming access is attempted but fails due to incorrect user-ID or password. This alarm alerts administrators of intrusion after a provisionable number of failed login attempts.

Every time users log in to a shelf they must give a user ID and a password. If the information they enter corresponds to a valid userid and password they are allowed access to the shelf. If the user ID or password is wrong, they are allowed to re-enter the user information to try again and a counter is advanced incrementally by one. The provisionable range of invalid logins is between 2 and 9 before the port is locked out. The default value is 5 login attempts.

Users are locked out based on their originating address. Once the counter reaches the maximum number of invalid attempts the port is locked out for the required amount of time. An alarm is then raised to inform the system administrator that an intrusion attempt has occurred. Security logs will record the originating address and connection type of invalid access attempt to the NP or SP. [Figure 2-42 Logical flow of intrusion attempt handling](#) shows how the mechanism works.

Intrusion attempt handling is disabled by default.

**Figure 2-42**  
**Logical flow of intrusion attempt handling**



## Password management

### Password restrictions

For the OPTera Metro 3500 network element, use a password identifier (PID) to activate a user login session to the user-ID (UID) specified, or to change the current PID. The PID is a confidential code to qualify the authorized system user's access to the account specified by a UID. PIDs are between 8 and 10 characters in length with a combination of alphanumeric (A-Z, 0-9) and special characters. The following special characters are supported for the password:

! " # \$ % ' ( ) \* + - . / < = > @ [ ] ^ \_ { | } ~

See [Enhanced password restrictions on page 2-136](#) for password restrictions.

The following characters are not supported for the PID:

- semicolon (;)
- colon(:)
- ampersand (&)
- comma (,)
- all control characters

- spaces (deleted as entered), lowercase (switched to uppercase as entered)
- question mark (?)

**Note 1:** Carriage returns (the <Enter> key) are always ignored in the TL1 interface.

**Note 2:** To maintain case sensitivity when the password includes lowercase characters, you must enclose the password in double quotes (“”). The double quotes are not included in the length of the password. When you enclose the password in double quotes, you cannot include a backslash (\), space, or double quote as part of the password.

#### **Enhanced password restrictions**

Enhanced password restrictions force you to choose more secure passwords using a password checking algorithm that satisfies the following requirements:

- a user can choose as their password, an existing password that is already associated with another user ID thereby never divulging an existing password
- passwords must be at least eight characters in length and contain a combination of alphanumeric characters including at least one alphabetic and at least one numeric or special character as listed above
- passwords cannot contain the associated user-ID
- the network element provides a mechanism that prevents a user from selecting a password that is part of the specified set of excluded passwords, such as locally used acronyms and surnames.
- to maintain case sensitivity when the password includes lowercase characters, you must enclose the password in double quotes (“”)

#### **Password Reuse**

To ensure that users do not reuse passwords, the following requirements are enforced:

- there is a minimum waiting period (provisionable from 0 to 999 days) before an existing password can be updated
- the reuse of the most recently used five passwords is not allowed

#### **Password Aging**

Password aging forces users to change their passwords periodically. The longer a password remains in use, the greater the chance an intruder can discover that password. When you change your password frequently you reduce the chance of an intruder break-in.

The password aging interval can be set on a per user-ID basis. The User Privilege Code (UPC) 4 and 5 accounts cannot be disabled because of password aging which ensures that there is always a way to login to the network element. Users will be prompted for password changes accordingly.

Users with UPC 1 through 3 will not be allowed to log in if their passwords have expired. There are two password modes for level 1 through 3 accounts: 'Assigned' and 'Valid'.

- A user password is in 'Assigned' mode when the system administrator was the last person to change the password (that is, initial account creation or user forgot password). At this point, the system administrator and the user both know the password. The user is expected to change his/her password to one that only he/she knows.
- A user password is in 'Valid' mode when the user password was last changed by the user (that is, in this situation, the user is the only person who knows the password).

The following intervals are provisionable by a level 4 or 5 user to support password aging:

- Password Expiry Period: the length of time after which the password is no longer valid.
- Password Validation Period: if the system administrator is the last person to change the password (for example, initial creation of account or user forgot password), the period of time a user has to change the password before it expires.
- Password Warning Period: the number of days prior to password expiration that is presented in a warning message upon logging into the network element.
- Password Change Period: a specified minimum waiting period before an existing password can be updated.

#### **Temporary Accounts**

You can use the password aging feature to implement a temporary user account feature. A temporary account is specified upon creation and denies the user access when the password expires. A temporary account is created by enabling password expiry, disabling password validation, and setting the password change period one day longer than the password expiry period. These settings force the expiry of the password before it can be changed.

For information about the Challenge Response Authentication Protocol, see [Centralized Security Administration \(CSA\) on page 2-124](#).

### **Customer managed networks**

This feature provides transport functionality that allows security of the SDCC network and allows you to block a customer node from another customer's node at a level beyond Userid and Passwords in the network. This functionality adds an extra layer of security and lowers the potential of intrusion to blocked nodes.

OPTera Metro allows any user with a UPC level 4 and above to add, delete, or retrieve the Access Control List (ACL) for a node. Each OPTera Metro network element supports an ACL which allows a customer to provision nodes onto an allow or deny list. These lists determine whether or not another node is allowed to access the relevant node. The ACL provisioner has the flexibility to define separate outgoing and incoming access. Your customers modify their own lists but are restricted to incoming access only. In other words, the customer provisions the nodes that are able to access their node.

An Incoming network violation alarm is raised when a denied node attempts to gain access.

### **Security log audit trail**

The security log, by default, records all TL1 commands on the network element that require level 2 access or higher with the following level 1 command exceptions:

- ACT-USER, CANC-USER, ED-SECU-PID
- ALW-MSG-ALL
- INH-MSG-ALL

The caption of the security log includes the following:

- date and time of the event
- user identification
- type of event
- names of resources accessed
- success or failure of event

The following events are recorded in the security log:

- all user login and logouts
- invalid user authentication attempts (as well as alarm/alerts generated due to invalid authentication attempts)
- authorized commands (according to user class)
- changes made in a users security profiles and attributes
- changes made in security profiles and attributes associated with a channel or port
- changes made in the network element's security configuration

These logs are archived in a circular buffer resident on the SPx or NPx and accessible through Site Manager's Security menu. The circular buffer has a capacity of 600 logs per node (estimated 1 week's activity). Logging on to Preside or Site Manager is not recorded. The Login is limited to operations on Site Manager/Preside that invoke (directly or indirectly) TL1 commands and



events on the local network element as opposed to a network level view. Further, the events shall be categorized by a Log Name which is indicative of the situation that caused the log. See [Log Names on page 2-139](#).

**Table 2-28**  
**Log Names**

Log name	Log events
SECU400 User Login/Logout	<p>This log indicates a user login/logout from one of the system ports.</p> <p>This log will indicate invalid login attempts, noting whether</p> <ul style="list-style-type: none"> <li>• the password was wrong for a valid user id</li> <li>• the userid was invalid</li> <li>• the password had expired</li> </ul> <p>The TL1 commands logged under this category are ACT-USER and CANC-USER.</p>
SECU401 Unauthorized Command Attempted	<p>This log indicates a user's attempt to perform an action that is not permitted by the UPC assigned to that user ID. For example, when a UPC level 1 attempts a UPC level 4 command like DLT-SECU-USER.</p>
SECU406 Valid Command Use	<p>This log records authorized command use according to user privilege code (UPC). All TL1 commands included in LOGEVENTS are logged, except for those level one and Preside login commands previously mentioned.</p>
SECU407 Login Time Out	<p>This log indicates the login time-out on system ports.</p>
SECU408 Intrusion Attempt	<p>This log indicates multiple login failure on system ports. The log is generated when the maximum number of login attempts are exceeded.</p>
SECU410 Customer Managed Networks Log	<p>This log indicates the successfully logged-in users from remote nodes that have accessed the network element. This implies the user is on the access list for the network element.</p>
SECU412 Customer Managed Networks Log	<p>This log indicates the unsuccessful log-in attempts from remote nodes that have tried to access the network element. This implies the user is on the deny list for the network element.</p>

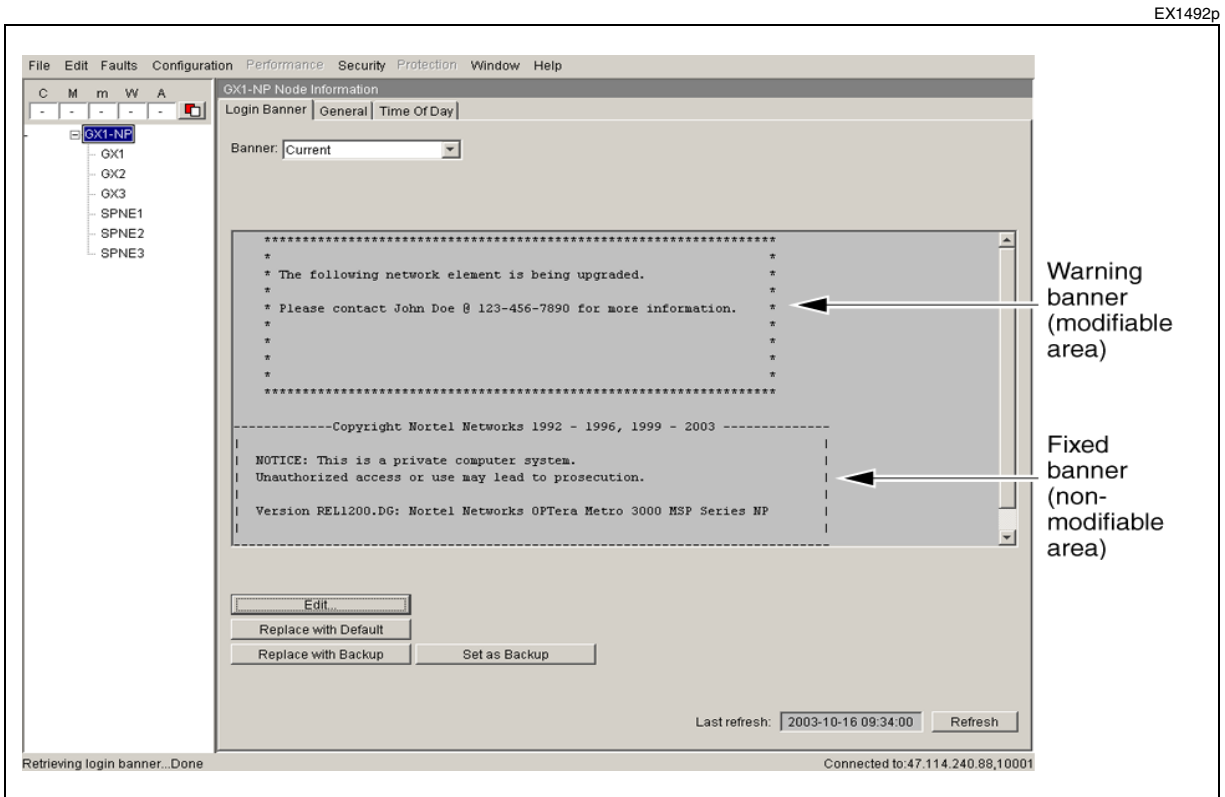
**General Broadcast tool**

General Broadcast (GB) tool which allows users that are logged in to network elements to send and receive messages. The purpose of the General Broadcast tool is for sending and receiving messages to and from all NEs or to a particular NE in which users are logged in to.

### Modifiable Login Banner

The default login banner is subdivided into two parts: a warning banner and a fixed banner part, see [Figure 2-43 on page 2-140](#). Users can modify the login warning banner with their own warning message, the fixed banner part is not modifiable. Both banners will be displayed following a successful connection to network element (SPx or NPx).

**Figure 2-43**  
**Example of Modified Login Banner**

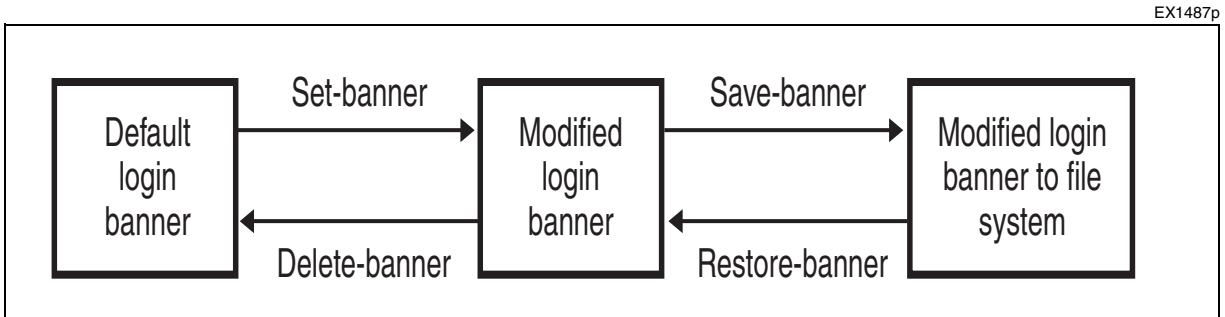


The modifiable login banner falls into 3 categories:

- the default login banner, which is displayed in the first entry point of the login if user does not modify the warning banner or deletes the modified login banner.
- the current modified login banner which is displayed following a successful connection.
- the backup modified login banner that is saved in the file system. The current modified login banner can contain a temporary warning message notifying users logging into the network element that a maintenance activity (i.e. upgrade, reconfiguration, etc.) is taking place.

Once the temporary warning message is no longer needed, the backup modified warning banner can be restored. [Figure 2-44 on page 2-141](#) illustrates how these banners work.

**Figure 2-44**  
**Login banner functionality**



### Engineering rules

The following engineering rules apply to the modified login banner feature:

- The maximum size of the modified login banner (including boundaries) shall be 20 lines by 71 characters.
- Only 18 lines in Warning Login banner are modifiable, the remaining 2 lines are reserved for the boundary before the first and last line of the warning banner.
- Each line consists of 71 characters, however only 63 characters in the banner line can be modified.

**Note:** The “\*” boundary is automatically added around the login banner.

- The login warning message can be modified on a per network element (i.e. SPx or NPx) or to all network elements in a NP's span of control through TL1 using TID = All.

**Note:** Applying the modified login banner to all NEs through Site Manager is achieved in one of two methods:

- TL1 Command Builder tool to generate a script which then can be used to apply the modified login banner to all NEs.
- Site Manager's cut and paste capability to apply the modified login banner text to each individual NE through the Login Banner application.
- Modified login banner data on the SPx and NPx is maintained during;
  - warm restarts
  - cold restarts
  - during network element power cycles

- The following operations Set, Save, Delete and Restore can not be executed if one or more of the following conditions exist on the SPx or NPx;
  - Upgrade in Progress
  - Load Mismatch (for SPx)
  - Duplicate SID
  - Database Save and Restore in Progress
- The following operations Set, Save, Delete and Restore can not be executed if the following condition exist on the SPx or NPx;
  - Disk Full

### STS Managed DSM

OPTera Metro 3500 offers DS1 services off STS based platform. DS1s are mapped to the DSM, in groups of 28: 1-28, 29-56, 57-84) in to individual STS1s. The STX-192 circuit pack switches the STS1s through the network.

Figure 2-45 on page 2-142, shows an example of an end-to-end connections of STS-managed DS1 facilities in an OC-192 ring, as supported in this release.

**Figure 2-45**  
**End-to-end connections of STS-managed DS1 facilities off an OC-192 ring**

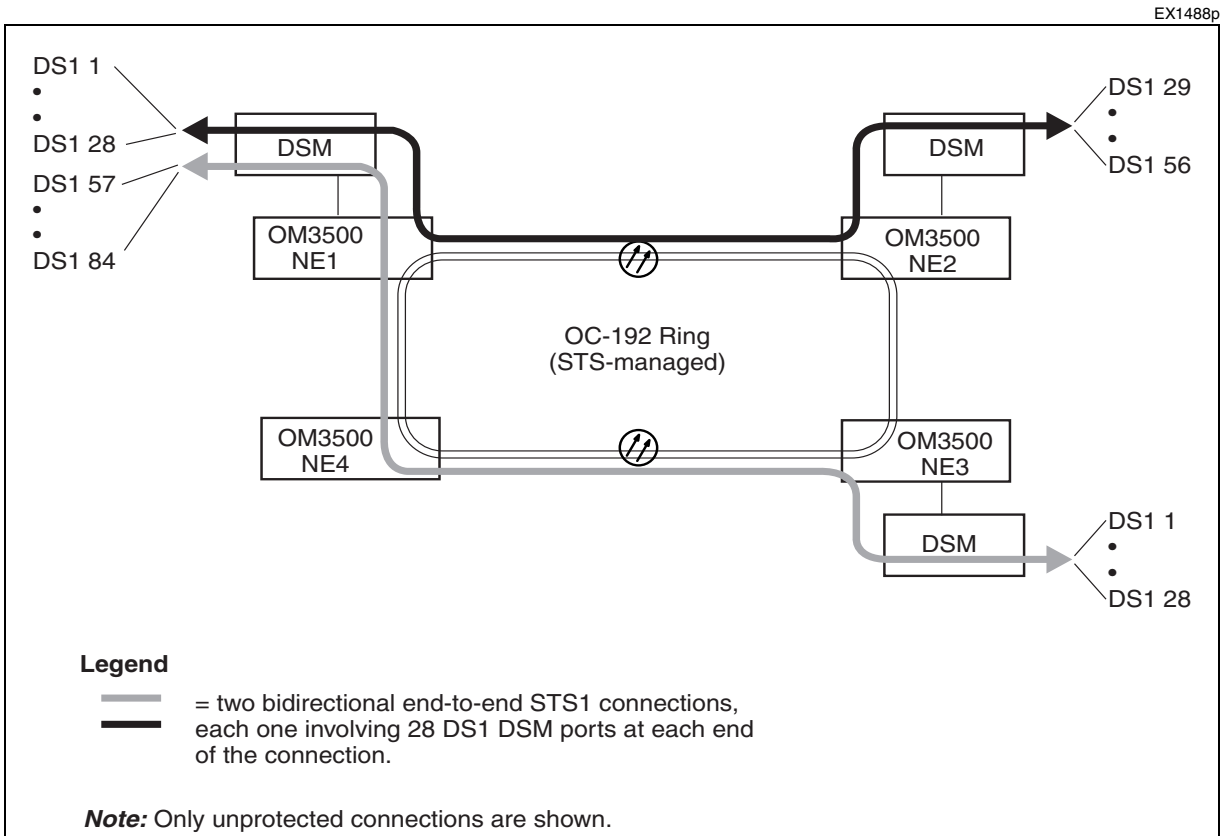


Figure 2-46 on page 2-143, shows an example of hybrid (VT & STS-managed) end-to-end connections in an OC-192 ring.

**Figure 2-46**  
**Hybrid end-to-end connections of DS1 facilities in an OC-192 ring**

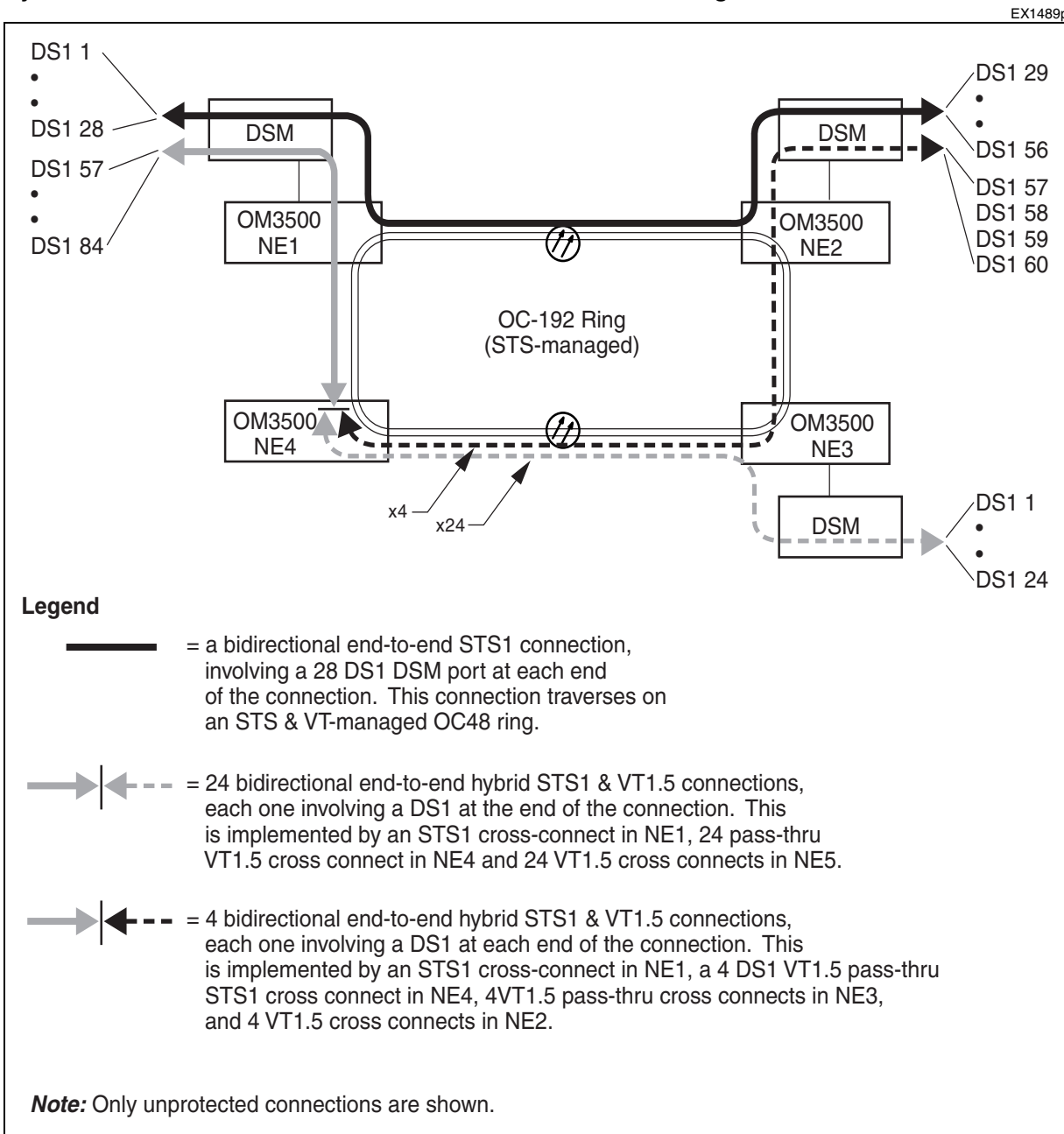
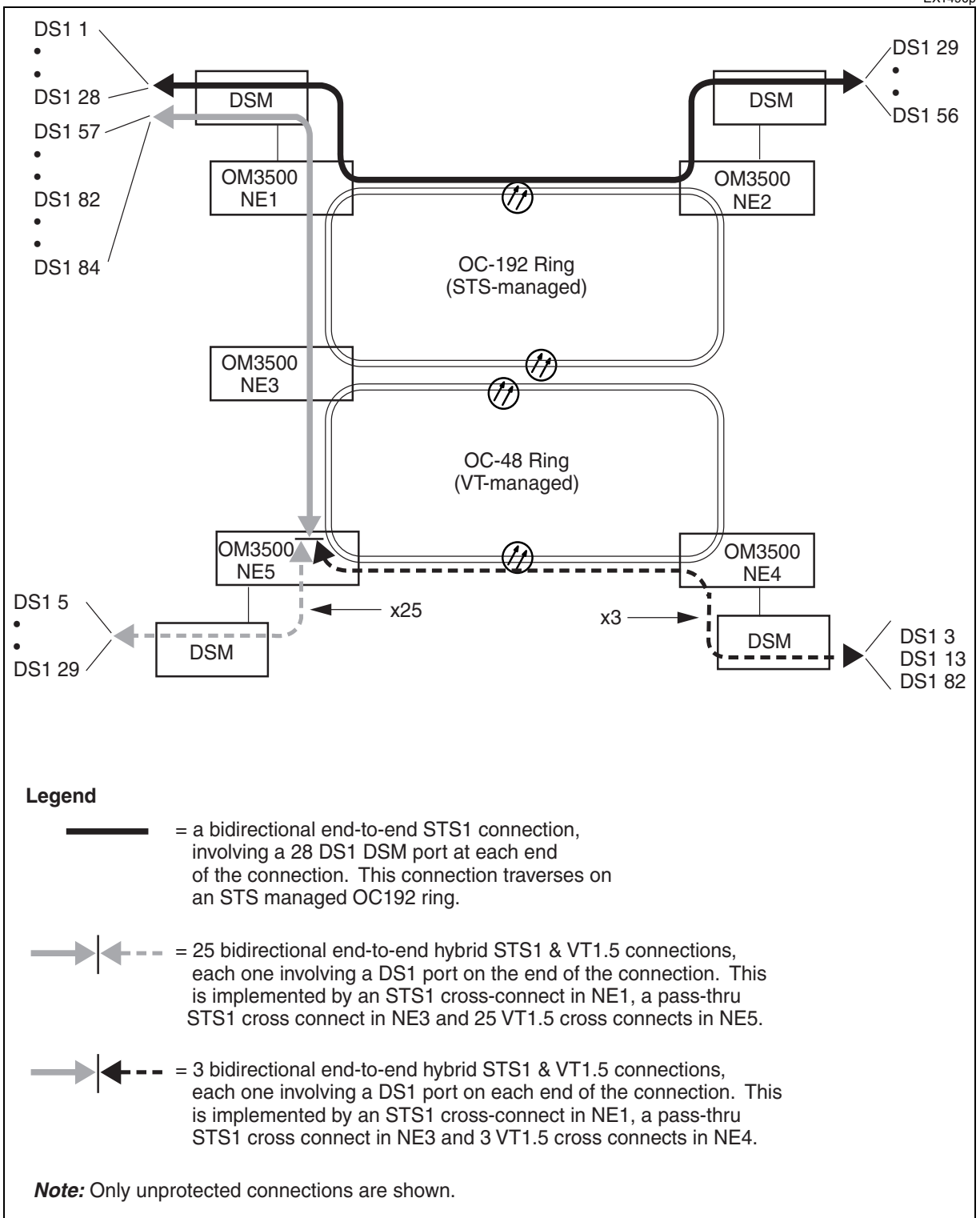


Figure 2-47 on page 2-144 shows an example of hybrid (VT & STS-managed) end-to-end connections in an OC-192 ring.

**Figure 2-47**  
**Hybrid end-to-end connections of DS1 facilities off an OC-192 ring**

EX1490p



A STS-1 managed DS1 facility is cross connected to other endpoints in the NE together with the other 27 DS1 facilities in one of the three facility groups on the OC-3 card on the DSM by connecting the STS1 that corresponds to that group of facilities. [Table 2-29 on page 2-145](#) provides the STS1 endpoints to DS1 facility grouping assignments.

**Table 2-29**  
**STS1 endpoints to DS1 facility grouping assignments**

<b>STS1 AID</b> Where <hslot> = 3 through 10 <hport> = 1 through 4	<b>STS1 AID is used to perform BWM operations on the group of DS1 facilities:</b>
OC3-1-1-1-%HLINK-OC3-<hslot>-<hport>	in ports 1 through 28 of a DS1 DSM
OC3-1-1-2-%HLINK-OC3-<hslot>-<hport>	in ports 29 through 56 of a DS1 DSM
OC3-1-1-3-%HLINK-OC3-<hslot>-<hport>	in ports 57 through 84 of a DS1 DSM

The STS-1 managed DSM will support the following STS-1 PM parameters:

- Code Violation-Path (CV-P)
- Errored Seconds-Path (ES-P)
- Severely Errored Seconds-Path (SES-P)
- AIS/LOP Seconds-Path (ALS-P)
- Unavailable Seconds-Path (UAS-P)

### Engineering rules

The following engineering rules apply to the STS-1 managed DSM feature:

- OPTera Metro 3500 shelves equipped with STX-192 circuit packs (in slots 13 and 14) only supports STS-1 managed DS1 facilities.
- OPTera Metro 3500 shelves equipped with VTX-series circuit packs (in slots 13 and 14) support both VT and STS-1 managed DS1 facilities.
- STS-Managed DS1 facilities do not support individual Connection IDs, instead the STS1 cross connection can be assigned a Connection ID.
- Site Manager will support:
  - STS-managed circuits.
  - VT managed circuits.
  - mix of STS & VT managed circuits.
- STS-1 managed DSM provisioning data will survive:
  - upgrades
  - SPx replacement
  - Save and Restore operations
- You can not provision an STS1 cross connect between DS3 circuit pack to an STS-1 managed DSM.
- You can not provision DS1 facilities on DS1 DSM to DS1 facilities on channelized DS3 circuit pack using a single STS1-level bandwidth management command. The channelized DS3 circuit packs is VT-managed which is not supported by the STS-managed STX-192 circuit pack.

### Support for 12 DSM

OPTera Metro 3500 Release 12.0 and higher supports 12 protected or unprotected DSMs. The DSM units could be configured as:

- STS managed only (with STX-192 circuit pack in slots 13 and 14).
- STS managed only (with VTX-series circuit packs in slots 13 and 14).
- STS or VT Managed combination (with VTX-series circuit packs in slot 13 and 14).
- VT managed only (with VTX-series circuit packs in slots 13 and 14 only).

### Synchronization

SONET-based equipment derives many of its basic attributes from synchronous operation. Synchronization is required in networks that contain

- add/drop multiplexers (ADMs)
- synchronous tributaries



These configurations require synchronization among the network elements to avoid the effects of the SONET synchronous transport signal pointer repositioning within the frame. When a network element is synchronized, all synchronous tributaries and high-speed signals generated by that network element are synchronized to its timing source.

Normally, one network element in a ring (UPSR or BLSR) is externally timed. To protect the network timing against complete nodal failure, two network elements in a ring can be externally timed.

See [Figure 2-49 on page 2-155](#) for an example of a network showing the synchronization flow, head-end network element, synchronization boundary, and synchronization status messaging.

Each network element is synchronized by one of the following methods:

- internal timing
- external timing
- line timing

### **Internal timing**

A SONET-compliant free-running clock produced within the network element provides internal timing. Network elements with VTX-48, VTX-48e and STX-192 modules provide timing signals of Stratum 3 (ST3) quality.

### **External timing**

An external timing signal is obtained from a building-integrated timing supply (BITS) clock of ST3 or better.

### **Line timing**

Line timing is when a timing signal is derived from an incoming SONET frame (OC-3, OC-12, OC-48, OC-192), DS1 facility or EC-1 facility.

*Note 1:* Line timing is derived from DS1 circuit pack (NTN430AA, BA) in OPTera Metro 3500 shelf equipped with VTX-series circuit packs.

*Note 2:* Line timing is derived from EC-1x3 (NTN436AA) circuit pack.

There are two types of line timing: transport and tributary.

#### **Transport line timing**

Transport line timing is shown in [Figure 2-49 on page 2-155](#), example c).

When using transport line timing, a network element derives timing from a received transport signal. Possible sources of transport line timing are OC-3, OC-12, OC-48 and OC-192 facilities.

**Tributary line timing**

Tributary line timing is shown in [Figure 2-49 on page 2-155](#), example d). When using tributary line timing, a network element derives timing from a received tributary signal. Possible sources of tributary line timing are OC-3, OC-12, OC-48, DS1, and EC-1 facilities.

**Note 1:** Tributary line timing is derived from DS1 circuit pack (NTN430AA, BA) provisioned in OPTera Metro 3500 shelf equipped with VTX-series circuit packs. DS1 lining timing is not derived from the DSM modules.

**Note 2:** Tributary line timing is derived from EC-1x3 (NTN436AA) circuit pack.

When the network element timing mode is set to Line Timing (no distinction is made between Transport or Tributary on the user interface), it selects one of up to two provisioned timing sources (primary and secondary timing references) as the active timing reference. This signal is used in network elements to synchronize the outgoing transport signals in all directions, and the synchronous tributaries terminated by the network element. The selection of the best quality signal is made based on the stability of the transport signal, the synchronization message, and any incoming synchronization status provisioned by the user. For more information on synchronization messaging, see [Synchronization-status messages on page 2-156](#).

**Table 2-30**  
**Timing signal sources**

<b>Internal timing mode</b>	
VTX-48, VTX-48e or STX-192 circuit pack	provide timing signals of ST3 quality
<b>External timing mode</b>	
BITS In A BITS In B	building-integrated timing supply (BITS) provide a clock of ST3 quality or better
<b>Line timing mode (transport / tributary)</b>	
OC-3	slots 3 through 10
OC-3x4	slots 3 through 10
OC-12	slots 3 through 12
OC-12x4 STS	slots 3 through 10 (see <a href="#">Note 1</a> )
OC-48	slots 11 and 12 (see <a href="#">Note 2</a> )
OC-48 STS	slots 3 through 12 (see <a href="#">Note 1</a> )
OC-192	slots 11 and 12 (see <a href="#">Note 1</a> )

**Table 2-30 (continued)**  
**Timing signal sources**

DS1	slots 3 through 10 (see Note 2)
EC-1x3	slots 3 through 10
<b>Note 1:</b> Requires STX-192 circuit packs provisioned in slots 13 and 14.	
<b>Note 2:</b> Supported on shelved equipped with VTX-series circuit packs in slots 13 and 14.	

The best timing reference source is a high-level stratum clock.

### Timing modes

The four possible timing modes for OPTera Metro 3500 network elements are:

- Free run. See [Free run mode on page 2-149](#).
- Acquire. See [Acquire mode on page 2-149](#).
- Normal. See [Normal mode on page 2-149](#).
- Holdover. See [Holdover mode on page 2-149](#).

#### Free run mode

Free run mode is a target mode that can be provisioned by the user. In free run mode, the voltage-controlled crystal oscillator (VCXO) clock in the module is not locked to a timing reference and runs at its natural frequency. Network elements with STX and VTX-series circuit packs provide timing references of ST3 quality.

#### Acquire mode

Acquire mode is not a mode that the user can provision. Acquire mode is the current mode when the VCXO clock in the module tracks a timing reference and the timing-mode-maintenance software quickly brings the clock frequency into approximate agreement with the timing reference frequency. That reference may be the 8-kHz timing signal derived from an incoming SONET signal, a DS1 signal, or BITS inputs. The signal format of the BITS input can be set to DS1 or composite clock.

#### Normal mode

Normal mode is a mode that can be provisioned by the user. When this is the current mode, the VCXO clock in the module locks to a timing reference. Normal mode is used during trouble-free operations.

#### Holdover mode

Holdover mode is not a mode that the user can provision. The module enters holdover mode automatically if the target mode is normal but all timing references have become unavailable. If the module enters holdover mode, the VCXO clock in the module holds within a certain frequency range of the last locked-in timing reference. When a timing reference becomes available again,

the module automatically enters acquire mode. The maximum time a module can remain in holdover mode is 24 hours. After 24 hours, the module enters the free run mode.

### Stratum clocks

Stratum clocks are stable timing reference signals that are graded according to their accuracy. American National Standards Institute (ANSI) standards have been developed to define four levels of stratum clocks. The accuracy requirements of these stratum levels are shown in [Table 2-31 on page 2-150](#).

**Table 2-31**  
**ANSI-required standard clock strata**

Clock quality	Minimum accuracy	Minimum holdover stability
Stratum 1	$\pm 1.0 \times 10^{-11}$	not applicable
Stratum 2	$\pm 1.6 \times 10^{-8}$	$1 \times 10^{-10}$ per day
Stratum 3	$\pm 4.6$ ppm	$\pm 0.37$ ppm during first 24 hours
SMC	$\pm 20$ ppm	$\pm 4.6$ ppm during first 24 hours
Stratum 4	$\pm 32$ ppm	not required

### Synchronization hierarchy

A synchronization hierarchy is a network of stratum clocks that contains one stratum 1 clock and several lower stratum clocks, as shown in [Figure 2-48 on page 2-152](#). The stratum 1 clock sends a reference signal to several stratum 2 clocks. These stratum 2 clocks, in turn, transmit synchronization signals to other stratum 2 and stratum 3 clocks. Similarly, stratum 3 clocks synchronize other stratum 3 and stratum 4 clocks.

For reliable operation, the synchronization network includes primary and secondary synchronization facilities to each stratum 2 and 3 node, and to many stratum 4 nodes. In addition, each stratum 2 and 3 node is equipped with an internal clock that can bridge short disruptions to the synchronization reference.

Each network element transmits a synchronization-status message (SSM) from all SONET interfaces (DS1, EC-1x3, OC-3, OC-12, OC-48 and OC-192). When the timing reference to a network element is disrupted, the network element enters holdover mode.

A network element in holdover mode transmits timing signals with the quality level of its internal clock, depending on the quality of the alternate timing reference. If the alternate timing reference is of a higher quality than the internal clock of a network element, then the network element uses the alternate timing reference. [Table 2-32 on page 2-151](#) describes the transmitted

timing signal quality from a network element in holdover mode in the event a timing reference is disrupted. See [Synchronization-status messages on page 2-156](#).

**Table 2-32**  
**Transmitted timing signal quality in holdover mode**

Module	Quality of disrupted timing reference	Quality of transmitted timing signal in holdover mode
VTX-48	≥ ST3	ST3
	< ST3 (NE ignores signal)	ST3
VTX-48e	≥ ST3	ST3
	< ST3 (NE ignores signal)	ST3
STX-192	≥ ST3	ST3
	< ST3 (NE ignores signal)	ST3

### Hierarchy violations

A hierarchy violation occurs when a clock of one stratum level is used to synchronize a clock of a higher stratum level. A stratum 3 clock synchronizing a stratum 2 clock is one such example. The synchronization network must be carefully planned so that no hierarchy violations occur.

### Timing loops

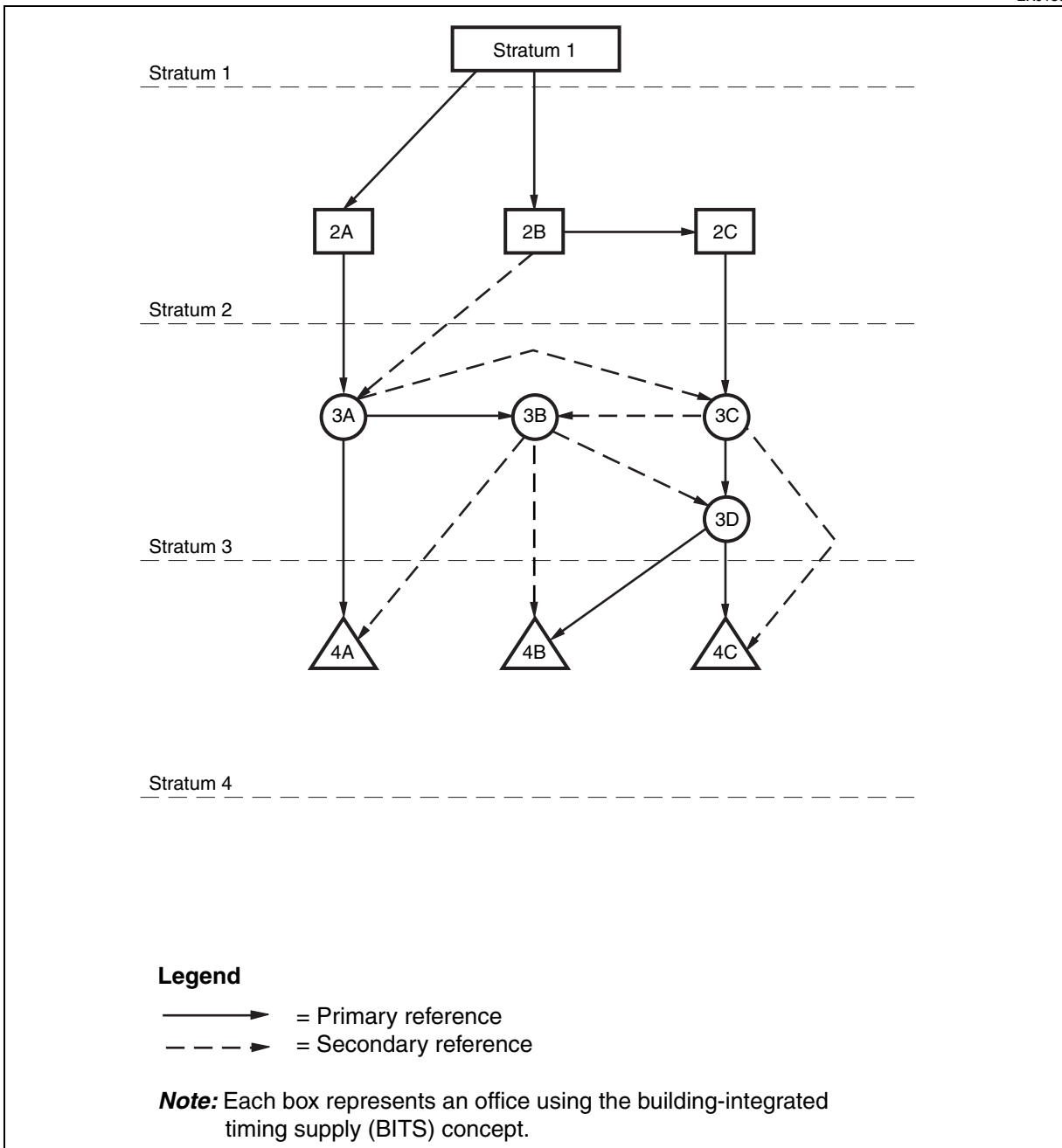
A timing loop is created when a clock is synchronizing itself, either directly or through intermediate equipment. A timing loop causes excessive jitter and can result in traffic loss.

Timing loops can be caused by a hierarchy violation, or by having clocks of the same stratum level synchronize each other. In a digital network, timing loops can be caused during the failure of a primary reference source, if the secondary reference source is configured to receive timing from a derived transport signal within the network.

A timing loop can also be caused by incorrectly provisioned synchronization status message (SSM) for some of the facilities in a linear or ring system. Under normal conditions, if there is a problem in the system (for example, pulled fiber), the SSM functionality will heal the timing in the system. However, if the SSM is incorrectly provisioned, the system might not be able to heal itself and might segment part of itself in a timing loop.

**Figure 2-48**  
**Hierarchical network synchronization**

EX0130



**Building-integrated timing supply (BITS)**

The building-integrated timing supply (BITS) concept requires that all digital equipment in a physical structure must receive timing from the same master clock. This master clock is the most accurate and stable clock in the structure. The BITS is driven by a Stratum 3 or better reference signal. This signal can come from the following sources:

- a timing signal derived from a SONET signal, such as the output of a BITS Out source in an OPTera Metro 3500 network element
- an external stratum clock

The BITS distributes a DS1 signal to all equipment in the same physical location.

The implementation of BITS has the following advantages.

**Performance**

The designation of a master timing supply for each structure simplifies and enhances the reliability of the timing distribution. The BITS concept minimizes the number of synchronization links entering a building, since each piece of equipment no longer has its own external timing source.

**Utilization of resources**

A single, high-quality reference timing source can be shared among many services within the office because BITS provides a large number of signals for distribution.

**Operations**

Record keeping for provisioning and maintenance purposes will be easier when new digital services are introduced because BITS is location-dependent, not service-dependent.

**Network element synchronization modes**

Different modes of synchronization are defined for the network element, depending on the timing source:

- internal timing. See [Internal timing on page 2-153](#).
- external timing. See [External timing on page 2-154](#).
- line timing. See [Line timing on page 2-154](#).
- tributary timing. See [Tributary line timing on page 2-155](#).

See [Figure 2-49 on page 2-155](#).

**Internal timing**

Internal timing is shown in [Figure 2-49 on page 2-155](#), example (a).

Internal timing is provided by a SONET-compliant free-running clock within the network element.

When the network element timing mode is set to Internal, the synchronization block in the STX and VTX-series circuit pack produces network element timing without any external timing sources. In Internal timing mode, the STX and VTX-series circuit packs provide a network element timing quality defined in [Table 2-32 on page 2-151](#).

#### **External timing**

External timing is shown in [Figure 2-49 on page 2-155](#), example (b).

An external timing signal can be obtained from a BITS clock of stratum 3 quality or better.

External timing uses a timing source independent of any internal clock or received transport signal. The external timing source is a highly accurate stratum clock. If the external source is lost, the STX and VTX-series circuit packs provide network element timing internally, for short periods, based on the last received reference (a function called holdover).

Primary and secondary timing references can also be provisioned; for example, the primary timing reference is set to BITS-A and the secondary reference is set to BITS-B. The system selects the active timing reference based on the stability of the transport signal, the synchronization message, and any incoming synchronization status provisioned by the user.

An external timing signal can be obtained from a BITS clock of stratum 3 or better.

#### **Line timing**

Line timing is a signal derived from an incoming SONET frame (EC1, OC-3, OC-12, OC-48 or OC-192) or an incoming DS1 signal.

Transport line timing is shown in [Figure 2-49 on page 2-155](#), example (c).

When using transport line timing, a network element derives timing from a received transport signal. The network element selects one of the two timing sources (primary and secondary timing references) as the active timing reference. The selection is made based on the stability of the transport signal, the synchronization message, and any incoming synchronization status provisioned by the user. (For information on synchronization messaging, see [Synchronization-status messages on page 2-156](#).) The derived signal is used in the network element to synchronize outgoing transport signals in both directions, and all synchronous tributary signals terminated by the network element. The quality of synchronization depends on the stability of the transport signal received from the remote end.



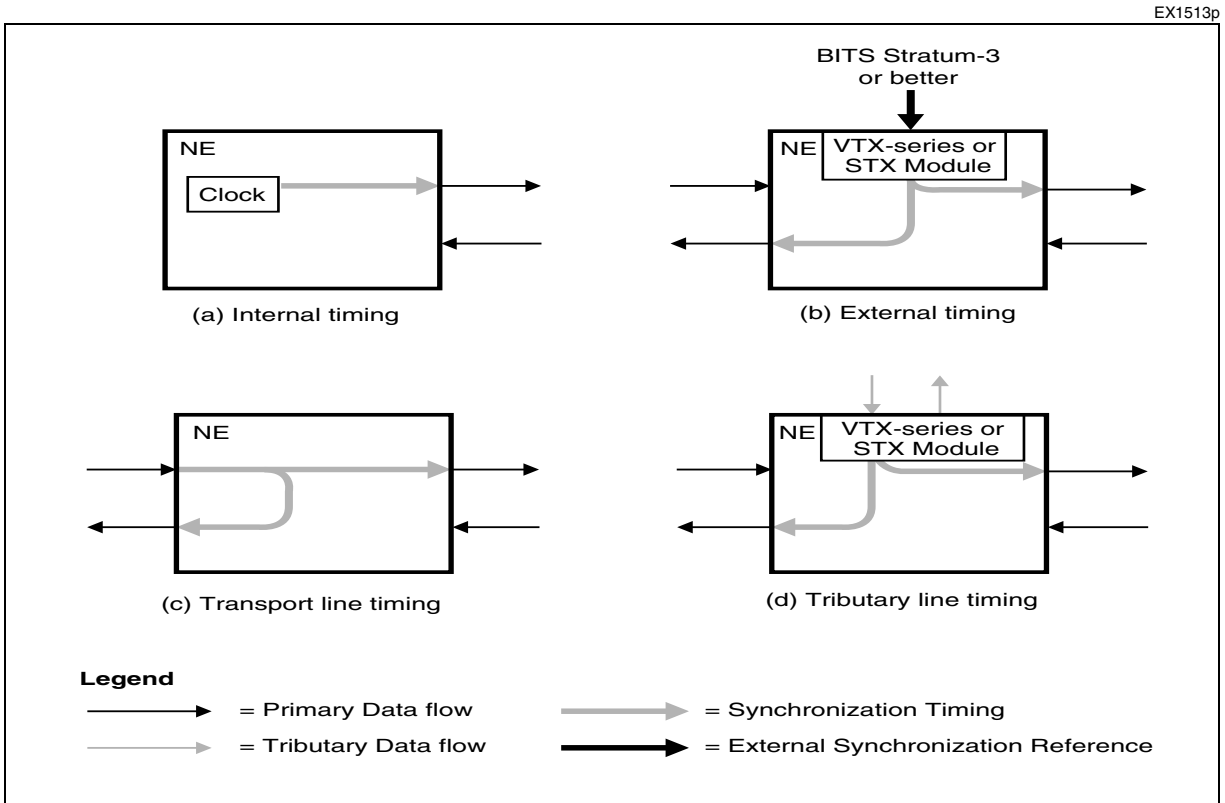
**Tributary line timing**

Tributary line timing is shown in Figure 2-49 on page 2-155, example (d).

When using tributary line timing, a network element derives timing from a received synchronous tributary signal. This signal is used in network elements to synchronize the outgoing transport signals in all directions, and the synchronous tributaries terminated by the network element. Sources of tributary timing are OC-3, OC-3x4, OC-12, OC-48, DS1, and EC-1 facilities. When the network element timing mode is set to Line Timing, the primary and secondary timing references can be provisioned as OC-3, OC-12, OC-48, DS1, and EC-1 facilities.

*Note:* DS1 facilities connected to a DSM module cannot be used as a timing reference.

**Figure 2-49**  
Flow of synchronization timing signals



**Timing sources and timing distribution**

The network elements in an OPTera Metro 3500 system can be integrated into a synchronization timing architecture. This architecture is a timing reference hierarchy that allows all network element timing to be referenced to an accurate common timing source.

For an OPTera Metro 3500 system to be synchronized with high-quality timing signals from an external source such as a BITS. If the system contains network elements not connected to external timing sources, then high-quality timing signals must be distributed from the network elements that are connected to external timing sources. The timing signals are distributed in the SONET signal. A network element that receives its timing signals in the SONET signal is line timed.

### **External timing reference input signals to STX and VTX-series circuit packs**

An OPTera Metro 3500 system can receive timing signals from an external timing source such as a stratum clock or a BITS. The BITS is connected to the network element by wire-wrap connectors on the Left OAM (LOAM). The VTX-series or STX-192 circuit packs are connected to the BITS through the backplane of the network element. The timing signals from an external timing source are called BITSIN-A and BITSIN-B.

The VTX-series or STX-192 circuit packs provide a stable reference frequency of 38.88 MHz from an external timing source to the transport and tributary circuit packs in the network element. Each STX and VTX-series circuit packs contains a synchronization block. Each synchronization block uses the stable reference frequency as the basis for the two system clocks (38.88-MHz and 2-kHz clock).

If the signal from the external timing source is interrupted, the STX and VTX-series circuit packs enters holdover mode, and continues to provide a stable reference frequency to the transport and tributary circuit packs.

BITSIN-A and BITSIN-B can be DS1 signals or composite clock signals. The ability to switch between BITSIN-A and BITSIN-B provides non-revertive 1+1 reference protection. If the two external references fail, then the node switches to holdover mode.

### **Synchronization-status messages**

Synchronization-status messages (SSM) indicate the quality of the timing signals currently available to a network element. The timing sources that can be provisioned in a network element include external timing from a BITS, timing derived from SONET interfaces, and the internal clock of the network element.

A network element can select the better of the two timing signals provided by the primary and secondary timing sources provisioned by the user. The selection is based on the quality values carried in the SSMs.

See [Figure 2-49 on page 2-155](#) for an example of a network showing the synchronization flow, head-end network element, synchronization boundary, and synchronization status messaging.

Synchronization-status messages are carried in bits 5 through 8 of the S1 byte in the SONET line overhead and in the extended superframe (ESF) datalink of the external DS1 signal from a BITS or a tributary. As the timing is passed from one network element to the next, each network element sends SSMs. If the quality of the timing changes, the SSMs inform the next network element of the change. See [Table 2-33](#).

**Table 2-33**  
**Synchronization status messages and quality levels**

Description	Quality level	SONET S1 byte (bit 5 to bit 8)	Designation	ESF datalink code byte
Stratum 1—Traceable	1	0001	ST1 (PRS)	000010
Synchronized—Traceability unknown	2	0000	STU	000100
Stratum 2—Traceable	3	0111	ST2	000110
Stratum 3—Traceable	4	1010	ST3	001000
SONET minimum clock—Traceable	5	1100	SMC	010001
Stratum 4—Traceable (see Note 1)	6	n/a	ST4	010100
Do not use for synchronization	8	1111	DUS	011000
Reserved for network synchronization use (holdover)	7	1110	RES	100000
<p><b>Note 1:</b> The ST4 message is carried in the ESF datalink of an external DS1 timing signal, not in the SONET overhead.</p> <p><b>Note 2:</b> Any unsupported synchronization status message S1 or DS1 ESF datalink is byte-mapped to a DUS designation.</p>				

### **User-specified quality levels for timing sources**

A user can specify or override the quality level of an incoming timing source. The user can specify the quality level if the timing source comes from equipment that does not support SSM, such as a BITS or equipment from another vendor. If a user specifies the quality level of a timing source, the user interface appends “-P” to the quality level, for example, ST2-P. Avoid overriding the quality level of an incoming tributary timing source if SSM is supported, to avoid timing loops.

### **BITS output with VTX-series or STX-192 circuit packs**

STX and VTX-series circuit packs provide 1+1 non-revertive timing reference switching for BITS Out. When the BITS Out primary and the secondary references fail, an alarm indication signal (AIS) is sent by the network element as BITS Out. The AIS advises equipment using the BITS Out of the failure so they do not use the BITS Out for synchronization.

When DS1 ESF is provisioned, SSM is supported on BITS Out. The BITS Out SSM is based on the status message from the active timing reference. BITS Out always selects the best quality timing reference based on the SSM of the incoming timing source.

### **User-initiated synchronization switches**

Synchronization switching can take place under the control of the user. With this capability, the user can select the optical interface to which a line-timed network element synchronizes. The line-timed network element accepts the user selected switch as long as the timing reference quality of both optical interface is the same and not equal to DUS, RES, SMC, or ST4.

Synchronization switching in a UPSR, BLSR and 1+1 is non-revertive.

OPTera Metro 3500 supports the following synchronization modes:

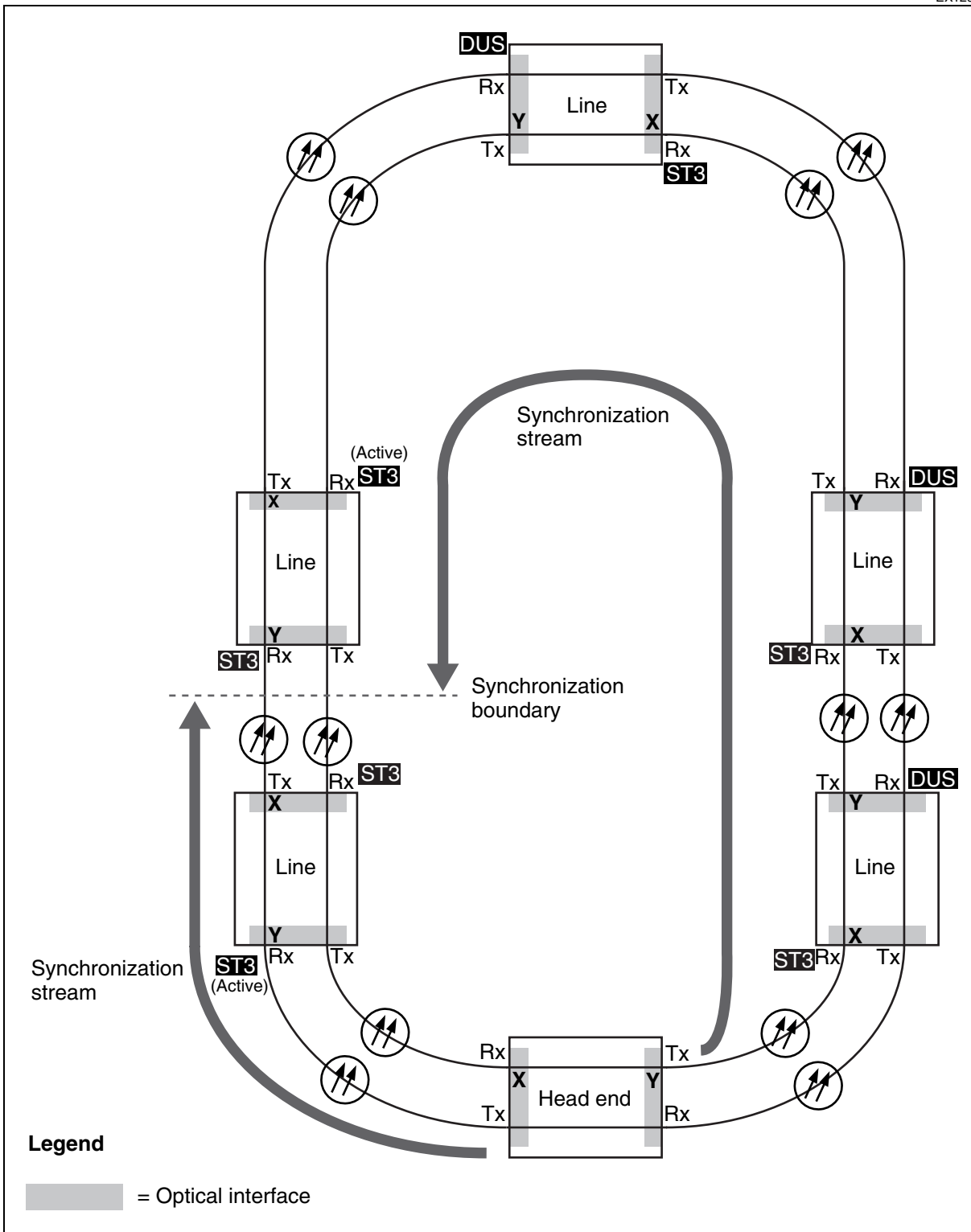
- two SF/ESF formatted BITS inputs and outputs
- line timing over DS1, OC-n, and EC-1 facilities
- internal Stratum 3 timing
- synchronization status messaging for BITS input and output, and for SONET facilities (OC-n)
- DS1 ESF BITS synchronization status messaging

**Note 1:** The DS1 service module (DSM) and the OC-3 interface connected to a DSM cannot be used as a synchronization source.

**Note 2:** Line timing with the EC-1x12 circuit pack is not supported.

**Figure 2-50**  
**Synchronization flow detail in an OPTera Metro 3500 network (example)**

EX1292



## Test Access

The test access feature monitors and tests signal quality of cross-connects through a test access port (TAP). This feature provides quick and reliable confirmation of service performance, as well as isolation of trouble when failure occurs in the network.

This feature is supported on SONET network elements.

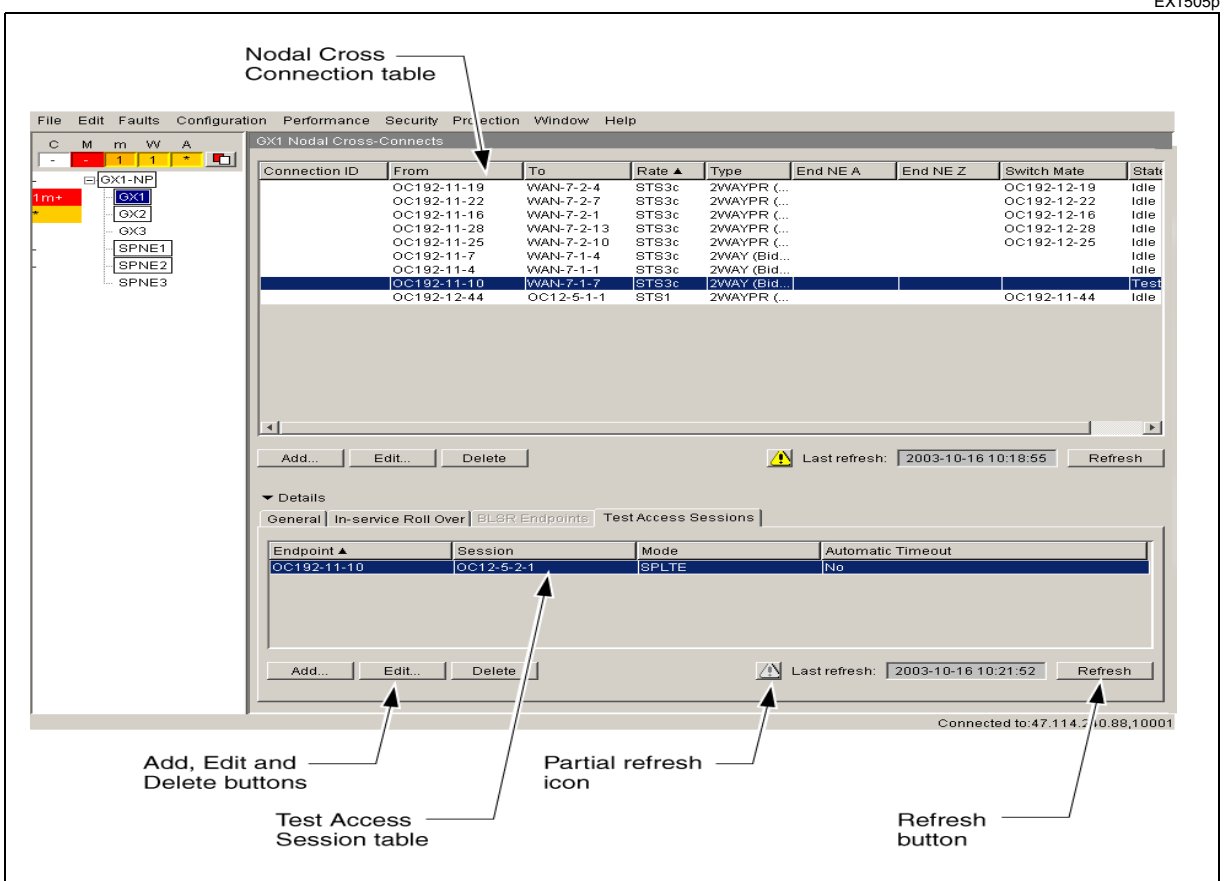
Test access implementation complies with the latest issues of:

- GR-818-CORE, Network Maintenance: Access and Testing - Generic Test Architecture
- GR-834-CORE, Network Maintenance: Access and Testing Messages
- GR-1402-CORE, Network Maintenance: Access And Testing - DS3 HCDS TSC/RTU and DTAU Functional Requirements
- GR-3008-CORE, Network Maintenance: Access and Testing - SONET STS-1 and SUB-STIS-1 TSC/RTU and DTAU Functional Requirements
- GR-2996-CORE, Generic Criteria for SONET Digital Cross-Connect Systems
- GR-253-CORE, Synchronous Optical Network (SONET) Transport Systems: Common Generic Criteria

[Figure 2-52 on page 2-162](#) illustrates the organization of the main components of the test access feature. The testing operations systems (TOS) sends testing requests in the form of TL1 commands to the test access equipment through an internal data network. The test access equipment is in the supported mode of test controller system (TCS). In the TCS mode, the test access equipment manages the test access session and sends TL1 commands to the network element. Communication between the test access equipment and network element occurs through a TCP/IP control link.

Site Manager Release 6.0 introduced a new application called “Test Access Sessions Application” which will allow a user to fully manage their test access sessions from Site Manager. [Figure 2-51 on page 2-161](#) shows the new Test Access Sessions Management window.

**Figure 2-51:**  
**Site Manager Test Access Session Management window**



### Test Access Ports (TAPs)

Any supported circuit pack in slots 3 through 10 can be provisioned as the TAP as long as it does not have any existing connections on it. Multiple test access connections can be established on a TAP as long as the TAP has the bandwidth available to carry all of the traffic.

The following facilities can be assigned as test access ports are DS1, DS3, EC1, OC3, OC12, and OC-48. A facility and all its channel is reserved for Test Access when its secondary state is set to test (TS).

The rates and path types that can be placed under test access are DS1, DS3, VT1.5, STS1, STS3c, STS12c, STS24c and STS48c.

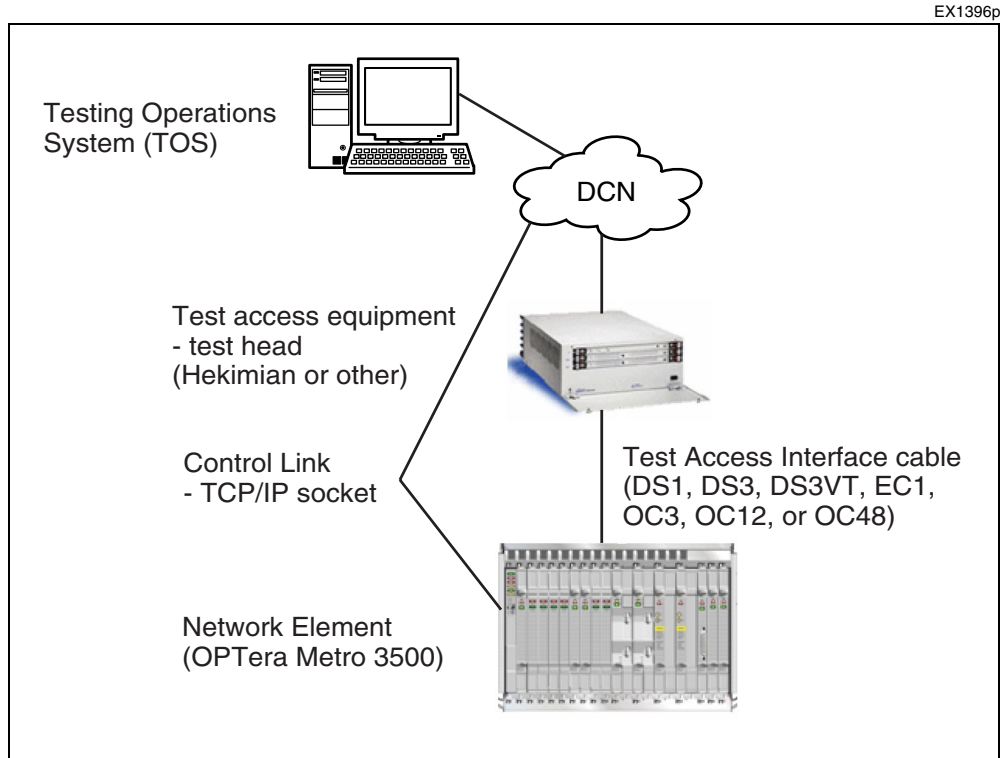
**Note 1:** E1 facilities path types are not supported.

**Note 2:** DS1 and VT1.5 rates are not supported on the STS managed STX-192 circuit pack.

**Note 3:** STS24c and STS48c rates are only supported on shelves equipped with OC-48 STS interfaces in slots 3 through 10 and STX-192 circuit packs.

**Note 4:** When a facility is provisioned as a TAP, the Loss of Signal LED becomes active on the circuit pack.

**Figure 2-52**  
**Test access components**



### Test access configurations

Supported test access states include:

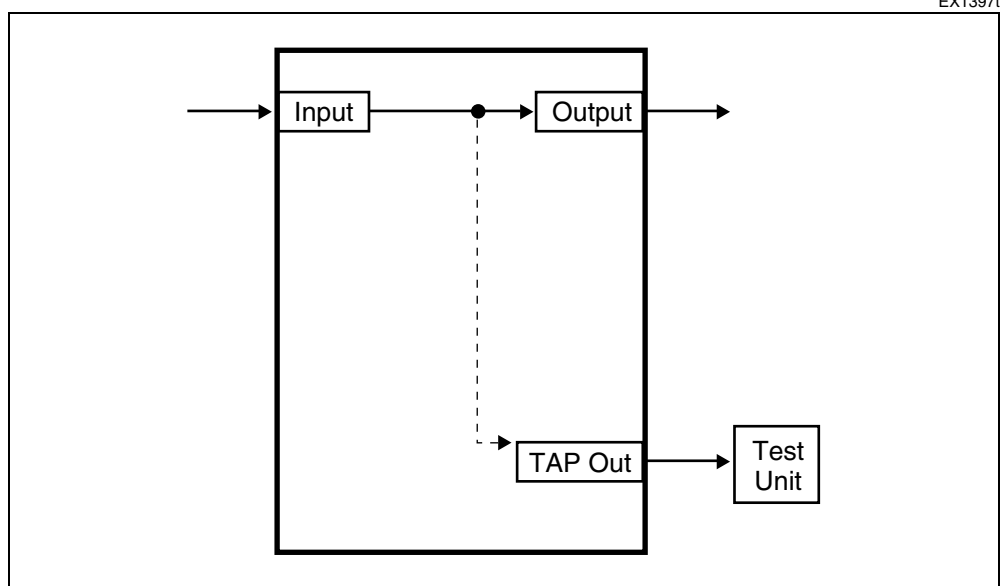
- monitoring test access (non-intrusive test state)
- split test access (intrusive test state-for out of service connections)

### Monitoring test access

A test access session in the monitoring state, does not affect traffic and it does not trigger a protection switch. Traffic is sent to the test unit via the TAP and is allowed to continue on its original path. See [Figure 2-53](#) on [page 2-163](#).



**Figure 2-53**  
**Test access-monitor state**



The monitoring configurations supported include:

- Single Facility Access Digroup, Monitor Equipment side (Single FAD, MONE) see [Figure 2-54](#)
- Single Facility Access Digroup, Monitor Facility side (Single FAD, MONF) see [Figure 2-55](#)
- Dual Facility Access Digroup, Monitor Equipment and Facility sides (Dual FAD, MONEF) see [Figure 2-56](#)

*Note:* In [Figure 2-54](#) to [Figure 2-57](#) “equipment side” and “facility side” shows the direction(s) of the connection under test.

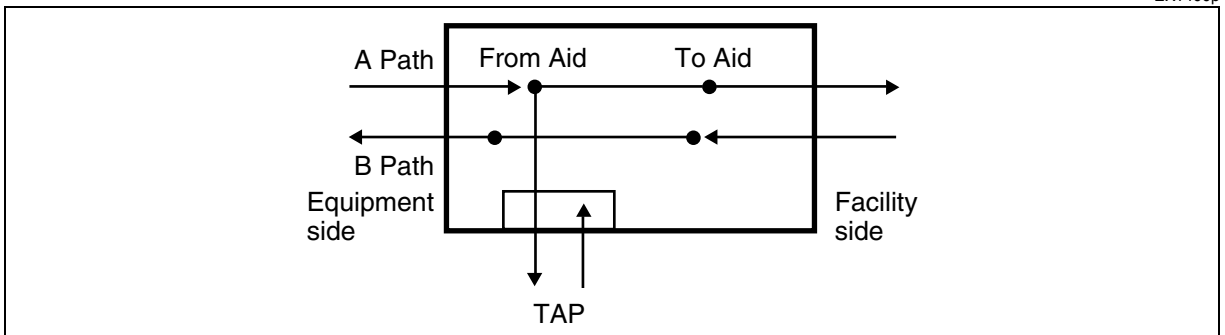
#### **Single FAD, MONE and Single FAD MONF**

In a single FAD environment, only one direction of the signal can be monitored at a time.

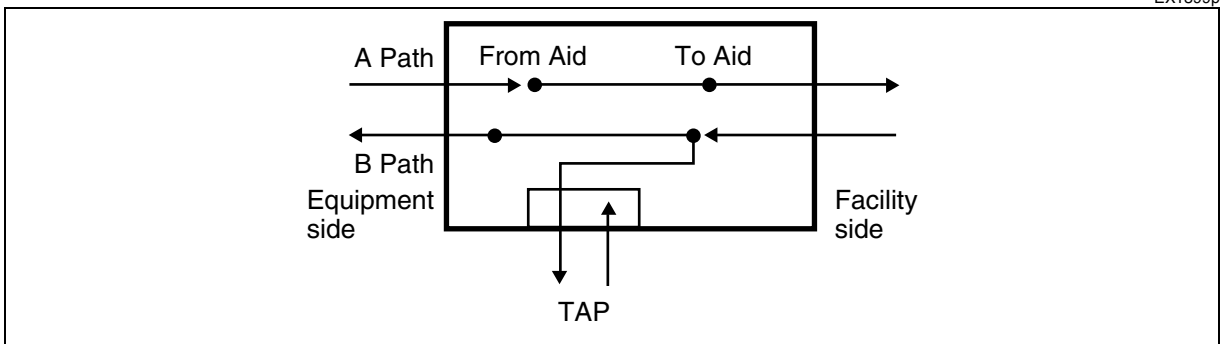
In the case of Single FAD, MONE, the monitored connection is from the equipment side input to the facility side output, see A transmission path as shown in [Figure 2-54](#).

In the case of Single FAD, MONF, the monitored connection is from the facility side input to the equipment side output, see B transmission path as shown in [Figure 2-55](#).

**Figure 2-54**  
Monitoring test access-Single FAD, MONE



**Figure 2-55**  
Monitoring test access-Single FAD, MONF

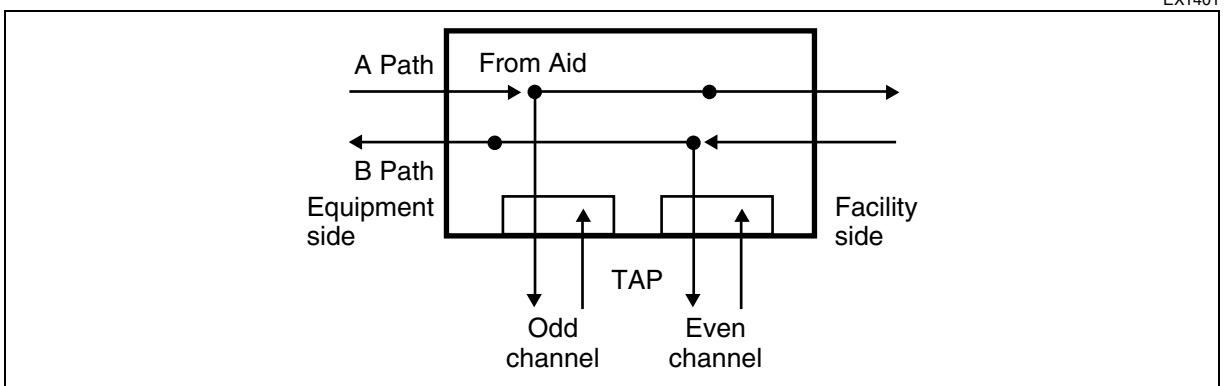


**Dual FAD, MONEF**

In a dual FAD environment, both signal directions (path A and path B) can be monitored at the same time.

In the case of dual FAD, MONEF the monitored connections are provided from the odd pair of a dual FAD TAP to the A transmission path and from the even pair of a dual FAD TAP to the B transmission path of the circuit.

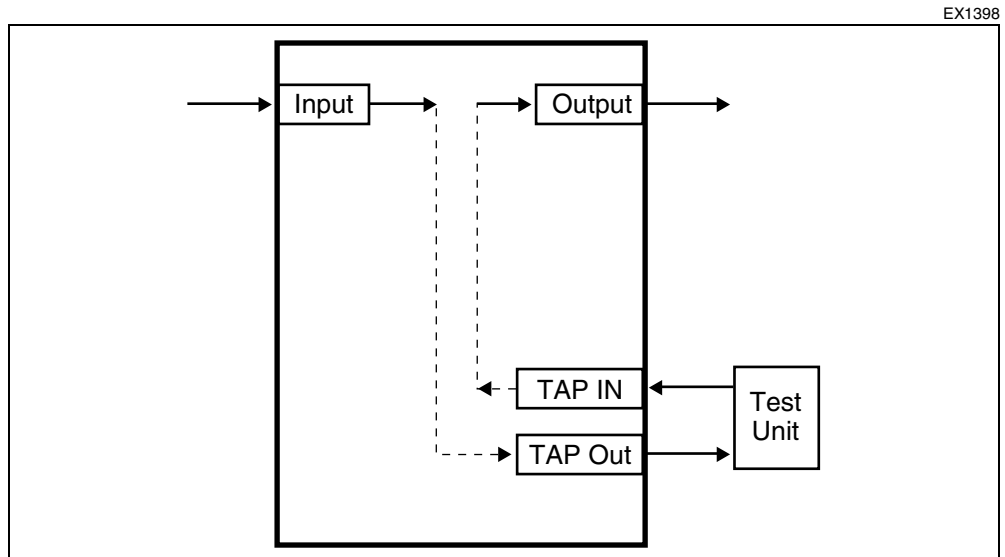
**Figure 2-56**  
Monitoring test access-Dual FAD, MONEF



## Split test access

The split test access is an intrusive, service-affecting operation. The original cross connection is split, with the incoming signal being connected (via TAP) to the test unit receiver and the outgoing signal is fed from the transmitter of test unit. See [Figure 2-57](#).

**Figure 2-57**  
Test access-split state



The split test access configurations that are supported include:

- Single Facility Access Digroup, Split Equipment side (Single FAD, SPLTE) see [Figure 2-58](#)
- Single Facility Access Digroup, Split Facility side (Single FAD, SPLTF) see [Figure 2-59](#)
- Single Facility Access Digroup, Split Equipment input and continue from TAP (Single FAD, SPLTA) see [Figure 2-60](#)
- Dual Facility Access Digroup, Split Equipment and Facility sides (Dual FAD, SPLTEF) see [Figure 2-61](#)

**Note:** In [Figure 2-58](#) to [Figure 2-61](#) “equipment side” and “facility side” shows the direction(s) of the connection under test.

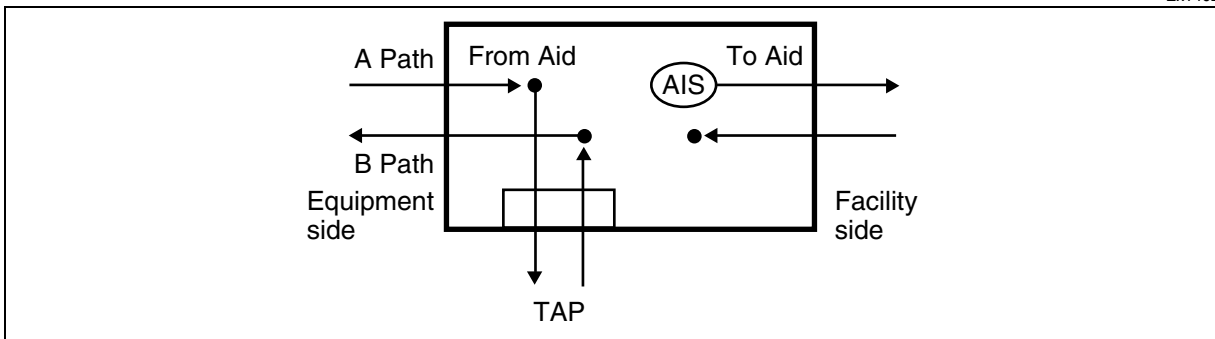
### Single FAD, SPLTE and Single FAD SPLTF

In a single FAD environment, only one direction of the signal can be tested at a time.

In the case of Single FAD, SPLTE, both the A and B paths are interrupted with the input of A path-equipment side going to the TAP input and the output to B path-equipment side as shown in [Figure 2-58](#).

**Figure 2-58**  
Split test access-Single FAD, SPLTE

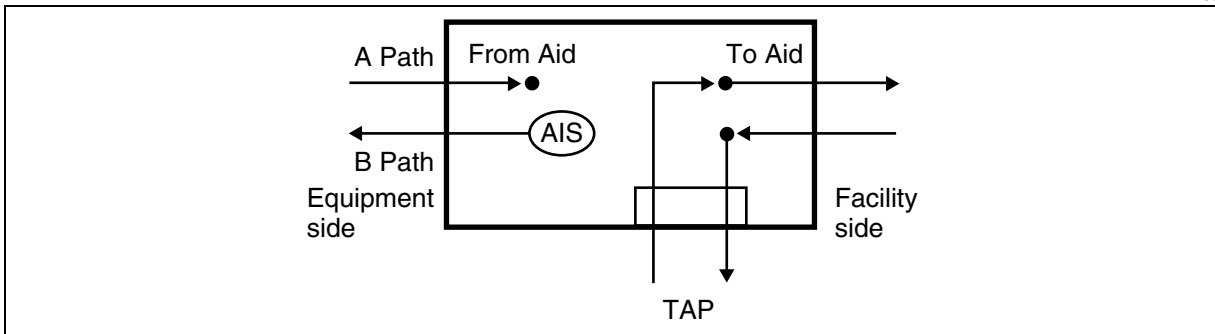
Ex1402



In the case of Single FAD, SPLTE, both the A and B paths are interrupted with the input of B path-facility side going to the TAP input and the output to A path-facility side as shown in [Figure 2-59](#).

**Figure 2-59**  
Split test access-Single FAD, SPLTF

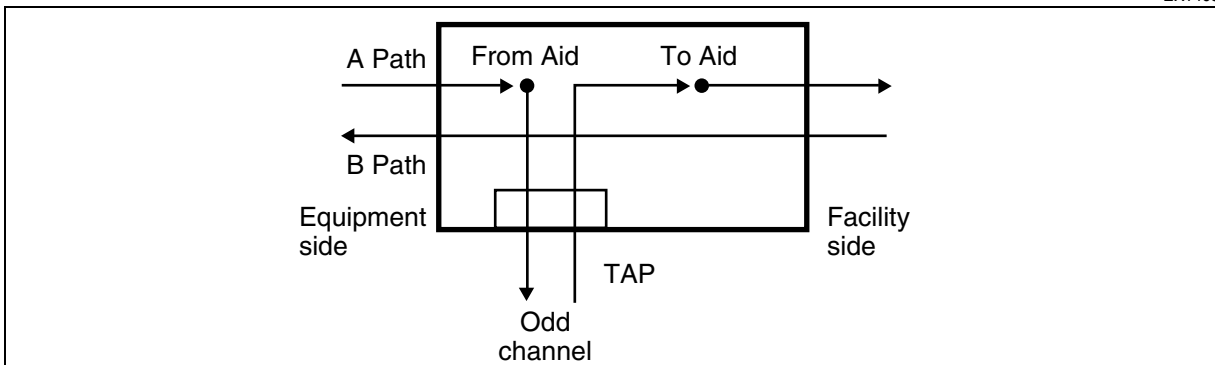
EX1403



In the case of Single FAD, SPLTA, the A path is split and connected on both the right side (facility side) and left side (equipment side) of the accessed circuit to the FAD as shown in [Figure 2-60](#).

**Figure 2-60**  
Split test access-Single FAD, SPLTA

EX1405

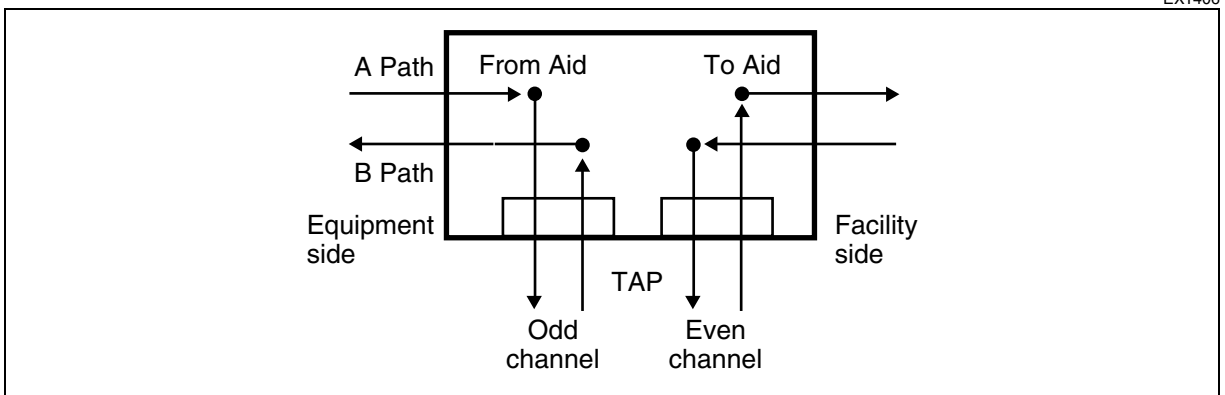


**Dual FAD, SPLTEF**

In a dual FAD environment, both signal directions (path A and path B) can be monitored at the same time.

In the case of dual FAD, SPLTEF both the A and B paths are interrupted with the input of A path (equipment side) going to the odd TAP input and the output of the odd TAP going to the B path (equipment side). The input of B path (facility side) goes to the even TAP input and the output of the even TAP goes to the A path (facility side).

**Figure 2-61**  
**Split test access-Dual FAD, SPLTEF**

**Loss of association and auto recovery**

Connections during a test access session are viewed as temporary and revert back to the original connections when a test access loss of association (LOA) occurs. Power failures and a loss of communication between the test access equipment and OPTera Metro 3500 shelf can trigger a test access LOA.

To detect a loss of association with the test access equipment, the OPTera Metro 3500 monitors the time interval between TL1 messages from the test access equipment. If the OPTera Metro 3500 does not detect a TL1 message before the set time-out period, a loss of association is declared and the test access connections are dropped and the original connections are restored.

**Note 1:** The time-out period can be set between 0 and 900 seconds using the ED-SYS command. The default value is 300 seconds. If the time-out period is set to 0, loss of association is not monitored and therefore never declared.

**Note 2:** The TL1 command REPT-INITZN is used to release all test access sessions on the network element by removing all test access connections and restoring previous connections.

### Engineering rules

The following engineering rules apply to the test access feature:

- Optical TAPs must be in unprotected mode.
- A TAP can simultaneously accommodate connections from more than one interface (until the TAP capacity is reached).
- For shelves equipped with the STX-192 circuit pack, the SONET signal routed to the TAP is down to STS-1 granularity and can include concatenated paths or whole line to the 2.48 Gbit/s rate accommodate.
- For shelves equipped with the VTX-series circuit pack, the SONET signal routed to the TAP is down to VT1.5 granularity and can include concatenated paths or whole line to the 622 Mbit/s rate accommodate.
- Multiple test access ports can be provisioned on an OPTera Metro 3500 shelf.
  - The maximum number of TAPs that can be provisioned on a shelf is equal to the maximum number of working ports the shelf configuration can support in slots 3 through 10.
- If a test access session (monitor or split) is active, changing the protection scheme for any electrical or optical interface on the network element is prevented.
- The TAP must be defined before a test access connection can be provisioned
- Only test access connections can use the TAP.
- Optical interfaces in slots 11 and 12 can not be used as test access ports.
- Test access connections are deleted and original connections restored:
  - if the SPx or the circuit pack of the TAP is replaced.
  - during SPx or the circuit pack of the TAP restarts (warm/cold).
  - during brownouts.
- Test access connections are maintained:
  - during restarts (warm/cold) of interface under test.

### User interface

#### Site Manager

Site Manager Release 6.0 introduced a new application called Test Access Session Management. This application allows user to manage their test access sessions from Site Manager. This application is a nodal application, so test access sessions can only be managed on one network element.

Site Manager Test Access Sessions Management application will support the following functionality:

- to add a test access session
- to edit a test access session
- to delete a test access session or multiple test access sessions
- to retrieve test access sessions

**Note:** For backward compatibility, Test Access Sessions Management Site Manager Release 6 will also support OPTera Metro 3500 Release 11.

For more information, refer to the *Site Manager Planning and Installation Guide*.

## Time of day synchronization

The time of day feature maintains synchronized real-time between OPTera Metro 3000 network elements. Network time can be provisioned such that it automatically adjusts for time zone offsets and daylight savings periods from the reference time.

The network processor can be provisioned to obtain its timing reference from a server that supports NTP 3.0 protocol on TCP/IP. This server can be another network processor (a network processor can operate in a client-server mode). The network processor can provide the synchronized timing source for the shelf processors within its span of control. Communication between the network processor and shelf processor occurs over the OSI network. See [Figure 2-62](#).

**Note 1:** User datagram protocol (UDP) messages generated by NTP server processes are delivered to UDP port 123.

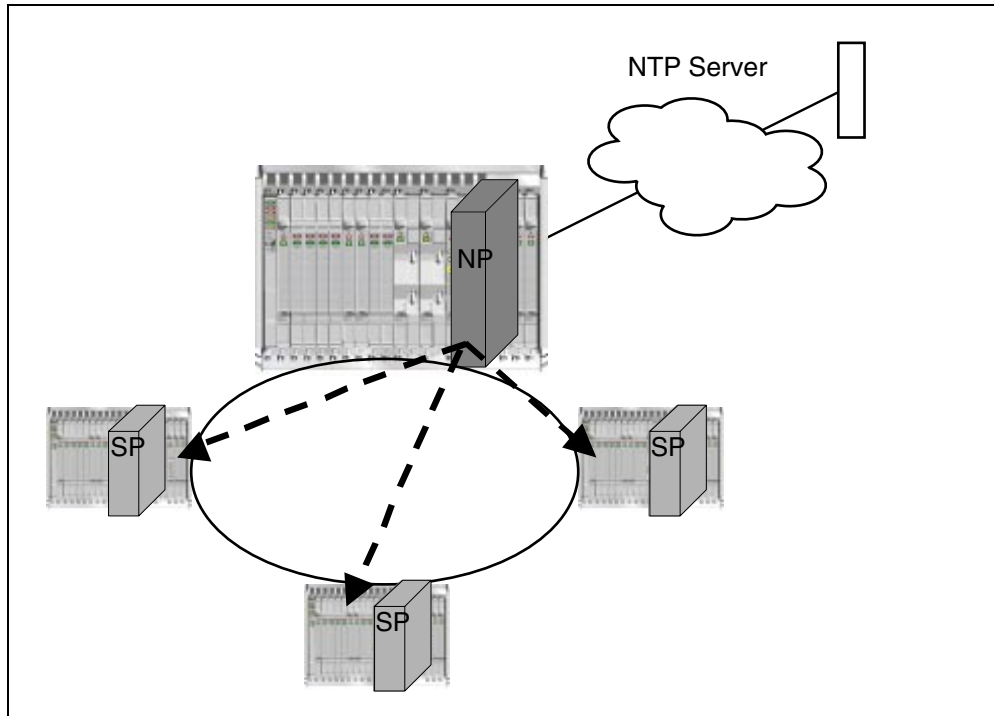
**Note 2:** When all of the provisioned NTP servers are not available, the network processor continues to service NTP requests by using its internal clock to provide synchronized timing to SPs under its span of control.

**Note 3:** The shelf processor is able to switch to a secondary network processor in the event that the primary network processor becomes unavailable. This provides a redundant path in the case where multiple network processors are used to monitor the same span of control.

**Note 4:** In the case where time of day synchronization status is on, and a version 3.0 NTP server is used, the date on the network processor wraps around to November 25th, 1900 after the network processor clock reaches a date of December 31st, 2036. The date, December 31st, 2036, can be manually set on the network processor.

**Figure 2-62**  
**Time of day synchronization (SPs are under the NP's span of control)**

EX1407



The maximum number of provisionable servers on the network processor is five. The NTP client automatically queries servers and synchronizes to the best clock by considering the stratum value of the servers and the dispersion (latency). The maximum number of network processors that can be provisioned as the timing sources on a shelf processor is two. If more than one external timing server is provisioned, the system reverts to the backup network processor in the event the primary server is not reachable or servicing time of day requests.

For procedures on provisioning time of day synchronization parameters using Site Manager, see *Security and Administration*, 323-1059-302.



**Table 2-34**  
**TOD synchronization parameters (Site Manager)**

Parameter	Values (Default)	Description
<b>TOD parameters applicable to NP and SP</b>		
Status	(Off), On	Indicates if time of day synchronization is active or inactive.
Offset threshold	1 to 1800 seconds for NP 2 to 8 seconds for SP (default is 5 seconds)	Time of day offset threshold allowed in seconds. If the threshold is exceeded, a TOD threshold crossing alert is generated.
Server parameters (Source, Address, Status)	Source is 1 to 5 for NP Source is 1 or 2 for SP  Address is IP address of NTP server for NP Address is TID of timing reference for SP  Status is: IS-IDLE IS-ACTIVE UNKNOWN NOT-IN-SYNC STRATUM-TOO-HIGH DISPERSION-TOO-LARGE	The source, address and status of the timing reference.  IS-IDLE, Server has not responded but is kept as a backup.  IS-ACTIVE, Synchronizing to this server.  UNKNOWN, Server status is unknown or not reachable.  NOT-IN-SYNC, The server is out of synchronization and can not be used.  STRATUM-TOO-HIGH, The servers stratum is too high.  DISPERSION-TOO-LARGE, The network latency to this server is too large.  <b>Note:</b> An * designates which server the client is using for synchronization.
<b>TOD parameters applicable to NP only</b>		
Minimum Polling Interval	(2) to 65536 seconds Increments of 2 <sup>N</sup> where N is 1, 2, 3...16.	Minimum polling interval when timing reference source is checked. Increase the polling period if your NTP server(s) are overworked or if precision is not an issue.
Maximum Polling Interval	2 to 65536 seconds (default is 16) Increments of 2 <sup>N</sup> where N is 1, 2, 3...16.	Maximum polling interval when timing reference source is checked.
Time Of Day	YYYY-MM-DD HH:MIN:SEC.millisec	Current time of day and time.
Detected offset	+/- hh,mm,sec or UNKNOWN	Difference between the timing reference source time and the NP time from last poll.
Polling interval	hours,mins,secs	Time interval of when timing reference source is checked.

**Table 2-34 (continued)**  
**TOD synchronization parameters (Site Manager)**

Parameter	Values (Default)	Description
Next synchronization	YYYY-MM-DD HH:MIN:SEC UNKNOWN	Date and time of next time of day synchronization.
Last synchronization	YYYY-MM-DD HH:MIN:SEC UNKNOWN	Date and time of last time of day synchronization.
Time offset	+/- 0 to 720 minutes	Time offset is the difference between the network elements real time clock and the reference time of the time of day synchronization source (the master clock). For example, if reference time is GMT, (most NTP servers use GMT as reference), you will need to set a -3 hour offset (- 180 minutes) if the real time clock on the element is to report its time as GMT -3 hours.
Use daylight saving	Yes or No	Allows you to implement daylight savings if applicable.
Daylight saving offset	0 to 120 minutes	Daylight savings offset is the difference between the network elements real time clock and the time offset during daylight saving periods. For example, if reference time is GMT, and the time offset is -3 hours, and the daylight savings period adjustment is +1 hour (report time on the element as GMT -2 hour during daylight savings periods), you will need to set a 60 minute daylight savings offset.
Start date/End date	Day, Week, Month and Time	The start and end of daylight saving time
Automatically calculate next start/end date	Yes or No	Allows you to have the next daylight savings period automatically calculated.

**TL1 Changes to Cross Connect AID parameter**

With the introduction of the new STX-192 circuit pack in OPTera Metro Release 12.0, a new naming convention was required to represent the VT and STS managed circuit packs in slots 13 and 14. To support the new naming convention for the Clock and X-Connect (CLX) card, new AIDs (CLX-13 and CLX-14) for the equipment type are introduced for these cards provisioned in slots 13 and 14. The default AID will be “CLX”, however the Card Type parameter will indicate the actual card type (VTX-48, VTX-48e or STX-192).

For system running OPTera Metro Release 12.0 or higher, the default AID for slots 13 and 14 will be CLX-13 and CLX-14 respectively.

Table 2-35 on page 2-173 provides a sample of the output of RTRV-EQPT command when performed with different STX and VTX-series circuit packs.

**Table 2-35**  
**CLX RTRV-EQPT Behaviour**

Card in Slot 13 and 14	RTRV-EQPT Output
None	"CLX-13::CTYPE=VTX:OOS-AU, UEQ" "CLX-14::CTYPE=VTX:OOS-AU, UEQ"
VTX-48	"CLX-13::CTYPE=VTX48, PEC= ..." "CLX-14::CTYPE=VTX48, PEC= ..."
VTX-48e	"CLX-13::CTYPE=VTX48e, PEC= ..." "CLX-14::CTYPE=VTX48e, PEC= ..."
STX-192	"CLX-13::CTYPE=STX192, PEC= ..." "CLX-14::CTYPE=STX192, PEC= ..."

## TL1 event exerciser

With one TL1 command (RTRV-NE-AOMSG: [TID] : [ALL] : CTAG) in Site Manager's TL1 Command Builder, a UPC level 4 account user can request an output of all possible TL1 autonomous messages (including alarms and events). The output has exact wording for autonomous messages and is available at both the SPx and NPx.

**Note:** Requesting an output from the SPx will generate all autonomous messages possible from the SPx. Requesting an output from the NPx will generate all autonomous messages possible from the NPx.

Execution of the TL1 command will not impact traffic currently on the system and will not impact OAM performance on a separate network element.

## TL1 event / log feature

Network elements will track configuration changes, unsuccessful TL1 command attempts, and shelf inventory changes. Autonomous events (DBCHG, LOG, and INVENTORY) display after the TL1 return code. A file containing the history of all three event types is updated with the latest DBCHG, LOG, and INVENTORY events each time an event occurs. This file will survive restarts and circuit pack pulls and is retrievable by the user. The DBCHG and LOG events apply to both the network processor and shelf processor circuit packs.

**Note 1:** All information is stored regardless of whether broadcasting is provisioned as 'ON' or 'OFF'.

**Note 2:** Event broadcasting is set to 'OFF' by default.

### Database change events

Database change events (DBCHG events) result only in the case of successfully completed commands. DBCHG events include the following information:

- User ID of the person who entered the command (alphanumeric string up to 20 characters in length)
- Command identifier (for example, ENT-CRS-VT1)
- AID(s) that were acted upon (if applicable)
- CTAG
- Position defined parameters from the command
- Keyword defined parameters from the command
- Primary and secondary states from the command

### Log events

Log events result after either of the following occurs:

- a TL1 command is unsuccessful (TL1 return code is not COMPLD)
- a TL1 command is attempted, regardless of success or failure, with an account of UPC 4 or higher

*Note:* Retrieval command (RTRV) from a UPC account of 3 or lower does not result in a log event

Log events include the following information:

- User ID of the person who entered the command (alphanumeric string up to 20 characters in length)
- Priority
- Status of the command
- Command identifier (for example, ENT-CRS-VT1)
- AID(s) that were acted upon (if applicable)
- CTAG
- Position defined parameters from the command
- Keyword defined parameters from the command
- Primary and secondary state parameters from the command
- Failure string

### Inventory events

Inventory events are generated and displayed when inventory changes (for example, pulling or inserting circuit packs) occur.

### **ATAG sequence numbers**

ATAG is a numeric transaction identifier similar to CTAG. The ATAG value is automatically generated by a TL1 agent and is used exclusively as a sequence number for autonomous messages. It is a number from 1 to 999999. The first ATAG used is 1 when the agent first initializes or is reset. The ATAG automatically wraps to 1 for the next autonomous message when the previous message is assigned 999999.

Each instance of a Database change (DBCHG), Log (LOG), or Inventory (INVENTORY) event is assigned a unique ATAG value. ATAGs survive warm / cold restarts, circuit pack pulls, and circuit pack swaps. ATAGs do not survive save and restore activities. ATAGs are global to the entire network element (that is, the sequence is continuous and uninterrupted spanning all users and sessions on a network element).

### **Topology enhancements**

OPTera Metro 3500 Release 11.0 introduced the following enhancements to the topology mapping feature:

- a network processor will recognize an adjacent OPTera Metro 3000 network element outside the network processor span of control
- a network processor will recognize an adjacent OPTera Connect DX network element
- the MAC address of an OPTera Connect DX is displayed

In order for a network processor to retrieve a connection to an adjacent network element, there must be an SDCC connection between the network processor's local shelf and the adjacent neighbor.

### **VT management option on STX equipped OPTera Metro 3500**

OPTera Metro 3500 equipped with STX-192 circuit packs is a cross-connect which operates at STS-1 and higher granularity. When you use STS-managed OPTera Metro 3500 NEs with equipment that supports virtual tributaries (VT), such as OPTera Metro 3000 equipped with VTX-series circuit packs, consider VT management when planning traffic flow and the path originating and terminating points.

This section discusses VT management on subtending UPSR and VT grooming.

#### **VT management on a UPSR**

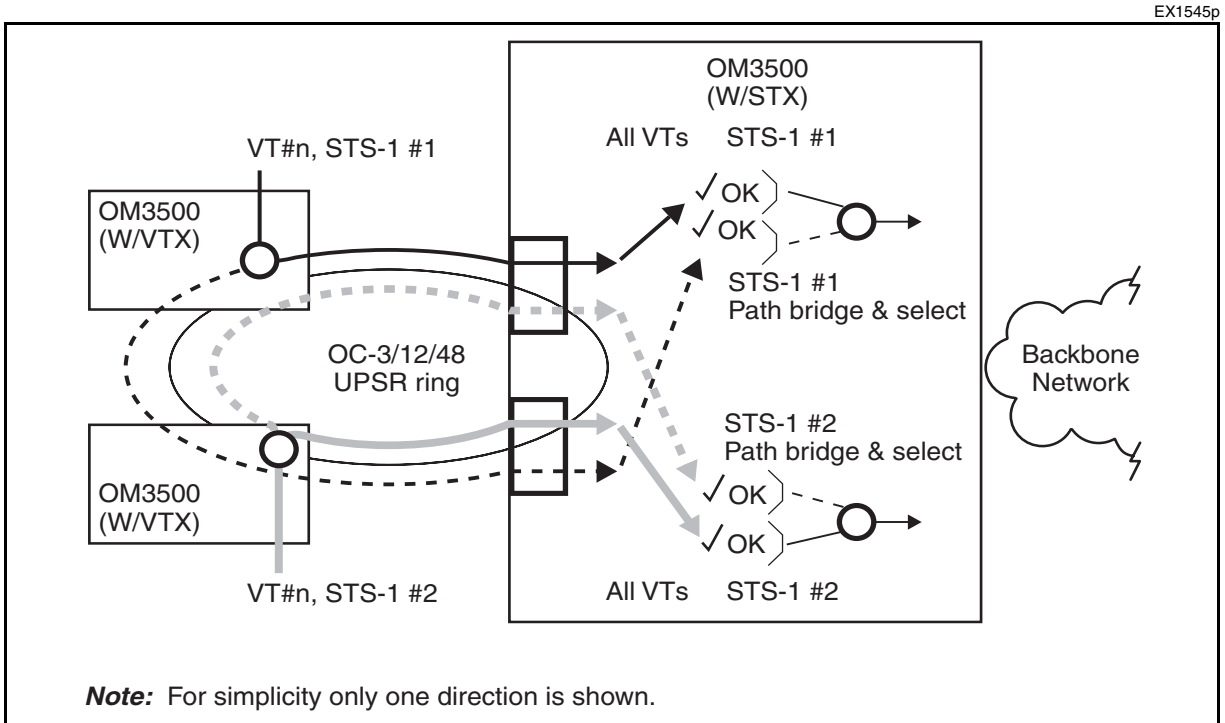
Since the STS-managed OPTera Metro 3500(with STX) does not switch at the VT level, when you provision a connection between two VT-managed OPTera Metro 3000 NEs that pass through STS-managed OPTera Metro 3500, use the same VT and VT group number at the OPTera Metro 3000 endpoints.

Two ways to manage VTs on a UPSR are:

- Use dedicated STS at each node and *provision STS connections at each pass-through VT-managed OPTera Metro 3000 node on the subtending UPSR*. This option is simple to implement and prevents VT traffic loss in case of a fiber cut. [Figure 2-63 on page 2-176](#) shows a configuration that uses dedicated STS at each site and [Figure 2-64 on page 2-177](#) shows the same configuration after a fiber cut. There is no loss of VT traffic.
- Use a virtual ring with shared VT-managed STS. [Figure 2-65 on page 2-178](#) shows a configuration that uses a virtual ring with shared VT-managed STS and [Figure 2-66 on page 2-179](#) shows the same configuration after a fiber cut. There is no loss of VT traffic.

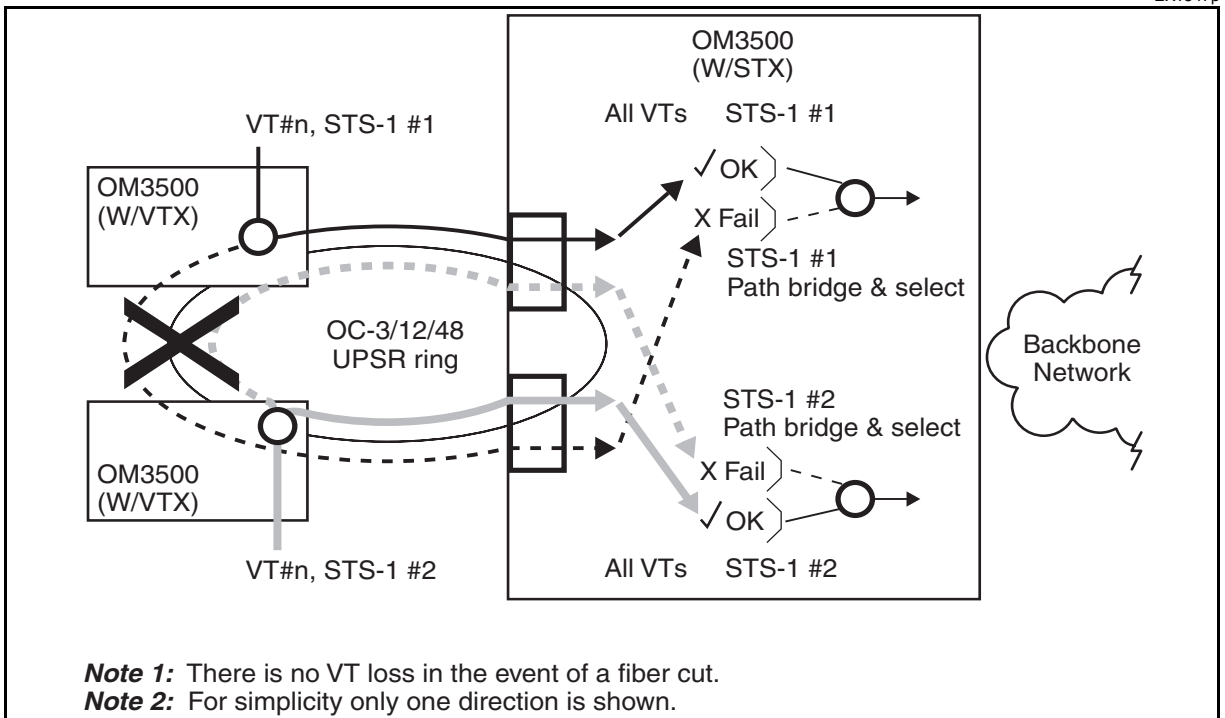
**Note:** Using shared VT-managed STS can result in traffic loss in case of a fiber cut if the VTs are not managed correctly. For example, using an STS path selector on STS-managed OPTera Metro 3500 to terminate an STS which contains VTs from various nodes (a shared VT-managed STS) can result in VT traffic loss in case of a single fiber cut. See [Figure 2-67 on page 2-180](#).

**Figure 2-63**  
Per-site dedicated STS



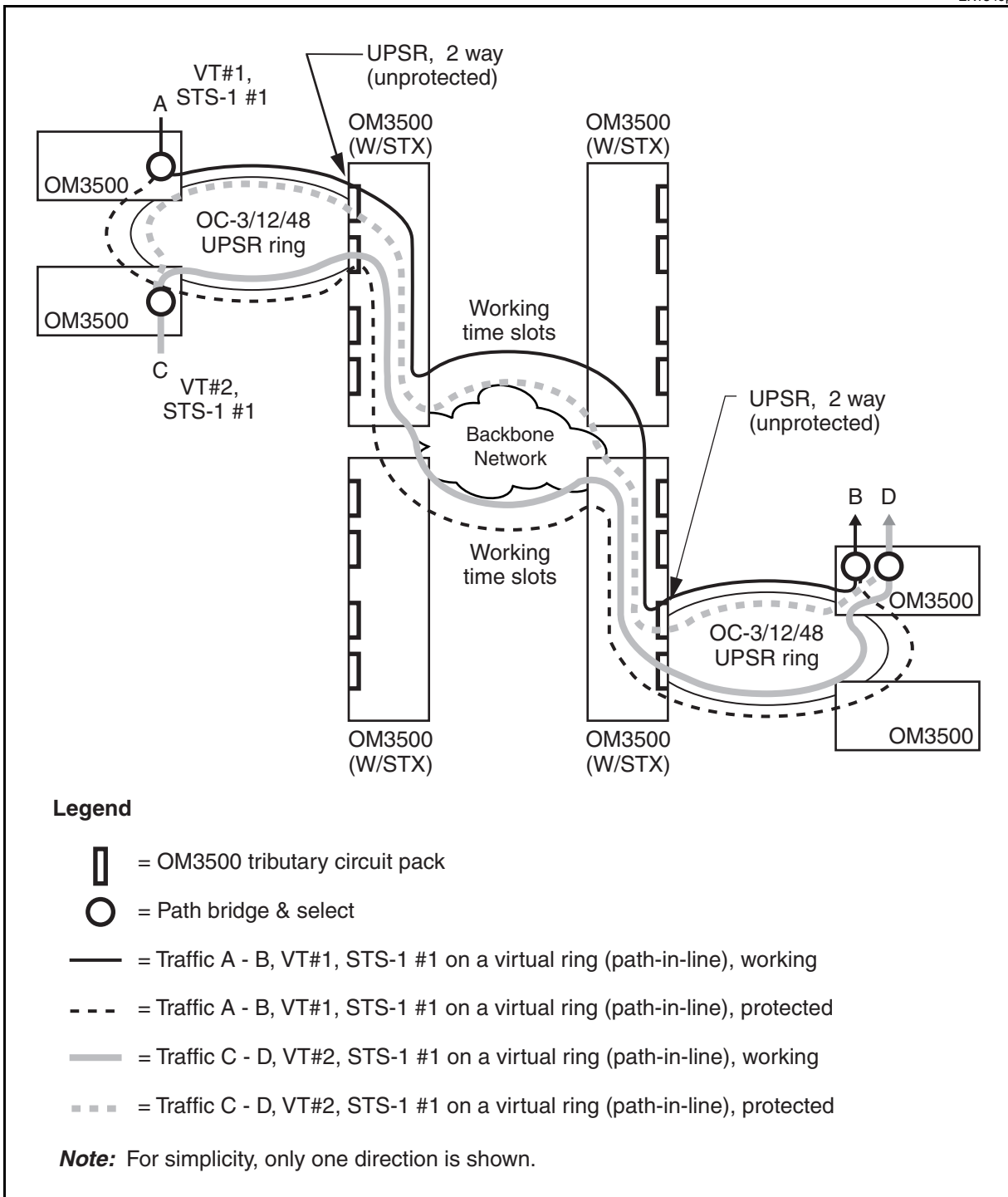
**Figure 2-64**  
**Per-site dedicated STS - no VT loss in case of a fiber cut**

EX1547p



**Figure 2-65**  
**Virtual ring (path-in-line) and shared VT-managed STS**

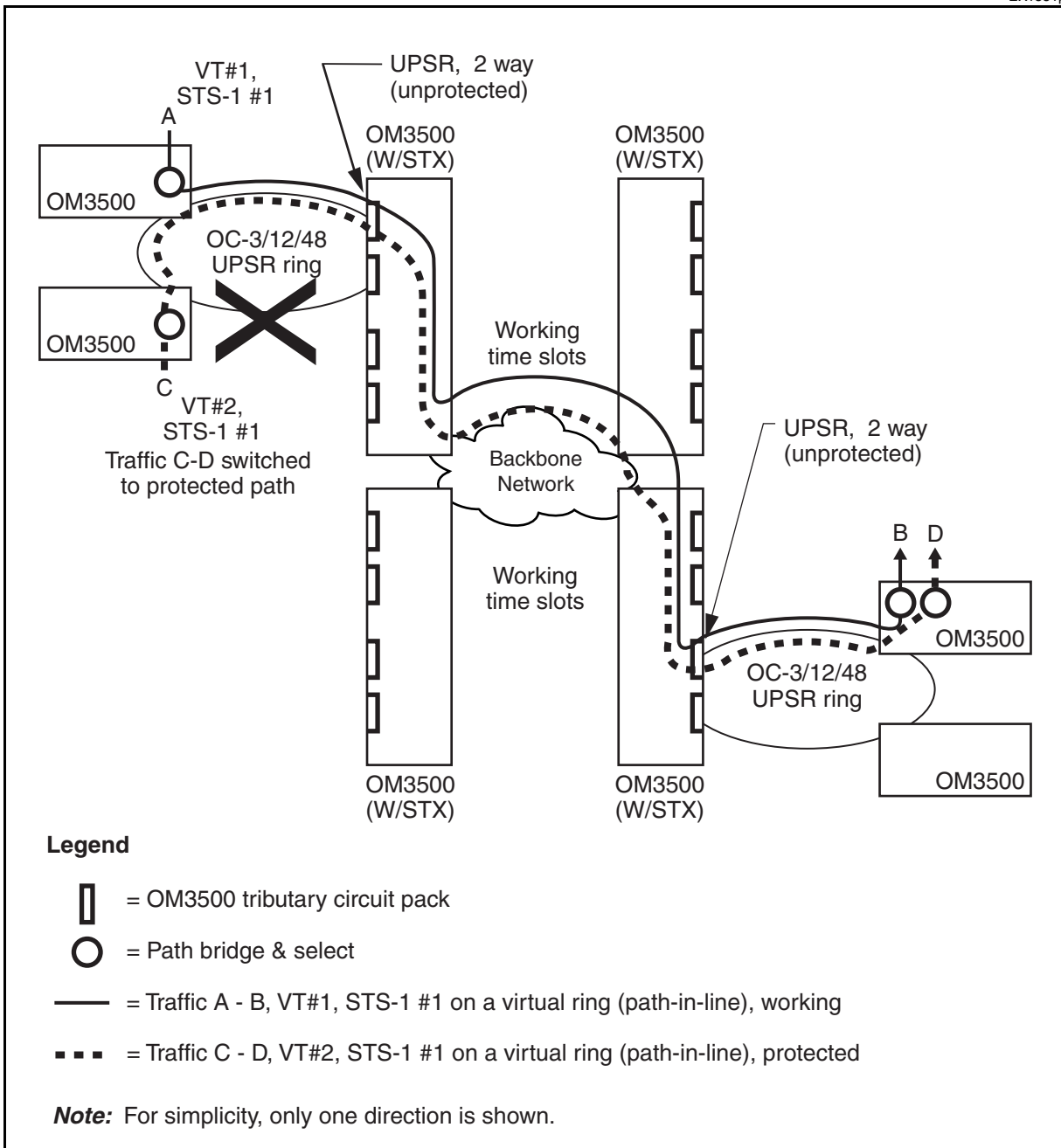
EX1549p





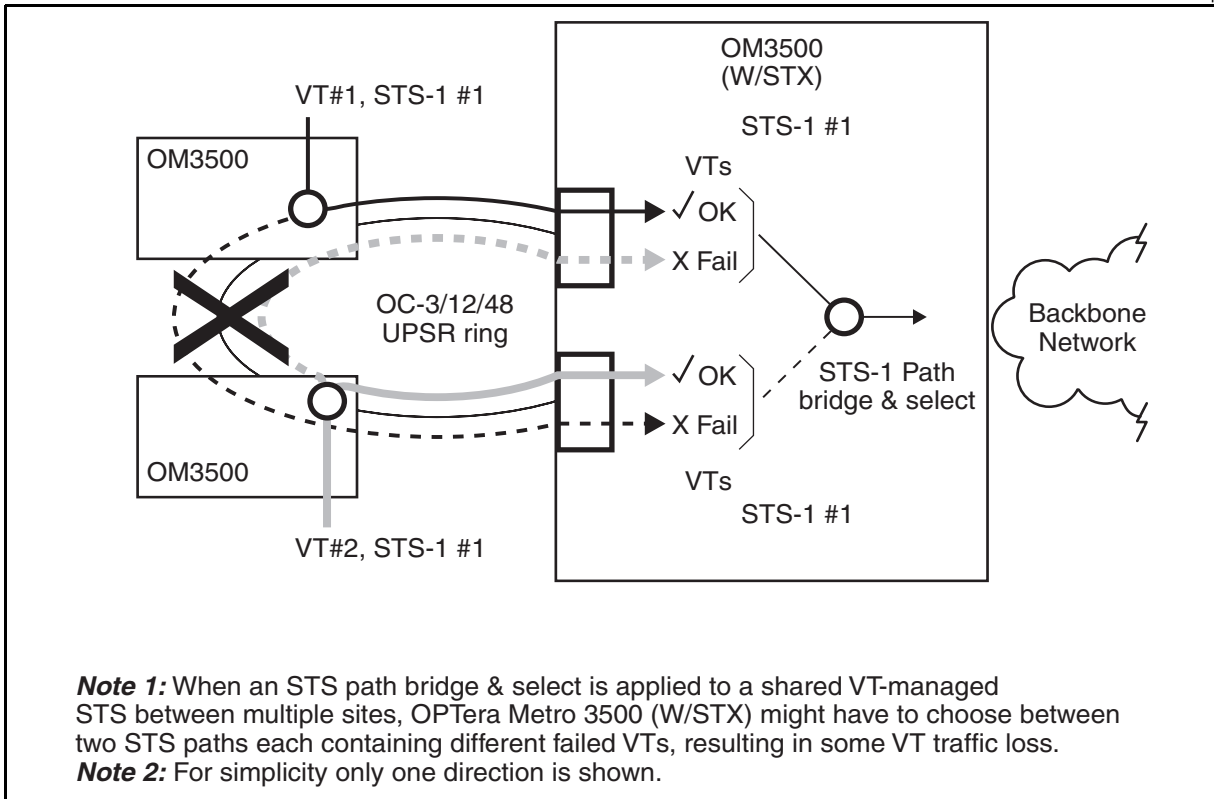
**Figure 2-66**  
**Virtual ring (path-in-line) and shared VTmanaged STS - no VT loss in case of a fiber cut**

EX1551p



**Figure 2-67**  
**Improper use of STS path bridge and select on a shared VT-managed STS results in VT traffic loss in case of a fiber cut**

EX1553p



## VT grooming on a UPSR

You can use OPTera Metro 3000 NEs equipped with VTX circuit packs at an OPTera Metro 3500 STS-managed site to groom VTs. VT grooming can optimize bandwidth on the OPTera Metro 3500 STS-managed backbone network. When you use OPTera Metro 3500 STS-managed NEs with OPTera Metro 3000 NEs that support virtual tributaries (VT), consider VT management when planning traffic flow and the path originating and terminating points.

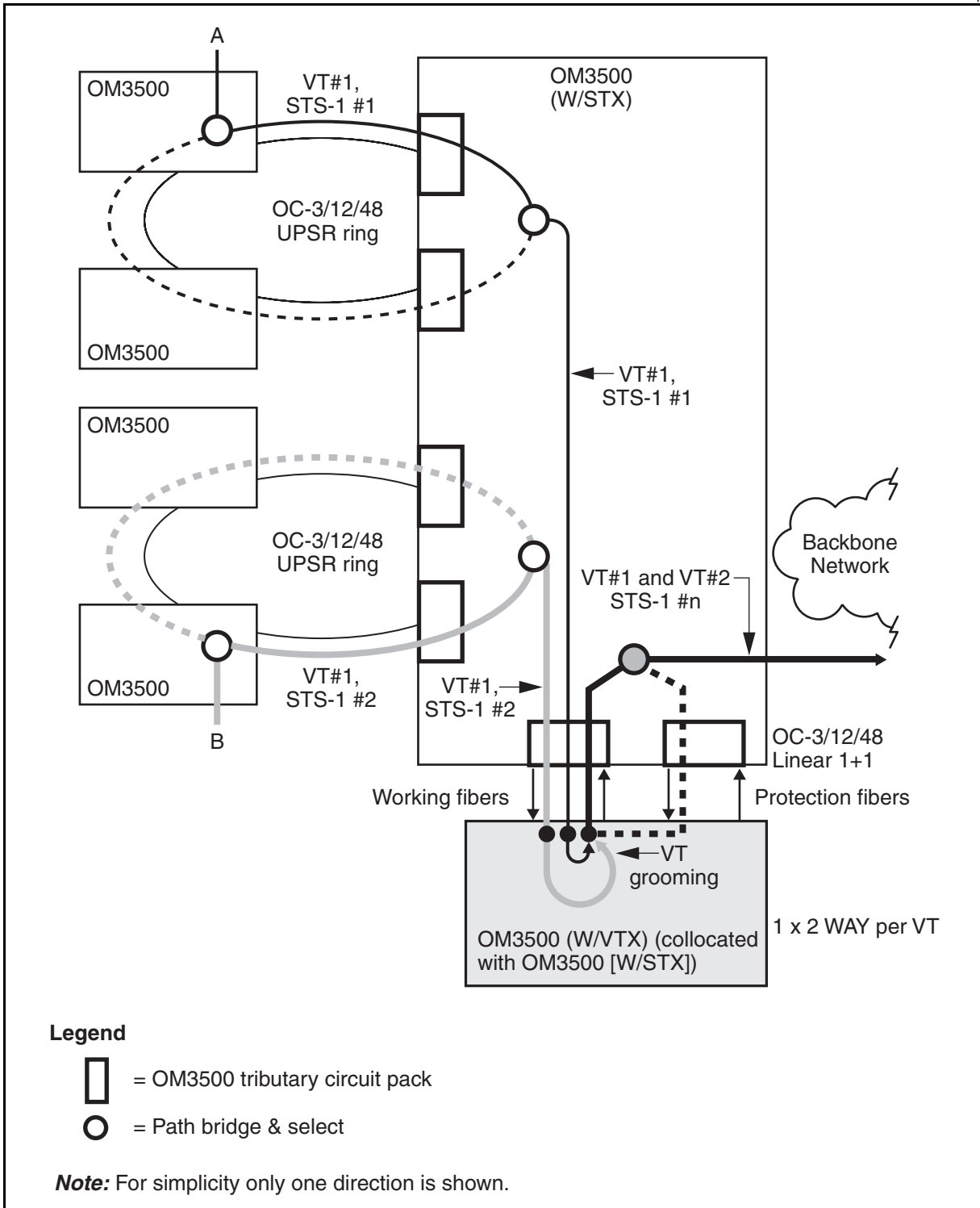
**Note:** An OPTera Metro 3500 shelf equipped with STX-192 circuit packs does not support VT management.

Two methods for grooming VTs are:

- Use dedicated STS at each node and ***provision STS connections at each passthrough OPTera Metro 3000 node on the subtending UPSR***. In this option, each remote site has dedicated STS. An OPTera Metro 3000 NE connected to an OPTera Metro 3500 STS-managed NE in a linear 1+1 configuration grooms VT traffic before sending the traffic to the OPTera Metro 3500 STS-managed backbone network or to other tributary ports. The grooming of VTs optimizes bandwidth on the OPTera Metro 3500 STS-managed backbone network (see [Figure 2-68 on page 2-182](#)).
- Use shared VT-managed STS. In this option, remote OPTera Metro 3000 sites form a virtual UPSR with an OPTera Metro 3000 NE at an OPTera Metro 3500 STS-managed site. The UPSR virtual ring passes through the OPTera Metro 3500 STS-managed site. The OPTera Metro 3000 NE at the OPTera Metro 3500 STS-managed site grooms VT traffic before sending the traffic to the OPTera Metro 3500 STS-managed backbone network or to other tributary ports. Again, the grooming of VTs optimizes bandwidth on the OPTera Metro 3500 STS-managed backbone network (see [Figure 2-69 on page 2-183](#)).

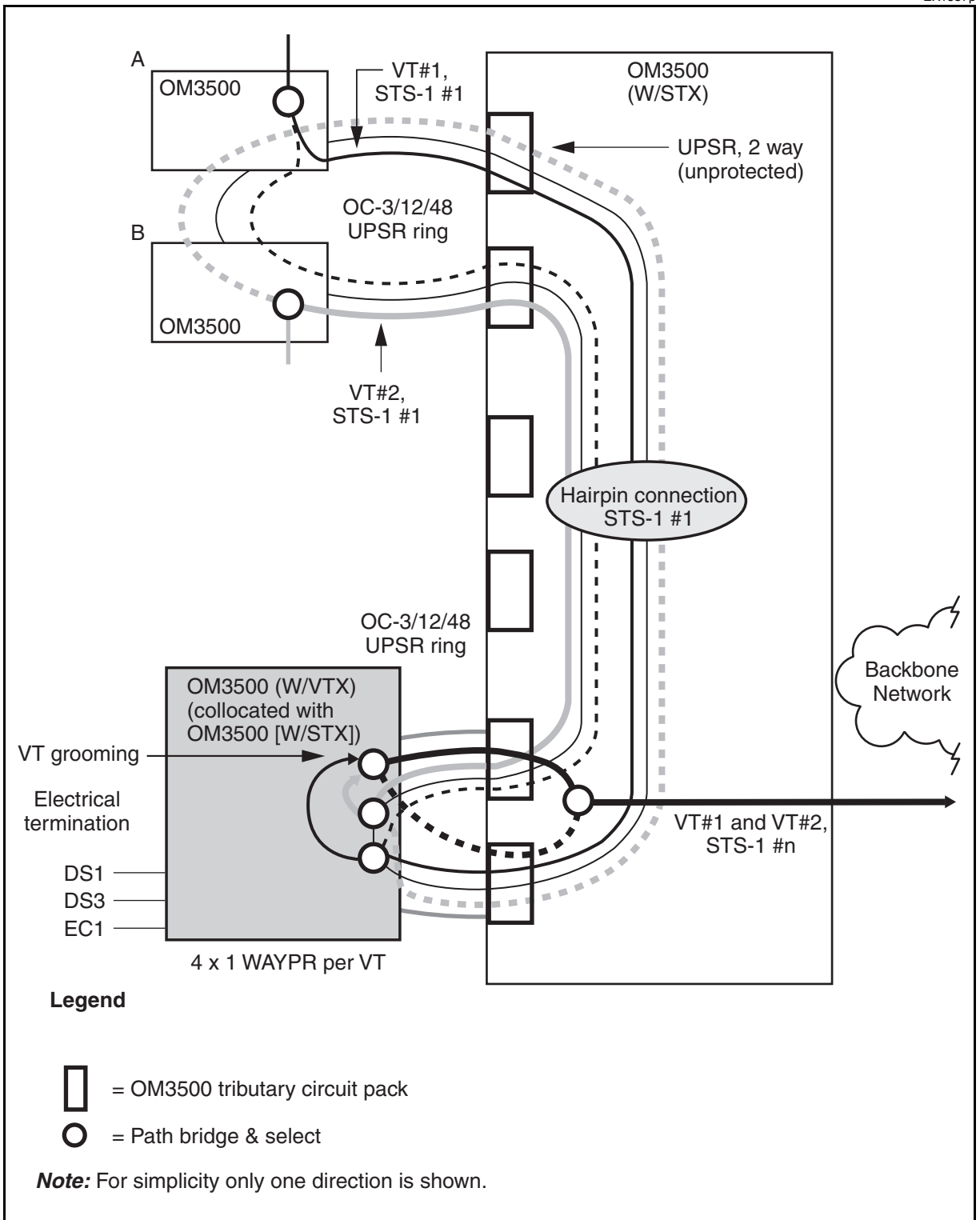
**Figure 2-68**  
**VT grooming with dedicated STS at each site**

EX1555p



**Figure 2-69**  
**VT grooming with shared VT-managed STS**

EX1557p



### **Collocated OPTera Metro 3000 NE and dedicated STS at each site**

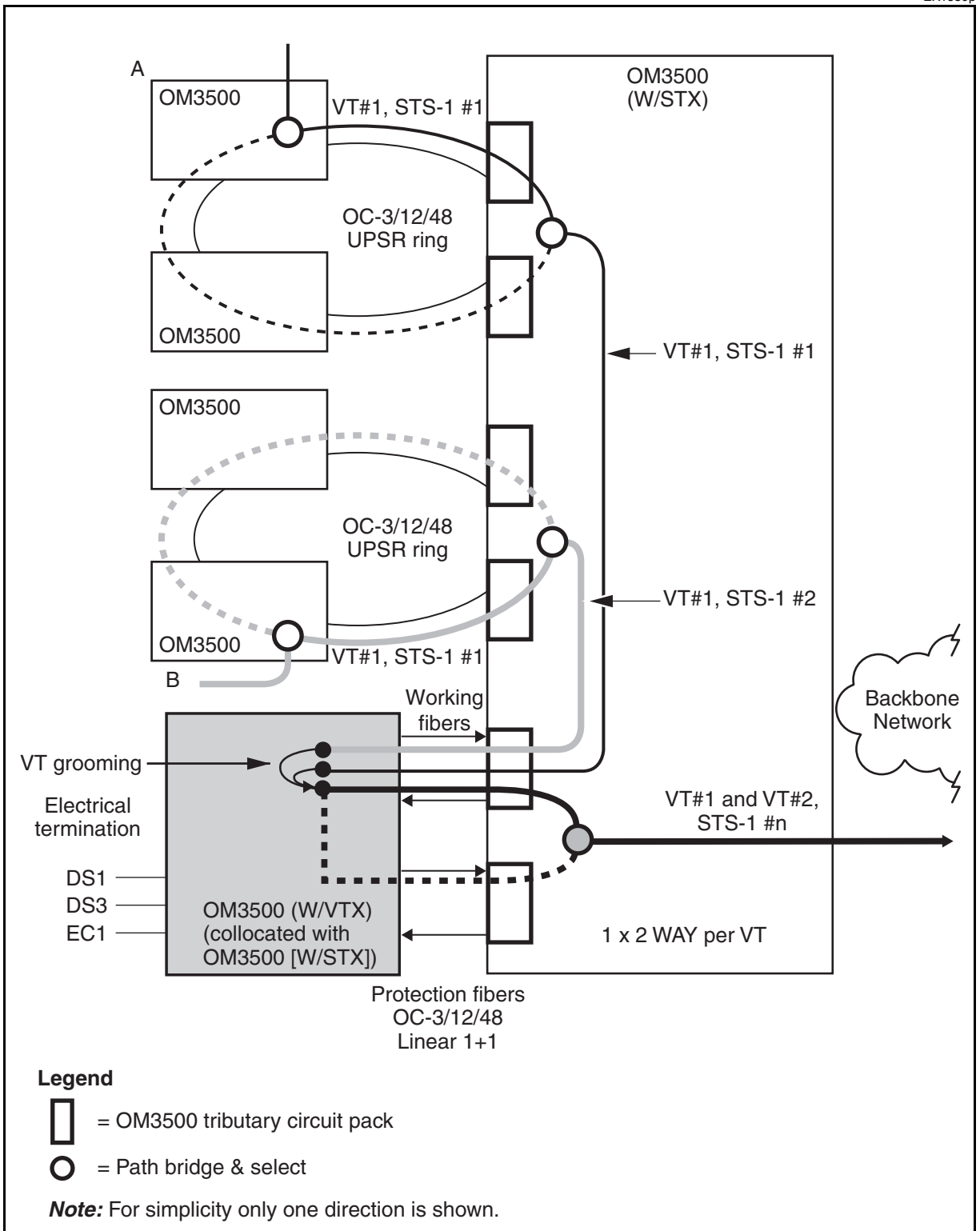
Using a collocated OPTera Metro 3000 NE and dedicated STS at each site provides the following values over a head-end ring node connection:

- For TDM traffic, it provides a termination point for electrical services (DS1, DS3, EC1) and allows efficient bandwidth utilization of the OPTera Metro 3500 STS-managed backbone network through VT grooming.
- For Ethernet traffic, it allows efficient transport through a Gigabit Ethernet RPR connection to the OPTera Connect DX NE.
- It is a modular network design with low initial costs. That is, you can collocate OPTera Metro 3000 NEs according to demand. Each NE can support a mix of TDM and Ethernet traffic or you can dedicate NEs for either TDM or Ethernet traffic.

[Figure 2-70 on page 2-185](#) shows a configuration that transports TDM traffic using a collocated OPTera Metro 3500 NE.

**Figure 2-70**  
**Collocated OPTera Metro 3500 NE and dedicated STS at each site - TDM traffic grooming**

EX1559p



### **Collocated OPTera Metro 3000 NE and shared VT-managed STS**

A connection that uses a collocated OPTera Metro 3000 NE and shared VT-managed STS has the advantage of not requiring dedicated STS at each site, resulting in more efficient use of bandwidth at the edge. See [Figure 2-71 on page 2-187](#).

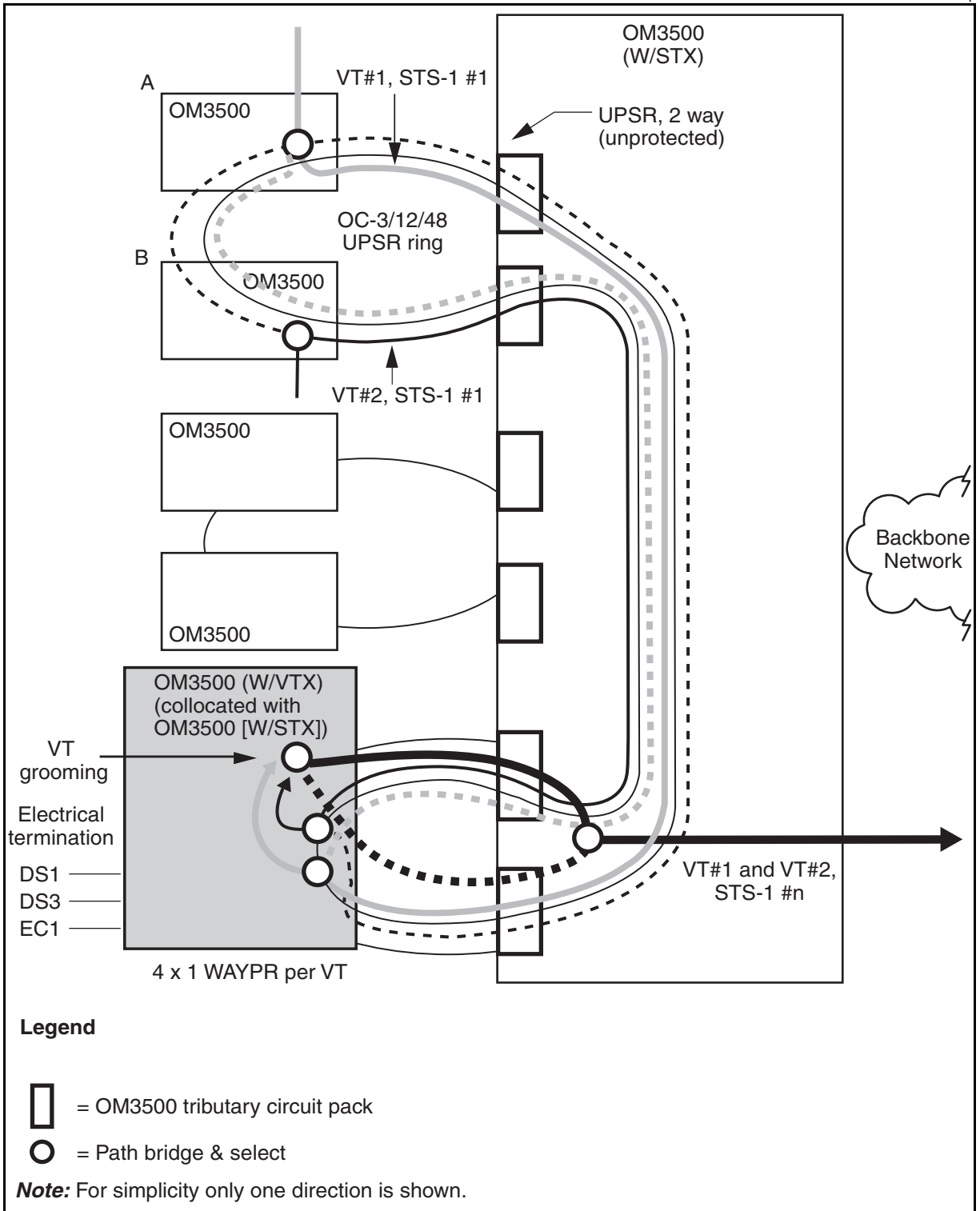
With this type of connection, you can use multiple virtual rings at the edge with each virtual ring covering a different physical route and having different termination points. Each virtual ring can operate at STS-1 or higher bandwidth. See [Figure 2-72 on page 2-188](#).

As with the option described in the previous section, this connection is a modular network design with low initial costs and allows efficient bandwidth utilization of the OPTera Metro 3500 STS-managed backbone network.



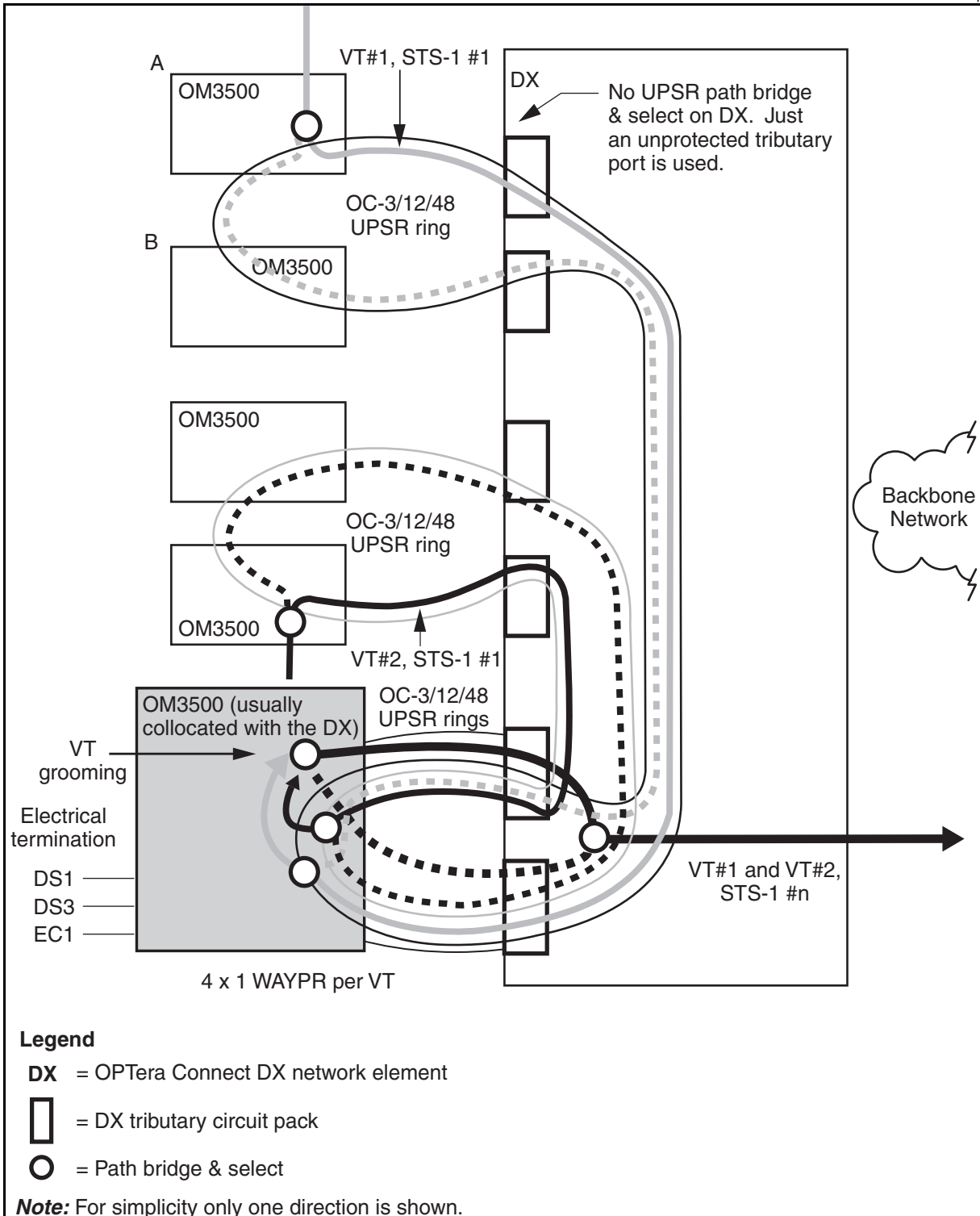
**Figure 2-71**  
**Collocated OPTera Metro 3500 NE and shared VT-managed STS – TDM traffic and grooming**  
**(Scenario 1)**

EX1561p



**Figure 2-72**  
**Collocated OPTera Metro 3500 NE and shared VT-managed STS – TDM traffic and grooming**  
**(Scenario 2)**

EX1563p



## UPSR planning guidelines summary

This section summarizes guidelines for STS-managed OPTera Metro 3500 and OPTera Metro 3000 UPSR configurations.

### General guidelines

- Always consider current and future traffic requirements when designing a network.
- Always consider “A-Z” traffic in terms of logical rings. Note that UPSR logical rings start and end at the path bridge and select points.

### Physical subtending rings

- If your subtending ring application does not use OPE circuit packs or shared VT-managed STS:
  - Keep your logical UPSR ring small. Use a UPSR path selector on STS-managed OPTera Metro 3500 for traffic entering STS-managed OPTera Metro 3500 (not for traffic that originates and terminates on the same subtending ring).
- If your subtending ring application uses shared VT-managed STS:
  - Evaluate your bandwidth requirements. If possible, eliminate the shared VT-managed STS and instead dedicate STS at each site. See [Figure 2-63 on page 2-176](#) for an example.
  - If you cannot dedicate STS at each site, do not use a UPSR path selector on the shared VT-managed STS. Extend your shared STS as larger logical rings towards a node capable of terminating the UPSR path (use STS-managed OPTera Metro 3500 as a passthrough node only). See [Figure 2-65 on page 2-178](#) for an example.
  - If you cannot dedicate STS at each site or extend the logical ring, your application might not be suited for a subtending ring. Consider using a collocated head-end ring connection.

### Virtual rings across the STS-managed OPTera Metro 3500 backbone network

In a logical UPSR that spans a physical UPSR/BLSR/UPSR configuration (also referred to as a virtual ring), the UPSR protection path is also routed on BLSR working time slots. See [Figure 2-65 on page 2-178](#) for an example.

### VT grooming at an STS-managed OPTera Metro 3500 site

An OPTera Metro 3000 NE collocated at an STS-managed OPTera Metro 3500 site can be used to groom VTs in order to optimize bandwidth utilization across the STS-managed OPTera Metro 3500 backbone network.

The collocated OPTera Metro 3000 NE can use dedicated STS at each site or shared VT-managed STS. See [Figure 2-70 on page 2-185](#) for an example of dedicated STS at each site. See [Figure 2-71 on page 2-187](#) and [Figure 2-72 on page 2-188](#) for examples of shared VT-managed STS.



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## Hardware feature descriptions

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This chapter provides descriptions of the OPTera Metro 3500 Shelf and OPTera Metro 3500 Universal Shelf with supported components for Release 12.1

**Table 3-1**  
**New hardware in OPTera Metro 3500 Release 12.1**

Hardware	Page
<a href="#">Extended Reach (ZX) Small Form Factor Pluggable (SFP)</a>	<a href="#">3-3</a>

**Table 3-2**  
**OPTera Metro 3500 hardware**

Hardware	Page
<a href="#">OPTera Metro 3500 Shelf and the OPTera Metro 3500 Universal Shelf</a>	<a href="#">3-4</a>
<a href="#">Replaceable I/O modules</a>	<a href="#">3-26</a>
<a href="#">Common modules</a>	<a href="#">3-37</a>
<a href="#">OPTera Metro 3500 cooling unit assembly and cooling unit fan modules</a>	<a href="#">3-40</a>
<a href="#">Universal cooling unit assembly and cooling unit fan modules for extended temperature applications</a>	<a href="#">3-41</a>
<a href="#">20 A (Universal) power module</a>	<a href="#">3-42</a>
<a href="#">OPTera Metro 3000 breaker interface panel (BIP)</a>	<a href="#">3-42</a>
<a href="#">STX-192 circuit pack</a>	<a href="#">3-51</a>
<a href="#">VTX-48 circuit pack</a>	<a href="#">3-54</a>
<a href="#">VTX-48e circuit pack</a>	<a href="#">3-55</a>
<a href="#">Extended shelf processor (SPx)</a>	<a href="#">3-56</a>
<a href="#">Extended network processor (NPx)</a>	<a href="#">3-57</a>
<a href="#">ILAN interface</a>	<a href="#">3-59</a>

**Table 3-2 (continued)**  
**OPTera Metro 3500 hardware**

Hardware	Page
OC-192 optical interface circuit pack	3-59
OC-192 DWDM G.709 FEC optical interface circuit pack	3-64
OC-48 optical interface circuit pack	3-65
OC-48 STS optical interface circuit pack	3-68
OC-48 DWDM circuit pack	3-71
OC-12 optical interface circuit pack	3-72
OC12x4 STS IR optical interface circuit pack	3-75
OC-3 optical interface circuit pack	3-77
OC-3x4 optical interface circuit pack	3-80
EC-1x3 circuit pack	3-82
EC-1x12 circuit pack	3-84
DS1 mapper	3-86
DS3x3 mapper	3-87
DS3x12 / DS3x12e mapper	3-89
DS3VTx12 mapper	3-90
2x100BT-P2P circuit pack	3-91
OPTera Packet Edge System 4x100BT circuit pack	3-94
OPTera Packet Edge System 4x100FX circuit pack	3-96
OPTera Packet Edge System 2xGigE (2x1000SX, 2x1000LX) circuit pack	3-97
2xGigabit Ethernet/Fibre Channel - Point-to-Point circuit pack	3-98
OPTera Packet Edge System 2xGigE (2x1000SX, 2x1000LX) circuit pack	3-100
Protection switch controller (PSC)	3-100
Protection switch extender (PSX)	3-101
OMX + Fiber Manager 4CH	3-101
OMX shelf (not required with OMX + Fiber Manager 4CH)	3-103
Fiber Manager (not required with OMX + Fiber Manager 4CH)	3-104
DS1 service module (DSM) shelf	3-107
DSM DS1x84 termination module (TM)	3-111

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## Extended Reach (ZX) Small Form Factor Pluggable (SFP) (NTTP51DZ)

OPTera Metro 3500 Release 12.1 introduces a new extended reach (ZX) small form factor pluggable for the 2xGigE/FC-P2P interfaces.

The new extended reach (ZX) small form factor pluggable uses a 1550nm laser and provides a minimum optical link budget of 24dB, which corresponds to a minimum distance of 80km (assuming fiber loss of 0.25dB/km). The ZX SFP provides a quick and reliable interface for 1000BASE-ZX Gigabit Ethernet and 1.062GB Fibre Channel applications and is compliant with IEEE 802.3z Gigabit Ethernet 1000BASE-LX PMD specifications and with 1.062GBd Fibre Channel 100-SM-LC-L FC-PI standards.

*Note:* Loss-less flow control is guaranteed for LX distances.

Refer to [Table 4-15 on page 4-29](#) for specifications for the SX, LX and ZX SFP.

## **OPTera Metro 3500 Shelf and the OPTera Metro 3500 Universal Shelf (NTN476AA, DA, AH)**

Release 12 supports the OPTera Metro 3500 Shelves (NTN476DA, NTN476AA) and the OPTera Metro 3500 Universal Shelf (NTN476AH). Both the OPTera Metro 3500 Shelf and the OPTera Metro 3500 Universal Shelf have 17 slots. Tributary I/O connections are located at the top of the shelf for field-installable I/O modules.

The OPTera Metro 3500 Universal Shelf is rated at 20 A from 0°C to +50°C and is rated at 12.5 A from -40°C to +65°C. See [Table 4-1 on page 4-1](#) (in Part 2 of this guide) for power requirements.

The Universal shelf supports both front rear-facing I/Os. Both the OPTera Metro 3500 Shelf and the OPTera Metro 3500 Universal Shelf are rated to operate in a controlled environment central office within the temperature range of 0°C to 50°C (32°F to 122°F). However, the OPTera Metro 3500 Universal Shelf is rated to operate under extended temperature conditions as well, in the range of -40°C to +65°C (-40°F to +149°F).

**Note:** The OPTera Metro 3500 Universal Shelf (NTN476AH) can operate in the extended temperature range only if all its accessory components are also rated for the extended temperature range. See [Table 3-3 on page 3-6](#).

The Universal shelf has various enhancements to facilitate easy installation of I/O modules and temperature control. All the circuit packs are interchangeable between shelves, however, some restrictions apply, see [Table 3-3 on page 3-6](#) for details.

On all types of shelves, slot 1 contains three separate subslots: 1a, 1b, and 1c. Slot 1a is for the left interface (LIF) and slots 1b and 1c are for the power modules. The left OAM (LOAM) attaches to the LIF from the left side of the shelf. The system retrieves inventory information for the LIF, the LOAM, and the power modules through slot 1. You must insert the LIF to retrieve inventory information for these circuit packs.

### **Shelves equipped with VTX-48 or VTX-48e circuit packs**

On all types of shelves, slots 11 through 14 are double-width slots for the OC-48 circuit packs and the VTX-48 or VTX-48e circuit packs. Slots 11 and 12 are high-speed interface slots for the OC-48 or OC-12 optical interface circuit packs. The VTX-48e circuit pack supports the OC-12 line rate for the optics in slots 11 and 12 on any shelf. Slots 13 and 14 are for the VTX-48 modules, which provide the VT and STS cross-connect functions for all service slots. The VTX-48 and VTX-48e circuit packs interface as STS-48 with the optical interface slots 11 and 12 and interface as STS-3 and STS-12 with the slots 3 through 10.



**Shelves equipped with STX-192 circuit packs**

On all types of shelves, slots 13 and 14 are double-width slots for the STX-192. Slots 11 and 12 are high-speed interface slots for the OC-48 STS or OC-192 optical interface circuit packs. Slots 13 and 14 are for the STX-192 circuit packs, which provide the STS cross-connect functions for all service slots. The STX-192 circuit pack interface as STS-192 or STS-48 with the optical interface slots 11 and 12 and interface as STS-3, STS-12 and STS-48 with the slots 3 through 10.

See [Figure 3-1](#) for an example of the OPTera Metro 3500 Shelf (NTN476DA) and [Figure 3-3](#) for an example of the OPTera Metro 3500 Universal Shelf (NTN476AH). For an example of the OPTera Metro 3500 Shelf (NTN476DA) equipped with replaceable I/O modules, see [Figure 3-2](#). For an example of the OPTera Metro 3500 Universal Shelf (NTN476AH) equipped with fans and a replaceable I/O module, see [Figure 3-4](#) and [Figure 3-5](#).

**Table 3-3**  
**Supported shelf equipment and operational temperature ranges**

Circuit pack / equipment	PEC	Operational temperature range	
		OPTera Metro 3500 Shelf Assembly (NTN476DA, NTN476AA)	OPTera Metro 3500 Universal Shelf Assembly (NTN476AH)
<b>OC-3 circuit packs</b>			
OC-3 IC (Interconnect)	NTN401DA	0°C to 50°C (32°F to 122°F)	-40°C to +65°C (-40°F to +149°F)
OC-3 LR (Long Reach)	NTN401AA	0°C to 50°C (32°F to 122°F)	-40°C to +65°C (-40°F to +149°F)
OC-3x4 IR (Intermediate Reach) • pre-installed SC connectors	NTN441AA	0°C to 50°C (32°F to 122°F)	-40°C to +65°C (-40°F to +149°F)
OC-3x4 IR (Intermediate Reach) • pre-installed LC connectors • supports multimode interworking	NTN441AC	0°C to 50°C (32°F to 122°F)	-40°C to +65°C (-40°F to +149°F)
<b>OC-12 circuit packs</b>			
OC-12 LR (Long Reach)	NTN404AA	0°C to 50°C (32°F to 122°F)	-40°C to +65°C (-40°F to +149°F)
OC-12 IR (Intermediate Reach)	NTN404BA	0°C to 50°C (32°F to 122°F)	-40°C to +65°C (-40°F to +149°F)
OC-12 ER (Extended Reach)	NTN404CA	0°C to 50°C (32°F to 122°F)	-40°C to +65°C (-40°F to +149°F)
OC-12 IC (Interconnect)	NTN404DA	0°C to 50°C (32°F to 122°F)	-40°C to +65°C (-40°F to +149°F)
OC-12 LR (Long Reach) • supporting STS-12c	NTN404JA	0°C to 50°C (32°F to 122°F)	-40°C to +65°C (-40°F to +149°F)
OC-12 IR (Intermediate Reach) • supporting STS-12c	NTN404KA	0°C to 50°C (32°F to 122°F)	-40°C to +65°C (-40°F to +149°F)

**Table 3-3 (continued)**  
**Supported shelf equipment and operational temperature ranges**

Circuit pack / equipment	PEC	Operational temperature range	
		OPTera Metro 3500 Shelf Assembly (NTN476DA, NTN476AA)	OPTera Metro 3500 Universal Shelf Assembly (NTN476AH)
OC-12 ER (Extended Reach) • supporting STS-12c	NTN404LA	0°C to 50°C (32°F to 122°F)	-40°C to +65°C (-40°F to +149°F)
OC-12 IC (Interconnect) • supporting STS-12c	NTN404MA	0°C to 50°C (32°F to 122°F)	-40°C to +65°C (-40°F to +149°F)
OC-12x4 STS IR (Intermediate Reach)	NTN446CA	0°C to 50°C (32°F to 122°F)	0°C to 50°C (32°F to 122°F)
<b>OC-48 non-DWDM circuit packs</b>			
OC-48 SR (Short Reach) • 1310nm	NTN440EA	0°C to 50°C (32°F to 122°F)	0°C to 50°C (32°F to 122°F)
OC-48 SR (Short Reach) • 1310nm	NTN440EH	0°C to 50°C (32°F to 122°F)	-40°C to +65°C (-40°F to +149°F)
OC-48 LR (Long Reach) • 1550nm	NTN440DA	0°C to 50°C (32°F to 122°F)	0°C to 50°C (32°F to 122°F)
OC-48 IR (Intermediate Reach) • 1310nm	NTN440BA	0°C to 50°C (32°F to 122°F)	0°C to 50°C (32°F to 122°F)
OC-48 IR (Intermediate Reach) • 1310nm	NTN440BH	0°C to 50°C (32°F to 122°F)	-40°C to +65°C (-40°F to +149°F)
OC-48 ELR (Extended Long Reach) • 1550nm	NTN440FA	0°C to 50°C (32°F to 122°F)	0°C to 50°C (32°F to 122°F)
OC-48 STS SR (Short Reach)	NTN440HA	0°C to 50°C (32°F to 122°F)	0°C to 50°C (32°F to 122°F)

**Table 3-3 (continued)**  
**Supported shelf equipment and operational temperature ranges**

Circuit pack / equipment	PEC	Operational temperature range	
		OPTera Metro 3500 Shelf Assembly (NTN476DA, NTN476AA)	OPTera Metro 3500 Universal Shelf Assembly (NTN476AH)
OC-48 STS IR (Intermediate Reach)	NTN440KA	0°C to 50°C (32°F to 122°F)	0°C to 50°C (32°F to 122°F)
OC-48 STS LR (Long Reach)	NTN440LA	0°C to 50°C (32°F to 122°F)	0°C to 50°C (32°F to 122°F)
<b>OC-48 DWDM circuit packs</b>			
OC-48 LR DWDM (C-Band) <ul style="list-style-type: none"> <li>16 circuit packs spanning Band 1, Channel 1 to Band 4, Channel 4</li> <li>See Note 3</li> </ul>	NTN442**	0°C to 50°C (32°F to 122°F)	0°C to 50°C (32°F to 122°F)
OC-48 ER DWDM (C-Band) <ul style="list-style-type: none"> <li>7 circuit packs spanning Band 1, Channel 1 to Band 4, Channel 4</li> <li>See Note 4</li> </ul>	NTN408**	0°C to 50°C (32°F to 122°F)	-40°C to +65°C (-40°F to +149°F)
OC-48 LR DWDM (L-Band) <ul style="list-style-type: none"> <li>8 circuit packs spanning Band 5, Channel 1 to channel 4 and Band 7, Channel 1 to Channel 4</li> <li>See Note 5</li> </ul>	NTN442**	0°C to 50°C (32°F to 122°F)	0°C to 50°C (32°F to 122°F)
OC-48 LR DWDM <ul style="list-style-type: none"> <li>1535.04 nm</li> <li>The OMX does not support the OC-48 DWDM 1535.04 nm (NTN442EA) circuit pack.</li> </ul>	NTN442EA	0°C to 50°C (32°F to 122°F)	0°C to 50°C (32°F to 122°F)
OC-48 ER DWDM <ul style="list-style-type: none"> <li>1535.04 nm</li> <li>The OMX does not support the OC-48 DWDM 1535.04 nm (NTN408AS) circuit pack.</li> </ul>	NTN408AS	0°C to 50°C (32°F to 122°F)	-40°C to +65°C (-40°F to +149°F)
OC-48 LR DWDM <ul style="list-style-type: none"> <li>1555.75nm</li> <li>The OMX does not support the OC-48 DWDM 1555.75 nm (NTN442FB) circuit pack.</li> </ul>	NTN442FB	0°C to 50°C (32°F to 122°F)	0°C to 50°C (32°F to 122°F)

**Table 3-3 (continued)**  
**Supported shelf equipment and operational temperature ranges**

Circuit pack / equipment	PEC	Operational temperature range	
		OPTera Metro 3500 Shelf Assembly (NTN476DA, NTN476AA)	OPTera Metro 3500 Universal Shelf Assembly (NTN476AH)
OC-48 ER DWDM <ul style="list-style-type: none"> <li>• 1555.75nm</li> <li>• The OMX does not support the OC-48 DWDM 1555.75 nm (NTN408CW) circuit pack.</li> </ul>	NTN408CW	0°C to 50°C (32°F to 122°F)	-40°C to +65°C (-40°F to +149°F)
OC-48 DWDM <ul style="list-style-type: none"> <li>• 1596.34 nm</li> <li>• Conforms to ITU 100GHz space grid</li> <li>• The OPTera Metro OMX does not support the OC-48 DWDM 1596.34 nm (NTN442LF) circuit pack.</li> </ul>	NTN442LF	0°C to 50°C (32°F to 122°F)	0°C to 50°C (32°F to 122°F)
OC-48 DWDM <ul style="list-style-type: none"> <li>• 1578.69 nm</li> <li>• Conforms to ITU 100GHz space grid</li> <li>• The OPTera Metro OMX does not support the OC-48 DWDM 1578.69 nm (NTN442NB) circuit pack.</li> </ul>	NTN442NB	0°C to 50°C (32°F to 122°F)	0°C to 50°C (32°F to 122°F)
<b>OC192 non-DWDM circuit packs</b>			
OC-192 IR <ul style="list-style-type: none"> <li>• 1550nm</li> </ul>	NTN445CB	0°C to 50°C (32°F to 122°F)	0°C to 50°C (32°F to 122°F)
OC-192 LR G.709 FEC (Long Reach) <ul style="list-style-type: none"> <li>• 1550nm</li> </ul>	NTN445DA	0°C to 50°C (32°F to 122°F)	0°C to 50°C (32°F to 122°F)
<b>OC192 DWDM circuit packs</b>			
OC-192 DWDM G.709 FEC <ul style="list-style-type: none"> <li>• 1535.04 nm</li> <li>• The OMX does not support the OC-192 DWDM G.709 FEC 1535.04 nm (NTN445JA) circuit pack.</li> </ul>	NTN445JA	0°C to 50°C (32°F to 122°F)	0°C to 50°C (32°F to 122°F)
OC-192 DWDM G.709 FEC <ul style="list-style-type: none"> <li>• 8 circuit packs spanning Band 1 Channel 1 to Band 2 Channel 4</li> <li>• See Note 6</li> </ul>	NTN445**	0°C to 50°C (32°F to 122°F)	0°C to 50°C (32°F to 122°F)

### 3-10 Hardware feature descriptions

**Table 3-3 (continued)**  
**Supported shelf equipment and operational temperature ranges**

Circuit pack / equipment	PEC	Operational temperature range	
		OPTera Metro 3500 Shelf Assembly (NTN476DA, NTN476AA)	OPTera Metro 3500 Universal Shelf Assembly (NTN476AH)
<b>Electrical tributary circuit packs</b>			
DS1	NTN430AA	0°C to 50°C (32°F to 122°F)	-40°C to +65°C (-40°F to +149°F)
DS1e • far-end DS1 PM enhancements	NTN430BA	0°C to 50°C (32°F to 122°F)	-40°C to +65°C (-40°F to +149°F)
DS1x84TM • pre-installed LC connectors	NTN313AC	-40°C to +65°C (-40°F to +149°F) on the DSM shelf (NTN407MA)	
DS1x84TM	NTN313AA	-40°C to +65°C (-40°F to +149°F) on the DSM shelf (NTN407MA)	
DS3x3	NTN437AA	0°C to 50°C (32°F to 122°F)	-40°C to +65°C (-40°F to +149°F)
DS3x12	NTN435AA	0°C to 50°C (32°F to 122°F)	0°C to 50°C (32°F to 122°F)
DS3x12	NTN435AH	0°C to 50°C (32°F to 122°F)	-40°C to +65°C (-40°F to +149°F)
DS3x12e • near-end path PM enhancements • alarm enhancements	NTN435BA	0°C to 50°C (32°F to 122°F)	-40°C to +65°C (-40°F to +149°F)
DS3VTx12 • channelized DS3 service	NTN435FA	0°C to 50°C (32°F to 122°F)	-40°C to +65°C (-40°F to +149°F)
EC-1x3	NTN436AA	0°C to 50°C (32°F to 122°F)	-40°C to +65°C (-40°F to +149°F)
EC-1x12	NTN436DA	0°C to 50°C (32°F to 122°F)	-40°C to +65°C (-40°F to +149°F)

**Table 3-3 (continued)**  
**Supported shelf equipment and operational temperature ranges**

Circuit pack / equipment	PEC	Operational temperature range	
		OPTera Metro 3500 Shelf Assembly (NTN476DA, NTN476AA)	OPTera Metro 3500 Universal Shelf Assembly (NTN476AH)
2x100BT-P2P <ul style="list-style-type: none"> <li>• Optical Ethernet-Private Line</li> <li>• Native Ethernet between two Ethernet ports and mapped into transparent Layer 1 network</li> <li>• IEEE 802.3i, 802.3u (10BASE-T and 100BASE-TX) compliant</li> <li>• 2 10BASE-T / 100BASE-TX ports</li> <li>• RJ-45 connectors</li> </ul>	NTN433AA	0°C to 50°C (32°F to 122°F)	0°C to 50°C (32°F to 122°F)
2xGigE/FC-P2P <ul style="list-style-type: none"> <li>• Optical Ethernet-Private Line</li> <li>• 2 LAN ports independently configurable as GigaBit Ethernet or Fibre Channel (FC100 and FICON)</li> <li>• SFP optics offering both SX, LX and ZX reaches (ordered separately)</li> </ul>	NTN438DA	0°C to 50°C (32°F to 122°F)	0°C to 50°C (32°F to 122°F)
Small Form Factor Pluggables <ul style="list-style-type: none"> <li>• 1000-BaseSX 850 nm (NTTP51AA)</li> <li>• 1000-BaseLX 1310 nm (NTTP51BD)</li> <li>• 1000-BaseZX 1550 nm (NTTP51DZ)</li> <li>• LC connectors</li> </ul>	NTTP51AA NTTP51BD NTTP51DZ	0°C to 50°C (32°F to 122°F)	0°C to 50°C (32°F to 122°F)

**Table 3-3 (continued)**  
**Supported shelf equipment and operational temperature ranges**

Circuit pack / equipment	PEC	Operational temperature range	
		OPTera Metro 3500 Shelf Assembly (NTN476DA, NTN476AA)	OPTera Metro 3500 Universal Shelf Assembly (NTN476AH)
<b>OPTera Packet Edge System circuit packs</b>			
OPTera Packet Edge System 4x100BT <ul style="list-style-type: none"> <li>• IEEE 802.3i, 802.3u (10BASE-T and 100BASE-TX) compliant</li> <li>• 4 10BASE-T / 100BASE-TX ports</li> <li>• RJ-45 connectors</li> </ul>	NTN433BB	0°C to 50°C (32°F to 122°F)	0°C to 50°C (32°F to 122°F)
OPTera Packet Edge System 4x100FX-MM <ul style="list-style-type: none"> <li>• IEEE 802.3u (Fast Ethernet) compliant</li> <li>• 62.5 μM Multi-Mode fiber</li> <li>• Max dist: 2km</li> <li>• 4 100BASE-FX ports</li> <li>• MT-RJ connectors</li> <li>• See Note 2.</li> </ul>	NTN433EA	0°C to 50°C (32°F to 122°F)	0°C to 50°C (32°F to 122°F)
OPTera Packet Edge System 4x100FX-SM <ul style="list-style-type: none"> <li>• IEEE 802.3u (Fast Ethernet) compliant</li> <li>• 10 μM Single Mode fiber</li> <li>• Max dist: 15km</li> <li>• 4 100BASE-FX ports</li> <li>• MT-RJ connectors</li> <li>• See Note 2.</li> </ul>	NTN433FA	0°C to 50°C (32°F to 122°F)	0°C to 50°C (32°F to 122°F)
OPTera Packet Edge System 2x1000SX <ul style="list-style-type: none"> <li>• IEEE 802.3z (Gigabit Ethernet) compliant</li> <li>• 50 or 62.5 μM Multi-Mode fiber</li> <li>• Max dist: 500-550m (50μM MMF), 220-275m (62.5μM MMF)</li> <li>• 2 1000BASE-X ports</li> <li>• SC connectors</li> <li>• See Note 2.</li> </ul>	NTN438AA	0°C to 50°C (32°F to 122°F)	0°C to 50°C (32°F to 122°F)



**Table 3-3 (continued)**  
**Supported shelf equipment and operational temperature ranges**

Circuit pack / equipment	PEC	Operational temperature range	
		OPTera Metro 3500 Shelf Assembly (NTN476DA, NTN476AA)	OPTera Metro 3500 Universal Shelf Assembly (NTN476AH)
OPTera Packet Edge System 2x1000LX <ul style="list-style-type: none"> <li>• IEEE 802.3z (Gigabit Ethernet) compliant</li> <li>• 50 or 62.5 μM Multi-Mode fiber, or 10 μM Single Mode fiber</li> <li>• Max dist: 550m (50, 62.5μM MMF), 5km (SMF)</li> <li>• 2 1000BASE-X ports</li> <li>• SC connectors</li> <li>• See Note 2.</li> </ul>	NTN438BA	0°C to 50°C (32°F to 122°F)	0°C to 50°C (32°F to 122°F)
<b>Cross-connect / synchronization circuit packs</b>			
VTX-48 <ul style="list-style-type: none"> <li>• supporting OC-48 line rate in slots 11 and 12</li> <li>• Refer to <a href="#">Table 3-7 on page 3-52</a> for electrical and optical circuit packs supported</li> <li>• supports VT1.5 and STS grooming</li> </ul>	NTN414AA	0°C to 50°C (32°F to 122°F)	0°C to 50°C (32°F to 122°F)
VTX-48e <ul style="list-style-type: none"> <li>• supporting OC-12 or OC-48 line rate in slots 11 and 12</li> <li>• Refer to <a href="#">Table 3-7 on page 3-52</a> for electrical and optical circuit packs supported.</li> <li>• supports VT1.5 and STS grooming</li> </ul>	NTN414AB	0°C to 50°C (32°F to 122°F)	0°C to 50°C (32°F to 122°F)
VTX-48e <ul style="list-style-type: none"> <li>• supporting OC-12 or OC-48 line rate in slots 11 and 12</li> <li>• Refer to <a href="#">Table 3-7 on page 3-52</a> for electrical and optical circuit packs supported.</li> </ul>	NTN414AH	0°C to 50°C (32°F to 122°F)	-40°C to +65°C (-40°F to +149°F)

**Table 3-3 (continued)**  
**Supported shelf equipment and operational temperature ranges**

Circuit pack / equipment	PEC	Operational temperature range	
		OPTera Metro 3500 Shelf Assembly (NTN476DA, NTN476AA)	OPTera Metro 3500 Universal Shelf Assembly (NTN476AH)
STX-192 <ul style="list-style-type: none"> <li>• supporting OC-192 or OC-48 line rate in slots 11 and 12</li> <li>• Refer to <a href="#">Table 3-7 on page 3-52</a> for electrical and optical circuit packs supported.</li> <li>• supports STS grooming only</li> </ul>	NTN415AA	0°C to 50°C (32°F to 122°F)	0°C to 50°C (32°F to 122°F)
<b>Protection switching circuit packs</b>			
PSC	NTN412AA	0°C to 50°C (32°F to 122°F)	-40°C to +65°C (-40°F to +149°F)
PSX	NTN413AA	0°C to 50°C (32°F to 122°F)	-40°C to +65°C (-40°F to +149°F)
<b>Network / Shelf processors, and ILAN circuit packs</b>			
SPx	NTN423BA	0°C to 50°C (32°F to 122°F)	0°C to 50°C (32°F to 122°F)
SPx	NTN423BH	0°C to 50°C (32°F to 122°F)	-40°C to +65°C (-40°F to +149°F)
NPx	NTN424BA	0°C to 50°C (32°F to 122°F)	0°C to 50°C (32°F to 122°F)
NPx	NTN424BH	0°C to 50°C (32°F to 122°F)	-40°C to +65°C (-40°F to +149°F)
Intershelf LAN (ILAN)	NTN425AA	0°C to 50°C (32°F to 122°F)	0°C to 50°C (32°F to 122°F)
<b>Power modules and BIPs</b>			
20 A power module	NTN451HA	0°C to 50°C (32°F to 122°F)	-40°C to +65°C (-40°F to +149°F)
12.5 A power module	NTN451GA	0°C to 50°C (32°F to 122°F)	Not supported on this platform
OPTera Metro 3500 Breaker Interface Panel (BIP) <ul style="list-style-type: none"> <li>• 20 Amp</li> </ul>	NTN458RA	0°C to 50°C (32°F to 122°F)	-10°C to +60°C (14°F to 140°F)

**Table 3-3 (continued)**  
**Supported shelf equipment and operational temperature ranges**

Circuit pack / equipment	PEC	Operational temperature range	
		OPTera Metro 3500 Shelf Assembly (NTN476DA, NTN476AA)	OPTera Metro 3500 Universal Shelf Assembly (NTN476AH)
<b>Cooling unit assemblies</b>			
Universal shelf cooling unit assembly • includes 3 cooling unit fan modules	NTN458QH	Not supported on this platform	-40°C to +65°C (-40°F to +149°F)
Cooling unit assembly • includes 3 cooling unit fan modules • Not supported on the NTN476AH Shelf Assembly	NTN458QA	0°C to 50°C (32°F to 122°F)	Not supported on this platform
Fan kit • includes 3 cooling unit fan modules • Only supported on the NTN476AA Shelf Assembly	NTN458GA	0°C to 50°C (32°F to 122°F)	Not supported on this platform
<b>Accessory shelves</b>			
DS1 service module (DSM) shelf	NTN407MA	-40°C to +65°C (-40°F to +149°F)	
OMX shelf • If you have an OMX + Fiber Manager 4CH, you do not require an OMX shelf.	NTN449ZW	0°C to 50°C (32°F to 122°F)	
OMX + Fiber Manager 4CH • See Note 7	NT0H32*E	0°C to 50°C (32°F to 122°F)	
Enhanced OMX + Fiber Manager 4CH • See Note 8	NT0H32*F	0°C to 50°C (32°F to 122°F)	
<b>I/O modules</b>			
DS1 1-28 Front I/O module • serving DS1 ports 1-28 • front access	NTN452AA	0°C to 50°C (32°F to 122°F)	Not supported on this platform
DS1 29-56 Front I/O module • serving DS1 ports 29-56 • front access	NTN452CA	0°C to 50°C (32°F to 122°F)	Not supported on this platform

**Table 3-3 (continued)**  
**Supported shelf equipment and operational temperature ranges**

Circuit pack / equipment	PEC	Operational temperature range	
		OPTera Metro 3500 Shelf Assembly (NTN476DA, NTN476AA)	OPTera Metro 3500 Universal Shelf Assembly (NTN476AH)
DS1 29-84 Front I/O module <ul style="list-style-type: none"> <li>• serving DS1 ports 29-84</li> <li>• front access</li> </ul>	NTN452EA	0°C to 50°C (32°F to 122°F)	Not supported on this platform
DS1 1-28 Front Enhanced I/O module <ul style="list-style-type: none"> <li>• serving DS1 ports 1-28</li> <li>• front access</li> <li>• enhanced latch mechanism</li> </ul>	NTN452AH	Not supported on this platform	-40°C to +65°C (-40°F to +149°F)
DS1 29-56 Front Enhanced I/O module <ul style="list-style-type: none"> <li>• serving DS1 ports 29-56</li> <li>• front access</li> <li>• enhanced latch mechanism</li> </ul>	NTN452CH	Not supported on this platform	-40°C to +65°C (-40°F to +149°F)
DS1 29-84 Front Enhanced I/O module <ul style="list-style-type: none"> <li>• serving DS1 ports 29-84</li> <li>• front access</li> <li>• enhanced latch mechanism</li> </ul>	NTN452EH	Not supported on this platform	-40°C to +65°C (-40°F to +149°F)
DS1 1-28 Rear I/O module <ul style="list-style-type: none"> <li>• serving DS1 ports 1-28</li> <li>• rear access</li> <li>• enhanced latch mechanism</li> </ul>	NTN452BA	Not supported on this platform	-40°C to +65°C (-40°F to +149°F)
DS1 29-56 Rear I/O module <ul style="list-style-type: none"> <li>• serving DS1 ports 29-56</li> <li>• rear access</li> <li>• enhanced latch mechanism</li> </ul>	NTN452DA	Not supported on this platform	-40°C to +65°C (-40°F to +149°F)
DS1 29-84 Rear I/O module <ul style="list-style-type: none"> <li>• serving DS1 ports 29-84</li> <li>• rear access</li> <li>• enhanced latch mechanism</li> </ul>	NTN452FA	Not supported on this platform	-40°C to +65°C (-40°F to +149°F)

**Table 3-3 (continued)**  
**Supported shelf equipment and operational temperature ranges**

Circuit pack / equipment	PEC	Operational temperature range	
		OPTera Metro 3500 Shelf Assembly (NTN476DA, NTN476AA)	OPTera Metro 3500 Universal Shelf Assembly (NTN476AH)
BNC 12-Port Front I/O module <ul style="list-style-type: none"> <li>• serving DS3 and EC-1 ports</li> <li>• front access</li> </ul>	NTN452JA	0°C to 50°C (32°F to 122°F)	Not supported on this platform
BNC 12-Port Front Enhanced I/O module <ul style="list-style-type: none"> <li>• serving DS3 and EC-1 ports</li> <li>• front access</li> <li>• enhanced latch mechanism</li> </ul>	NTN452JH	Not supported on this platform	-40°C to +65°C (-40°F to +149°F)
BNC 12-Port Rear I/O module <ul style="list-style-type: none"> <li>• serving DS3 and EC-1 ports</li> <li>• rear access</li> <li>• enhanced latch mechanism</li> </ul>	NTN452KA	Not supported on this platform	-40°C to +65°C (-40°F to +149°F)
8xRJ-45 Front I/O module <ul style="list-style-type: none"> <li>• serving 10BASE-T and 100BASE-TX Ethernet ports</li> <li>• front access</li> </ul>	NTN452NA	0°C to 50°C (32°F to 122°F)	Not supported on this platform
8xRJ-45 Front Enhanced I/O module <ul style="list-style-type: none"> <li>• serving 10BASE-T and 100BASE-TX Ethernet ports</li> <li>• front access</li> <li>• enhanced latch mechanism</li> </ul>	NTN452NH	Not supported on this platform	-40°C to +65°C (-40°F to +149°F)
8xRJ-45 Rear I/O module <ul style="list-style-type: none"> <li>• serving 10BASE-T and 100BASE-TX Ethernet ports</li> <li>• rear access</li> <li>• enhanced latch mechanism</li> </ul>	NTN452HB	Not supported on this platform	-40°C to +65°C (-40°F to +149°F)

**Table 3-3 (continued)**  
**Supported shelf equipment and operational temperature ranges**

Circuit pack / equipment	PEC	Operational temperature range	
		OPTera Metro 3500 Shelf Assembly (NTN476DA, NTN476AA)	OPTera Metro 3500 Universal Shelf Assembly (NTN476AH)
<b>LIFs and LOAMs</b>			
LIF (left interface)	NTN451BA	0°C to 50°C (32°F to 122°F)	Not supported on this platform
LOAM (left OAM)	NTN451MA	0°C to 50°C (32°F to 122°F)	0°C to 50°C (32°F to 122°F)
LIF (left interface)	NTN451BH	0°C to 50°C (32°F to 122°F)	-40°C to +65°C (-40°F to +149°F)
LOAM (left OAM)	NTN451MH	0°C to 50°C (32°F to 122°F)	-40°C to +65°C (-40°F to +149°F)
<p><b>Note 1:</b> To obtain the definition of the OPTera Metro 3500 hardware baseline, contact the +44-20-8945-2333 for International Optical Networks (ION).</p> <p><b>Note 2:</b> The 2x100BT-P2P circuit pack and OPE circuit pack distances are IEEE-specified segment lengths, based on the assumptions that all distances are for full-duplex transmission. The IEEE distances reflect worst-case attenuation scenarios.</p> <p><b>Note 3:</b> The PECs for the sixteen OC-48 LR DWDM circuit packs in C-Band are as follows: NTN442AA, AB, AC, AD, BA, BB, BC, BD, CA, CB, CC, CD, DA, DB, DC, DD.</p> <p><b>Note 4:</b> The PECs for the seven OC-48 ER DWDM circuit packs in C-Band are as follows: NTN408AA, AE, AJ, AN, CJ, CN, DA.</p> <p><b>Note 5:</b> The PECs for the eight OC-48 LR DWDM circuit packs in L-Band are as follows: NTN442JA, JB, JC, JD, LA, LB, LC, LD.</p> <p><b>Note 6:</b> The PECs for the eight OC-192 DWDM G.709 FEC circuit packs in C-Band are as follows: NTN445EA, EB, EC, ED, FA, FB, FC, FD.</p> <p><b>Note 7:</b> The PECs for the eight OMX + Fiber Manager 4CH are as follows: NT0H32AE, BE, CE, DE, EE, FE, GE, HE.</p> <p><b>Note 8:</b> The PECs for the eight Enhanced OMX + Fiber Manager 4CH are as follows: NT0H32AF, BF, CF, DF, EF, FF, GF, HF.</p>			

**Table 3-4**  
**Shelf slots and supported circuit packs**

Slot	Circuit pack (see Note 6)
1a	LIF, LOAM
1b	Power module
1c	Power module
2	Protection switch controller (PSC)
3	DS1, DS3x3, DS3x12, DS3x12e, DS3VTx12, EC-1x3, EC-1x12, OC-3, OC-3x4, OC-12, OC-12x4 STS, OC48 STS, 4x100BT, 4x100FX, 2x1000SX (2xGigE), 2x1000LX (2xGigE), 2x100BT-P2P, 2xGigE/FC-P2P. See Note 1 and 2.
4	DS1, DS3x3, DS3x12, DS3x12e, DS3VTx12, EC-1x3, EC-1x12, OC-3, OC-3x4, OC-12, OC-12x4 STS, OC48 STS, 4x100BT, 4x100FX, 2x1000SX (2xGigE), 2x1000LX (2xGigE), 2x100BT-P2P, 2xGigE/FC-P2P. See Note 2 and 3.
5	DS1, DS3x3, DS3x12, DS3x12e, DS3VTx12, EC-1x3, EC-1x12, OC-3, OC-3x4, OC-12, OC-12x4 STS, OC48 STS, 4x100BT, 4x100FX, 2x1000SX (2xGigE), 2x1000LX (2xGigE), 2x100BT-P2P, 2xGigE/FC-P2P. See Note 1 and 2.
6	DS1, DS3x3, DS3x12, DS3x12e, DS3VTx12, EC-1x3, EC-1x12, OC-3, OC-3x4, OC-12, OC-12x4 STS, OC48 STS, 4x100BT, 4x100FX, 2x1000SX (2xGigE), 2x1000LX (2xGigE), 2x100BT-P2P, 2xGigE/FC-P2P. See Note 2 and 3.
7	DS1, DS3x3, DS3x12, DS3x12e, DS3VTx12, EC-1x3, EC-1x12, OC-3, OC-3x4, OC-12, OC-12x4 STS, OC48 STS, 4x100BT, 4x100FX, 2x1000SX (2xGigE), 2x1000LX (2xGigE), 2x100BT-P2P, 2xGigE/FC-P2P. See Note 1 and 2.
8	DS1, DS3x3, DS3x12, DS3x12e, DS3VTx12, EC-1x3, EC-1x12, OC-3, OC-3x4, OC-12, OC-12x4 STS, OC48 STS, 4x100BT, 4x100FX, 2x1000SX (2xGigE), 2x1000LX (2xGigE), 2x100BT-P2P, 2xGigE/FC-P2P. See Note 2 and 3.
9	DS1, DS3x3, DS3x12, DS3x12e, DS3VTx12, EC-1x3, EC-1x12, OC-3, OC-3x4, OC-12, OC-12x4 STS, OC48 STS, 4x100BT, 4x100FX, 2x1000SX (2xGigE), 2x1000LX (2xGigE), 2x100BT-P2P, 2xGigE/FC-P2P. See Note 1 and 2.
10	DS1, DS3x3, DS3x12, DS3x12e, DS3VTx12, EC-1x3, EC-1x12, OC-3, OC-3x4, OC-12, OC-12x4 STS, OC48 STS, 4x100BT, 4x100FX, 2x1000SX (2xGigE), 2x1000LX (2xGigE), 2x100BT-P2P, 2xGigE/FC-P2P. See Note 2 and 3.
11	OC-12, OC-48, OC-48 DWDM, OC-48 STS, OC-192 STS, OC-192 DWDM G.709. See Note 4 and 5.
12	OC-12, OC-48, OC-48 DWDM, OC-48 STS, OC-192 STS, OC-192 DWDM G.709. See Note 4 and 5.
13	VTX-48, VTX-48e, STX-192
14	VTX-48, VTX-48e, STX-192
15	Extended Shelf processor (SPx)

**Table 3-4 (continued)**  
**Shelf slots and supported circuit packs**

Slot	Circuit pack (see Note 6)
16	Extended network processor (NPx), Intershelf LAN (ILAN)
17	Protection switch extender (PSX)

**Note 1:** DS1 interfaces are supported on shelves equipped with VTX-series circuit packs.

**Note 2:** OC12x4 STS and OC48 STS interfaces supported on shelves equipped with STX-192 circuit packs.

**Note 3:** The 2x1000SX (2xGigE) and 2x1000LX (2xGigE) are double-width circuit packs that are inserted into and provisioned for the odd-slot number that they occupy. That is, each 2xGigE circuit pack occupies 2 slots as follows: slot 3 and 4, slot 5 and 6, slot 7 and 8, slot 9 and 10.

**Note 4:** OC-12 interface in slots 11 and 12 supported with shelves equipped with VTX-48e circuit packs.

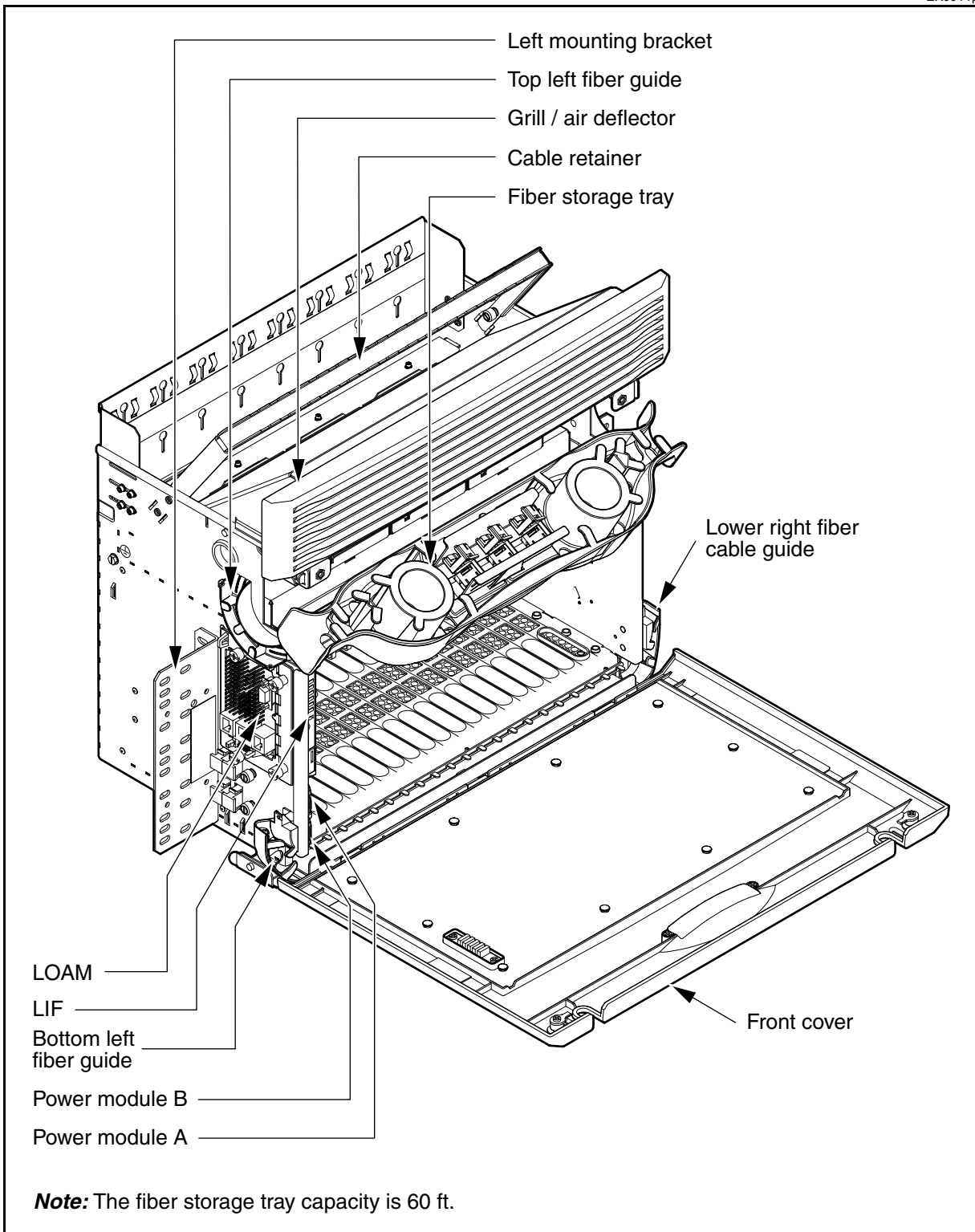
**Note 5:** OC-48 STS, OC-192 STS and OC-192 DWDM G.709 FEC interfaces supported on shelves equipped with STX-192 circuit packs.

**Note 6:** Refer to equipping rules for each circuit pack in this chapter.



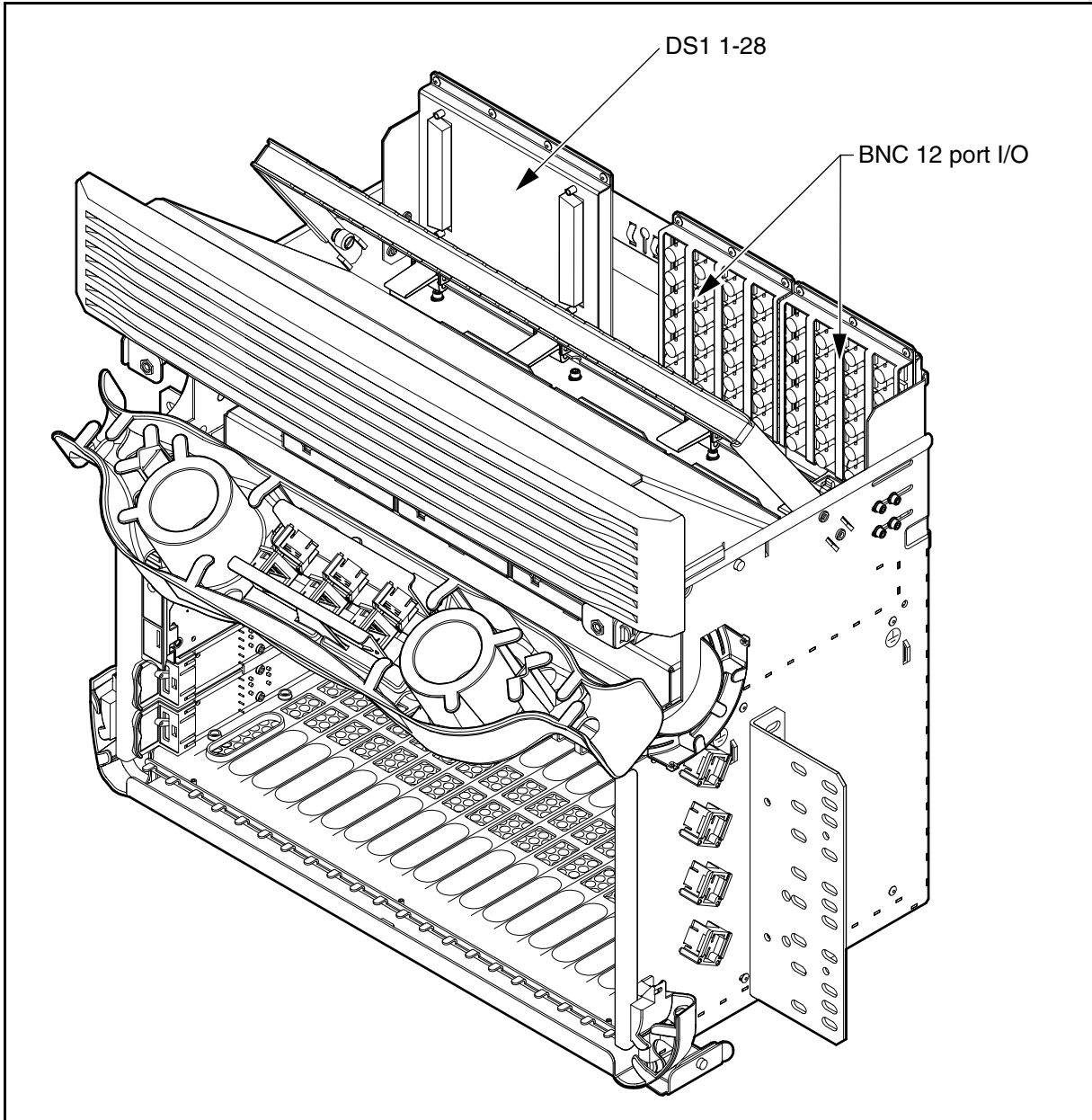
**Figure 3-1**  
**OPTera Metro 3500 Shelf Assembly (NTN476DA)**

EX0911p



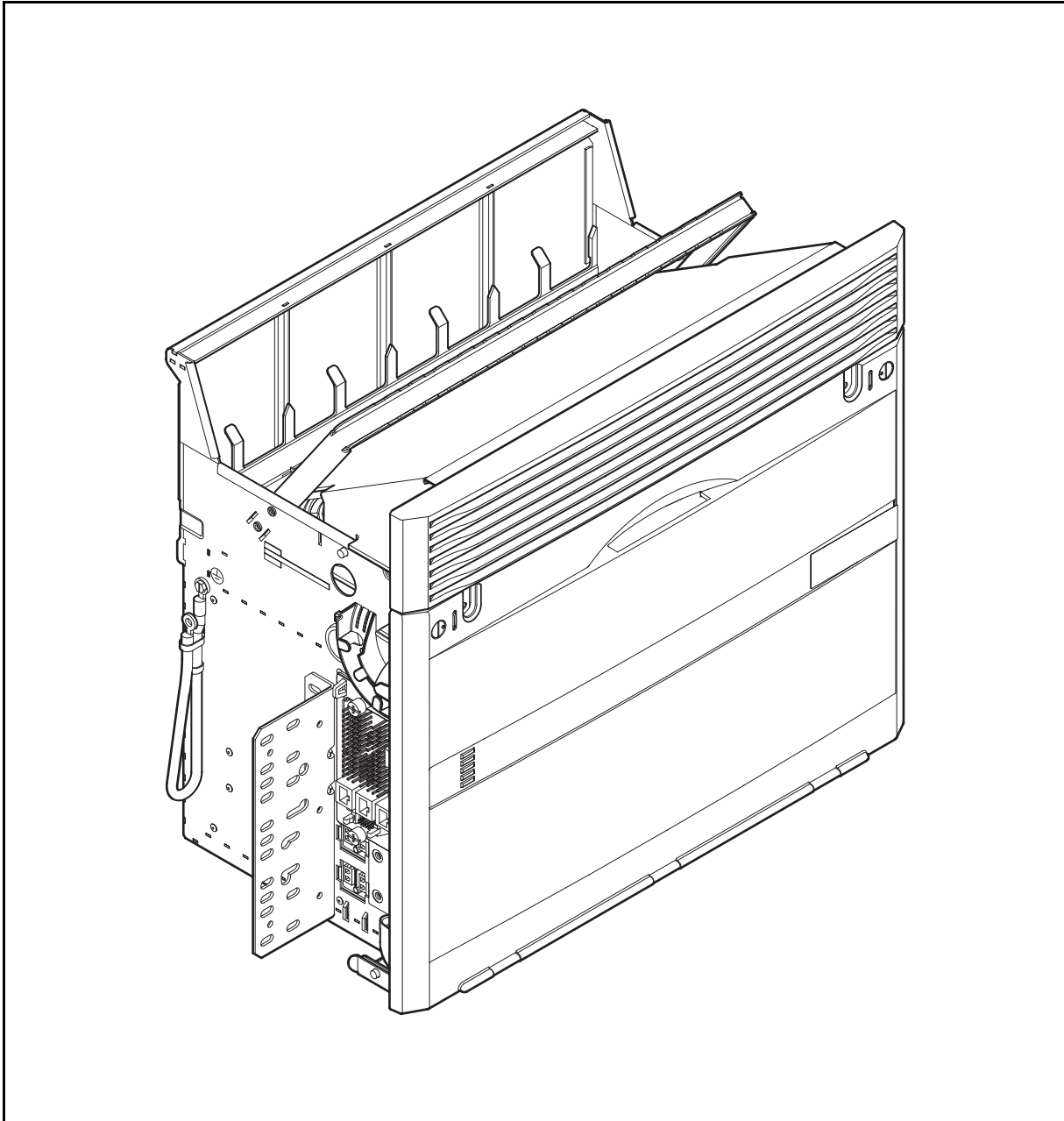
**Figure 3-2**  
**OPTera Metro 3500 Shelf Assembly (NTN476DA) equipped with DS1 1-28 Front I/O module (NTN452AA) and BNC 12-Port Front I/O module (NTN452JA)**

EX804p



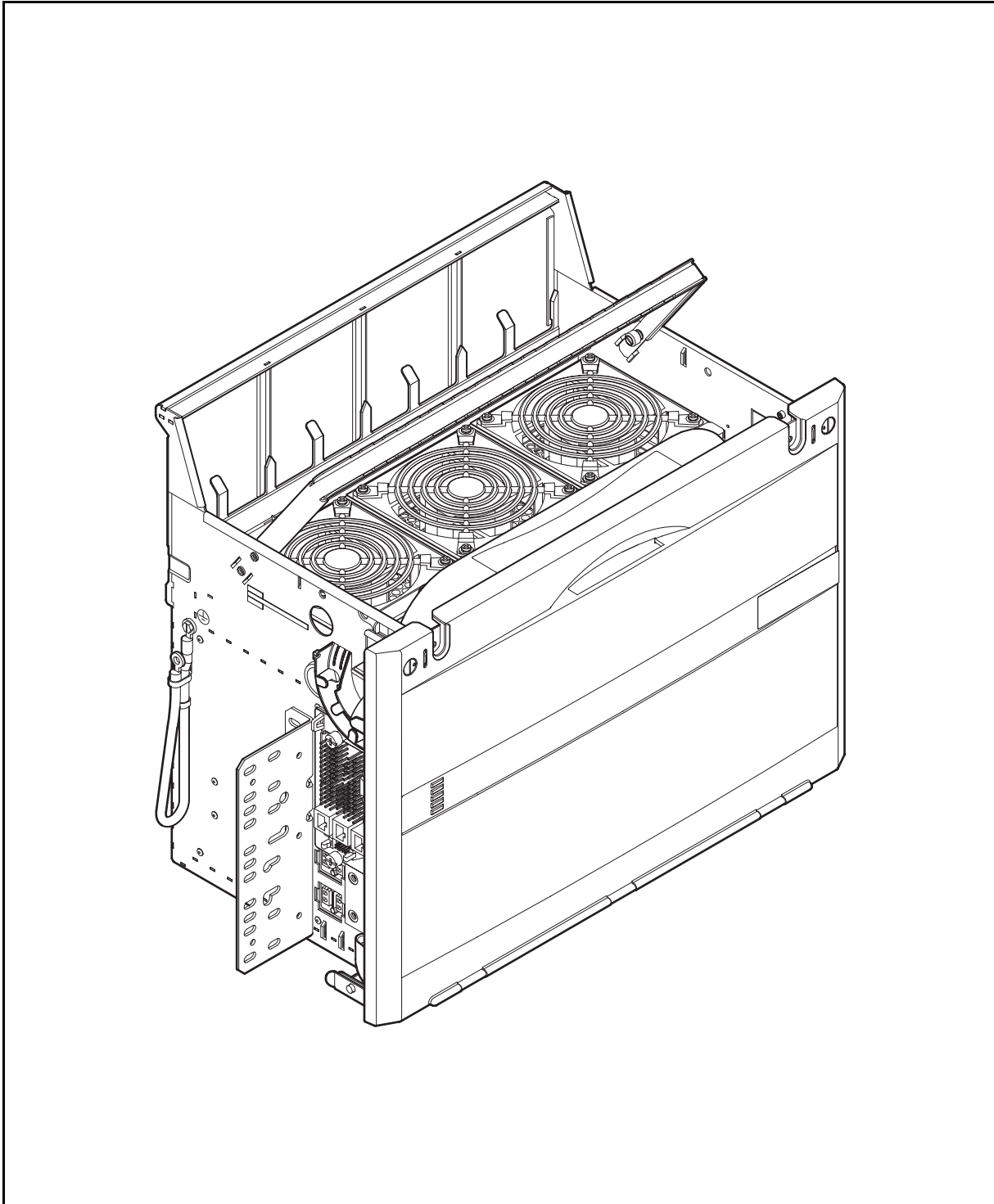
**Figure 3-3**  
**OPTera Metro 3500 Universal Shelf Assembly (NTN476AH) with air deflector**

EX1157p



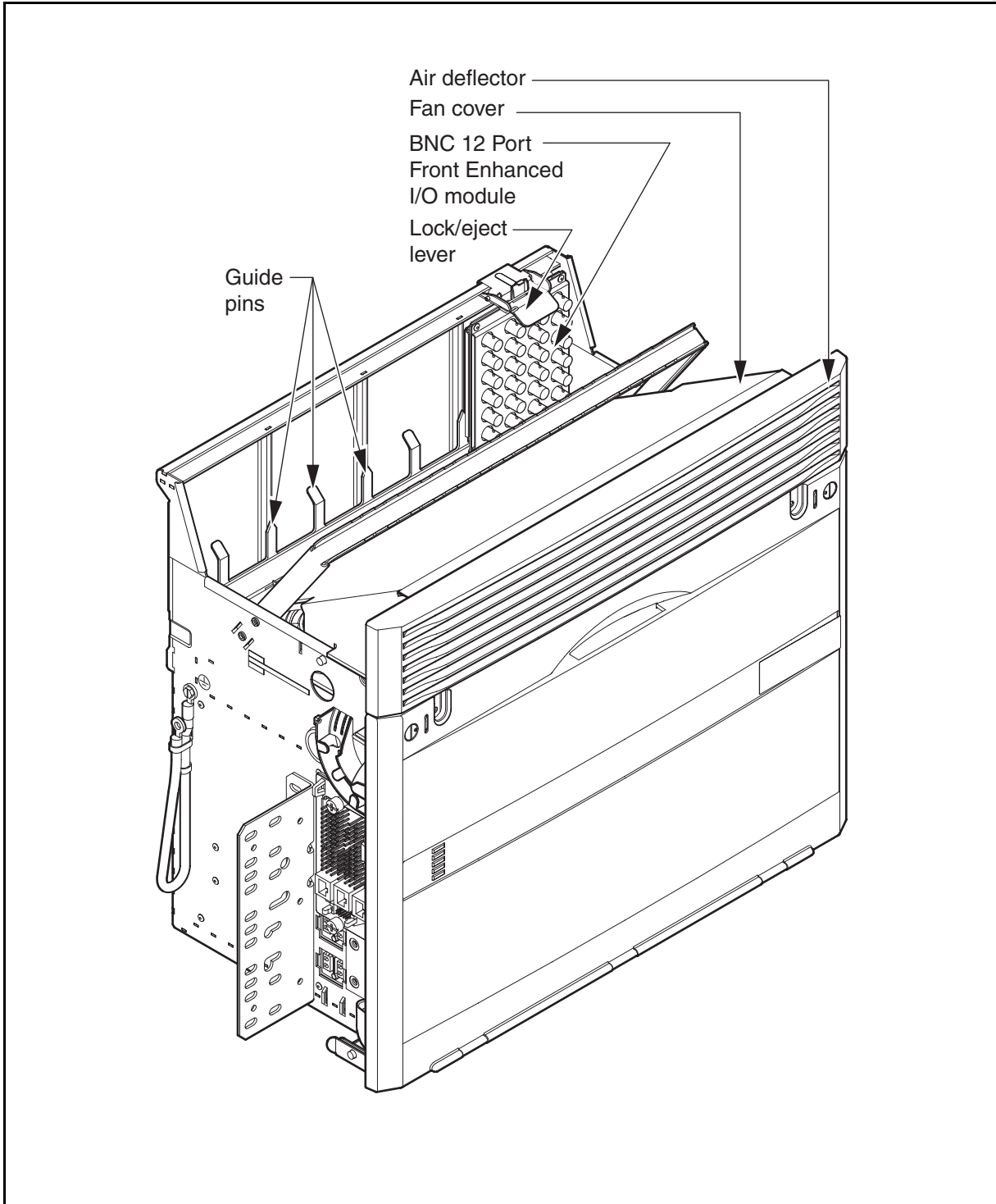
**Figure 3-4**  
**OPTera Metro 3500 Universal Shelf Assembly (NTN476AH) (without air deflector)**

EX1158p



**Figure 3-5**  
**OPTera Metro 3500 Universal Shelf Assembly (NTN476AH) equipped with a BNC 12-Port Front Enhanced I/O module (NTN452JH)**

EX1159p



## Replaceable I/O modules

I/O modules for the OPTera Metro 3500 Shelf and the OPTera Metro 3500 Universal Shelf provide input and output of electrical signals for traffic. To provide additional width for the optical interfaces and STX and VTX-series circuit packs, the tributary I/O connections are located on the top of the shelf. The I/O modules are removable and replaceable.

The traffic I/O slots on both the OPTera Metro 3500 Shelf and OPTera Metro 3500 Universal Shelf are numbered 3 through 10. The I/O slots correspond with the transport slots. There are rules for which type of traffic I/O module can be present in which slot, based on the equipment in the corresponding transport slot.

**Note 1:** On the OPTera Metro 3500 Universal Shelf, you can mix Rear I/O modules with Front Enhanced modules.

**Note 2:** You are recommended to use 'straight' cables for front-facing DS1 I/O modules.

**Note 3:** You are recommended to use 'right-angle' cables for rear-facing DS1 I/O modules.

See [Table 3-3 on page 3-6](#) for operational temperature ranges and hardware / shelf type compatibility.

The OPTera Metro 3500 Shelf Assembly (NTN476AA or NTN476DA) I/O modules are as follows:

- DS1 1-28 Front I/O module (NTN452AA), see [Figure 3-6](#)
- DS1 29-56 Front I/O module (NTN452CA), see [Figure 3-7](#)
- DS1 29-84 Front I/O module (NTN452EA), see [Figure 3-8](#)
- BNC 12-Port Front I/O module (NTN452JA), see [Figure 3-9](#)
- 8xRJ-45 Front I/O module (NTN452NA), see [Figure 3-10](#)

**Note:** One 8xRJ-45 I/O is required for each 2x100BT-P2P circuit pack or 4x100BT circuit pack.

The OPTera Metro 3500 Universal Shelf Assembly (NTN476AH) I/O modules are as follows:

- DS1 1-28 Front Enhanced I/O module (NTN452AH), see [Figure 3-11](#)
- DS1 29-56 Front Enhanced I/O module (NTN452CH), see [Figure 3-12](#)
- DS1 29-84 Front Enhanced I/O module (NTN452EH), see [Figure 3-13](#)
- BNC 12-Port Front Enhanced I/O module (NTN452JH), see [Figure 3-14](#)
- 8xRJ-45 Front Enhanced I/O module (NTN452NH), see [Figure 3-15](#)
- DS1 1-28 Rear I/O module (NTN452BA), see [Figure 3-16](#)
- DS1 29-56 Rear I/O module (NTN452DA), see [Figure 3-17](#)
- DS1 29-84 Rear I/O module (NTN452FA), see [Figure 3-18](#)
- BNC 12-Port Rear I/O module (NTN452KA), see [Figure 3-20](#)
- 8xRJ-45 Rear I/O module (NTN452HB), see [Figure 3-19](#)

**Note:** One 8xRJ-45 I/O is required for each 2x100BT-P2P circuit pack or 4x100BT circuit pack.

For details of I/O slot positions and the traffic type supported by each module, see [Table 3-5](#). For examples of the OPTera Metro 3500 shelf equipped with I/O modules, see [Figure 3-2](#) and [Figure 3-3](#).

**Note:** You must install a Rear I/O Cable Retainer (NTN450ZA for the 23-inch bracket, NTN450ZB for the 19-inch bracket) for each of your OPTera Metro 3500 shelves equipped with a Rear I/O module. The cable retainer relieves cable pressure on the connectors of the rear I/Os. See *Installation*, 323-1059-201 for installation information. See [PEC tables on page 8-10](#) (in Part 2 of this guide) for ordering information.

**Table 3-5**  
**I/O module type and slot positions**

ADD / DROP Traffic type	Quantity	I/O module name / PEC	Supported shelf type / PEC	I/O slot positions	Corresponding transport slot	
DS1	28	DS1 1-28 Front I/O module (NTN452AA)	OPTera Metro 3500 Shelf Assembly (NTN476AA or NTN476DA)	3-5	4-6	
		DS1 1-28 Rear I/O module (NTN452BA)	OPTera Metro 3500 Universal Shelf Assembly (NTN476AH)			
		DS1 1-28 Front Enhanced I/O module (NTN452AH)	OPTera Metro 3500 Universal Shelf Assembly (NTN476AH)			
	28	28	DS1 29-56 Front I/O module (NTN452CA)	OPTera Metro 3500 Shelf Assembly (NTN476AA or NTN476DA)	6-8	6-8
			DS1 29-56 Rear I/O module (NTN452DA)	OPTera Metro 3500 Universal Shelf Assembly (NTN476AH)		
			DS1 29-56 Front Enhanced I/O module (NTN452CH)	OPTera Metro 3500 Universal Shelf Assembly (NTN476AH)		
	56	56	DS1 29-84 Front I/O module (NTN452EA)	OPTera Metro 3500 Shelf Assembly (NTN476AA or NTN476DA)	6-10	6-10
			DS1 29-84 Rear I/O module (NTN452FA)	OPTera Metro 3500 Universal Shelf Assembly (NTN476AH)	6-10	6-10
			DS1 29-84 Front Enhanced I/O module (NTN452EH)	OPTera Metro 3500 Universal Shelf Assembly (NTN476AH)		

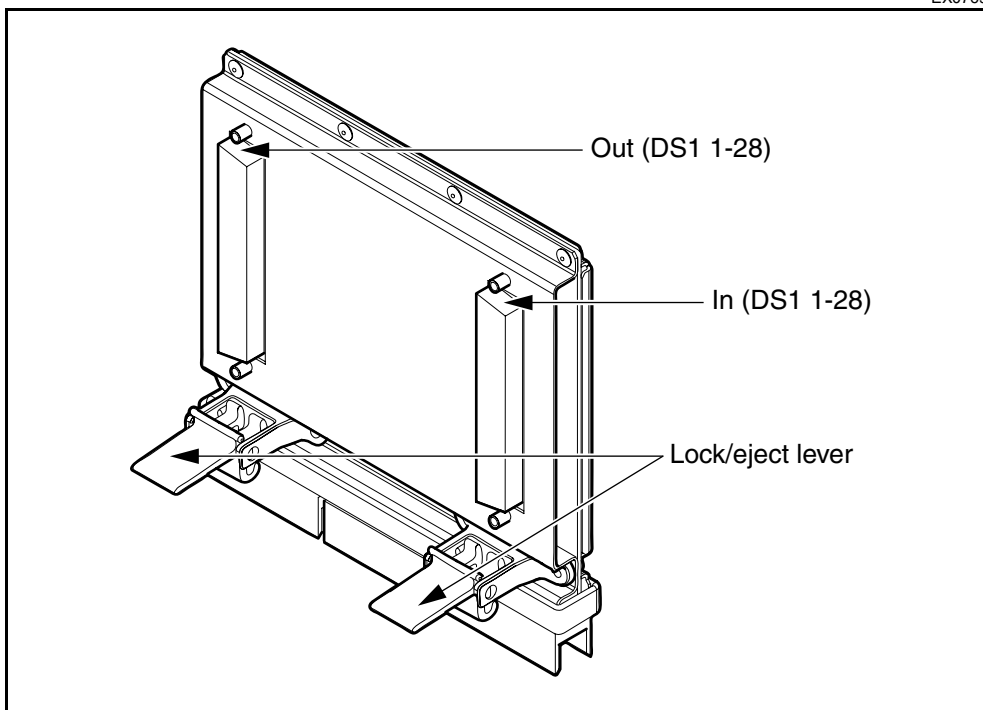


**Table 3-5 (continued)**  
**I/O module type and slot positions**

<b>ADD / DROP Traffic type</b>	<b>Quantity</b>	<b>I/O module name / PEC</b>	<b>Supported shelf type / PEC</b>	<b>I/O slot positions</b>	<b>Corresponding transport slot</b>
DS3, EC-1	12	BNC 12-port Front I/O module (NTN452JA)	OPTera Metro 3500 Shelf Assembly (NTN476AA or NTN476DA))	3-4, 5-6, 7-8, 9-10	3-4, 5-6, 7-8, 9-10
		BNC 12-port Rear I/O module (NTN452KA)	OPTera Metro 3500 Universal Shelf Assembly (NTN476AH)		
		BNC 12-port Front Enhanced I/O module (NTN452JH)	OPTera Metro 3500 Universal Shelf Assembly (NTN476AH)		
Ethernet: 10BaseT, 100BaseTX	4	8xRJ-45 Front I/O module (NTN452NA)	OPTera Metro 3500 Shelf Assembly (NTN476AA or NTN476DA)	3-10	3-10
		8xRJ-45 Rear I/O module (NTN452HB)	OPTera Metro 3500 Universal Shelf Assembly (NTN476AH)		
		8xRJ-45 Front Enhanced I/O module (NTN452NH)	OPTera Metro 3500 Universal Shelf Assembly (NTN476AH)		

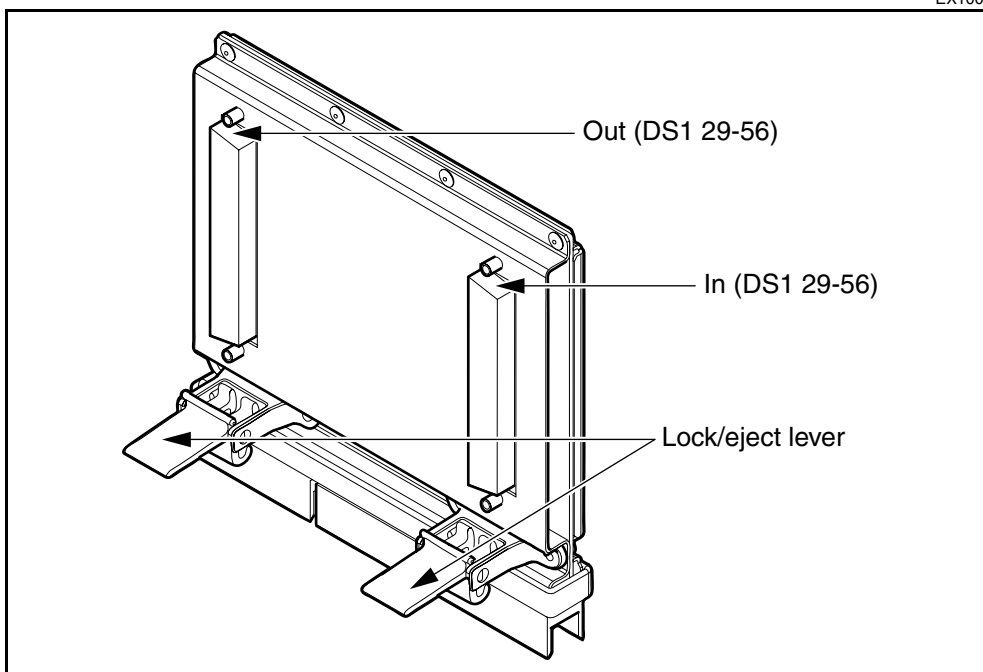
**Figure 3-6**  
**DS1 1-28 Front I/O module (NTN452AA)**

EX0769p



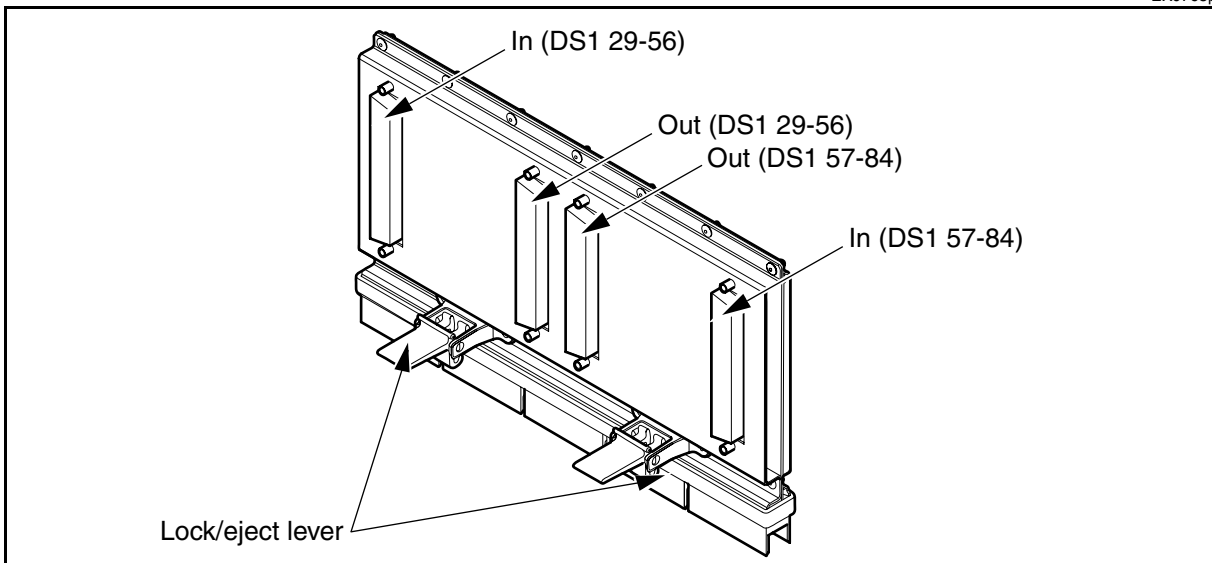
**Figure 3-7**  
**DS1 29-56 Front I/O module (NTN452CA)**

EX1004t



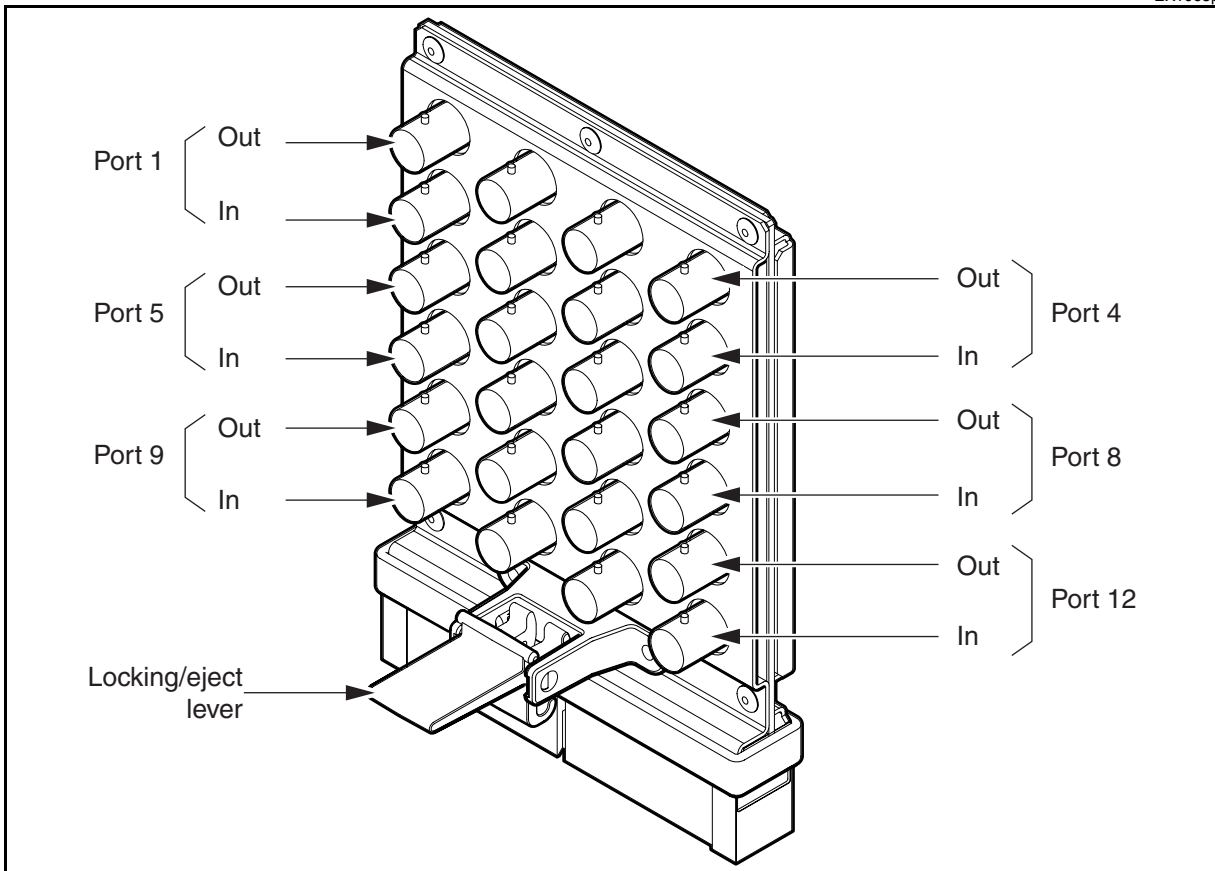
**Figure 3-8**  
**DS1 29-84 Front I/O module (NTN452EA)**

EX0765p



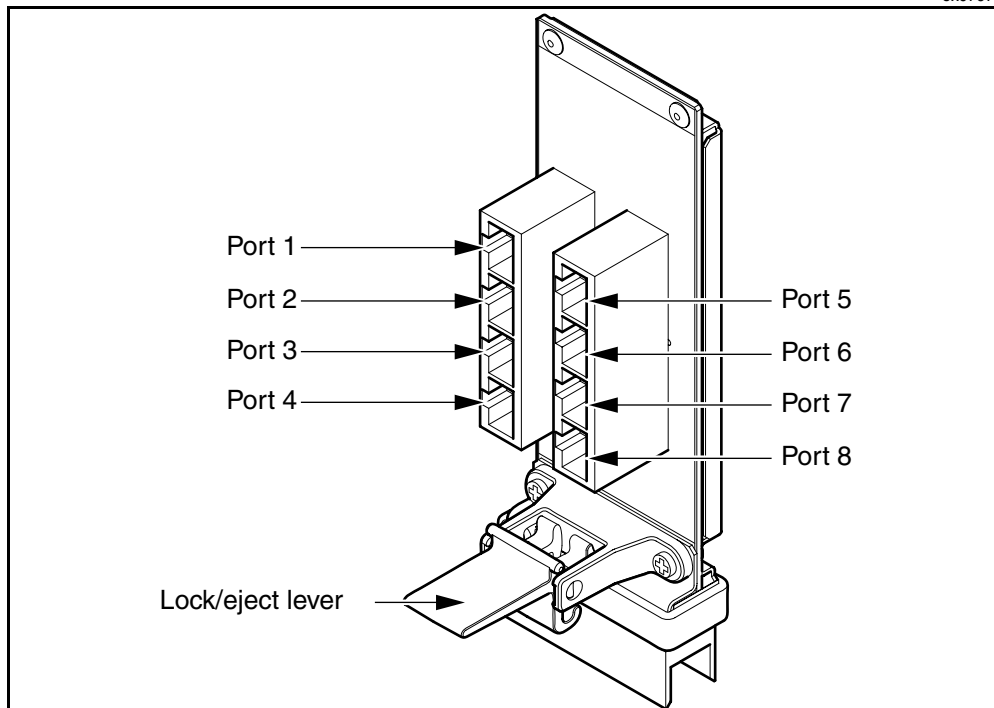
**Figure 3-9**  
**BNC 12-Port Front I/O module (NTN452JA)**

EX1065p



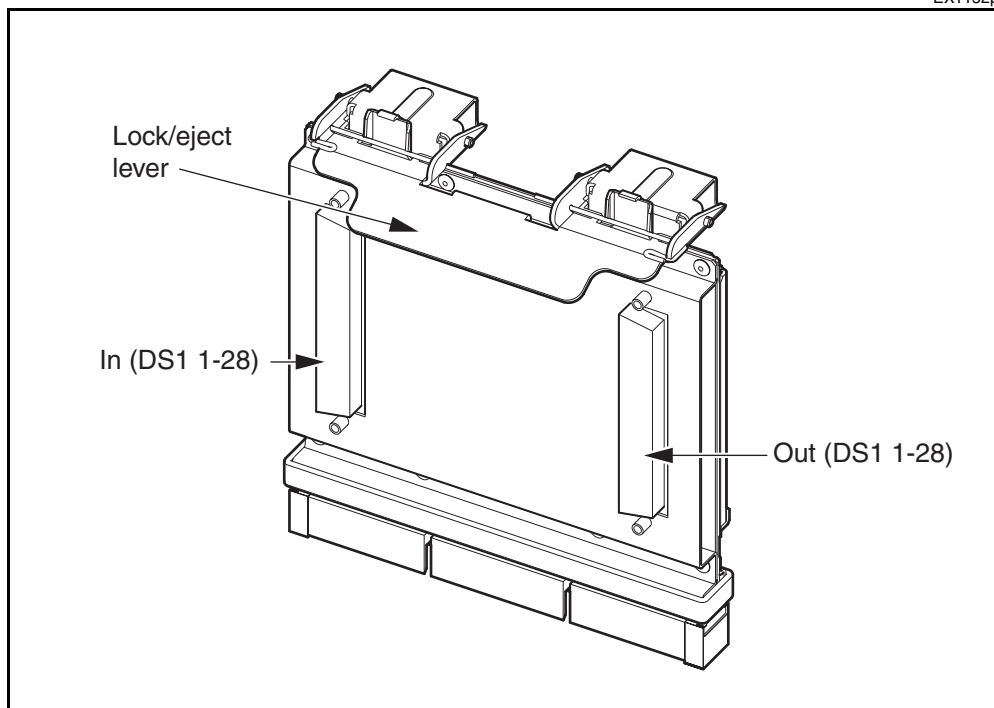
**Figure 3-10**  
**8xRJ-45 Front I/O module (NTN452NA)**

ex0797t



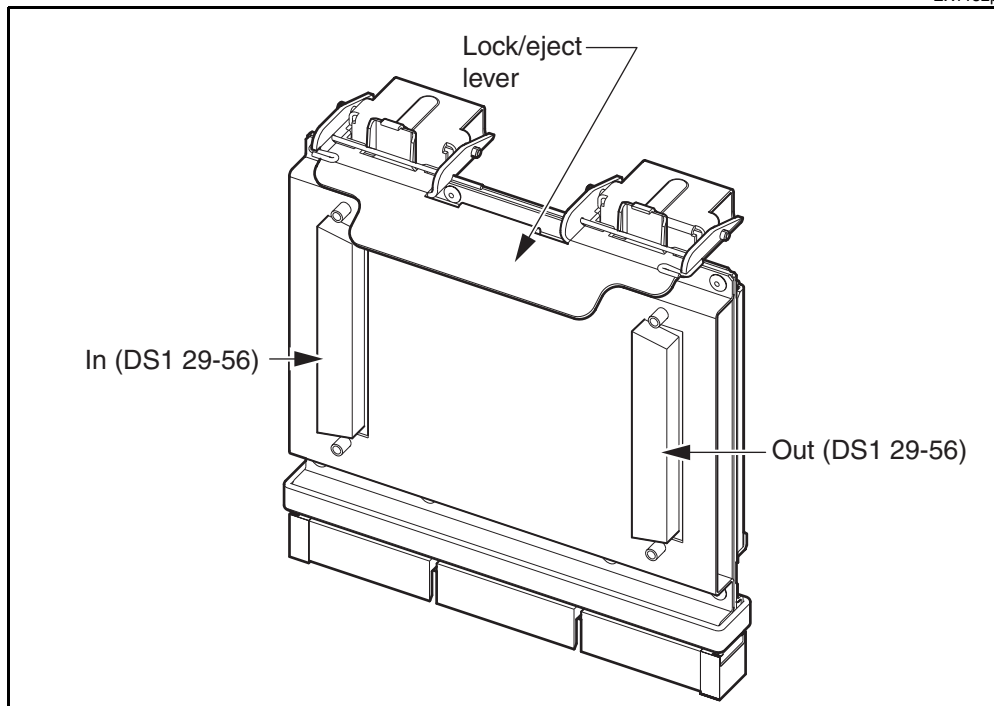
**Figure 3-11**  
**DS1 1-28 Front Enhanced I/O module (NTN452AH)**

EX1152p



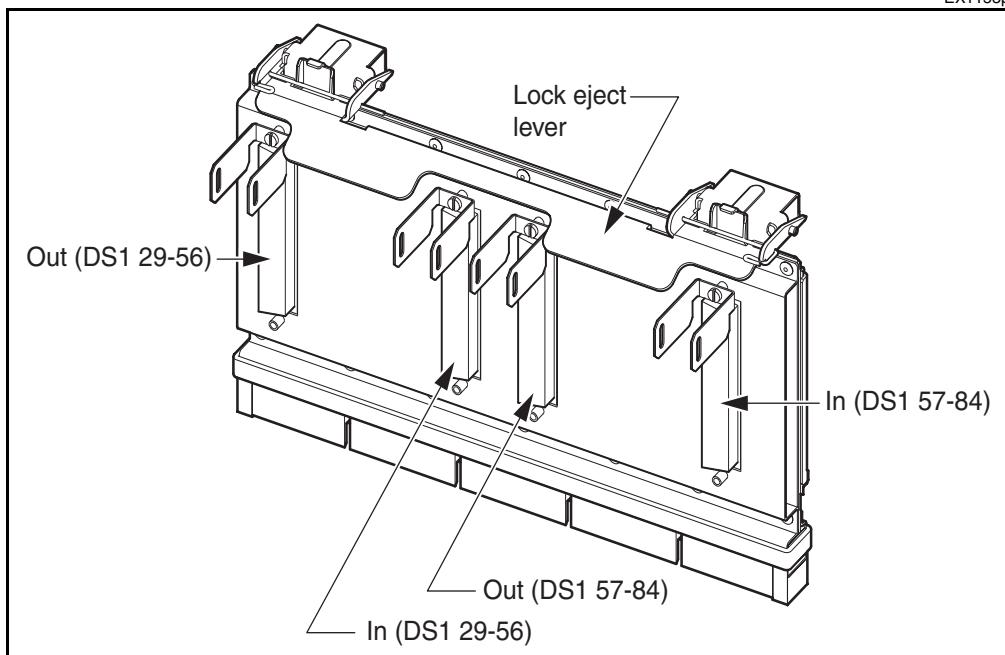
**Figure 3-12**  
**DS1 29-56 Front Enhanced I/O module (NTN452CH)**

EX1152p



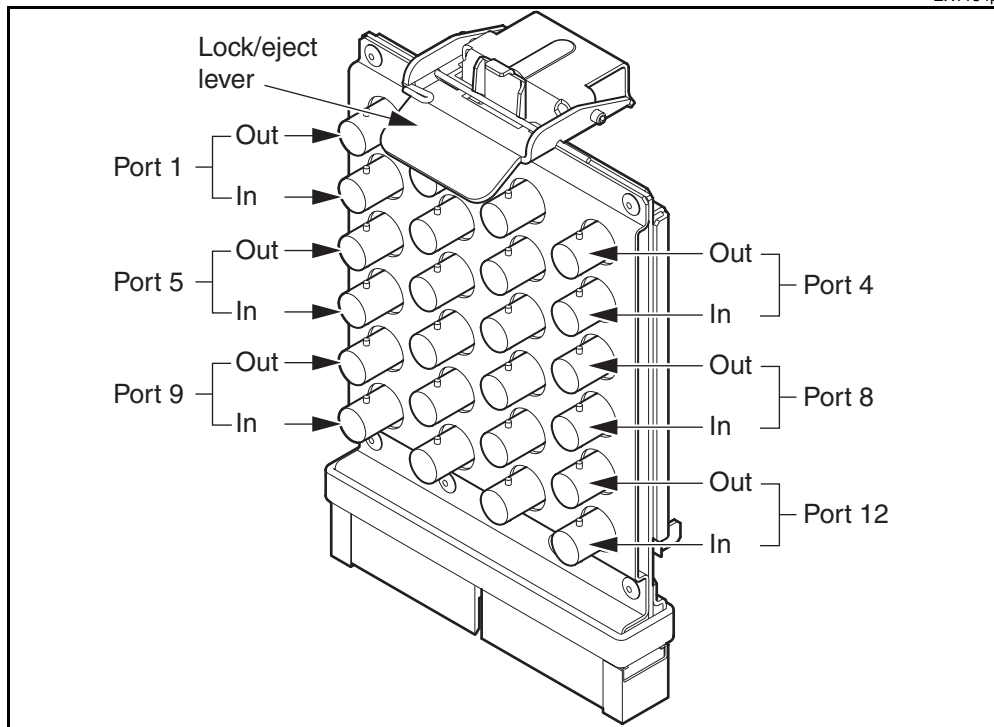
**Figure 3-13**  
**DS1 29-84 Front Enhanced I/O module (NTN452EH)**

EX1153p



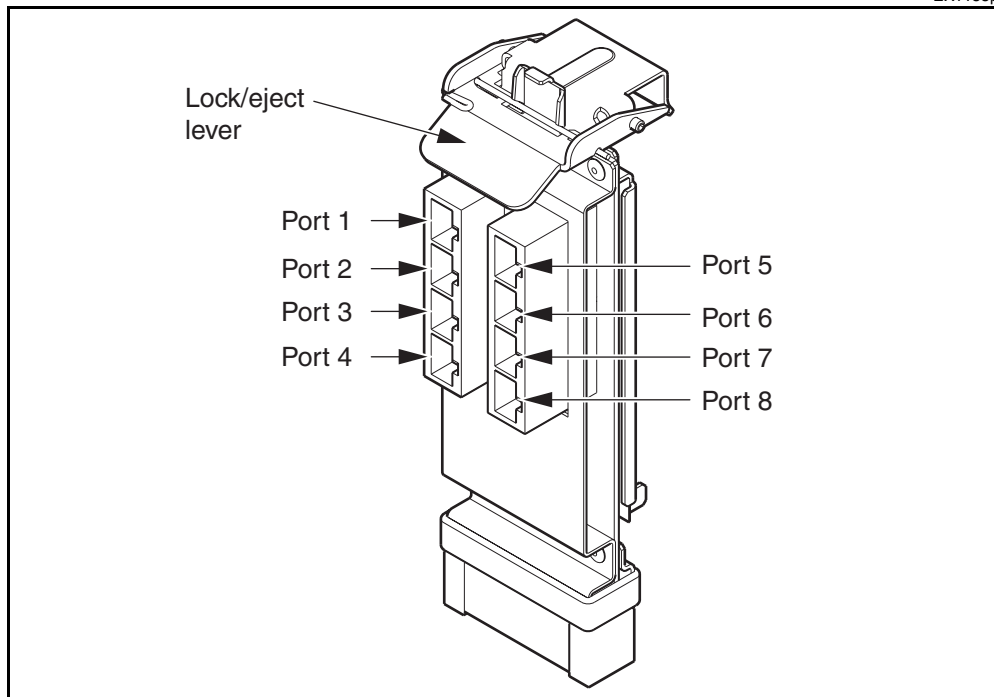
**Figure 3-14**  
**BNC 12-Port Front Enhanced I/O module (NTN452JH)**

EX1154p



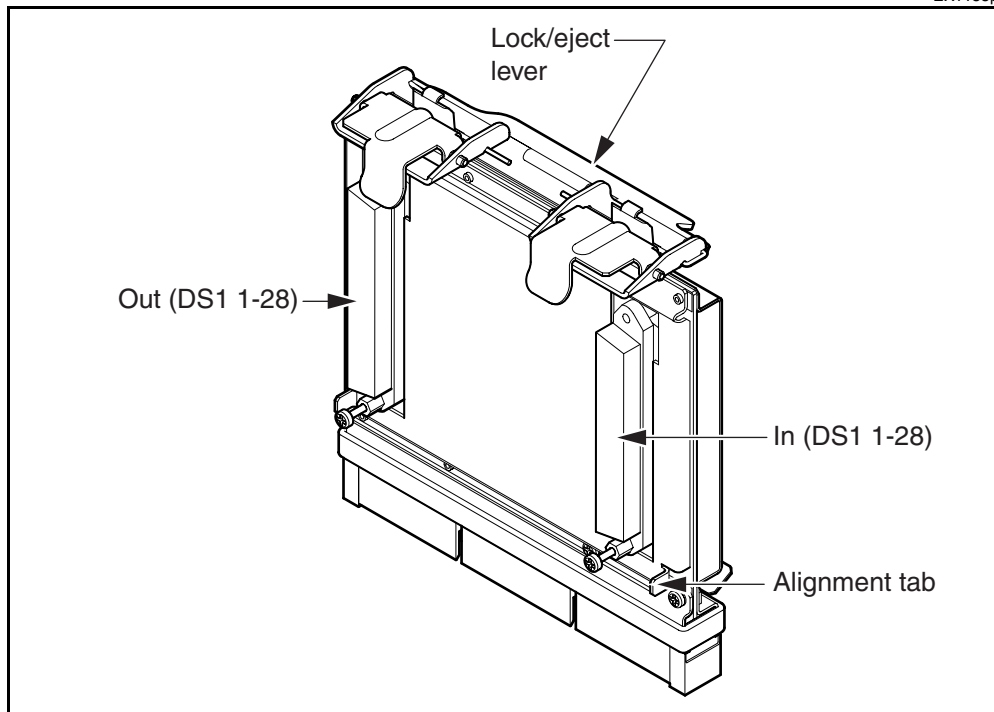
**Figure 3-15**  
**8xRJ-45 Front Enhanced I/O module (NTN452NH)**

EX1155p



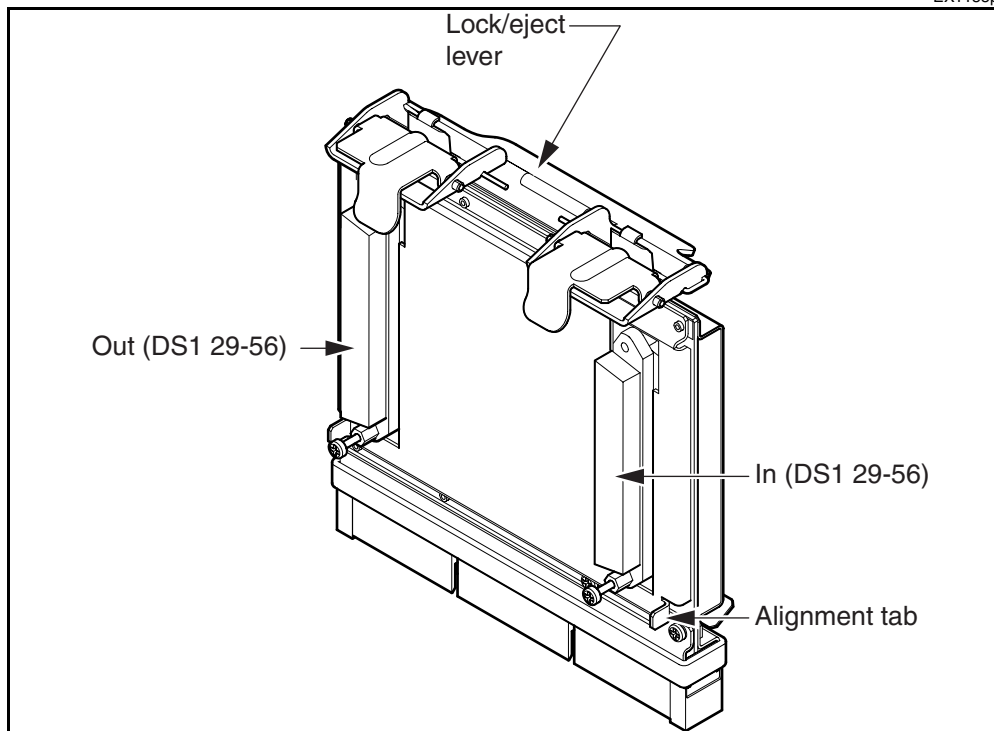
**Figure 3-16**  
**DS1 1-28 Rear I/O module (NTN452BA)**

EX1155p



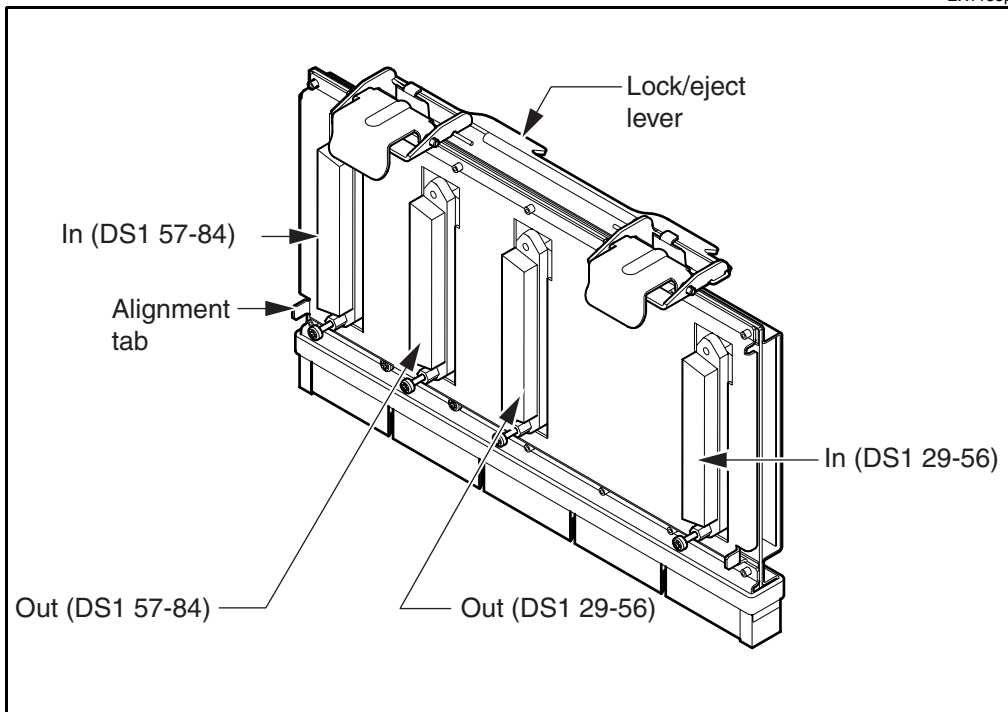
**Figure 3-17**  
**DS1 29-56 Rear I/O module (NTN452DA)**

EX1155p



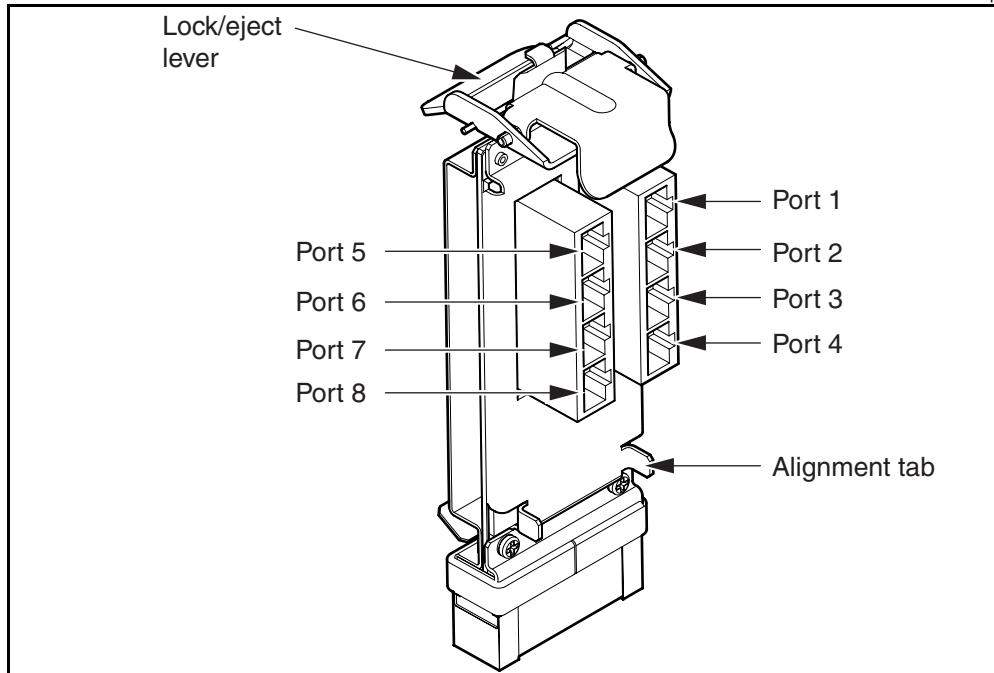
**Figure 3-18**  
**DS1 29-84 Rear I/O module (NTN452FA)**

EX1155p



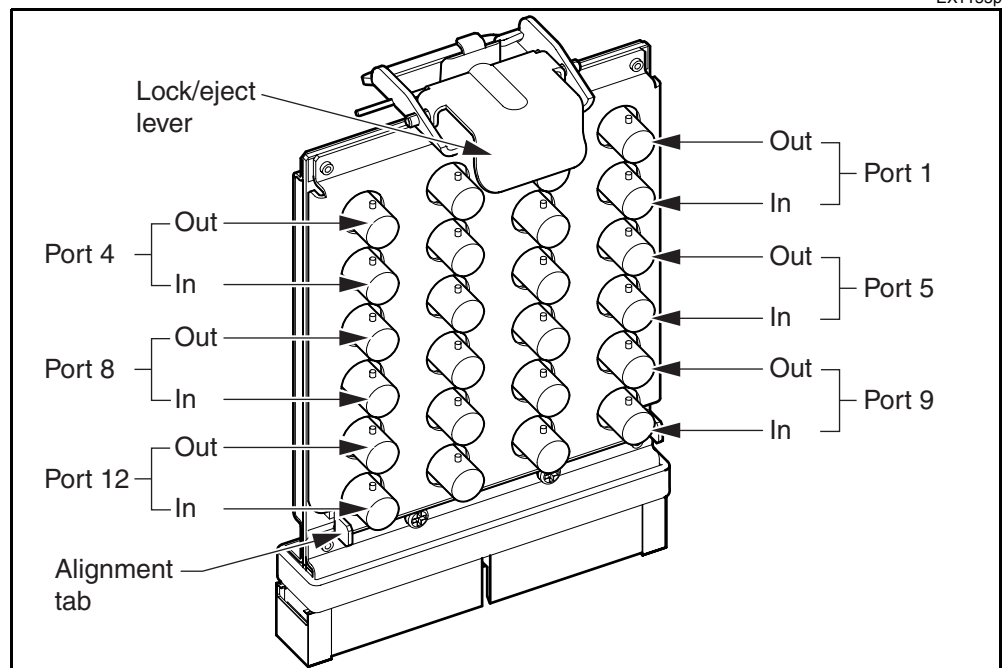
**Figure 3-19**  
**8xRJ-45 Rear I/O module (NTN452HB)**

EX1155p





**Figure 3-20**  
**BNC 12-Port Rear I/O module (NTN452KA)**



## Common modules

OPTera Metro 3500 Shelf and the OPTera Metro 3500 Universal Shelf support replaceable common modules in [Table 3-5 on page 3-28](#).

### Left OAM (LOAM) (NTN451MA, NTN451MH)

The LOAM supports the following:

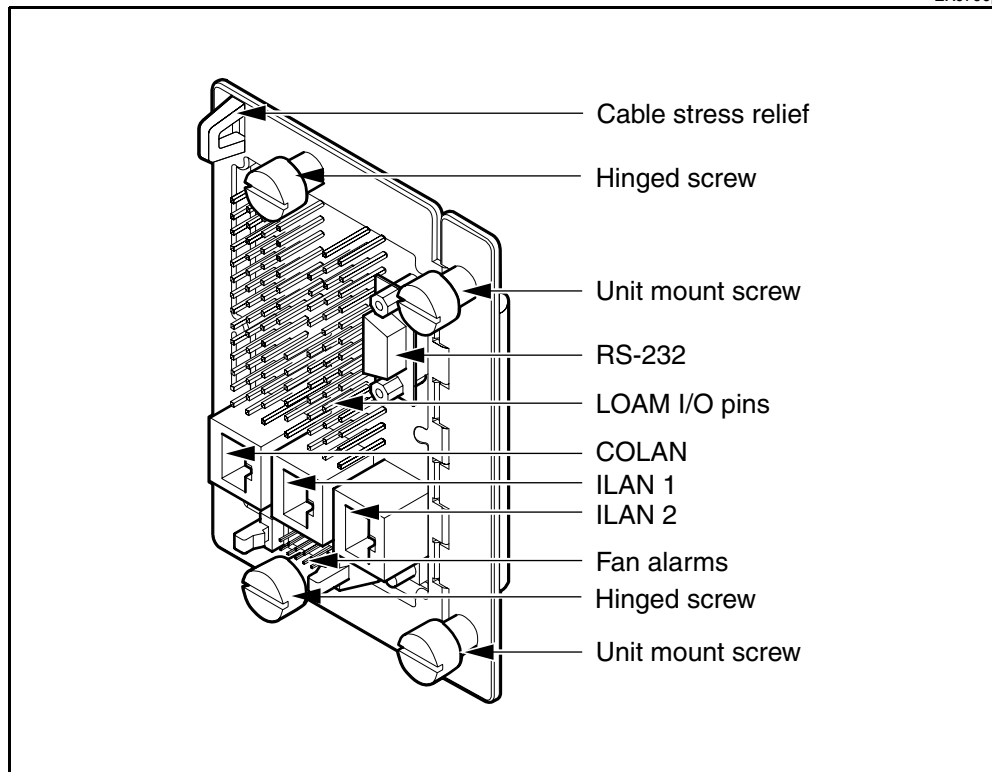
- RS-232 terminal
- building-integrated timing supply (BITS)
- telemetry byte-oriented serial (TBOS) protocol
- environmental alarms
- shelf alarms
- X.25 terminal
- ILAN
- central office LAN (COLAN)

The LOAM attaches to the LIF and hinges out to face the front of the OPTera Metro 3500 Shelf. See [Figure 3-21](#) for the details of the LOAM.

See [Table 3-3 on page 3-6](#) for operational temperature ranges.

**Figure 3-21**  
**Left OAM (LOAM) (NTN451MA, NTN451MH)**

EX0790p



**Left interface (LIF)**  
**(NTN451BA, NTN451BH)**

The LIF is inserted in slot 1a and provides a connection for the LOAM. The LIF also provides the inventory connection for the power modules.

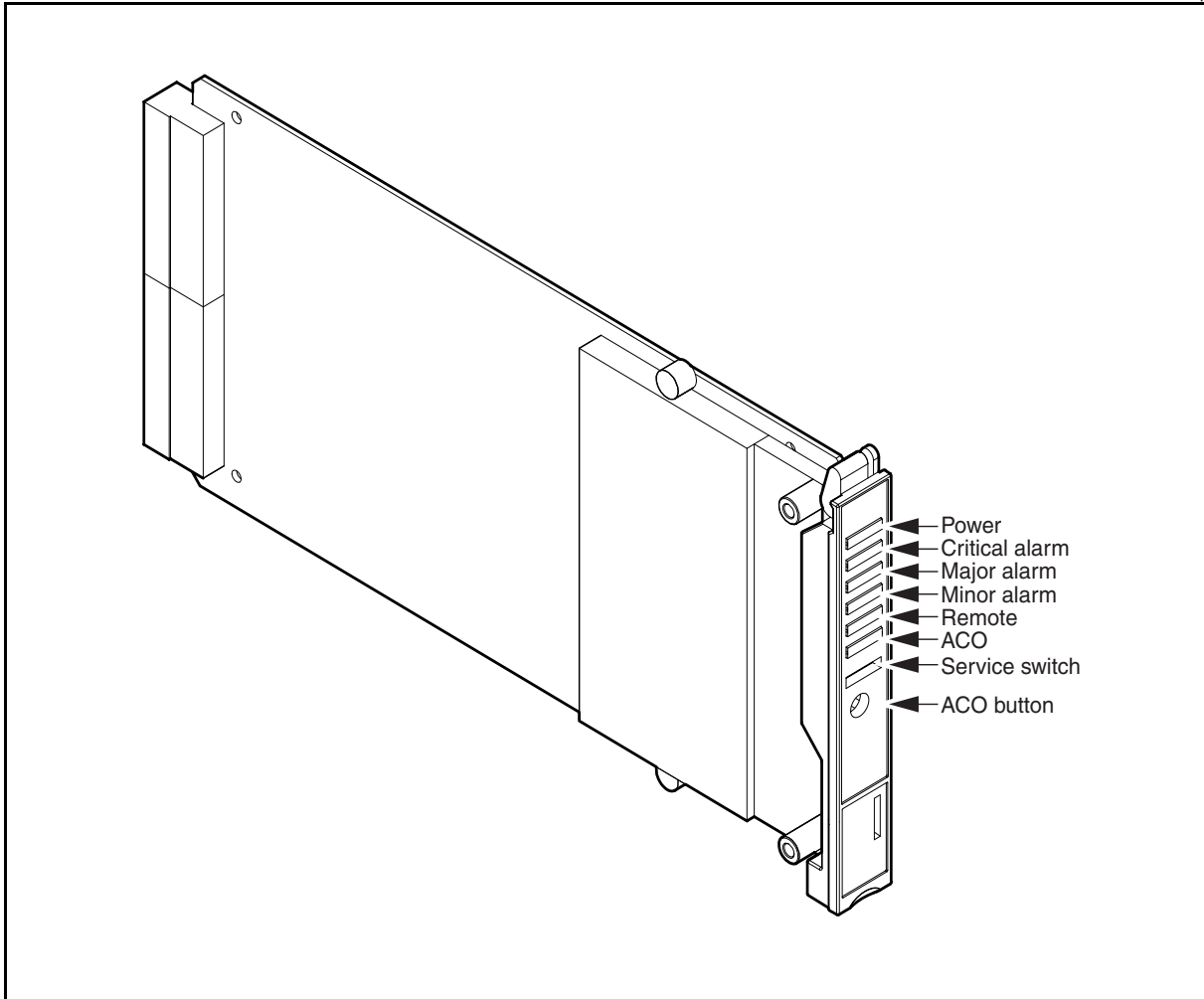
See [Table 3-3 on page 3-6](#) for operational temperature ranges.

See [Figure 3-22](#) for the details of the LIF. The following table provides a list of the LIF LEDs.

LED	Description
Power	Shelf is receiving power when the LED is lit.
Critical	A Critical alarm condition exists for one of the circuit packs on the shelf.
Major	A Major alarm condition exists for one of the circuit packs on the shelf.
Minor	A Minor alarm condition exists for one of the circuit packs on the shelf.
Remote	An alarm condition exists on one of the other network elements in the system.
ACO	The ACO button has been pressed and an audible alarm can be suppressed. This LED is also used for the Lamp Test.

**Figure 3-22**  
**Left interface (LIF) (NTN451BA, NTN451BH)**

EX0730p



## OPTera Metro 3500 cooling unit assembly and cooling unit fan modules (NTN458QA)

The cooling unit assembly (NTN458QA) contains three cooling unit fan modules (NTN458HC) and environmental sensors. See [Figure 3-23](#). The cooling unit assembly forces air through the shelf when environmental conditions require a decrease in the shelf temperature.

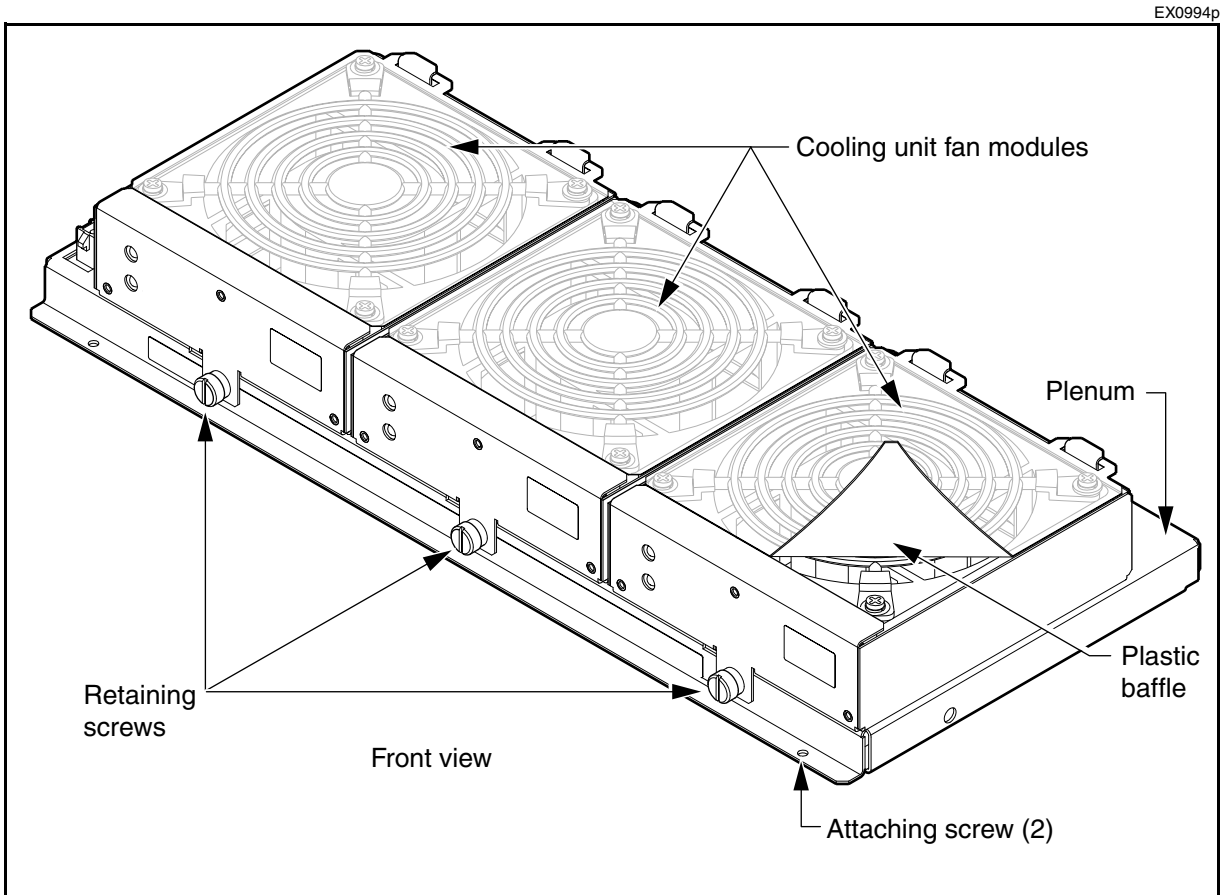
See [Table 3-3 on page 3-6](#) for operational temperature ranges.

**Note 1:** The Universal shelf cooling unit assembly (NTN458QH) is only supported on the OPTera Metro 3500 Universal Shelf Assembly (NTN476AH).

**Note 2:** The Cooling unit assembly (NTN458QA) is only supported on the OPTera Metro 3500 Shelf Assembly (NTN476DA and NTN476AA).

**Note 3:** The Fan kit (NTN458GA) is only supported on the OPTera Metro 3500 Shelf Assembly (NTN476AA).

**Figure 3-23**  
OPTera Metro 3500 Cooling unit assembly (NTN458QA)



## Universal cooling unit assembly and cooling unit fan modules for extended temperature applications (NTN458QH)

The OPTera Metro 3500 Universal cooling unit assembly (NTN458QH) contains three cooling unit fan modules (NTN458HH) and environmental sensors. This fan unit is effective for extended temperature applications.

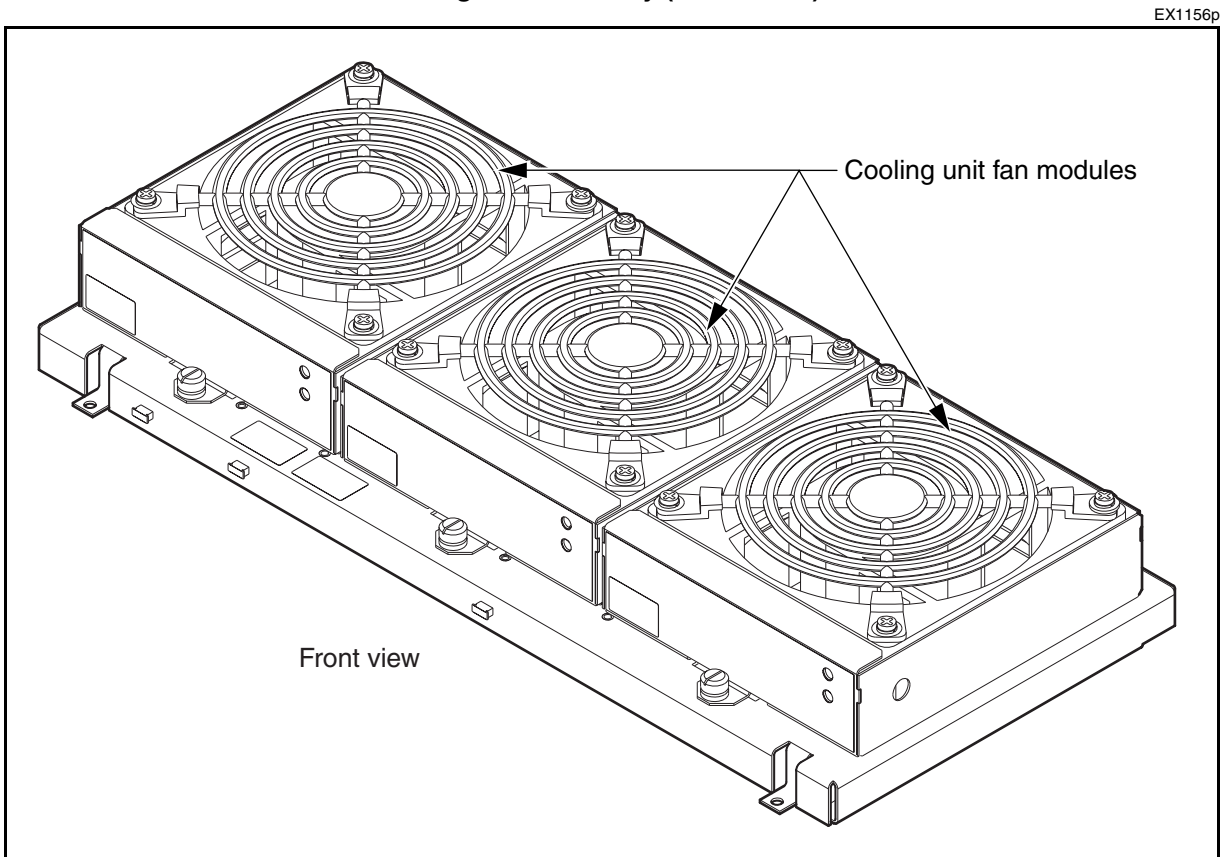
See [Table 3-3 on page 3-6](#) for operational temperature ranges.

**Note 1:** The Universal shelf cooling unit assembly (NTN458QH) is only supported on the OPTera Metro 3500 Universal Shelf Assembly (NTN476AH).

**Note 2:** The Cooling unit assembly (NTN458QA) is only supported on the OPTera Metro 3500 Shelf Assembly (NTN476DA and NTN476AA).

**Note 3:** The Fan kit (NTN458GA) is only supported on the OPTera Metro 3500 Shelf Assembly (NTN476AA).

**Figure 3-24**  
OPTera Metro 3500 Universal cooling unit assembly (NTN458QH)



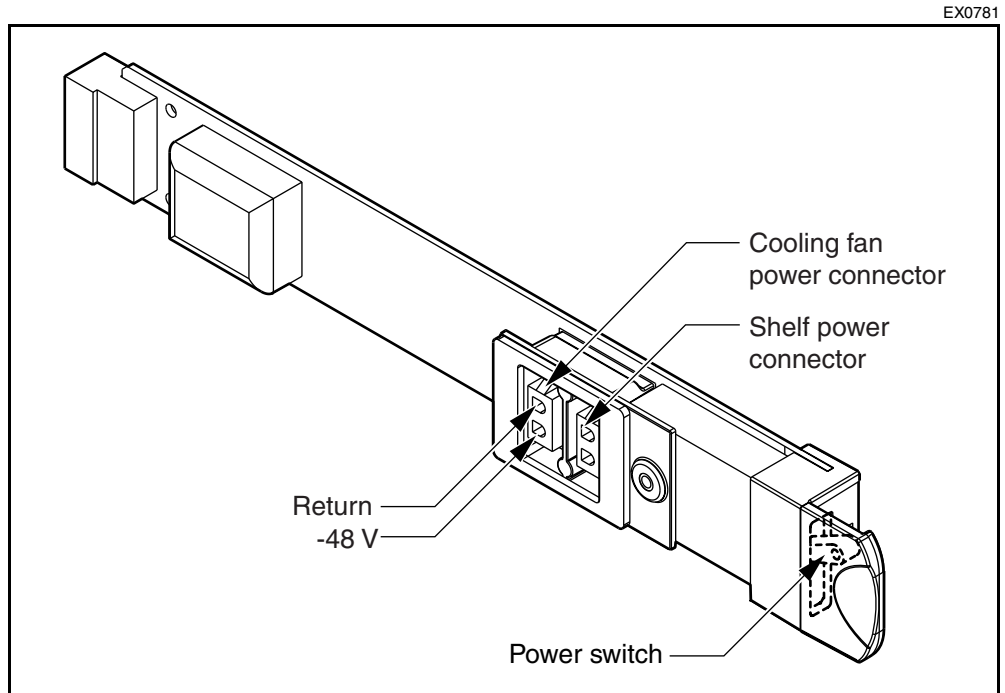
## 20 A (Universal) power module (NTN451HA)

The OPTera Metro 3500 Universal Shelf supports the Universal power module (NTN451HA).

The power modules in slots 1b and 1c provide the required -48 V dc interface to power the shelf. The power module in slot 1b is called Power A and the power module in slot 1c is called Power B. The interfaces have circuit breakers to protect the A and B power rails.

See [Table 3-3 on page 3-6](#) for operational temperature ranges.

**Figure 3-25**  
**Universal power module (NTN451HA)**



## OPTera Metro 3000 breaker interface panel (BIP) (NTN458RA)

The breaker interface panel (BIP) NTN458RA is mounted at the top of the OPTera Metro 3500 equipment frame and supports four breakers at 20 A, three breakers at 5 A, and one breaker at 15 A. NTN458RA is rated for operation in the temperature range of -10°C to +60°C. The BIP can accommodate four OPTera Metro 3500 shelves, eight DSMs or any combination of OPTera Metro 3500 and DSMs which does not exceeding 80 A.

### **Power Input Alarm**

This circuit detects input power failure. A green light “on” indicates normal operation. If input power has been lost, this light is off. In normal operation, the power input alarm external relay contacts are in an energized or powered state. The contacts are in a deenergizing or powered-off state when input power is lost, providing C to NC closure for the alarm state.

### **Breaker Alarm**

Breaker alarms operate in one of two ways. Both methods have a red indicator light “off” for normal operation and “on” when the alarm circuit is activated.

The first method uses indicating type breakers that provide a mechanical connection to activate the alarm card. The second method uses open-circuit electronic sensing across the fuse holder. Open-circuit detection usually requires a reset switch to clear the breaker alarm.

Both methods have the breaker alarm external relay contacts deenergized or in a powered-off state for normal operation and energized or in a powered-on state when a breaker alarm is detected, providing C to NO closure for the alarm state.

### **Bay Alarms**

Bay alarms are visual indications for the rack frame (system level). These alarms can be a combination of three different levels: critical, major, and minor. Critical alarms are red; a major alarm can either be a red or yellow; and the minor alarm is always yellow. The external alarm contacts are deenergized or in a powered-off state for normal operation and energizing or going to a power-on state when an external alarm is detected. Activation of these types of alarms comes from external equipment alarm contacts that are either in the rack frame or system and provide an alarm ground to the input ports of the alarm system.

### **Alarm Circuits**

Most monitoring alarm systems require an alarm ground signal to activate the individual alarms.

The most common, is a single-point contact or paralleled contact configuration. An alarm ground wire connects to the common of the external relay contact, and the associated NC or NO contact connects to the alarm monitoring system. When the alarm activates, the relay closure between the C and either the NC or NO sends an alarm ground to the alarm monitoring system, activating the appropriate alarm. Multiple relay contacts can be paralleled in this configuration to activate a single or multiple input to the alarm monitoring system.

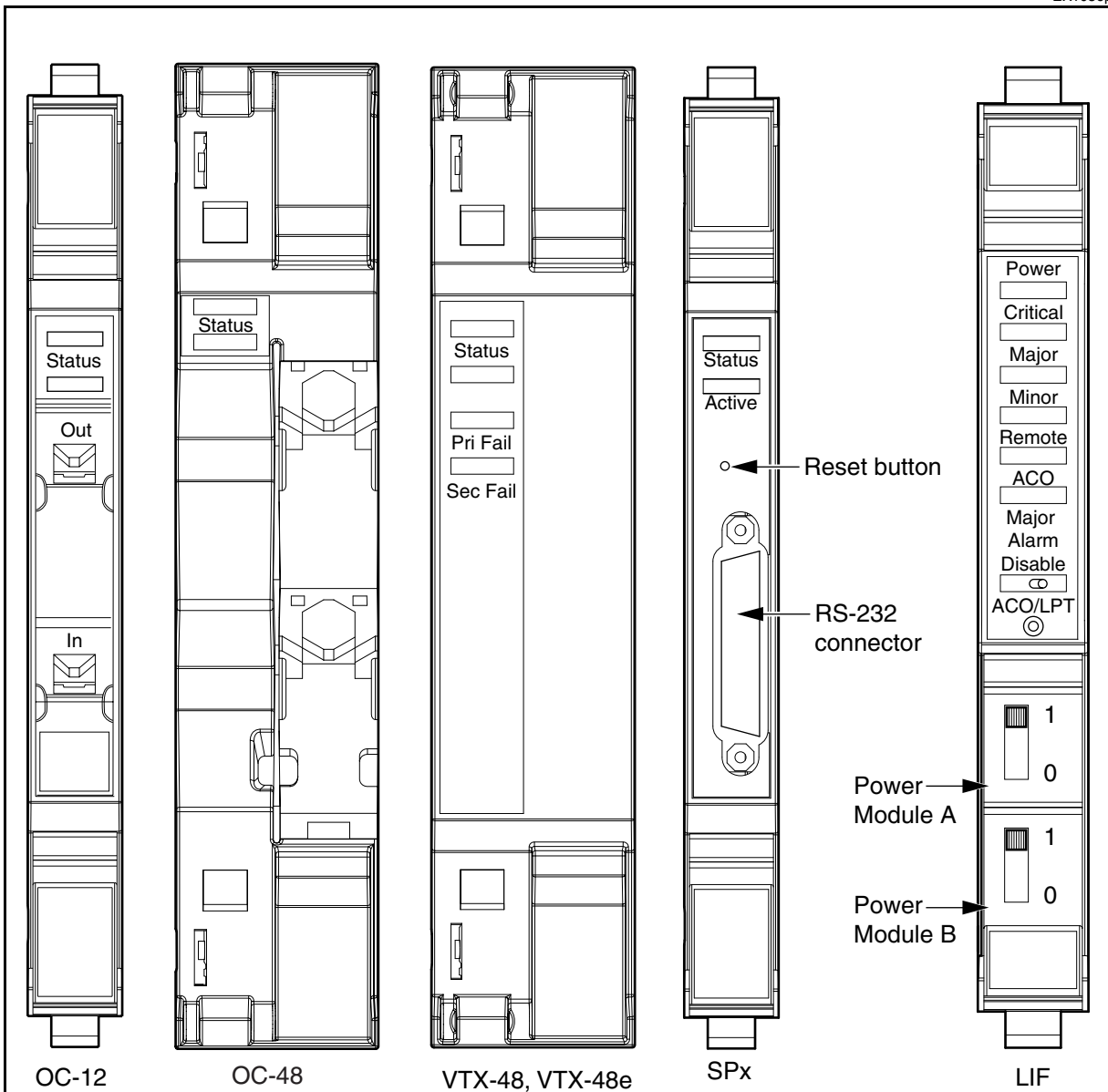
## **OPTera Metro 3500 BIP (European deployment) (NTFW56BA)**

The BIP NTFW56BA (for European deployment) is mounted at the top of the OPTera Metro 3500 equipment frame. Two redundant office battery inputs (-48 V dc) independently feed a separate set of four 15A circuit breakers, which in turn feed equipment in the rack. The power terminals on the NT7E56BA breaker interface panel are located behind the front left-hand panel of the chassis. See [Table 3-3 on page 3-6](#) for operational temperature ranges.



**Figure 3-26**  
**Core circuit packs - VTX equipped OPTera Metro 3500 shelf**

EX1056p

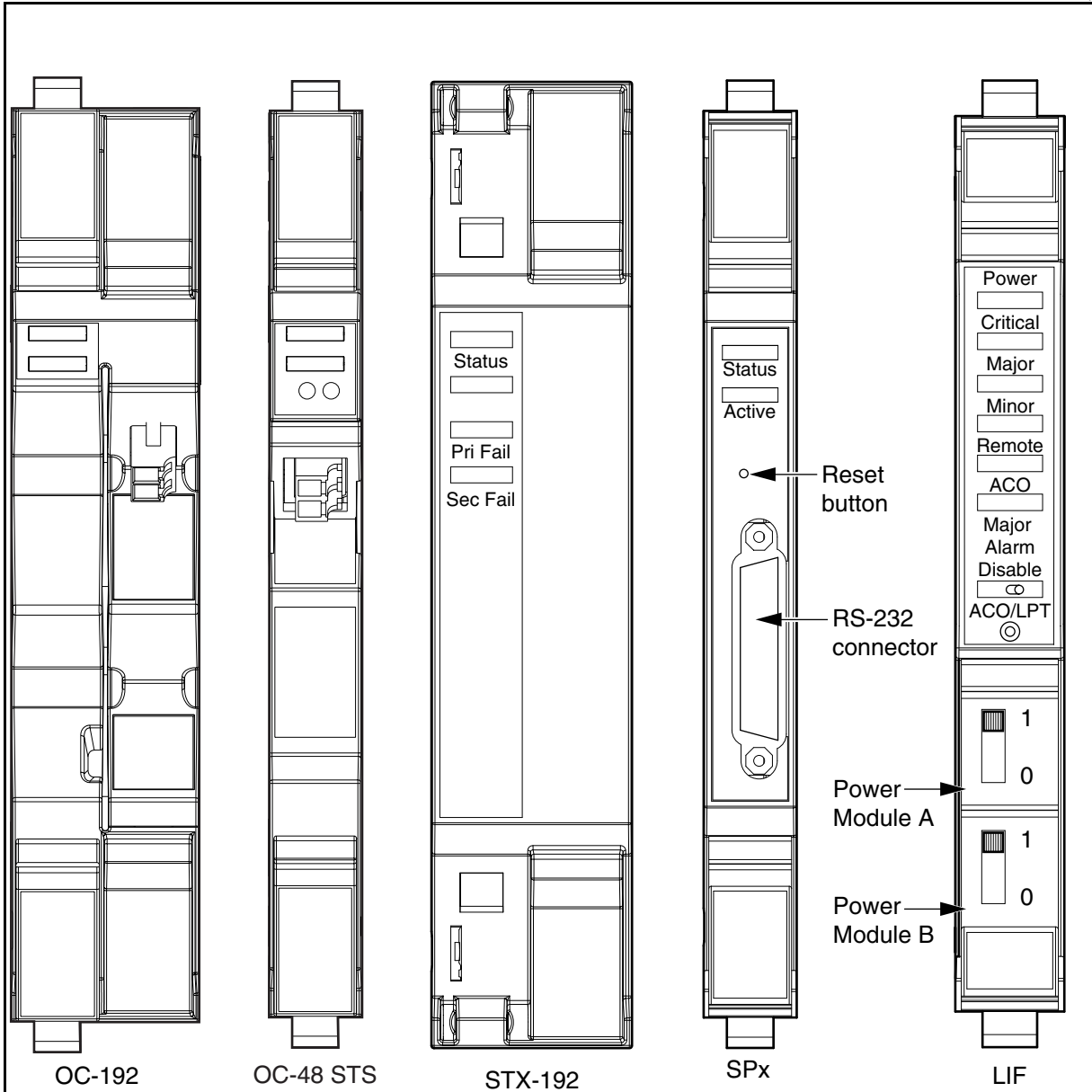


**Note 1:** If OC-48 circuit packs are installed in slots 11 and 12, then the OC-12 circuit pack is not a core circuit pack.

**Note 2:** If OC-12 circuit packs are installed in slots 11 and 12, then the OC-48 circuit pack is not a core circuit pack.

**Figure 3-27**  
**Core circuit packs - STX-192 equipped OPTera Metro 3500 shelf**

EX1473p

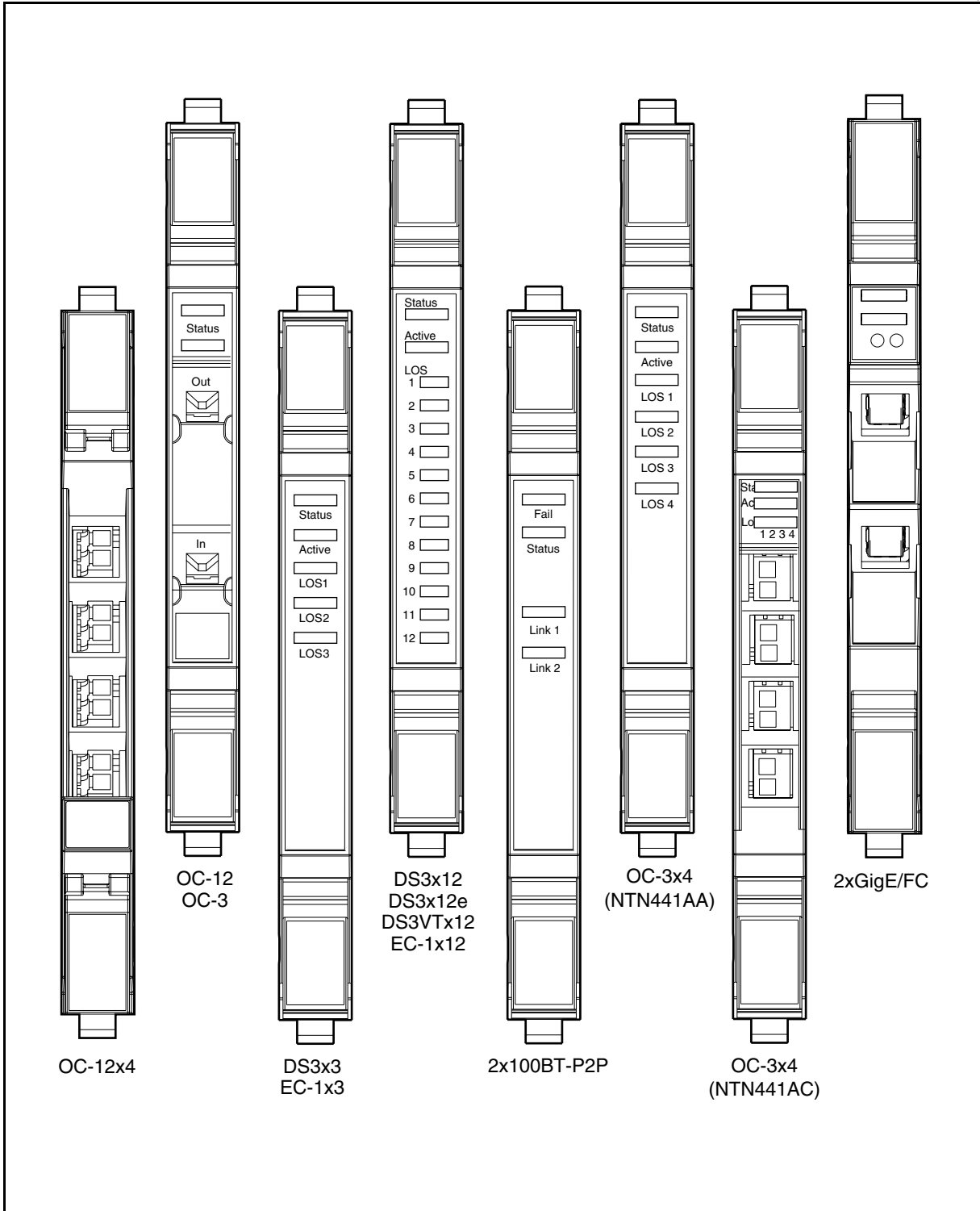


**Note 1:** If OC-192 circuit packs are installed in slots 11 and 12, then the OC-48 circuit pack is not a core circuit pack.

**Note 2:** If OC-48 STS circuit packs are installed in slots 11 and 12, then the OC-192 circuit pack is not a core circuit pack.

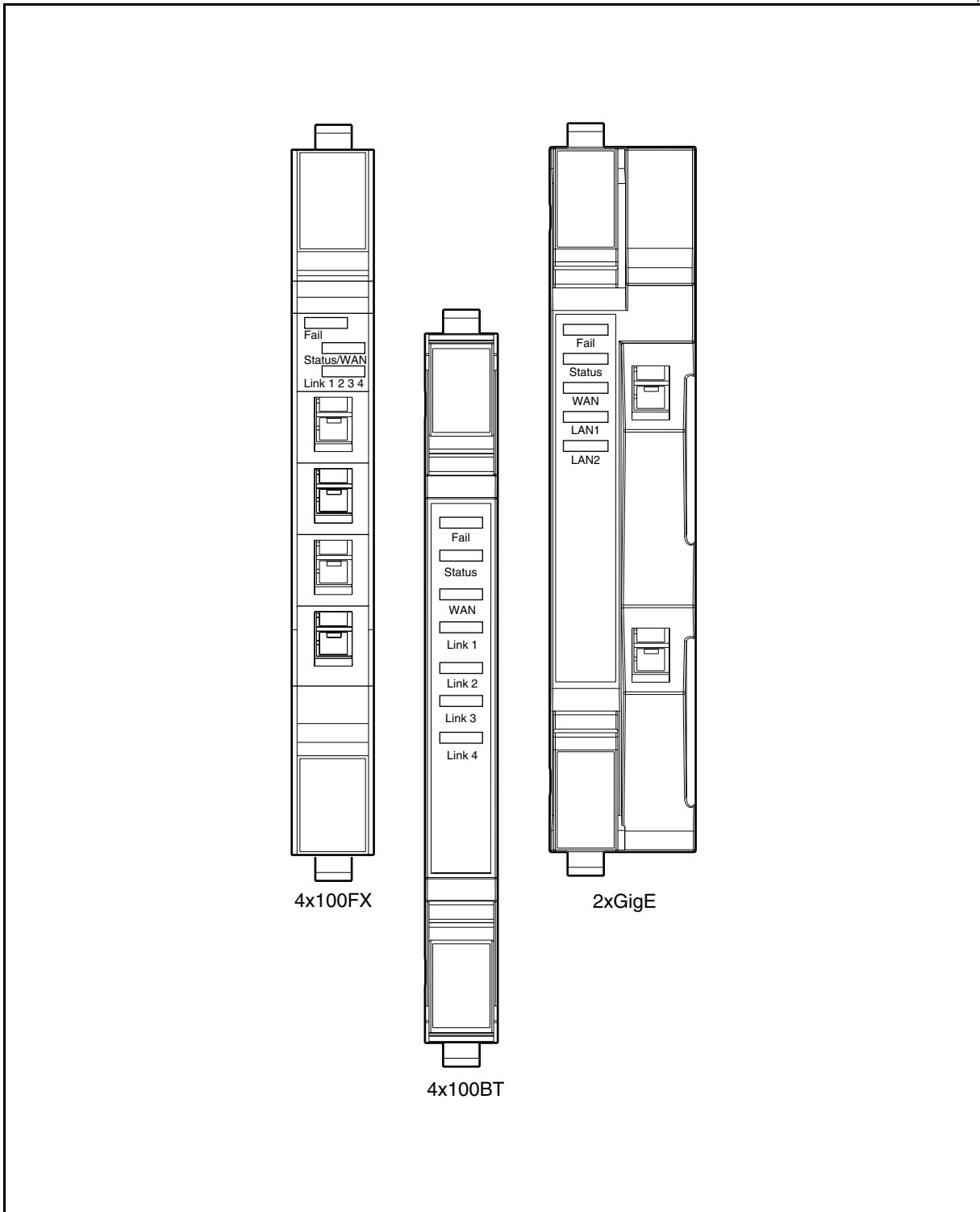
**Figure 3-28**  
Tributary circuit packs

EX1474p



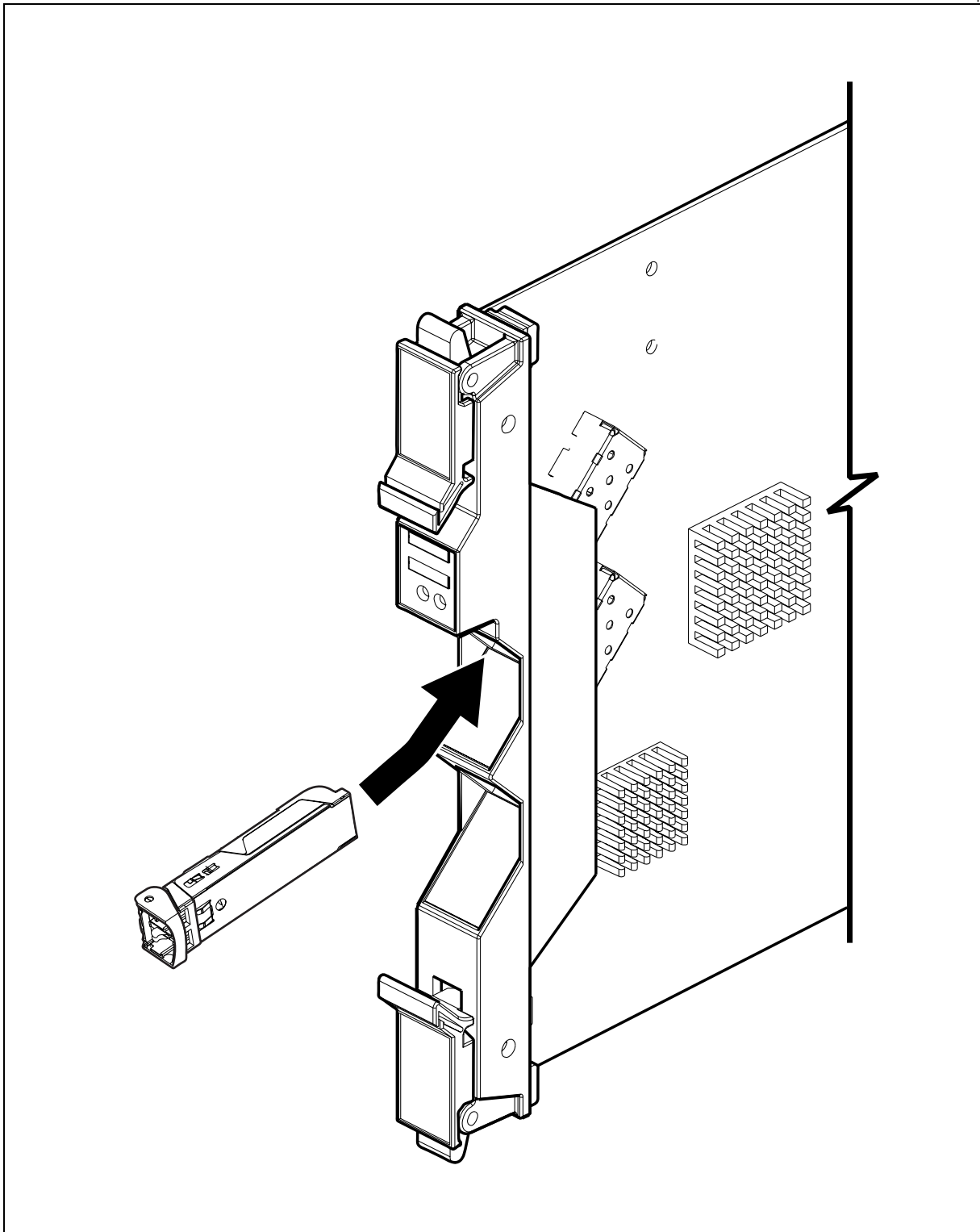
**Figure 3-29**  
**OPTera Packet Edge circuit packs**

EX1417p



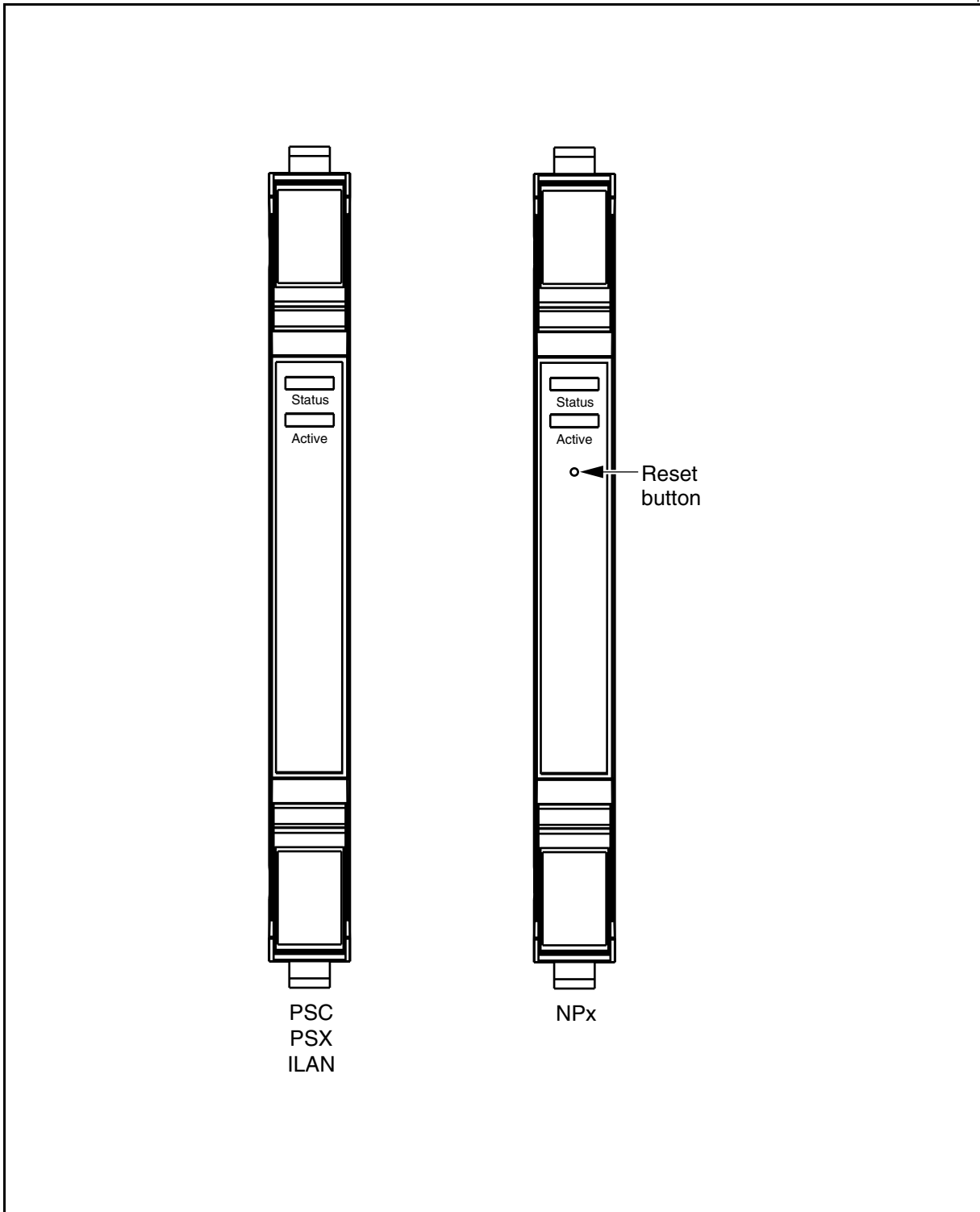
**Figure 3-30**  
2xGigE/FC-P2P and SFP interfaces

EX1459p



**Figure 3-31**  
NPx, ILAN, PSC, and PSX circuit packs

EX1195p



## STX-192 circuit pack (NTN415AA)

STX-192 circuit packs can be equipped in slots 13 and 14. The STX-192 circuit pack is rated for operation in the temperature range of 0°C to +50°C.

STX-192 circuit packs provide monitoring and control for provisioning, cross-connect management, shelf timing generation, and synchronization messaging. The internal clock quality is Stratum 3 (ST3). The STX-192 circuit packs also support DS1 ESF BITS synchronization status messaging.

The STX-192 circuit packs manage synchronization and shelf bandwidth as separate entities. For example, if there is a synchronization failure on the STX-192 circuit pack in slot 13, and a bandwidth management functional block failure on the STX-192 circuit pack in slot 14, the system can still carry traffic and provide synchronization timing to other network elements.

STX-192 equipment operates in 1+1 redundant mode to provide cross-connect and clock distribution functions for OPTera Metro 3500. It is always auto-provisioned and cannot be deleted. Only one of the two STX-192 circuit packs can be taken out of service at a time.

### External timing reference input signals

The OPTera Metro 3500 shelf can receive timing signals from an external timing source such as a stratum clock or a BITS when the shelf is equipped with a STX-192 circuit pack. The BITS is connected to the network element by wire-wrap connectors on the left OAM (LOAM). The timing signals from an external timing source are called BITSIN-A and BITSIN-B.

### Equipping rules

The STX-192 circuit pack is a double-width circuit pack that can be installed in slot 13 and slot 14 of the OPTera Metro 3500 shelf.

**Note:** You can not mix STX-192 circuit packs with VTX-series circuit packs (e.g. VTX-48 and STX-192) during normal operation. A circuit pack incompatibility alarm will be raised if this occurs.

**Table 3-6**  
**STX and VTX-series compliancy matrix**

Card in Slot 13	Card in Slot 14	Card types	Slot numbers	Alarm description
VTX-48	VTX-48	OC-192 STS	11 & 12	"Circuit Pack Incompatible" alarm will be raised against the cards in slots 11 and 12.
VTX-48	VTX-48	OC-48 STS OC-12x4 STS	3 through 10	"Circuit Pack Incompatible" alarm will be raised against the cards in slots 3 through 10.
VTX-48	VTX-48	OC48 STS OC-12x4 STS	11 & 12	"Circuit Pack Incompatible" alarm will be raised against the cards in slots 11 and 12.
STX-192	STX-192	DS1, E1/DS1, DS3, DS3VTx12, DS3/VT, EC1, OC-48	Any	"Circuit Pack Incompatible" alarm will be raised against the cards in slots 3 through 10.
STX-192	VTX-48	Any	Any	"Circuit Pack Incompatible" alarm will be raised slot 13 and 14.
VTX-48	STX-192	Any	Any	"Circuit Pack Incompatible" alarm will be raised slot 13 and 14.

For a complete list of electrical and optical interfaces supported by VTX-48, VTX-48e and STX-192 equipped OPTera Metro 3500 shelf, refer to [Table 3-7 on page 3-52](#).

**Table 3-7**  
**OPTera Metro 3500 Electrical and Optical Interface Support**

Electrical & Optical Interfaces	Maximum number of facilities per shelf		Number of facilities per interface		Slots supported	
	VTX-48	STX-192	VTX-48	STX-192	VTX-48	STX-192
DS1	84	-	12	1	3 - 10 See Note 1	-
DS3x3	12	12	3	3	3 - 10	3 - 10
DS3x12	48	48	12	12	3 - 10	3 - 10
DS3VTx12	48	-	12	-	3 - 10	-
EC-1x3 See Note 2	12	12	3	3	3 - 10	3 - 10
EC-1x12	48	48	12	12	3 - 10	3 - 10
OC-3	8	8	1	1	3 - 12	3 - 10
OC-3x4	32	32	4	4	3 - 10	3 - 10



**Table 3-7 (continued)**  
**OPTera Metro 3500 Electrical and Optical Interface Support**

Electrical & Optical Interfaces	Maximum number of facilities per shelf		Number of facilities per interface		Slots supported	
OC-12	10	10	1	1	3 - 12 See Note 2	3 - 10
OC-12x4 STS	-	32	-	4	-	3 - 10
STM-1x4 See Note 3	32	32	4	4	3 - 10	3 - 10
4x10/100BT (RPR)	32	32	4	4	3 - 10	3 - 10
4x100FX (RPR)	32	32	4	4	3 - 10	3 - 10
2x1000SX 2x1000SX (GigE RPR)	8	8	2	2	3 - 10	3 - 10
2xGigE/FC-P2P	16	16	2	2	3 - 10	3 - 10
2x10/100BT (P2P)	16	16	2	2	3 - 10	3 - 10
OC-48	2	-	1	-	11 - 12	-
OC-48 STS	-	10	-	1	-	3 - 12
OC-192 STS	-	2	-	2	-	11 - 12
DSM See Note 4	12	12	1	1	3 - 10 See Note 5	3 - 10 See Note 5
<p><b>Note 1:</b> PSC is in slot 2, DS1 mappers in all other slots.</p> <p><b>Note 2:</b> Only the NTN436AA version of the EC-1x3 is supported</p> <p><b>Note 3:</b> Supported for Japan Configurations only.</p> <p><b>Note 4:</b> Single OPTera Metro 3500 shelf will support 12 protected or unprotected DSM modules.</p> <p><b>Note 5:</b> OC-3 or OC-3x4 interfaces equipped in these slots.</p>						

All OPTera Metro 3500 shelves equipped with STX-192 circuit packs will require they be equipped with:

- 20 Amp Power Modules (NTN451HA)
- Cooling unit assembly (NTN458QA)

Installation of other units than those listed above will result in “Equipment Below Baseline” alarm to be raised.

See [Table 3-3 on page 3-6](#) for operational temperature ranges.

### Alarm LED definitions

The following table provides a list of LEDs on the STX-192 circuit packs.

LED name	Color	Description
Status (top)	red	Circuit pack failure
Status (bottom)	green	STX in an in-service state
Pri Fail	yellow	Loss of primary timing reference signal
Sec Fail	yellow	Loss of secondary timing reference signal

### VTX-48 circuit pack (NTN414AA)

VTX-48 circuit packs can be equipped in slots 13 and 14. The VTX-48 circuit pack is rated for operation in the temperature range of 0°C to +50°C.

VTX-48 circuit packs provide monitoring and control for provisioning, cross-connect management, shelf timing generation, and synchronization messaging. The internal clock quality is Stratum 3 (ST3). The VTX-48 circuit packs also support DS1 ESF BITS synchronization status messaging.

The VTX-48 circuit packs manage synchronization and shelf bandwidth as separate entities. For example, if there is a synchronization failure on the VTX-48 circuit pack in slot 13, and a bandwidth management functional block failure on the VTX-48 circuit pack in slot 14, the system can still carry traffic and provide synchronization timing to other network elements.

VTX-48 equipment operates in 1+1 redundant mode to provide cross-connect and clock distribution functions for OPTera Metro 3500. It is always auto-provisioned and cannot be deleted. Only one of the two VTX-48 circuit packs can be taken out of service at a time.

### External timing reference input signals

The OPTera Metro 3500 shelf can receive timing signals from an external timing source such as a stratum clock or a BITS when the shelf is equipped with a VTX-48 circuit pack. The BITS is connected to the network element by wire-wrap connectors on the left OAM (LOAM). The timing signals from an external timing source are called BITSIN-A and BITSIN-B.

## Equipping rules

The VTX-48 circuit pack is a double-width circuit pack that can be installed in slot 13 and slot 14 of the OPTera Metro 3500 shelf.

**Note 1:** The VTX-48 circuit pack (NTN414AA) only supports the OC-48 line rate in slots 11 and 12.

**Note 2:** The OC-12 line rate is supported in slots 11 and 12 only if slots 13 and 14 are equipped with VTX-48e circuit packs (NTN414AB or NTN414AH).

## Alarm LED definitions

The following table provides a list of LEDs on the STX-192 circuit packs.

LED name	Color	Description
Status (top)	red	Circuit pack failure
Status (bottom)	green	VTX in an in-service state
Pri Fail	yellow	Loss of primary timing reference signal
Sec Fail	yellow	Loss of secondary timing reference signal

## VTX-48e circuit pack (NTN414AB, NTN414AH)

The VTX-48e circuit pack supports the use of both OC-12 and OC-48 line rate in slots 11 and 12.

VTX-48e circuit packs provide monitoring and control for provisioning, cross-connect management, shelf timing generation, and synchronization messaging. The internal clock quality is Stratum 3 (ST3). VTX-48e circuit packs also support DS1 ESF BITS synchronization status messaging.

VTX-48e circuit packs manage synchronization and shelf bandwidth as separate entities. For example, if there is a synchronization failure on the VTX-48e circuit pack in slot 13, and a bandwidth management functional block failure on the VTX-48e circuit pack in slot 14, the system can still carry traffic and provide synchronization timing to other network elements.

VTX-48 equipment operates in 1+1 redundant mode to provide cross-connect and clock distribution functions for OPTera Metro 3500. It is always autoprovisioned and cannot be deleted. Only one of the two VTX-48e circuit packs can be taken out of service at a time.

### Equipping rules

The VTX-48e circuit pack is a double-width circuit pack that is installed in slot 13 and slot 14 of the OPTera Metro 3500 shelf. The OPTera Metro 3500 shelf must be equipped with VTX48e circuit packs if OC-12 circuit packs are in the line slots.

*Note 1:* The VTX-48 circuit pack (NTN414AA) only supports the OC-48 line rate in slots 11 and 12.

*Note 2:* The OC-12 line rate is supported in slots 11 and 12 only if slots 13 and 14 are equipped with VTX-48e circuit packs (NTN414AB or NTN414AH).

See [Table 3-3 on page 3-6](#) for operational temperature ranges.

### Alarm LED definitions

The following table provides a list of LEDs on the VTX-48e circuit packs.

LED name	Color	Description
Status (top)	red	Circuit pack failure
Status (bottom)	green	VTX in an in-service state
Pri Fail	yellow	Loss of primary timing reference signal
Sec Fail	yellow	Loss of secondary timing reference signal

### Extended shelf processor (SPx) (NTN423BA, BH)

The extended shelf processor (SPx) provides shelf level control, handles all shelf communications, and runs the system software. The SPx uses a diskless storage media for permanent storage of the software load and to record the network element provisioning and history. RS-232 connections can be made either to the SPx faceplate connector or to a LOAM connector. System software resides in the SPx or the network processor nonvolatile memory.

The SPx raises equipment alarms for the co-located extended network processor (NPx), backs up NPx provisioning data and provides shelf information and NPx provisioning data to the NPx during an NPx restart.

### TL1 sessions

TL1 sessions are hosted by the SPx and all TL1 commands are interpreted by the processor. Once the commands have been interpreted, the SPx instructs the dedicated processors in other circuit packs as to what action is to be taken.

## Alarms and TBOS

Office alarms, TBOS, and environmental I/O are under the control of the SPx.

The SPx monitors all circuit packs in the system for problems. When a problem arises in any area, the SPx registers the problem in its alarms database so that the alarm can be retrieved by a user in a TL1 session.

## Reset button

When the reset button is pressed, the SPx software and hardware initialize. During the initialization process, all the LEDs on the SPx turn on, SDCC communications with the shelf are unavailable, and RS-232 communications with the shelf are unavailable. The SPx reset button should only be used when the SPx is not responding.

## Section data communication channel (SDCC)

The SPx controls the section data communications channels (SDCC). All remote TL1 sessions use SDCC as the communications link between network elements.

## Equipping rules

The SPx must be installed in slot 15. See [Table 3-3 on page 3-6](#) for operational temperature ranges.

It is possible for a shelf to carry traffic and maintain equipment and path protection switching without an SPx. If the SPx fails or is removed, all communications and performance monitoring with the shelf are inactive.

## Alarm LED definitions

The following table provides a list of LEDs of the SPx.

LED	Color	Description
Status	Red	Circuit pack failure
	Yellow	Loss of one or more SDCC connections or TIA/EIA-232 connection
Active	Green	In service

## Extended network processor (NPx) (NTN424BA, BH)

The extended network processor (NPx) provides network level control. The NPx supports TCP/IP, X.25, and a seven-layer OSI stack. The NPx communicates with Preside Site Manager and the Multiservice Managed Object Agent (MOA) over TCP/IP. It supports TL1 communication over X.25 with other operations support systems (OSS).

The NPx communicates with the co-located SPx through the backplane over Ethernet. The NPx also allows up to 16 nodes with NPxs to be daisy-chained through the intershelf local area network (ILAN) port on the ILAN or NPx circuit pack.

The NPx circuit pack provides access to the ILAN1, ILAN2, and COLAN ports on the LOAM.

**Note:** The COLAN is 10BASE-T and half duplex

The NPx supports user accounts with a level 5 user privilege code (UPC) for network surveillance purposes. Logging in to the NPx using a user account with level 5 UPC from a local connection, you can retrieve alarms and events from all network elements in the NPx span of control. The NPx can have up to 16 network elements in its span of control. The network elements in the NPx span of control can be any combination of OPTera Metro 3000 Multiservice platform series network elements.

The NPx supports file transfer to and from Preside and Multiservice MOA for electronic software delivery, and to and from a PC to install files on the system. The NPx also allows other network processors or shelf processors to retrieve new software loads for upgrade purposes.

**Note 1:** One NPx can surveil a mixed span of control (that is, OPTera Metro 3100, 3300, 3400, and 3500 network elements all will be seen in an NPx circuit pack's span of control).

**Note 2:** An NPx circuit pack can store up to 7 software loads. Before transferring a software load to the NPx, ensure there is at least 20,000 kB of space available on the NPx.

### **TL1 sessions**

The NPx hosts TL1 sessions for commands related to the NPx and NPx facilities.

### **Alarms and provisioning data**

NPx provisioning data is backed up at the co-located shelf processor. The NPx reports alarms for NPx facilities. The co-located SPx reports NPx equipment alarms on behalf of the NPx. When the NPx is restarted, it receives all its provisioning data from the co-located SPx. The Save and Restore functionality saves each individual network element's backup data to the repository located on the NPx.

### **Reset button**

When the reset button is pressed, the network processor hardware and software initialize. During the initialization process, all the LEDs on the NPx turn on and communications provided by the NPx are unavailable. The NPx reset button should only be used when the NPx is not responding.

**Equipping rules**

The NPx must be installed in slot 16. See [Table 3-3 on page 3-6](#) for operational temperature ranges.

**Alarm LED definitions**

The following table provides a list of LEDs on the NPx circuit pack.

LED	Color	Description
Status	Red	Circuit pack failure, reset or insertions
	Yellow	Facility failure
Active	Green	In service

**ILAN interface  
(NTN425AA)**

The ILAN circuit pack (NTN425AA) provides the Ethernet hubbing functionality required to interconnect OPTera Metro 3000 shelves. The ILAN circuit pack provides a low cost solution to Ethernet connectivity between OPTera Metro, OC-48 Classic Phoenix SP, OPTera Connect DX and OPTera Long Haul OPCs and the OPTera Connect HDX as well as the capability to daisy-chain up to 16 shelves. The ILAN interface gives the user access to ILAN ports 1 and 2 on the LOAM.

*Note:* The ILAN interface circuit pack does not give the user access to COLAN ports.

**Equipping rules**

The ILAN circuit pack must be inserted in slot 16. See [Table 3-3 on page 3-6](#) for operational temperature ranges.

**OC-192 optical interface circuit pack  
(NTN445CB, DA)**

The main transport OC-192 circuit pack operates at an OC-192 line rate (9.953 Gbit/s for IR and 10.709 Gbit/s for LR and DWDM). The OC-192 circuit pack can be installed in slots 11 and 12 in a UPSR, 1+1 linear system and BLSR. In the 1+1 linear protection scheme, OC-192 circuit packs can be provisioned in either unidirectional or bidirectional mode. See [Table 3-3 on page 3-6](#) for operational temperature ranges.

See [Table 3-9](#) for the OC-192 optical wavelengths and line rates supported for the transmit and receive optical circuit packs.

**Table 3-8**  
**OC-192 optical wavelength**

OC-192 circuit pack	Wavelength	Line rate (Gbit/s)
Intermediate Reach (IR)	1550 nm	9.953
Long Reach (LR)	1550 nm	10.709
DWDM Long Reach (LR)	See <a href="#">Dense wavelength division multiplexing (DWDM) on page 2-46</a>	10.709

### STS-1 path trace for OC-192

OPTera Metro 3500 supports path trace capability for OC-192 services. Path trace is a 64 byte ASCII string that can be provisioned by the user. Path trace is transmitted through the J1 byte of the STS Path Overhead. It can be used by STS path terminating equipment (PTE) to verify its continued connection to the intended transmitting STS PTE.

### Section trace for OC-192

OPTera Metro 3500 supports section trace capability for OC-192 services. Section trace provides a diagnostic tool that can determine installation and commissioning problems such as misconnected optical fibers. Section trace occupies the J0 SONET byte (formerly known as the C1 byte to indicate the STS-1 ID) of the section overhead. Section trace is injected at the transmit end of a section and extracted at the receive end where it can be checked against an expected section trace value.

### Section data communication channel (SDCC)

A DWDM OC-192 line carries a DCC channel that can be edited, provisioned, and deprovisioned.

**Note 1:** The maximum number of simultaneous SDCC-provisionable ports on an OPTera Metro 3500 shelf is 34 (the shelf must be equipped with eight unprotected OC-3x4 or OC-12x4 STS circuit packs in slots 3 through 10, and a protected pair of OC-48 or OC-192 circuit packs in slots 11 and 12).

**Note 2:** For Nortel Networks interworking and multi-vendor network scenarios, DCC interoperability can be achieved with the appropriate provisioning. See *Optical Networks Data Communications Network Planning Guide*, NTR710AM.

### Forward Error Correction (FEC)

Forward error correction detects and corrects small burst errors of 8 bits on an STS-48 basis. The FEC feature adds some redundancy parity bits on the transmit side and removes the bits on the receive side. The OC-192 DWDM G.709 FEC interface supports standard encoding and decoding RS-8 (Reed-Solomon) as specific in ITU-T G.709/Y.1331 standards.



### Alarm LED definitions

The following table lists the OC-192 interface circuit pack LEDs.

LED	Color	Description
Status (top)	Red	Circuit pack failure
	Yellow	Loss of signal
Status (bottom)	Green	In service and carrying traffic

The following table lists the modified alarms associated to the OC-192 interface circuit pack.

Alarm Text or conditions
Default k-bytes
Invalid K-bytes
Node ID mismatch
Traffic Squelched
Wait to Restore
Wait to Restore - Remote
Lockout of Protection Complete - Remote
Lockout of Protection Complete
Lockout of Working Complete
Manual Switch Complete
Manual Switch Complete - Remote
Force Switch Complete
Force Switch Complete - Remote
Protection switch Fail
Auto Switch Complete
Protection Exerciser Failed
Protection Exerciser Complete

**Note:** When the OC-192 circuit pack receives an unequipped signal on concatenated traffic rates (STSnC) connections, the OC-192 circuit pack will raise an UNEQ alarm: "STS3C Rx Unequipped, STS12C Rx Unequipped, STS24C Rx Unequipped, or STS48C Rx Unequipped".

### Equipping rules

The OC-192 optical interface circuit pack can be installed in slots 11 and 12. See [Table 3-3 on page 3-6](#) for operational temperature ranges.

An OPTera Metro 3500 network element with a protected OC-192 line rate requires two OC-192 circuit packs in slots 11 and 12 of each shelf.

**Note 1:** Requires the shelf to be equipped with STX-192 circuit packs in slots 13 and 14.

**Note 2:** Supports STS managed connections only.

**Note 3:** Interoperability with the OPTera Metro 3500 OC-192 Long reach (LR) G.709 FEC and OC-192 DWDM G.709 FEC optical interfaces requires G.709 compatible optics. You can equip the OPTera Metro 3500 shelf with a mix OC-192 IR and OC-192 G.709 circuits, however they must connect to the same type of card on the other end of the fiber span.

### OC-192 protection switching

OC-192 traffic can be protected by 1+1 linear, UPSR, or BLSR protection.

#### 1+1 linear protection

OC-192 linear protection switching is 1+1 non-revertive, unidirectional or bidirectional. If a fiber cut occurs in either the receive or transmit fibers of the active fiber path, or the transmitter or receiver of an OC-192 optical interface circuit pack fails at either end of the active fiber span, traffic is switched from the active OC-192 transmitter or receiver to the standby OC-192 transmitter or receiver. Switching can also take place under user control.

In bidirectional protection switching, if traffic in one of the two directions is interrupted, traffic in both directions is switched to the protection line. In unidirectional protection switching, if traffic in one of the two directions is interrupted, only the interrupted traffic switches to the protection line; traffic in the uninterrupted direction remains on the working fiber. Both OC-192 interface circuit packs are active if unidirectional switching occurs and one fiber fails.

The signal degrade threshold is user-provisionable for the working OC-192 facility of a 1+1 linear protected OC-192 pair. The default value is  $10^{-6}$ . The threshold is provisionable within the range  $10^{-5}$  to  $10^{-9}$ . If the bit error rate (BER) drops below the threshold, an autonomous protection switch occurs.

#### UPSR path protection

OC-192 path switching uses nonrevertive protection. There are no permanent, STS-1/, STS-3c, STS-12, STS-12c, STS-24c, STS-48c protection or working paths. The network element receives two incoming STS-1/, STS-12, STS-3c, STS-12c, STS-24c or STS-48c signals: one from the provisioned working optical interface circuit pack and one from the switchmate optical interface circuit pack. The network element selects the better of the two signals.

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Protection of path failures on a single OC-192 optical interface completes in 60 ms, but protection of simultaneous path failures on multiple optical interfaces completes in less than 200 ms.

**BLSR protection**

BLSR protection switching is revertive. If a fiber cut occurs in either the receive or transmit fibers of the active channel, or the transmitter or receiver OC-192 optical interface circuit pack fails at either end of the fiber span of the active channel, traffic is switched from the working channel to the protection channel (usually from the short path to the long path on the other side of the ring).

The Wait-to-Restore (WTR) bridge request is issued on both the long and short paths when working channels meet the restoral threshold after a signal degrade or signal fail condition. This request is used to maintain the current state during the WTR period unless one or a combination of the following conditions occurs:

- a bridge request of higher priority than WTR is received
- another failure is detected
- an externally initiated command becomes active

The WTR time is between 1 to 12 minutes (default is 5 minutes). The WTR period is provisionable for each optical interface pair.

**Note:** You can provision an infinite WTR period, so that BLSRs autonomously switch non-revertively.

Switching can also take place under user control. In BLSR user-initiated switches, the user may initiate a lockout on either the working or protection channels on a span. Both of these effectively 'lock' traffic onto the working channel. The lockout of the protection channel of the span also prevents any protection switching from occurring anywhere in the ring.

Forced and manual switches on the working channels switch traffic to the protection channel. A forced switch has a higher priority than a manual switch. For the complete BLSR protection switching hierarchy, see [Table 2-27 on page 2-119](#). Both forced and manual switches can be released.

In ring switches, the protection channels are shared among each span of the ring. If a scenario arises where multiple points in a BLSR fail or nodes become isolated, there is the potential for misconnected traffic. Services originally on separate spans but sharing the same time slot may compete for the same protection time slot. Squelching is a mechanism to prevent this.

For more information about squelching, see [BLSR networks \(2-fiber\) on page 2-10](#).

## OC-192 DWDM G.709 FEC optical interface circuit pack (See [Table 8-11](#) on [page 8-19](#) in [Part 2](#) of this guide for PEC codes)

The OC-192 DWDM G.709 FEC circuit pack is provisioned in the same way as other OC-192 circuit packs.

The OC-192 DWDM circuit pack and OMX are required to support DWDM topologies for OPTera Metro 3500.

**Note 1:** The OMX does not support 1535.04 nm wavelength.

**Note 2:** Additional wavelengths for DWDM C-Band may be introduced in the future.

**Note 3:** Supports ITU-T G.709/Y.1331 standard.

### Section data communication channel (SDCC)

A DWDM OC-192 line carries a DCC channel that can be edited, provisioned, and deprovisioned.

**Note 1:** The maximum number of simultaneous SDCC-provisionable ports on an OPTera Metro 3500 shelf is 34 (the shelf must be equipped with eight unprotected OC-3x4 or OC-12x4 STS circuit packs in slots 3 through 10, and a protected pair of OC-48 or OC-192 circuit packs in slots 11 and 12).

**Note 2:** For Nortel Networks interworking and multi-vendor network scenarios, DCC interoperability can be achieved with the appropriate provisioning. See *Optical Networks Data Communications Network Planning Guide*, NTR710AM.

### Forward Error Correction (FEC)

Forward error correction detects and corrects small burst errors of 8 bits on an STS-48 basis. The FEC feature adds some redundancy parity bits on the transmit side and removes the bits on the receive side. The OC-192 LR G.709 FEC and OC-192 DWDM G.709 FEC interfaces support standard encoding and decoding RS-8 (Reed-Solomon) as specific in ITU-T G.709/Y.1331 standards.

### Alarm LED definitions

The following table lists the OC-192 DWDM interface circuit pack LEDs.

LED	Color	Description
Status (top)	Red	Circuit pack failure
	Yellow	Loss of signal
Status (bottom)	Green	In service and carrying traffic

## Equipping rules

The OC-192 DWDM G.709 FEC circuit pack are equipped in slots 11 and 12 of the OPTera Metro shelf. See [Table 3-3 on page 3-6](#) for operational temperature ranges.

**Note 1:** Requires the shelf to be equipped with STX-192 circuit packs in slots 13 and 14.

**Note 2:** Interoperability with the OPTera Metro 3500 OC-192 Long reach (LR) G.709 FEC and OC-192 DWDM G.709 FEC optical interfaces requires G.709 compatible optics. You can equip the OPTera Metro 3500 shelf with a mix OC-192 IR and OC-192 G.709 circuits, however they must connect to the same type of card on the other end of the fiber span.

## OC-48 optical interface circuit pack (NTN440BA, DA, FA, EA, EH, BH)

The main transport OC-48 circuit pack operates at an OC-48 line rate (2488 Mbit/s). The OC-48 circuit pack can be installed in slots 11 and 12 in a UPSR, 1+1 linear system and BLSR. In the 1+1 linear protection scheme, OC-48 circuit packs can be provisioned in either unidirectional or bidirectional mode. See [Table 3-3 on page 3-6](#) for operational temperature ranges.

See [Table 3-9](#) for the OC-48 optical wavelengths that are supported for the transmit and receive optical circuit packs.

**Table 3-9**  
**OC-48 optical wavelength**

OC-48 circuit pack	Wavelength
Short reach (SR)	1310 nm
Intermediate reach (IR)	1310 nm
Long reach (LR)	1550 nm
Extended long reach (ELR)	1550 nm
DWDM long reach (LR)	See <a href="#">Dense wavelength division multiplexing (DWDM) on page 2-46</a> .
DWDM extended reach (ER)	See <a href="#">Dense wavelength division multiplexing (DWDM) on page 2-46</a> .

## STS-1 path trace for OC-48

OPTera Metro 3500 supports path trace capability for OC-48 services. Path trace is a 64 byte ASCII string that can be provisioned by the user. Path trace is transmitted through the J1 byte of the STS Path Overhead. It can be used by STS path terminating equipment (PTE) to verify its continued connection to the intended transmitting STS PTE.

### Section trace for OC-48

OPTera Metro 3500 supports section trace capability for OC-48 services. Section trace provides a diagnostic tool that can determine installation and commissioning problems such as misconnected optical fibers. Section trace occupies the J0 SONET byte (formerly known as the C1 byte to indicate the STS-1 ID) of the section overhead. Section trace is injected at the transmit end of a section and extracted at the receive end where it can be checked against an expected section trace value.

### Section data communication channel (SDCC)

An OC-48 line carries a DCC channel that can be edited, provisioned, and deprovisioned.

**Note 1:** The maximum number of simultaneous SDCC-provisionable ports on an OPTera Metro 3500 shelf is 34 (the shelf must be equipped with eight unprotected OC-3x4 circuit packs in slots 3 through 10, and a protected pair of OC-48 circuit packs in slots 11 and 12).

**Note 2:** For Nortel Networks interworking and multi-vendor network scenarios, DCC interoperability can be achieved with the appropriate provisioning. See *Optical Networks Data Communications Network Planning Guide*, NTR710AM.

### Alarm LED definitions

The following table lists the OC-48 interface circuit pack LEDs.

LED	Color	Description
Status (top)	Red	Circuit pack failure
	Yellow	Loss of signal
Status (bottom)	Green	In service and carrying traffic

### Equipping rules

The OC-48 optical interface circuit pack can be installed in slots 11 and 12. See [Table 3-3 on page 3-6](#) for operational temperature ranges.

**Note:** Requires the shelf to be equipped with VTX-series circuit packs in slots 13 and 14.

An OPTera Metro 3500 network element with a protected OC-48 line rate requires two OC-48 circuit packs in slots 11 and 12 of each shelf.

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## OC-48 protection switching

OC-48 traffic can be protected by 1+1 linear, UPSR, or BLSR protection.

### 1+1 linear protection

OC-48 linear protection switching is 1+1 non-revertive, unidirectional or bidirectional. If a fiber cut occurs in either the receive or transmit fibers of the active fiber path, or the transmitter or receiver OC-48 optical interface circuit pack fails at either end of the active fiber span, traffic is switched from the active OC-48 transmitter or receiver to the standby OC-48 transmitter or receiver. Switching can also take place under user control.

In bidirectional protection switching, if traffic in one of the two directions is interrupted, traffic in both directions is switched to the protection line. In unidirectional protection switching, if traffic in one of the two directions is interrupted, only the interrupted traffic switches to the protection line; traffic in the uninterrupted direction remains on the working fiber. Both OC-48 interface circuit packs are active if unidirectional switching occurs and one fiber fails.

The signal degrade threshold is user-provisionable for the working OC-48 facility of a 1+1 linear protected OC-48 pair. The default value is  $10^{-6}$ . The threshold is provisionable within the range  $10^{-5}$  to  $10^{-9}$ . If the bit error rate (BER) drops below the threshold, an autonomous protection switch occurs.

### UPSR path protection

OC-48 path switching uses nonrevertive protection. There are no permanent, VT1.5/, STS-1, STS-3c, STS-12, or STS-12c protection or working paths. The network element receives two incoming VT1.5/, STS-1, STS-12, STS-3c, or STS-12c signals: one from the provisioned working optical interface circuit pack and one from the switchmate optical interface circuit pack. The network element selects the better of the two signals.

*Note:* VT1.5 signal rate is supported on OPTera Metro 3500 shelves equipped with VTX-series circuit packs.

Protection of path failures on a single OC-48 optical interface completes in 60 ms, but protection of simultaneous path failures on multiple optical interfaces completes in less than 200 ms.

### BLSR protection

BLSR protection switching is revertive. If a fiber cut occurs in either the receive or transmit fibers of the active channel, or the transmitter or receiver OC-48 optical interface circuit pack fails at either end of the fiber span of the active channel, traffic is switched from the working channel to the protection channel (usually from the short path to the long path on the other side of the ring).

The Wait-to-Restore (WTR) bridge request is issued on both the long and short paths when working channels meet the restoral threshold after a signal degrade or signal fail condition. This request is used to maintain the current state during the WTR period unless one or a combination of the following conditions occurs:

- a bridge request of higher priority than WTR is received
- another failure is detected
- an externally initiated command becomes active

The WTR time is between 1 to 12 minutes (default is 5 minutes). The WTR period is provisionable for each optical interface pair.

**Note:** You can provision an infinite WTR period, so that BLSRs autonomously switch non-revertively.

Switching can also take place under user control. In BLSR user-initiated switches, the user may initiate a lockout on either the working or protection channels on a span. Both of these effectively 'lock' traffic onto the working channel. The lockout of the protection channel of the span also prevents any protection switching from occurring anywhere in the ring.

Forced and manual switches on the working channels switch traffic to the protection channel. A forced switch has a higher priority than a manual switch. For the complete BLSR protection switching hierarchy, see [Table 2-27 on page 2-119](#). Both forced and manual switches can be released.

In ring switches, the protection channels are shared among each span of the ring. If a scenario arises where multiple points in a BLSR fail or nodes become isolated, there is the potential for misconnected traffic. Services originally on separate spans but sharing the same time slot may compete for the same protection time slot. Squelching is a mechanism to prevent this.

For more information about squelching, see [BLSR networks \(2-fiber\) on page 2-10](#).

## **OC-48 STS optical interface circuit pack (NTN440HA, KA, LA)**

The main transport OC-48 circuit pack operates at an OC-48 line rate (2488 Mbit/s). The OC-48 circuit pack can be installed in slots 3 through 12 in a UPSR, and 1+1 linear system. In the 1+1 linear protection scheme, OC-48 circuit packs can be provisioned in either unidirectional or bidirectional mode. See [Table 3-3 on page 3-6](#) for operational temperature ranges.

See [Table 3-10](#) for the OC-48 optical wavelengths that are supported for the transmit and receive optical circuit packs.



**Table 3-10**  
**OC-48 STS optical wavelength**

OC-48 STS circuit pack	Wavelength
Short Reach (SR)	1310 nm
Intermediate reach (IR)	1310 nm
Long reach (LR)	1550 nm

### STS-1 path trace for OC-48

OPTera Metro 3500 supports path trace capability for OC-48 services. Path trace is a 64 byte ASCII string that can be provisioned by the user. Path trace is transmitted through the J1 byte of the STS Path Overhead. It can be used by STS path terminating equipment (PTE) to verify its continued connection to the intended transmitting STS PTE.

### Section trace for OC-48

OPTera Metro 3500 supports section trace capability for OC-48 services. Section trace provides a diagnostic tool that can determine installation and commissioning problems such as misconnected optical fibers. Section trace occupies the J0 SONET byte (formerly known as the C1 byte to indicate the STS-1 ID) of the section overhead. Section trace is injected at the transmit end of a section and extracted at the receive end where it can be checked against an expected section trace value.

### Section data communication channel (SDCC)

An OC-48 line carries a DCC channel that can be edited, provisioned, and deprovisioned.

**Note 1:** The maximum number of simultaneous SDCC-provisionable ports on an OPTera Metro 3500 shelf is 34 (the shelf must be equipped with eight unprotected OC-3x4 or OC-12x4 STS circuit packs in slots 3 through 10, and a protected pair of OC-48 or OC-192 circuit packs in slots 11 and 12).

**Note 2:** For Nortel Networks interworking and multi-vendor network scenarios, DCC interoperability can be achieved with the appropriate provisioning. See *Optical Networks Data Communications Network Planning Guide*, NTR710AM.

### Alarm LED definitions

The following table lists the OC-48 STS interface circuit pack LEDs.

LED	Color	Description
Status (top)	Red	Circuit pack failure
	Yellow	Loss of signal
Status (bottom)	Green	In service and carrying traffic

### Equipping rules

The OC-48 STS optical interface circuit pack can be installed in slots 3 through 12. See [Table 3-3 on page 3-6](#) for operational temperature ranges.

*Note 1:* Requires the shelf to be equipped with STX-192 circuit packs in slots 13 and 14.

*Note 2:* Supports STS managed connections only.

### OC-48 protection switching

OC-48 traffic can be protected by 1+1 linear, or UPSR protection.

#### 1+1 linear protection

OC-48 linear protection switching is 1+1 non-revertive, unidirectional or bidirectional. If a fiber cut occurs in either the receive or transmit fibers of the active fiber path, or the transmitter or receiver OC-48 optical interface circuit pack fails at either end of the active fiber span, traffic is switched from the active OC-48 transmitter or receiver to the standby OC-48 transmitter or receiver. Switching can also take place under user control.

In bidirectional protection switching, if traffic in one of the two directions is interrupted, traffic in both directions is switched to the protection line. In unidirectional protection switching, if traffic in one of the two directions is interrupted, only the interrupted traffic switches to the protection line; traffic in the uninterrupted direction remains on the working fiber. Both OC-48 interface circuit packs are active if unidirectional switching occurs and one fiber fails.

The signal degrade threshold is user-provisionable for the working OC-48 facility of a 1+1 linear protected OC-48 pair. The default value is  $10^{-6}$ . The threshold is provisionable within the range  $10^{-5}$  to  $10^{-9}$ . If the bit error rate (BER) drops below the threshold, an autonomous protection switch occurs.

#### UPSR path protection

OC-48 path switching uses nonrevertive protection. There are no permanent STS-1 STS-3c, STS-12, STS-12c, STS24c or STS-48c protection or working paths. The network element receives two incoming STS-1, STS-3c, STS-12,

STS-12c, STS24c or STS-48c signals: one from the provisioned working optical interface circuit pack and one from the switchmate optical interface circuit pack. The network element selects the better of the two signals.

Protection of path failures on a single OC-48 optical interface completes in 60 ms, but protection of path failures on multiple OC-48 optical interfaces completes in less than 200 ms.

## OC-48 DWDM circuit pack

(See [Table 8-8 on page 8-15 in Part 2 of this guide for PEC codes](#))

The OC-48 DWDM circuit pack is provisioned in the same way as other OC-48 circuit packs.

The OC-48 DWDM circuit pack and OMX are required to support DWDM topologies for OPTera Metro 3500.

**Note 1:** There are four wavelengths (channels) in each band. Each OMX accommodates one band. Combined, the 8 OMX's can accommodate 32 wavelengths on a single fiber.

**Note 2:** The OPTera Metro OMX does not support OC-48 DWDM 1535.04 nm, OC-48 DWDM 1555.75 nm, OC-48 DWDM 1596.34 nm or OC-48 DWDM 1578.69 nm wavelengths.

**Note 3:** Additional wavelengths for DWDM C-Band may be introduced in the future.

Each OC-48 DWDM circuit pack corresponds to a specific wavelength of light. The DWDM band and channel number are specified on the circuit pack label. Variable optical attenuators (VOA) are required when the received power level exceeds the received overload level, observed, for example, in short fiber distances between nodes. For more information, see [Dense wavelength division multiplexing \(DWDM\) on page 2-46](#).

## Section data communication channel (SDCC)

A DWDM OC-48 line carries a DCC channel that can be edited, provisioned, and deprovisioned.

**Note 1:** The maximum number of simultaneous SDCC-provisionable ports on an OPTera Metro 3500 shelf is 34 (the shelf must be equipped with eight unprotected OC-3x4 circuit packs in slots 3 through 10, and a protected pair of OC-48 DWDM circuit packs in slots 11 and 12).

**Note 2:** For Nortel Networks interworking and multi-vendor network scenarios, DCC interoperability can be achieved with the appropriate provisioning. See *Optical Networks Data Communications Network Planning Guide*, NTR710AM.

### Alarm LED definitions

The following table lists the OC-48 DWDM interface circuit pack LEDs.

LED	Color	Description
Status (top)	Red	Circuit pack failure
	Yellow	Loss of signal
Status (bottom)	Green	In service and carrying traffic

### Equipping rules

The OC-48 DWDM circuit pack are equipped in slots 11 and 12 of the OPTera Metro shelf.

*Note:* Requires the shelf to be equipped with VTX-series circuit packs in slots 13 and 14.

See [Table 3-3 on page 3-6](#) for operational temperature ranges.

### OC-12 optical interface circuit pack (NTN404AA, BA, CA, DA, JA, KA, LA, MA)

Four OC-12 circuit packs, OC-12 IR (NTN404KA), IC (NTN404MA), LR (NTN404JA), and ER (NTN404LA) support the VT1.5, STS-1, STS-3c, and STS-12c signal rate as well as STS-12c performance monitoring.

OPTera Metro 3500 continues to support the OC-12 IR (NTN404BA), IC (NTN404DA), LR (NTN404AA), and ER (NTN404CA) optical interface circuit packs, which support the VT1.5, STS-1, and STS-3c, signal rates and associated PMs.

The central wavelength of the transmit optics is 1310 nm for the Interconnect and LR optical reaches, and is 1550 nm for the ER optical reach.

*Note 1:* The OC-12 circuit pack is considered a core circuit pack when provisioned in slots 11 and 12. In addition, the OC-12 circuit pack can be used as a tributary circuit pack when provisioned in slots 3 to 10.

*Note 2:* The VTX-48e circuit packs supports the OC-12 line rate for the optics in slots 11 and 12.

#### Optical transmit

The OC-12 interface receives one STS-12 or STS-12c from each STX and VTX-series circuit packs. The OC-12 interface converts the STS-12 or STS-12c into an OC-12 optical signal. The OC-12 optical signal is then transmitted on the optical transmit channel.

**Optical receive**

The OC-12 interface receives an optical OC-12 signal on the optical receive channel. The OC-12 optical signal is converted into an STS-12 or STS-12c signal. The STS-12 or STS-12c signal is transmitted to the STX and VTX-series circuit packs.

Since different optical reaches are supported on OC-12, optical link budgets need to be calculated to determine if VOAs are required on a particular link.

**Equipping rules**

The OC-12 optical interface circuit pack can be installed in slots 3 through 12. See [Table 3-3 on page 3-6](#) for operational temperature ranges.

*Note:* For support of the OC-12 line rate in slots 11 and 12, your shelf must be equipped with the VTX-48e circuit pack (NTN414AB or NTN414AH).

**1+1 linear**

A protected linear system operating an OC-12 line rate requires two OC-12 circuit packs in each shelf. An unprotected linear system requires only one OC-12 optical interface circuit pack in each shelf. The additional OC-12 optical interface circuit packs can be installed in the shelf to provide OC-12 tributaries.

**Unidirectional path switched rings (UPSRs)**

UPSRs operating at an OC-12 line rate require two OC-12 circuit packs in each shelf.

**OC-12 Protection switching**

OC-12 traffic is protected by linear and path protection.

OC-12 linear protection switching is 1+1 non-revertive, unidirectional, or bidirectional. If a fiber cut occurs in either the receive or transmit fibers of the active fiber path, or the transmitter or receiver OC-12 optical interface circuit pack fails at either end of the active fiber path, traffic is switched from the active OC-12 transmitter or receiver to the standby OC-12 transmitter or receiver. Switching can also take place under user control.

For bidirectional protection switching, if one of the two fibers fails, traffic on both fibers is switched to protection. For unidirectional protection switching, if one fiber fails, traffic from that fiber is switched to protection, traffic on the other fiber remains on the fiber. Both OC-12 interface circuit packs are active if unidirectional switching occurs and one fiber fails.

The signal degrade threshold is user-provisionable for the working OC-12 facility of a 1+1 linear protected OC-12 pair. The default value is  $10^{-6}$ . The threshold is provisionable within the range  $10^{-5}$  to  $10^{-9}$ . If the bit error rate (BER) drops below the threshold, an autonomous protection switch occurs.

OC-12 path switching uses nonrevertive protection. There are no permanent VT1.5, STS-1, STS-3c, or STS-12c protection or working paths. The network element receives two incoming VT1.5, STS-1, STS-3c, or STS-12c signals: one from the provisioned working optical interface circuit pack and one from the switchmate optical interface circuit pack. The network element selects the better of the two signals.

**Note:** VT1.5 signal rate is supported on OPTera Metro 3500 shelves equipped with VTX-series circuit packs.

Protection of path failures on a single OC-12 optical interface completes in 60 ms, but protection of simultaneous path failures on multiple OC-12 optical interfaces completes in less than 200 ms.

**Section data communication channel (SDCC)**

An OC-12 line carries a DCC channel that can be edited, provisioned, and deprovisioned.

**Note 1:** The maximum number of simultaneous SDCC-provisionable ports on an OPTera Metro 3500 shelf is 34 (the shelf must be equipped with eight unprotected OC-3x4 or OC-12x4 STS circuit packs in slots 3 through 10, and a protected pair of OC-48 or OC-192 circuit packs in slots 11 and 12).

**Note 2:** For Nortel Networks interworking and multi-vendor network scenarios, DCC interoperability can be achieved with the appropriate provisioning. See *Optical Networks Data Communications Network Planning Guide*, NTR710AM.

**Alarm LED definitions**

The following table provides a list of LEDs of the OC-12 interface circuit pack.

LED	Color	Description
Status (top)	Red	Circuit pack failure
	Yellow	Loss of signal
Status (bottom)	Green	In service and carrying traffic

## OC12x4 STS IR optical interface circuit pack (NTN446CA)

The OC-12x4 optical interface circuit pack provides the same functionality as the OC-12 optical interface circuit pack, but has four optical lines. The OC-12x4 STS optical interface circuit pack can provide add/drop capability for four OC-12 tributary interfaces. The OC-12x4 STS circuit pack provides STS management capability only: STS-1, STS-3c, and STS12c.

The OC-12x4 optical interface circuit pack comes equipped with LC type connectors that are located on the front of the circuit pack.

### Multimode Interworking

The OC-12x4 STS circuit pack supports multimode interworking for short distances (intra-office) if the following conditions are met:

- The multimode fiber (MMF) complies with the characteristics as described in ANSI T1.416.01-1999:

Parameters	Value
Core diameter	62.5 $\mu\text{m}$
Cladding diameter	125 $\mu\text{m}$
Attenuation @ 1300 nm	1.0 dB/km (max)
Modal bandwidth @ 1300 nm	500MHz-km (min)
Dispersion slope	0.093ps/nm <sup>2</sup> -km
Dispersion minimum	1365 nm (max)

- 62.5  $\mu\text{m}$  mode-conditioning patch-cord is required on the transmitter at each end of the link.
- The multimode fiber (MMF) link length (excluding mode-conditioning patch cord) is greater than (>) 5 m and less than (<) 500 m.
- Mating receivers either have no 'pigtailed' or use MMF 'pigtailed'.
- Mating receiver do not use a single-mode stub for reflectance reduction.
- Mating transmitters are connected to the mode-conditioning patch cords via Single Mode Fiber (SMF).
- Mating receivers meet IR-1/S-4.1 parameters as per ANSI T1.105.06-2002/ITU-T G.957.
- One fiber per direction.

Exception to any of these conditions require consultation with Nortel Networks.

**Optical transmit**

The OC-12x4 STS optical interface circuit pack receives STS-12, and STS-12c frames from the STX-192 circuit pack. The OC-12x4 STS optical interface circuit pack converts the STS-12 or STS-12c signals into OC-12 optical signals.

**Optical receive**

The OC-12x4 STS interface receives optical signals on the optical receive channel and converts the OC-12 signals into STS-12 or STS-12c signals. The STS-12 or STS-12c signal is transmitted to the STX-192 circuit pack.

**Equipping rules**

The OC-12x4 STS optical interface circuit pack can be installed in any of slots 3 through 10 on the OPTera Metro 3500 shelf. See [Table 3-3 on page 3-6](#) for operational temperature ranges.

*Note 1:* Requires the shelf be equipped with STX-192 circuit packs in slots 13 and 14.

*Note 2:* You can provision the protection schemes of the four optical ports on the OC-12x4 STS circuit pack independently of one another and in all possible combinations. For example, ports 1 and 2 may be 1+1 linear, while ports 3 and 4 may be UPSR.

**1+1 linear**

A protected 1+1 linear system operating at an OC-12 line rate - and employing OC-12x4 STS circuit packs - requires two OC-12x4 STS circuit packs in each shelf. Unprotected OC-12 linear systems require only one OC-12x4 STS circuit pack in each shelf. The additional OC-12x4 STS optical interface circuit packs can be installed in the shelf to provide OC-12 tributaries.

*Note:* 1+1 line protection can be used only between OC-12 ports which have the same port number and which are located on OC-12x4 STS optical interface circuit packs installed in adjacent slots. OC-12 ports in the odd slot act as the working line, and OC-12 ports in the even slot act as the protection line.

**Unidirectional path switched rings (UPSRs)**

UPSRs operating at an OC-12 line rate - and employing OC-12x4 STS circuit packs - require two OC-12x4 STS circuit packs in each shelf.



### Section data communication channel (SDCC)

An OC-12 line carries a DCC channel that can be edited, provisioned, and deprovisioned. Each OC-12x4 STS circuit pack carries four SDCC channels (one for each OC-12 port).

**Note 1:** The maximum number of simultaneous SDCC-provisionable ports on an OPTera Metro 3500 shelf is 34 (the shelf must be equipped with eight unprotected OC-3x4 or OC-12x4 STS circuit packs in slots 3 through 10, and a protected pair of OC-48 or OC192 circuit packs in slots 11 and 12).

**Note 2:** For Nortel Networks interworking and multi-vendor network scenarios, DCC interoperability can be achieved with the appropriate provisioning. See *Optical Networks Data Communications Network Planning Guide*, NTR710AM.

### Alarm LED definitions

The following table provides a list of LEDs of the OC-12x4 STS optical interface.

LED	Color	Description
Status	Red	Circuit pack failure
Active	Green	In service and carrying traffic
LOS(1-4)	Yellow	Loss of signal on the port

### OC-3 optical interface circuit pack (NTN401AA, DA)

OPTera Metro 3500 supports OC-3 IC and OC-3 LR optical interface circuit packs.

The OC-3 optical interface circuit pack converts STS-3 signals into OC-3 signals and OC-3 signals into STS-3 signals.

The central wavelength for both the transmit and receive optics is 1310 nm.

**Note:** The DS1 service module (DSM) connects to the OPTera Metro 3500 network element through the ports on a host OC-3 or OC-3x4 circuit pack.

#### Optical transmit

The STX or VTX-series circuit pack sends STS-3 or STS-3c frames to the OC-3 interface. The OC-3 optical interface circuit pack converts the STS-3 or STS-3c electrical signal into an optical signal which is transmitted on the optical transmit channel.

#### **Optical receive**

The OC-3 optical interface circuit pack receives an optical signal on the optical receive channel. The optical signal is converted into an STS-3 or STS-3c electrical signal and routed to the STX or VTX-series circuit packs.

Since the receiver sensitivity is 0 dBm, VOAs are not required for OC-3 optical interface circuit packs.

#### **Equipping rules**

The OC-3 optical interface circuit pack can be installed in slots 3 through 10. See [Table 3-3 on page 3-6](#) for operational temperature ranges.

#### **1+1 linear**

A protected 1+1 linear system operating at an OC-3 line rate requires two OC-3 circuit packs in each shelf. Unprotected OC-3 linear systems require only one OC-3 circuit pack in each shelf.

#### **Unidirectional path switched rings (UPSRs)**

UPSRs operating at an OC-3 line rate require two OC-3 circuit packs in each shelf.

#### **OC-3 Protection switching**

OC-3 traffic is protected by linear and path protection.

OC-3 linear protection switching is 1+1 non-revertive, unidirectional or bidirectional. If a fiber cut occurs in either the receive or transmit fibers of the active fiber path, or the transmitter or receiver OC-3 optical interface circuit pack fails at either end of the active fiber path, traffic is switched from the active OC-3 transmitter or receiver to the standby OC-3 transmitter or receiver. Switching can also take place under user control.

For bidirectional protection switching, if one of the two fibers fail, traffic on both fibers is switched to protection. For unidirectional protection switching, if one fiber fails, traffic from that fiber is switched to protection, traffic on the other fiber remains on the fiber. Both OC-3 interface circuit packs are active if unidirectional switching occurs and one fiber fails.

The signal degrade threshold is user-provisionable for the working OC-3 facility of a 1+1 linear protected OC-3 pair. The default value is  $10^{-6}$ . The threshold is provisionable within the range  $10^{-5}$  to  $10^{-9}$ . If the bit error rate (BER) drops below the threshold, an autonomous protection switch occurs.

OC-3 path switching uses nonrevertive protection. There are no permanent VT1.5, STS-1, or STS-3c protection or working paths. The network element receives two incoming VT1.5, STS-1, or STS-3c signals: one from the provisioned working optical interface circuit pack and one from the switchmate optical interface circuit pack. The network element selects the better of the two signals.

**Note:** VT1.5 signal rate is supported on OPTera Metro 3500 shelves equipped with VTX-series circuit packs.

Protection of path failures on a single OC-3 optical interface circuit pack completes in 60 ms, but protection of simultaneous path failures on multiple OC-3 optical interface circuit packs complete in less than 200 ms.

### Section data communication channel (SDCC)

An OC-3 line carries a DCC channel that can be edited, provisioned, and deprovisioned.

**Note 1:** The DS1 service module (DSM) connects to the OPTera Metro 3500 network element through the ports on a host OC-3 or OC-3x4 circuit pack.

**Note 2:** As of OPTera Metro Release 12, the default Section DCC provisioning for optical interfaces provisioned in the slots 3 through 10 will default to disabled. SDCC for the host OC-3 ports must be enabled, in order for autoprovisioning or manual provisioning of DSM to function.

**Note 3:** The maximum number of simultaneous SDCC-provisionable ports on an OPTera Metro 3500 shelf is 34 (the shelf must be equipped with eight unprotected OC-3x4 or OC-12x4 STS circuit packs in slots 3 through 10, and a protected pair of OC-48 or OC-192 circuit packs in slots 11 and 12).

**Note 4:** For Nortel Networks interworking and multi-vendor network scenarios, DCC interoperability can be achieved with the appropriate provisioning. See *Optical Networks Data Communications Network Planning Guide*, NTR710AM.

### Alarm LED definitions

The following table provides a list of LEDs of the OC-3 optical interface circuit pack.

LED	Color	Description
Status (top)	Red	Circuit pack failure
	Yellow	Loss of signal
Status (bottom)	Green	In service and carrying traffic

## OC-3x4 optical interface circuit pack (NTN441AA, AC)

The OC-3x4 optical interface circuit pack provides the same functionality as the OC-3 optical interface circuit pack, but has four optical lines. The OC-3x4 optical interface circuit pack can provide add/drop capability for four OC-3 tributary interfaces.

**Note 1:** The DS1 service module (DSM) connects to the OPTera Metro 3500 network element through the ports on a host OC-3 or OC-3x4 circuit pack.

**Note 2:** The NTN441AA version of the OC-3x4 circuit pack is shipped from the factory with eight SC connectors located on a sliding panel and accessed from the front of the circuit pack.

**Note 3:** The NTN441AC version of the OC-3x4 circuit pack is shipped from the factory with four duplex LC connectors located on the front of the circuit pack.

The OC-3x4 optical interface circuit pack comes equipped with SC (NTN441AA) or LC (NTN441AC) type connectors that are located on a sliding panel and accessed from the front of the circuit pack. Pull the sliding panel out from the circuit pack just enough to complete the work required. The connectors are on the panel behind the small clear plastic doors found on each side of the panel. The clear plastic doors are labeled to ensure proper connection of the fibers. After you connect the fiber, gently push the sliding panel back into the circuit pack.

### Multimode Interworking

The NTN441AC version of the OC-3x4 circuit pack supports multimode interworking for short distances (intra-office) if the following conditions are met:

- The multimode fiber (MMF) complies with the characteristics as described in ANSI T1.416.01-1999:

Parameters	Value
Core diameter	62.5 $\mu\text{m}$
Cladding diameter	125 $\mu\text{m}$
Attenuation @ 1300 nm	1.0 dB/km (max)
Modal bandwidth @ 1300 nm	500Mhz-km (min)
Dispersion slope	0.093ps/nm <sup>2</sup> -km
Dispersion minimum	1365 nm (max)

- 62.5  $\mu\text{m}$  mode-conditioning patch-cord is required on the transmitter at each end of the link.
- The multimode fiber (MMF) link length (excluding mode-conditioning patch cord) is greater than ( $>$ ) 5 m and less than ( $<$ ) 2 km.
- Mating receivers either have no 'pigtailed' or use MMF 'pigtailed'.
- Mating receiver do not use a single-mode stub for reflectance reduction.
- Mating transmitters are connected to the mode-conditioning patch cords via Single Mode Fiber (SMF).
- Mating receivers meet IR-1/S-1.1 parameters as per ANSI T1.105.06-2002/ITU-T G.957.
- One fiber per direction.

Exception to any of these conditions require consultation with Nortel Networks.

#### **Optical transmit**

The OC-3x4 optical interface circuit pack receives STS-3 or STS-3c frames from the STX or VTX-series circuit packs circuit pack. The OC-3x4 optical interface circuit pack converts the STS-3 or STS-3c signals into OC-3 optical signals.

#### **Optical receive**

The OC-3x4 interface receives optical signals on the optical receive channel and converts the OC-3 signals into STS-3 or STS-3c signals. The STS-3 or STS-3c signals are routed to the STX or VTX-series circuit packs circuit pack. Due to receiver overload tolerance, VOAs are not required for OC-3x4 optical interface circuit packs when working against IR optical interfaces.

### **Equipping rules**

The OC-3x4 optical interface circuit pack can be installed in any of slots 3 through 10 on the OPTera Metro 3500 shelf. See [Table 3-3 on page 3-6](#) for operational temperature ranges.

**Note:** You can provision the protection schemes of the four optical ports on the OC-3x4 circuit pack independently of one another and in all possible combinations. For example, ports 1 and 2 may be 1+1 linear, while ports 3 and 4 may be UPSR.

#### **1+1 linear**

A protected 1+1 linear system operating at an OC-3 line rate - and employing OC-3x4 circuit packs - requires two OC-3x4 circuit packs in each shelf. Unprotected OC-3 linear systems require only one OC-3x4 circuit pack in each shelf. The additional OC-3x4 optical interface circuit packs can be installed in the shelf to provide OC-3 tributaries.

**Note:** 1+1 line protection can be used only between OC-3 ports which have the same port number and which are located on OC-3x4 optical interface circuit packs installed in adjacent slots. OC-3 ports in the odd slot act as the working line, and OC-3 ports in the even slot act as the protection line.

**Unidirectional path switched rings (UPSRs)**

UPSRs operating at an OC-3 line rate - and employing OC-3x4 circuit packs - require two OC-3x4 circuit packs in each shelf.

**Section data communication channel (SDCC)**

An OC-3 line carries a DCC channel that can be edited, provisioned, and deprovisioned. Each OC-3x4 circuit pack carries four SDCC channels (one for each OC-3 port).

**Note 1:** The maximum number of simultaneous SDCC-provisionable ports on an OPTera Metro 3500 shelf is 34 (the shelf must be equipped with eight unprotected OC-3x4 or OC-12x4 STS circuit packs in slots 3 through 10, and a protected pair of OC-48 or OC-192 circuit packs in slots 11 and 12).

**Note 2:** For Nortel Networks interworking and multi-vendor network scenarios, DCC interoperability can be achieved with the appropriate provisioning. See *Optical Networks Data Communications Network Planning Guide*, NTR710AM.

**Alarm LED definitions**

The following table provides a list of LEDs of the OC-3x4 optical interface.

LED	Color	Description
Status	Red	Circuit pack failure
Active	Green	In service and carrying traffic
LOS(1-4)	Yellow	Loss of signal on the port

**EC-1x3 circuit pack  
(NTN436AA)**

Release 12 supports a version of the EC-1x3 mapper specifically for the OPTera Metro 3500 shelf.

The EC-1x3 circuit pack receives and transmits three EC-1 signals from external equipment and provides accessibility to VT1.5s or STS-1s within the network element. This circuit pack is fully bidirectional. The facility signal attributes for an EC-1x3 circuit pack facility are provisionable.

## Equipping rules

Connectivity for the 3 EC-1 signals at each slot is through the BNC 12-Port Front I/O module (NTN452JA) on the OPTera Metro 3500 Shelf (NTN476DA). On the OPTera Metro 3500 Universal Shelf (NTN476AH) you must use the BNC 12-Port Front Enhanced I/O module (NTN452JH) or the BNC 12-Port Rear I/O module (NTN452KA).

The EC-1x3 circuit pack can be installed in slots 3 through 10. EC-1x3 circuit packs are installed in pairs. The first EC-1x3 circuit pack of the pair is installed in an odd slot. The second EC-1x3 circuit pack of the pair is installed in the adjacent even slot. The second EC-1x3 circuit pack functions as the protection EC-1x3 circuit pack for the working circuit pack in the odd slot.

The maximum number of working EC-1x3 circuit packs that can be inserted in a shelf is four.

See [Table 3-3 on page 3-6](#) for operational temperature ranges.

**Note 1:** If there is a 1-28 DS1 I/O module installed, and if slots 5 and 6 are not equipped with DS1 mappers, you may not install EC-1x3 circuit packs in slots 5 or 6 (there is not enough room for slot 5 or slot 6's BNC I/O modules).

**Note 2:** If there is a 29-56 DS1 I/O module installed, and if slots 7 and 8 are not equipped with DS1 mappers, you may not install EC-1x3 circuit packs in slots 7 and 8 (there is not enough room for slot 7 or slot 8's BNC I/O modules).

**Note 3:** If there is a 29-84 DS1 I/O module installed, and if slots 7 through 10 are not equipped with DS1 mappers, you may not install EC-1x3 circuit packs in slots 7 through 10 (there is not enough room for slot 7 through slot 10's BNC I/O modules).

## Protection switching

EC-1x3 protection switching is 1+1 non-revertive. If a working EC-1x3 circuit pack becomes defective, the traffic is switched to the protection EC-1x3 circuit pack. Switching can also take place under user control.

## Section data communication channel (SDCC)

An EC-1 line carries a DCC channel that can be edited, provisioned, and deprovisioned. An EC-1x3 circuit pack can only carry one SDCC channel, provisionable on any of the three EC-1 ports.

**Note 1:** The maximum number of simultaneous SDCC-provisionable ports on an OPTera Metro 3500 shelf is 34 (the shelf must be equipped with eight unprotected OC-3x4 or OC-12x4 STS circuit packs in slots 3 through 10, and a protected pair of OC-48 or OC-192 circuit packs in slots 11 and 12).

**Note 2:** For Nortel Networks interworking and multi-vendor network scenarios, DCC interoperability can be achieved with the appropriate provisioning. See *Optical Networks Data Communications Network Planning Guide*, NTR710AM.

### Alarm LED definitions

The following table provides a list of the EC-1x3 circuit pack LEDs. See [Figure 3-28 on page 3-47](#) for the EC-1x3 circuit pack faceplate layout showing the location of the LEDs.

LED	Color	Description
Status	Red	Circuit pack failure
Active	Green	Circuit pack equipment is active and at least one EC-1 line facility is in service with at least one cross-connect
LOS(1-3)	Yellow	Loss of signal on the port

### EC-1x12 circuit pack (NTN436DA)

The EC-1x12 circuit pack receives and transmits twelve EC-1 signals from external equipment and provides accessibility to VT1.5/s or STS-1s within the network element. This circuit pack is fully bidirectional. The facility signal attributes for an EC-1x12 circuit pack facility are provisionable.

### Equipping rules

Connectivity for the 12 EC-1 signals at each slot is through the BNC 12-Port Front I/O module (NTN452JA) on the OPTera Metro 3500 Shelf (NTN476DA). On the OPTera Metro 3500 Universal Shelf (NTN476AH) you must use the BNC 12-Port Front Enhanced I/O module (NTN452JH) or the BNC 12-Port Rear I/O module (NTN452KA).

The EC-1x12 circuit pack can be installed in slots 3 through 10. EC-1x12 circuit packs are installed in pairs. The first EC-1x12 circuit pack of the pair is installed in an odd slot. The second EC-1x12 circuit pack of the pair is installed in the adjacent even slot. The second EC-1x12 circuit pack functions as the protection EC-1x12 circuit pack for the working circuit pack in the odd slot.

The maximum number of working EC-1x12 circuit packs that can be inserted in a shelf is four.

See [Table 3-3 on page 3-6](#) for operational temperature ranges.

**Note 1:** If there is a 1-28 DS1 I/O module installed, and if slots 5 and 6 are not equipped with DS1 mappers, you may not install EC-1x12 circuit packs in slots 5 or 6 (there is not enough room for slot 5 or slot 6's BNC I/O modules).



**Note 2:** If there is a 29-56 DS1 I/O module installed, and if slots 7 and 8 are not equipped with DS1 mappers, you may not install EC-1x12 circuit packs in slots 7 and 8 (there is not enough room for slot 7 or slot 8's BNC I/O modules).

**Note 3:** If there is a 29-84 DS1 I/O module installed, and if slots 7 through 10 are not equipped with DS1 mappers, you may not install EC-1x12 circuit packs in slots 7 through 10 (there is not enough room for slot 7 through slot 10's BNC I/O modules).

### Protection switching

EC-1x12 protection switching is 1+1 non-revertive. If a working EC-1x12 circuit pack becomes defective, the traffic is switched to the protection EC-1x12 circuit pack. Switching can also take place under user control.

### Section data communication channel (SDCC)

EC-1x12 circuit packs do not support SDCC channels.

### Alarm LED definitions

The following table provides a list of the EC-1x12 circuit pack LEDs. See [Figure 3-28 on page 3-47](#) for the EC-1x12 circuit pack faceplate layout showing the location of the LEDs.

LED	Color	Description
Status	Red	Circuit pack failure
Active	Green	Circuit pack equipment is active and at least one EC-1 line facility is in service with at least one cross-connect
LOS (1-12)	Yellow	Loss of signal on the port

## DS1 mapper (NTN430AA, BA)

Two types of DS1 mappers are available: the DS1 mapper (NTN430AA) and the DS1 enhanced mapper (NTN430BA). The DS1 enhanced mapper (NTN430BA) is able to request and collect DS1 far-end performance monitoring information.

Both of these DS1 mappers support 12 DS1 circuits.

### Equipping rules

The DS1 mapper can be installed in slots 3 through 10. See [Table 3-3 on page 3-6](#) for operational temperature ranges.

**Note 1:** Slot 3 is reserved for the protection DS1 mapper. Slots 4-10 are for working DS1 mappers.

**Note 2:** If there is a 1-28 DS1 I/O module installed, and if slots 5 and 6 are not equipped with DS1 mappers, you may not install DS3x3, DS3x12, DS3x12e, DS3VTx12, EC-1x12, 2x100BT-P2P, or 4x100BT circuit packs in slots 5 or 6 (there is not enough room for slot 5 or slot 6's I/O modules).

**Note 3:** If there is a 29-56 DS1 I/O module installed, and if slots 7 and 8 are not equipped with DS1 mappers, you may not install DS3x3, DS3x12, DS3x12e, DS3VTx12, EC-1x12, 2x100BT-P2P, or 4x100BT circuit packs in slots 7 and 8 (there is not enough room for slot 7 or slot 8's I/O modules).

**Note 4:** If there is a 29-84 DS1 I/O module installed, and if slots 7 through 10 are not equipped with DS1 mappers, you may not install DS3x3, DS3x12, DS3x12e, DS3VTx12, EC-1x12, 2x100BT-P2P, or 4x100BT circuit packs in slots 7 through 10 (there is not enough room for slot 7 through slot 10's I/O modules).

**Note 5:** DS1 mapper is not supported on OPTera Metro 3500 shelves equipped with STX-192 circuit packs in slots 13 and 14.

In a shelf with 84 DS1 services terminating on DS1 mappers in slots 3 through 10, connectivity is demonstrated in [Table 3-11](#).

**Table 3-11**  
**DS1 I/O module types**

DS1 ports	OPTera Metro 3500 Shelf Assembly (NTN476AA, DA)		OPTera Metro 3500 Universal Shelf Assembly (NTN476AH)			
	Front access only		Front access		Rear access	
	I/O name	I/O PEC	I/O name	I/O PEC	I/O name	I/O PEC
1-28	DS1 1-28 Front I/O module	NTN452AA	DS1 1-28 Front Enhanced I/O module	NTN452AH	DS1 1-28 Rear I/O module	NTN452BA
29-56	DS1 29-56 Front I/O module	NTN452CA	DS1 29-56 Front Enhanced I/O module	NTN452CH	DS1 29-56 Rear I/O module	NTN452DA
29-84	DS1 29-84 Front I/O module	NTN452EA	DS1 29-84 Front Enhanced I/O module	NTN452EH	DS1 29-84 Rear I/O module	NTN452FA

You can provision a maximum of 84 protected DS1 facilities for each shelf.

### Alarm LED definitions

The following table provides a list of the DS1 mapper LEDs. See [Figure 3-28 on page 3-47](#) for the DS1 mapper faceplate layout showing the location of the LEDs.

LED	Color	Description
Status	Red	Circuit pack failure
Active	Green	DS1 equipment is active and at least one DS1 line facility is in service with at least one cross-connect

### DS3x3 mapper (NTN437AA)

The DS3x3 mapper has three DS3 ports and provides add/drop capability for three DS3 signals. Each port functions independently and in the same way as a DS3 mapper.

*Note:* Neither the DS3x3 mapper nor DS3 services are VT managed.

### Equipping rules

Connectivity for the three DS3 signals at each slot is through the BNC 12-Port Front I/O module (NTN452JA) on the OPTera Metro 3500 Shelf (NTN476DA). On the OPTera Metro 3500 Universal Shelf (NTN476AH) you must use the BNC 12-Port Front Enhanced I/O module (NTN452JH) or the BNC 12-Port Rear I/O module (NTN452KA).

DS3x3 mappers are installed in pairs and DS3 protection switching is 1+1 non-revertive.

The DS3x3 circuit pack can be installed in slots 3 through 10. DS3x3 circuit packs are installed in pairs. The first DS3x3 circuit pack of the pair is installed in an odd slot. The second DS3x3 circuit pack of the pair is installed in the adjacent even slot. The second DS3x3 circuit pack functions as the protection DS3x3 circuit pack for the working circuit pack in the odd slot.

The maximum number of working DS3x3 circuit packs that can be inserted in a shelf is four.

See [Table 3-3 on page 3-6](#) for operational temperature ranges.

**Note 1:** If there is a 1-28 DS1 I/O module installed, and if slots 5 and 6 are not equipped with DS1 mappers, you may not install DS3x3 circuit packs in slots 5 or 6 (there is not enough room for slot 5 or slot 6's BNC I/O modules).

**Note 2:** If there is a 29-56 DS1 I/O module installed, and if slots 7 and 8 are not equipped with DS1 mappers, you may not install DS3x3 circuit packs in slots 7 and 8 (there is not enough room for slot 7 or slot 8's BNC I/O modules).

**Note 3:** If there is a 29-84 DS1 I/O module installed, and if slots 7 through 10 are not equipped with DS1 mappers, you may not install DS3x3 circuit packs in slots 7 through 10 (there is not enough room for slot 7 through slot 10's BNC I/O modules).

### Protection switching

DS3x3 protection switching is 1+1 non-revertive. If a working DS3x3 mapper becomes defective, the traffic is switched to the protection DS3x3 mapper. Switching can also take place under user control.

### Alarm LED definitions

The following table provides a list of LEDs of the DS3x3 mapper. See [Figure 3-28 on page 3-47](#) for the DS3x3 mapper faceplate layout showing the location of the LEDs.

LED	Color	Description
Status (top)	Red	Circuit pack failure
Status (bottom)	Green	DS3x3 equipment is active and at least one DS3 line facility is in service with at least one cross-connect
LOS (1-3)	Yellow	Loss of signal on the port

## DS3x12 / DS3x12e mapper (NTN435AA, AH) / (NTN435BA)

The DS3x12 mapper (NTN435AA, NTN435AH) and DS3x12e (NTN435BA) mapper have 12 DS3 ports which function independently. Each mapper's bandwidth capacity is 12 DS3 signals added/dropped in each slot. Each OPTera Metro 3500 shelf's capacity is 48 DS3 add/drop signals, with 1+1 equipment protection for each circuit pack.

Mappers are installed in pairs and DS3 protection switching is 1+1 non-revertive for each mapper.

The DS3x12e mapper (NTN435BA) has the same functionality as the DS3x12 mapper (NTN435AA, NTN435AH), plus additional path PMs and alarms as follows:

*Note:* Neither the DS3x12 mapper, the DS3x12e mapper nor DS3 services are VT managed.

### DS3 Path PMs (Near-End) available only on DS3x12e mapper

- CV-P (Coding Violation - Path) on DS3 Rx
- ES-P (Errored Second - Path) on DS3 Rx
- SES-P (Severely Errored Second - Path) on DS3 Rx
- UAS-P (Unavailable Second - Path) on DS3 Rx

### DS3 alarms available only on DS3x12e mapper

- 'DS3 Rx Frequency out of Range' - DS3 is out of frequency in the Rx direction
- 'DS3 Rx Parity > 10E-6' - DS3 parity error rate exceeds 10E-6 in the Rx direction
- 'DS3 Tx Frequency out of Range' - DS3 is out of frequency in the Tx direction
- 'STS Path Trace Mismatch' - Path trace mismatch detected

### Equipping rules

Connectivity for the twelve DS3 signals at each slot is through the BNC 12-Port Front I/O module (NTN452JA) on the OPTera Metro 3500 shelf (NTN476AA, NTN476DA). On the OPTera Metro 3500 Universal Shelf (NTN476AH) you must use the BNC 12-Port Front Enhanced I/O module (NTN452JH) or the BNC 12-Port Rear I/O module (NTN452KA).

The DS3x12 / DS3x12e mapper can be installed in slots 3 through 10. Mappers are installed in pairs. The first mapper of the pair is installed in an odd slot. The second mapper of the pair is installed in the adjacent even slot. The second mapper functions as protection for the working mapper in the odd slot.

The maximum number of working DS3x12 / DS3x12e mappers that can be inserted in a shelf is four.

See [Table 3-3 on page 3-6](#) for operational temperature ranges.

**Note 1:** Mixing a DS3x12 mapper with a DS3x12e mapper as a protected pair will result in the protected pair to behave as 2 DS3x12 circuit packs. Additional path PMs and alarms supported with the DS3x12e are not available when circuit packs mixed.

**Note 2:** If there is a 1-28 DS1 I/O module installed, and if slots 5 and 6 are not equipped with DS1 mappers, you may not install DS3x12 or DS3x12e circuit packs in slots 5 or 6 (there is not enough room for slot 5 or slot 6's BNC I/O modules).

**Note 3:** If there is a 29-56 DS1 I/O module installed, and if slots 7 and 8 are not equipped with DS1 mappers, you may not install DS3x12 or DS3x12e circuit packs in slots 7 and 8 (there is not enough room for slot 7 or slot 8's BNC I/O modules).

**Note 4:** If there is a 29-84 DS1 I/O module installed, and if slots 7 through 10 are not equipped with DS1 mappers, you may not install DS3x12 or DS3x12e circuit packs in slots 7 through 10 (there is not enough room for slot 7 through slot 10's BNC I/O modules).

### Alarm LED definitions

The following table provides a list of the DS3x12 / DS3x12e mapper LEDs. See [Figure 3-28 on page 3-47](#) for the DS3x12 and DS3x12e mapper faceplate layout showing the location of the LEDs.

LED	Color	Description
Status	Red	Circuit pack failure
Active	Green	DS3x12 equipment is active and at least one DS3 line facility is in service with at least one cross-connect
LOS (1-12)	Yellow	Loss of signal on the port

### DS3VTx12 mapper (NTN435FA)

Each of the 12 ports of the DS3VTx12 mapper receives a channelized DS3 signal and demultiplexes it into 28 DS1s. The DS1s are mapped into VT1.5s and carried off the circuit pack to the VTX-series circuit packs where they are cross-connected into any of the supported transport or tributary circuit packs. This mapper is fully bidirectional.

For more information about channelized DS3 service and the DS3VTx12 mapper, see [Channelized DS3 service \(DS3VTx12 mapper\) on page 2-44](#).

For more information about supported DS3 PM parameters for the DS3VTx12 mapper, see [Table 2-23 on page 2-108](#).

For more information about supported DS1 PM parameters for the DS3VTx12 mapper, see [Table 2-24 on page 2-109](#).

### Equipping rules

The DS3VTx12 mapper can be installed in slots 3 through 10. DS3VTx12 mappers are installed in pairs. The first DS3VTx12 mapper of the pair is installed in an odd slot. The second DS3VTx12 mapper of the pair is installed in the adjacent even slot. The second DS3VTx12 mapper functions as the protection DS3VTx12 mapper for the working mapper in the odd slot.

**Note:** The maximum number of working DS3VTx12 mappers that can be inserted in an OPTera Metro 3500 shelf is four. DS3/VTx12 mapper is supported on OPTera Metro 3500 shelves equipped with VTX- series circuit packs in slots 13 and 14.

### DS3/VT protection switching

DS3VTx12 protection switching is 1+1 non-revertive. If a working DS3VTx12 mapper becomes defective, the traffic is switched to the protection DS3VTx12 mapper. Switching can also take place under user control.

### Alarm LED definitions

The following table provides a list of the DS3VTx12 mapper LEDs. See [Figure 3-28 on page 3-47](#) for the DS3VTx12 mapper faceplate layout showing the location of the LEDs.

LED	Color	Description
Status	Red	Circuit pack failure
Active	Green	DS3x12 equipment is active and at least one DS3 line facility is in service with at least one cross-connect
LOS (1-12)	Yellow	Loss of signal on the port

### 2x100BT-P2P circuit pack (NTN433AA)

This circuit pack gives users native Ethernet, using standard STS-1 or STS-3c connections without the need for SNMP or BCC management.

**Note 1:** The 2x100BT-P2P circuit pack only supports far-end link conditioning at 100Mb/s (100BASE-TX).

**Note 2:** The 2x100BT-P2P circuit pack is only supported in the operational temperature range of 0°C to 50°C (32°F to 122°F).

For information about Optical Ethernet Private Line service, see [Optical Ethernet-Private Line \(OE-PL\) services using 10/100 Ethernet on page 2-66](#)

For information about Ethernet Operational Measurements, see [Ethernet Operational Measurements on page 2-70](#).

### Equipping rules

Each 2x100BT-P2P circuit pack requires an 8xRJ-45 Front I/O module (NTN452NA) on the OPTera Metro 3500 Shelf (NTN476AA, NTN476DA). On the OPTera Metro 3500 Universal Shelf (NTN476AH) you must use the 8xRJ-45 Front Enhanced I/O module (NTN452NH) or the 8xRJ-45 Rear I/O module (NTN452HB).

Both versions of the shelf support eight 2x100BT-P2P circuit packs in slots 3 through 10. 2x100BT-P2P circuit packs only operate in an unprotected mode. Users can install only 2x100BT-P2P, 4x100BT, 4x100FX, and 2xGigE/FC-P2P circuit packs in adjacent slots. Only ports 1 and 2 of the I/O module will be used by the 2x100BT-P2P circuit pack. The remaining ports remain unused.

If a 2x100BT-P2P, 4x100FX, 4x100BT or 2xGigE/FC-P2P circuit pack is inserted into an odd slot ( $n_{\text{odd}}$ ), then you can only insert one of the following circuit packs into the even slot ( $n_{\text{odd}}+1$ ):

- 2x100BT-P2P
- 4x100BT
- 4x100FX
- 2xGigE/FC-P2P

If a 2x100BT-P2P, 4x100FX, 4x100BT or 2xGigE/FC-P2P circuit pack is inserted into an even slot ( $n_{\text{even}}$ ), then you can only insert one of the following circuit packs into the odd slot ( $n_{\text{even}}-1$ ):

- 2x100BT-P2P
- 4x100BT
- 4x100FX
- 2xGigE/FC-P2P

**Note:** There is no equipment protection for the 2x100BT-P2P circuit pack.

See [Table 3-3 on page 3-6](#) for operational temperature ranges.

**Note 1:** If there is a 1-28 DS1 I/O module installed, and if slots 5 and 6 are not equipped with DS1 mappers, you may not install 2x100BT-P2P circuit packs in slots 5 or 6 (there is not enough room for slot 5 or slot 6's 8xRJ-45 I/O modules).



**Note 2:** If there is a 29-56 DS1 I/O module installed, and if slots 7 and 8 are not equipped with DS1 mappers, you may not install 2x100BT-P2P circuit packs in slots 7 and 8 (there is not enough room for slot 7 or slot 8's 8xRJ-45 I/O modules).

**Note 3:** If there is a 29-84 DS1 I/O module installed, and if slots 7 through 10 are not equipped with DS1 mappers, you may not install 2x100BT-P2P circuit packs in slots 7 through 10 (there is not enough room for slot 7 through slot 10's 8xRJ-45 I/O modules).

The following table describes the compatibility of each I/O module with both shelf types.

Shelf	I/O module	I/O scenario description
OPTera Metro 3500 Shelf Assembly (NTN476AA, NTN476DA)	8xRJ-45 Front I/O module (NTN452NA)	front access to the I/O
OPTera Metro Universal Shelf Assembly (NTN476AH)	8xRJ-45 Front Enhanced I/O module (NTN452NH)	front access to the I/O, extended temperature range
	8xRJ-45 Rear I/O module (NTN452HB)	rear access to the I/O, extended temperature range

### Alarm LED definitions

The following table provides a list of the 2x100BT-P2P circuit pack LEDs. See [Figure 3-28 on page 3-47](#) for the 2x100BT-P2P circuit pack faceplate layout showing the location of the LEDs.

LED name	Color	Description
Status	red	Circuit pack failure
Active	green	The circuit pack is active. At least one Ethernet facility is in service or at least one cross-connect exists.
Link (1-2)	yellow	No link pulse is detected on Ethernet port and the port is administratively up.

## OPTera Packet Edge System 4x100BT circuit pack (NTN433BB)

Each OPTera Packet Edge System circuit pack works as a distributed switch and bridge to connect Ethernet LANs on a high-speed SONET network.

### Equipping rules

Each OPTera Packet Edge System 4x100BT circuit pack requires an 8xRJ-45 Front I/O module (NTN452NA) on the OPTera Metro 3500 Shelf (NTN476AA, NTN476DA). On the OPTera Metro 3500 Universal Shelf (NTN476AH) you must use the 8xRJ-45 Front Enhanced I/O module (NTN452NH) or the 8xRJ-45 Rear I/O module (NTN452HB).

Both versions of the shelf support eight OPTera Packet Edge System 4x100BT circuit packs in slots 3 through 10. 4x100BT circuit packs only operate in an unprotected mode.

If a 2x100BT-P2P, 4x100FX, 4x100BT or 2xGigE/FC-P2P circuit pack is inserted into an odd slot ( $n_{\text{odd}}$ ), then you can only insert one of the following circuit packs into the even slot ( $n_{\text{odd}}+1$ ):

- 2x100BT-P2P
- 4x100BT
- 4x100FX
- 2xGigE/FC-P2P

If a 2x100BT-P2P, 4x100FX, 4x100BT or 2xGigE/FC-P2P circuit pack is inserted into an even slot ( $n_{\text{even}}$ ), then you can only insert one of the following circuit packs into the odd slot ( $n_{\text{even}}-1$ ):

- 2x100BT-P2P
- 4x100BT
- 4x100FX
- 2xGigE/FC-P2P

**Note:** There is no equipment protection for the 4x100BT circuit pack.

See [Table 3-3 on page 3-6](#) for operational temperature ranges.

**Note 1:** If there is a 1-28 DS1 I/O module installed, and if slots 5 and 6 are not equipped with DS1 mappers, you may not install 4x100BT circuit packs in slots 5 or 6 (there is not enough room for slot 5 or slot 6's 8xRJ-45 I/O modules).

**Note 2:** If there is a 29-56 DS1 I/O module installed, and if slots 7 and 8 are not equipped with DS1 mappers, you may not install 4x100BT circuit packs in slots 7 and 8 (there is not enough room for slot 7 or slot 8's 8xRJ-45 I/O modules).

**Note 3:** If there is a 29-84 DS1 I/O module installed, and if slots 7 through 10 are not equipped with DS1 mappers, you may not install 4x100BT circuit packs in slots 7 through 10 (there is not enough room for slot 7 through slot 10's 8xRJ-45 I/O modules).

The following table describes the compatibility of each I/O module with both shelf types.

Shelf	I/O module	I/O scenario description
OPTera Metro 3500 Shelf Assembly (NTN476AA, NTN476DA)	8xRJ-45 Front I/O module (NTN452NA)	front access to the I/O
OPTera Metro Universal Shelf Assembly (NTN476AH)	8xRJ-45 Front Enhanced I/O module (NTN452NH)	front access to the I/O, extended temperature range
	8xRJ-45 Rear I/O module (NTN452HB)	rear access to the I/O, extended temperature range

### Alarm LED definitions

The following table provides a list of the OPE 4x100BT circuit pack LEDs. See [Figure 3-28 on page 3-47](#) for the OPE 4x100BT circuit pack faceplate layout showing the location of the LEDs.

LED name	Color	Description
Status	red	Circuit pack failure
Active	green	The OPTera Packet Edge System circuit pack is active. At least one LAN facility is in service or at least one cross-connect exists.
WAN	yellow	The OPTera Packet Edge System circuit pack has at least one cross-connect. Either one or both WAN ports have an STS path problem.
Link (1-4)	yellow	No link pulse is detected on Ethernet port and the port is administratively up.

## OPTera Packet Edge System 4x100FX circuit pack (NTN433EA, FA)

The OPTera Packet Edge System circuit pack works as a distributed switch and bridge to connect Ethernet LANs on a high-speed SONET network. OPTera Metro 3500 supports the singlemode and multimode 4x100FX circuit packs.

The OPTera Packet Edge System 4x100FX circuit pack allows a fiber LAN tributary interface to connect directly to the circuit pack faceplate. The 4x100FX circuit pack supports STS-1, STS-3c, and STS-12c bandwidth rates.

### Equipping rules

The OPTera Metro 3500 shelf supports eight OPTera Packet Edge System 4x100FX circuit packs in slots 3 through 10. 4x100FX circuit packs only operate in an unprotected mode. Users can install only 2x100BT-P2P, 4x100BT, 4x100FX, and 2xGigE/FC-P2P circuit packs in adjacent slots.

If a 2x100BT-P2P, 4x100FX, 4x100BT or 2xGigE/FC-P2P circuit pack is inserted into an odd slot ( $n_{\text{odd}}$ ), then you can only insert one of the following circuit packs into the even slot ( $n_{\text{odd}+1}$ ):

- 2x100BT-P2P
- 4x100BT
- 4x100FX
- 2xGigE/FC-P2P

If a 2x100BT-P2P, 4x100FX, 4x100BT or 2xGigE/FC-P2P circuit pack is inserted into an even slot ( $n_{\text{even}}$ ), then you can only insert one of the following circuit packs into the odd slot ( $n_{\text{even}-1}$ ):

- 2x100BT-P2P
- 4x100BT
- 4x100FX
- 2xGigE/FC-P2P

**Note:** There is no equipment protection for the 4x100BT circuit pack.

See [Table 3-3 on page 3-6](#) for operational temperature ranges and operating distances.

**Note:** The OPE 4x100FX circuit packs are shipped from the factory with MT-RJ connectors.

### Alarm LED definitions

The following table provides a list of the OPTera Packet Edge 4x100FX circuit pack LEDs. See [Figure 3-28 on page 3-47](#) for the 4x100FX faceplate layout.

LEDs	Color	Description
Status	Red	When active, indicates that a circuit pack equipment failure has been detected.
Active	Green	When active, indicates that the circuit pack is active and either at least one of the LAN ports is IS (Data) or at least one cross connect exists (SONET).
WAN	Yellow	Active when the circuit pack has at least one cross-connect and is attached to a resilient packet ring (RPR) and either the east, west, or both WAN ports are experiencing an STS path problem.
Link (1-4)	Yellow	Active when the administrative state of one of the four LAN ports is up and the operational state is down.

### OPTera Packet Edge System 2xGigE (2x1000SX, 2x1000LX) circuit pack (NTN438AA, BA)

The OPTera Packet Edge System 2xGigE circuit packs support Gigabit Ethernet bandwidth.

The OPTera Packet Edge System 2xGigE circuit pack allows a fiber LAN tributary interface to connect directly to the circuit pack faceplate. The 2xGigE circuit pack supports STS-1, STS-3c, and STS-12c bandwidth rates.

#### Equipping rules

OPTera Packet Edge System 2xGigE circuit pack is double-sized. The OPTera Metro 3500 shelf supports four 2xGigE circuit packs in slots 3, 5, 7, and 9.

See [Table 3-3 on page 3-6](#) for operational temperature ranges and operating distances.

**Note:** The 2xGigE circuit packs are shipped from the factory with SC connectors.

### Alarm LED definitions

The following table provides a list of the OPTera Packet Edge 2xGigE circuit pack LEDs. See [Figure 3-28 on page 3-47](#) for the 2xGigE faceplate layout.

LED	Color	Description
Status	Red	When active, indicates that a circuit pack equipment failure has been detected.
Active	Green	When active, indicates that the circuit pack is active and either at least one of the LAN ports is IS (Data) or at least one cross-connect exists (SONET).
WAN	Yellow	Active when the circuit pack has at least one cross-connect and is attached to an OPTera Packet Edge System ring and either the east, west, or both WAN ports are experiencing an STS path problem.
Link (1-2)	Yellow	Active when the administrative state of one of the two LAN ports is up and the operational state is down.

### 2xGigabit Ethernet/Fibre Channel - Point-to-Point circuit pack (NTN438DA)

The 2xGigE/FC-P2P circuit pack also provides 2 independent LAN ports allowing for transport of Gigabit Ethernet or Fibre Channel signals across a SONET network where the traffic can be groomed, switched and monitored by the network,

The 2xGigE/FC-P2P circuit pack allows a fiber LAN tributary interface to connect directly to the circuit pack faceplate. The 2xGigE/FC-P2P circuit pack supports contiguous and virtual concatenation connections, refer [Bandwidth management on page 2-84](#)

### Equipping rules

The OPTera Metro 3500 shelf supports eight OPTera Packet Edge 2xGigE/FC-P2P circuit packs in slots 3 through 10. 2xGigE/FC-P2P circuit packs only operate in an unprotected mode.

Users can install only 2x100BT-P2P, 4x100BT, 4x100FX and 2xGigE/FC-P2P circuit packs in adjacent slots.

---

If a 4x100BT, 4x100FX, 2x100BT-P2P or 2xGigE/FC-P2P circuit pack is inserted into an odd slot ( $n_{\text{odd}}$ ), then you can only insert one of the following circuit packs into the odd slot ( $n_{\text{odd}}+1$ ):

- 2x100BT-P2P
- 4x100BT
- 4x100FX
- 2xGigE/FC-P2P

If a 4x100BT, 4x100FX, 2x100BT-P2P or 2xGigE/FC-P2P circuit pack is inserted into an even slot ( $n_{\text{even}}$ ), then you can only insert one of the following circuit packs into the odd slot ( $n_{\text{even}}-1$ ):

- 2x100BT-P2P
- 4x100BT
- 4x100FX
- 2xGigE/FC-P2P

**Note:** There is no equipment protection for 2xGigE/FC-P2P circuit packs.

The 2xGigE/FC-P2P circuit packs supports two SFP optic modules. Each SFP module is offered in either short reach (SX, NTTP51AA), long reach (LX, NTTP51BD) and extended reach (ZX, NTTP51DZ) range. A dust cap (A0512434) is required for any unequipped port.

**Note 1:** Support with VTX-series or STX-192 circuit packs in slots 13 and 14.

**Note 2:** The 2xGigE/FC-P2P circuit pack is shipped with two dust caps (A0512434).

See [Table 3-3 on page 3-6](#) for operational temperature ranges and operating distances.

### Alarm LED definitions

The following table provides a list of the OPTera Packet Edge 2xGigE/FC-P2P circuit pack LEDs. See [Figure 3-28 on page 3-47](#) for the 2xGigE/FC-P2P faceplate layout.

LED	Color	Description
Status	Red	When active, indicates that a circuit pack equipment failure has been detected.
Active	Green	When active, indicates that the circuit pack is active and either at least one of the LAN ports is IS (Data) or at least one cross-connect exists (SONET).
Link (1-2)	Red	When active, indicates that a SFP module failure has been detected.
	Yellow	When active, indicates that one of a LAN port is in a "Link down" State. This includes LOS, Loss of 8B_10B synch and auto-negotiation in progress (for GigE) or FCLINKSTATE not ACTIVE (for FC)

### Protection switch controller (PSC) (NTN412AA)

The PSC (NTN412AA) controls DS1 equipment protection switching for all 84 DS1 ports, and monitors DS1 status, including alarm conditions and performance monitoring thresholds. If a working DS1 mapper fails, it switches all of the DS1 traffic to the protection DS1 mapper.

The PSC houses all of the relays that do the protection switching for DS1 ports 1 through 28. The PSC is also responsible for the provisioning and maintenance of all DS1 mappers.

#### Equipping rules

The PSC must be installed in slot 2 before the working and protection DS1 mapper circuit packs can be provisioned.

See [Table 3-3 on page 3-6](#) for operational temperature ranges.

**Note:** PSC circuit pack is supported on OPTera Metro 3500 shelves equipped with VTX- series circuit packs in slots 13 and 14.



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## Protection switch extender (PSX) (NTN413AA)

The PSX circuit pack (NTN413AA) houses all of the relays that perform DS1 equipment protection switching for DS1 ports 29 to 84. The relays are controlled by the PSC.

### Equipping rules

The PSX must be installed in slot 17 if DS1 ports 29 to 84 are being used. A PSX requires a PSC installed on the shelf.

See [Table 3-3 on page 3-6](#) for operational temperature ranges.

*Note:* PSX circuit pack is supported on OPTera Metro 3500 shelves equipped with VTX- series circuit packs in slots 13 and 14.

## OMX + Fiber Manager 4CH (NT0H32AE, BE, CE, DE, EE, FE, GE, HE)

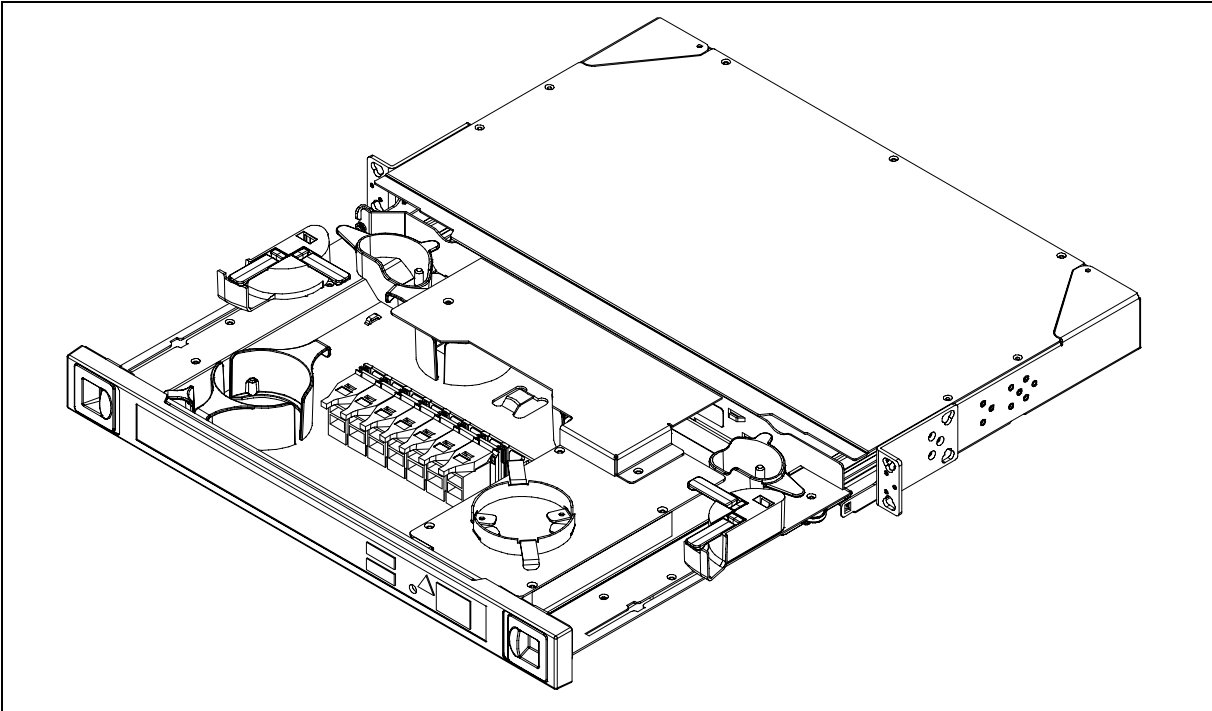
The OMX + Fiber Manager 4CH offers superior fiber management capabilities. They have locking latches to prevent trays from being pulled out completely. The OMX + Fiber Manager 4CH is used with OPTera Metro 3500 shelves and is a stand-alone unit. The OMX + Fiber Manager 4CH multiplexes and demultiplexes up to four optical channels in one band.

*Note:* If your system is equipped with OMX + Fiber Manager 4CH equipment drawers, then you do not require separate OMX shelves (NTN449ZW) or Fiber Manager trays (NT0H57BB).

The distinguishing features of the OMX + Fiber Manager 4CH are:

- Each OMX + Fiber Manager 4CH is a 1U high external drawer that contains optical filters, a small patch panel with bulkhead connectors, and fiber management components. The drawers can be mounted anywhere in a rack. Nortel Networks recommends that you install the trays directly beneath the shelf.
- Each OMX + Fiber Manager 4CH uses bulkhead connectors and patch cords to connect circuit packs.

**Figure 3-32**  
**OMX + Fiber Manager 4CH equipment drawer**



**Enhanced OMX + Fiber Manager 4CH**  
**(NT0H32AF, BF, CE, DF, EF, FF, GF, HF)**

The Enhanced OMX + Fiber Manager 4CH product introduces a higher isolation, and lower insertion loss, Connectorized OMX product for the OPTera Metro 3500. The OMX + Fiber Manager 4CH offers fiber management capabilities. They have locking latches to prevent trays from being pulled out completely. The OMX + Fiber Manager 4CH is used with OPTera Metro 3500 shelves and is a stand-alone unit. The OMX + Fiber Manager 4CH multiplexes and demultiplexes up to four optical channels in one band.

*Note:* If your system is equipped with OMX + Fiber Manager 4CH equipment drawers, then you do not require separate OMX shelves (NTN449ZW) or Fiber Manager trays (NT0H57BB).

The distinguishing features of the OMX + Fiber Manager 4CH are:

- Each OMX + Fiber Manager 4CH is a 1U high external drawer that contains optical filters, a small patch panel with bulkhead connectors, and fiber management components. The drawers can be mounted anywhere in a rack. Nortel Networks recommends that you install the trays directly beneath the shelf.
- Each OMX + Fiber Manager 4CH uses bulkhead connectors and patch cords to connect circuit packs.

### **OMX shelf (not required with OMX + Fiber Manager 4CH) (NTN449ZW)**

The OMX shelf fits into a bay with four OPTera Metro 3500 shelves. OMX technology combines various wavelengths over a single optical fiber using a passive optical coupler.

An optical patch panel in the OMX shelf connects the optical fibers from the OC-192 or OC-48 DWDM circuit packs to OMX modules.

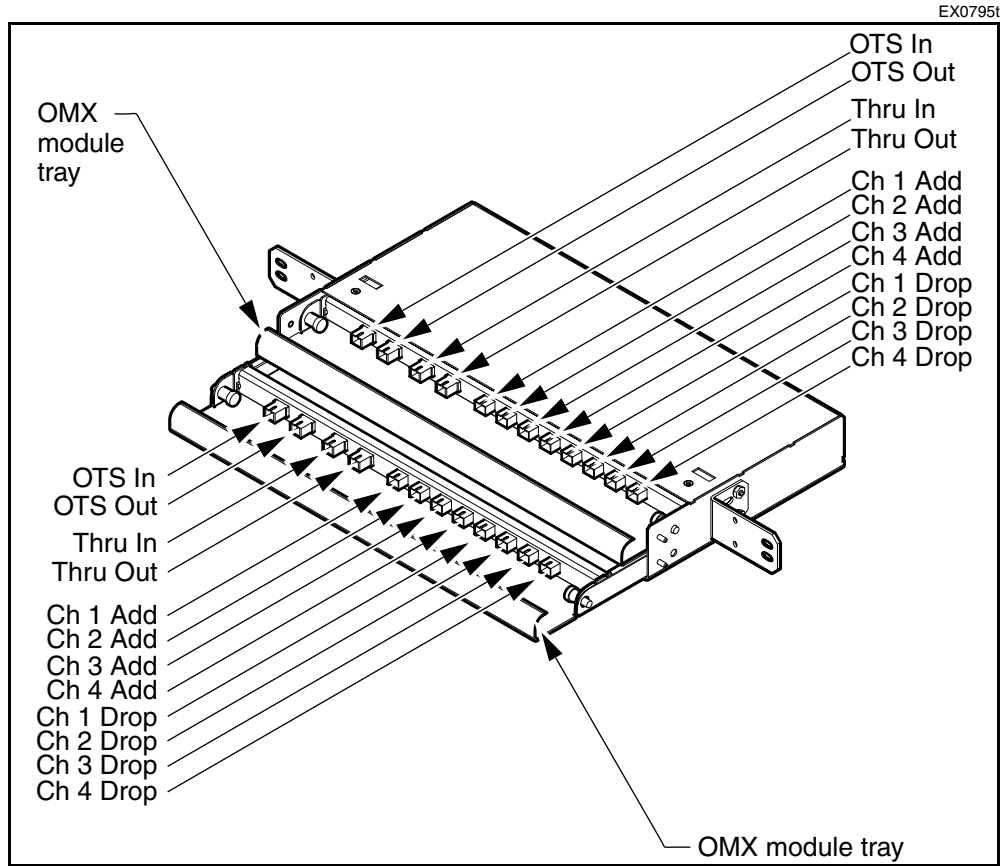
*Note:* The OPTera Metro OMX does not support OC-48 DWDM 1535.04 nm, OC-48 DWDM 1555.75 nm, OC-48 DWDM 1596.34 nm or OC-48 DWDM 1578.69 nm wavelengths.

The OMX modules multiplex optical signals together at the OC-192 or OC-48 line rate. Each OMX module has 12 faceplate interconnects. For details of the OMX shelf, see [Figure 3-33](#).

#### **Equipping rules**

One OMX shelf can be mounted in an eight foot bay equipped with four OPTera Metro 3500 shelves. One OMX shelf supports two OMX modules, one working and one protection. See [Table 3-3 on page 3-6](#) for operational temperature ranges.

**Figure 3-33**  
**OMX shelf (NTN449ZW)**



**Fiber Manager (not required with OMX + Fiber Manager 4CH) (NT0H57BB)**

The Fiber Manager is an external drawer used to manage slack optical fiber from the OMX shelf. For details of the Fiber Manager, see [Figure 3-34 on page 3-106](#).

The Fiber Manager

- is a 1 U high rack-mounted external drawer
- is used wherever slack fiber needs to be managed
- contains 16 flip-up fiber spools (each fiber spool can manage 1.6 m of fiber, maximum 3 mm diameter)
- can manage a maximum of 16 fibers (at 2 m each)
- has a fiber capacity of 240 ft (73.15 m)

The Fiber Manager can be front-mounted or mid-mounted in equipment racks of varying sizes. In order to meet specific installation requirements, the Fiber Manager is shipped with five different sets of mounting brackets. Each bracket is stamped with a letter to identify its type.

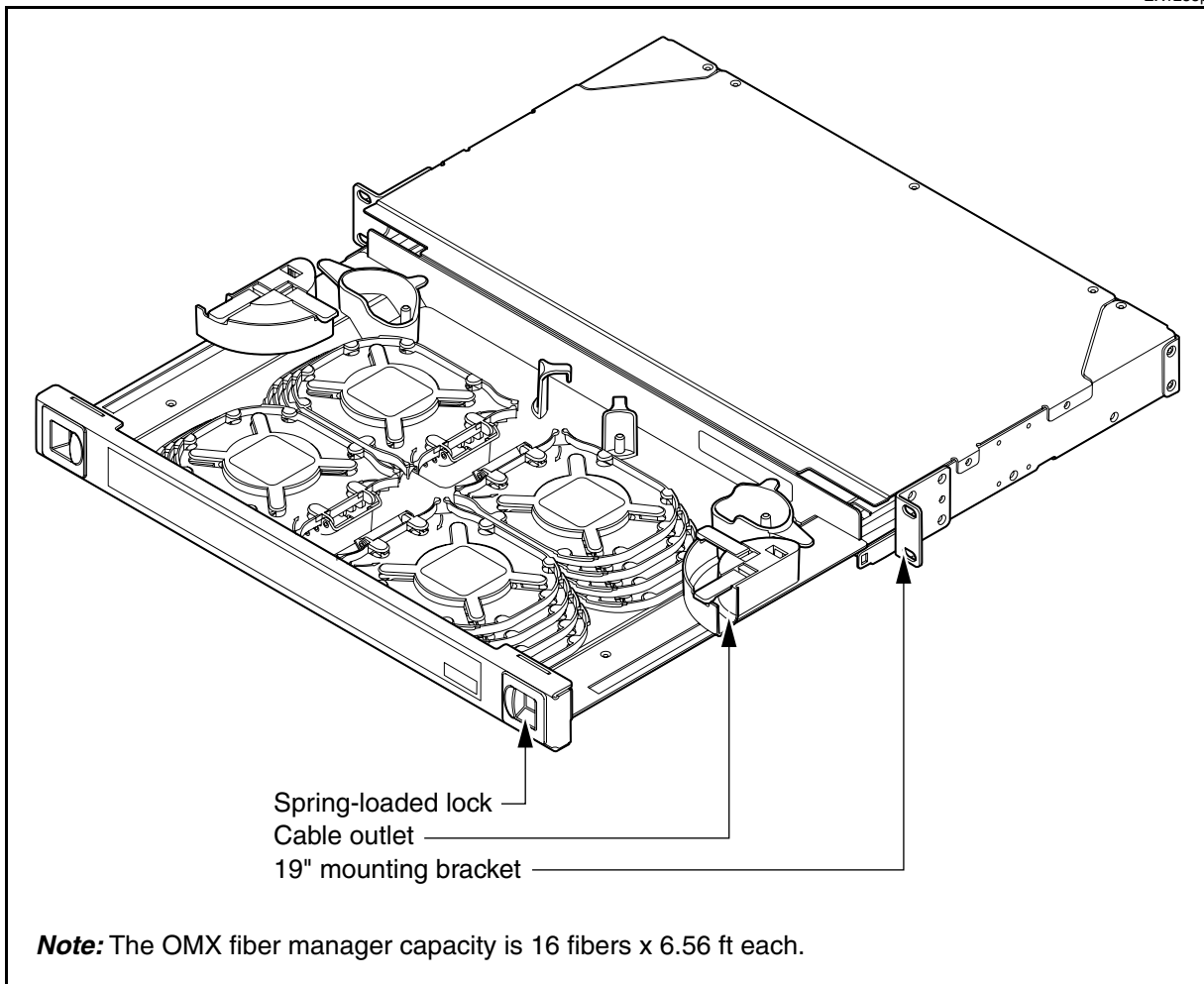
The letters and the type of rack each bracket is used with are listed in [Table 3-12 on page 3-105](#).

**Table 3-12**  
**Mounting bracket labels**

Letter	Rack type
A	EIA 19-in wide with 1.25 in (31.75 mm) hole spacing
B	EIA 19-in wide with 1.00 in (25.00 mm) hole spacing
C	EIA 23-in wide with 1.25 in (31.75 mm) hole spacing
D	EIA 23-in wide with 1.00 in (25.00 mm) hole spacing
E	ETSI width with 1.00 in (25.00 mm) hole spacing

**Figure 3-34**  
**Fiber manager (NT0H57BB)**

EX1255p



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## DS1 service module (DSM) shelf (NTN407MA)

The DS1 service module (DSM) is a peripheral shelf connected to an OPTera Metro 3500 network element. The DSM connects to the OPTera Metro 3500 network element through the ports on a host OC-3 or OC-3x4 circuit pack. The DSM is a terminal DS1 multiplexer. The DSM has three I/Os. Each I/O supports 1 through 28 DS1 facilities.

The DSM has two numbered slots for DSM DS1x84 termination module (TM) circuit packs. DSM DS1x84 TM circuit packs support 1 through 84 DS1 facilities. The two circuit packs provide 1+1 protection. The DSM can be equipped with one circuit pack for an unprotected configuration.

### Equipping rules

The DSM connects to the OC-3 ports on the OPTera Metro 3500 shelf using one (unprotected) or two (protected) OC-3 optical interfaces. An OPTera Metro 3500 shelf supports one through twelve protected or unprotected DSMs. See [Table 3-3 on page 3-6](#) for operational temperature ranges.

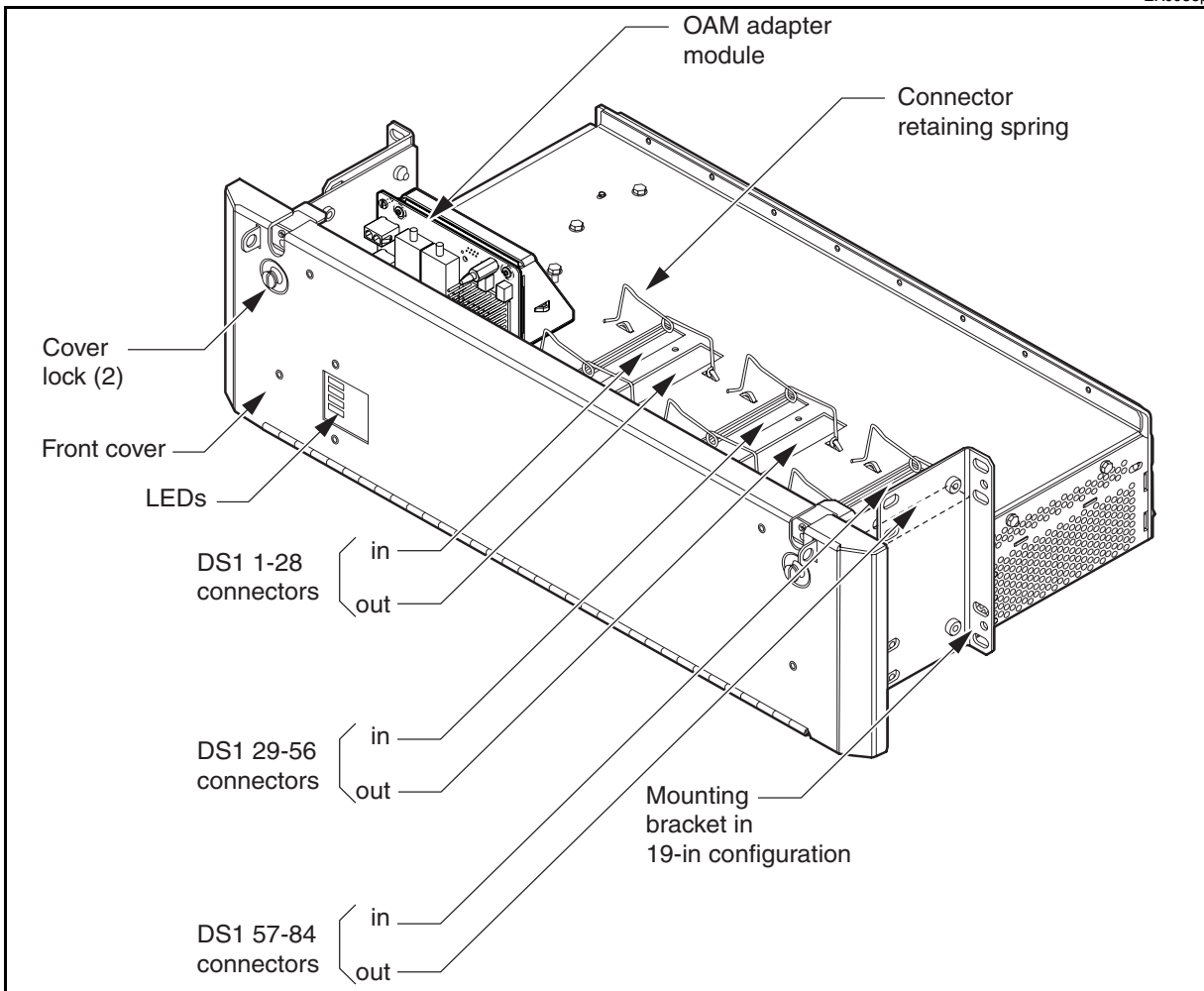
**Note:** To have up to twelve protected or unprotected DSM shelves on a single OPTera Metro 3500 shelf, you must use OC-3x4 circuit packs. If you use OC-3 circuit packs, your maximum number of protected DSM shelves is four or eight unprotected.

### Multiple IS

Multiple intermediate system (IS) is a function that allows the DSM, and communication between the DSM shelf and the shelf processor on the host network element, to remain hidden from the NPx and other network elements in the network.

**Figure 3-35**  
**DS1 service module (DSM) (NTN407MA)**

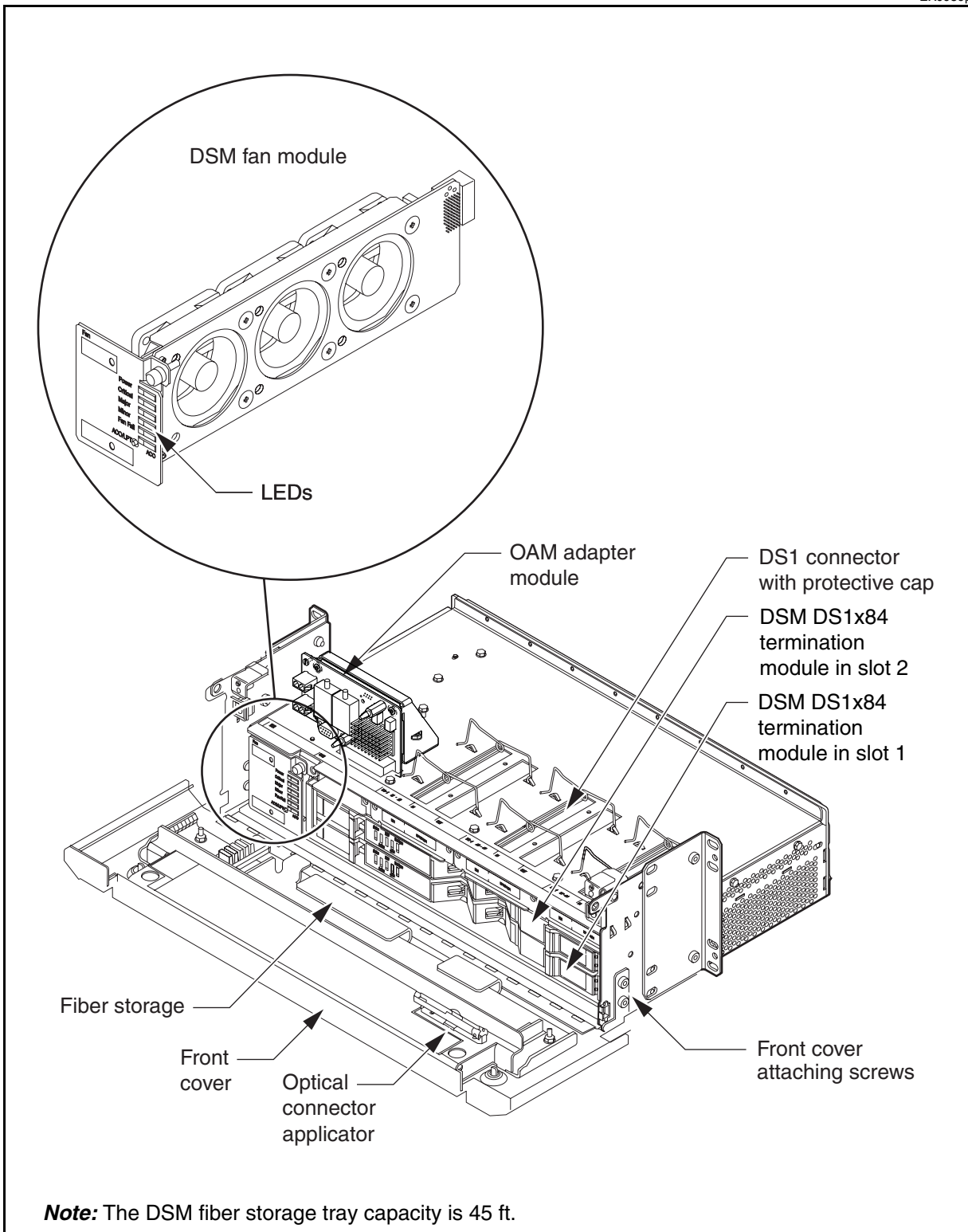
EX0958p





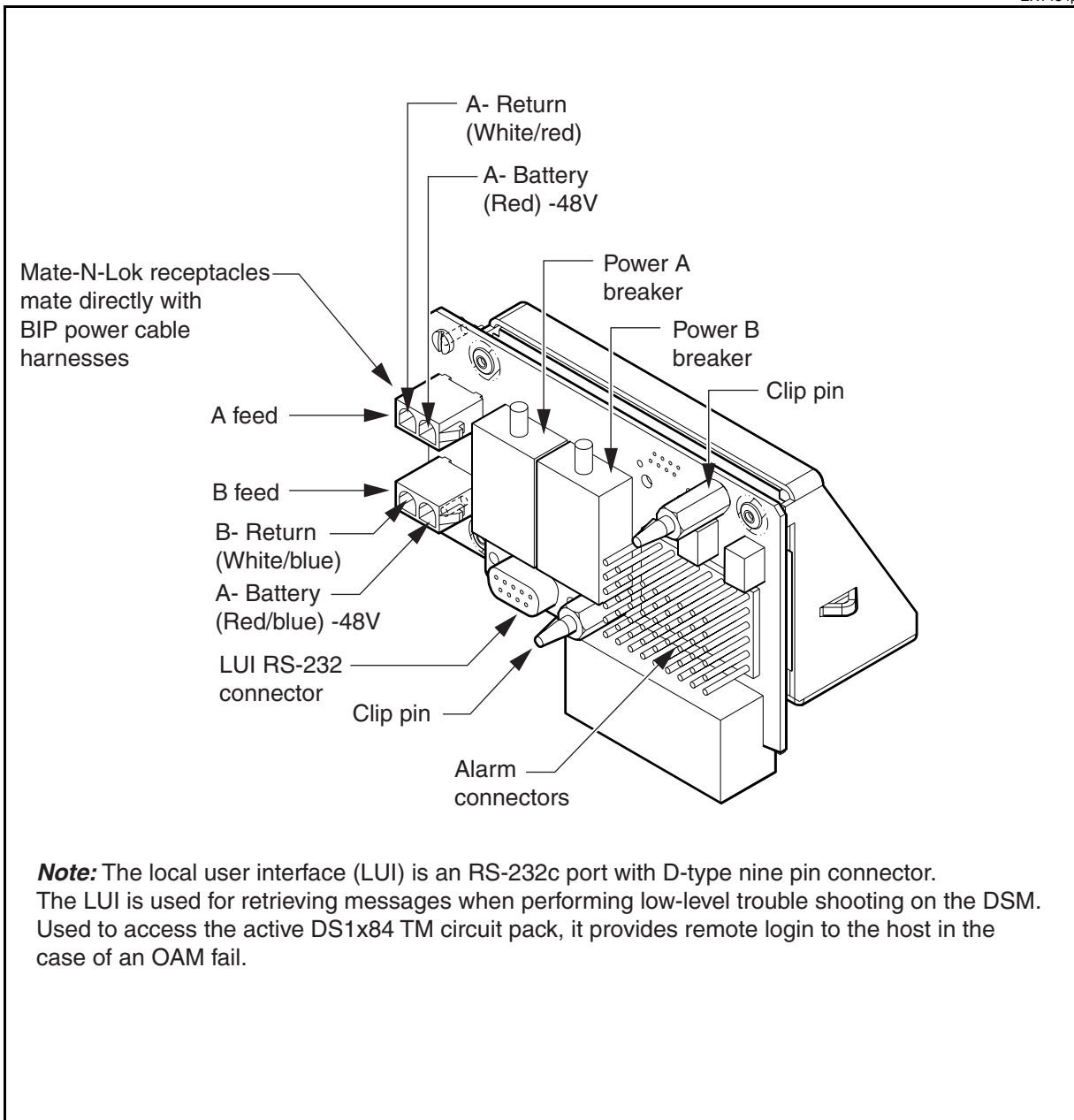
**Figure 3-36**  
**DS1 service module (NTN407MA) (front cover open) equipped with DS1x84TM circuit packs**

EX0959p



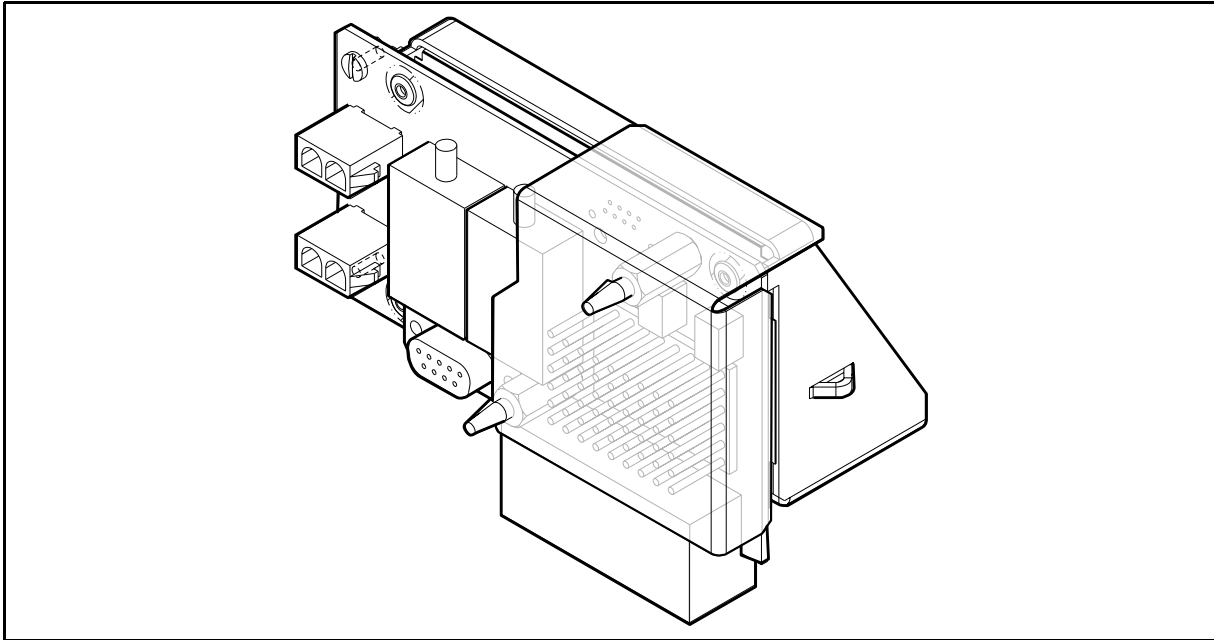
**Figure 3-37**  
**DSM OAM (Hardware Release 6) with cover off**

EX1434p



**Figure 3-38**  
**DSM OAM (Hardware Release 6) with cover on**

EX1438p



### **DSM DS1x84 termination module (TM)** **(NTN313AA, AC)**

The DSM DS1x84 termination module (DSM DS1x84 TM) has been developed for use in the DS1 service module (DSM). The DSM DS1x84 TM supports 84 DS1 facilities.

For each DSM DS1x84 TM, you need one OC-3 interface installed in the OPTera Metro 3500 shelf.

*Note:* You are recommended to use the DS1 right-angle cable assembly with the DSM shelf.

#### **Equipping rules**

When you order the DS1 service module (NTN407AA), DS1x84TM circuit packs (NTN313AA) and DSM Shelf (NTN407MA) are included.

When you order the DS1 service module (NTN407AC), DS1x84TM circuit packs (NTN313AC) and DSM Shelf (NTN407MA) are included.

When you order the DS1 service module (NTN407MA), you must order the DS1x84TM circuit packs (NTN313AA or NTN313AC) for slots 1 and 2 separately.

The DS1x84TM circuit pack is an intermediate reach optical interface, compliant with OC-3x4 optical specifications.

For more information, refer to:

- [DSM DS1x84 interface specifications on page 4-33](#) in Part 2 of this guide
- [OC-3x4 optical interface specifications on page 4-10](#) in Part 2 of this guide

**Note 1:** The NTN313AC circuit pack comes with LC connectors pre-installed.

**Note 2:** If you are ordering the NTN313AA circuit pack, you must also order the required optical connector kit (see [Optical connector kits on page 8-18](#)).

See [Table 3-3 on page 3-6](#) for operational temperature ranges.

### Protection switching

DSM DS1x84 termination module protection switching is 1+1 non-revertive. If a working DSM DS1x84 TM becomes defective, the traffic is switched to the protection DSM DS1x84 TM. Switching can also take place under user control.

### Alarm LED definitions

The following table provides a list of LEDs of the DSM DS1x84 TM.

LED Name	LED Color	ON condition description
Status	Status Red	Circuit pack is failed
Active	Active Green	Circuit pack is IS and ACT, OC3 facility and at least one DS1 facility are IS or OOS-AU and cross connected.
LOS	LOS Yellow	Loss of Signal on the OC3 facility.
Sync Ref Fail	Yellow	Loss of synchronization reference signal (own line).
OAM fail	Yellow	OAM link to SPx failed.



# **OPTera Metro 3500 Multiservice Platform**

## **Planning and Ordering Guide—Part 1 of 2**

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