General Description

76.7144FP51/2

Tellabs® 7100/7100N Optical Transport System

SONET/SDH Systems

Tellabs® 7190 Element Management System
Tellabs® 7191 Craft Station
Tellabs® 7194 Network Management System

Revision B, 5/09

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1. Introduction

1.01 This document provides an overview of Tellabs 7100® Optical Transport System (OTS) series of products and network configurations, including the Tellabs 7100N® Optical Transport System (OTS). It details system features, configurations, and applications. It also provides an overview of dense wavelength division multiplexing (DWDM) technology, including multiplexing schemes and optical layer management. A detailed description of system architecture and hardware is provided.

1.02 This document is intended for network planners and engineers. Customers can use this document to determine the suitability of implementing Tellabs 7100 OTS and Tellabs 7100N OTS technology into their optical networks. Users of this manual should be familiar with telephone industry technology.

Reason for Issue

1.03 Tellabs reissues this manual from Revision A to Revision B to include the changes in Table 1.1, page 2-1. Change bars indicate the changes Tellabs made from the previous to latest revision.

Table 1.1 General Description Revision History

Revision	Change History	Release Date
A	Initial release for Tellabs 7100 Optical Transport System FP5.1.x.	1/09
B	Update Features Introduced in FP5.1.x, page 2-15 and support for those features throughout the document.	5/09

2. Tellabs 7100/7100N Optical Transport Series

2.01 This section provides an overview of DWDM systems and the Tellabs 7100/7100N OTS operations.

DWDM and the Optical Layer

2.02 Dense wavelength division multiplexing (DWDM) is an optical technology used to increase the capacity and flexibility of the optical infrastructure. In a DWDM system, multiple optical signals are transmitted over multiple optical wavelengths on a single optical fiber. Traditional systems require multiple optical fibers to transmit multiple optical signals.

2.03 DWDM is a multiplexing hierarchy that leverages the optical layer of the transmission network. The optical layer interfaces the digital layer at the optical termination equipment, which can be considered part of both the electrical and the optical layer. The optical layer provides multiplexing schemes and management that are not present on the digital layer of the network.This optical infrastructure supports multiple data rates (for example, 622 Mbps, 2.5 Gbps, 10 Gbps), synchronous optical network (SONET) signal rates, and synchronous digital hierarchy (SDH) signal rates.

2.04 DWDM systems are divided into integrated and open systems. In integrated DWDM systems, the DWDM transmitter and receiver functionality is integrated into the transmitter/receiver of the digital transmission equipment. In open DWDM systems, special DWDM transmitter/receiver interface units (transponders) are used to provide the interface between the DWDM multiplexers and the adjacent digital transmission equipment.

Multiplexing Schemes

2.05 In DWDM systems, the signals to be multiplexed and demultiplexed are characterized by different optical wavelengths. The optical wavelengths of the Tellabs 7100/7100N OTS are chosen in agreement with the International Telecommunications Union (ITU-T) recommendations specifying up to 44 DWDM channels with center wavelengths placed in the erbium doped fiber amplifier (EDFA) gain band with 100 GHz between neighboring channels, and 88 DWDM channels with center wavelengths placed in the erbium doped fiber amplifier (EDFA) gain band with 50 GHz between neighboring channels. Wavelengths are placed from 1529 nm to 1563 nm, where the EDFA gain bands exhibit the most wavelength uniform gain characteristics.

Layer Management

2.06 The optical layer is managed as the digital (SONET/SDH) layer is, except for the physical transport of remote management data. In the optical layer, supervisory and management data from remote DWDM equipment cannot be transmitted over embedded digital channels. Instead, this data is transmitted over an independent optical supervisory channel (OSC) at 1510 nm. The OSC is terminated, processed, and retransmitted at the DWDM equipment that interfaces the optical transmission fiber.

Tellabs 7100/7100N OTS Operations

2.07 The Tellabs 7100 OTS is a metro, dense wavelength division multiplexing (DWDM) system based on a parallel architecture that provides scalable, non-service affecting growth to 88 protected wavelengths without network re-engineering. The Tellabs 7100N OTS is a full-featured system providing eight protected wavelength for niche applications within a Tellabs 7100 OTS network. These systems support ITU-T Recommendation G.709 Optical Transport Network (OTN)-based transport, enabling transparent high-capacity services. Services such as Carrier Ethernet, video, Storage Area Network, SONET, and SDH are carried on a shared infrastructure, scaling capacity as needed.

2.08 The Tellabs 7100/7100N OTS is built on unique, multi-patented system technologies that enable true next generation multiservice delivery. It features an integrated dynamic optical core combined with an intelligent services interface that delivers Add/Drop Multiplexer (ADM) capability on a single blade (SMTM-U module) in client ranges of 100 Mbps to 40 Gbps. The dynamic optical core enables service providers to meet today's network needs while supporting the ability to effortlessly deploy additional nodes for future expansion via a multi-degree Reconfigurable Optical ADM (ROADM).

2.09 The intelligent services interface can replace a currently installed ADM ring with a simple pair of modules, eliminating the costly implementation of stacked ADM rings, back-to-back ADM boxes between rings, and multiple rows of supporting equipment. Linear add/drop, ring, and mesh optical network topologies are supported on the same base platform. Service is easily changed by equipping endpoints with specific interface modules.

2.10 Tellabs 7100/7100N OTS provides the following benefits:

- fiber relief in fiber-constrained networks
- wavelength and capacity-based services
- deployment of new services without re-engineering networks
- efficient aggregate and transport of different types of traffic in metropolitan (metro) areas
- variable applications such as mesh, ring, and point-to-point

2.11 The Tellabs 7100/7100N OTS offers a single, flexible platform that can support current ADM and Wavelength Division Multiplexing (WDM) ring capabilities and ensure a smooth migration to future packet-based services over mesh networks. This section provides an overview of the Tellabs 7100 optical transport series of products. The Tellabs 7100 series includes the following products.

- Tellabs 7100 Optical Transport System (OTS)
- Tellabs 7100N Optical Transport System (OTS)
- Tellabs 7190® Element Management System (EMS)
- Tellabs 7191® Craft Station
- Tellabs 7194® Network Management System (NMS)
- Tellabs 7196® Optical Subnet Planner

2.12 Hardware elements of the Tellabs 7100/7100N OTS provide support for higher bandwidth applications and enhanced access. Hardware modules include 2.5G, 10G, and 40G transponders, reconfigurable multiplexers, multiplexers to support spur applications, packet multiplexers, colorless core multiplexers for high-density metro applications, optical protection modules, SONET/SDH/Packet module for digital cross-connects, intermediate- and long-reach amplifiers, system processors, and data processors. Multirate transponders interface transmission equipment at client rates between 100 Mbps and 10.7 Gbps, including Fibre Channel, OC-3/STM-1, OC-12/STM-4, OC-48/STM-16, OC-192/STM-64, OC-768/STM-256, Gigabit Ethernet (GbE), OTU2, OTU3, and 10 GbE.

Tellabs 7100N OTS

2.13 The Tellabs 7100N OTS is a compact version of the Tellabs 7100 OTS that can add or drop eight protected wavelengths and pass through up to 88 simultaneous channels. This product provides a 2-degree DWDM system (populated in 1-degree increments) comprised of up to seven 30-AMP shelves and a subset of Tellabs 7100 OTS transponder modules. It can be deployed as a one-shelf optical line amplifier (OLA), six-shelf OLA to support direct connect applications, or as a 2-degree SBOADM with one main shelf and up to six port shelves in 19- or 23-inch racks. The following modules are deployed in this application: SPM-N, CCM-IR, CCM-LR, OLA-IR, OLA-LR, LIAM-E88, LRAM-E88, ELRAM-E88, BFM, and CFM. This system also supports the following transponders: SSM-D, SSM-X, OTNM-D, FGTM, FGTM-M, SMTM-P, TGIM-P, 82.SMTM-U, 82.TGTM-E, and 82.MRTM-E. Slots are paired in the shelf backplane to accommodate interdependent module applications.

Tellabs 7190/7194 Management Systems

2.14 The Tellabs 7190/7194 management systems (Tellabs 7190 EMS and Tellabs 7194 NMS) provide integrated management of Tellabs 7100/7100N OTS NEs.The software features listed below provide support for higher bandwidth applications and enhanced access capabilities:

- performance monitoring of optical, Packet, SONET, SDH, and Ethernet traffic
- automatic optical power management and equalization
- end-to-end provisioning at one screen
- automatic laser transmit power shutdown upon fiber cut and automatic turn-up following restoration
- optical supervisory channel at OC-3/STM-1 rate

- CLI interface for packet signaling
- TL1 Gateway Network Element (GNE) functionality
- Embedded Operations Network (EON)
- TL1 interface for system management
- XML/TMF/SNMP/CORBA Northbound Interfaces

Tellabs 7100/7100N OTS Configurations

2.15 Tellabs 7100/7100N OTS supports the following 44- and 88-channel network configurations in FP5.1.x:

2.16 The following network configurations are supported:

__ Tellabs 7100 Single Bay OADM (SBOADM) - The Tellabs 7100 OTS single bay optical add/drop multiplexer (SBOADM) is a single network element with multiple DWDM interfaces. A four-degree SBOADM requires one main shelf, supports up to eight port shelves, and operates within a 44-channel plan. An eight-degree SBOADM requires two main shelves and supports up to eight port shelves, and operates within a 44- or 88-channel plan.

__ Tellabs 7100 Optical Line Amplifier (OLA) - a 44- or 88-channel OLA can be configured for short, medium, or long spans. The OLA does not support add/drop functions, but can be upgraded to a 2-degree node SBOADM without affecting traffic.

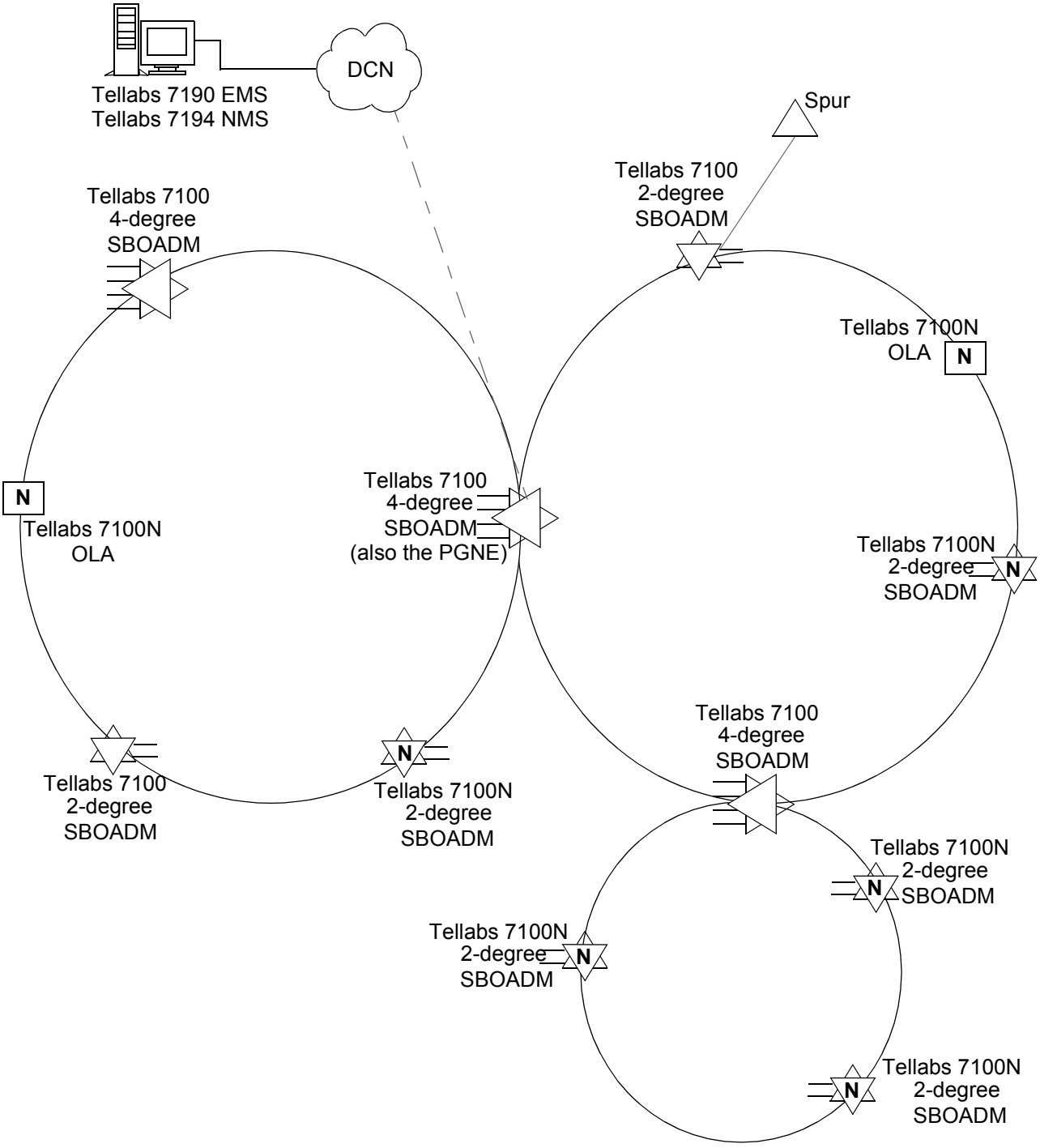
__ Tellabs 7100N OTS SBOADM - the main shelf has up two DWDM interfaces, A-side through B-side and supports eight protected wavelengths. The Tellabs 7100N OTS SBOADM is supported only in 44-channel systems.

__ Tellabs 7100N OLA - a 44- or 88-channel OLA can be configured for short, medium, or long spans. The OLA passes through up to 44 channels and does not support add/drop functions. This OLA is interchangeable with Tellabs 7100 44-channel OLA.

Note: *For complete descriptions of Tellabs 7100/7100N system modules and slot assignments per configuration, refer to Tellabs 7100 System Engineering and Tellabs 7100N System Engineering.*

2.17 A sample network of Tellabs 7100 series of products is illustrated in Figure 2.1, page 2-6.

Figure 2.1 FP5.1.x Tellabs 7100/7100N Series Optical Transport Products Network



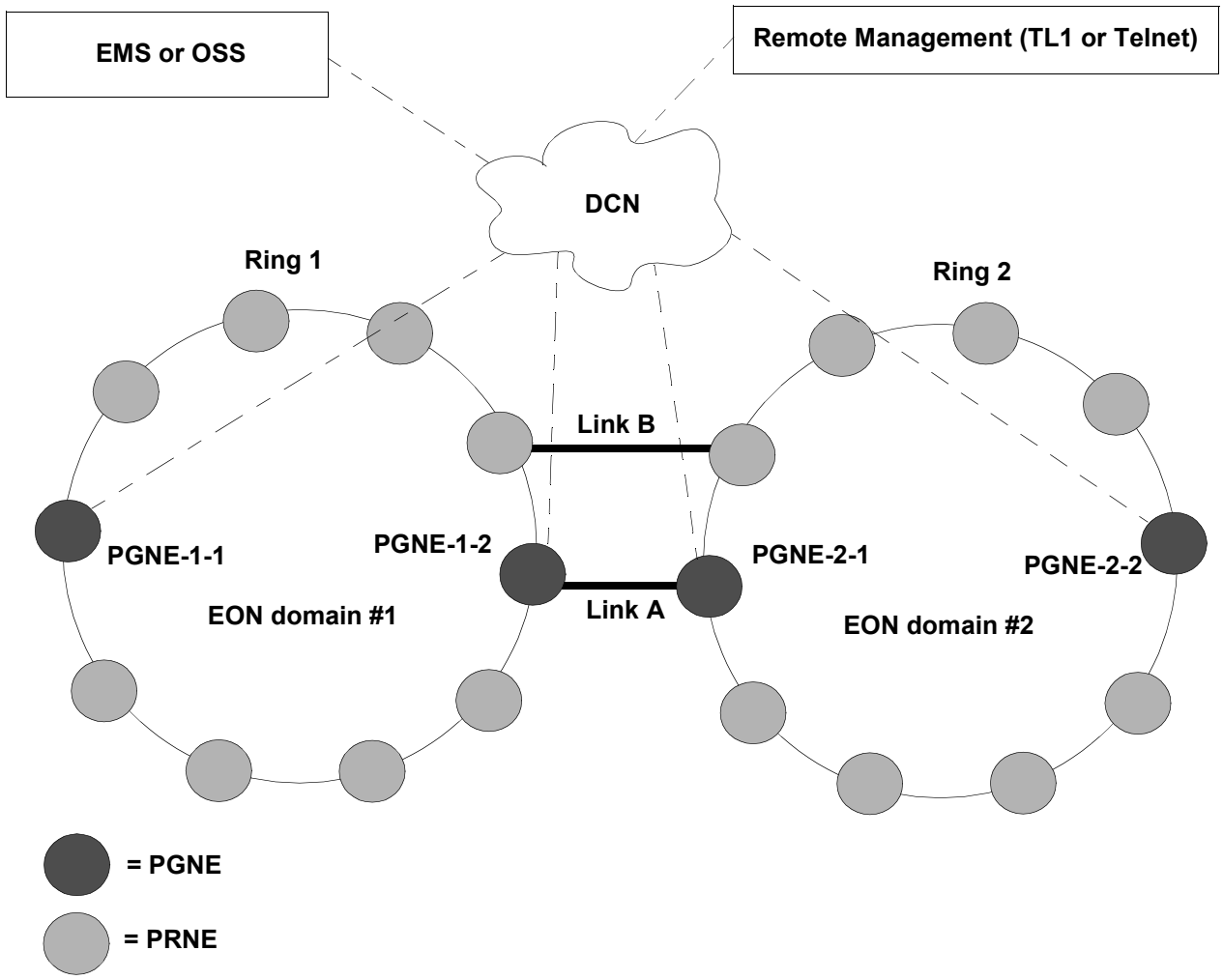
Embedded Operations Channel Network

2.18 The Embedded Operations Channel Network (EON) provides Embedded Operations Channels (EOCs) to route management traffic using Internet Protocol (IP) through an internal network among the NEs.

2.19 One NE in the EON is provisioned as a gateway NE (PGNE-1) and routes management traffic between the external DCN and the other NEs (PRNEs) in the EON. The PGNE-1 manages PRNEs through the Tellabs 7190 EMS and Tellabs 7194 NMS, acting as an entry point from the external DCN and enables packet routing among the PRNEs after an IP address is configured for each. A secondary gateway (PGNE-2) provides redundancy so that a single optical link failure does not cause a communication interruption between the Tellabs 7190/7194 management systems and any NE in the ring.

2.20 Tellabs recommends limiting to 30 the number of PRNEs assigned to a PGNE. When a network exceeds this limit, the EON can be partioned into two EONs by provisioning one of the PRNEs as a second PGNE-1 and modifying the traffic paths around that PRNE. Refer to the *Tellabs 7100/7100N Craft Station User Guide* for detailed procedures on partitioning NEs. Figure 2.2, page 2-7 illustrates the resulting two EONs interconnected via DWDM links after partitioning.

Figure 2.2 Embedded Operations Network



Autodiscovery

2.21 Autodiscovery is a self-inventory feature that enables the Tellabs 7100/7100N NEs to report their inventory to the Tellabs 7190/7194 management systems. On system startup, the NE performs a self survey to determine which hardware components are present. This information is retrieved by the system manager when it is connected to the NE. If there is a discrepancy between the configurations stored by the management system and the NE, the NE is assumed to have the valid configuration.

Performance Monitoring

2.22 Performance monitoring is the continuous, nonintrusive collection of system performance data and is used to determine the operational status of the network and the quality of service that the network is providing. PM checks for specific types of signal information and helps identify the cause of network transmission problems. PM is detailed in Facility Performance Monitoring, page 2-106.

Control Plane

2.23 The Tellabs 7100 OTS Control Plane feature provides rapid circuit provisioning across mesh architectures in transport networks. Control plane functionality is based on the ITU-T automatically switched optical network (ASON) architecture and utilizes IETF generalized multi-protocol label switching (GMPLS) protocols as extended by the OIF. It is embedded in the SPM and applied at STS or VC termination points on paired SMTM-U module facilities operating in SPFAB mode.

2.24 NEs are network aware in control plane applications, providing faster set-up and tear-down of call paths across the network. The call path is established at the STS or VC layer. The control plane automatically manages a link resource database in real-time to provide constraint-based routing and traffic engineering. The Tellabs 7100 OTS control plane application interfaces traditional and management plane systems to coordinate traffic and network resources.

2.25 Tellabs 7100 OTS Control Plane supports calls across multiple domains and flexible path protection at the STS/VC level. Re-designed protection schemes in FP5.1.x streamline provisioning requirements while enhancing reliability to control plane traffic.

2.26 Control Plane 1+1 (CP 1+1) protection provides two diverse connections (working and protected) between the ingress node and the egress node of a protection domain. This protection scheme is supported on the drop-side and the line-side between Tellabs 7100 OTS NEs within the Tellabs 7100 OTS control plane network (I-NNI). CP 1+1 protection is not supported on drop-side or line-side facilities provisioned between a Tellabs 7100 OTS NE and control plane entities outside of the Tellabs 7100 OTS network where only LAPS is supported over the E-NNI.

2.27 Flexible Path Protection is a protection scheme that removes previous shelf-slot pairing constraints and enables protection port pairing between any two ports on the line side, or any two ports on the drop side. It allows any port-side termination to be protected by any other port-side termination and any line-side termination to be protected by any other line-side termination within the same shelf. Protection port pairing with a line-side port and a drop-side port mixed pair is not supported. A protection port pair constitutes a Path Protection Group (PPG) supported by STSn/VCn path layer protection. These Path Protection Groups (PPG) are automatically created when the cross-connect is provisioned. For CP 1+1, two PPGs are created – one at the ingress/source node, and one at the egress/destination node.

2.28 Dynamic re-route supports multiple repair points for a signal path and permits automatic recovery from node failures with an efficient use of resources that are used only during route restoration, unlike Control Plane 1+1 (CP 1+1) protection where resources are pre-allocated. Dynamic re-route is supported in single domains and across multiple domains. When dynamic re-route restoration is provisioned, failure indications are propagated to repair nodes to direct an alternate route connection to bypass the call path. In the event of resource contention among multiple dynamic calls or simultaneous failures along the call path, crankback is used to address these conditions and retry failed calls.

Ethernet Packet Support

2.29 Packet subsystems are created on Tellabs 7100 OTS port shelves when packet modules (DPM, SPFAB, SMTM-P, and TGIM-P) are present and provisioned. Packet subsystems are created on Tellabs 7100N OTS port shelves when SMTM-P or TGIM-P are present and provisioned. The Packet subsystem can be managed with the Tellabs 7190/7194 management system or a Command Line Interface (CLI). Packet-based transponder modules, SMTM-P and TGIM-P, manage the ingress and egress ports for traffic flow. SMTM-P modules are equipped with small form pluggables (SFPs) designed to support traffic signal rates that interface the module. Refer to Table 2.1, page 2-9.

Table 2.1 SMTM-P/TGIM-P Specifications

Port Interfaces	SMTM-P	TGIM-P
Number of Interfaces	10	1
Pluggable Optics	SFP-based	XFP-based
Data Rates	10 Mbps–1 Gbps	10 Gbps
Protocols	10/100/1000 Mbps BaseT GbE (1 G Optical) 100Base-FX	10 G Ethernet LAN

2.30 Supported features include MAC Bridging, VLAN Bridging, an 802.3 compliant MAC client interface, Packet security, Packet fault management, Packet performance monitoring, multicasting, synchronized Ethernet, and line-side RPR protection.

2.31 In Tellabs 7100 OTS applications, the SONET/SDH/Packet Fabric (SPFAB) module provides a switch matrix for SONET/SDH signaling and Packet traffic to maximize system integration and bandwidth efficiency. It interfaces SMTM-U, SMTM-P, and TGIM-P modules to switch Packet and STS/VC-level cross-connects.

2.32 Packet applications support both SNMPv2 and SNMPv3. Quality of service certifications include Metro Ethernet Forum (MEF) services certification: E-Line service, E-LAN service, and Ethernet Private Line (EPL). Performance monitoring enhancements include Weighted Random Early Detection (WRED) congestion management, traffic-shaping queues, and continuity checks.

2.33 Improved fault management for 802.3 compliant MAC/PHY interfaces include Far End Fault Indication (FEFI) for 100FX interface, LOSYNC for NE IEEE 802.3 compliant MAC interface, signal degrade and signal fail conditions detected on incoming Ethernet traffic based on errored frames, provisionable alarm profiles, and additional alarms and conditions retrieved via SNMPv2c traps.

2.34 Traffic enhancements include tunneling Layer 2 control frames transparently (spanning tree bridge protocol data units and GVRP packets) at Provider Edge Bridge points. Ethernet types are filtered at the module port to reduce congestion. Link aggregation groups are managed by SNMPv2.

SDH Protocol Support

2.35 A suite of Tellabs 7100 OTS and Tellabs 7100N OTS features are provided in SDH signaling formats. Transparent STMnT (Synchronous Transfer Mode) signals are introduced to multiplex SDH-based traffic onto a single fiber to reduce fiber exhaust. STMnTs transport Virtual Containers (VC-4, VC-4-4C, or VC-4-16C) through the network untouched.

2.36 This feature also uses VCn grooming to support multiple types of traffic, including virtual concatenation. This utilizes the capacity provided by DWDM applications and eliminates the requirement for distinct ADMs. Within the Tellabs 7100 NE, distinct VCs may be individually cross-connected onto different STM-xs, which are associated to DWDM channels. Cross-connect terminations VC-4, VC4NV, VC-4-4C, and VC-4-16C are supported. Signals can be concatenated into groups via VC4NV (Level 4 Virtually Concatenated) facilities for provisioning and transport.

2.37 CRC4 framing format and E1 signaling are also supported. Signal protection is provided in both 1+1 protection and SNCPRING protection schemes. Graphical representations of both world maps and actual operating NEs are provided for visual provisioning.

Note: *In SDH standards, it is possible to support either high order VC-3 or low order VC-3 (TUG3 mapping). The Tellabs 7100/7100N OTS only supports high order VC-3 path layer entities per ITU-T G.707. Customer provisioning and use of VC-3 should carefully consider ITU-T recommendation for Multiplexing of AU-3s via AUG-1 (refer to ITU-T G.707/Y.1322 12/2003 Figure 7-4) in order to avoid any interruptions in traffic.*

Interoperability Features

2.38 Interoperability features are built in to the Tellabs 7100/7100N OTS for seamless integration into multiple vendor network.

Data Communications Channel (DCC)

2.39 DCC allows the messaging specific to multi-vendor devices in a Tellabs 7100 network to flow through the Tellabs 7100 NE that is provisioned as the network Gateway Network Element (GNE). The GNE serves as a conduit for communication between non-Tellabs management systems and the sub-tending multi-vendor devices they support, allowing both messaging and software downloads via an OSI-based Data Communication Network. DCC processing routes messages between the DCN interface, the SPM, the DPM, and the DCC interfaces on the SMTM-Us.

IP Over DCC

2.40 IP over DCC allows subtended SONET/SDH platforms to access an IP-based DCN. On the Tellabs 7100 OTS, it allows access to the signaling communication network (SCN) in control plane applications. IP traffic presented over the DCC may be locally processed or forwarded to another PRNE or to the PGNE.

2.41 Establishing an SCN expedites traffic processing by directing signaling and management traffic to different physical ports on the NE. The SCN on the Tellabs 7100 OTS is established via OCn, VCn, and HDP port provisioning.

OSI Traffic Tunnelled Over EON to Remote NEs

2.42 The management functions of GNEs can be extended to SDH/SONET ADMs that subtend remote Tellabs 7100/7100N NEs by tunneling OSI traffic over the EON to allow the PRNE to serve as a single GNE in the SDH/SONET ADM subnetwork. The NE supports up to 64 OSI associations per TCP session and up to 15 TTD TCP sessions.

Services Between Transponders and External Equipment

2.43 The ROADM/SBOADM DWDM optical network components in a Tellabs 7100/7100N OTS application can be decoupled in Tellabs 7100 OTS networks so that Ethernet, SONET, and SDH capabilities can be deployed without routing through mutiplexing functions on the NE. This flexibility simplifies provisioning and reduces start-up costs for smaller applications while preserving the capability to upgrade to ROADM/SBOADM DWDM services.

System Operation and Growth

2.44 This section provides general descriptions of features related to growing and modifying a Tellabs 7100/7100N OTS.

SPM Operation

2.45 The 71114B System Processor Module (SPM) and 71714 System Processor Module (SPM-N) automatically validate their NE location at each restart. This ensures that the supporting NE is not reprovisioned with an incorrect configuration during an SPM replacement.

2.46 To facilitate module replacement, the SPM/SPM-N stores module commissioning parameters and configuration data in the NE database located on the redundant SPM (and redundant SPM-N when present). This functionality allows the SPM/SPM-N to automatically restore its commissioning and configuration data when a module is replaced.

Auto-Negotiation

2.47 Auto-negotiation is provided on the SMTM-U to facilitate signal transport across a network. With auto-negotiation, the SMTM-U can communicate its transport properties, such as speed and duplex mode, to routers in the network so the two devices can determine the most efficient transport mode supported by both. On the SMTM-U, auto-negotiation is managed on the GbE facility. Performance is monitored through maintenance signaling on the client side.

Seamless Expansion

2.48 Additional degrees can be added to expand current nodes without reprovisioning wavelengths and 44-channel OLA configurations can be converted to 44-channel SBOADMs.

2.49 Amplifiers, RCMM-4Ds, and RCMM-8Ds can be replaced with corresponding modules of increased capacity or features without impacting currently provisioned wavelengths, facilities, or cross-connects.

Network Administration

2.50 This section provides general descriptions of features related to network administration on the Tellabs 7100/7100N OTS.

Northbound Interfaces

2.51 The Tellabs 7100/7100N OTS supports three northbound interface protocols:

Tellabs 7194 XML Northbound Interface

2.52 The Tellabs 7194 XML Northbound Interface uses open standard TeleManagement Forum (TMF) 854/XML protocol to facilitate communication between the Tellabs7194 management systems and other operations support systems (OSS). This feature provides a layer of uniformity for support of other network management systems by interfacing TMN-layered OSS architectures for rapid deployment of new services that meet SLA requirements. It supports HTTP/HTTPS protocols for inventory retrieval and alarm and notification forwarding features. HTTP/HTTPS capabilities include session and user IDs, multiple batch response, and server and key records.

2.53 The TMF MTOSI standard interface in the Tellabs 7194 XML NBI provides rapid deployment of new services. XML NBI supports single-port (TGTM-E) and multiple-port (SMTM-U) transponders in the Tellabs 7100/7100N OTS and the following services: SONET, GBE, TGBE, ESCON, FC, FICON ISC, and DV. It provides an end-to-end Sub-Network Connection (SNC) at the DWDM layer in single mesh networks. XML NBI also supports inventory and fault management.

Tellabs 7190 SNMP Northbound Interface

2.54 The Tellabs 7190 SNMP Northbound Interface provides a mediation layer over the Tellabs 7190 EMS to support SNMP-based network management. This allows SNMP-based management systems to manage telecommunication equipment operating the Tellabs 7190 EMS interface via an SNMP communication link.

2.55 The SNMP mediation layer converts SNMP requests into corresponding commands that are forwarded to the Tellabs 7190 EMS. Responses from the Tellabs 7190 EMS are converted to SNMP format and sent to the SNMP Manager. Alarms and events set on NEs and on the Tellabs 7190 EMS are converted to SNMP notifications and sent via the EMS to configured northbound managers. This feature supports SNMP protocol versions v1, v2c, and v3.

2.56 The Tellabs 7190 SNMP Northbound Interface also retrieves Packet Subsystem messages and alarms.

DHCP

2.57 The DHCP feature provides automatic addressing of Tellabs 7100/7100N OTSs configured as Remote Network Elements (RNE) on the internal Embedded Operations Network (EON). Address assignments are managed by the Tellabs 7100 NE that is configured as a Gateway Network Element (GNE).

Power Balancing

2.58 When a transponder is installed, the power balance feature automatically adjusts the EVOA setting, reducing the time it takes for the transponder to converge into the network. If an NE detects a fiber span variation, the automatic power balancing algorithm adjusts the gain of the input amplifier on that span.

Derived Timing Synchronization

2.59 When system synchronization is provided by derived timing, a pair of facilities supply redundant timing to all SMTM-x, SSM-D, SSM-X, OTNM-D and TGIM-P in an NE. The derived timing sources are OCn, STMn or OCH-P facilities provisioned on two different transponders. Derived timing is used in place of T1/E1 BITS timing.

3. Features Introduced in FP5.1.x

3.01 This section describes general system features new in Tellabs 7100/7100N OTS Feature Package 5.1.x (FP5.1.x).

Control Plane Enhancements

3.02 Tellabs 7100 OTS Control Plane now supports calls across multiple domains, flexible path protection at the STS/VC level, and dynamic re-route restoration with crankback. Re-designed protection schemes in FP5.1.x streamline provisioning requirements while enhancing reliability to control plane traffic.

3.03 Control Plane 1+1 (CP 1+1) protection provides two diverse connections (working and protected) between the ingress node and the egress node of a protection domain. This protection scheme is supported on the drop-side and the line-side between Tellabs 7100 OTS NEs within the Tellabs 7100 OTS control plane network (I-NNI). CP 1+1 protection is not supported on drop-side or line-side facilities provisioned between a Tellabs 7100 OTS NE and control plane entities outside of the Tellabs 7100 OTS network where only LAPS is supported over the E-NNI.

3.04 Flexible Path Protection is a protection scheme that removes previous shelf-slot pairing constraints and enables protection port pairing between any two ports on the line side, or any two ports on the drop side. It allows any port-side termination to be protected by any other port-side termination and any line-side termination to be protected by any other line-side termination within the same shelf. Protection port pairing with a line-side port and a drop-side port mixed pair is not supported. A protection port pair constitutes a Path Protection Group (PPG) supported by STSn/VCn path layer protection. These Path Protection Groups (PPG) are automatically created when the cross-connect is provisioned. For CP 1+1, two PPGs are created – one at the ingress/source node, and one at the egress/destination node.

3.05 Dynamic re-route supports multiple repair points for a signal path and permits automatic recovery from node failures with an efficient use of resources that are used only during route restoration, unlike Control Plane 1+1 (CP 1+1) protection where resources are pre-allocated. Dynamic re-route is supported in single domains and across multiple domains. When dynamic re-route restoration is provisioned, failure indications are propagated to repair nodes to direct an alternate route connection to bypass the call path. In the event of resource contention among multiple dynamic calls or simultaneous failures along the call path, crankback is used to address these conditions and retry failed calls.

Packet Enhancements

3.06 Packet applications support both SNMPv2 and SNMPv3. Quality of service certifications include Metro Ethernet Forum (MEF) services certification: E-Line service, E-LAN service, and Ethernet Private Line (EPL). Performance monitoring enhancements include Weighted Random Early Detection (WRED) congestion management, traffic-shaping queues, and continuity checks.

3.07 Improved fault management for 802.3 compliant MAC/PHY interfaces include Far End Fault Indication (FEFI) for 100FX interface, LOSYNC for NE IEEE 802.3 compliant MAC interface, signal degrade and signal fail conditions detected on incoming Ethernet traffic based on errored frames, provisionable alarm profiles, and additional alarms and conditions retrieved via SNMPv2c traps.

3.08 Traffic enhancements include tunneling Layer 2 control frames transparently (spanning tree bridge protocol data units and GVRP packets) at Provider Edge Bridge points. Ethernet types are filtered at the module port to reduce congestion. Link aggregation groups are managed by SNMPv2.

3.09 The Tellabs 7100 OTS now supports MPLS based LAG distribution. When the distribution criterion of a LAG is configured as a MPLS label, the NE distributes traffic for this LAG according to the following rules:

- If the packet has two labels and 0 or 1 tag, traffic is distributed based on these two labels.
- If the packet has three or more labels and 0 or 1 tags, traffic is distributed based on the next two labels following the most outer label.
- Otherwise, traffic is distributed based on the source MAC address and the destination MAC address.

3.10 The Tellabs 7100 OTS supports IGMP snooping. It allows customers to efficiently deploy IP multicast services controlled by IGMP messages. Referencing the TR-101 multicast model, the Tellabs 7100 OTS serves as the Ethernet Aggregation Node.

- IGMP snooping is the process of inspecting user-initiated IGMP messages which indicate which multicast groups the subscriber is joining and leaving. Through IGMP snooping, the Aggregation Node builds multicast MAC forwarding filters so that it can intelligently forward IP multicast groups/channels only to the ports connected to Hosts that request the groups/channels.
- For the IGMP Snooping feature, the NE is responsible for forwarding each multicast group received on a Multicast VLAN to only those member ports that have specifically requested that multicast group. This prevents needlessly flooding a multicast group to all attached ports. The NE identifies these ports by IGMP snooping. The NE inspects frames for IGMP messages and maintains Multicast MAC-address filters indicating which ports have requested specific multicast groups.

3.11 The Tellabs 7100 OTS supports Ethernet End to End OAM. This allows the service provider to monitor end to end from the equipment that interfaces with the customer, as well as end to end within each subnetwork and over each link.

Expanded Module Support in Tellabs 7100N OTS

3.12 Module support is expanded in the Tellabs 7100N OTS to include OTNM-D, SMTM-P, TGIM-P, and SSM-D/X, and supported traffic options now include Packet.

88-Channel Configurations

3.13 Two 88-channel configurations are introduced for increased capacity in the Tellabs 7100 OTS. The SBOADM configuration supports add/drop/pass-through of up to 88 channels. The OLA configuration amplifies and passes through up to 88 channels. Three new 88-channel amplifiers, one new 88-channel multiplexer, two mux/demux modules, and new main shelves support these configurations.

3.14 An 88-channel configuration is introduced for increased capacity in the Tellabs 7100N OTS. The Tellabs 7100N OLA configuration amplifies and passes through up to 88 channels. One of three 88-channel amplifiers can be placed in slot one and slot four of the Tellabs 7100N OLA main shelf to support this configuration.

Expanded Shelf Capacity

3.15 Network elements (NEs) in the Tellabs 7100 OTS can now support up to 12 port shelves per NE. Configurations 39 and 40 (with single Main Shelf 1) support 12 port shelves, while configuration 42 (with Main Shelves 1 and 15) supports 11 port shelves.

3.16 The Tellabs 7100N OTS can now support up to six port shelves per NE.

Expanded Y-cable Patch Panel Support

3.17 The Y-Cable patch panel now provides signal protection on the Tellabs 7100/7100N OTS through paired FGTMs and FGTM-Ms.

DCC Enhancements

3.18 DCC functionality enhanced to provide the capability to pass IP traffic over DCC to support routing of non-Tellabs NEs MCN traffic via Tellabs 7100 signaling communication network (SCN). The existing control plane interfaces and provisioning are used to support this feature for non-Tellabs NEs that are connected to the SMTM-U.

NorthBound Interface Enhancements

3.19 The TMF MTOSI standard interface in the Tellabs 7194 XML NBI is expanded to provide rapid deployment of new services. XML NBI supports single-port (TGTM-E) and multiple-port (SMTM-U) transponders in the Tellabs 7100/7100N OTS and the following services: SONET, GBE, TGBE, ESCON, FC, FICON ISC, and DV. It provides an end-to-end Sub-Network Connection (SNC) at the DWDM layer in single mesh networks. XML NBI also supports inventory and fault management.

3.20 The Tellabs 7190 SNMP Northbound Interface now retrieves Packet Subsystem messages and alarms.

3.21 Tellabs 7194 XML NBI supports using an inner topological link (TL) in place of an end to end OCH layer SNC to decouple DWDM and SONET/SDH networks.

3.22 The Tellabs 7194 XML NBI uses a Group Termination Point (GTP) to model STS1CNV and the STS3CNV in order to simplify VCAT service provisioning. This allows the user to create VCAT service with only one Web Services Description Language (WSDL) request.

3.23 The Tellabs 7194 XML NBI reduces the number of steps required to provision services using SNC provisioning operations to automatically create required path layer Connection Termination Points (CTPs).

3.24 The Tellabs 7194 XML NBI adds support for provisioning a SNC that passes through multiple SMTM-U modules on the same SONET ring.

3.25 The Tellabs 7194 XML NBI supports network side protected and port side unprotected service.

3.26 The Tellabs 7194 XML NBI adds support for provisioning Y-cable signal protection for the TGTM-E.

3.27 The Tellabs 7194 XML NBI adds support for the SONET path layer CTP creation on the line side when provisioning SNCs.

3.28 The Tellabs 7194 XML NBI supports alarms for Tellabs 5500 NGX.

Management Systems Features

3.29 Refer to the *Tellabs 7190/7194 Management Systems Software Release Document* for descriptions of the new Tellabs 7190/7194 management systems features.

3.30 Refer to the *Tellabs 7191 Craft Station Software Release Document* for descriptions of the new Tellabs 7191 Craft Station features.

FP5.1.x Hardware

3.31 This section describes hardware that is new in FP5.1.x.

71188-IR LIAM-E88 Line Input Amplifier Module - Enhanced 88-Channel

3.32 The 81.71188-IR LIAM-E88 Line Input Amplifier Module - Enhanced 88-Channel is a single slot amplifier module that provides input amplification of the incoming DWDM signal on 44-channel and 88-channel systems. The module includes a span distance measurement feature via the OSC channel/ FPGA and in-band OSNR for collection of accurate per channel measurements that are data rate insensitive. The module is equipped with a redundant 100 BaseT controller interface and an RJ-45 connector. It connects directly to a discoverable DCM module.

71188-LR LRAM-E88 Long Reach Amplifier Module - Enhanced 88-Channel

3.33 The 81.71188-LR LRAM-E88 Long Reach Amplifier Module - Enhanced 88-Channel is a single slot amplifier module that provides input amplification of the incoming DWDM signal on 44-channel and 88-channel systems. The module includes a span distance measurement feature via the OSC channel/ FPGA and in-band OSNR for collection of accurate per channel measurements that are data rate insensitive. The module is equipped with a redundant 100 BaseT controller interface and an RJ-45 connector. It connects directly to a discoverable DCM module.

71188-ER ELRAM-E88 Extended Long Reach Amplifier Module - Enhanced 88-Channel

3.34 The 81.71188-ER ELRAM-E88 Extended Long Reach Amplifier Module - Enhanced 88-Channel is a single slot amplifier module that provides input amplification of the incoming DWDM signal on 44-channel and 88-channel systems. The module includes a span distance measurement feature via the OSC channel/ FPGA. The discoverable DCM module connects through the RJ45 connector.

71123C Line Output Amplifier Module - Enhanced 88 Channel

3.35 The 81.71123C LOAM-E88 Line Output Amplifier Module - Enhanced 88-Channel is a single slot amplifier module which provides amplification of the outgoing DWDM signal in 88-channel systems and provides a redundant 100 BaseT controller interface.

71887B 8-Degree Reconfigurable Multiplexer Module - 88 Channel

3.36 The 81.71887B 8-Degree Reconfigurable Channel Multiplexer Module for 88 Channels (RCMM-8D88) is a two-slot module that provides reconfigurable multiplexing / demultiplexing of wavelengths and output amplification. The RCMM dynamically reconfigures up to 88 wavelengths for 50 Gig spacing, reducing wavelength blocking and enabling mesh restoration techniques. This module provides both TDM and Ethernet communications and is equipped with dual optical LC connectors that collect per channel optical power measurement. It can be cascaded to a maximum of 24 nodes.

New Revision of Tellabs 7100 OTS Shelves

3.37 New versions of the Tellabs 7100 OTS shelves are released that allow amplifier installation in slot 19:

- 82.07100A-60, Rev H - main shelf, NEBS compliant
- 82.07100C-60, Rev B - main shelf, ETSI compliant

714144 OMD44-1 and 714188 OMD44-45 Mux/Demux Modules

3.38 The 714144 OMD44-1 and 714188 OMD44-45 Mux/Demux modules connect to the RCMM-8D88 and perform optical multiplexing and demultiplexing of up to 88 channels. The 714144 OMD44-1 provides 44 dual LC connectors for adding or dropping channels 1 through 44. The 714188 OMD44-45 provides 44 dual LC connectors for adding or dropping channels 45 through 88. Both modules support electrical connections to the RCMM-8D88 module for inventory and communication. The OMD44-1 and OMD44-45 are typically installed in the 6-inch spacer panel on the rack.

83.71020 Generic Breaker Frame Alarm Panel

3.39 The 83.71020 Generic Breaker Frame Alarm Panel is not equipped with breaker kits. This generic form allows breakers to be sized according to configuration and ordered accordingly.

71125A Network Interfaced Raman

3.40 The 71125A Network Interfaced Raman (NIR) is an external amplifier that provides additional gain to input amplifiers in the Tellabs 7100/7100N OTS. The additional gain required from the NIR is calculated based on OSNR margin, the PMD present, fiber type, input amplifier used, wavelength, and the amount of insertion loss in the path. The NIR can be turned on and off in the software, and is typically deployed horizontally in the rack.

71125B Co-Propagating Raman Amplifier 700 mW

3.41 The 71125B Co-Propagating Raman Amplifier (CRA) is an external amplifier that allows the Tellabs 7100/7100N OTS to support traffic over larger optical span losses than would be possible if only using a Tellabs 7100/7100N amplifier. The CRA also allows a signal to travel through a larger number of total spans. The CRA provides post-amplification of a signal after the signal exits the Erbium Doped Fiber Amplifier (EDFA) of a Tellabs 7100/7100N amplifier. In a co-propagating deployment, the Raman amplification distributes a high pump power (700 mW) in the fiber in the same the direction of travel as the traffic.

82.71114B System Processor Module

3.42 The 82.71114B System Processor Module (SPM) can be installed in the main shelf or in the port shelf to replace the Data Processor Module (DPM).

Dispersion Compensation Module

3.43 New Dispersion Compensation Modules (DCMs) are equipped with a Communication port for connection to an amplifier that allows autodiscovery through the management system, craft station, and TL1 interfaces. When the DCM is autodiscovered, the fiber type and distance can be viewed and modified. A positive DCM is also available for applications using dispersion shifted fiber.

71328O-M Optical Transport Network Multiplexer

3.44 71328O-M Optical Transport Network Multiplexer (OTNM-D) multiplexes clients into the DWDM network transparently to provide increased capacity and flexibility for applications. The OTNM-D is designed with eight, low-speed SFP interfaces that support client rates from 100 Mbps to 4 Gbps. It supports a wide range of client signals, including SONET/SDH, Ethernet, Storage Area Network (SAN), OTU1, and video. The OTNM-D has an integrated line-side optical switch to provide DPRING protection. It can also be installed with the Y-Cable patch panel for signal protection.

71423M 40 Gbps, Multi-Port Tunable Transponder Module (FGTM-M)

3.45 The 82.71423M 40 Gbps, Multi-Port Tunable Transponder Module (FGTM-M) is a 40 Gbps, four-port tunable transponder module that multiplexes four 10 Gb client ports into one 40 Gb DWDM port. The FGTM-M accepts OC-192/STM64, 10G WAN Phy, 10G LAN Phy, or OTU2 client signals. It increases traffic-carrying capability four-fold and is easily installed in existing networks during a service upgrade without extensive network redesign or reconfiguration. It can also be installed with the Y-Cable patch panel for signal protection.

3.46 The FGTM-M supports the DQPSK modulation scheme on the line side facility and provides polarization mode dispersion compensation (PMDC) up to 10 ps.

82.71423 40 Gbps Transponder Module (FGTM)

3.47 The 82.71423 40 Gbps, single-port Tunable Transponder Module (FGTM) accepts OC-768 or STM-256 client signals. It increases traffic-carrying capability four-fold and is easily installed in existing networks during a service upgrade without extensive network redesign or reconfiguration. It can also be installed with the Y-Cable patch panel for signal protection.

3.48 The 82-issue FGTM supports the DQPSK modulation scheme on the line side facility and provides polarization mode dispersion compensation (PMDC) up to 10 ps.

SONET/SDH Switching Modules (SSMs)

3.49 The SONET/SDH Switching Modules (SSM) are available in the following formats: 71623S-M SONET/SDH Switching Module - 12 SFPs, 1 XFP, 1 MSA (SSM-D) and the 71623S SONET/SDH Switching Module - 12 SFPs, 2 XFPs (SSM-X). The SSM-D modules can be tuned to any of the ITU C-band 88 wavelengths (in the 88 channel plan) or 44 wavelengths (in the 44 channel plan) and support both SONET and SDH facility types.

3.50 The SSMs multiplex up to 12 low-speed clients and one high speed 10G client on its port-side interfaces into a high-rate OC-192/STM-64 interface and converts it into a DWDM optical channel on its line-side interface for transport over the Tellabs 7100/7100N OTS. A single channel of the DWDM interface is able to carry multiple low-speed signals for SONET, SDH, and Ethernet. The SSMs also support OC-192 and electrical Ethernet Client facilities. Protection schemes include OCH DPRING, UPSR, APS 1+1, and LAG port-side protection.

3.51 The SSM-D (XFP slot 1) has a widely tunable 10 Gb/s interface and supports OCH DPRING on the line-side or unprotected line-side UPSR.

3.52 The SSM-X (XFP slot 1) supports an OC-192, STM-64, or OTU2 line interface. It performs pass through to another SSM-D for line-side OCH-DPRING protection or add/drop multiplexing (ADM) functionality and supports unprotected line-side UPSR and line-side 1+1 APS.

3.53 When the SSM-D or SSM-X modules are deployed in the Tellabs 7100 OTS port shelf, they require at least one 82 version System Processor Module (SPM) or one Data Processor Module (DPM) in Tellabs 7100 OTS port shelf slot position 17 or 18.

4. Management Systems Graphical Interface Software

4.01 This section provides an overview of the Tellabs 7190/7194 management systems graphical user interface available for managing the Tellabs 7100/7100N OTS. The system management software is integrated to provide comprehensive Tellabs 7100/7100N OTS series management at the circuit (lightpath), network, and NE levels. These products include:

- Tellabs 7194 Network Management System (NMS) - graphical representation up to the network level to provide advanced system provisioning and management features, including simultaneous provisioning of multiple entities and en-to-end provisioning.
- Tellabs 7190 Element Management System (EMS) - provides graphical representation up to the network level.
- Tellabs 7191 Craft Station interface - provides provisioning capabilities for a single NE or multiple NEs if the connected NE is configured as a Gateway Network Element (GNE).
- TL1 Interface - command interface provides provisioning capabilities for a single NE or multiple NEs if the connected NE is configured as a Gateway Network Element (GNE).
- Tellabs 7196 Optical Subnet Planner - an automated tool for planning an optical network.

4.02 Tellabs 7100/7100N OTS series system management software is based on Transaction Language 1 (TL1) interfaces and Simple Network Management Protocol (SNMP). A dedicated message-forwarding interface between an operational support system (OSS) and a Tellabs 7190 EMS/Tellabs 7194 NMS server is also provided. The Tellabs 7190 EMS supports TL1 and SNMP protocols, and the Tellabs 7194 NMS supports XML protocols. For more information, refer to Northbound Interfaces, page 2-13.

4.03 The Tellabs 7191 craft station software is provided on the SPM and SPM-N modules (Web Craft), as well as on a CD for installation on a laptop or PC. The software embedded on the SPM allows provisioning, troubleshooting, and maintenance craft station functionality via a web browser.

Tellabs 7190 EMS and Tellabs 7194 NMS

4.04 The Tellabs 7190 EMS and Tellabs 7194 NMS provide a server/client management structure for the Tellabs 7100/7100N OTS network. They are typically deployed at central offices or network operations centers (NOCs). These products provide fault surveillance, configuration management, performance monitoring, and security control at the network level. Multiple users can access these management functions simultaneously from individual clients. The system management server software requires a Unix-based server and Oracle database server software. The client software runs on Unix-based or Microsoft® Windows®-based PCs.

4.05 Management system software for Tellabs 7100/7100N systems can be purchased with different feature sets. The Tellabs 7190 EMS provides basic functionality. Additional features are provided by the Tellabs 7194 NMS. The TL1 Northbound Interface provides TL1 alarm access. The XML Northbound Interface uses open standard TeleManagement Forum (TMF) 854/XML protocol to facilitate communication between the Tellabs 7190/7194 management systems and other operations support systems (OSS). The SNMP Northbound Interface provides a mediation layer to support SNMP-based network management.

Tellabs 7190 Element Management System Features

4.06 The Tellabs 7190 Element Management System includes the following basic features:

- Automatic network discovery
- NE power level measurement
- One-step software upgrade and database backup for single NE

Tellabs 7194 Network Management System Features

4.07 The Tellabs 7194 Network Management System includes the following basic features:

- Enhanced lightpath levels and baseline settings
- Wavelength tracing and fault isolation
- One-step software upgrade and database backup for multiple NEs
- Circuit tracing allowing fault isolation and root cause analysis
- Consolidated performance monitoring management
- End-to-End provisioning
- Multi-NE TL1 user management
- Multi-NE alarm profile management
- Multi-NE security management
- Control Plane provisioning

Tellabs 7190 SNMP Northbound Interface (Per NE)

4.08 The Tellabs 7190 SNMP Northbound Interface provides SNMP conversion and mediation for alarm forwarding between Tellabs 7190 EMS and OSS.

Tellabs 7194 XML Northbound Interface (Per NE)

4.09 The Tellabs 7194 XML Northbound Interface is based on open standard TeleManagement Forum (TMF) 854/XML (MTOSI) protocol for alarm forwarding and inventory retrieval to external OSS.

Tellabs 7191 Craft Station

4.10 The Tellabs 7191 craft station is a graphical user interface used to turn-up, provision, and perform routine maintenance on the Tellabs 7100/7100N optical transport systems. It is designed for short-term connection to a single NE for purposes of provisioning elements or troubleshooting minor anomalies.

4.11 The Tellabs 7191 craft station can be connected to an NE that is provisioned as a PGNE (gateway NE) and access all NEs on that EON. It can also be connected to an NE provisioned as an PRNE. Craft station software is provided via a web client (web craft), or it can be installed on a Windows-based PC. The following functions are provided only with the CD version of the software: online Help, basic commissioning of NEs, OLA/SBOADM upgrade acceptance testing, and multi-degree upgrade acceptance testing.

Tellabs 7196 Optical Subnet Planner

4.12 The Tellabs 7196 Optical Subnet Planner is a planning and engineering tool that plans cost-optimized Tellabs 7100/7100N OTS network configurations and develops corresponding product component lists for ordering. This tool can use database information of currently provisioned NEs via the Tellabs 7190/7194 management systems in order to import and build on currently provisioned network coordinates.

Tellabs Management Systems Architecture

4.13 The Tellabs 7190/7194 management systems communicate with Tellabs 7100/7100N NEs via a customer-provided data communications network (DCN) using the TL1 command protocol, Simple Network Management Protocol (SNMP), and Extensible Markup Language (XML). The TL1 command interface is supported for TL1 over TCP/IP. Customer-provided equipment in the DCN must support the transport of the TCP/IP protocol.

Note: *If an optical supervisory channel (OSC) is not provided, an individual connection between the Tellabs 7190/7194 management system and each NE is required.*

4.14 The Tellabs 7190/7194 management systems are based on a client/server architecture. The Tellabs 7190/7194 management systems client workstations provide an interface to the user and can be located anywhere that allows access to the Tellabs 7190/7194 management systems server. The client to server communication is Common Object Request Broker Architecture (CORBA) using Internet Inter-Object Request Broker Protocol (IIOP).

4.15 The primary host represents the physical server. Server groups represent logical entities or objects within the Tellabs 7190/7194 management systems that contain one or more NEs. Server groups are provisioned on the primary host.

4.16 Customers can deploy a centralized Tellabs 7190/7194 management systems server at the network operations center (NOC), and then secondary Tellabs 7190/7194 management systems servers at the central offices (CO). This application provides redundancy and guards against failures of the centralized server and failures in the data communications network. It also reduces management system downtime during upgrades of the centralized server.

4.17 Figure 4.1, page 2-27 and Figure 4.2, page 2-28 illustrate two typical applications.

Figure 4.1 Tellabs 7100/7100N Systems Network

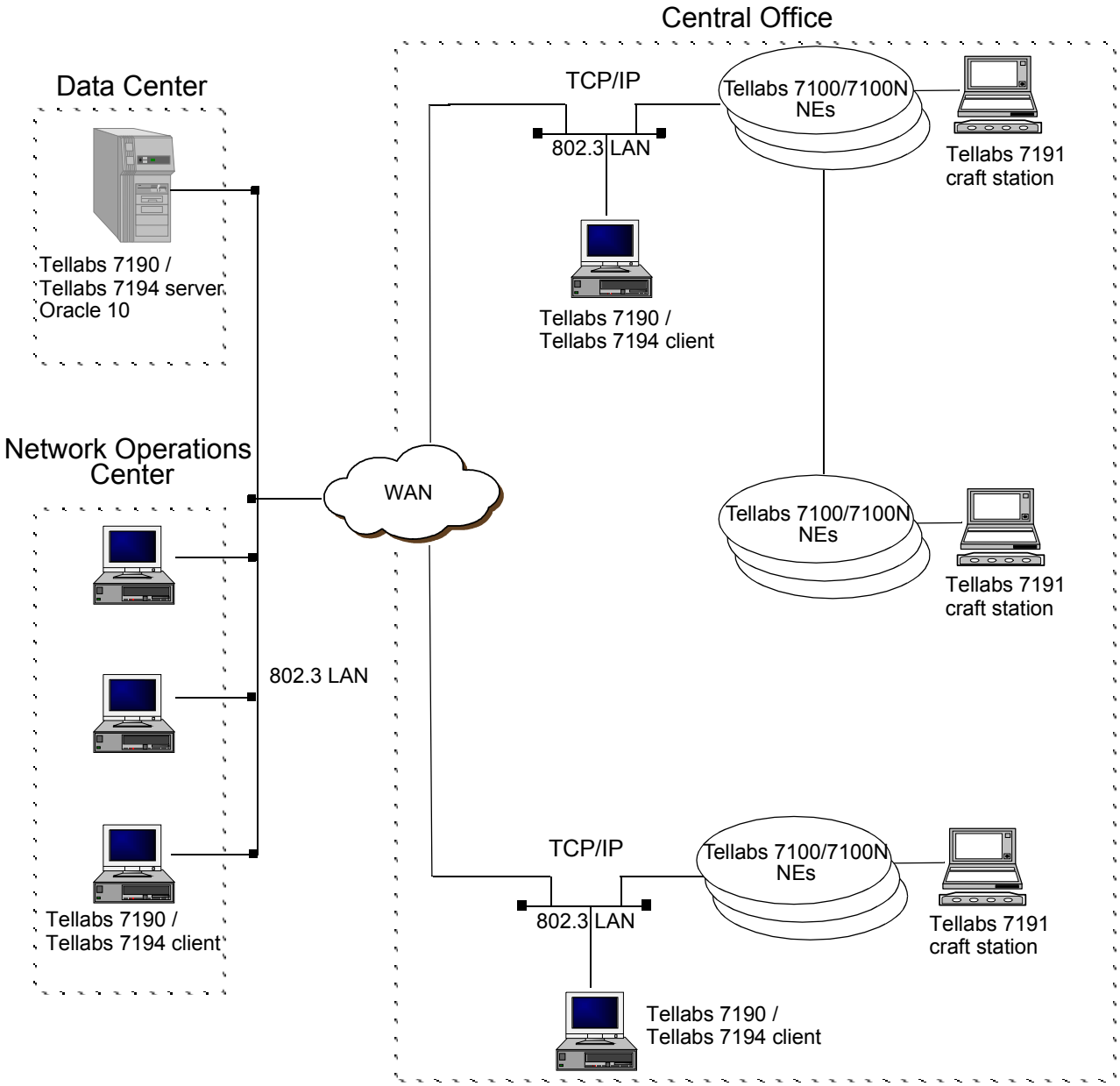
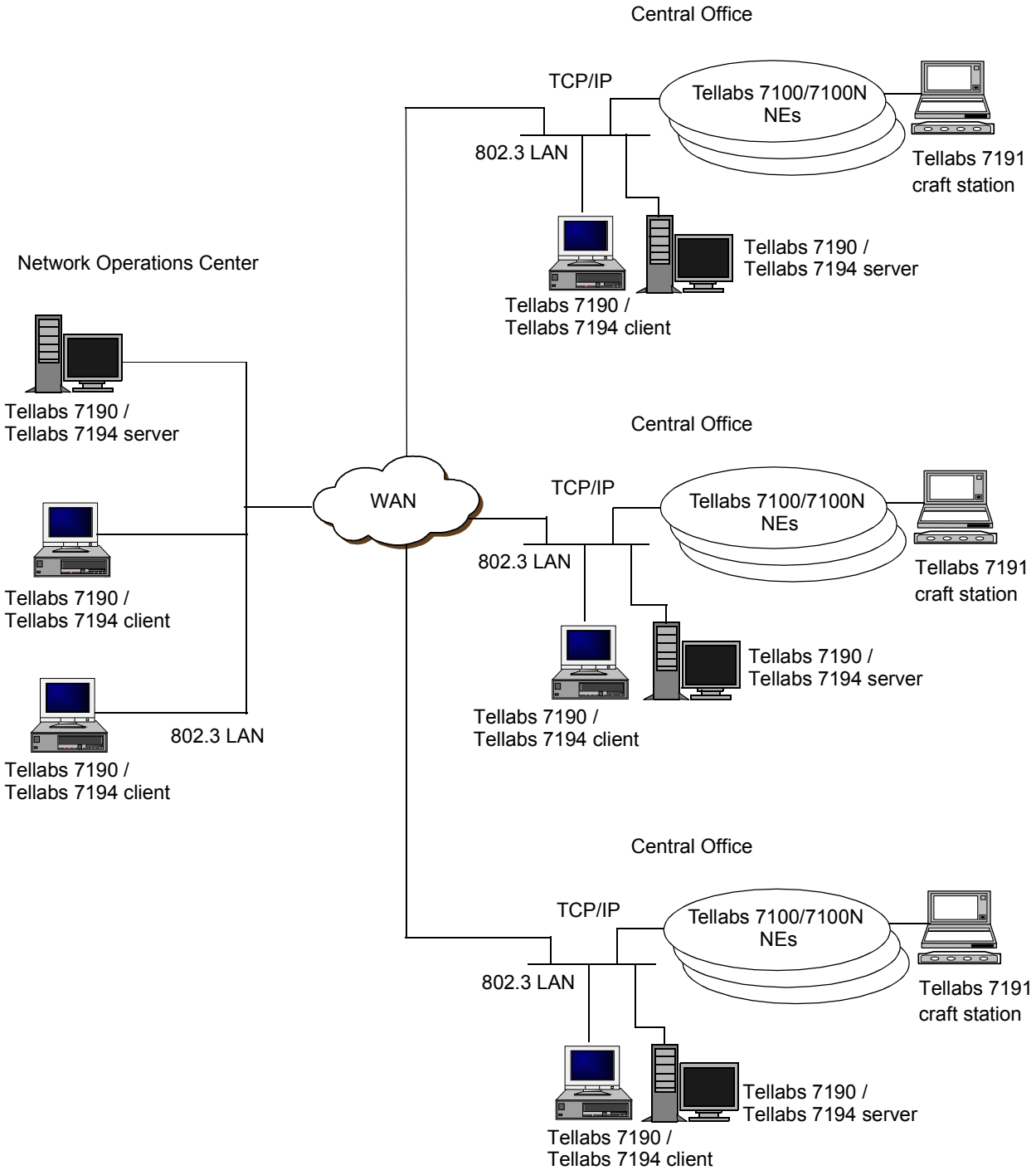


Figure 4.2 Tellabs 7100/7100N Network with Servers Installed at the Network Operations Center and Central Office



Network Management Features

4.18 The software features described in this section facilitate network management activities.

One-Step Upgrades

4.19 The Tellabs 7190 EMS one-step software upgrade and scheduled Database Backup/Restore facilitates the upgrade process for a single NE by combining multiple operations for EMS software upgrade and database backup/restore into a single screen.

4.20 The Tellabs 7194 NMS one-step software upgrade and scheduled Database Backup/Restore facilitates the upgrade process by combining multiple upgrade and database management operations on multiple network elements from a single dialog box. This feature also supports backing up and restoring databases of multiple network elements. One interface is provided for control and status of an upgrade, control and status of database backup, and controlling database restores.

NE Status Indicators

4.21 The status of individual NEs is nested in multiple levels in the Navigation Window hierarchy, starting at the root level and continuing down through site and region. NE states are represented iconically at these levels and include a tool tip that reports the number of NEs in the indicated condition at that level. NE conditions reported include loss of communication, auto-discovery state, metering enabled, autonomous notifications inhibited, locked NEs, and NEs that are out of service.

NE Metering Manages High-Volume Messaging Periods

4.22 NE metering temporarily disables event processing in the Tellabs 7190/7194 management systems when a flood of events from the network creates a backlog on the NE. NE metering is user-configured and indicated visually in the Navigation Tree.

NE Parameters Exported to Tellabs 7196 Planning Tool

4.23 The Tellabs 7194 NMS software retrieves and formats some NE parameters for export to the Tellabs 7196 Optical Subnet Planner (OSP). This allows easy reuse for incremental network expansion.

Primary and Secondary Database Backup

4.24 To protect against data loss, Tellabs 7100/7100N OTSs provide both a primary and secondary database backup. The primary non-volatile local backup memory is in the 71114B System Processor Module (SPM) and 71714 System Processor Module (SPM-N). The memory is automatically updated after data-affecting commands have been processed. Copies of the NE software and NE database are stored in the SPM/SPM-N.

4.25 A secondary backup memory can also be performed on an external server to protect provisioning information in the event of equipment failure. Secondary backup memory is updated following a request from the user.

4.26 TL1 commands allow files to be transferred from the system to an external local backup memory device. The system supports remote database backup and is capable of initiating memory backup to an external local backup memory device. Backup activities, including the transfer of a file, do not interrupt or interfere with traffic carried by Tellabs 7100/7100N OTS. The system database can be backed up as a file and restored using external means (download or upload) from the secondary local backup memory.

Database Restore

4.27 The Tellabs 7100/7100N OTS supports restoring a database from a remote location. This action can be taken using the Tellabs 7190 EMS, the Tellabs 7194 NMS, the Tellabs 7191 craft station, or with TL1 commands. Backed up files are transferred from an external backup memory source and restored on the operating server. FTP is used to transfer the secondary database backup file from the SPM/SPM-N or from an external source to an NE.

Software Upgrades

4.28 The Tellabs 7100/7100N OTS supports in-service upgrades. Software upgrades do not impact system traffic. If software distribution fails during an in-service upgrade, the software upgrade process is stopped. A manual back-out mechanism is used to return to the previous software version.

Note: *Tellabs recommends performing software upgrades during maintenance windows.*

Multiple NE Operations

4.29 This feature is provided with the Tellabs 7194 NMS and allows one action, such as an upgrade, to be performed simultaneously on multiple NEs within the network. The Multiple NE Operations feature simplifies the application of changes across impacted entities and ensures that the changes are applied consistently. The following operations can be performed:

- Multiple NE TL1 User Management: Copy TL1 user account profiles to multiple NEs.
- Alarm Profile Management: Copy alarm profiles to multiple NEs simultaneously.
- Security Management: Copy IP security certifications to multiple NEs simultaneously.
- Database Backups: Initiate or schedule database backups for multiple NEs simultaneously.
- Software Upgrades: Upgrade multiple NEs simultaneously.

User Security Partitioning

4.30 The Tellabs 7190/7194 management systems can define NE groups and assign different security profiles to these groups. This feature allows for partitioning of management responsibilities among different users.

Oracle® Data Guard

4.31 The Oracle Data Guard feature is configured for two server machines: one serving as primary server and one as a secondary server. It maintains synchronized databases between two servers while providing an entire backup system of the Tellabs 7190/7194 management systems. The secondary server acts as a cold standby in case of maintenance or failure on the primary server.

Retrieving Network Element TL1 Logs

4.32 Using the Tellabs 7190/7194 management systems, logs from multiple NEs can be retrieved through the report menu. NE logs are stored on the Tellabs 7190/7194 management systems for up to seven days in the NE Log Report.

Shelf Views with Active LEDs

4.33 The Tellabs 7190/7194 management systems and the Tellabs 7191 craft station enhance system monitoring activities with graphical representations of module front panels that mimic the actual front panel labels and LEDs of all modules and the shelf position of the module.

Fault and Alarm Management

4.34 The Tellabs 7100/7100N OTS continuously monitors incoming signals and internal system conditions, providing an alarm detection and reporting system to alert maintenance personnel in the event of a failure. All alarms are displayed and managed from an alarm window on the management system interface. For details on the Alarm Management feature, refer to Alarm Management, page 2-104.

Diagnostics

4.35 This feature provides visibility to the resource consumption by the Tellabs 7190/7194 management systems. The management system periodically polls its resources and displays the overall health of the management system, as well as the health of the memory, processes, and file systems upon which it is dependent. Alarm thresholds alarms are user-configured. On-demand and scheduled reports on the current and historical health and performance of the Tellabs 7190/7194 management systems are also available.

Alarm Profile Management

4.36 The Tellabs 7190/7194 management systems provide alarm profile management by allowing management system users to create templates for alarm profile tables and assign the templates to different NEs.

Alarm Synchronization

4.37 The alarm synchronization capabilities of the Tellabs 7190/7194 management systems include retrieval of historical alarm and event information during loss of communication or blackout periods between the Tellabs 7190/7194 management systems and the NE.

Alarm Filtering

4.38 Alarms can be filtered based on multiple condition types and multiple entity types. Substring matching on entity AIDs is also supported.

Alarm Sorting Based on Multiple Criteria

4.39 Alarm and event reports based on multiple criteria can be sorted based on up to three criteria.

Alarm/Event Time Zone

4.40 The alarm filter in the Tellabs 7190/7194 management systems allows clients to display alarms that occur at remote sites in local time. The filter configures local time at the NE where the alarm is set and GMT time at the server receiving the alarm.

Automatic Acknowledge of Transient Conditions

4.41 This feature allows acknowledgement of a transient condition 15 minutes after the condition occurs so new conditions can be separated from existing conditions. Once acknowledged, a filter can be applied to define the category of events that appear in the Event Window. A specific security user-profile is required to schedule force acknowledge of transient conditions.

Root Cause Analysis

4.42 Using the Tellabs 7194 NMS, circuit discovery and root cause analysis is performed at the optical layer. This feature assists in identifying the root cause of alarms that are affecting a circuit within the Tellabs 7100 managed network. Unlike filtering in the alarm window, all the alarms that are affecting the circuit in a single location are isolated and evaluated using root cause analysis. The element management system presents the alarms affecting the circuit and highlights alarms representing probable root causes.

Security Management

4.43 The Tellabs 7190/7194 management systems offer configurable security profiles for users. Each user is assigned a security profile to access the Tellabs 7100/7100N OTS. The six user profiles available are:

__ Admin (A8)

__ Operator (A7)

__ Provisioning (A6)

__ Test (A4)

__ Public (A2)

__ Interface Access(A0)

4.44 The Tellabs 7190/7194 management systems can be configured to control user access to specific NEs. Using the Tellabs 7194 NMS, TL1 user account profiles can be copied to multiple networks simultaneously. This simplifies the application of the changes being applied to the user accounts, and ensures that the changes are applied consistently across the impacted entities. It is also possibly to copy alarm profiles and IP security certifications to multiple network elements simultaneously. Refer to *Tellabs 7100/7100N System Administration Using Management Systems* for additional information.

Configuration Management

4.45 Tellabs 7100/7100N OTS Configuration Management (CM) provides the functions for provisioning a Tellabs 7100/7100N NE. All traditional operations, administration, maintenance, and provisioning (OAM&P) functions are supported, including:

- equipment configuration
- facility configuration
- cross-connects
- state management (placing equipment in-service or out-of-service as required)

Provisioning Features

4.46 This section describes Tellabs 7190/7194 management systems features that support provisioning.

Provisioning Defaults

4.47 A profile of default values for a given entity can be created and maintained in the Tellabs 7190/7194 management systems. Utilizing this feature increases the efficiency of provisioning activities and ensures that entities are provisioned consistently.

Centralized Configuration for STSn and VCn

4.48 The Tellabs 7190/7194 management systems provide the capability to apply a configuration change across multiple STSn or VCn on an SMTM-U from one dialog. Using a single Configuration dialog box, attributes can be provisioned and then applied to multiple STSn or VCn.

Wavelength Manager

4.49 This feature provides single-screen provisioning or deprovisioning of wavelengths on the Tellabs 7100/7100N OTS.

Network Views

4.50 Network views on the Tellabs 7190/7194 management systems provide network layer graphics to facilitate viewing and provisioning a network.

4.51 TID/CLLI positions are assigned to a location on the map. By positioning the mouse over the end-point of a DWDM link, the TID and CLLI of the NE supporting the end-point are displayed in a Tool tip. If an NE is deleted from the network, the Tellabs 7190/7194 management system retains the NE TID coordinates so the NE can be easily re-added if required. The TID coordinates can also be removed manually if the NE will not be re-added to the network.

4.52 Presentation of icons, the extent of the default view, and link entity groups is user-configurable. Country and state data is displayed, down to detail of highways, cities, and waterways. Bi-directional link properties are available, which display per direction information such as span loss, fiber ID, length, type, polarized mode dispersion (PMD), and chromatic dispersion (CD).

4.53 Each time the Network View is accessed, it defaults to an optimized view of the network based on node location. Network views can be associated with a particular region or site and saved for future reference. The view can then be set as the default for any user. For more information, refer to *Tellabs 7100/7100N Provisioning Using Management Systems*.

4.54 The currently displayed Network View is saved with user preferences upon exiting the client and re-displayed the next time the client is started. The Network View also provides an alarm summary count for entities within the current view. An Alarm tab is available for composite entities. A graphical presentation of the (enhanced) lightpath power levels from a network layer perspective is also available.

TID/CLLI Coordinates Import

4.55 TID/CLLI coordinates can be imported from an external file into the Tellabs 7190/7194 management systems.

Circuit Views

4.56 If enabled, this Tellabs 7194 NMS feature provides circuit/wavelength fault isolation for transponders and circuit/wavelength tracing. Circuit views show how nodes are connected. From a selected transponder, the Tellabs 7194 NMS discovers and provides a graphical display of the circuit from any transponder. From the circuit view, diagnostics such as Pseudo Random Bit Sequence (PRBS) test signals and loopbacks can be started.

Circuit Discovery (Optical Layer)

4.57 Using the Tellabs 7194 NMS, circuit discovery on the OCH layer includes resource lists of all entities supporting the circuit. It is also possible to put groups of these entities in-service and out-of-service simultaneously.

4.58 Root cause analysis is available from the Alarm window and the Circuit Discovery window. The EMS reports configuration anomalies, including forward error correction (FEC) mismatches, protection mismatches, and signal rate mismatches.

4.59 The following actions can be performed on entities supporting a circuit carried over an OCH facility:

- de-provision entities
- enable and disable performance monitoring (PM) on entities
- review current and historical PM on entities
- perform root cause analysis on discovered circuits
- OCH cross-connects are discovered and displayed at transponder add/drop site with increased anomaly detection (such as end-point compatibility)

End-To-End Provisioning of Circuits on Optical Layer

4.60 Using the Tellabs 7194 NMS, circuits can be provisioned on the optical layer and completed via circuit discovery. End-to-end provisioning of circuits on the optical layer also supports:

- provisioning of OCH circuits:
  - point-to-point, protected, and unprotected circuits
  - line-side UPSR/SNCPRING ring
  - optical drop and continue (broadcast) circuits
- discovery and provisioning of OC-192 and STM-64
- discovery and provisioning of STS/VC/STS1CNV/STS3CNV/VC4NV

End-to-End Sub-Circuit Management

4.61 End-to-end sub-circuit provisioning of STSn, VCn, and transparent OCn entities is supported in the Tellabs 7194 NMS.

End-to-End RPR Circuit Management

4.62 The Tellabs 7194 NMS optimizes network management with end-to-end provisioning of RPR circuits and wavelength provisioning and deprovisioning.

Lightpath Power Levels

4.63 If enabled, this optional feature is available from the Network Views of the Tellabs 7194 NMS. The Lightpath Power Levels feature reports baseline and nominal power values and allows modification of minimum, maximum and default values associated with this function. The optical power grid includes gain and span loss columns, amplifier OSC power measurements, color coding for out of range OSNR values, display of the power adjustment mode, and calculated span loss in the aggregate tabs. Minimum and maximum ranges can be retrieved and modified. The optical power grid layout can be saved and modified, and grid refresh time is user-configurable.

Performance Monitoring

4.64 This section describes features that support system performance.

Consolidated Performance Monitoring (PM)

4.65 Using circuit discovery on the Tellabs 7194 NMS, consolidated PM monitors PM on the circuit path supported by multiple NEs and isolates trouble areas. Consolidated PM is available only on the Tellabs 7194 NMS.

Performance Reports

4.66 The following system reports are available: SMAT Report, Alarm Report, NE Report, Equipment Inventory Report, Scheduled Backup Reports, Equipment Outage Report, Facility Inventory Report, Facility Protection Group Report, Cross-Connect Report, Historical PM Report, Equipment Availability Report, Wavelength Utilization Report, and NE Log Report.

4.67 Reports on the Tellabs 7190/7194 management systems can be scheduled for subsequent delivery and filtered according to specified criteria. On-demand reports can be e-mailed or delivered via FTP.

Capacity Reports

4.68 Two capacity reports are supported:

- The Equipment Availability report details information at a set of network elements. For each network element within scope, this includes the count of provisioned, equipped, and in-service modules of each type, as well as the number of additional port modules of each type that could be provisioned.
- The Wavelength Utilization report details information on wavelength utilization at a set of network element interfaces. For each wavelength at each interface, the report includes the wavelength cross-connect, the port-side equipment used, and a summary of the sub-wavelength utilization where applicable.

SMAT Reports

4.69 System management audit trail (SMAT) reports are available on the Tellabs 7190 EMS and Tellabs 7194 NMS. The SMAT report criteria can be filtered for NE-impacting activities or administrative activities.

5. System Applications

5.01 The Tellabs 7100/7100N OTS is designed for cost-effective transport of high-bandwidth services using dense wavelength division multiplexing (DWDM) technology. This allows management of high-bandwidth circuits through a combination of lightpath management features and software management systems that track lightpaths through the entire network.

5.02 DWDM networks provide end-to-end broadband transport circuits through modulation of multiple optical data streams onto separate light frequencies along a single optical fiber (typically grouped in pairs for bidirectional transmission). The application of DWDM technology through the Tellabs 7100 OTS leverages existing fiber plant infrastructure.

5.03 The Tellabs 7100/7100N OTS is available in six basic configurations:

- Tellabs 7100 OTS Single-Bay OADM (SBOADM) - 88 channels
- Tellabs 7100 OLA - 88 channels
- Tellabs 7100 OTS Single-Bay OADM (SBOADM) - 44 channels
- Tellabs 7100 OLA - 44 channels
- Tellabs 7100N OTS Single-Bay OADM (SBOADM)
- Tellabs 7100N OLA - 88 channels
- Tellabs 7100N OLA - 44 channels

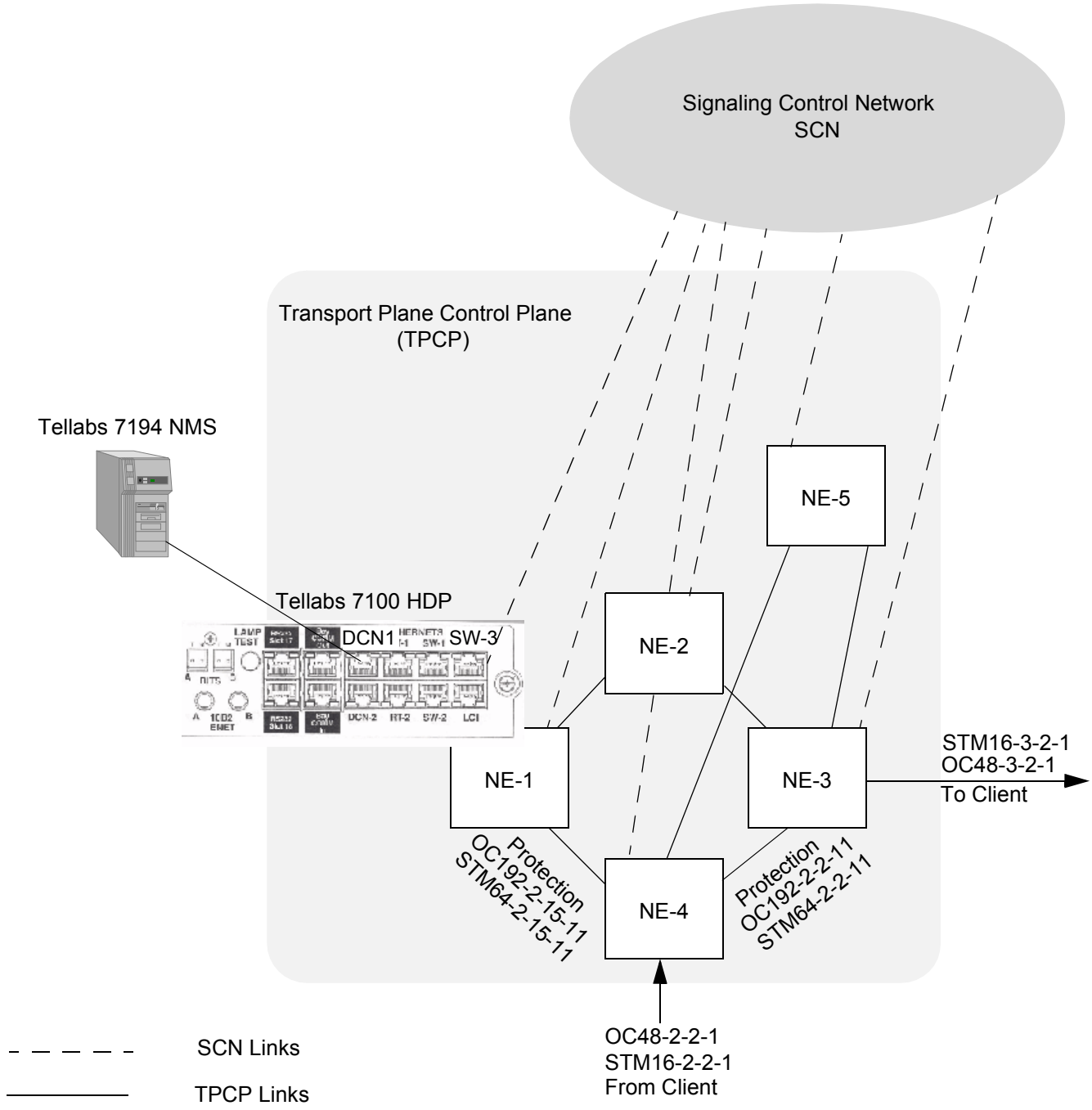
5.04 Combinations of these configurations allow the Tellabs 7100/7100N OTSs to be used in the following applications:

- control plane
- point-to-point
- DWDM rings and ring inter-networking
- mesh networks
- direct connect
- spur applications

Control Plane Applications

5.05 The Tellabs 7100 OTS control plane provides dynamic call provisioning across the data transport network. Control plane enables network visibility in Tellabs 7100 NEs so end-to-end connections are configured across the network on both Tellabs equipment and other vendor equipment via topological links. It is provisioned locally via facilities on SMTM-U modules in SPFAB-equipped port shelves. Figure 5.1, page 2-40 is a high-level representation of a Tellabs 7100 OTS in a control plane application.

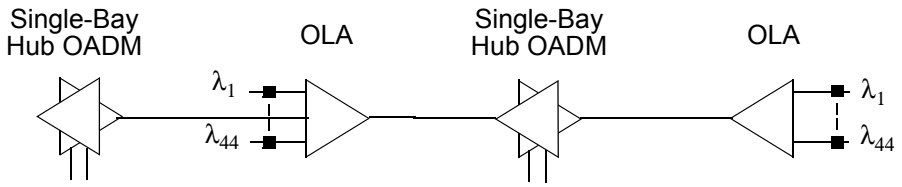
Figure 5.1 High-Level Control Plane Application



Point-to-Point Topology

5.06 A point-to-point topology forms a chain in which the network elements can add or drop traffic at specific points. Amplification is provided between points if required. Refer to Figure 5.2, page 2-41.

Figure 5.2 Tellabs 7100 NEs in a Point-to-Point Topology



DWDM Ring Networks

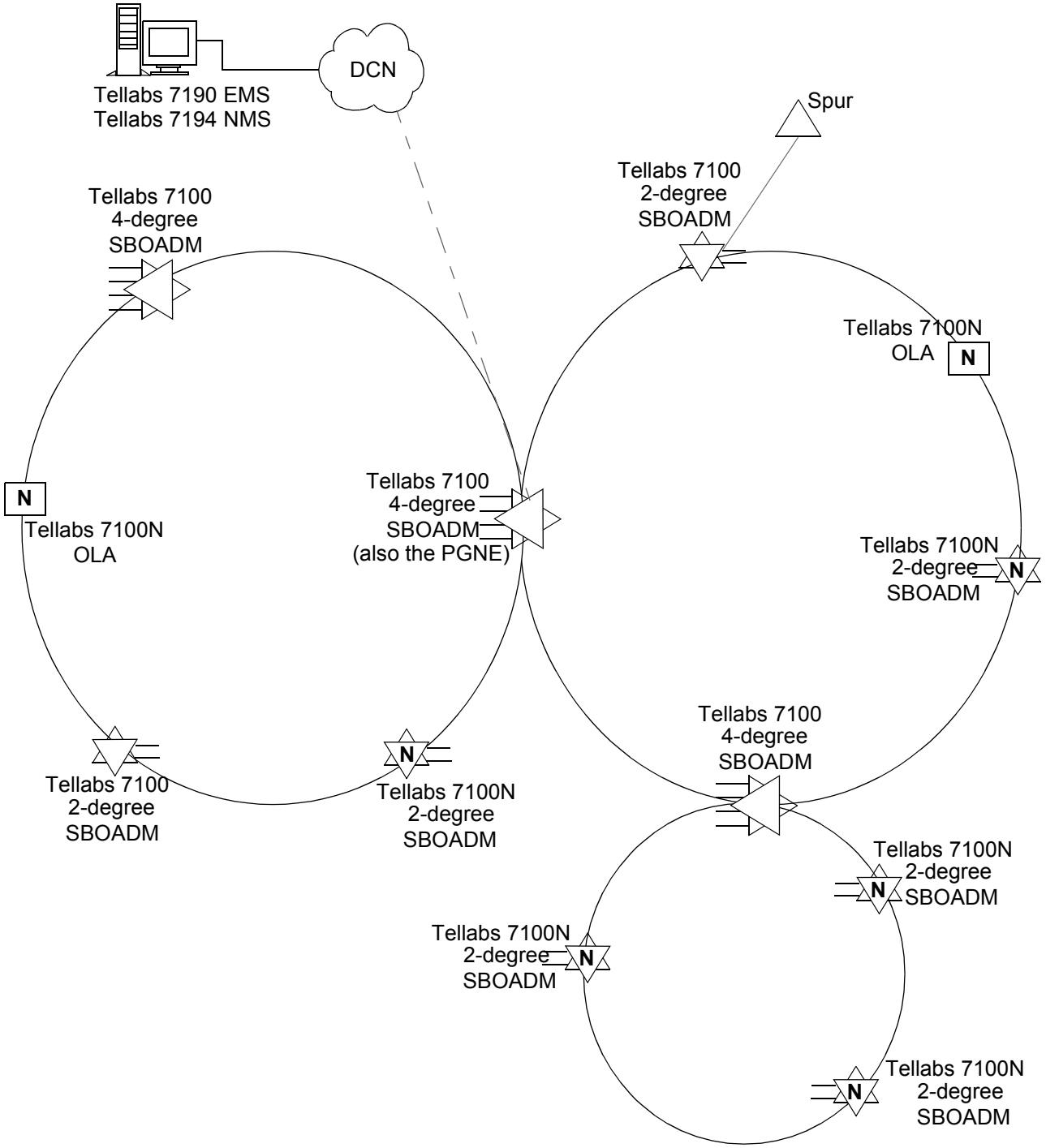
5.07 A Tellabs 7100/7100N OTS ring network is a circular topology in which a series of NEs are connected to form an unbroken ring. Ring configurations provide two separate signal paths. In the event the fiber is severed, a signal can travel along the alternate signal path to reach its destination. The ring configuration also allows repairs to be made without disrupting customer service.

5.08 For ring internetworking, the channels of one ring are passed through another ring. Bands or channels are passed from a SBOADM in one ring to a SBOADM in another ring, interconnecting the two rings. A Tellabs 7100/7100N SBOADM can be used to interconnect two rings as shown in Figure 5.3, page 2-42. This example comprises 2-degree and 4-degree SBOADMs, an OLA, a spur NE, and Tellabs 7100N OTS NEs.

Tellabs 7100N OTS

5.09 The Tellabs 7100N OTS is a feature-rich, eight-channel Tellabs 7100 OTS application. It provides a smaller footprint and is designed for metro networks where the capacity of a Tellabs 7100 OTS is not required. The Tellabs 7100N OTS can add/drop up to eight channels and amplify up to 88 pass-through channels. Refer to Figure 5.3, page 2-42.

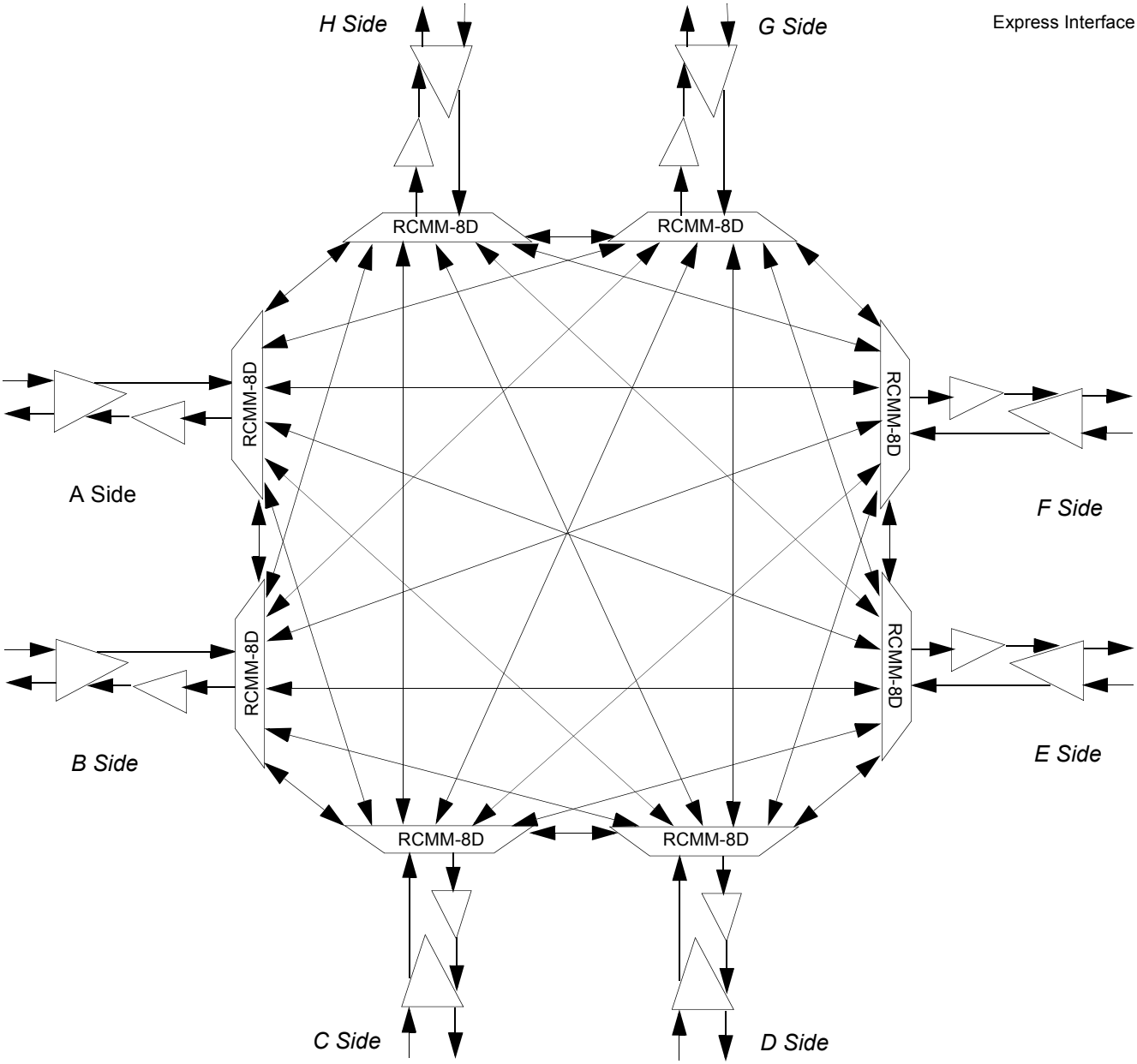
Figure 5.3 Tellabs 7100/7100N OTS Inter-Network Ring



Mesh Network

5.10 A mesh network has a grid-type topology.Tellabs 7100/7100N OTSs are connected together by fiber spans to provide alternate paths across the network. This is possible via optical pass-through on a channel-by-channel basis. A mesh network offers more protection than ring topologies because there is more than a single choice for a protection path. A mesh optical network uses SBOADMs for pass-through, with or without transponders. Wavelength conversion is supported with transponders. All connections at the individual channel level are managed via the RCMM, which provides the reconfigurable OADM functionality. Lightpath tracing and verification is completed using the optical path trace feature. Figure 5.4, page 2-43 shows an 8-degree mesh network.

Figure 5.4 Tellabs 7100 OTS Mesh Network



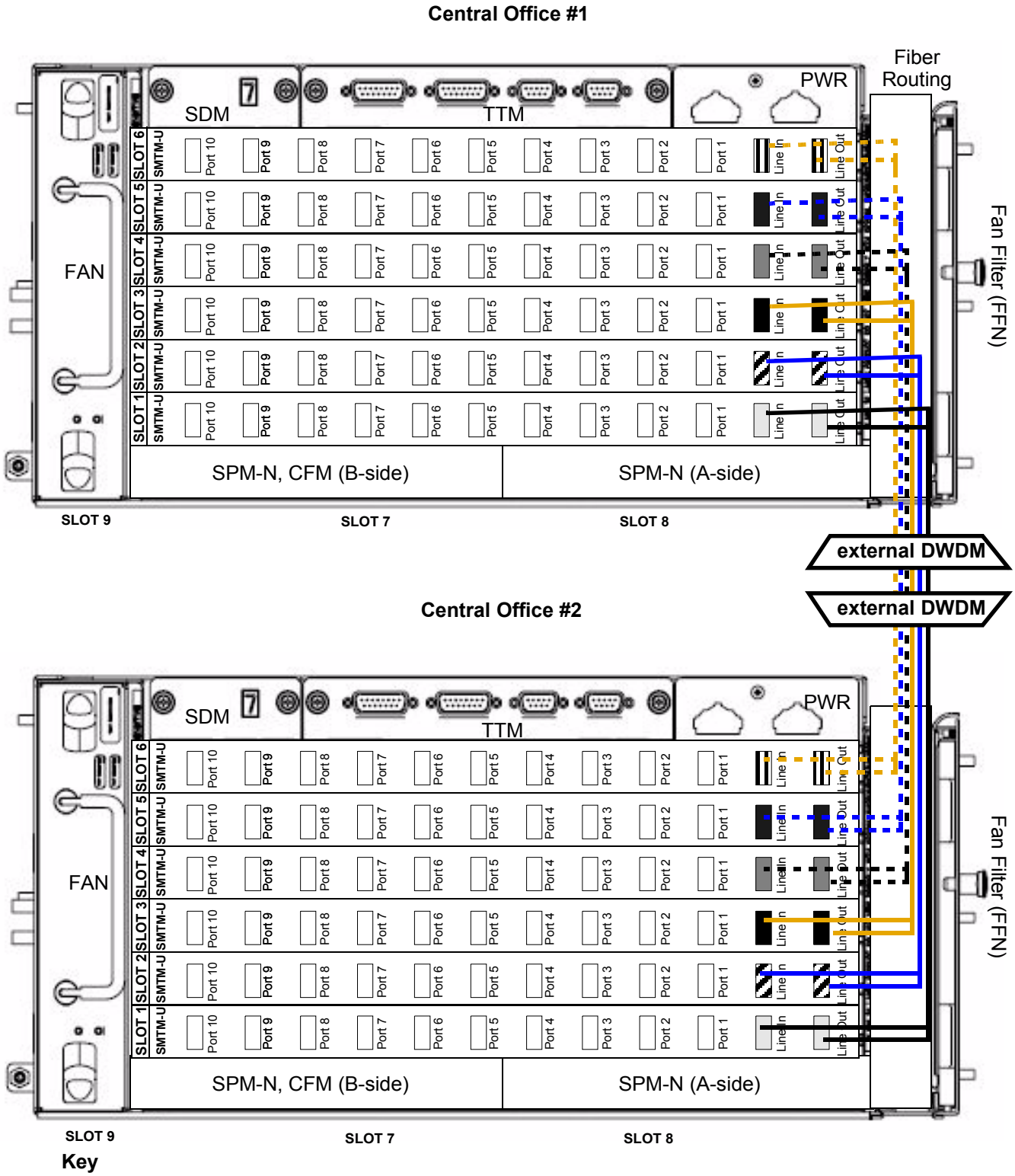
Direct Connect Overview

5.11 The Direct Connect feature eliminates the previously required connection between multiplexers and transponder modules. The Direct Connect feature provides a direct path between the line-side optical channel on a Tellabs 7100/7100N transponder and a DWDM multiplexer or transponder that is external to the Tellabs 7100/7100N OTS. The channel mimics a foreign wavelength, allowing a single, wavelength connection to external equipment without provisioning the path through a multiplexer (RCMM-xD, RCMM-8D88, CMM-44, or CCM-xR). The line-side G.709 signal on the transponder is tuned to one of the 88 channels supported on the Tellabs 7100 OTS, or one of the 44 channels supported on the Tellabs 7100N OTS. The Direct Connect feature can also be provisioned on the line-side optical channel of two transponders in different Tellabs 7100/7100N OTSs, creating a SONET/SDH ring. The Direct Connect feature is provisioned via the Connected parameter for OCH-P facilities supported on MRTM-E, TGTM-E, FGTM, FGTM-M, SMTM-U, SSM-X, SSM-D, OTNM-D, SMTM-P, and TGIM-P transponders. Figure 5.5, page 2-45 illustrates this application.

5.12 The Direct Connect feature is configured per module. Modules using the Direct Connect feature may be mixed on the same shelf with other modules that do not use the Direct Connect feature.

5.13 When all the Tellabs 7100N transponder modules are configured for the Direct Connect feature, the SBOADM Main Shelf configuration does not require Colorless Core Modules (CCMs). When CCMs are not used, slots 1 through 6 must be populated with Blank Filler Modules (BFMs) or Direct Connect transponders.

Figure 5.5 SBOADM Direct Connect Port Shelves Showing End-to-End Tellabs 7100N OTS Transponders to External DWDM



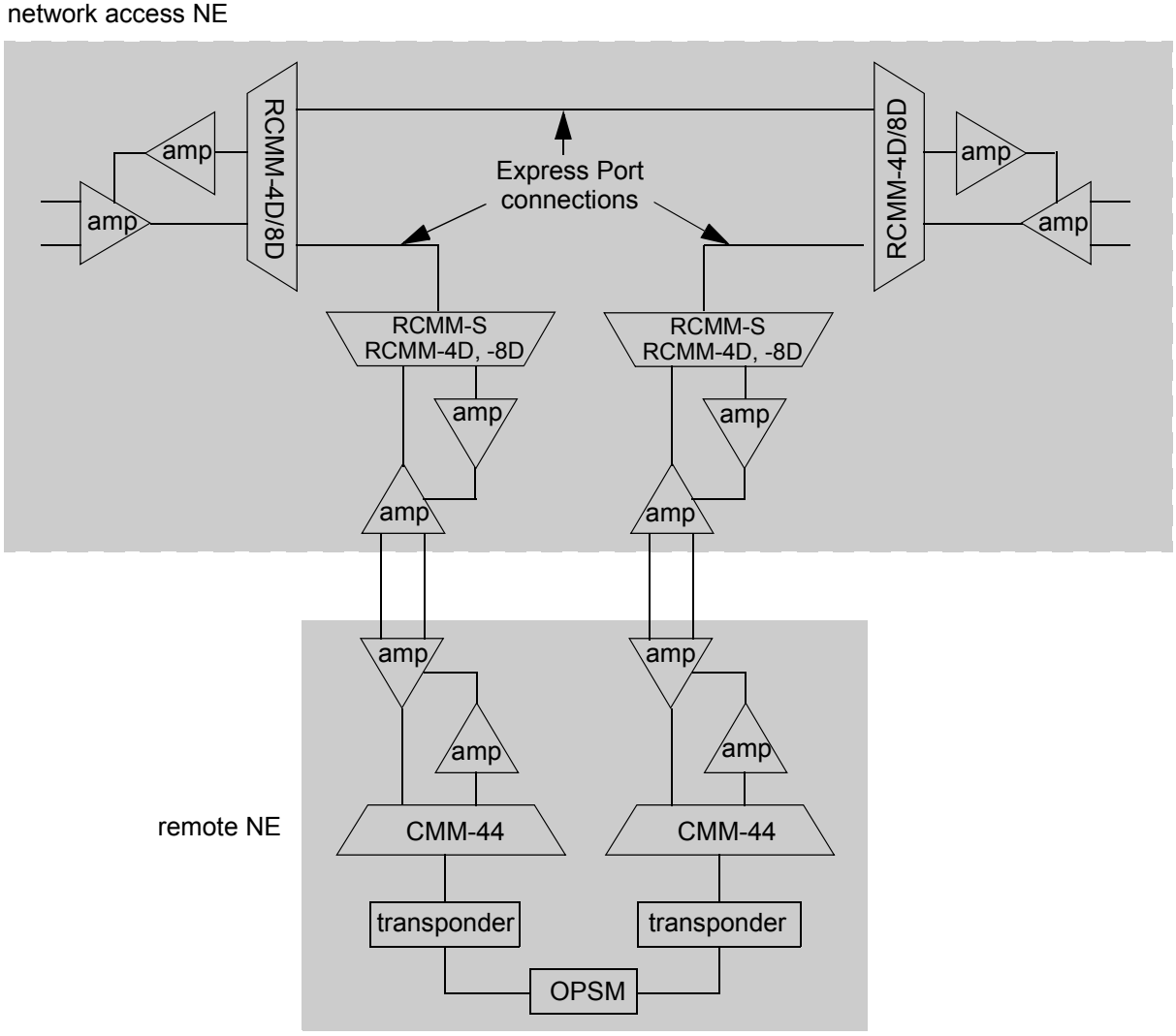
Spur Applications

5.14 A spur is a point-to-point Tellabs 7100/7100N network connection between a remote location and a Tellabs 7100 site that is part of the main artery or ring. This connection between the remote site (spur site) and the site on the main artery or ring (main site) can be protected or non-protected.

5.15 The spur application requires the use of the 71337 Channel Multiplexer Module-44 Channel (CMM-44) in the 2-Degree Spur SBOADM. The 4-Degree Spur SBOADM and the 8-Degree Spur SBOADM use the 71227E Reconfigurable Channel Multiplexer Module-Spur (RCMM-S).

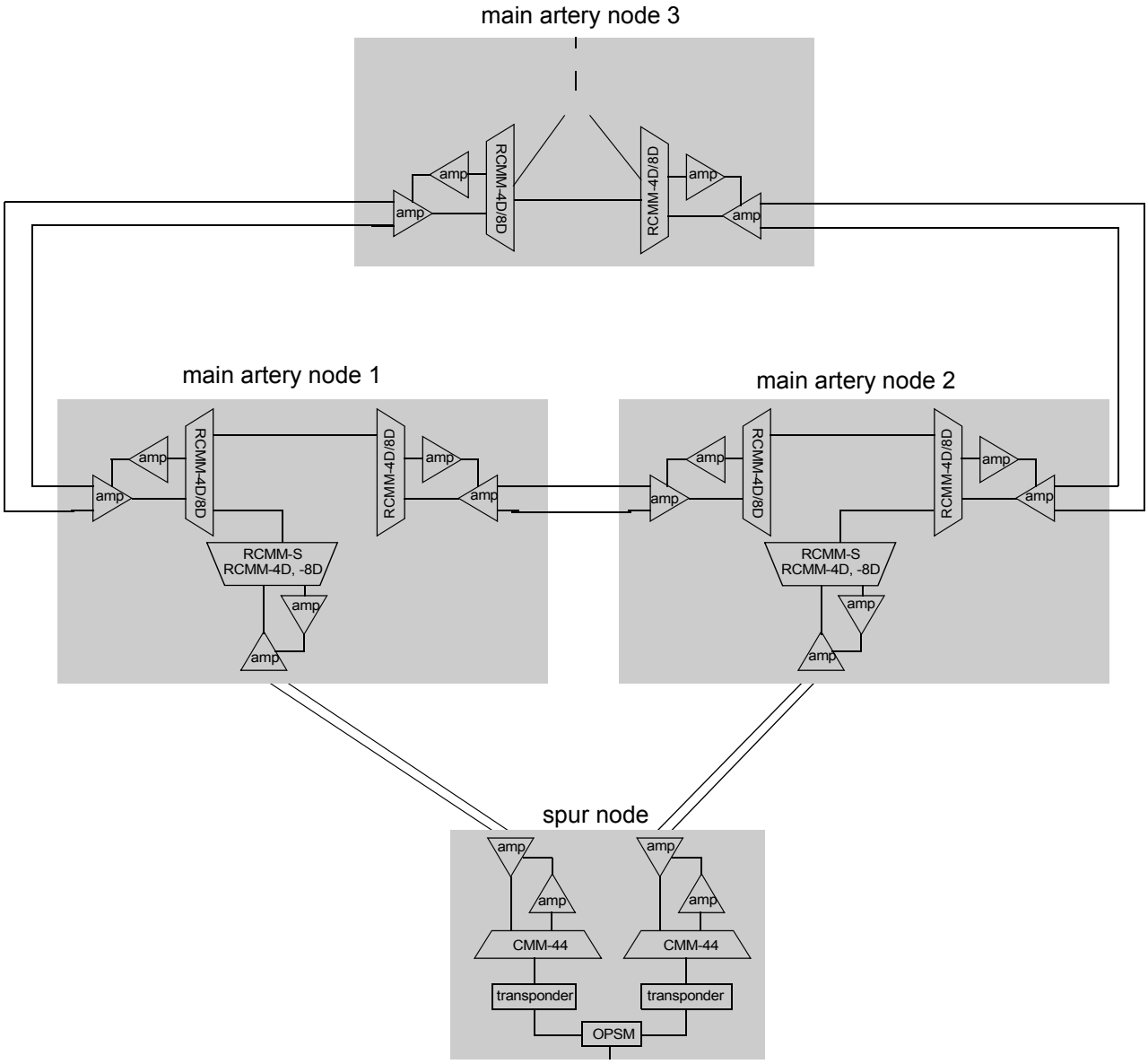
5.16 Figure 5.6, page 2-46 illustrates a typical spur application with a CMM-44 at the remote NE and an RCMM-S at the network access NE. Two CMM-44s and RCMM-Ss provide protected service.

Figure 5.6 44-Channel Spur Application with Protection



5.17 Figure 5.7, page 2-47 illustrates a dual home ring interconnection with spurs. Each spur span ends on a different node on the main artery. This configuration provides better protection against main artery node failure.

Figure 5.7 Dual Home Ring Interconnection with Spurs



6. Physical Configurations

6.01 This section describes the physical configurations available for the hardware associated with the Tellabs 7100 OTS or Tellabs 7100N OTS. Tellabs 7100/7100N OTSs are configured with a variety of modules. All module, cabling, and connector interfaces are accessible from the front of the shelves. The systems are provisioned and operated with management system applications, through TL1 command sessions, or a Command Line Interface. Some system information can be translated and forwarded via SNMP and XML interfaces.

6.02 The following network configurations are supported:

- Tellabs 7100 Single Bay OADM (SBOADM) - The Tellabs 7100 OTS single bay optical add/drop multiplexer (SBOADM) is a single network element with multiple DWDM interfaces. A four-degree SBOADM requires one main shelf, supports up to eight port shelves, and operates within a 44-channel plan. An eight-degree SBOADM requires two main shelves and supports up to eight port shelves, and operates within a 44- or 88-channel plan.
- Tellabs 7100 Optical Line Amplifier (OLA) - a 44- or 88-channel OLA can be configured for short, medium, or long spans. The OLA does not support add/drop functions, but can be upgraded to a 2-degree node SBOADM without affecting traffic. This configuration can also be designed for the direct connect application.
- Tellabs 7100N OTS SBOADM - the main shelf has up two DWDM interfaces, A-side through B-side and supports eight protected wavelengths. The Tellabs 7100N OTS SBOADM is supported only in 44-channel systems.
- Tellabs 7100N OLA - a 44- or 88-channel OLA can be configured for short, medium, or long spans. The OLA passes through up to 88 channels and does not support add/drop functions. This OLA is interchangeable with Tellabs 7100 OLA. This configuration can also be designed for the direct connect application.

Note: *For complete descriptions of Tellabs 7100/7100N system modules and slot assignments per configuration, refer to Tellabs 7100 System Engineering or Tellabs 7100N System Engineering.*

FP5.1.x Configurations

6.03 Table 6.1, page 2-49 describes hardware configurations supported on the Tellabs 7100 OTS and the Tellabs 7100N OTS. These configurations are provisioned during basic commissioning of an NE.

Table 6.1 Supported Hardware Configurations

Software Configuration	Configuration Type	Sub-Type	Hardware Rev	Amplifier SpanA	Amplifier Span B	Can be Changed To
0	NA - Unknown	NA	NA	NA	NA	All
Tellabs 7100N OTS Configurations						
17	7100_OLA	CH44_N	4[1]	CM	CM	0
18	SBOADM	CH44_N	4	CM	CM	0
19	7100_OLA	CH88_N	4	CM	CM	0
Tellabs 7100 OTS 88-Channel Configurations						
31	7100_OLA	CH88	3	LAMP	LAMP	0, 32
32	SBOADM	CH88_RCMM8	3[2]	LAMP	LAMP	0
Tellabs 7100 OTS 44-Channel Configurations						
39	SBOADM	CH44_RCMM4	3[3]	LAMP	LAMP	0, 42[4]
40	SBOADM	CH44_RCMM2	3	LAMP	LAMP	0, 39, 41
41	7100_OLA	CH44	3	LAMP	LAMP	0, 40
42	SBOADM	CH44_RCMM8	3	LAMP	LAMP	0
Note: 0 indicates that the user can delete the database and return to UNKNOWN_SUBNODE configuration.						

1. Hardware revision 4 is supported in main shelf 81.07170A and port shelf 81.07170B.
2. Hardware revision 3 is supported in main shelf 82.07100A-60 and port shelf 82.01700B-60.
3. Hardware revision 3 is supported in main shelf 82.07100A-60 and port shelf 82.01700B-60.
4. Configuration 39 cannot be changed to configuration 42 if PS-13 is provisioned.

44-Channel Configurations

6.04 This section describes 44-channel system configurations supported in FP5.1.x.

8-Degree Reconfigurable SBOADM (ROADM)

6.05 The 8-Degree Reconfigurable SBOADM provides reconfigurable multiplexing and demultiplexing of wavelengths that are added, dropped, or passed through from one DWDM interface to up to seven other DWDM interfaces within one NE. The 8-Degree SBOADM requires two main shelves to accommodate eight DWDM directions and eight RCMM-8Ds or RCMM-Ss modules. Each main shelf is equipped with a maximum of four LIAM-Es, LRAM-Es or ELRAM-Es; four LOAM-E; four RCMM-8Ds or RCMM-Ss; and two SPMs.

4-Degree Reconfigurable SBOADM (ROADM)

6.06 The 4-Degree Reconfigurable SBOADM provides reconfigurable multiplexing and demultiplexing of wavelengths that are added, dropped, or passed through from one DWDM interface to up to three other DWDM interfaces within one NE. The 4-Degree SBOADM requires one main shelf to accommodate four DWDM directions and four RCMM-8D or RCMM-S modules. The main shelf is equipped with a maximum of four LIAM-Es, LRAM-Es or ELRAM-Es; four LOAM-Es; four RCMM-8Ds or RCMM-Ss; and two SPMs.

Tellabs 7100N SBOADM

6.07 The 2-Degree Tellabs 7100N OTS provides reconfigurable multiplexing and demultiplexing of eight wavelengths that are added, dropped, or passed through from one DWDM interface to another DWDM interface within one NE. This application requires one Tellabs 7100N main shelf to accommodate two DWDM directions, equipped with two CCMs and two SPM-Ns.

44-Channel OLA

6.08 The 44-channel OLA amplifies and passes through up to 44 wavelengths. It requires one main shelf which is equipped with amplifiers, filler modules, and SPM/SPM-N.

88-Channel Configurations

8-Degree, 88-Channel Reconfigurable SBOADM (ROADM)

6.09 The 8-Degree, 88-channel Reconfigurable SBOADM provides reconfigurable multiplexing and demultiplexing of wavelengths that are added, dropped, or passed through from one DWDM interface to up to seven other DWDM interfaces within one NE. It requires two main shelves to accommodate eight DWDM directions and eight RCMM-8D modules. Each main shelf is equipped with a maximum of four LIAM-E88s or four LRAM-E88s or four ELRAM-E88s, four LOAM-E88s; four RCMM-8D88s; and two SPMs.

88-Channel OLA

6.10 The 88-channel OLA amplifies and passes through up to 88 wavelengths. It requires one main shelf which is equipped with two LIAM-E88s, LRAM-E88s, or ELRAM-E88s, as well as filler modules and two SPMs/SPM-Ns.

Main Shelf Modules for SBOADM Configurations

6.11 Modules are installed in the main shelf according to the NE type and the wavelengths that are required. Refer to Table 6.2, page 2-51 to locate the appropriate configuration:

Table 6.2 44-Channel SBOADM/ROADM Configurations

44-Channel SBOADM/ROADM Configurations		
Multiplexer Configuration	**Figure Number**	**Configuration Number[1]**
2-Degree SBOADM/ROADM equipped with two RCMMs	Figure 6.1, page 2-52	40
SBOADM/ROADM equipped with six RCMMs	Figure 6.2, page 2-53	40
SBOADM/ROADM equipped with up to eight RCMM-8D88 for 88 channels	Figure 6.3, page 2-54	32
SBOADM/ROADM equipped with four RCMMs in Spur Application	Figure 6.4, page 2-55	39
SBOADM/ROADM equipped with four RCMMs	Figure 6.5, page 2-55	39
SBOADM/ROADM equipped with two RCMMs and two RCMM-Ss - Spur Application	Figure 6.6, page 2-56	39
SBOADM/ROADM equipped with eight RCMMs - Spur Application	Figure 6.7, page 2-56	42
SBOADM/ROADM equipped with two RCMMs-8Ds and six RCMMs - Spur Applications	Figure 6.8, page 2-57	42
Tellabs 7100N SBOADM/ROADM	Figure 6.9, page 2-58	18

1. The configuration numbers correspond to the configurations that are described in the ED-NE command section of *Tellabs 7100/7100S TL1 Command Reference Manual*.

Tellabs 7100 SBOADM Main Shelf

6.12 Figure 6.1, page 2-52 through Figure 6.8, page 2-57 illustrate the different SBOADM main-shelf applications supported by Tellabs 7100 OTS hardware.

Note 1: *In configurations 39 and 42, the RCMM-4D/8D can be replaced with RCMM-S or BOFM.*

Note 2: *In configuration 40, additional port shelves can be added and may be located in a separate bay if required.*

Figure 6.1 Main Shelf Layout for SBOADM/ROADM with Two RCMM-4D/8Ds - Configuration #40

1	2	3 4	5	6	7	8	9	10	11	12	13	14 15	16	17	18	19
A-Side LIAM-E/LRAM-E/ELRAM-E	A-Side LOAM-E	A-Side RCMM-4D/8D	TRN, OPSM, CPM, BFM, AIM, OFM, MOFM	TRN, OPSM, CPM, BFM, AIM, OFM, MOFM	TRN, OPSM, CPM, BFM, AIM, OFM, MOFM	TRN, OPSM, CPM, BFM, AIM, OFM, MOFM	TRN, OPSM, CPM, BFM, AIM, OFM, MOFM	TRN, OPSM, CPM, BFM, AIM, OFM, MOFM	TRN, OPSM, CPM, BFM, AIM, OFM, MOFM	TRN, OPSM, CPM, BFM, AIM, OFM, MOFM	OPSM, CPM, BFM, AIM, OFM, MOFM	B-Side RCMM-4D/8D	B-Side LOAM-E	SPM	SPM	B-Side LIAM-E/LRAM-E/ELRAM-E

Note: *TRN = transponder modules, including OTNM-D, SSM-X, SSM-D, MRTM-E, TGTM-T, SMTM-U, SMTM-SD, SMTM-UniD, FGTM, FGTM-M.*

Figure 6.2 Main Shelf Layout for SBOADM/ROADM with up to Eight RCMM-8Ds in Two Main Shelves - Configuration # 42

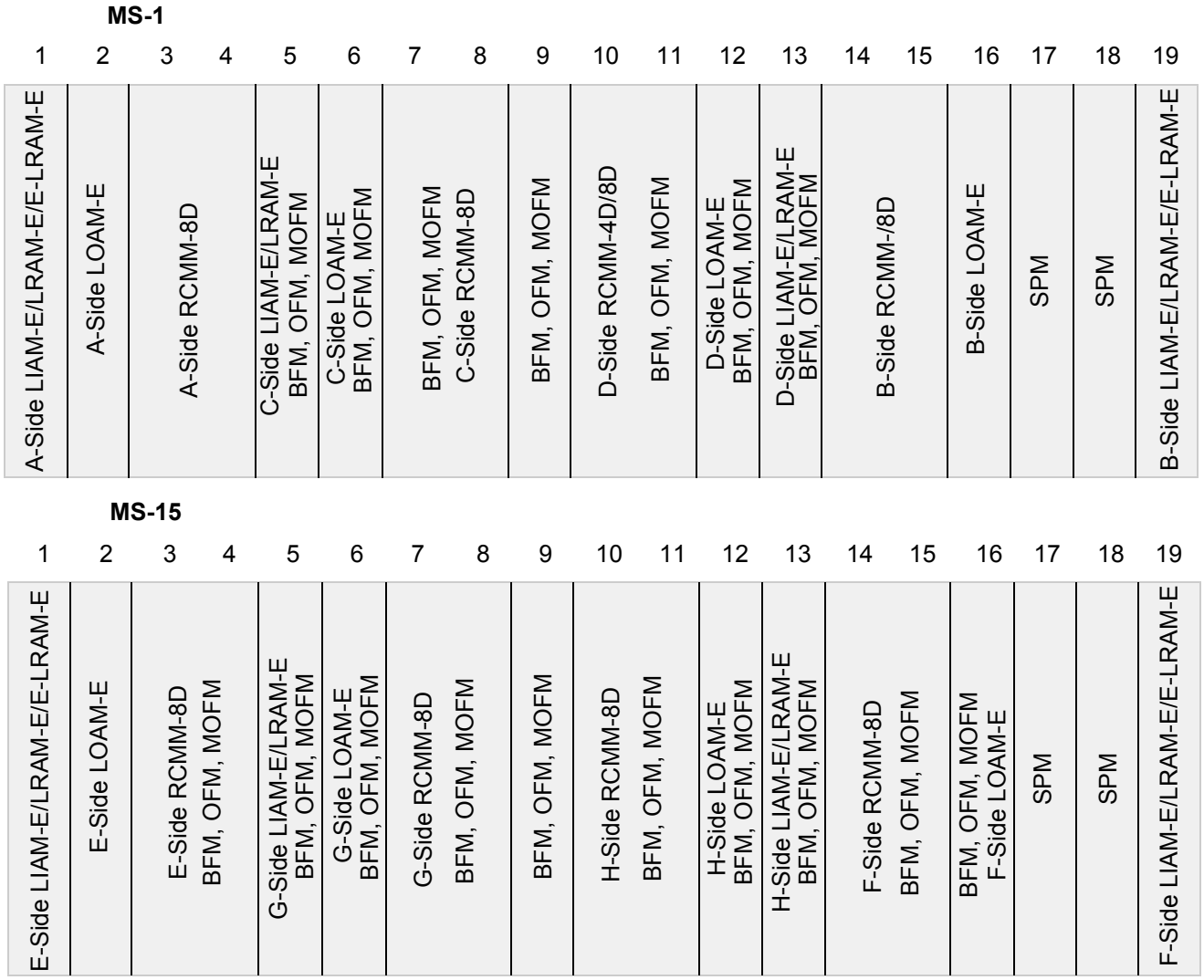


Figure 6.3 Main Shelf Layout for 88-Channel SBOADM/ROADM with up to Eight RCMM-8Ds in Two Main Shelves - Configuration # 32

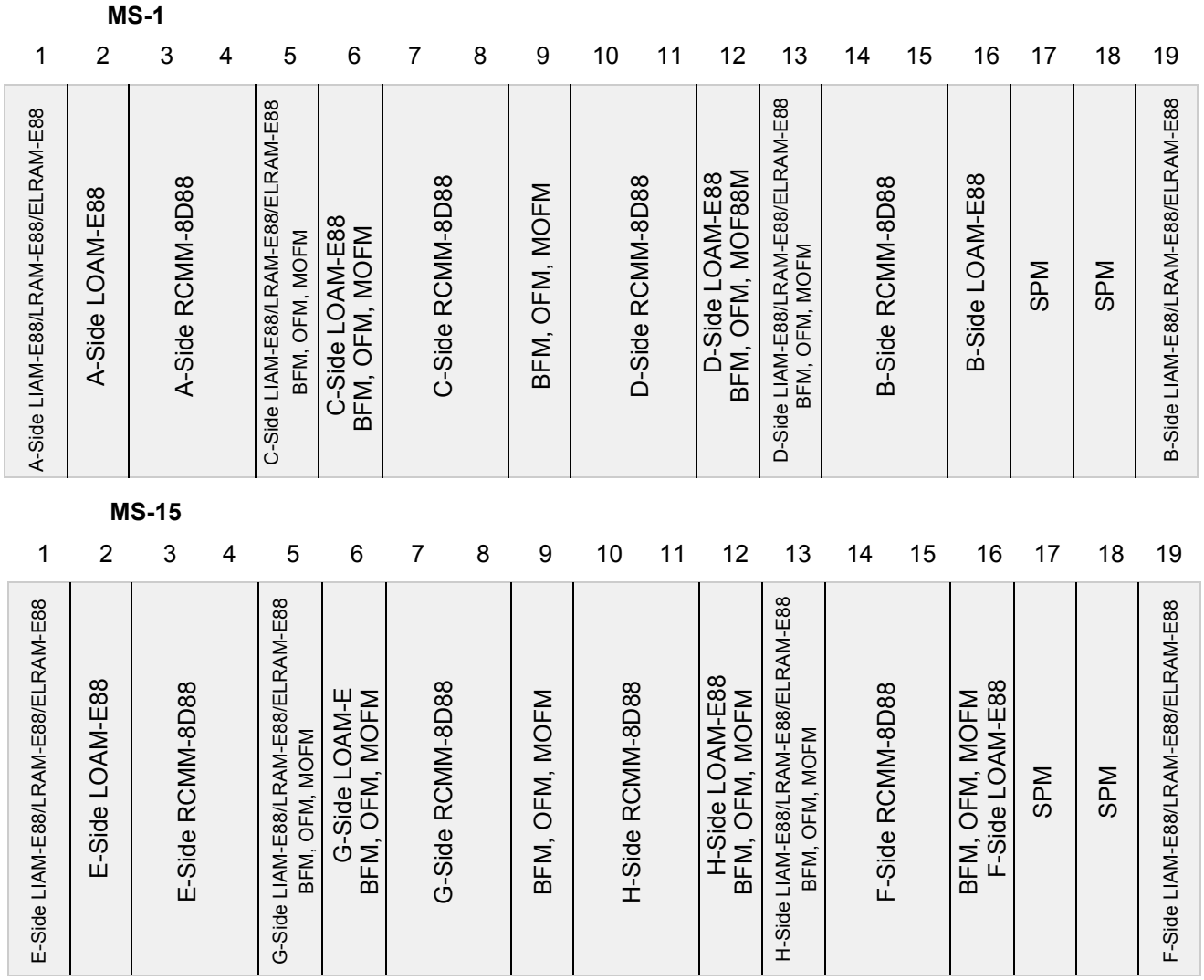


Figure 6.4 Main Shelf Layout for SBOADM/ROADM with one or two CMM-44s – Configuration # 40 in Spur Application

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
A-Side LIAM-E/LRAM-E/ELRAM-E	A-Side LOAM-E	BFM, OFM, MOFM	A-Side CMM-44	TRN, OPSM, CPM, BFM, OFM, MOFM	TRN, OPSM, CPM, BFM, OFM, MOFM	TRN, OPSM, CPM, BFM, OFM, MOFM	TRN, OPSM, CPM, BFM, OFM, MOFM	TRN, OPSM, CPM, BFM, OFM, MOFM	TRN, OPSM, CPM, BFM, OFM, MOFM	TRN, OPSM, CPM, BFM, OFM, MOFM	TRN, OPSM, CPM, BFM, OFM, MOFM	OPSM, CPM, BFM, AIM, OFM, MOFM	BFM, OFM, MOFM	BFM, OFM, MOFM B-Side CMM-44	B-Side LOAM-E	SPM	SPM	B-Side LIAM-E/LRAM-E/ELRAM-E

Note: *TRN = transponder modules, including MRTM-E, TGTM-E, SMTM-U, SMTM-SD, SMTM-UniD.*
The SBOADM/ROADM with one or two CMM-44s configuration is used in conjunction with a SBOADM/ROADM that contains RCMM-4Ds or RCMM-8Ds with or without RCMM-S.

Figure 6.5 Main Shelf Layout for SBOADM/ROADM with Four RCMM-4D/8Ds - Configuration # 39

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
A-Side LIAM-E/LRAM-E/ELRAM-E	A-Side LOAM-E	A-Side RCMM-4D/8D		C-Side LIAM-E/LRAM-E/ELRAM-E BFM, OFM, MOFM	C-Side LOAM-E BFM, OFM, MOFM	C-Side RCMM-4D/8D BFM, OFM, MOFM		BFM, OFM, MOFM	D-Side RCMM-4D/8D BFM, OFM, MOFM		D-Side LOAM-E BFM, OFM, MOFM	D-Side LIAM-E/LRAM-E/ELRAM-E BFM, OFM, MOFM	B-Side RCMM-4D/8D		B-Side LOAM-E	SPM	SPM	B-Side LIAM-E/LRAM-E/ELRAM-E

Figure 6.6 Main Shelf Layout for SBOADM/ROADM with Two RCMM-4D/8Ds and Two RCMM-Ss - Configuration # 39 in Spur Application

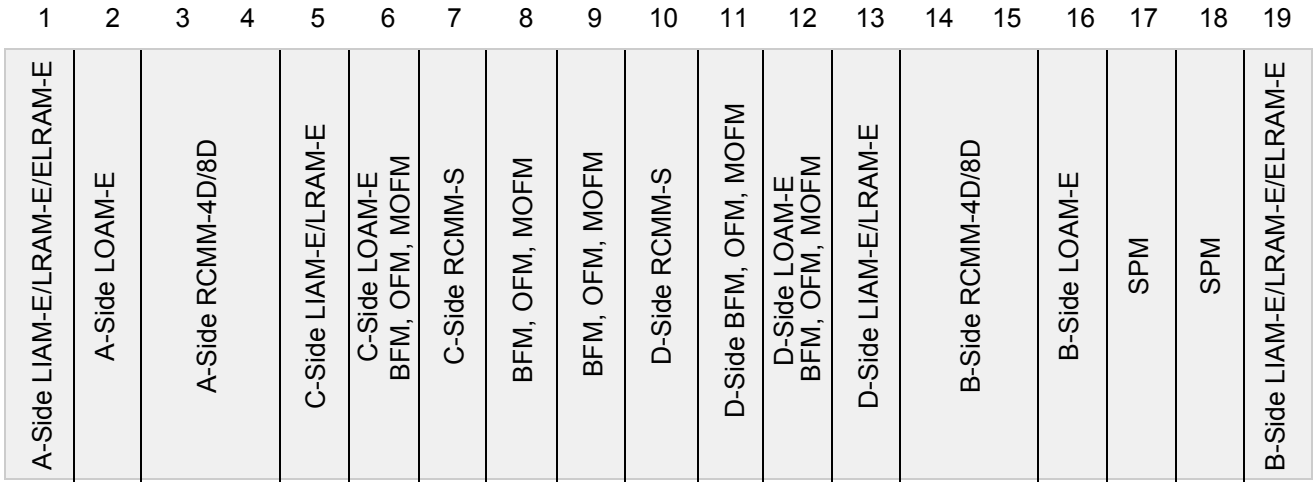


Figure 6.7 Main Shelf Layout for SBOADM/ROADM with Eight RCMM-8Ds on Two Shelves - Configuration # 42 in Spur Application with RCMM-S44

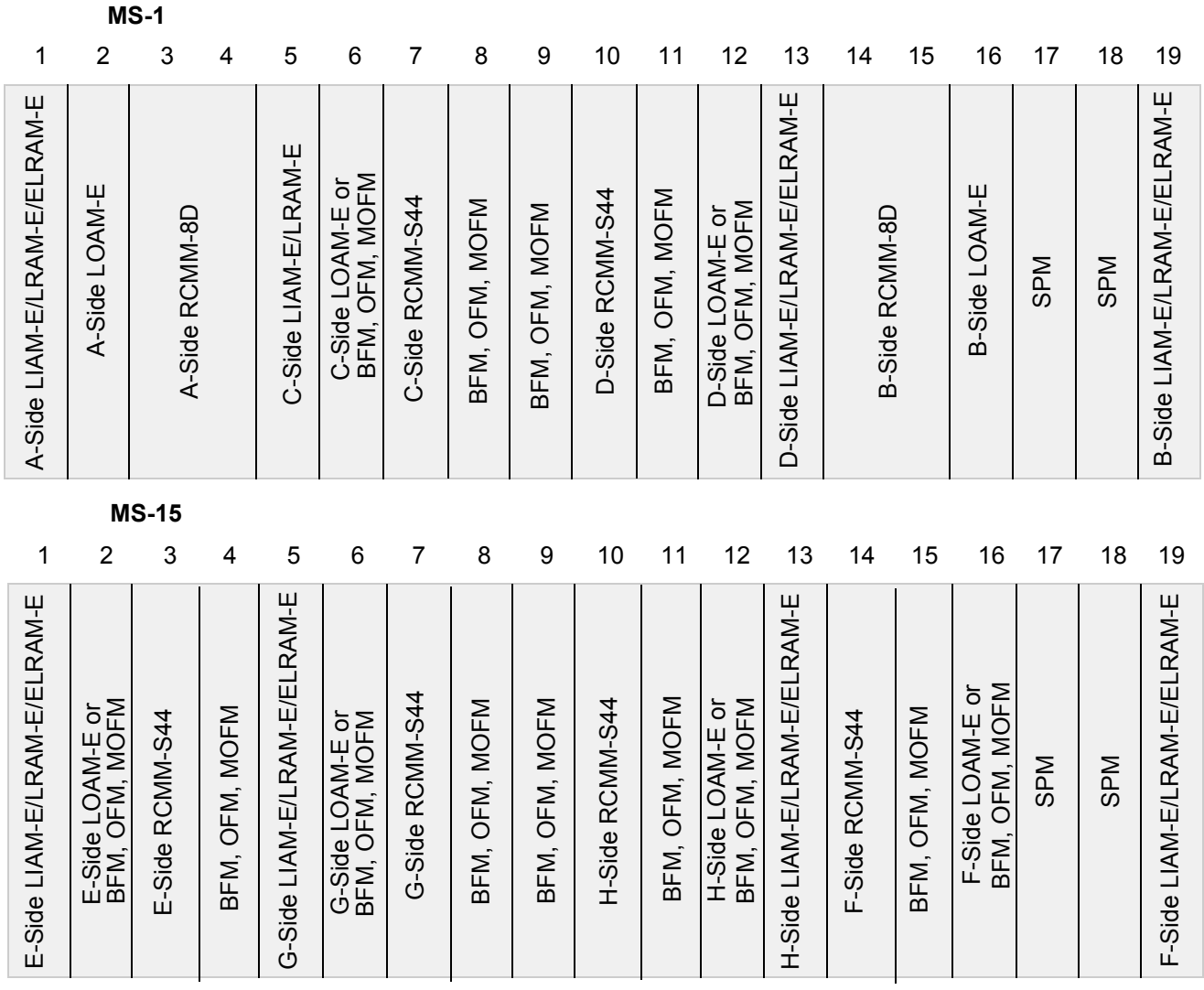
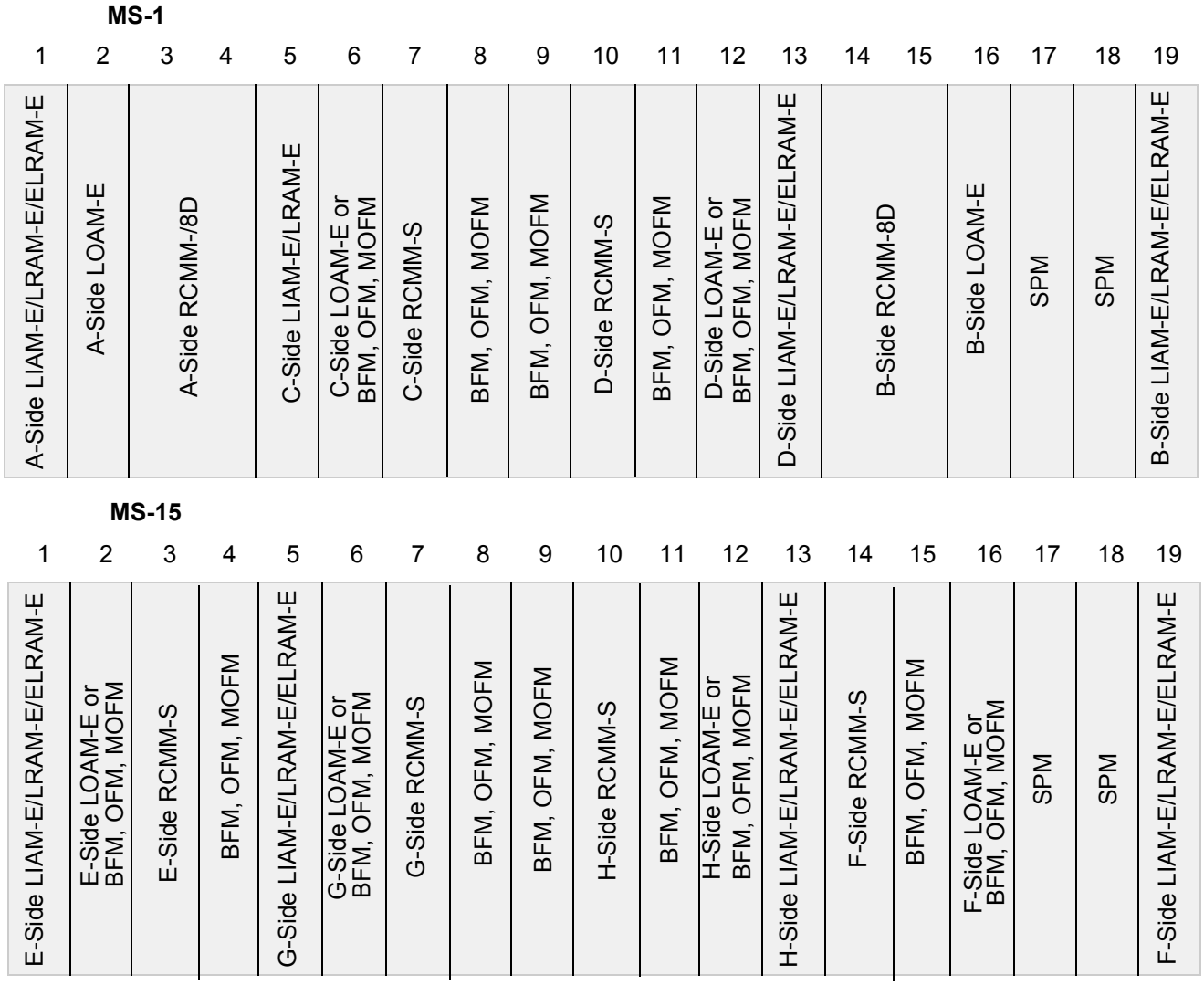


Figure 6.8 Main Shelf Layout for SBOADM/ROADM with Two RCMM-8Ds and Six RCMM-Ss on Two Main Shelves – Configuration # 42 in Spur Application with RCMM-S

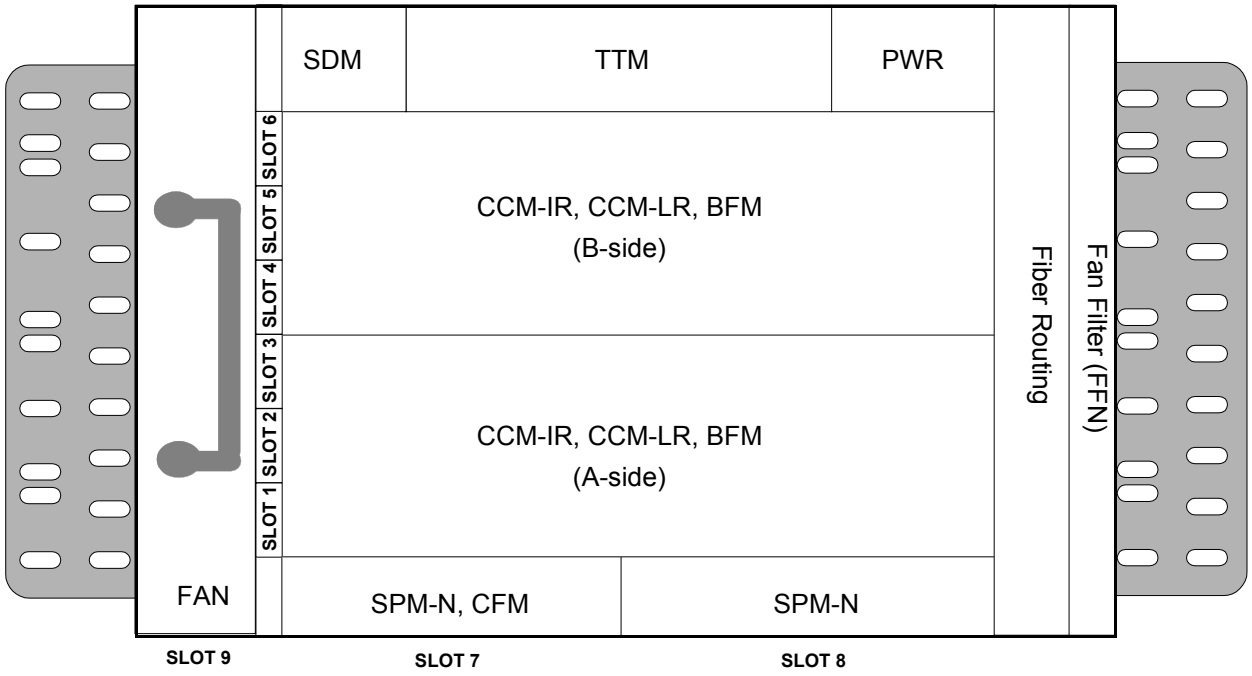


Note: *Empty slots may be filled with BFM, OFM or MOFM modules.*

Tellabs 7100N SBOADM Main Shelf

6.13 Figure 6.9, page 2-58 illustrates the 2-degree SBOADM main-shelf application supported by Tellabs 7100N OTS hardware.

Figure 6.9 Main Shelf Layout for Tellabs 7100N OTS SBOADM/ROADM with Two CCMs Configuration # 18



Main Shelf Modules for OLA Configurations

6.14 This section describes optical line amplifier applications in the main shelf of a Tellabs 7100 OTS or a Tellabs 7100N OTS. Refer to Table 6.3, page 2-59 to locate the appropriate configuration:

Table 6.3 OLA Configurations

OLA Configurations		
OLA Configuration (#41)		
A-Side Amplifier Type	**B-Side Span Amplifier Type**	**Description**
LIAM-E	LIAM-E	Medium A-Side Span and Medium B-Side Span
ELRAM-E/LRAM-E	ELRAM-E/LRAM-E	Long A-Side Span and Long B-Side Span
LIAM-E	ELRAM-E/LRAM-E	Medium A-Side Span and Long B-Side Span
ELRAM-E/LRAM-E	LIAM-E	Long A-Side Span and Medium B-Side Span
OLA Configuration (#31)		
A-Side Amplifier Type	**B-Side Span Amplifier Type**	**Description**
LIAM-E88	LIAM-E88	Medium A-Side Span and Medium B-Side Span
ELRAM-E88/LRAM-E88	ELRAM-E88/LRAM-E88	Long A-Side Span and Long B-Side Span
LIAM-E88	ELRAM-E88/LRAM-E88	Medium A-Side Span and Long B-Side Span
ELRAM-E88/LRAM-E88	LIAM-E88	Long A-Side Span and Medium B-Side Span
OLA Configuration (#17)		
A-Side Amplifier Type	**B-Side Span Amplifier Type**	**Description**
OLA-IR	OLA-IR	Medium A-Side Span and Medium B-Side Span
OLA-LR	OLA-LR	Long A-Side Span and Long B-Side Span
OLA-IR	OLA-LR	Medium A-Side Span and Long B-Side Span
LIAM-E88	LIAM-E88	Medium A-Side Span and Medium B-Side Span
ELRAM-E88/LRAM-E88	ELRAM-E88/LRAM-E88	Long A-Side Span and Long B-Side Span

Table 6.3 OLA Configurations

OLA Configurations		
LIAM-E88	ELRAM-E88/LRAM-E88	Medium A-Side Span and Long B-Side Span
ELRAM-E88/LRAM-E88	LIAM-E88	Long A-Side Span and Medium B-Side Span
OLA Configuration (#19)		
A-Side Amplifier Type	**B-Side Span Amplifier Type**	**Description**
LIAM-E88	LIAM-E88	Medium A-Side Span and Medium B-Side Span
ELRAM-E88/LRAM-E88	ELRAM-E88/LRAM-E88	Long A-Side Span and Long B-Side Span
LIAM-E88	ELRAM-E88/LRAM-E88	Medium A-Side Span and Long B-Side Span
ELRAM-E88/LRAM-E88	LIAM-E88	Long A-Side Span and Medium B-Side Span

Tellabs 7100 OTS OLA

6.15 Figure 6.10, page 2-60 and Figure 6.11, page 2-61 illustrate the main shelf module layouts of Tellabs 7100 OTS OLA configurations (configuration #31 and #41). Different amplifier are allowed per direction.

Figure 6.10 Main Shelf Layout for 44-Channel OLA (Configuration # 41)

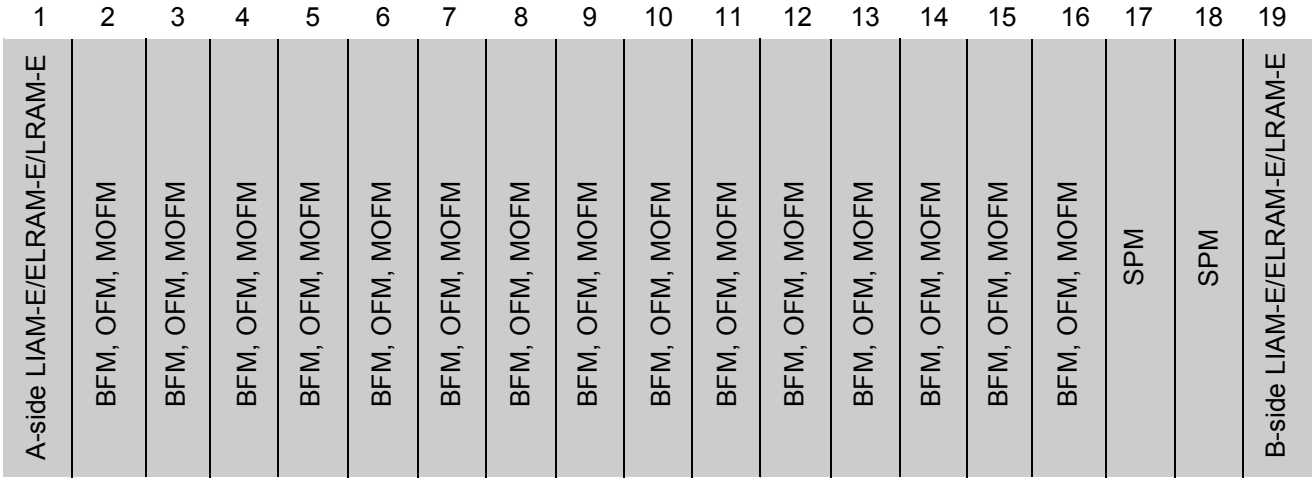
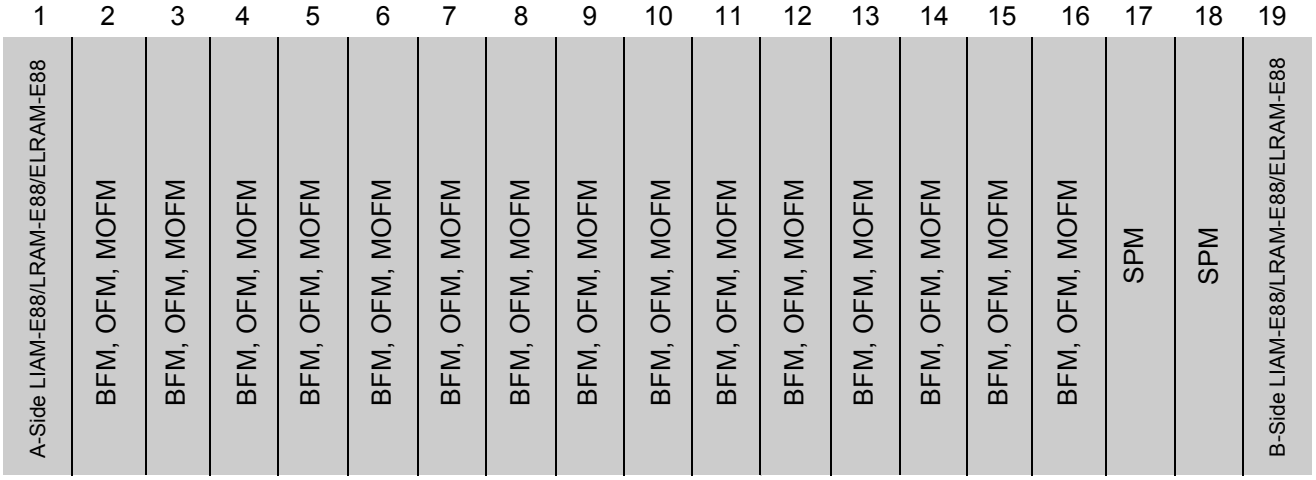


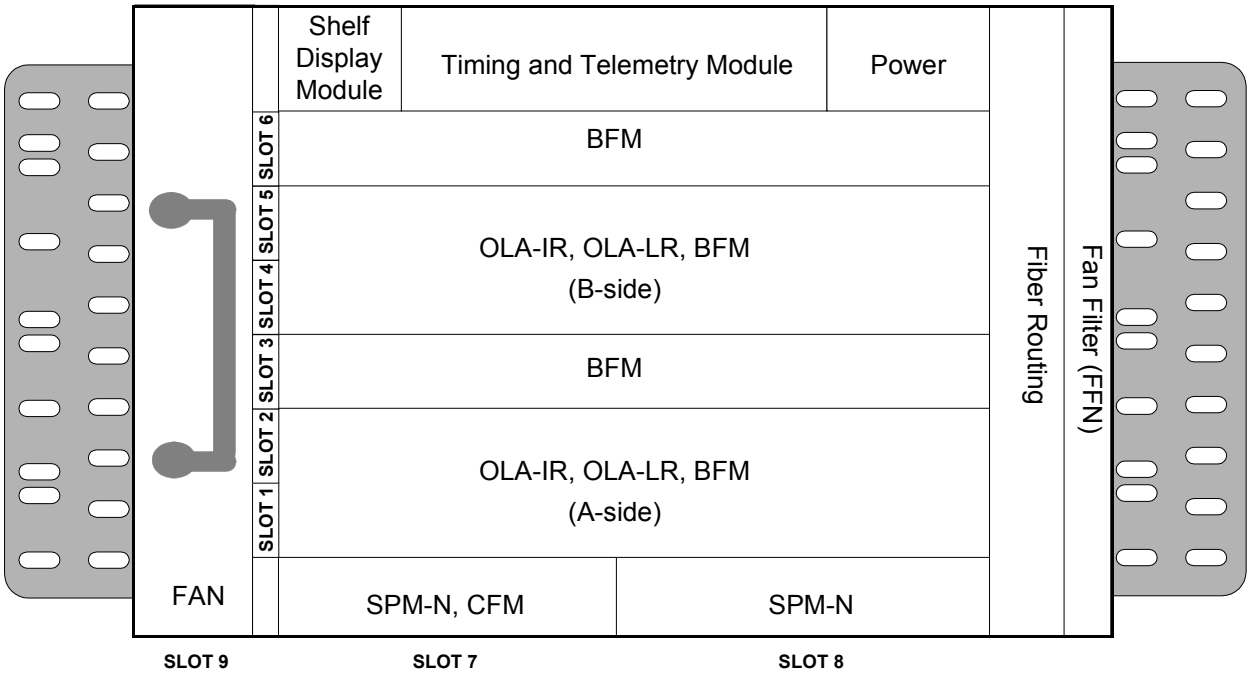
Figure 6.11 Main Shelf Layout for 88-Channel OLA (Configuration # 31)



Tellabs 7100N OTS OLA

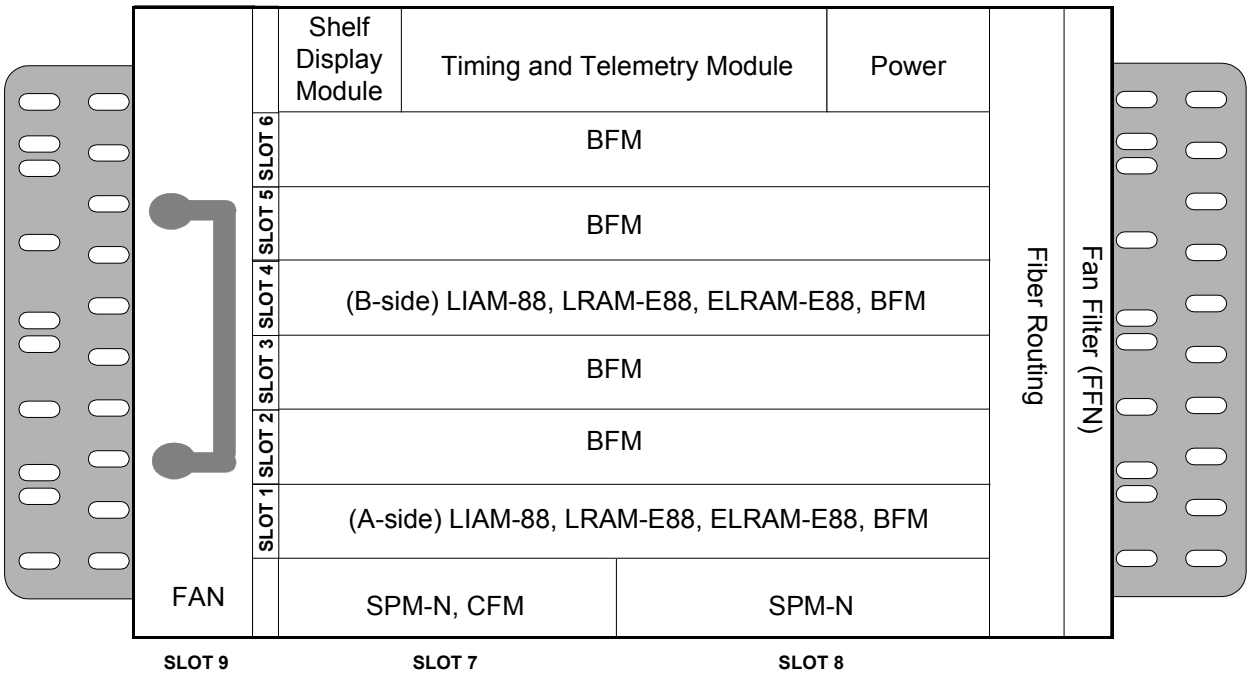
6.16 Figure 6.12, page 2-61, Figure 6.13, page 2-62, and Figure 6.14, page 2-62 illustrate the main shelf module layouts of a Tellabs 7100N OTS OLA configurations (configuration #17 and #19).

Figure 6.12 Shelf Layout for Tellabs 7100N OTS OLA Configuration # 17 with OLA-xR



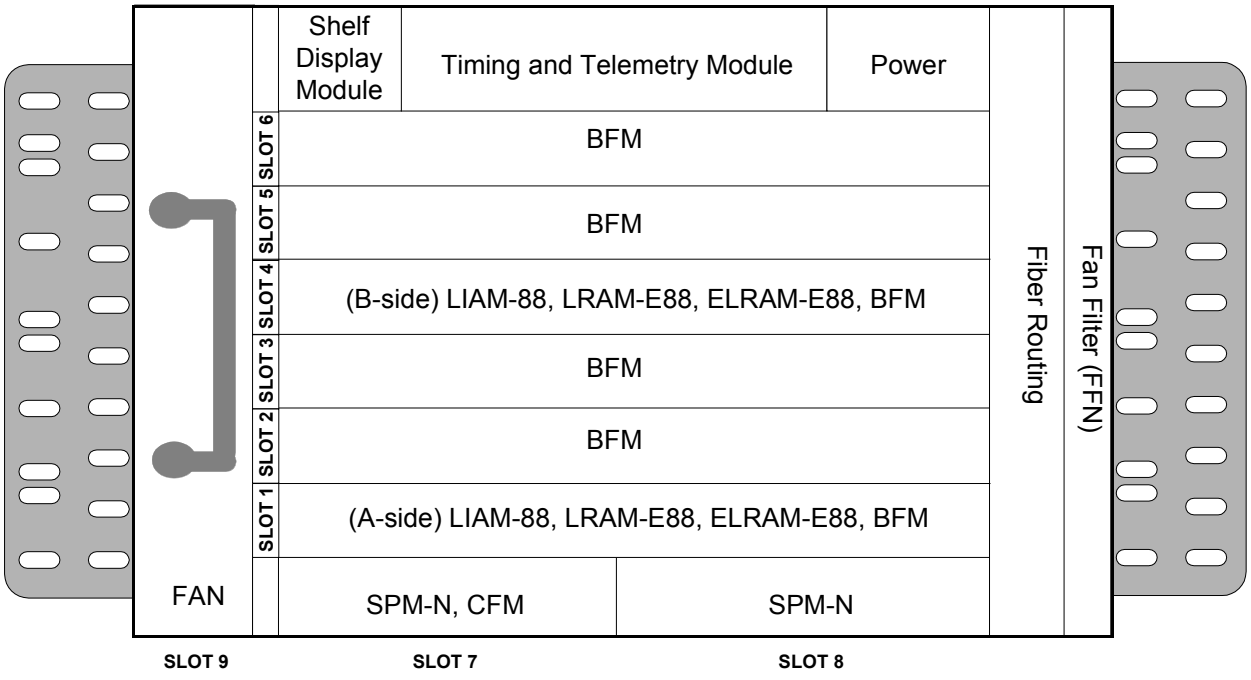
Note: *BFMs can be replaced with transponders for direct connect applications.*

Figure 6.13 Shelf Layout for Tellabs 7100N OTS OLA with OLA-xR Configuration # 17 with 88-channel Amplifiers



Note: *BFMs can be replaced with transponders for direct connect applications.*

Figure 6.14 Shelf Layout for Tellabs 7100N OTS OLA Configuration # 19



Note: *BFMs can be replaced with transponders for direct connect applications.*

Port Shelf Modules for SBOADM Configurations

6.17 This section describes port shelf layouts for Tellabs 7100 OTS and Tellabs 7100N OTS.

Note: *In the Tellabs 7100 OTS port shelf, paired slots are: 1 and 16, 2 and 15, 3 and 14, 4 and 13, 5 and 12, 6 and 11, 7 and 10, and 8 and 9. In the Tellabs 7100N OTS port shelf, paired slots are: 1 and 4, 2 and 5, and 3 and 6.*

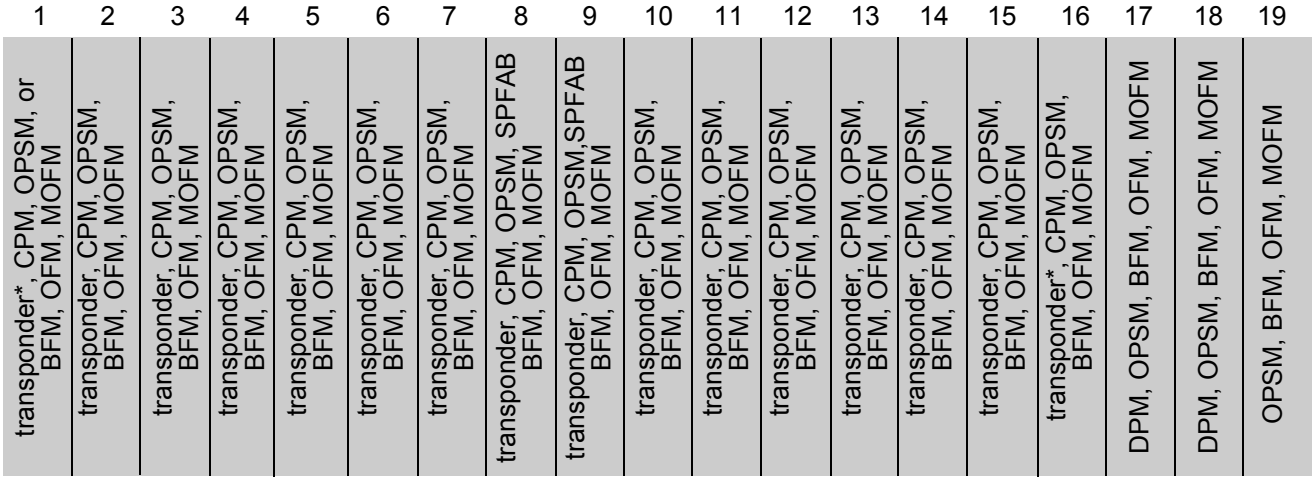
Tellabs 7100 OTS Port Shelf

6.18 Tellabs 7100 OTS port shelves support the following modules: FGTM, FGTM-M, MRTM-E, TGTM-E, CPM, SSM-X, SSM-D, OTNM-D, SMTM-U, SMTM-SD, SMTM-UniD, TGIM-P, SMTM-P, SPFAB, DPMs, and OPSM. Channel pass-through modules (CPM) and amplified interconnect modules (AIM) may be deployed in port shelves, serving as the demarcation point for non-Tellabs client signals (alien wavelengths).

6.19 Empty slots must be filled with either a Blank Filler Module (BFM), Optical Filler Module (OFM), or Multi-Port Optical Filler Module (MOFM). The OFM and MOFM front panels provide receptacles to hold optical fiber connectors of cables that have been installed and are available for future use. The Tellabs 7100N OTS supports a maximum of eight port shelves.

6.20 Refer to Figure 6.15, page 2-63 for a port shelf module layout for a Tellabs 7100 OTS configuration.

Figure 6.15 Port Shelf Module Layout



Note: *Transponder = FGTM, FGTM-M, MRTM-E, TGTM-E, SMTM-U, SSM-X, SSM-D, OTNM-D, SMTM-SD, SMTM-P, TGIM-P, and SMTM-UniD in configurations using 44- or 88-channel plans. Each FGTM requires two-slots.*
The SSM-X/SSM-D and OTNM-D modules require at least one System Processor Modules (82.SPM) or Data Processor Modules (DPMs) in Port Shelf slot positions 17 and 18.

Packet Subsystem in Tellabs 7100 OTS Port Shelf

6.21 The following modules support Packet applications: TGIM-P, SMTM-P, SPFAB, 82.SPM, SPM-N, and DPMs. Packet functionality requires a minimum of one DPM, SPM-N, or 82.SPM, one SPFAB, and two SMTM-Ps or TGIM-Ps. If DPM and SPFAB are not paired, these modules are not protected. Packet modules and non-Packet modules can be mixed in a port shelf.

6.22 Refer to Figure 6.16, page 2-64 for Packet module locations in a Tellabs 7100 OTS port shelf. SMTM-P and TGIM-P modules are typically paired. Slots showing SMTM-P and TGIM-P can also be filled with other transponder modules.

Figure 6.16 Port Shelf Layout for Packet Subsystem

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
SMTM-P, TGIM-P	SMTM-P, TGIM-P	SMTM-P, TGIM-P	SMTM-P, TGIM-P	SMTM-P, TGIM-P	SMTM-P, TGIM-P	SMTM-P, TGIM-P	SPFAB	SPFAB	SMTM-P, TGIM-P	SMTM-P, TGIM-P	SMTM-P, TGIM-P	SMTM-P, TGIM-P	SMTM-P, TGIM-P	SMTM-P, TGIM-P	SMTM-P, TGIM-P	DPM, 82.SPM, OPSM, BFM, OFM, MOFM	DPM, 82.SPM, OPSM, BFM, OFM, MOFM	OPSM, BFM, OFM, MOFM

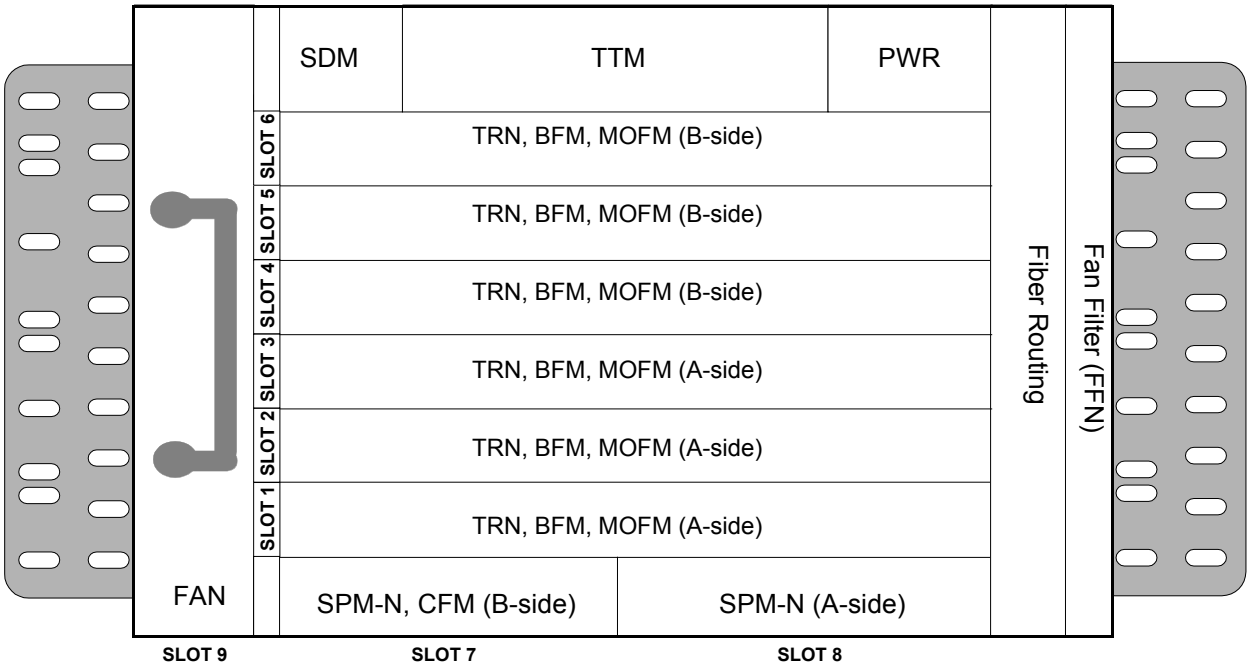
Tellabs 7100N OTS Port Shelf

6.23 Tellabs 7100N OTS port shelves hold two SPM-Ns and the following transponders: FGTM, FGTM-M, MRTM-E, TGTM-E, SMTM-U, SSM-X, SSM-D, OTNM-D, SMTM-P, and TGIM-P. Slots 1 through 6 that are empty must be filled with an 81.71000F Blank Filler Module (BFM) or an 81.71000E Multi-port Optical Filler Module (MOFM). Slot 7 must be filled with an 81.71700C Controller Filler Module (CFM) if it does not contain an SPM-N. Tellabs 7100N OTS supports a maximum of six port shelves.

6.24 Packet functionality in the Tellabs 7100N OTS port shelf is supported by the TGIM-P and SMTM-P. TGIM-P and SMTM-P modules are typically paired. The paired slots are 1 and 4, 2 and 5, and 3 and 6.

6.25 Refer to Figure 6.17, page 2-65 to see a port shelf module layout for a Tellabs 7100N OTS configuration.

Figure 6.17 Tellabs 7100N OTS Port Shelf Module Layout (Configuration 17)



Note: *TRN = FGTM, FGTM-M, MRTM-E, OTNM-D, SMTM-U, SSM-D, SSM-X, TGTM-E, TGIM-P, and SMTM-P.*
Each FGTM requires two-slots.

Signal Flow Diagrams

6.26 This section contains the signal flow diagrams for the Tellabs 7100/7100N SBOADM. Refer to Table 6.4, page 2-66:

Table 6.4 SBOADM Configurations

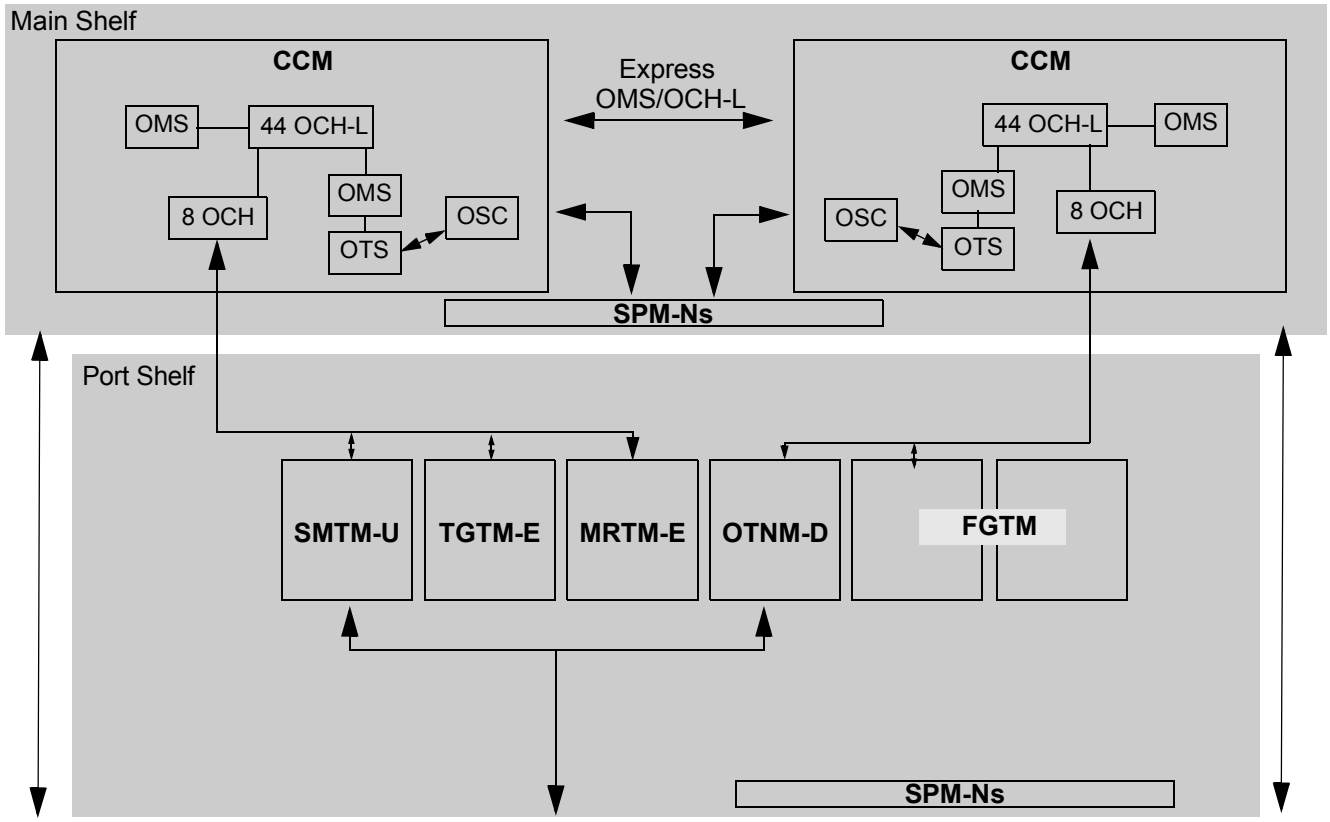
Configuration Type	Refer to	Software Configuration Number[1]
Tellabs 7100N SBOADM with two CCMs	Figure 6.18, page 2-67	18
44-Channel SBOADM with two RCMMs	Figure 6.19, page 2-68	40
44-Channel SBOADM with four RCMMs	Figure 6.20, page 2-69	39
SBOADM with eight RCMMs	Figure 6.21, page 2-70	42
SBOADM with one shelf	Figure 6.23, page 2-72	40
SBOADM with Port-Side Protection	Figure 6.24, page 2-73	40
SBOADM with Line-Side Protection	Figure 6.25, page 2-74	40,
Spur Application with Port-Side Protection	Tables 6.26, page 2-75	39, 40

1. The configuration numbers correspond to the configurations that are described in the ED-NE command section of *Tellabs 7100/7100N TL1 Command Reference Manual*.

SBOADM/ROADM Configuration in Tellabs 7100N OTS

6.27 Figure 6.18, page 2-67 illustrates a Tellabs 7100N OTS SBOADM/ROADM with two CCMs, showing possible signal paths between modules.

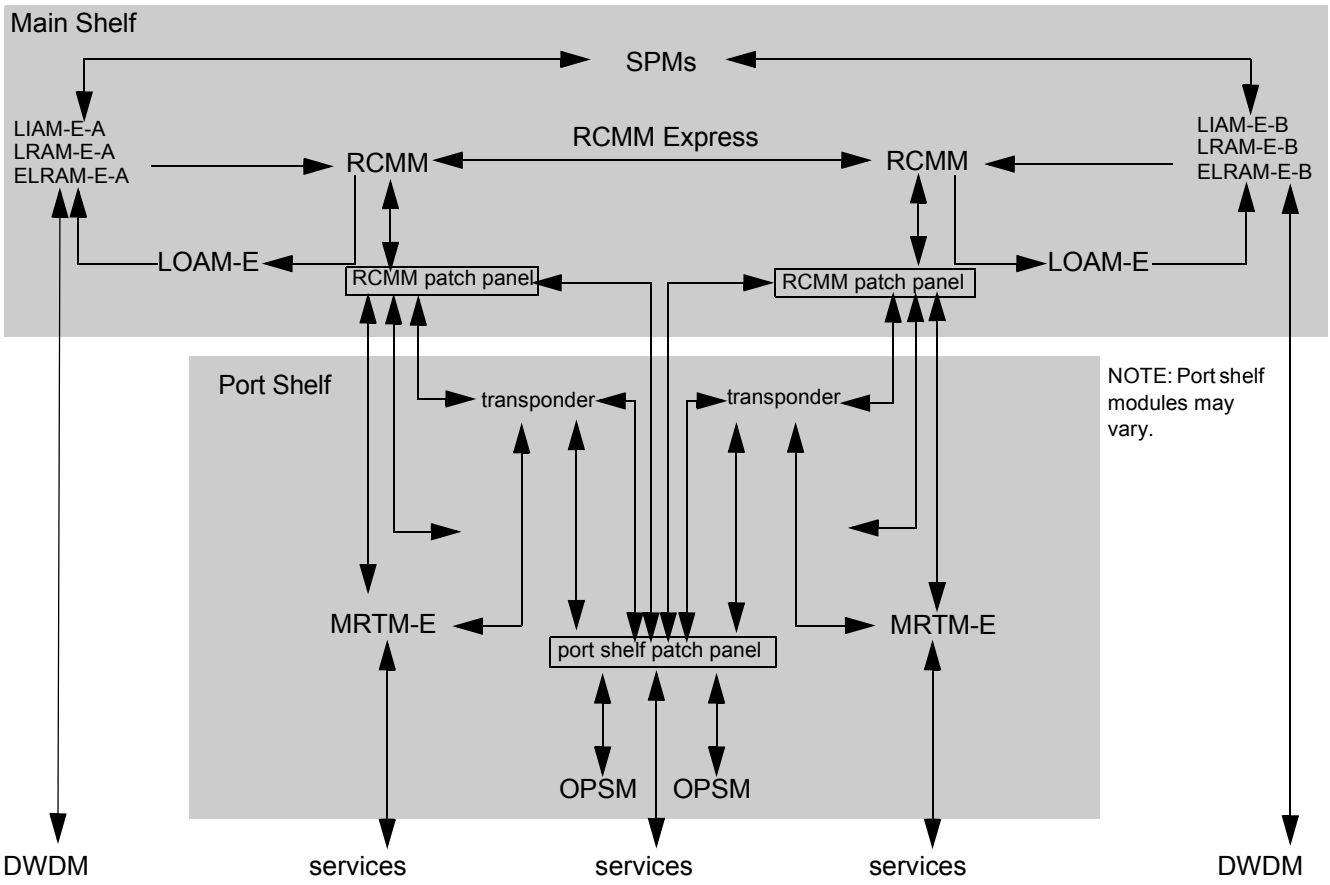
Figure 6.18 Signal Flow Diagram for Tellabs 7100N OTS SBOADM/ROADM (Configuration # 17)



SBOADM/ROADM Configurations with Two RCMM-4D/8D

6.28 Figure 6.19, page 2-68, illustrates a SBOADM/ROADM with two RCMM-4D/8Ds and shows some possible signal paths between modules and patch panels.

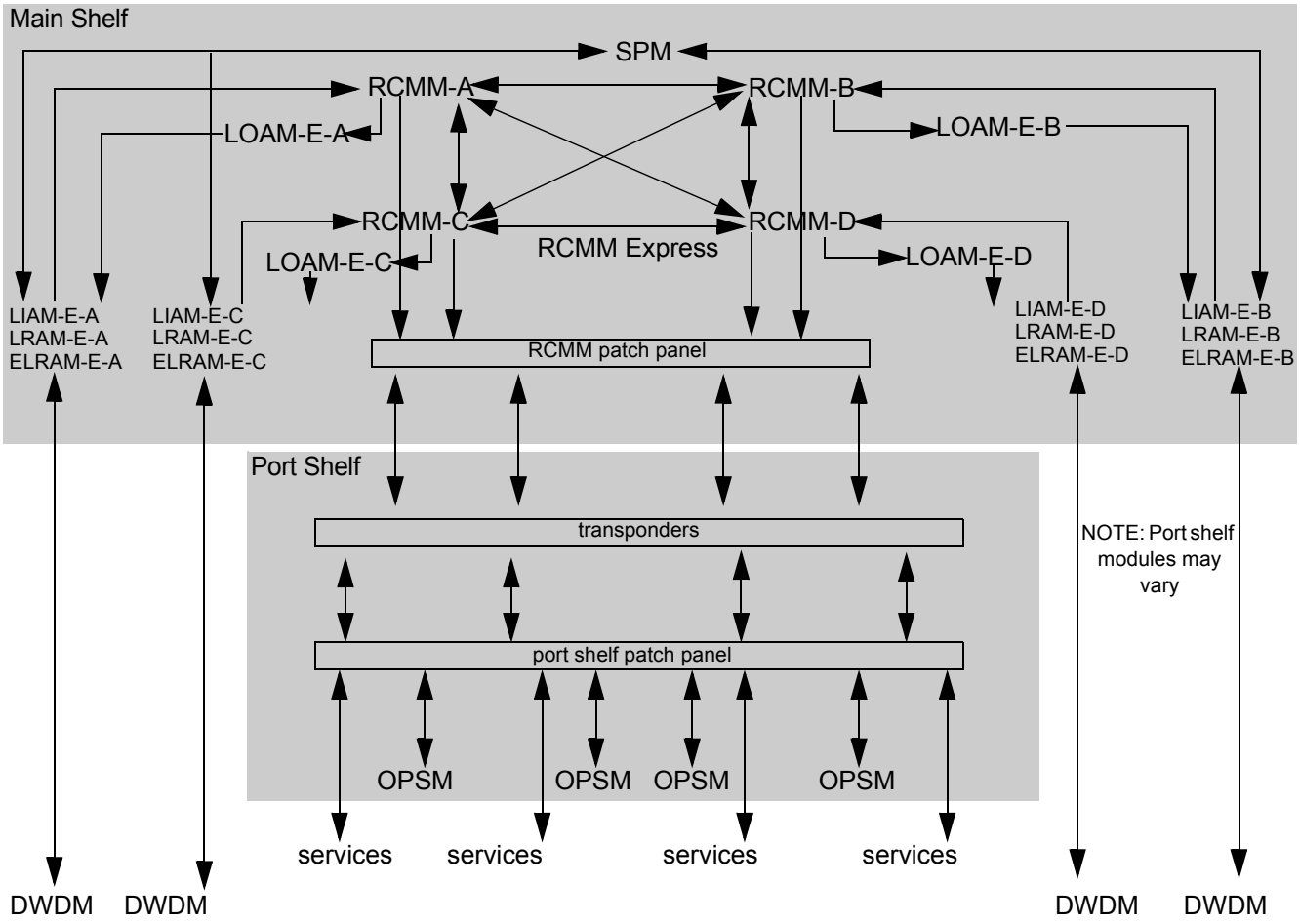
Figure 6.19 Signal Flow Diagram for SBOADM/ROADM With Two RCMM-4D/8Ds (Configuration # 40)



SBOADM/ROADM Configurations with Four RCMM-4D/8D

6.29 Figure 6.20, page 2-69 illustrates a SBOADM/ROADM with four RCMM-4D/8Ds and shows possible signal paths between modules and patch panels.

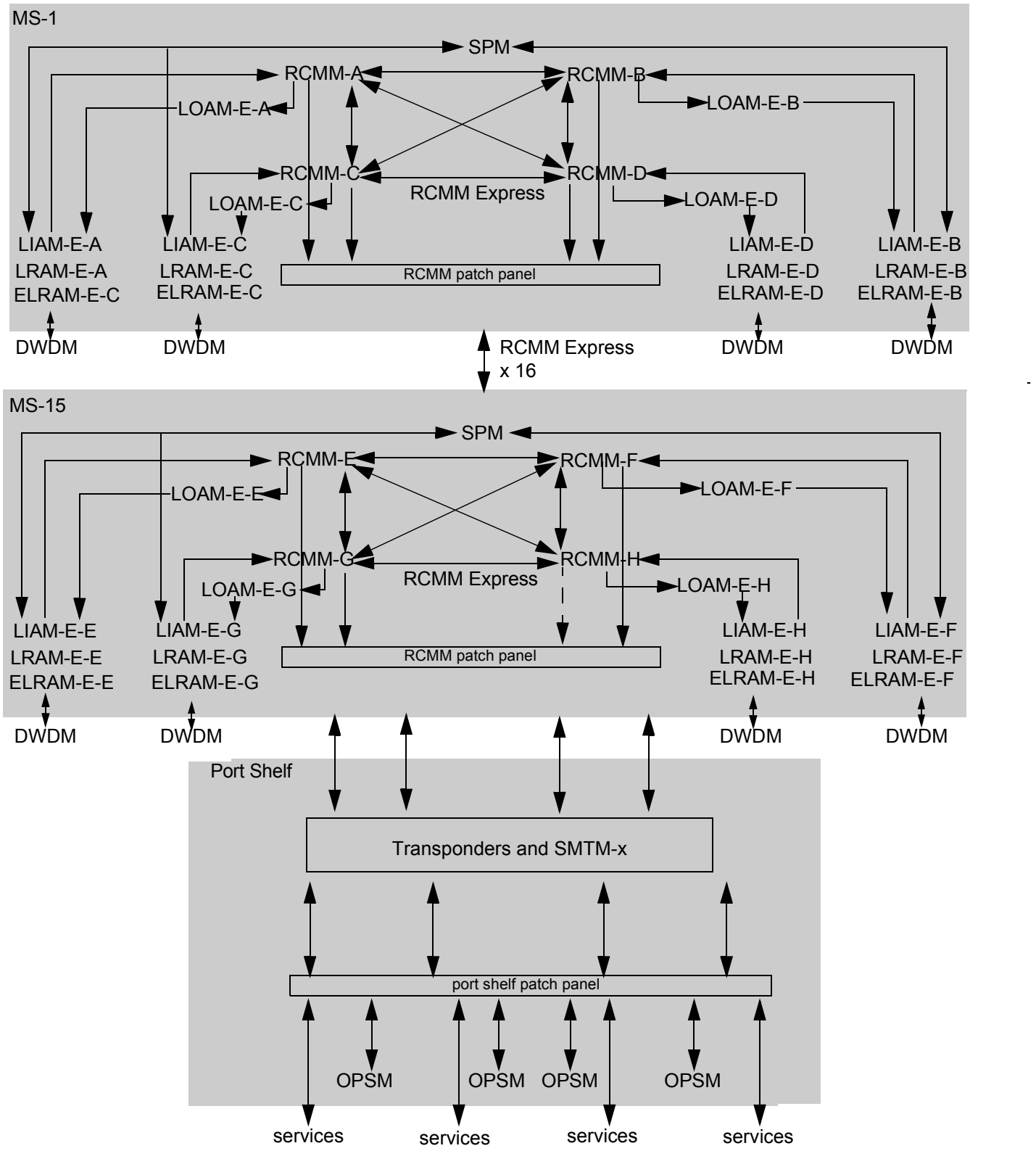
Figure 6.20 Signal Flow Diagram for SBOADM/ROADM With Four RCMM-4D/8Ds (Configuration # 39)



SBOADM/ROADM Configurations with Eight RCMM-4D/8D

6.30 Figure 6.21, page 2-70 illustrates a SBOADM/ROADM with eight RCMM-8Ds and shows possible signal paths between modules and patch panels.

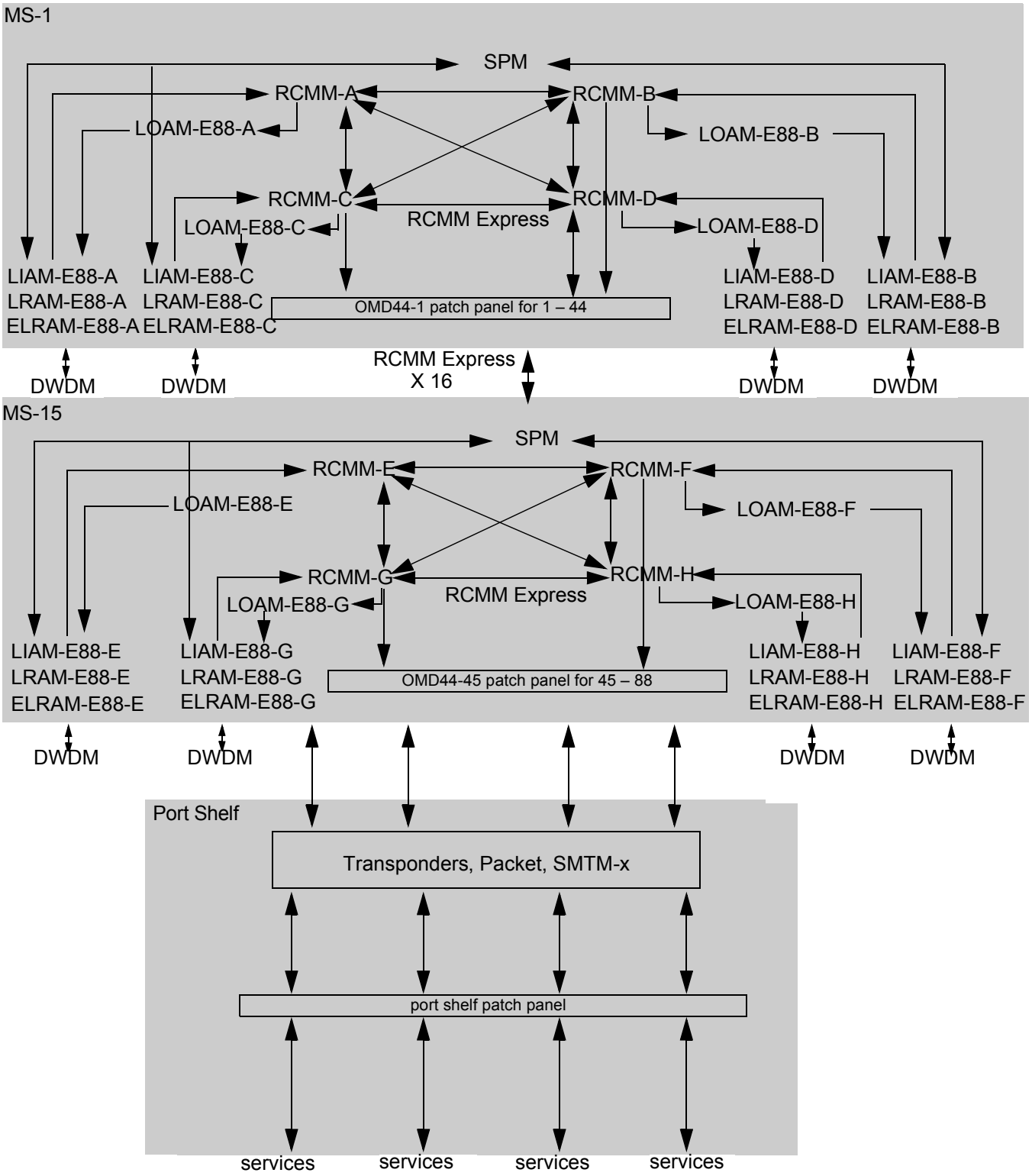
Figure 6.21 Signal Flow Diagram for SBOADM/ROADM With Eight RCMM-4D/8Ds (Configuration # 42)



SBOADM/ROADM Configurations with Eight RCMM 8D88s

6.31 Figure 6.21, page 2-70 illustrates a SBOADM/ROADM with eight RCMM-8D88s and shows signal paths between modules and patch panels.

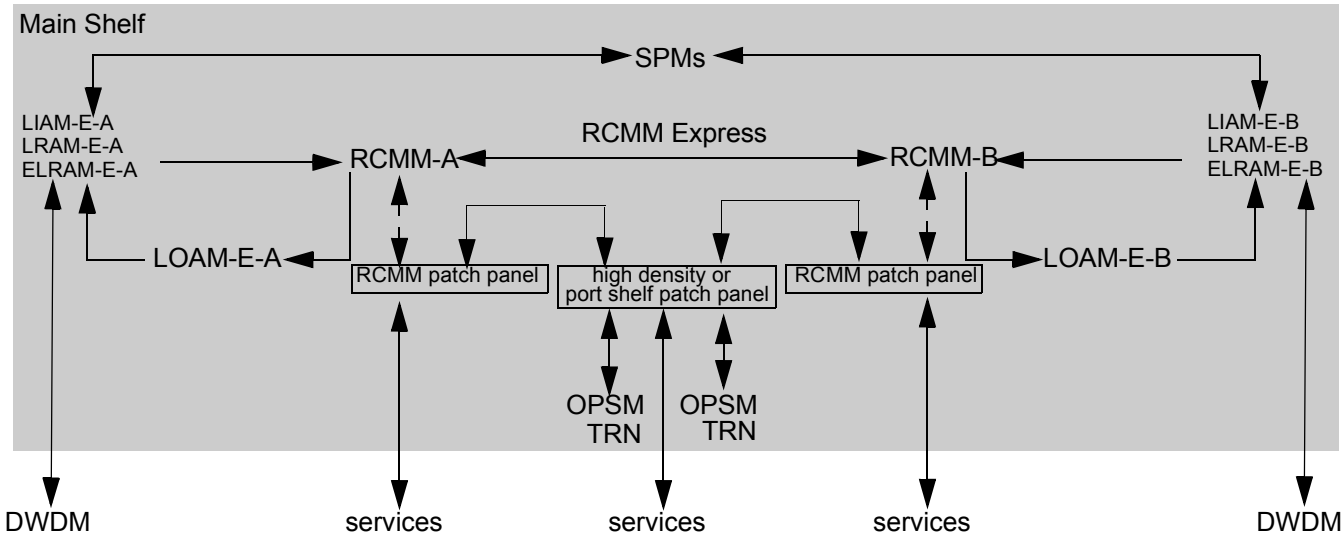
Figure 6.22 Signal Flow Diagram for SBOADM/ROADM With Eight RCMM-8D88s (Configuration # 32)



SBOADM/ROADM Configurations with One Shelf

6.32 Figure 6.23, page 2-72 illustrates a SBOADM/ROADM with two RCMM-4D/8Ds and an OPSM in one shelf. This allows dropping wavelengths without a port shelf.

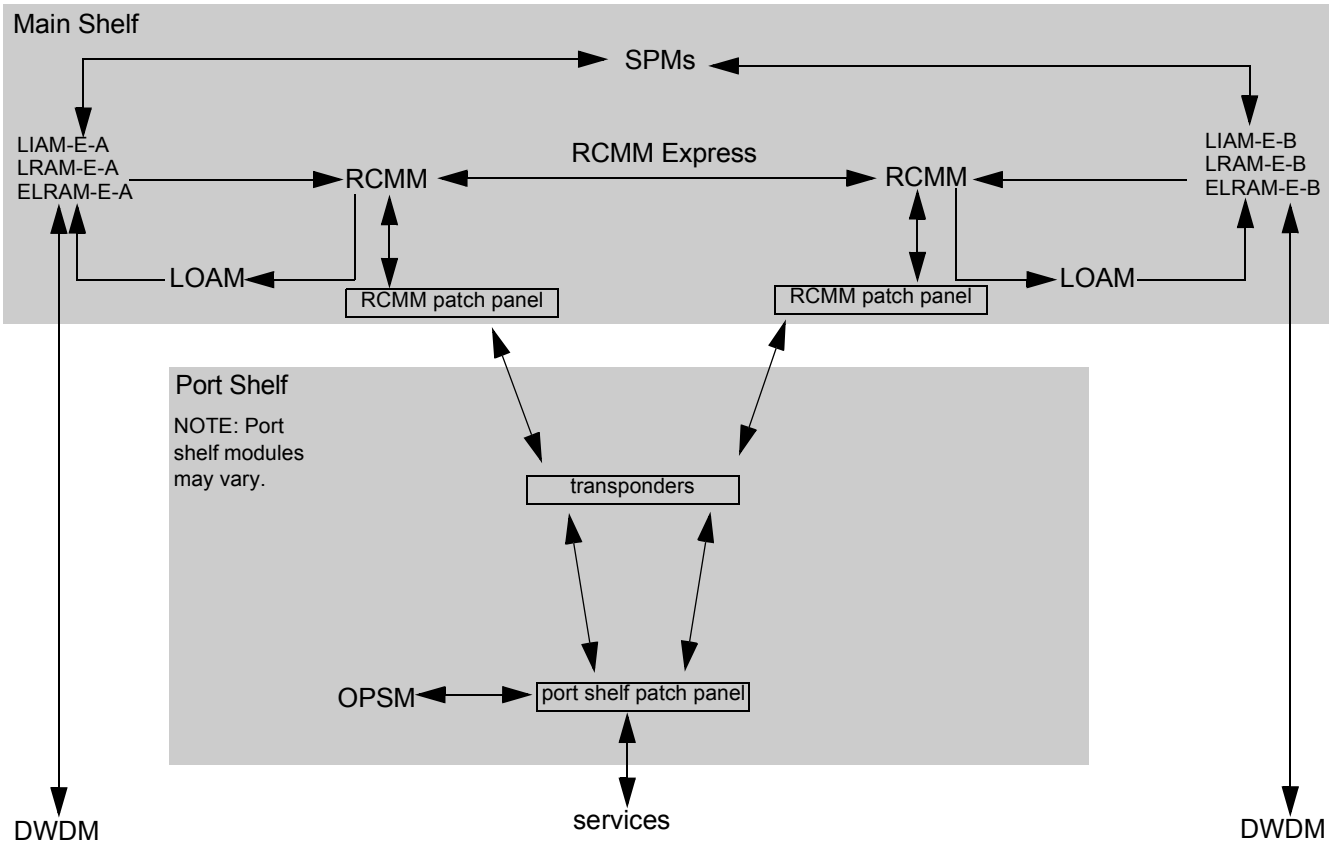
Figure 6.23 Signal Flow Diagram for SBOADM/ROADM With Two RCMM-4D/8Ds (Configuration # 40)



Signal Flow for a SBOADM/ROADM for Port-Side Protection

6.33 Figure 6.24, page 2-73 shows the SBOADM/ROADM configured for port-side protection. Port-side protection is configured by connecting the client signal to the OPSM protection switch. The OPSM duplicates the client signal to send to two transponder modules. In the reverse direction, the OPSM selects the best signal coming from both transponders based on BER or the optical level. Port-side protection protects against both equipment and span failures.

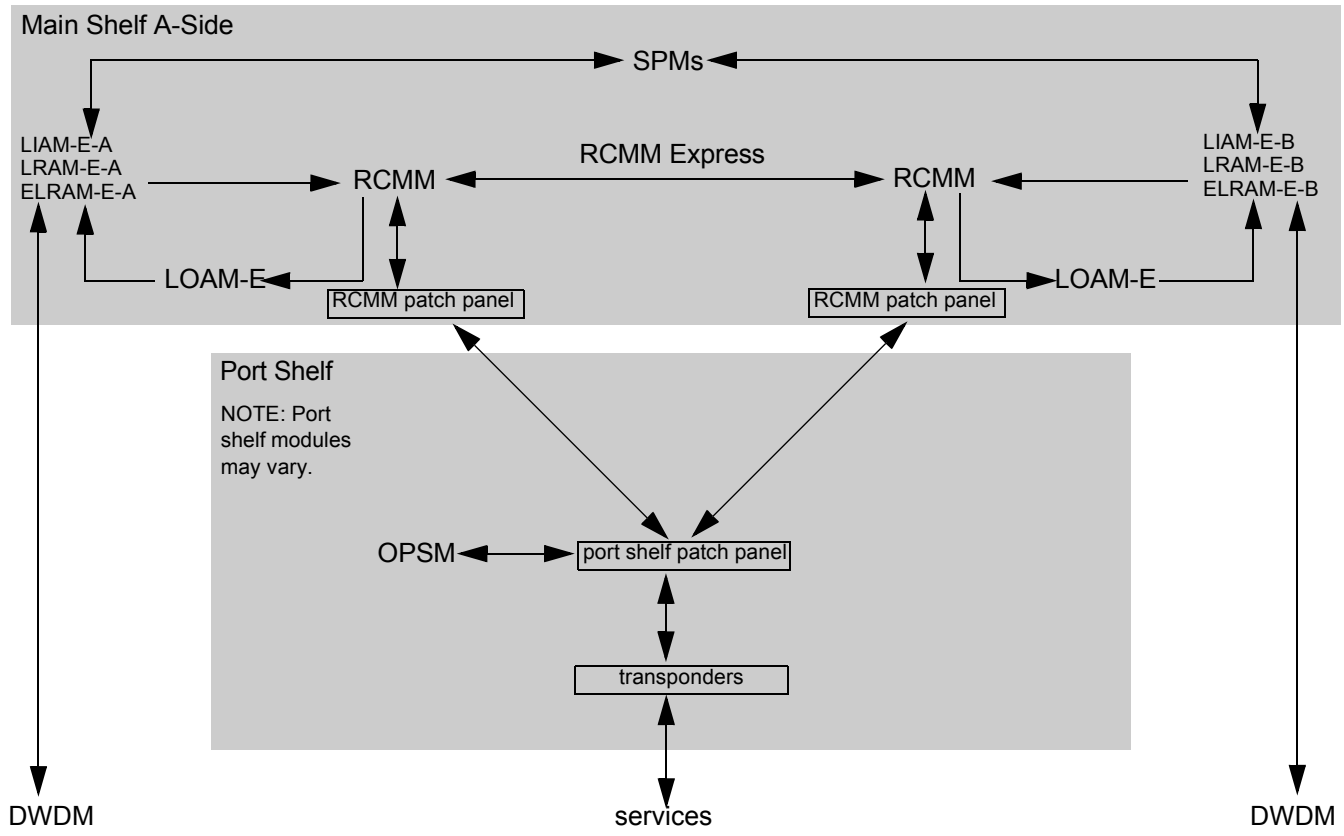
Figure 6.24 Signal Flow Diagram for 44-Channel SBOADM/ROADM Showing Port-Side Protection (Configuration # 40)



Signal Flow for SBOADM/ROADM with Line-Side Protection

6.34 Figure 6.25, page 2-74 shows an SBOADM/ROADM configured for line-side protection. Line-side protection is configured by connecting the 15xx line interface of a single transponder to an OPSM protection switch. The OPSM duplicates the transponder signal to send to two RCMMs. In the reverse direction, the OPSM selected the best signal coming from both RCMMs based on BER or the optical level. Line-side protection secures against span failures only.

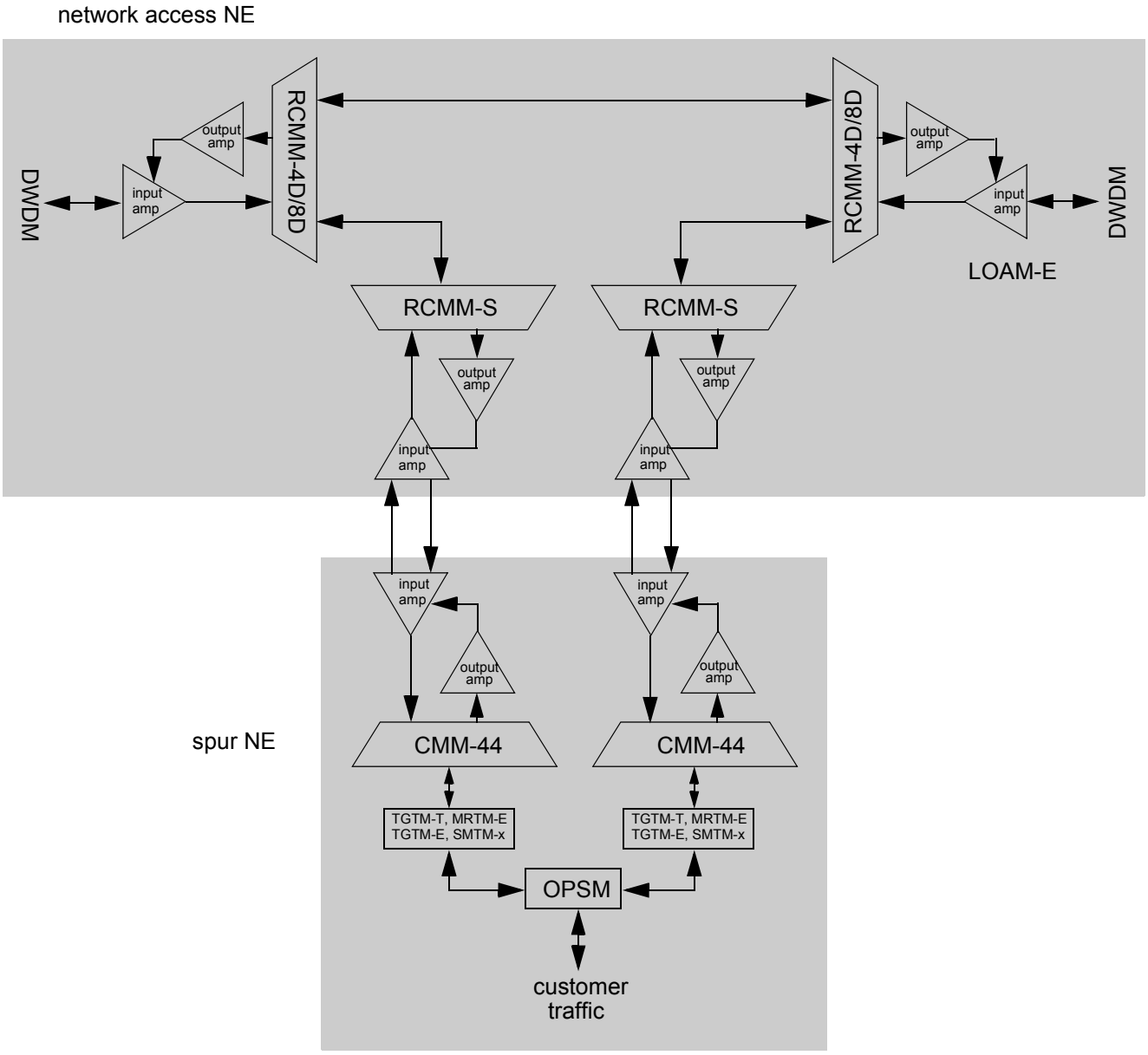
Figure 6.25 Signal Flow Diagram for SBOADM/ROADM Showing Line-Side Protection (Configuration # 40)



Signal Flow for Spur Application with Port-Side Protection

6.35 Figure 6.26, page 2-75 shows a spur application configured for port-side protection. The network access NE consists of a SBOADM/ROADM with two RCMM-4D/8Ds and two RCMM-Ss. The spur NE comprises a SBOADM with two CMM-44s.

Figure 6.26 44-Channel Spur Application with Port-Side Protection



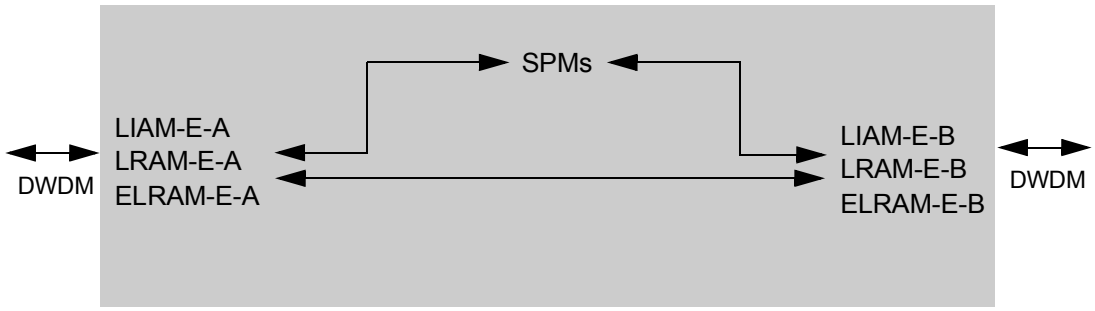
Tellabs 7100 OTS OLA Configurations

6.36 An optical line amplifier (OLA) functions in tandem with SBOADM/ROADM NEs to provide amplification of the DWDM signal at intermediate locations along the network pathway. Two LIAM-Es, LRAM-Es, LIAM-E88s, LRAM-E88s, ELRAM-Es, or ELRAM-E88s provide amplification in this configuration. The A-side span type may be different than the B-side span, allowing for different span arrangements.

6.37 When the Tellabs 7100 OTS is configured for optical line amplifier (OLA) applications, it does not support add/drop functions. An OLA can be converted to a SBOADM without affecting traffic passing through it by adding an RCMM and a LOAM-E output amplifier.

6.38 Figure 6.27, page 2-76 illustrates an OLA configured for medium spans (LIAM-Es), long spans (LRAM-E or ELRAM-E), and mixed spans.

Figure 6.27 OLA Application

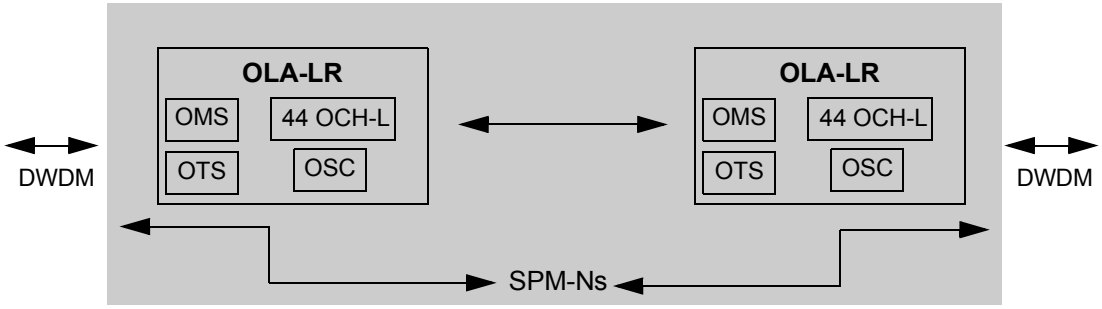


Tellabs 7100N OTS OLA Configurations

6.39 The Tellabs 7100N OLA configuration functions in tandem with SBOADM/ROADM NEs to provide amplification of the DWDM signal at intermediate locations along the network pathway. Two OLA-IRs, OLA-LRs, LIAM-E88s, LRAM-E88s, or ELRAM-E88s provide amplification in this configuration. The A-side span type may be different than the B-side span, allowing for different span arrangements.

6.40 Figure 6.28, page 2-77 illustrates the OLA configured for a long-reach OLA configuration. Tellabs 7100N OTS OLA configurations can be provisioned for long spans (OLA-LR, LRAM-E88, or ELRAM-E88), intermediate spans (OLA-IR or LIAM-E88), or mixed spans.

Figure 6.28 OLA Application



7. System Architecture

7.01 The Tellabs 7100/7100N OTS is a dense wavelength division multiplexing (DWDM) system that transports various signal protocols at speeds ranging from 100 Mbps to 40 Gbps per transponder via 44- or 88-channel systems. It is based on a single- or multi-shelf system that can be deployed as a high-volume bandwidth reconfigurable optical add/drop multiplexer (SBOADM/ROADM) or as individual amplifier stations (OLA) that can be converted to SBOADMs when future capacity is required.

7.02 Each channel can be provisioned to carry from 100 Mbps to 40 Gbps signal capacity or 100 Mbps to 2.488 Gbps Broadband signals. Channels are provisioned to either be added/dropped or optically passed-through an NE or for uni-directional broadcast (including drop and continue application) through the RCMM Express ports. STS or VC facilities carrying GbE signals can be grouped for concatenated transport between SMTM-Us.

7.03 The Tellabs 7100/7100N OTS supports synchronous optical network (SONET), gigabit Ethernet (GbE), synchronous digital hierarchy (SDH), Packet, SNMP, and other protocols in local exchange (LEX) and long distance (LD) applications. It supports various point-to-point, ring, or mesh network topologies on which both wavelength and private line services can be configured. Supported configurations:

__ DWDM Ring - A ring topology allows a service provider to offer optical protection to its customers in the event of equipment or fiber failure, a capability that is crucial when service agreements call for the highest levels of reliability. Ring topologies rely on terminating equipment or optical protection modules to perform protection switching at the optical channel level.

__ DWDM Ring Interconnection - An interconnecting ring topology is used in larger networks that require higher capacities and routing diversity. If rings are terminated on different NEs, an 88-channel system requires an Ethernet cable to interconnect the OSC channel between optically connected rings because the rings share a single NE by using the same SPM. Additional features of a DWDM ring interconnection scheme include: a channel capacity of up to 88 channels in each ring, four ring termination at a single NE equipped with eight DWDM interfaces, and multiple signal protection schemes through channel sharing between rings.

__ DWDM Point-to-Point OADM - A linear OADM forms a chain in which all of the NEs can add or drop traffic at specific points along the network path. This topology can be comprised of a variety of NEs, including Hub OADMs, SBOADMs, and OLAs. This topology is used to interconnect multiple sites where signal protection is not required.

__ DWDM Mesh With Spur - For larger networks, provides additional capacity, protection, and multiple protection pathways. DWDM mesh topologies provide multiple traffic paths in case of failures.

__ Tellabs 7100N OTS - For medium-sized applications where DWDM is desired but the full capacity of a Tellabs 7100 OTS is not required, the Tellabs 7100N OTS provides a smaller footprint with eight protected wavelengths and a two-degree interface.

Tellabs 7100/7100N OTS Shelves

7.04 Tellabs 7100 OTS NEs comprise a one or two main shelves and up to 12 port shelves. The following applications are supported:

- Tellabs 7100 single-bay hub optical add-drop multiplexer (SBOADM) - 44 channels
- Tellabs 7100 optical line amplifier (OLA) - 44 channels
- Tellabs 7100 single-bay hub optical add-drop multiplexer (SBOADM) - 88 channels
- Tellabs 7100 optical line amplifier (OLA) - 88 channels

7.05 The Tellabs 7100N OTS shelves provide eight module slots and support configurations of up to six port shelves. Each 30-AMP shelf is equipped with a fan tray, fiber trough, a built in alarm panel, T1/E1 timing interfaces, and alarm contacts. Each shelf provides six universal slots for amplifier, multiplexer, and transponder modules and two slots for the system processors. The shelf is equipped with universal power termination posts, and can be mounted vertically or horizontally in racks in the following applications:

- Tellabs 7100N OTS optical add-drop multiplexer (SBOADM)
- Tellabs 7100N OTS optical line amplifier (OLA) - 44 channels
- Tellabs 7100N OTS optical line amplifier (OLA) - 88 channels

7.06 Additional information on system configurations is provided in System Applications, page 2-39. Additional information on the module positions in the main shelf and the port shelves is provided in Physical Configurations, page 2-48. The following paragraphs provide a brief description of each of the Tellabs 7100/7100N series modules.

Tellabs 7100 OTS Modules

7.07 This section describes the modules supported in the Tellabs 7100 OTS.

Note: *For detailed information on the various modules, their functions, operation, and front panel descriptions, refer to the respective module practices.*

System Processor Module (SPM)

7.08 The 81.71114B System Processor Module (SPM) is a main shelf processor module that runs the network element (NE) software, managing all of the modules in the NE. The SPM conducts monitoring, communicates with the system management software and modules within the NE, and maintains data in persistent storage. All modules connect with the SPM to retrieve software loads as well as to exchange provisioning and performance monitoring data. The communication interface between modules in a shelf is 10Base-2 and the communication interface between shelves is 100Base-T.

82.71114B System Processor Module

7.09 The 82.71114B System Processor Module (SPM) can be installed in the main shelf or in the port shelf to perform the functions of the Data Processor Module (DPM).

Note: *You must use at least one 82 version System Processor Module (SPM) or one Data Processor Module (DPM) in Tellabs 7100 OTS port shelf slot position 17 or 18, if the system contains either SMTM-P, TGIM-P, OTNM-D, SSM-D, or SSM-X modules.*

Amplified Interface Module (AIM)

7.10 The 71127A Amplified Interface Module (AIM) provides a channel pass-through interface and amplification for alien wavelengths.

Data Processor Module (DPM)

7.11 The 71115 Data Processor Module (DPM) forwards and distributes control traffic. The main functions of the DPM are routing control traffic to and from Section/Line/Multiplex Section/Regenerator Section DCC on a port shelf, routing control traffic to and from Ethernet interfaces on a port shelf, and providing management visibility and redundancy of its routing functions.

Note: *You must use at least one 82 version System Processor Module (SPM) or one Data Processor Module (DPM) in Tellabs 7100 OTS port shelf slot position 17 or 18, if the system contains either SMTM-P, TGIM-P, OTNM-D, SSM-D, or SSM-X modules.*

Line Input Amplifier Module-Enhanced (LIAM-E)

7.12 The 71122C Line Input Amplifier Module-Enhanced (LIAM-E) is a single slot amplifier module that provides input amplification of the incoming DWDM signal. Enhancements to this module include OSC add/drop capability and increased amplification. The LIAM-E has both a line-side and a port-side optical monitoring port. The LIAM-E is used in both SBOADM and OLA configurations.

Long Reach Amplifier Module-Enhanced (LRAM-E)

7.13 The 71124C Long Reach Amplifier Module-Enhanced (LRAM-E) is a single slot amplifier module that provides input amplification of the incoming DWDM signal. Enhancements to this module include OSC add/drop capability and increased amplification. The LRAM-E has both a line-side and a port-side optical monitoring port. The LRAM-E is used in both SBOADM and OLA configurations.

Extended Long Reach Amplifier Module-Enhanced (ELRAM-E)

7.14 The 71126A Extended Long Reach Amplifier Module-Enhanced (ELRAM-E) is a single slot, high-gain input amplifier module that provides input amplification of the incoming DWDM signal, generation and termination of the OSC signal, and test ports. It provides the same functionality as the LRAM-E with the addition of higher gain values and mid-stage access.

Line Output Amplifier Module-Enhanced (LOAM-E)

7.15 The 71123B Line Output Amplifier Module-Enhanced (LOAM-E) is a single slot amplifier module that provides amplification of the outgoing DWDM signal. Enhancements to this module include increased amplification. The LOAM-E is used in SBOADM configurations.

Line Input Amplifier Module - Enhanced 88-Channel (LIAM-E88)

7.16 The 71188-IR Line Input Amplifier Module - Enhanced 88-Channel (LIAM-E88) is a single slot amplifier module that provides input amplification of the incoming DWDM signal on 44-channel and 88-channel systems. The module includes a span distance measurement feature via the OSC channel/ FPGA and in-band OSNR for collection of accurate per channel measurements that are data rate insensitive. The module is equipped with a redundant 100 BaseT controller interface and an RJ-45 connector. It connects directly to a discoverable DCM module.

Long Reach Amplifier Module - Enhanced 88-Channel (LRAM-E88)

7.17 The 71188-LR Long Reach Amplifier Module - Enhanced 88-Channel (LRAM-E88) is a single slot amplifier module that provides input amplification of the incoming DWDM signal on 44-channel and 88-channel systems. The module includes a span distance measurement feature via the OSC channel/ FPGA and in-band OSNR for collection of accurate per channel measurements that are data rate insensitive. The module is equipped with a redundant 100 BaseT controller interface and an RJ-45 connector. It connects directly to a discoverable DCM module.

Extended Long Reach Amplifier Module - Enhanced 88-Channel (ELRAM-E88)

7.18 The 81.71188-ER ELRAM-E88 Extended Long Reach Amplifier Module - Enhanced 88-Channel is a single slot amplifier module that provides input amplification of the incoming DWDM signal on 44-channel and 88-channel systems. The module includes a span distance measurement feature via the OSC channel/ FPGA. The discoverable DCM module connects through the RJ45 connector.

Line Output Amplifier Module - Enhanced 88 Channel (LOAM-E88)

7.19 The 71123C Line Output Amplifier Module - Enhanced 88-Channel is a single slot amplifier module which provides amplification of the outgoing DWDM signal in 88-channel systems and provides a redundant 100 BaseT controller interface.

Channel Pass-Through Module (CPM)

7.20 The 71511 Channel Pass-Through Module (CPM) manages wavelengths from non-Tellabs transponders with a transmit output power that is greater than 0 dBm and forwards them to RCMM-xDs. The SC connectors on the CPM provide the demarcation point to the 15xx interface of non-Tellabs transponders. This module also manages non-Tellabs transponders (alien wavelengths).

Reconfigurable Channel Multiplexer Module (RCMM-xD)

7.21 The 71227A/71227B Reconfigurable Channel Multiplexer Module, 4-Degree or 8-Degree (RCMM-4D/8D) provides reconfigurable multiplexing and demultiplexing of wavelengths in Tellabs 7100 Single Bay Hub OADM (SBOADM) configurations. The RCMM-4D/8D provides the ability to dynamically reconfigure wavelengths that are added or passed-through. To ensure proper wavelength equalization, an EVOA per wavelength is built in. The RCMM-4D/8D is located in the main shelf. This module has the following interfaces: line interface, Express interface (three Express ports on the 4D and seven Express ports on the 8D), a test port, and 44 add/drop ports. The add/drop interface is provided on eight MPO connectors. Seven connectors service six add ports and six drop ports, and one connector services two add and two drop ports.

Reconfigurable Channel Multiplexer Module-Spur (RCMM-S)

7.22 The 71227E Reconfigurable Channel Multiplexer Module-Spur (RCMM-S) is used in spur applications. It provides a 1:2 splitter/combiner in 4-Degree and 8-Degree Spur SBOADM applications.

Note: *A spur is a point-to-point Tellabs 7100 network connection between a remote location and a Tellabs 7100 site on the main artery or ring.*

7.23 In the line-to-port direction, the splitter on the RCMM-S takes the incoming signal coming from an input amplifier module on the SPUR interface, and forwards it to the Express port of an RCMM-4D/8D module in the same NE. In the port-to-line direction, it takes a signal from the Express port of RCMM-4D/8D and forwards it to a LOAM-E output amplifier module toward the spur site.

8-Degree Reconfigurable Multiplexer Module - 88 Channel (RCMM-8D88)

7.24 The 71887B 8-Degree Reconfigurable Channel Multiplexer Module for 88 Channels (RCMM-8D88) is a two-slot module that provides reconfigurable multiplexing / demultiplexing of wavelengths and output amplification. The RCMM dynamically reconfigures up to 88 wavelengths for 50 Gig spacing, reducing wavelength blocking and enabling mesh restoration techniques. This module provides both TDM and Ethernet communications and is equipped with dual optical LC connectors that collect per channel optical power measurement. It can be cascaded to a maximum of 24 nodes.

Channel Multiplexer Module - 44 Channel (CMM-44)

7.25 The 71337 Channel Multiplexer Module - 44 Channel (CMM-44) provides multiplexing and demultiplexing of wavelengths in Tellabs 7100 Single Bay Hub OADM (SBOADM) configurations. The CMM-44 combines up to 44 channels onto a single aggregate OMS signal on the line side. In the demux direction, it demultiplexes the aggregate signal into 44 channels. The CMM-44 does not have an Express interface.

7.26 The CMM-44 output is routed to the input and output amplifiers for transport to the network access NE. At the network access NE, the signal is received at the input amplifier and routed to an RCMM-S.

Note: *All signals connected to the CMM-44 port side have to be at the same power level because the module does not have a per-channel EVOA.*

714144 OMD44-1 and 714188 OMD44-45 Mux/Demux Modules

7.27 The 714144 OMD44-1 and 714188 OMD44-45 Mux/Demux modules connect to the RCMM-8D88 and perform optical multiplexing and demultiplexing of up to 88 channels. The 714144 OMD44-1 provides 44 dual LC connectors for adding or dropping channels 1 through 44. The 714188 OMD44-45 provides 44 dual LC connectors for adding or dropping channels 45 through 88. Both modules support electrical connections to the RCMM-8D88 module for inventory and communication. The OMD44-1 and OMD44-45 are typically installed in the 6-inch spacer panel on the rack.

SONET/SDH/Packet Fabric Module (SPFAB)

7.28 The 71150A SONET/SDH/Packet Fabric (SPFAB) module provides a switch matrix for TDM traffic (SONET or SDH) and Packet traffic to maximize system integration and bandwidth efficiency in metro access networks. This feature supports the ability to groom TDM traffic between SMTM-Us that interface the SPFAB and to switch Ethernet traffic between TGIM-Ps and SMTM-Ps that interface the SPFAB. An Ethernet switch fabric handles packet traffic and an STS/VC switch fabric handles the STS/VC traffic. TDM traffic is groomed at STS-1, STS-3c, STS-12c, STS-48c, VC-4, VC-4-4c, VC-4-16c, and VC-464C rates.

7.29 The SPFAB supports 28 interfaces (14 line side, 14 port side) at 10 Gbps each. This module operates in protected mode in slots 8 and 9 of the port shelf of a Tellabs 7100 OTS. It provides multicast with up to 153 legs to multiple transponders, CNV for virtual concatenation, red-lined cross-connects, 8 KHz and Stratum 3 or QL-SEC synchronization and up to 280 Gbps of cross-connects.

Dispersion Compensation Module (DCM)

7.30 The Dispersion Compensation Module (DCM) manages the chromatic dispersion that can build up over long distances in optical networks. It compensates for signal degradation by reshaping the pulse width of wavelengths as they are received. Tellabs 7100/7100N OTS DCMs provide dispersion compensation for 2.5G, 10G, and 40G transponders in distances of 10 through 150 kilometers. They support SMF-28, TrueWave-RS, and LEAF fibers.

7.31 Specific Dispersion Compensation Modules (DCMs) are equipped with a Communication port for connection to an amplifier that allows autodiscovery through the management system, craft station, and TL1 interfaces. When the DCM is autodiscovered, the fiber type and distance can be viewed and modified. A positive DCM is also available for applications using dispersion shifted fiber.

71125A Network Interfaced Raman

7.32 The 71125A Network Interfaced Raman (NIR) is an external amplifier that provides additional gain to input amplifiers in the Tellabs 7100/7100N OTS. The additional gain required from the NIR is calculated based on OSNR margin, the PMD present, fiber type, input amplifier used, wavelength, and the amount of insertion loss in the path. The NIR can be turned on and off in the software, and is typically deployed horizontally in the rack.

71125B Co-Propagating Raman Amplifier 700 mW

7.33 The 71125B Co-Propagating Raman Amplifier (CRA) is an external amplifier that allows the Tellabs 7100/7100N OTS to support traffic over larger optical span losses than would be possible if only using a Tellabs 7100/7100N amplifier. The CRA also allows a signal to travel through a larger number of total spans. The CRA provides post-amplification of a signal after the signal exits the Erbium Doped Fiber Amplifier (EDFA) of a Tellabs 7100/7100N amplifier. In a co-propagating deployment, the Raman amplification distributes a high pump power (700 mW) in the fiber in the same the direction of travel as the traffic.

Filler Modules

7.34 The 71000C Blank Filler Module (BFM) is used to fill an empty slot when an active module is not required. The BFM ensures shelf airflow and EMI shielding characteristics. The 71000F BFM is provided for Tellabs 7100N shelves.

7.35 The 71000D Optical Filler Module (OFM) and 71000E Multi-port Optical Filler Module (MOFM) are used to fill empty slots when an active module is not required. The OFM and MOFM ensure shelf airflow and EMI shielding characteristics. The optical connectors on the module front panel provide a secure and convenient place to store optical cable connectors that may be provided for future use. The 71000E Multi-port Optical Filler Module (MOFM) is supported in both Tellabs 7100 and Tellabs 7100N shelves.

XFP/SFP Management

7.36 Small form pluggables (SFP) and 10G Small Form Factor Pluggables (XFP) are small optical transceivers that can be installed in the following modules: 71328xx Subrate Multiplexer Transponder Module (SMTM-U, SMTM-UniD, SMTM-P, or SMTM-SD) and 71326-NS Multirate Transponder Module-Enhanced (MRTM-E). The Software Lock of XFP is supported with the 71323-NX 10G Transponder Module - Enhanced (TGTM-E) and 71323P 10G Transponder - Packet Interface Transponder Module (TGIM-P). The Tellabs 7100 OTS provides software management of SFPs and XFPs. A Tellabs software key is programmed into each SFP/XFP so it is recognized when installed. The Tellabs 7100/7100N NE recognizes only Tellabs SFPs/XFPs. SFP and XFPs may be added as required. Different SFP/XFP interface types can be mixed on the same transponder.

Optical Protection and Synchronization Module (OPSM)

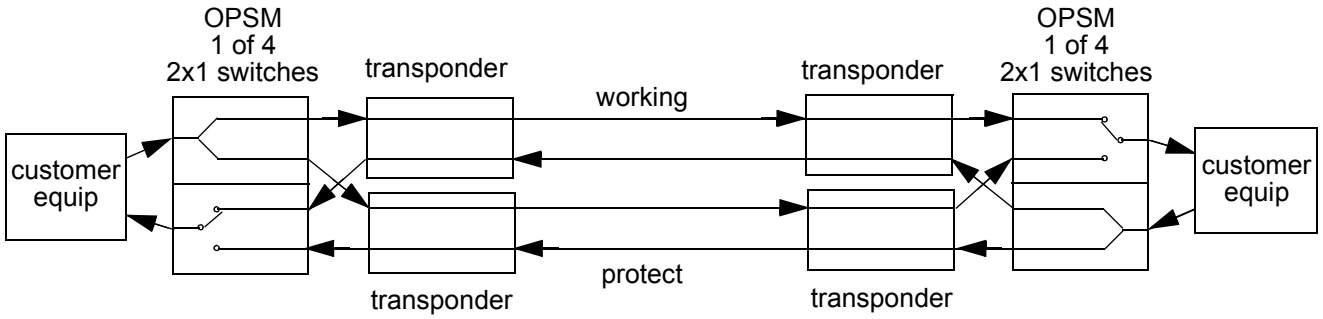
7.37 The 71239 Optical Protection and Synchronization Module (OPSM) can be used to provide 1+1 port-side protection or 1+1 line-side protection. In the transmit direction, an optical splitter provides two duplicated signals at the line side output to the transponders. The OPSM receive circuits include a selector which selects one of two signals and presents it at the port side interface. Each OPSM includes four independent protection switches for up to four independent circuits or up to eight transponders. This type of protection protects against both equipment and network failures.

7.38 The OPSM can be used for transponder line-side protection. In this application, the client signal goes to a single transponder and then the line side of the transponder is connected to the port side of the OPSM. The associated line sides of the protection switch are then connected to the add/drop ports of the channel multiplexer (RCMM). Connection can be done on channel multiplexers located in either the same NE or in different NEs.

7.39 The OPSM resides in the Tellabs 7100 port shelves and is inserted in the circuit between the customer equipment and the transponders. Refer to Figure 7.1, page 2-86.

Note: *The OPSM is supported in Tellabs 7100 OTS applications only.*

Figure 7.1 OPSM 1+1 Protection Feature



Tellabs 7100N OTS Modules

7.40 This section describes the modules supported in the Tellabs 7100N OTS.

Note: *For detailed information on the various modules, their functions, operation, and front panel descriptions, refer to the respective module practices.*

System Processor Module (SPM-N)

7.41 The Tellabs 7100N OTS 81.71714 System Processor Module (SPM-N) provides control and management functions for all shelves that comprise the Tellabs 7100N NE. It is typically deployed redundantly in slots 7 and 8 of the main and port shelves. It provides 10/100BaseT Ethernet interfaces (RJ-45) for the following connections: data communication network (DCN), embedded operation network (EON), secure Ethernet virtual private networks (VPN), and a local craft. The module is also equipped with an RS-232 (RJ-45) port for maintenance access.

Colorless Core Module (CCM-xR)

7.42 The Tellabs 7100N OTS 81.717271/81.717273 Colorless Core Modules (CCM-IR, CCM-LR) are 3-slots wide and provide 8-channel add/drop multiplexing and amplification services. The CCM-IR/CCM-LR multiplexer feature supports remote wavelength provisioning at the Express interface, 2-degree applications via connections between two CCM-IR/CCM-LR at the Express ports, and wavelength reconfiguration for up to eight wavelengths. This module is colorless, in that any channel can be directed to any port. The CCM-IR/CCM-LR amplifier functionality is available for intermediate- and long-distance amplification. Each module provides automatic and manual gain adjustment functionality, automatic transmit power shutdown, automatic DWDM line-out attenuation, automatic gain control to manage added/dropped channels and fiber cuts, and automatic gain configuration to compensate for presence of DCMs.

Optical Line Amplifier

7.43 The Tellabs 7100N OTS Optical Line Amplifier Core modules (OLA-IR, OLA-LR) provide amplification for up to 44 channels. The 81.717471 (OLA-IR) supports intermediate spans, and the 81.717473 (OLA-LR) supports long spans. These modules are typically deployed in Optical Line Amplifier (OLA) configurations where the NE is comprised of a single shelf that provides amplification support. Each module provides automatic and manual gain adjustment functionality, automatic transmit power shutdown, automatic DWDM line out attenuation, automatic gain control to manage fiber cuts, and automatic gain configuration to compensate for presence of DCMs.

88-Channel Input Amplifiers

7.44 The 81.71188-IR LIAM-E88 Line Input Amplifier Module - Enhanced 88-Channel, the 81.71188-LR LRAM-E88 Long Reach Amplifier Module - Enhanced 88-Channel, and the 71188-ER Extended Long Reach Amplifier Module - Enhanced 88-Channel (ELRAM-E88) are single slot amplifier modules that provide input amplification of the incoming DWDM signal on 44-channel and 88-channel Tellabs 7100N OLA configurations. Refer to Tellabs 7100 OTS Modules, page 2-79.

Filler Modules

7.45 The 81.71700C Controller Filler Module (CFM) is a passive module for slot 7 of the main or port shelf when a redundant SPM-N is not deployed. The 81.71000F Blank Filler Module (BFM) and 81.71000E Multi-port Filler Module (MOFM) are passive modules equipped with front-access latches for slots one through six of the main or port shelf.

Tellabs 7100/7100N OTS Transponders

7.46 This section describes the transponder modules supported in the Tellabs 7100/7100N OTS.

Note: *For detailed information on the various modules, their functions, operation, and front panel descriptions, refer to the respective module practices.*

Multirate Transponder Module-Enhanced (MRTM-E)

7.47 The 71326-NS Multirate Transponder Module-Enhanced (MRTM-E) converts the client optical facility signal to one of 44 selectable channels to be added to the DWDM network. In the reverse direction, the MRTM converts the selected channel signal to be dropped from the DWDM network to the client optical signal. MRTM-E accepts any line rate between 100 Mb/s and 2.7 Gb/s.

Note: *The Tellabs 7100N OTS supports the 82.71326-NS MRTM-E only.*

Universal 10G Transponder Module-Tunable (TGTM-T)

7.48 The 71323/A Universal 10G Transponder Module-Tunable (TGTM-T) is a single-slot module that provides tunability of wavelengths with 100 GHz spacing on the line-side interface. The TGTM-T encodes OC-192, STM-64, 10 Gbps LAN, and 10 Gbps WAN port-side signals into an FEC encoded and ITU-T compliant WDM signal. The TGTM-T performs the following functions: tunablitity of wavelengths with 100 GHz spacing on the line-side interface, support of 10 GHz WAN (OC-192/10GBase-W) with an OTU2 structure, support of 10 GHz LAN (10GBase-R) client-side interface with an OTU2 structure, FEC on the line-side interface, and optical channel FEC performance monitoring.

Note: *The Tellabs 7100N OTS does not support the TGTM-T.*

81.71323-NX Enhanced 10G Transponder Module (TGTM-E)

7.49 The 71323-NX Enhanced 10G Transponder Module (TGTM-E) is a single slot module that provides tunability of 44 wavelengths with 100 GHz spacing on the line-side interface. The TGTM-E encodes OC-192, STM-64, OTU2, 10G Fiber Channel, and 10 Gbps Ethernet customer-provided signal into an OTU2 DWDM signal. The TGTM-E supports LAN PHY to provide transport service for Local Area Network (LAN) service on the DWDM network.

7.50 The TGTM-E has removable client side XFP and supports more variants of 10G LAN facility than the earlier TGTM-T. It supports the 10G FC (Fiber Channel) and OTU2 as client interface. Paired TGTM-Es implement optical-to-electrical-to-optical regeneration through the backplane.

Note: *The Tellabs 7100N OTS only supports the 82.71323-NX and 81.71323A-NX TGTM-Es.*

81.71423 40G Transponder Module (FGTM)

7.51 The 71423 40 Gbps, single-port Tunable Transponder Module (FGTM) accepts OC-768 or STM-256 client signals. It increases traffic-carrying capability four-fold and is easily installed in existing networks during a service upgrade without extensive network redesign or reconfiguration.

82.71423 40 Gbps Transponder Module (FGTM)

7.52 The 82.71423 40 Gbps, single-port Tunable Transponder Module (FGTM) accepts OC-768 or STM-256 client signals. It increases traffic-carrying capability four-fold and is easily installed in existing networks during a service upgrade without extensive network redesign or reconfiguration. It can also be installed with the Y-Cable patch panel for signal protection.

7.53 The 82-issue FGTM supports the DQPSK modulation scheme on the line side facility and provides polarization mode dispersion compensation (PMDC) up to 10 ps.

Subrate Multiplexer Transponder Module (SMTM-x)

7.54 The Subrate Multiplexer Transponder Module (SMTM-x) is available in the following formats: 71328x Subrate Multiplexer Transponder Module-Universal (SMTM-U), 71328P Subrate Multiplexer Transponder-Packet (SMTM-P), 71328UD Subrate Multiplexer Transponder-Unidirectional (SMTM-UniD), and 71328SD Subrate Multiplexer Transponder Module-SONET/SDH/Data (SMTM-SD). The SMTM-x modules can be tuned to any of the 88 wavelengths and support both SONET and SDH facility types. For the SMTM-U and SMTM-SD, the high-speed, line-side interface is fully tunable over the ITU band.

7.55 The SMTM-x multiplexes up to ten low-speed channels on its port-side interfaces into a high-rate OC-192/STM-64 interface and converts it into a DWDM optical channel on its line-side interface for transport over the Tellabs 7100 OTS. A single channel of the DWDM interface is able to carry multiple low-speed signals for SONET, SDH, Ethernet, and Storage Area Network (SAN). The SMTM-U, SMTM-UniD, and SMTM-SD support 4G fiber channel (4.25 Gbps) facilities.

7.56 The SMTM-U also performs pass-through to another SMTM-U for port-side 1+1 (APS), line-side UPSR/SNCPRING, OCH-DPRING protection, or add/drop multiplexing (ADM) functionality. The SMTM-U supports port-side UPSR/SNCPRING.

7.57 The SMTM-UniD is a uni-directional module which supports traffic in the DWDM to client (port) direction only. Like SMTM-SD, it does not provide ADM functionality or collect Ethernet PM. Performance monitoring is only supported on the OC-192/STM-64 high-speed interface.

Note: *The Tellabs 7100N OTS supports the 82.71328U SMTM-U only.*

71328O-M Optical Transport Network Multiplexer (OTNM-D)

7.58 71328O-M Optical Transport Network Multiplexer (OTNM-D) multiplexes clients into the DWDM network transparently to provide increased capacity and flexibility for applications. The OTNM-D is designed with eight, low-speed SFP interfaces that support client rates from 100 Mbps to 4 Gbps. It supports a wide range of client signals, including SONET/SDH, Ethernet, Storage Area Network (SAN), OTU1, and video. The OTNM-D has an integrated line-side optical switch to provide DPRING protection. It can also be installed with the Y-Cable patch panel for signal protection.

7.59 When the OTNM-D is deployed in the Tellabs 7100 OTS port shelf, it requires at least one 82 version System Processor Module (SPM) or one Data Processor Module (DPM) in Tellabs 7100 OTS port shelf slot position 17 or 18.

10G Subrate Multiplexer Transponder Module - Packet (SMTM-P)

7.60 The 71328P 10G Subrate Multiplexer Transponder Module - Packet (SMTM-P) supports Packet subsystem functions. Each SMTM-P provides one, 10 Gb line-side facility interface and ten port-side facility interfaces that support signal rates of 10/100/1000 Mbps. Each of the ten port-side facility interfaces can be configured to support either electrical or optical SFPs. The port-side optical interfaces support 100BaseFX and GbE.

7.61 When the SMTM-P module is deployed in the Tellabs 7100 OTS port shelf, SPFAB and DPM or 82 version SPM modules must be installed in the same shelf. The DPM and 82 issue SPM provide the control plane functions for the SMTM-P. The SONET/SDH/Packet Fabric (SPFAB) module provides switching and grooming capabilities at the Layer 2 level to route traffic between SMTM-Ps in the same shelf.

7.62 The line-side facility is connected to the SPFAB line-side switching port. The ten port-side facilities are combined into one 10 Gb port-side interface and are connected to the SPFAB port-side switching port.

7.63 When the SMTM-P module is deployed in the Tellabs 7100N OTS, the Tellabs 7100N shelf backplane provides switching and grooming capabilities at the Layer 2 level to route traffic between SMTM-Ps in the same shelf.

10G Transponder - Packet Interface Module (TGIM-P)

7.64 The 71323P 10G Transponder - Packet Interface (TGIM-P) module supports Packet subsystem functions. The TGIM-P is a one-slot wide module with Packet switching capability and one laser that is tunable across 44 wavelengths. It has one 10GbE port-side interface (IEEE 802.3ae compliant).

7.65 When the TGIM-P is deployed in the port shelf of the Tellabs 7100 OTS, it interfaces the 71150A SPFAB and 71115 DPM modules or 82 version SPM. The DPM and 82 issue SPM provide the control plane functions for the TGIM-P module. The SPFAB module provides switching and grooming capabilities at the Layer 2 level to route traffic between TGIM-Ps in the same shelf.

7.66 When the TGIM-P is deployed in the Tellabs 7100N OTS, Tellabs 7100N shelf backplane provides switching and grooming capabilities at the Layer 2 level to route traffic between TGIM-Ps in the same shelf.

7.67 The TGIM-P supports power monitoring, performance monitoring, traffic management, and V-LAN based classification and forwarding. It can also be provisioned for line-side RPR and client-side IEEE 802.3ad Link Aggregation protection.

SONET/SDH Switching Modules (SSMs)

7.68 The SONET/SDH Switching Modules (SSM) are available in the following formats: 71623S-M SONET/SDH Switching Module - 12 SFPs, 1 XFP, 1 MSA (SSM-D) and the 71623S SONET/SDH Switching Module - 12 SFPs, 2 XFPs (SSM-X). The SSM-D modules can be tuned to any of the ITU C-band 88 wavelengths (in the 88 channel plan) or 44 wavelengths (in the 44 channel plan) and support both SONET and SDH facility types.

7.69 The SSMs multiplex up to 12 low-speed clients and one high speed 10G client on its port-side interfaces into a high-rate OC-192/STM-64 interface and converts it into a DWDM optical channel on its line-side interface for transport over the Tellabs 7100/7100N OTS. A single channel of the DWDM interface is able to carry multiple low-speed signals for SONET, SDH, and Ethernet. The SSMs also support OC-192 and electrical Ethernet Client facilities. Protection schemes include OCH DPRING, UPSR, APS 1+1, and LAG port-side protection.

7.70 The SSM-D (XFP slot 1) has a widely tunable 10 Gb/s interface and supports OCH DPRING on the line-side or unprotected line-side UPSR.

7.71 The SSM-X (XFP slot 1) supports an OC-192, STM-64, or OTU2 line interface. It performs pass through to another SSM-D for line-side OCH-DPRING protection or add/drop multiplexing (ADM) functionality and supports unprotected line-side UPSR and line-side 1+1 APS.

7.72 When the SSM-D or SSM-X modules are deployed in the Tellabs 7100 OTS port shelf, they require at least one 82 version System Processor Module (SPM) or one Data Processor Module (DPM) in Tellabs 7100 OTS port shelf slot position 17 or 18.

Tellabs 7100 OTS Common Equipment

7.73 The Tellabs 7100 OTS common equipment includes the components all configurations require to operate. The common equipment performs tasks such as alarm management, power feeds to all shelves, Ethernet connections to the management software, intra-shelf, equipment, and NE connections, and rack cooling.

7.74 For detailed descriptions of the common equipment and their front panel features, refer to the applicable module practice. For common equipment part numbers, refer to *Tellabs 7100 System Engineering*.

88-Channel Shelves

7.75 Tellabs 7100 OTS shelves for 88-channel applications allow amplifier installation in slot 19:

- 82.07100A-60, Rev H - main shelf, NEBS compliant
- 82.07100C-60, Rev B - main shelf, ETSI compliant

83.71020 Generic Breaker Frame Alarm Panel

7.76 The 83.71020 Generic Breaker Frame Alarm Panel is not equipped with breaker kits. This generic form allows breakers to be sized according to configuration and ordered accordingly.

Breaker Frame Alarm Panel (BFAP)

7.77 The BFAP provides front access for the central office (CO) inlet power, power distribution, external alarm connections, and fault indicators. It also provides redundant terminations to incoming -48 Vdc feeds and over-current protection for the NE. Circuit breakers in the BFAP prevent damage to the NE.

7.78 The BFAP distributes power and monitors alarms and shelf status for all shelves in the rack. If an input over-voltage occurs, the circuit breaker in the BFAP opens, preventing damage to the NE.

Breaker Frame Alarm Module (BFAM)

7.79 The BFAM, installed on the BFAP, has the following functions:

- monitors the power status and alarm status of the shelves
- indicates fault conditions on the NE using the *frame alarm* LED
- provides frame alarm relay contacts for use by the central office (CO) for frame alarm indicators or other purposes
- provides shelf *fault* LEDs to aid in locating a faulted shelf
- monitors the status of the circuit breakers and fuses

7.80 Six power feed lines and one combined power return line from the BFAP supply power to the BFAM. The six power feed lines are filtered and fused before entering the module. The six power feed lines split into two groups, -48 V feed A group and -48 V feed B group. Each group branches into three power feed lines called -48 V feeds 1A, 2A, and 3A, and -48 V feeds 1B, 2B, and 3B. The BFAM monitors these power feed lines for faults, signaling the LEDs to light green for active and red for fault.

Alarm Interface Panel (AIP)

7.81 The AIP houses alarm LEDs and alarm contacts for the severity values of critical, SPM fault, major, and minor alarms. For each alarm severity, there are contacts for visual indicators, audible alarms, and telemetry contacts.

7.82 Behind the front panel of the AIP is a 56-pin wire-wrap connector. The wire-wrap pin connections are used to signal the BFAP of an alarm condition on a shelf, communicate alarms on the NE to CO external equipment (visual, audible, and telemetry indicators), and communicate an alarm cutoff request to the CO. Telemetry contacts provide for four external alarms and four control points.

Fan Assembly

7.83 A fan assembly is integrated below each Tellabs 7100 OTS shelf and a fan assembly is installed above the shelf. A fan filter/plenum assembly is located under the integrated fan assembly in each shelf.

7.84 The main shelf fan assembly reports any failure or abnormal conditions to the SPM. Port shelf fan assemblies report failures to the SPM indirectly through the AIP. The failure and alarm conditions reported include the following:

- failure of one or more fans
- power failure of either of the two feeds, feed A or feed B
- absence of fan filter

Horizontal Distribution Panel Modules

7.85 The Tellabs 7100 OTS shelves are constructed with three removable circuit boards that plug directly into the backplane: the Horizontal Distribution Panel (HDP) modules. Two of the HDPs are Control & Timing Modules (HDP-CT), one of the HDP modules is passive (HDP-P). The HDP-P provides connections to BFAP, FANS, E1/T1 BITS, AIP, EMS, DCN, other NEs or other bays within same NE. The HDP-CTs provide redundant communication between the main shelf and each port shelf it supports.

7.86 The main shelf HDP functions include:

- Ethernet interfaces to other shelves
- Ethernet interfaces to the Tellabs 7190/7194 management systems
- command line system initialization port
- shelf power feeds, A and B
- alarm connections to the AIP
- lamp test button to test the main shelf module LEDs
- Ethernet interfaces to other shelves
- shelf power feeds, A and B
- lamp test button to test the port shelf module LEDs
- control and timing

Tellabs 7100N OTS Common Equipment

7.87 The Tellabs 7100N OTS common equipment performs tasks such as alarm management, power feeds to all shelves, Ethernet connections to the management software, intra-shelf, equipment, and NE connections, and rack cooling.

7.88 For detailed descriptions of the common equipment and their front panel features, refer to the applicable module practice. For common equipment part numbers, refer to *Tellabs 7100N System Engineering*.

Shelf with Fan Tray

7.89 Both the main shelf and the port shelf for the Tellabs 7100N OTS include a fan module for system cooling. The fan module is incorporated into the shelf and provides a replaceable filter.

Telemetry and Timing Module

7.90 The 81.71710 Telemetry and Timing Module (TTM) provides front access for the central office (CO) inlet power, power distribution, external alarm connections (four output, five input), and fault indicators. It also provides redundant terminations to incoming -48 Vdc feeds and redundant BITS connections. and for the NE. Circuit breakers in the TTM provide over-current protection to the NE. The TTM distributes power and monitors alarms and shelf status for all shelves in the rack.

Shelf Display Module

7.91 The 81.71780 Shelf Display Module (SDM) provides an LED indicator that identifies the Tellabs 7100N OTS main shelf and port shelf by number as assigned in the Tellabs 7190 EMS, Tellabs 7194 NMS or TL1 Command interface. The main shelf is numbered **1**, followed sequentially by each port shelf.

SPM-N

7.92 In the Tellabs 7100N OTS, ports on each SPM-N provide the following functions:

- Ethernet interfaces to other shelves
- Ethernet interfaces to the Tellabs 7190 EMS and Tellabs 7194 NMS
- command line system initialization port
- alarm connections to the AIP
- lamp test button to test the main shelf module LEDs
- lamp test button to test the port shelf module LEDs

Facility and System Alarms

7.93 The Tellabs 7100/7100N OTS automatically detects and reports internal hardware, software, communication, and loss of incoming signal faults. Alarms are reported in the following ways:

- Alarms are sent to the management system interface by the NE where craft personnel can acknowledge and clear alarms. The Tellabs 7190 EMS and Tellabs 7194 NMS display the alarm color on the graphical user interface (GUI).
- Alarms are shown on the NE using LEDs on the BFAM, AIP, fan assembly, and individual modules. When equipment is alarmed, the LEDs on the equipment indicate a faulted condition. For detailed information on the LED functions for equipment on the Tellabs 7100/7100N NE, refer to the applicable module practice.
- Alarms are reported to the CO through audible, telemetry, and visual relay contacts on the AIP. Audible alarms can be suppressed by activating the alarm cutoff switch on the AIP.
- The BFAP has wire-wrap contacts for CO reporting.

Alarm Generation

7.94 Each alarm reported by the Tellabs 7190/7194 management systems includes the following information:

- sequence ID
- state - active, acknowledged, or cleared
- service affecting or not service affecting
- severity - critical, major, minor, or warning
- fault location
- type - equipment, facility, common equipment, quality of service
- source - system element reporting the alarm
- trouble code
- description
- set time - date and time alarm was reported
- clear time - date and time alarm was cleared
- cleared by - NE or user that cleared the alarm
- acknowledge time - date and time alarm was acknowledged
- acknowledged by - date and time alarm was acknowledged

7.95 The alarm severity types supported by the Tellabs 7100/7100N OTS apply to equipment and physical layer communications. Refer to Table 7.1, page 2-97, for alarm severity types and their LED colors. All fault conditions detected by the NE are stored and can be retrieved at any time using TL1 commands or the management system interface. The alarms are stored in an alarm log. When the alarm log cache overflows, the oldest alarms are deleted in a first-in, first-out order. Alarms can be aged by craft personnel. When alarms are aged, all alarms within the specified age are transferred from the alarm log to a backup log.

Table 7.1 Alarm Severity Descriptions and LED Colors

Alarm Severity	Description	Alarm LED Color
Critical	A service affecting condition has occurred and immediate corrective action by a craftsperson is required. This severity is used when the object in alarm has failed and is out-of-service.	Red
Major	A service affecting condition has occurred and immediate corrective action by a craftsperson is required. This severity is used when the capability of the object in alarm is severely degraded.	Red
Minor	A non-service affecting condition has occurred and corrective action should be taken by a craftsperson to prevent a more serious fault.	Amber

Signal Monitoring

7.96 The following signals are monitored by the Tellabs 7100/7100N OTS:

- loss of signal (LOS)—monitored on the dense wavelength division multiplexing (DWDM), OC-3/STM-1, OC-12/STM-4, OC-48/STM-16, GbE, and broadband signals
- loss of supervisory channel (LOOSC)—monitored on the DWDM signals

7.97 A loss of signal generates a critical alarm, and a loss of supervisory channel generates a major alarm. When a loss of signal or loss of supervisory channel is detected on the NE, an alarm is sent to the Tellabs 7190/7194 management systems, and the appropriate LED on the AIP is lit. Visual, audible, and telemetry alarms are also sent to the CO external equipment notifying craft personnel of a faulted condition on the NE.

System Reliability

7.98 The Tellabs 7100/7100N OTS NE manages large volumes of traffic—440 Gbps over a single pair of optical fibers. System reliability is vital in preventing degradation or loss of service. Reliability features of the Tellabs 7100 OTS include:

- The multiplexing functionality blocks all undesired wavelengths, preventing a misconnection from affecting existing traffic.
- Amplifiers have automatic gain control providing automatic power level control, without any bit error rate (BER) impact in the network, as channels are added or removed (including fiber cuts).
- The supervisory channel optics and electronics are inserted and removed before the amplification of the other traffic bearing channels thus allowing communication to and through a node even when traffic bearing channels are not functional.
- Optical pass-through functionality allows individual channels to be passed through to another NE without the use of transponders.
- System Processor Module (SPM/SPM-N) replacement is not service affecting, but it does cause a brief interruption between the NE and the management system.
- A redundant -48 Vdc power supply, feed A and feed B, is provided on the BFAP.
- Transponders employ wavelength locking devices to ensure that DWDM channels stay at their desired wavelengths.
- Six fans, with load sharing for cooling, are installed above and below each Tellabs 7100 OTS shelf.
- One removable fan module is installed in each Tellabs 7100N OTS shelf.

System Security

7.99 The following security requirements are provided:

Management Systems User Level Security

Account Inactivity Policy

- Reports the date and time of the user's last successful login and the number of unsuccessful login attempts since the last successful login
- Provides the ability to configure the account inactivity threshold on user accounts

Password Reuse Policy

- Provides the ability to configure the amount of time a user needs to wait before reusing a password

Password Expiration Reminder

- Provides the ability to configure the amount of time prior to password expiration that the system sends an expiration notice

Password Complexity Policy

- Provides enhanced password complexity policy

Simultaneous Sessions Policy

- Configures the number of simultaneous sessions allowed

Security Events Generated

- Increased security events generated for: an invalid log in due to invalid user name or invalid password; a lockout of a user account because the number of unsuccessful login attempts to the EMS exceeds the system defined threshold; and unsuccessful log ins to a locked account

TL1 User Level Security

Inactivity Policy

- Configures an inactivity report threshold for user accounts on an NE
- Configures an inactivity disabled threshold value for user accounts

Password Complexity Policy

- Provides enhanced password complexity policy

Security Profile Management

- User-configurable default values for entity creation

IP Security

7.100 The IP security feature strengthens the security of communications between a GNE and the management system (EMS, NMS, or craft station) and the TL1 sessions coming in through the DCN port. Creating a secure association between the management system and the GNE allows each party in the exchange to verify the other's identity.

7.101 IP security uses encapsulating security payload (ESP) protocol, provides digital certificates, specific encryption and authentication algorithms, specific secure associate (SA) and internet key exchange (IKE) lifetimes, and the ability to download certificates in PKCS12 files.

Network Protection Features

7.102 Protection groups can be provisioned in the Tellabs 7100 OTS via the optical protection and synchronization module (OPSM) and the SMTM-U. On an SMTM-U pair, protection is available for line side (1+1 DPRING, SNCPRING, or UPSR) or port side (1+1, SNCPRING, or UPSR) for any type of client signal. The OPSM can provide both equipment and path protection (port-side protection) when placed between customer equipment and any pair of transponder modules. The OPSM also provides path protection only (line-side protection) when installed between a single transponder and two channel multiplexer ports. Refer to Managing Network Conditions, page 2-115, for protection illustrations.

7.103 Protection groups can be provisioned in the Tellabs 7100N OTS via the SMTM-U.

Line-Side Protection

7.104 The OPSM can be used for transponder line-side protection. In this application, the client signal goes to a single transponder and then the line side of the transponder is connected to the port side of the OPSM. The associated line sides of the protection switch are then connected to the add/drop ports of the channel multiplexer (RCMM). The connection is on channel multiplexers located in either the same NE or in different NEs.

7.105 The 71328O-M Optical Transport Network Multiplexer (OTNM-D) has an integrated line-side optical switch to provide DPRING protection.

Port-Side Protection on SMTM-U

7.106 In addition to supporting DWDM-side dedicated protection ring (DPRING), unidirectional path switch ring (UPSR/SNCPRING), and port-side 1+1 automatic protection switching (1+1 APS), the SMTM-U also supports port-side UPSR for OCn facilities and port-side SNCPRING for STMn facilities.

7.107 This protection via paired SMTM-Us eliminates the need for local add-drop multiplexer (ADM) equipment at the co-located site. In an OCn access ring, UPSR provides protection at the path layer and allows for drop and continue at the STS level. In an STMn access ring, SNCPRING provides protection at the path layer and allows for drop and continue at the VC level.

OPSM Hold-Off Timer

7.108 The OPSM facility protection entity allows a user-provisioned hold-off time between 60 and 1000 milliseconds before a protection switch takes place.

End-to-End Circuit LOS Propagation

7.109 This feature allows a failure indication (for example, loss of signal) to be propagated over the network instead of the alarm being annunciated at the network elements along the path of the circuit. In the event of a failure, End-to-End Circuit LOS Propagation allows the laser to be shut down at the far end of a circuit so that protection switches via an OPSM or external equipment can occur. End-to-End Circuit LOS is propagated through the TGTM and MRTM transponder family.

Y-Cable Patch Panel

7.110 The Y-Cable patch panel provides signal protection on the Tellabs 7100/7100N OTS through paired TGTM-Es, OTNM-Ds, or FGTMs. The signal is split at the Y-Cable patch panel and one copy of the signal is directed to a pre-defined facility on each module. On the destination side, both signals are received by the modules, compared for integrity, and one is forwarded to the targeted client.

The OSI Data Communication Channel

7.111 This section describes provisioning the OSI Data Communications Channel (DCC) supported on the System Processor Module (SPM/SPM-N). DCC allows multi-vendor device messaging to flow through network elements provisioned as Gateway Network Elements (GNEs) or Direct-OSC in a Tellabs 7100/7100N network. Refer to Figure 7.2, page 2-103 for a detailed illustration of the OSI Data Communications Channel.

7.112 The Tellabs 7100/7100N GNE serves as the conduit for TL1 communication between other-vendor management systems and devices and subtending Remote Network Elements (RNEs), allowing both TL1 messaging and file transfer, access and management (FTAM) software downloads via an Open System Interconnection (OSI) router.

7.113 DCC processing routes messages among the Data Communication Network (DCN) interface, the SPM/SPM-N, the DPM, and the DCC interfaces on SMTM-Us. Each SDH port provides Multiplex Section DCC and Regenerator Section DCC for in-band data communication. Each SONET port provides Section DCC and Line DCC for DCC message processing. The DPM and SPM/SPM-N perform the following functions to allow DCC:

- Routing control traffic to and from Section/Line DCC or Multiplex Section/Regenerator Section DCC on the port shelf.
- Providing management visibility and redundancy for routing functions.

7.114 The OSI router manages DCC messaging for the NEs using TID Address Resolution Protocol (TARP) to find and share the addresses of the TIDs of all NEs on a LAN.

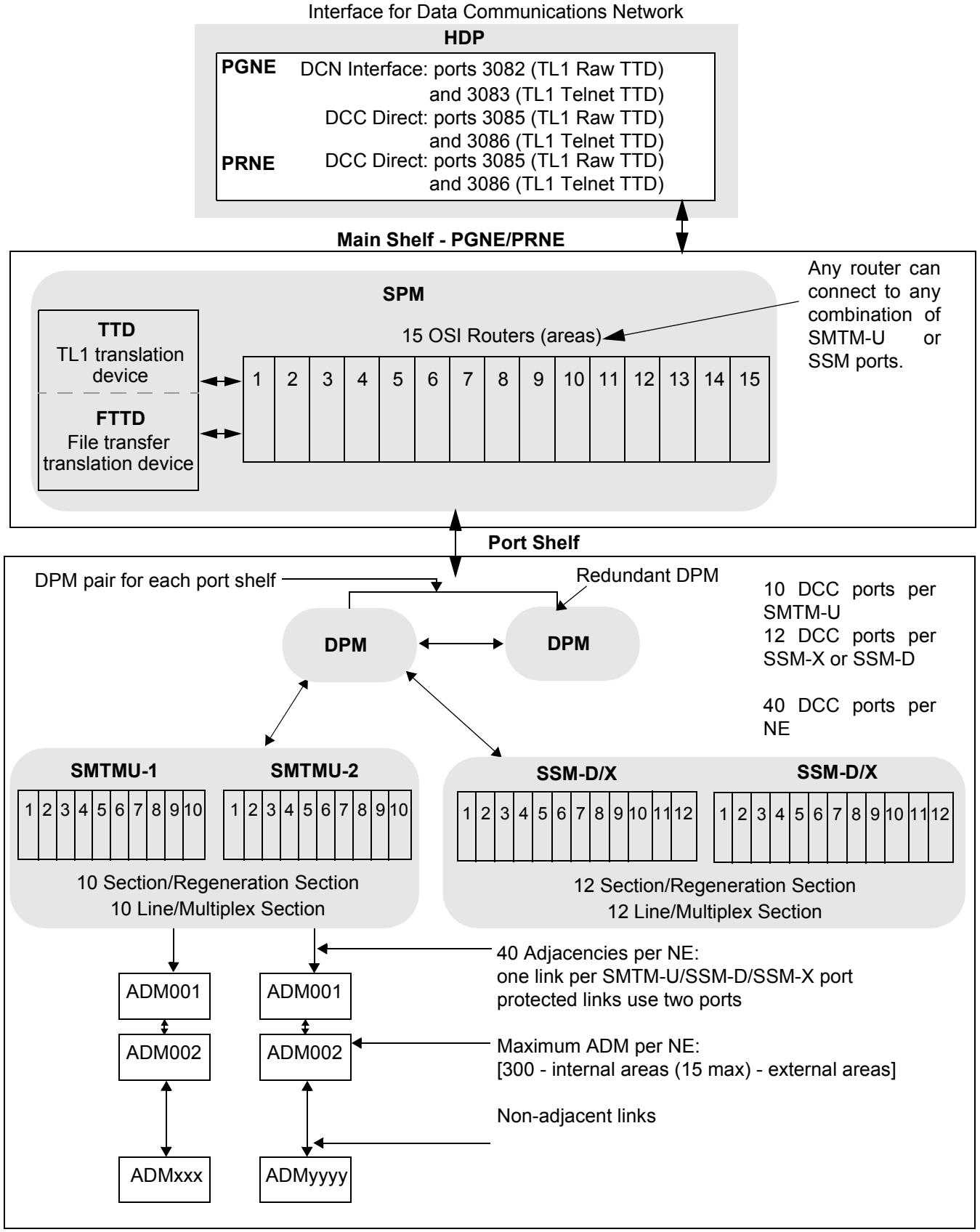
7.115 A Tellabs 7100 GNE provides OSI connectivity to 32 subtending RNEs, as well as to its partner GNE, via GRE tunnels. This transparently conveys OSI messages over the OSC channel to Tellabs 7100/7100N RNEs and to subtended ADMs.

Note: *Tellabs 7100/7100N OTS management interfaces are not available on the OSI network. They are accessible only on the Tellabs 7100/7100N OTS private EON network.*

7.116 The DCN interface provides DCC TL1 Translation Device (TTD) service. Tellabs 7100/7100N OTS NEs support up to 15, Transmission Control Protocol (TCP) connections from TL1 Raw TTD connections (port 3082/3085) or TL1 Telnet connections (port 3083/3086).

7.117 DCC is provisioned on the OCn facilities on SMTM-Us. If Revision D or higher SMTM-Us are installed in a port shelf, DPM modules must be installed in slots 17 and 18 of the same port shelf. If the SMTM-Us are installed in a main shelf, DCC functionality is supported on the SPM/SPM-Ns in the main shelf.

Figure 7.2 Data Communications Channel Architecture for SONET or SDH Applications



8. Performance and Maintenance Features

8.01 Performance and maintenance features of the Tellabs 7100/7100N OTS support and monitor system and facility integrity. This section describes the following features of the Tellabs 7100/7100N OTS:

Facility Alarm Monitoring

8.02 System integrity is preserved by an alarm detection and reporting system that alerts users promptly in the event of a failure. System alarms are classified as critical, major, minor, and System Processor Module (SPM) fault. Critical and major alarms are service-affecting alarms, while a minor alarm is non-service affecting. An SPM fault is not immediately service-affecting but should be treated as a possible major alarm.

8.03 A major alarm signals that a service-affecting failure has severely degraded the capability of the object in alarm. A minor alarm signals the existence of a fault that is non-service affecting. An SPM fault signals that the SPM has failed, resulting in alarms not being sent to the management system interfaces.

8.04 When an alarm occurs, an indication of the alarm is provided on the network element (NE) using an SPM *Fault* LED on the 71010 Alarm Interface Panel (AIP).

Alarm Management

8.05 The Tellabs 7100/7100N OTS continuously monitors incoming signals and internal system conditions and provides feedback in the form of alarms, events, and performance data. All alarms are displayed and can be managed from an alarm window in the Tellabs 7190 EMS, Tellabs 7194 NMS, and the Tellabs 7191 craft station. Alarms are also reported in the TL1 interface.

Alarm Types

8.06 The following incoming signals to the Tellabs 7100/7100N OTS are monitored for loss of signal (LOS):

- dense wavelength division multiplexing (DWDM)
- SONET OC-n
- SDH STM-n
- Gigabit Ethernet (GbE/10 GbE)
- broadband
- loss of supervisory channel (on DWDM signals)

8.07 Alarms are generated by the Tellabs 7100/7100N NE to indicate an equipment, facility, or environmental problem. Alarms are raised due to signal errors and equipment faults.

8.08 All fault conditions detected by the system are stored and can be retrieved on demand in an alarm log (persistent store) residing in the Tellabs 7190/7194 management systems. When the alarm message cache overflows, the oldest message is deleted in a first-in, first-out order. The user has the option of aging alarms so that after a specified period of time, the alarms are automatically archived or moved to a backup log.

8.09 Multiple filters can be set up using Tellabs 7190/7194 management systems to control the alarm display. The filters are based on source, severity, and state attributes.

8.10 If communication is interrupted between the NE and the Tellabs 7190/7194 management systems, the management systems automatically synchronize all alarms with the NE when communication is restored. Synchronization can also be manually invoked at any time.

TL1 Interface

8.11 Tellabs 7100/7100N OTSs use two TL1 interfaces:

- Tellabs 7100 OSS interface
- Tellabs 7100 local interface

8.12 The TL1 operational support system (OSS) interface between a TL1-based OSS and the Tellabs 7190 EMS and Tellabs 7194 NMS server enables the OSS to receive and filter alarms from Tellabs 7100 network elements (NEs) in TL1 format. This TL1 OSS interface feature includes alarm re-synchronization and alarm filtering based on alarm severity. Alarms can be retrieved on demand for selected NEs. For activation, the TL1 alarm forwarding process requires a user name and password from the OSS.

8.13 The *Tellabs 7100/7100N TL1 Command Reference Manual* lists the TL1 autonomous messages and TL1 input commands supported by the Tellabs 7100 OTS.

Facility Performance Monitoring

8.14 Tellabs 7100/7100N NEs are easily provisioned to collect, store, and display data related to system performance. This is referred to as Performance Monitoring (PM).

8.15 PM is designed to detect and isolate any significant signal quality reduction so that the reduction can be resolved before it impacts service. The PM feature checks for specific types of signal information to measure the quality of signals passing through the system.

8.16 PM includes the following features:

- PM Data Collection—the system monitors terminations for performance degradation levels and collects and stores the data.
- PM Data Reporting and Retrieval—the system issues PM reports, on demand or scheduled, showing the PM data on user selected termination points.

8.17 Tellabs 7100/7100N OTSs monitor the following conditions:

- Signal power through lightpath and optical channel monitoring is available on demand on all amplifier, channel multiplexer, and transponder modules (line side).
- Optical power transmitted on the DWDM and optical channel signals.
- Optical power received on the DWDM and optical channel signals.
- SONET coding violation (CV) counts on SONET client signals.
- SDH coding violation (BBERS) counts on SDH client signals.
- Laser temperature on the transponders.
- Laser bias current on the transponders.
- Symbol Error (SE) counts are monitored on all 8B/10B encoded signals such as GbE, ESCON, FICON, and Fibre Channel.
- Ethernet data such as jabbers, packet flow and broadcast.
- STS- and VC-level performance data.

TL1 Ethernet PM

8.18 The TL1 Ethernet PM feature allows the user access to Ethernet statistics through traditional TL1-based performance monitoring mechanisms.

SNMPv3 and RMON Support to Receive Ethernet PM

8.19 The SNMP RMON feature provides support for an RMON manager to retrieve Ethernet statistics from a Tellabs 7100/7100N OTS. The Tellabs 7100/7100N SNMP RMON functionality is configurable via the Tellabs 7190 EMS, Tellabs 7194 NMS, and TL1 interface.

Path Level PM

8.20 Path Level PM collects performance data at the STSn or VCn path level on the SMTM-U.

Transponder BER Test Signal Generation

8.21 The Transponder BER Test Signal Generation feature integrates the transmit and receive PRBS BER test signal on transponders. Using the PRBS test signal in conjunction with loopbacks at various points in the network, faults can be better isolated within the network. The integration of the BER feature eliminates the need for expensive test equipment. The BER feature generates the PRBS pattern toward the port side or line side via the corresponding facility. The Tellabs 7100/7100N OTS can also identify which facility detects whether the received PRBS pattern contains errors. The BER feature adds support for facility and terminal loopbacks of line-side facilities.

Accumulation and Storage

8.22 Performance data for each monitored parameter (monitoring point) is stored in a register. Performance parameters are accumulated on a continuous basis for specified data collection intervals. The data collection intervals are 15 minutes or 24 hours. PM data collection can be activated or deactivated for eligible entities.

8.23 The NE generates scan reports for selected and enabled PM points in 15-minute and 24-hour increments. Scan reports can contain optical power measurements, laser temperature, and laser bias current providing data for coding violation (CV) counts. The NE saves the most recent data in a database (persistent store). Scan report data accumulated by the NE is retrieved on demand along with the monitoring point data.

8.24 The performance data measurements include:

- current power level
- minimum power level
- maximum power level

Note: *Performance trend graphs in the Tellabs 7190 EMS and Tellabs 7194 NMS indicate the actual monitoring points by NE and module.*

8.25 This performance data provides trend analysis to indicate if a circuit (lightpath) is approaching the minimum or maximum threshold limit. Maintenance operators are able to conduct manual fault localization along a lightpath in the absence of autonomous alarms and due to the complexities involved in managing an all-optical network.

Optical Threshold Crossing Alert (OTCA)

8.26 Threshold crossing alert messages signify performance degradation based on preset thresholds and are an integral part of the performance monitoring process. A user-configurable threshold is provided for the current 15-minute register for each performance parameter. Minimum and maximum values of thresholds for the following optical parameters are configurable:

- laser bias current (LBC) as a percentage of nominal
- laser temperature (LT) as degrees Celsius deviation from nominal
- optical power transmitted (OPT) as dBm
- optical power received (OPR) as dBm

8.27 Optical power is configurable at either the channel or module level. Default optical threshold values for each entity type are built into the NE. The OTCA feature provides the following functions:

- PM points retrievable on demand
- optical channel power levels retrievable on demand
- ability to create configurable thresholds
- autonomous reporting of TCAs

End-to-End Circuit LOS Propagation

8.28 The Tellabs 7100/7100N OTS provides the capability to propagate a failure indication (LOS) over a network to shut down the laser at the far-end of a circuit. Shutting down the laser at the far-end of a circuit is necessary to support protection switching with an OPSM or with external equipment.

8.29 The Maintenance Propagation Parameter is used to configure the laser shutdown capability. The following values are supported by the Maintenance Propagation Parameter:

- Client End Automatic Laser Shutdown (ALS) - Shuts down the laser in the line to port direction upon a failure indication.
- Line End ALS - Shuts down the laser in the port to line direction upon a failure indication.
- Propagate - Propagates failure indication without generating an alarm.

8.30 Table 8.1, page 2-109 lists the maintenance signals used to propagate failures.

Table 8.1 Maintenance Signals for Propagating Failures

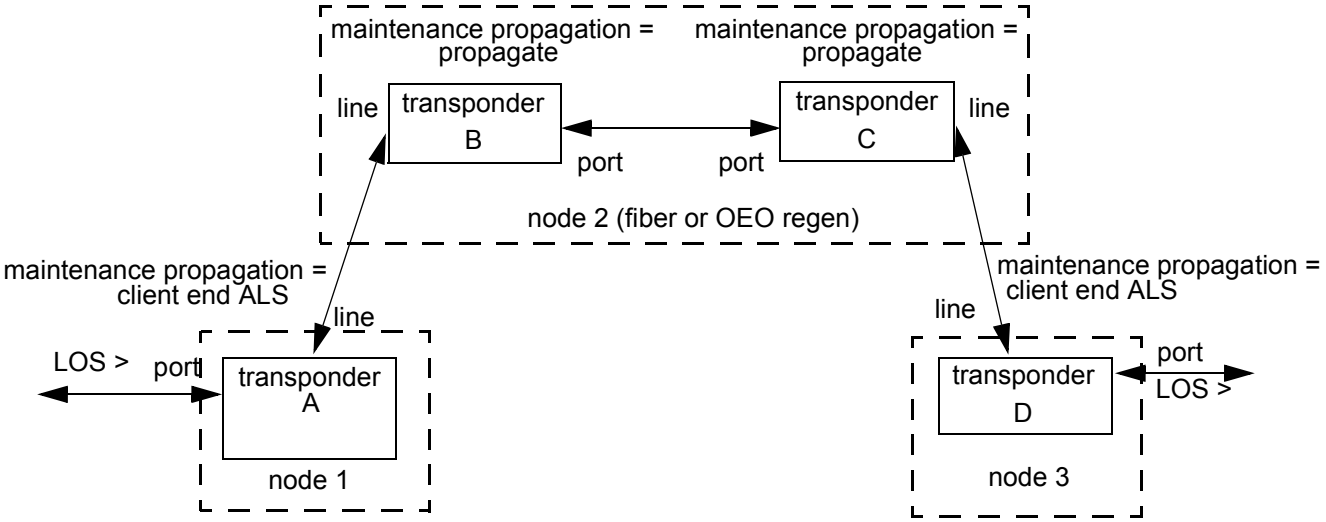
Module	Port Facilities	Maintenance Signal Sent in the Port to Line Direction	Maintenance Signal Sent in the Line to Port Direction
SMTM-SD SMTM-U	SONET/SDH	Internal AIS	AIS-L
	GBEP/OPTD	GFP-CSF	8B/10B Illegal Code
SMTM-UniD	SONET/SDH	not applicable	AIS-L
	GBEP/OPTD	not applicable	8B/10B Illegal Code
MRTM-E	GBEP/GOPT	TAIS	TAIS
MRTM-E, TGTM-E, TGTM-T	OCn/STMn, TGBEP	AIS-L	AIS-L
TGTM-E, TGTM-T	TGLAN, TGFC	TAIS	TAIS

8.31 End-to-End Circuit LOS Propagation is not allowed if the firmware status of the module is NOT_CURRENT. Enable End-to-End Circuit LOS Propagation by setting the value of MAINT_PROP to a value other than NA.

Client Laser Shutdown

8.32 Figure 8.1, page 2-109 illustrates how to configure transponders to shut down the laser to a client connected to the Tellabs 7100/7100N system. In this instance, the transponders in the regeneration node are configured to propagate the failure information while the transponders in the end nodes are configured to shut down the laser to the client.

Figure 8.1 Client Laser Shutdown

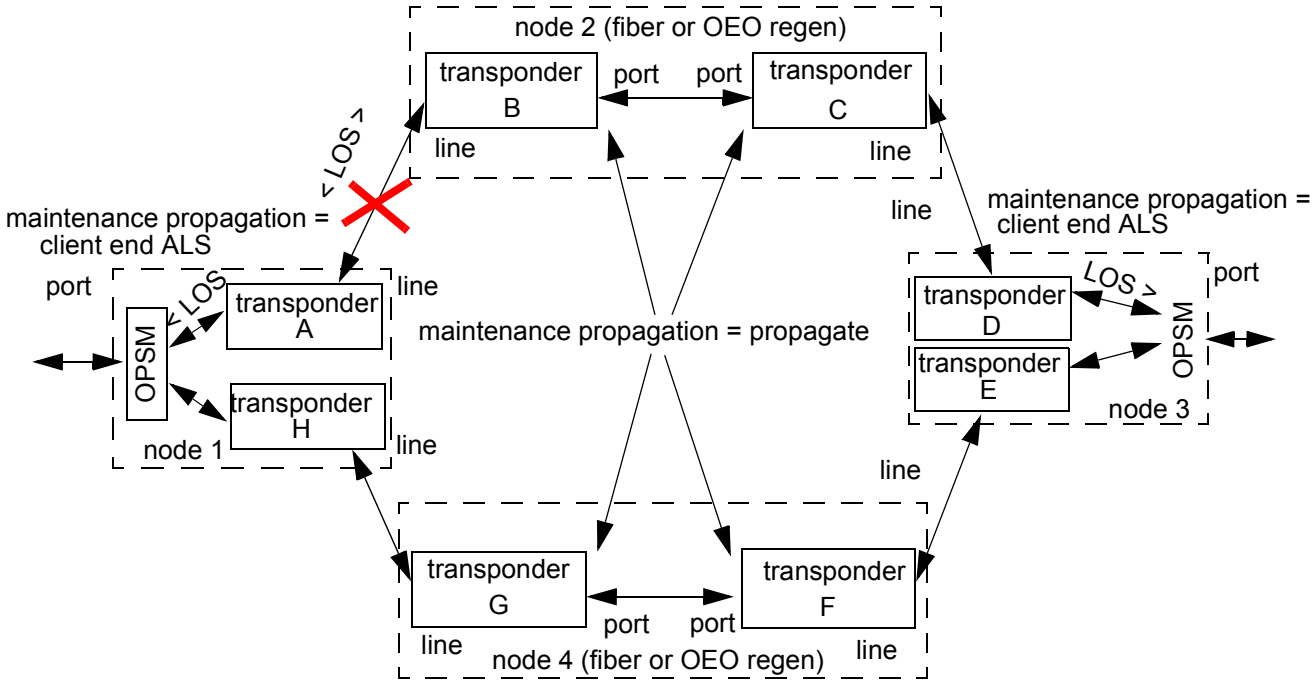


Port-Side OPSM Protection

8.33 Figure 8.2, page 2-110 illustrates how to configure transponders to shut down the laser to an OPSM for port-side OPSM protection. In this example, the regeneration nodes are configured to propagate the failure information and the transponders in the end nodes are configured to shut down the laser to the OPSM (Client End ALS).

Note: *OPSMs are supported in the Tellabs 7100 OTS only.*

Figure 8.2 Port-Side OPSM Protection Configuration

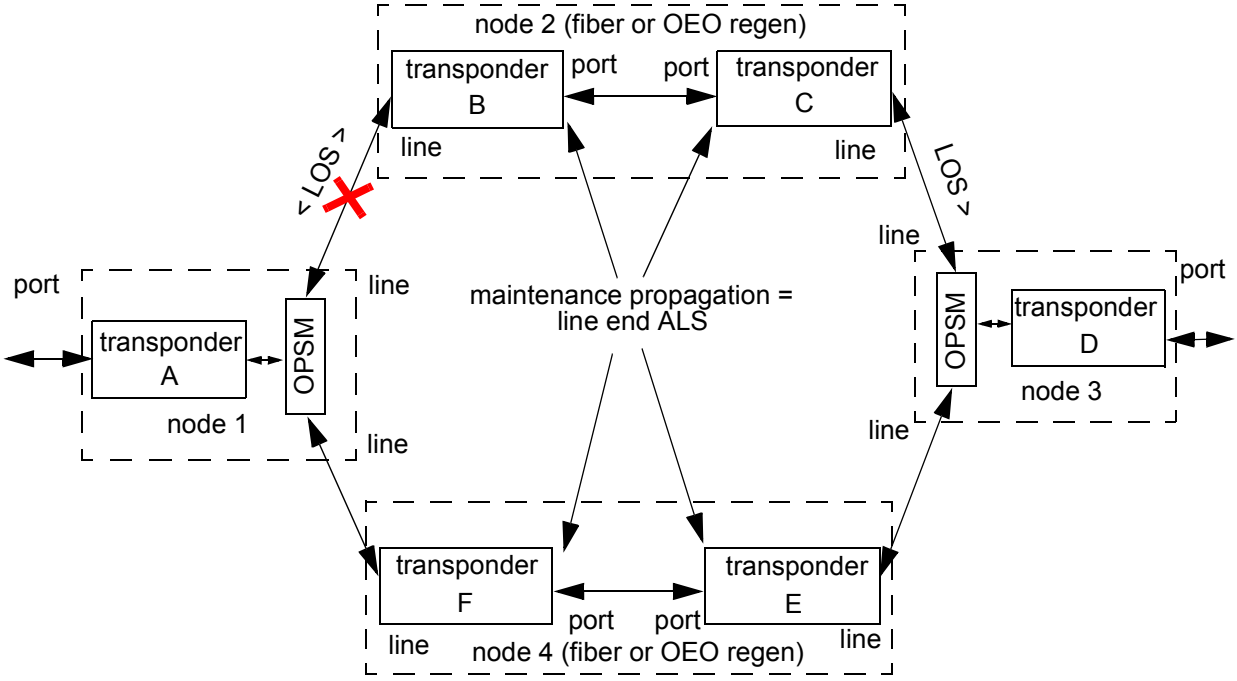


Line-Side OPSM Protection

8.34 Figure 8.3, page 2-111 illustrates how to configure transponders to shut down the laser to an OPSM to support line-side OPSM protection. In this example, transponders in the node that is connected to the OPSM are configured to shut down the laser to the OPSM (Line End ALS).

Note: *OPSMs are supported in the Tellabs 7100 OTS only.*

Figure 8.3 Line-Side OPSM Protection Configuration



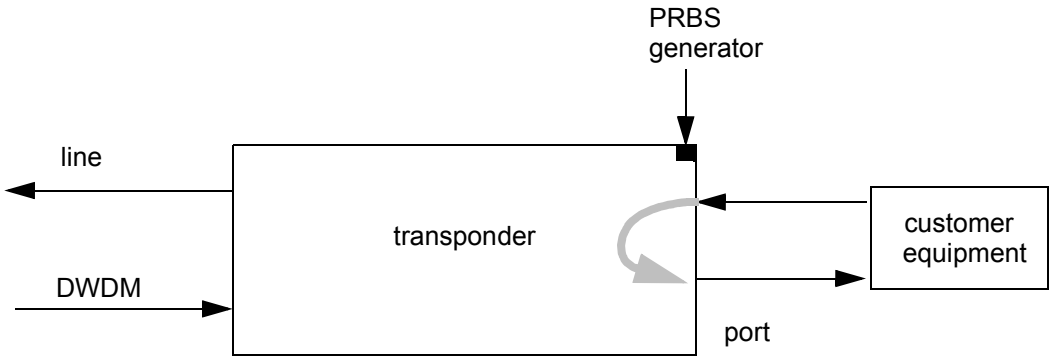
Maintenance Loopbacks

8.35 Maintenance loopbacks loop the channel on an incoming facility back on itself in the outgoing direction for monitoring purposes. Loopbacks are performed on SMTM-x or transponders and can be initiated and released via the Tellabs 7194 NMS, the Tellabs 7190 EMS, the Tellabs 7191 craft station, or through TL1 commands.

8.36 There are four types of loopbacks: a facility loopback of a client signal (port side), facility loopback of an OCH-P facility (line side), terminal loopback of a client signal (port side), and terminal loopback of an OCH-P facility (line side).

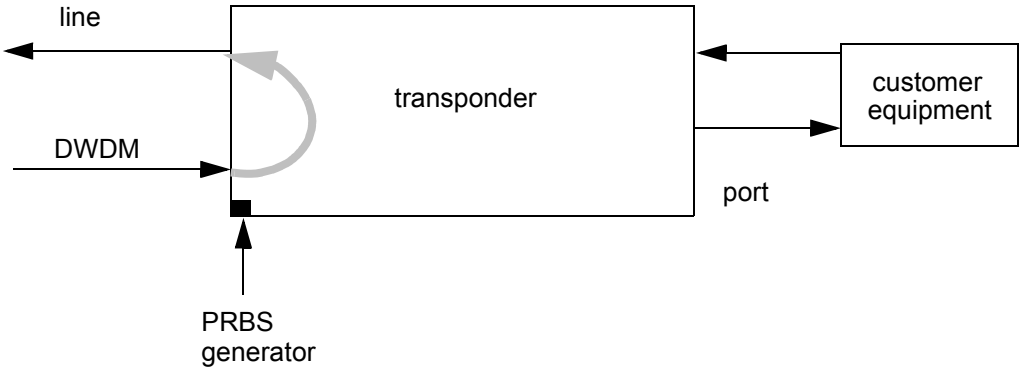
8.37 A facility loopback loops the client port-side signal back towards the customer equipment. Refer to Figure 8.4, page 2-112.

Figure 8.4 Facility Loopback of Port-Side Facility



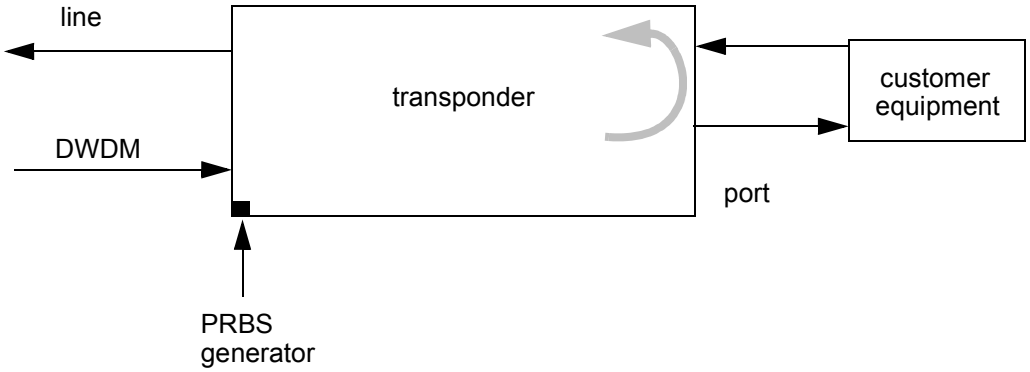
8.38 A facility loopback loops the OCH-P line-side signal back towards the DWDM network. Refer to Figure 8.5, page 2-112.

Figure 8.5 Facility Loopback of OCH-P Line-Side Facility



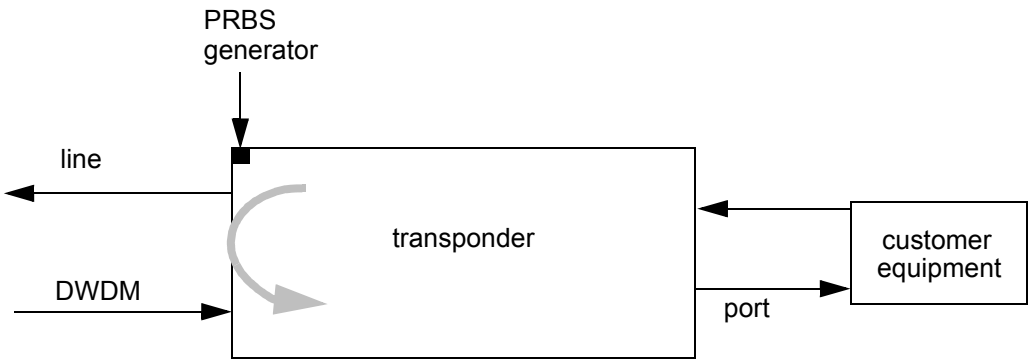
8.39 A terminal loopback loops the client port-side signal back towards the DWDM network. Refer to Figure 8.6, page 2-113.

Figure 8.6 Terminal Loopback of Port-Side Facility



8.40 A terminal loopback loops the OCH-P line-side signal back towards the customer equipment. Refer to Figure 8.7, page 2-113.

Figure 8.7 Terminal Loopback of OCH-P Line-Side Facility



USER NOTES

TELLABS DOCUMENTATION

Appendix A. Managing Network Conditions

A.01 This section describes how the 7100/7100N OTS addresses network conditions that are exterior to the system itself.

Signal Protection

A.02 Signal transport can be interrupted in DWDM systems by events such as fiber cuts and equipment failures. The Tellabs 7100/7100N OTS proactively addresses these conditions with both signal and equipment protection capabilities.

A.03 For an outline of signal protection schemes, refer to Table A.1, page 2-116.

A.04 The following signal protection schemes are illustrated in this section:

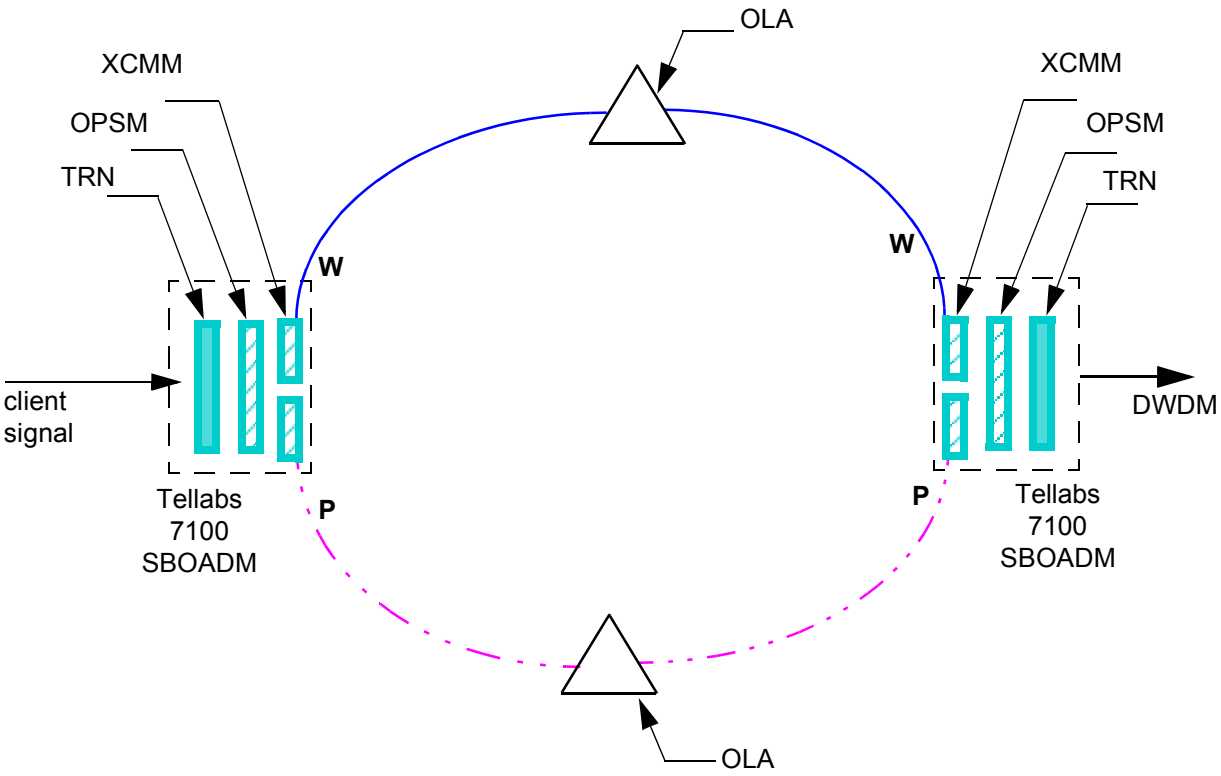
Table A.1 Signal Protection Schemes

Protection Type	Protection Module	Use Module	Client Protection	Path Protection	Equipment Protection
Network	OPSM	Auto MRTM-E TGTM-E FGTM SMTM-U	No	Yes	No
Network	Transponder	OTNM-D OTNM-x	No	Yes	No
Network	Switch Fabric	Auto SMTM-U SMTM-P TGIM-P	No	Yes	No
Network	Paired Transponders	Auto SMTM-U SSM-D SSM-x	No	Yes	No
Network - Equipment	OPSM Y-cable	Auto MRTM-E TGTM-E FGTM OTNM-D OTNM-x SMTM-U SSM-D SSM-x	No	Yes	Yes
Client	Paired Transponders	Auto SMTM-U SSM-D SSM-x	Yes	Yes	Yes
Unprotected	NA	Auto (transponders based on rates)	No	No	No
External	NA	Auto (transponders based on rates)	External	Yes	Yes

Network Protection with OPSM

A.05 Network protection provides signal protection using the OPSM and one transponder module. The signal is split at the OPSM and directed to two separate network paths. On the destination side, the OPSM compares the integrity of the signals and forwards one to the targeted client.

Figure A.1 Network Protection with OPSM



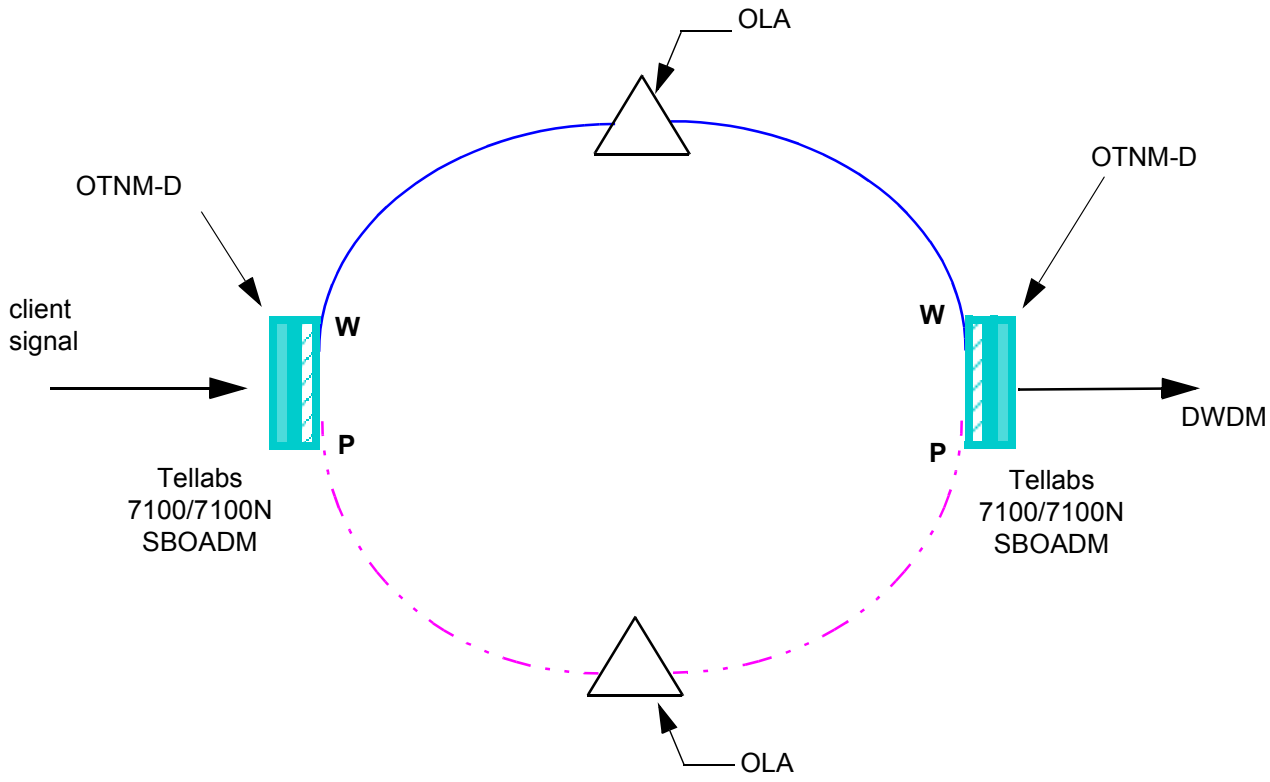
XCMM = ECMM, RCMM

TRN = Transponder

Network Protection with OTNM-Ds

A.06 Network protection is also provided via paired OTNM-D that split the signal in the backplane and each OTNM-D directs the signal to a different path. On the destination side, the signals are received by the OTNM-Ds, compared for integrity, and one is forwarded to the targeted client.

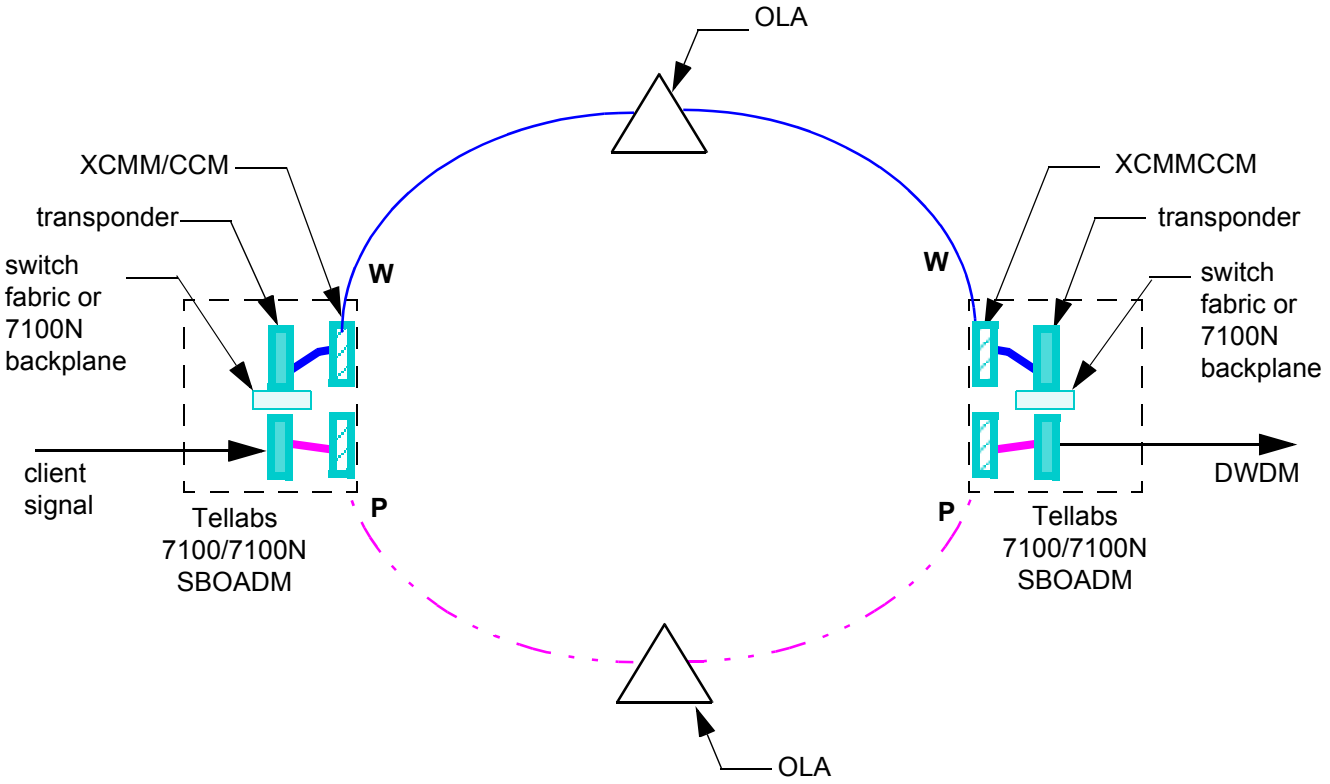
Figure A.2 Network Protection with OTNM-Ds



Network Protection with Switch Fabric

A.07 The switch fabric provides signal protection on the Tellabs 7100/7100N OTS through paired transponders. The signal is split at the switch fabric and one copy of the signal is directed to a pre-defined facility on each transponder, resulting in a working signal and a protecting signal. Both signals are forwarded to the DWDM network in different directions. On the destination side, the signals are received by the transponders, compared for integrity, and one is forwarded to the targeted client.

Figure A.3 Network Equipment Protection Using the Switch Fabric

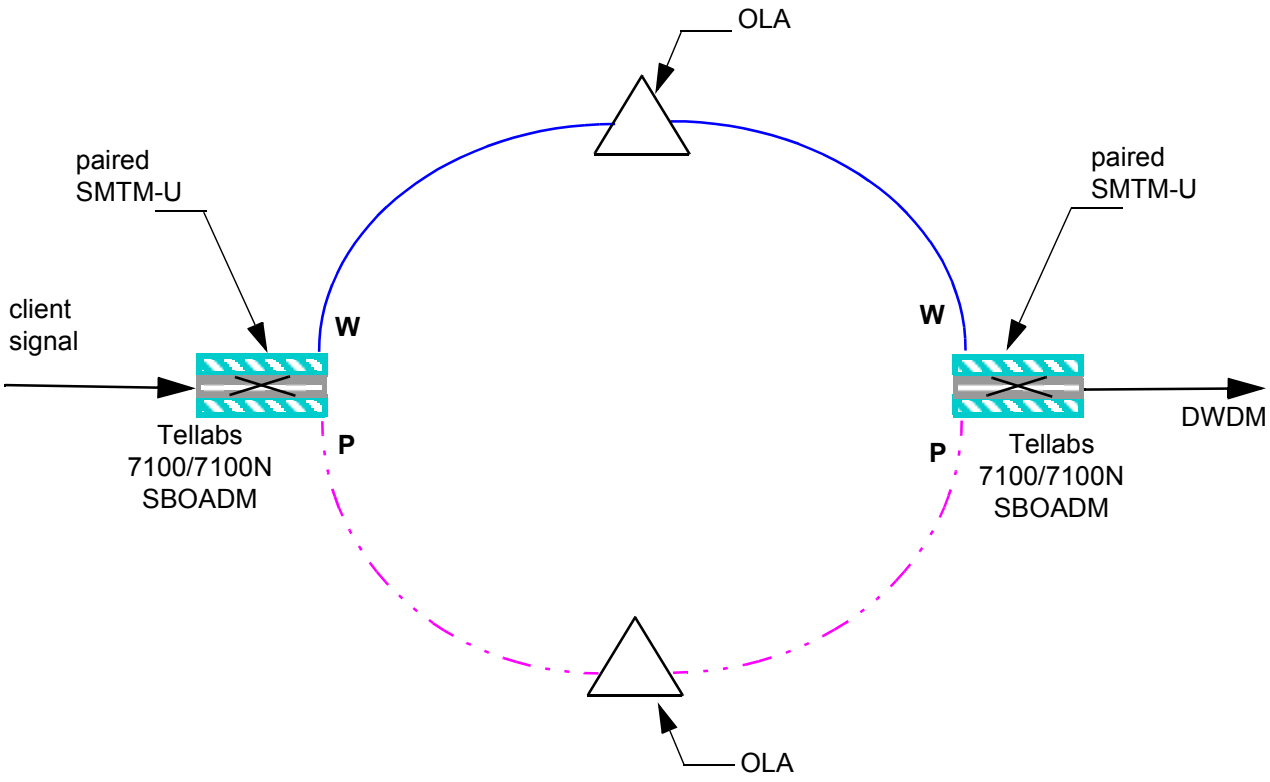


XCMM = ECMM, RCMM

Network Protection with Paired Transponders

A.08 Network protection is also provided via paired SMTM-U that split the signal in the backplane and each SMTM-U directs the signal to a different path. On the destination side, the signals are received by the SMTM-Us, compared for integrity, and one is forwarded to the targeted client.

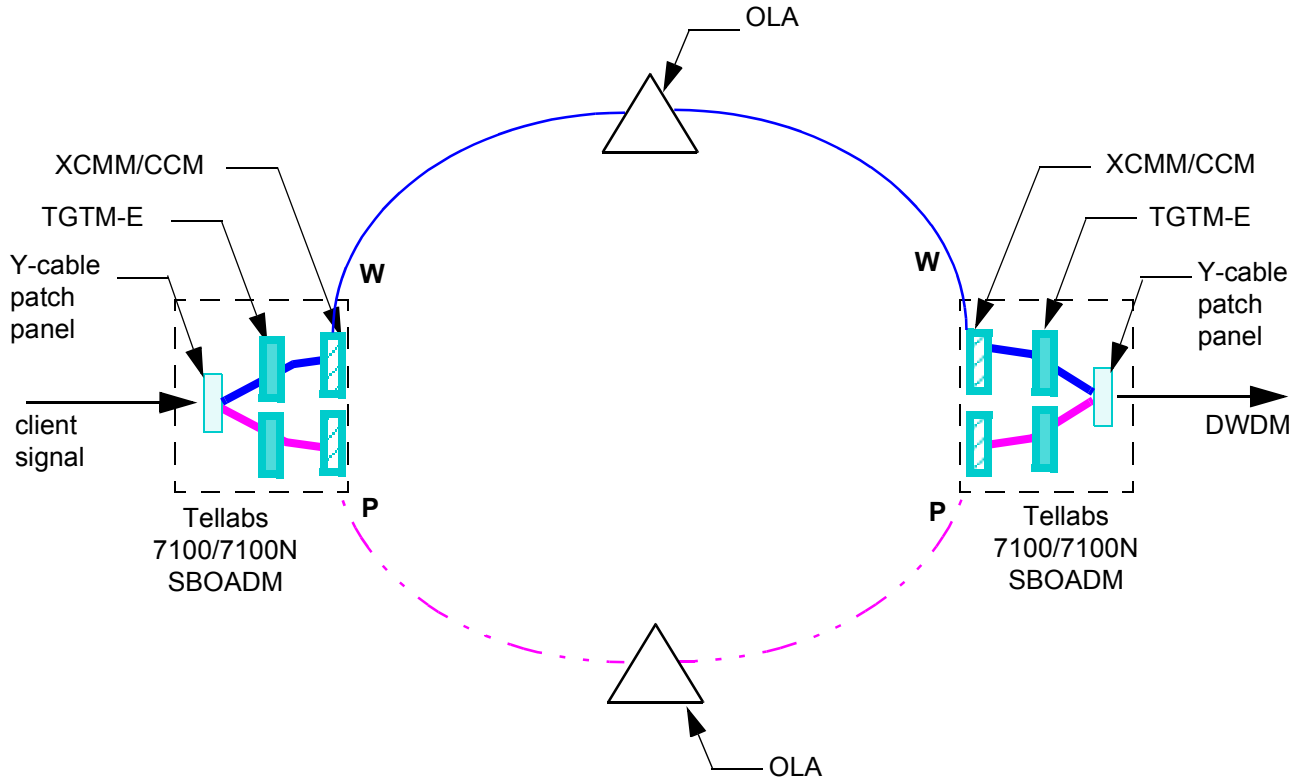
Figure A.4 Network Protection with Paired Transponders



Network Equipment Protection with Y-Cable Patch Panel

A.09 The Y-Cable patch panel provides signal protection on the Tellabs 7100/7100N OTS through paired TGTM-Es. The signal is split at the Y-Cable patch panel and one copy of the signal is directed to a pre-defined facility on each TGTM-E, resulting in a working signal and a protecting signal. Both signals are forwarded to the DWDM network in different directions. On the destination side, the signals are received by the TGTM-Es, compared for integrity, and one is forwarded to the targeted client.

Figure A.5 Network Equipment Protection Using the Y-Cable Patch Panel

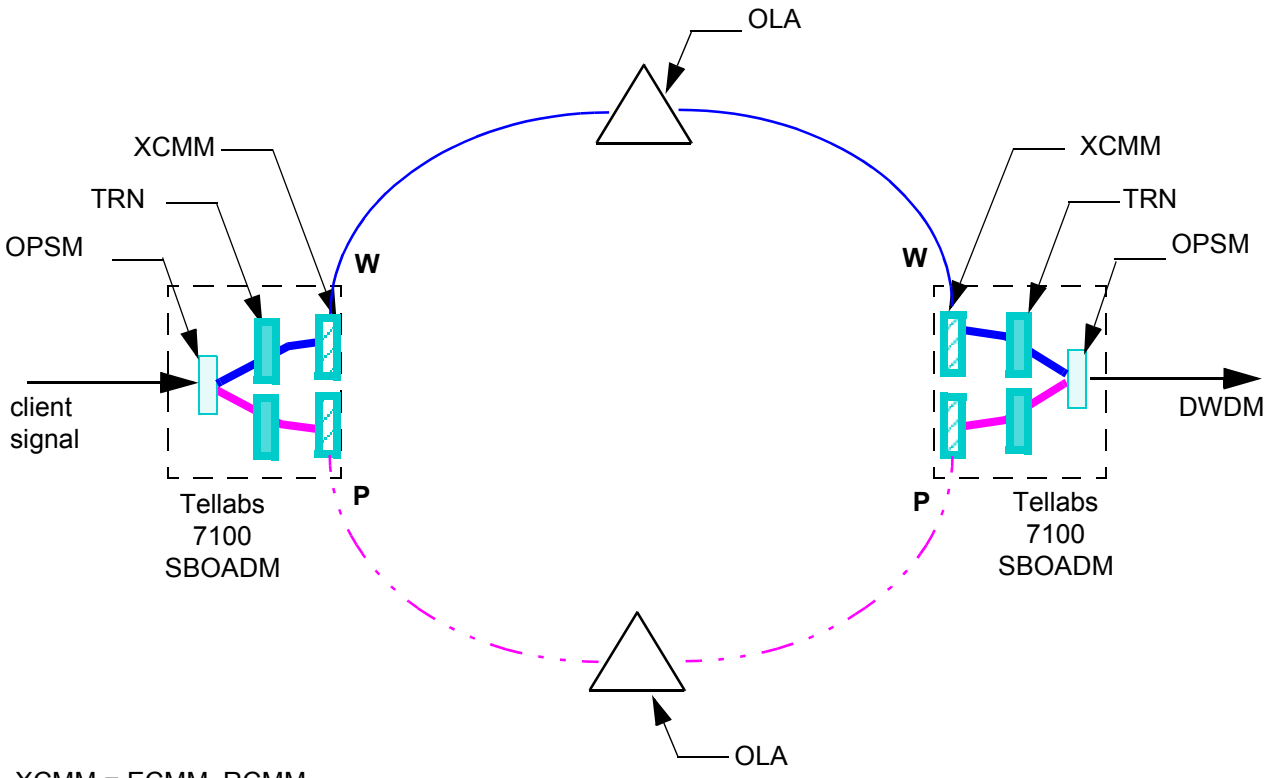


XCMM = ECMM, RCMM

Network Equipment Protection with OPSM

A.10 Network protection provides equipment and path protection using the OPSM with two transponder modules. The signal is split at the OPSM and directed to two different transponders for delivery to the network. At the drop point, two transponders compare signal strength and integrity and forward the strongest of the two.

Figure A.6 Network Equipment Protection Using the OPSM



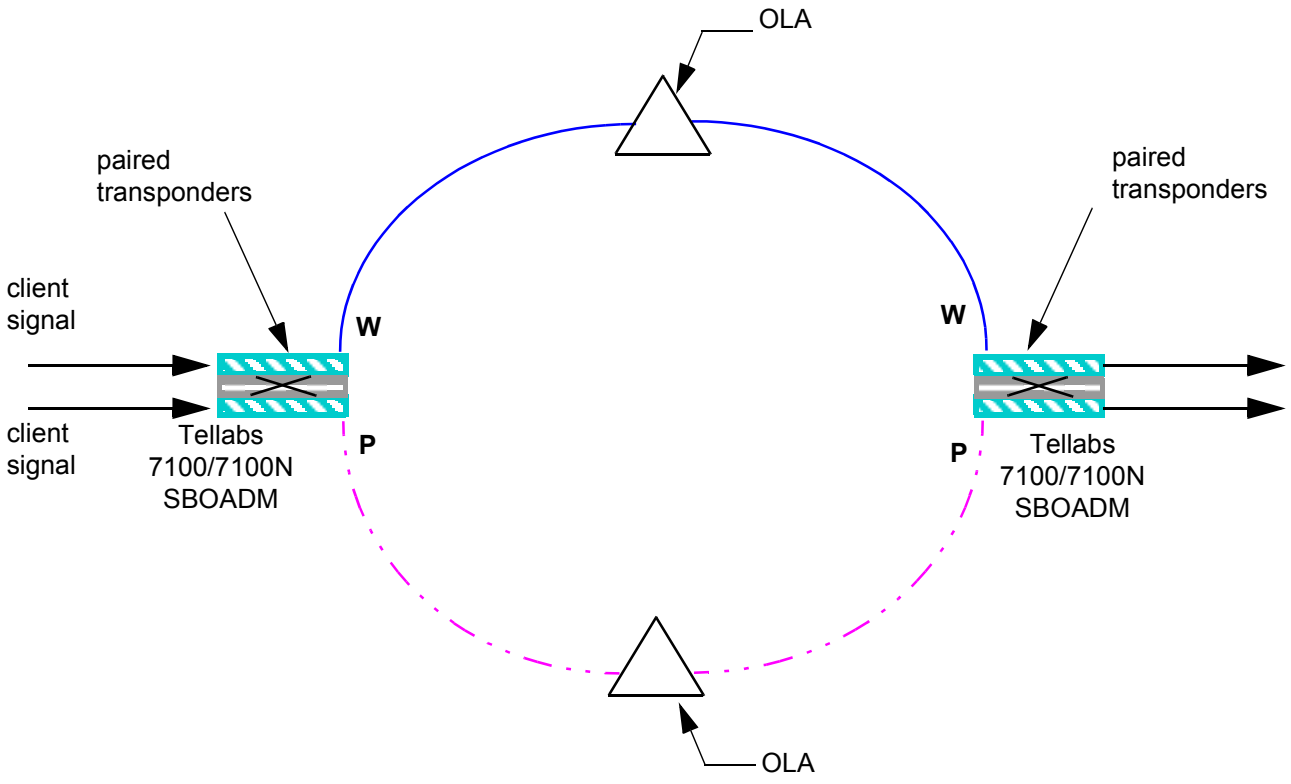
XCMM = ECMM, RCMM

TRN = Transponder

Client Protection with Paired Transponders

A.11 Client protection is also provided via paired transponders that choose the better signal and each transponder directs the signal to a different path. On the destination side, the signals are received by the transponders, compared for integrity, and one is forwarded to both of the targeted clients.

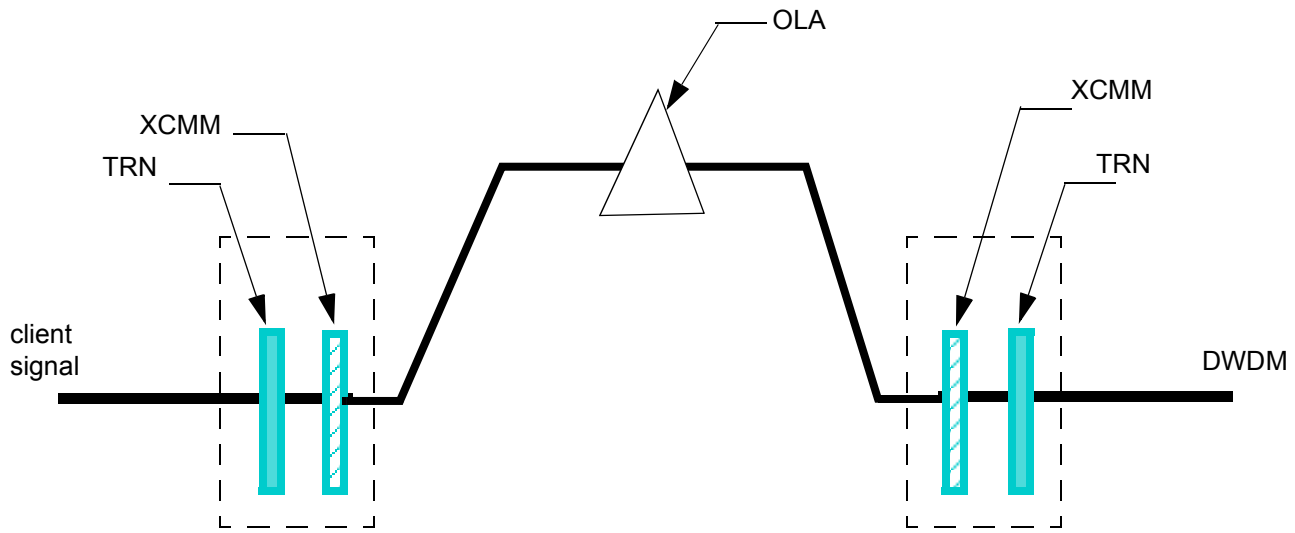
Figure A.7 Network Protection with Paired Transponders



Unprotected Scenario

A.12 Unprotected traffic is completely dependent on no-fault equipment and cable. This protection scenario requires a high level of confidence in the cable segment between the two Tellabs 7100 systems.

Figure A.8 No Protection



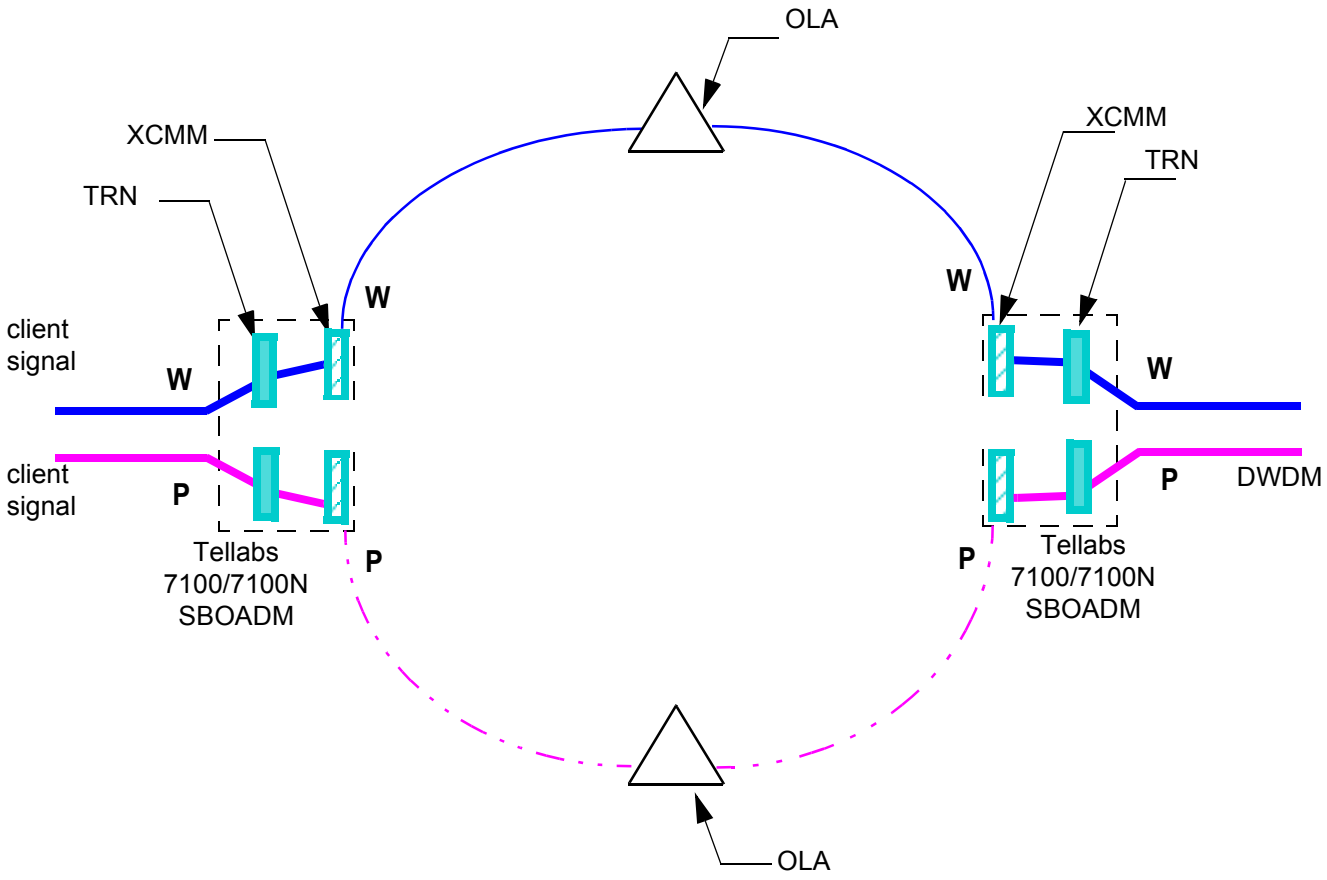
XCMM = ECMM, RCMM

TRN = Transponder

External Protection

A.13 External protection applies when the signal is split at the client equipment, before it enters the Tellabs 7100 OTS environment. On the destination side, the client compares the integrity of the signals and forwards one.

Figure A.9 External Protection



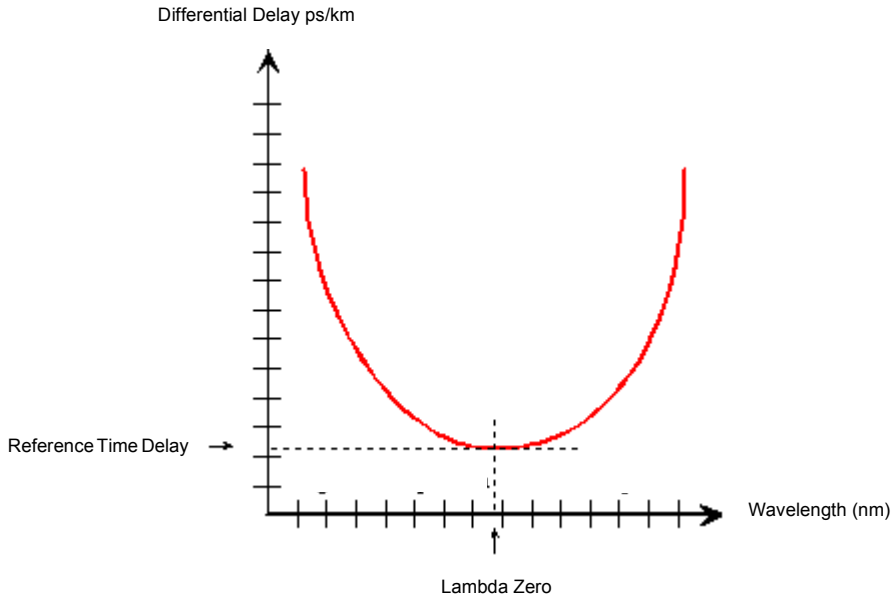
Chromatic Dispersion

A.14 Chromatic dispersion is a property of fiber that limits the transmission distance of a system and impacts bit error rates. It is intrinsic to the chemical properties within the fiber and therefore remains fairly constant throughout the life of the fiber. Dispersion is created when the pulse of the signal begins to spread. The spreading increases over distance and creates differential delay. Wavelengths or frequencies on the same fiber experience different differential delays due to the refractive index (or density) of the fiber.

Note: The total chromatic dispersion tolerance of Tellabs 10G transponders is -266 to 1445 ps/nm. The total chromatic dispersion tolerance of Tellabs 2.5G transponders is -266 to 6800 ps/nm.

A.15 Figure A.10, page 2-126 shows typical differential delays of standard Single Mode Fiber (SMF) relative to wavelength.

Figure A.10 Differential Delay Relative to Wavelength on Single Mode Fiber

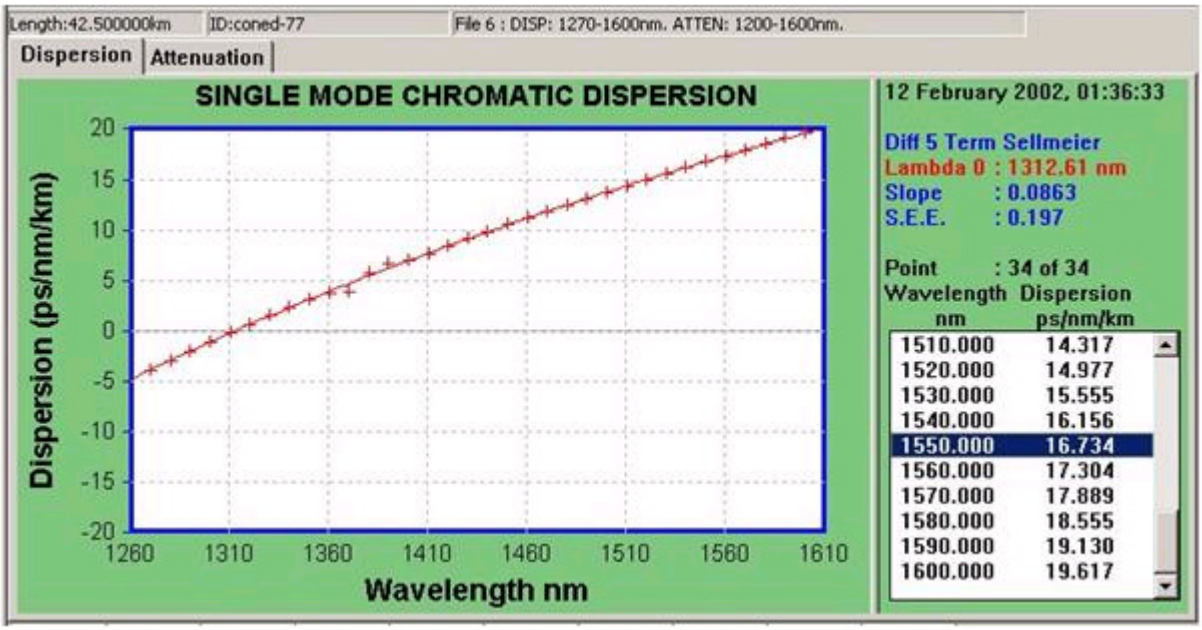


A.16 All wavelengths experience differential delay as they travel through fiber. The wavelength that experiences the smallest delay is referred to as “lambda zero” or “zero dispersion wavelength.” For single mode fiber, lambda zero is typically around 1310 nm. Wavelengths to the right and left of the lambda zero wavelength experience differential delay greater than the lambda zero wavelength.

A.17 Wavelengths to the right of lambda zero are said to have positive dispersion. Positive dispersion indicates shorter wavelengths traveling more quickly than longer wavelengths. Wavelengths to the left of lambda zero are said to have negative dispersion. Negative dispersion indicates longer wavelengths traveling more quickly than shorter wavelengths.

A.18 Chromatic dispersion is calculated as the rate of change of fiber delay with respect to wavelength and is expressed in units of ps/nm/km. Figure A.11, page 2-127 shows a typical chromatic dispersion plot for standard single mode fiber.

Figure A.11 Typical Chromatic Dispersion Trace of a Single Mode Fiber



A.19 The following data is used to evaluate dispersion in the network. Use this information for system design and when selecting chromatic Dispersion Compensation Modules (DCMs).

- **Dispersion at 1550 nm.** For standard single mode fiber (SMF-28) this figure is approximately 16 – 18 ps/nm/km.
- **Lambda Zero.** For SMF-28 this is approximately 1310 nm.
- **Slope**

How to Calculate

A.20 To calculate chromatic dispersion, follow these steps:

__ 1. Determine the dispersion per km by identifying the fiber type. Refer to Table A.2, page 2-128.

Table A.2 Typical Dispersion of Various Fiber Types

Fiber Type	Corning's Implementation	Description	Typical Chromatic Dispersion at 1550 nm (ps/nm*km)	Suitable for DWDM
ITU-G.652	SMF-28	Standard Single Mode Fiber	17	√
ITU-G.653	-	Dispersion Shifted Fiber	0	X
ITU-G.655	Leaf	Non Zero Dispersion Shifted Fiber	3.8	√
ITU-G.655	MetroCor	Non Zero Negative Dispersion Shifted Fiber	-7.2	√

__ 2. Determine the total glass length of the wavelength. This is the length of the optical path a wavelength travels without transponder regeneration.

Note: For mixed fiber types, determine the total glass length for each fiber type.

__ 3. Calculate the total glass length dispersion (excluding DCMs).

Single fiber type:

Total glass length dispersion = (Dispersion per km * Total glass length) ps/nm

Mixed fiber type:

Total glass length dispersion = ((Dispersion per km of fiber type 1 * Total glass length of fiber type 1)

+ (Dispersion per km of fiber type 2 * Total glass length of fiber type 2)

+ (Dispersion per km of fiber type n * Total glass length of fiber type)

+ ……...))

__ 4. Calculate the total dispersion added by DCMs.

Total DCM dispersion = (nominal dispersion of DCM x) + (nominal dispersion of DCM y) + (nominal dispersion of DCM n)

For example: -1190 ps/nm = (-340 ps/nm) + (- 850 ps/nm)

Where: **-340** and **-850** are the nominal dispersions of the 20 km and 50 km DCMs respectively.

__ 5. Calculate the total glass length dispersion (with DCMs).

Total glass length dispersion (with DCMs) = [(Total glass length dispersion (no DCM)) + (Total DCM dispersion)] ps/nm

In cases where the fiber used is SMF-28, calculations can be kept simple by subtracting the DCM km value from the fiber length.

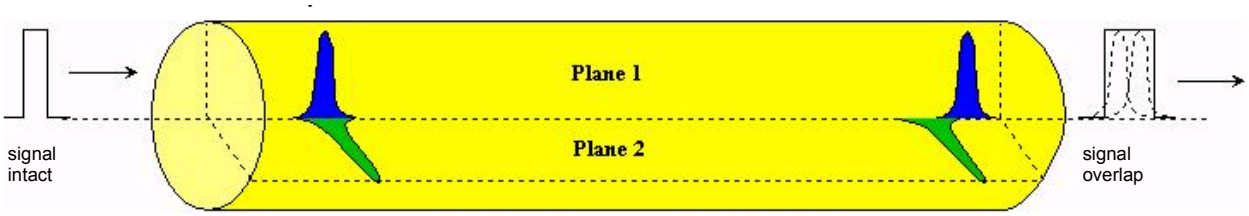
Polarization Mode Dispersion

A.21 Like chromatic dispersion, polarization mode dispersion (PMD) impacts the speed at which signals travel through a network. PMD is caused by physical imperfections in the fiber. The result is a spreading of the signal pulse. The flaws in the fiber are typically lack of symmetry at the core and/or cladding.

Note: The total polarization mode dispersion tolerance of Tellabs 10G transponders is 10 ps. The total polarization mode dispersion tolerance of Tellabs 2.5G transponders is 40 ps.

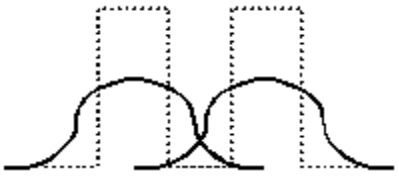
A.22 Figure A.12, page 2-129 shows the pulse spreading effect on a signal traveling down a fiber with PMD.

Figure A.12 Pulse Spreading Effect



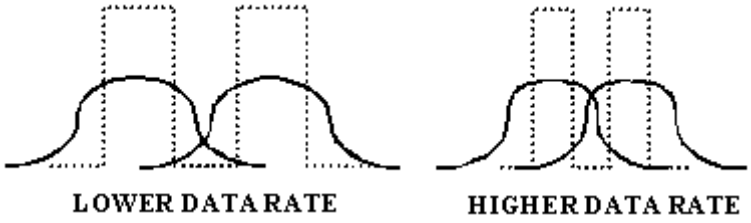
A.23 Pulse spreading continues to increase as the length of the fiber increases. Eventually the data pulses begin to overlap because of the spread. Overlapping data pulses degrades BER performance. Refer to Figure A.13, page 2-129.

Figure A.13 Overlapping Data Pulses Due to Pulse Spreading



A.24 Following the example shown in Figure A.12, page 2-129, if the fiber length is kept constant, then the pulse spreading at any given wavelength also remains the same. The fiber link supports data rates up to a certain speed. Beyond this speed, the result is poor BER performance. Chromatic Dispersion Compensation modules are required to allow the use of higher data rates. Refer to Figure A.14, page 2-130.

Figure A.14 Example of Pulse Overlapping Due to Increasing the Data Rate and Keeping the Fiber Distance Fixed



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