CISCO SYSTEMS

4X 2.5-GBPS MUXPONDER CARD FOR THE CISCO ONS 15454 MULTISERVICE TRANSPORT PLATFORM

Figure 1
Cisco ONS 15454 4x 2.5-Gbps
Muxponder Card

The Cisco® ONS 15454 Multiservice Transport Platform (MSTP 4x 2.5-Gbps Muxponder card expands the Cisco ONS platform's OC-48/STM-16 interface density. The card enables the delivery of transparent 2.5-Gbps-based services for enterprises or metropolitan and regional service provider networks (Figure 1).
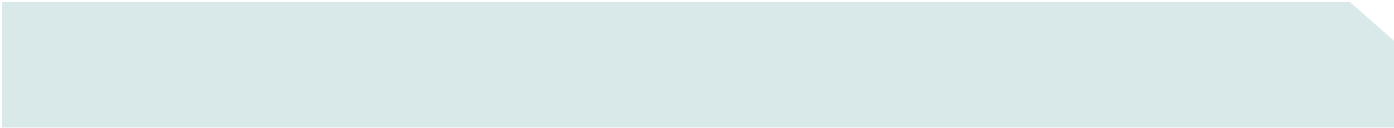
BACKGROUND

Metro transport networks must support numerous service demands, from low-rate DS-1/T1, DS-3/E3, 10/100BASE-T, and OC-3/STM-1 to higher-rate OC-12/STM-4, Gigabit Ethernet, OC-48/STM-16, OC-192/STM-64, and 10 Gigabit Ethernet services. In the recent past, SONET add/drop multiplexers (ADMs) provided the services platform to aggregate and transport services up to OC-48/STM-16, whereas metro dense wavelength-division multiplexing (DWDM) platforms were designed for optical signals from OC-3/STM-1 to OC-192/STM-64, including Gigabit Ethernet and 10 Gigabit Ethernet. Unfortunately, deploying multiple platforms (including metro DWDM and SONET ADMs) to support multiple services is not cost-effective for many service provider and enterprise networks. The Cisco ONS 15454 MSPP with a muxponder card provides a more cost-effective networking solution to enable the delivery of all services, from lower-speed DS-1/E1, high-density 2.5 Gbps, and high-bandwidth OC-192/STM-64.

PRODUCT OVERVIEW

The Cisco ONS 15454 MSPP 4x 2.5-Gbps Muxponder card can transport four OC-48/STM-16 payloads over an OC-192/STM-64-based, 100-GHz spaced, 50-GHz stabilized, ITU-compliant wavelength with provisionable digital wrapper (G.709) with selectable Forward Error Correction (FEC). The muxponder card is a plug-in module to the Cisco ONS 15454 MSPP, enabling a high-density, cost-effective solution for OC-48/STM-16 services transport over a platform capable of low-rate services down to 1.5 Mbps. The muxponder card architecture contains four client interfaces that are mapped to a single line interface, without accessing the Cisco ONS 15454 shelf cross-connect fabric.

Each client interface provides a 2.488-Mbps (OC-48/STM-16) SONET/SDH interface via a Small Form-Factor Pluggable (SFP) optics module with LC connectors, providing the flexibility to support several optical reaches, including short-reach/intraoffice, intermediate-reach/short-haul, and long-reach/long-haul, with support for qualified DWDM and DWDM SFP modules. The muxponder card supports any mixture of SFP reach types and also supports in-service insertion or removal without affecting other active ports, allowing ultimate networking flexibility and reduced preplanning activities.

The DWDM line interface provides one 9.95328-Gbps (OC-192/STM-64) or 10.70923-Gbps (OC-192/STM-64 with G.709 digital wrapper enabled), long-reach/long-haul, ITU-compliant, 100-GHz spaced optical interface using LC connectors supporting OC-48/STM-64 interfaces. The DWDM output line interface is tunable across two adjacent 100-GHz wavelengths, reducing inventories for spares. Using amplification and dispersion compensation, the muxponder card is capable of a 300-kilometer (km) reach. When operated within the outlined specifications, each card will transport the 10-Gbps signal with a maximum bit error rate (BER) of 10E-15.

The muxponder card incorporates the four clients and one DWDM line interface on the same card. The muxponder cards are deployable in the 12 multiservice interface card slots of the Cisco ONS 15454 platform, in systems with or without cross-connect cards. The addition of a cross-connect card allows the platform to support hybrid applications, containing transparent 2.5-Gbps services as well as aggregation of the other services supported by the Cisco ONS 15454 platform. The only other common card required for operation is the timing, communications, and control (TCC) card.

The muxponder card provides many carrier-class features and capabilities necessary to deliver 2.5-Gbps services, including selectable protocol transparency, wavelength tunability, flexible protection mechanisms, flexible timing options, and management capabilities.

Selectable Protocol Transparency

The muxponder card provides the capability to deliver "transparent" 2.5-Gbps wavelength services, OC-48/STM-16 terminated signals, and a high-density solution for cost-effective, point-to-point SONET/SDH payload transport for the Cisco ONS 15454 platform. The card is provisionable to either pass most of the SONET/SDH overhead bytes transparently or to terminate the line and section overhead. In transparent mode, client terminal equipment interconnected over a muxponder-card-based circuit can communicate over the section/multiplexer section data communications channel (SDCC/MSDCC), can signal 1+1 and bidirectional line switched ring/multiplex section shared protection ring (BLSR/MS-SPR) protection switching using the K1 and K2 bytes, and can support provisionable section trace capabilities over the J0 byte. In addition, the muxponder circuit, whether provisioned in transparent or terminating mode, can support unidirectional-path switched ring/subnetwork connection protection (UPSR/SNCP)-based client circuits.

The client and DWDM line interfaces can support nonconcatenated SONET/SDH payloads on an STS-1, VC-4, VC-12, and VT1.5 basis as well as concatenated SONET/SDH payloads (STS-Nc, N= 3, 6, 9, 12, 24, or 48; or VC-4-Mc, M= 1, 2, 3, 4, 8, or 16).

Wavelength Tunability

The muxponder cards operate on the 100-GHz ITU grid and are tunable across two adjacent 100-GHz channels per card. The incorporation of tunability into the muxponder cards reduces the customer's inventory required to cover all the system wavelengths.

Flexible Protection Mechanism Support

The muxponder card, depending upon the requirement of the network, can be deployed to support the many protection mechanisms found in optical transport networks. Table 1 outlines the protection options supported enabling the user to deliver the service-level agreements (SLAs) required by the application.

Table 1. Protection Formats

| Protection Type	Capabilities	Figure
Unprotected	Offers no client terminal interface, muxponder card, or DWDM line protection. The client signal is transported over a single unprotected muxponder card.	Figure 2
1+1 protected	Provides protection for the client terminal interface, muxponder card, and DWDM line protection through client automatic protection switching/linear multiplex section protection (APS/LMSP) signaling transported transparently over the muxponder card.	Figure 3
UPSR/SNCP and BLSR/MSP-SPR	Similar to unprotected format. Protection is provided through client line or path protection via transparent signal transport through muxponder circuit.	Figure 4
Y-cable protection	Provides muxponder card and DWDM line protection without requiring client terminal equipment-interface protection. Uses Y-protection device to optically split a single client interface to two muxponder cards. The Cisco ONS 15454 system controls the muxponder card active/standby status to provide a single signal feed to client equipment.	Figure 5

Figure 2

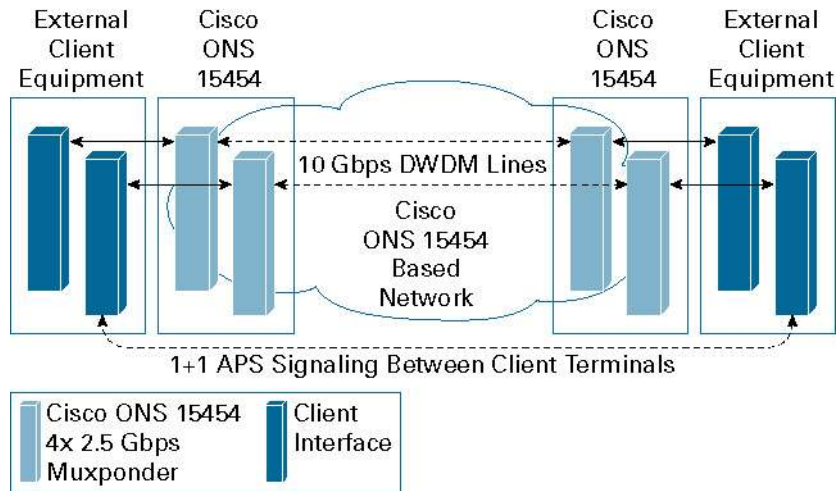Unprotected
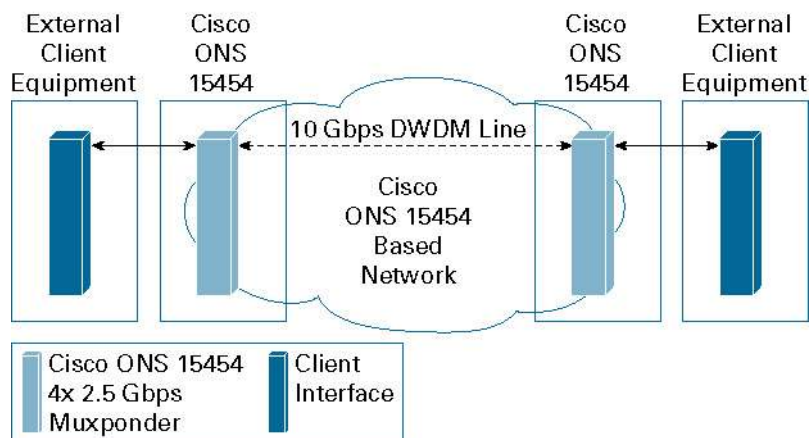
Figure 3

1+1 Protection

Figure 4

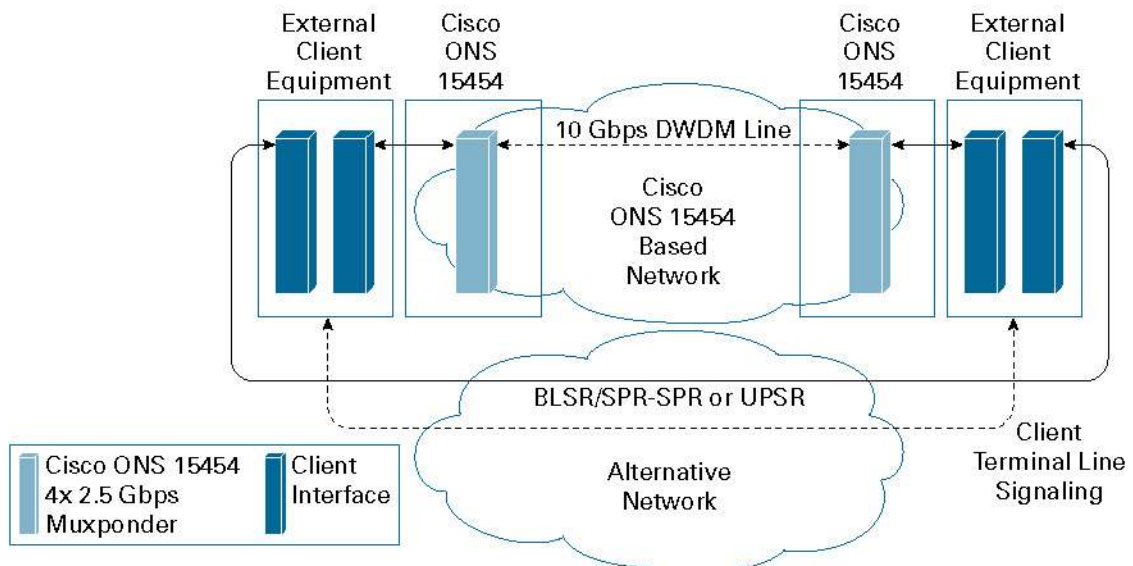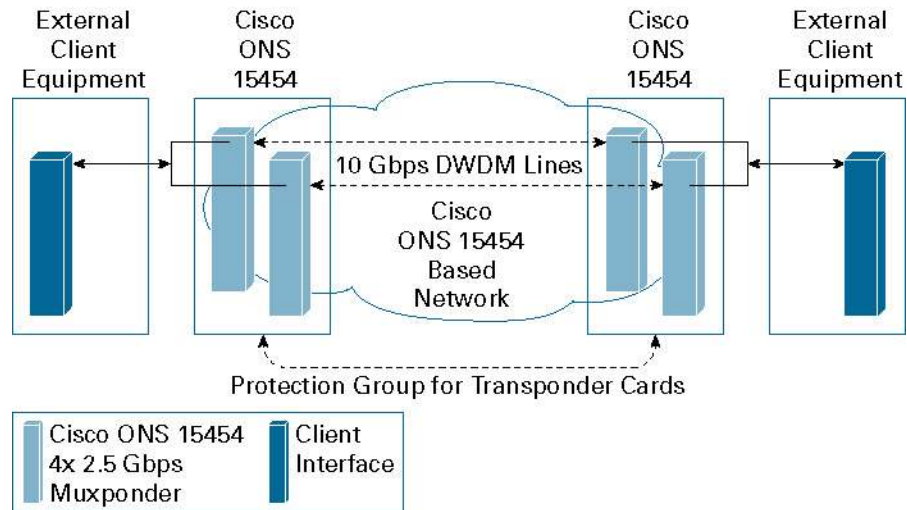UPSR/SNCP and BLSR/MSP-SPR Protection

Figure 5
Y-Cable Configuration

Flexible Timing Options

The muxponder card times the client-side optical transmitter port from the DWDM line-interface received signal, while in the reverse direction, the DWDM line transmitter uses timing from the shelf processor. The Cisco ONS 15454 platform provides the option to recover timing signals for node-timing reference, with sync-status messaging support, from any of the four client optical interfaces or the DWDM line interface, in addition to the standard options of using an external clock derived from a Building Integrated Timing Supply (BITS) clock or another optical interface card on the Cisco ONS 15454 system.

Management

The Cisco ONS 15454 provides comprehensive management capabilities for operations, administration, monitoring, and provisioning (OAMP) accessed through the integrated Cisco transport controller-craft interface with support from the Cisco transport-manager element management system (EMS). The muxponder card incorporates provisionable digital-wrapper (G.709) functions, providing DWDM wavelength performance-management capabilities, especially for services being transported transparently across the network. Without the digital-wrapper function, a carrier transporting a service transparently would be unable to identify network impairments that may degrade the transported signal and exceed SLA requirements. The digital wrapper's general communication channel (GCC) enables a separate communications channel, versus the section DCC/regenerator section DCC (SDCC/RSDCC) in SONET/SDH signals, to be used by the platform when transparent signals are transported. This GCC allows the Cisco ONS 15454 to extend its advanced network autodiscovery capabilities to DWDM-based services. The integrated Cisco ONS 15454 craft manager and the Cisco transport manager EMS provide the user with OAMP access for the system.

Performance Monitoring

The performance-monitoring capabilities of the muxponder card provide support for both transparent and nontransparent signal transport. For SONET/SDH signals, standard performance monitoring, threshold-crossing conditions, and alarms are supported per Telcordia GR-474 and GR-2918, as well ITU G.783 and ETS 300 417-1 standards. Each digital-wrapper channel is monitored per GR-253-CORE (SONET) and ITU-T G.738 and G.7710 (SDH). Optical parameters on the client and DWDM line-interfaces support include loss of signal, laser end of life, transmit optical power, and receive optical power. Calculation and accumulation of the performance-monitoring data is in 15-minute and 24-hour intervals.

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

APPLICATION DESCRIPTION

The muxponder card adds the capability to cost-effectively aggregate 2.5-Gbps services and transport them with or without overhead transparency. Figure 6 displays a typical service provider backbone-network application. The muxponder card on the Cisco ONS 15454 network allows Service Provider A to transport its interface traffic requirements, terminating the SONET/SDH overhead. For Service Providers B, C, and D, the muxponder card allows their traffic to be transparently transported over Service Provider A's network, facilitating end-to-end SDCC visibility for the transported services.

Figure 6
High-Density OC-48/STM-16 Transport
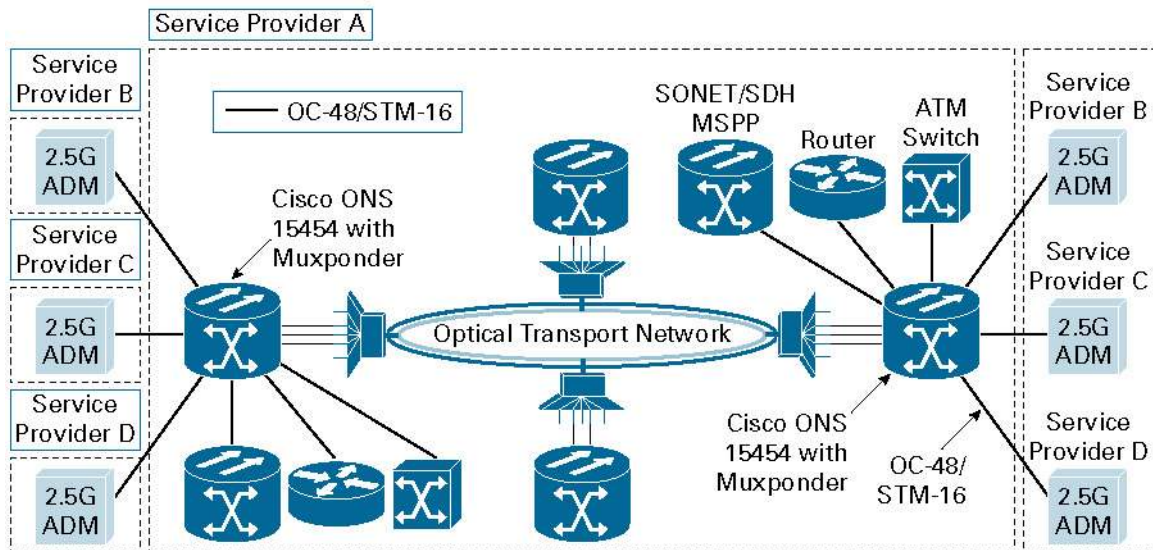
As well as transporting 2.5-Gbps service, the user can deliver a mixture of service types, from DS-1/E1 to 10-Gbps services using a common Cisco ONS 15454 transport platform, reducing system complexity, capital expenditures, and operational expenses related to technician training.

THE CISCO ADVANTAGE

The Cisco ONS 15454 4x 2.5-Gbps Muxponder card complements and extends the service capabilities of the Cisco ONS 15454 MSPP. The muxponder card allows users to take advantage of their existing fiber plant and installed base of Cisco ONS 15454 systems, while providing the required services, such as DS-1/E1, DS-3/E3, OC-n/STM-n, Ethernet, ATM, and video, over the same Cisco ONS 15454 platform. The muxponder solution improves the 2.5-Gbps service densities of the Cisco ONS 15454 while reducing the networking costs associated with the typical deployment option of an overlay metro DWDM platform to transport a mixture of services (Figures 7 and 8).

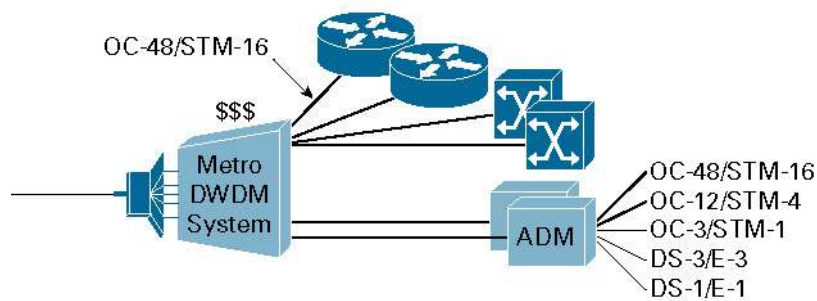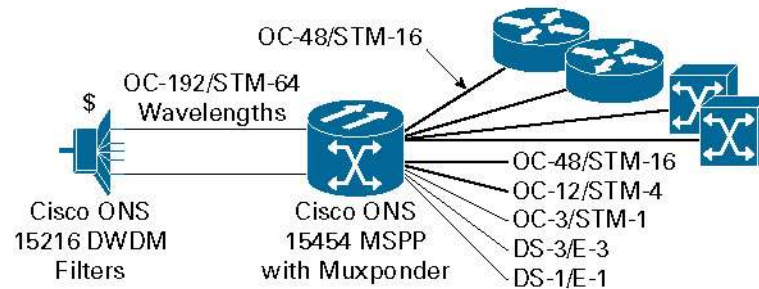**Figure 7**

Today's DWDM Architectures

Figure 8

Cisco ONS 15454 Hybrid DWDM Architectures

The Cisco ONS 15454 optical transport solution offers significant advantages over traditional network elements offering 10-Gbps interfaces, including the following.

- Unprecedented Service Densities

  The Cisco ONS 15454 platform supports up to 48 2.5-Gbps interfaces per node. When installed in a typical central-office bay frame, a bay can support up to 192 2.5-Gbps interfaces. These industry-leading densities are attainable due to the single-slot footprint of the muxponder interface card.

- Multiple Restoration Types

  The Cisco ONS 15454 platform supports 2- or 4-fiber BLSR/MS-SPR, UPSR/SNCP, linear APS/MSP, and path-protected mesh networking (PPMN). This allows the service provider to deploy the platform in all areas of the transport networking applications, including the

interoffice network, normally deployed using 2- or 4-fiber BLSR/MS-SPR restoration, as well as the collector or fiber to the building networks, normally using UPSR/SNCP restoration.

- Common Line Cards and Chassis

  One software load supports all restoration types listed previously, eliminating unnecessary guesswork when ordering. All protection configurations are covered under a single right-to-use software license. After the software is purchased, all features and full functions are available to the user.

- Single Software Load

  One software load supports all of the restoration types listed previously, eliminating unnecessary guesswork when ordering. No software right-to-use license is required for each protection type. After the software is purchased, all features with full capability are available to the user.

- Common Chassis

  A common chassis supporting all optical interface speeds allows the technician to spend time deploying bandwidth and services instead of learning about multiple equipment platforms. Many equipment vendors offer optical line-speed specific platforms (OC-3/STM-1, OC-12/STM-4, DWDM, and so on) and categorize platforms by restoration mechanisms (UPSR/SNCP, 2F-BLSR/MS-SPR, and 4F-BLSR/MS-SPR). This not only causes ordering confusion, but brings into question whether the inventoried equipment will accommodate the capability required to support the desired application. The Cisco ONS 15454 platform's line-rate and restoration flexibility makes ordering and deploying simple, fast, and easy. With integrated DWDM capabilities, the need to deploy another metro-DWDM platform is reduced.

- Multiservice Interface Selection

  DS-1/E1 through OC-192/STM-64, Ethernet, Fast Ethernet, Gigabit Ethernet, and 10 Gigabit Ethernet interfaces are all supported. This eliminates the "missing interface" found with many vendors' bit rate-specific product offerings.

  The Cisco ONS 15454, the industry's leading metro optical transport platform, delivers supercharged SONET/SDH transport, integrated optical networking, unprecedented multiservice interfaces, and competitive economic benefits.

CISCO ONS 15454 4X 2.5-GBPS MUXPONDER CARD FEATURES AND SPECIFICATIONS

Compact Design

- Single-width card slot design for high-density, 2.5-Gbps solutions
- Up to 12 muxponder cards per shelf assembly enables up to 192 2.5-Gbps interfaces per bay frame

Flexible Protection Options

- Transparent APS/LMSP, UPSR/SNCP, and BLSR/MSP-SPR
- Unprotected (0+1)
- Client Y-protection option

Table 2 lists the regulatory compliances of the Cisco ONS 15454 4x 2.5-Gbps Muxponder card.

Table 2. Regulatory Compliance[1]

Countries Supported	
SONET/ANSI System	**SDH/ETSI System**
• Canada	• European Union
• United States	• Australia
• Mexico	• New Zealand
• Korea	• Singapore
• Japan	• China
• European Union	• Mexico
	• Hong Kong
	• Korea
EMC (Class A)	
• ICES-003Issue 3, 1997	• EN 300 386-TC
• GR-1089-CORE, Level 3	• CISPR22, CISPR24
• 47CFR15	• EN55022, EN55024
Safety	
• CAN/CSA-C22.2 No.950-95, Third Edition	• UL 60950
• GR-1089-CORE	• IEC 60950/EN60950, Third Edition
Laser	
• UL 60950	• CDRH (Accession letter and report
• IEC60950/EN60950	• IEC 60825-1 Am.2 (2001)
• IEC 60825-2 (2000)	
Environmental	
• GR-63-CORE, Level 3	• ETS 300-019-2-2 (Transportation, Class 2.3)
• ETS 300-019-2-1 (Storage, Class 1.1)	• ETS 300-019-2-3 (Operational, Class 3.1E)
Optical	
• GR-253-CORE	• G.709
• G.691	• G.975
Quality	
• TR-NWT-000332, Issue 4, Method 1 calculation for 20-year mean time between failure (MTBF)	
Miscellaneous	
• AT&T Network Equipment Development Standards (NEDS) Generic Requirements, AT&T 802-900-260, Issue 3, December 1999	• Verizon SIT.NEBS.NPI.2002.010, October 2002
• SBC TP76200MP, May 2003	• Worldcom ESD requirement

1. All compliance documentation may not be completed at the time of product release. Please check with your Cisco sales representative for countries outside of Canada, the United States, and the European Union.

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Tables 3 and 4 list the system requirements and the specifications for the Cisco ONS 15454 4x 2.5-Gbps Muxponder card.

Table 3.   System Requirements

Component	Cisco ONS 15454 SONET/ANSI	Cisco ONS 15454 SDH/ETSI
Processor	TCC2 or TCC2P	TCC2 or TCC2P
Cross-connect	All (not required)	All (not required)
Shelf assembly	15454-SA-ANSI or 15454-SA-HD shelf assembly with FTA3 version fan-tray assembly	15454-SA-ETSI shelf assembly with SDH 48V fan-tray assembly
System software	Release 4.6.0 or later	Release 4.6.0 or later
Slot compatibility	1 to 6, 12 to 17	1 to 6, 12 to 17

Table 4.   Specifications

Specification	Short Reach/Intra-Office	Intermediate Reach/Short Haul
Client Interfaces (SFP)		
Type	SFP	SFP
Specification		
Telcordia GR-253-Core	GR-253-Core SR-1	GR-253-Core IR-1
ITU	I-16.1	S-16.1
Automatic laser shutdown and restart	ITU-T G.664 (06/99)	ITU-T G.664 (06/99)
Targeted fiber distance, unamplified, SMF28^2 (FD_{smf28})	2 km	15 km
Wavelength, nominal (λ_{Tnom})	1310 nm	1310 nm
Spectral range (λ_{Tmin} to λ_{Tmax})	1266 to 1360	1260 to 1360 nm
Spectral width at 20 dB ($\Delta\lambda_{20}$)	4 nm	1 nm
Optical transmitter		
Type	Fabry-Perot	Distributed Feedback /Direct Modulation
Output power (P_{Tmin} to P_{Tmax})	–10 to –3	–5 to 0 dBm
Required optical return loss, minimum	24 dB	24 dB
Extinction ratio, minimum (r_{eminx})	8.2 dB	8.2 dB
Laser safety class	1	1
Optical receiver		
Type	PIN	PIN
Sensitivity at BER (P_{Rmin} to P_{Rmax})	–18 to –3 dBm	–18 to 0 dBm
Chromatic dispersion tolerance (D_{SRmax})	12 ps/nm	–
Power penalty (P_O)	1	1
BER, maximum (BER_{min})	10E-12	10E-12
Reflectance between Tx (S) and Rx (R) (maximum)	–27 dB	–27 dB
Receiver reflectance (maximum)	–27 dB	–27 dB

Specification	Short Reach/Intra-Office	Intermediate Reach/Short Haul
Optical signal to noise ratio (0.5-nm bandwidth at 10E-12 BER)	30 dB	30 dB (unamplified link)
Input wavelength bandwidth (λ_{c_rx})	1266 to 1360 nm	1260 to 1360 nm
Connector type (Tx/Rx)	LC	LC

2. Fiber distance of <FDsmf28>km in SMF28 of equivalent <SRolb>dB optical link budget. Assumes D1550 = 17 ps/nm/km, D1310 = 3.3 ps/nm/km; fiber+splice+connector loss at 1550 nm = 0.275 dB/km and 1310 nm = 0.55dB/km; including <Po> dB dispersion penalty at <DLRmax>ps.

Specification	DWDM Line Interface
DWDM Line Interface	
Specification	
Telcordia GR-253-Core	GR-253-Core LR-2
ITU	L-64.2c
Automatic laser shutdown and restart	ITU-T G.664 (06/99)
Nominal wavelength (λ_{Tnom})	Two-channel tunable (Table 4)
Spectral range (λ_{Tmin} to λ_{Tmax})	1530 to 1561 nm
Spectral width at 20dB ($\Delta\lambda_{20}$)	+/–0.025 nm
Optical transmitter	
Type	Continuous wave lithium niobate external modulator
Output power (P_{Tmin} to P_{Tmax})	–16 to +3 dBm (software adjustable)
Required optical return loss, minimum (ORL_{min})	24 dB
Extinction ratio, minimum (r_{eminx})	>10 dBm
Laser safety class	1
Optical receiver	
Type	Avalanche photo diode
Sensitivity, FEC off (P_{Rmin} to P_{Rmax})	
Optical signal-to-noise ration (OSNR) < 23 dB	–21 to –8 dBm
OSNR < 23 dB at +/–1000 ps/nm	–19 to –9 dBm
Sensitivity, FEC on (P_{Rmin} to P_{Rmax})	
OSNR < 23 dB, unamplified	–24 to –8 dBm
OSNR < 23 dB at +/–1000 ps/nm	–22 to –8 dBm
Note: OSNR defined at 0.5-nm bandwidth	
Chromatic dispersion tolerance (D_{LRmax})	Up to +/–1000 ps/nm (2-dB penalty)
Minimum BER (BER_{min})	
FEC off	10E-12
FEC on	10E-15
Reflectance between far-end Tx and near-end Rx (maximum)	–27 dB
Receiver reflectance (maximum)	–14 dB
Input wavelength bandwidth (λ_{c_rx})	1530 to 1565 nm
Connector type (Tx/Rx)	LC, duplex (shuttered)

Specification	
Management	
Card LEDs	
Failure (FAIL)	Red
Active/standby (ACT/STBY)	Green/yellow
Signal fail (SF)	Yellow
Client port LEDS (per port)	
Active input signal	Green
DWDM port LEDs	
Active input signal	Green
Output wavelength	Green
Power	
Card power draw (including SFPs)	
Typical	45W
Maximum	50W
Operating Environment	
Temperature	23 to 131°F (–5 to 55°C)
Humidity	5 to 95 percent noncondensing
Storage Environment	
Temperature	–40 to 185°F (–40 to 85°C)
Humidity	5 to 95 percent noncondensing

Lists the wavelength channel plan for muxponder cards

Table 5.   Wavelength Channel Plan[3]

Card (xx.x)	λ (nm)	Card (xx.x)	λ (nm)	Card (xx.x)	λ (nm)	Card (xx.x)	λ (nm)
30.3	1530.33	38.1	1538.19	46.1	1546.12	54.1	1554.13
	1531.12		1538.98		1546.92		1554.94
31.9	1531.90	39.7	1539.77	47.7	1547.72	55.7	1555.75
	1532.68		1540.56		1548.51		1556.55
34.2	1534.25	42.1	1542.14	50.1	1550.12	58.1	1558.17
	1535.04		1542.94		1550.92		1558.98
35.8	1535.82	43.7	1543.73	51.7	1551.72	59.7	1559.79
	1536.61		1544.53		1552.52		1560.61

3. Lead times on wavelength-based optical modules vary substantially. For assistance with wavelength selection, please refer to Cisco price list or lead-time tool, available on Cisco.com at: http://www.cisco.com/en/US/ordering/index.shtml

Table 6 provides ordering information.

Table 6. Ordering Information[4]

Part Number	Description
15454-10M-L1-xx.x	4x OC-48 muxponder optics card; 4 client SFP optics module slots; long-reach, two-wavelength-tunable, OC-192 100-GHz ITU-compliant DWDM line optics with LC connector, SONET platform
15454E-10M-xx.x	4x STM-16 muxponder optics card; 4 SFP optics module client slots; long-haul, two-wavelength-tunable, 100-GHz ITU-compliant DWDM line optics with LC connector; SDH platform
ONS-SE-2G-S1=	OC-48/STM-16 SFP optics module, short-reach/intraoffice, 1310-nm, single-mode, LC connectors
15454-SFP-OC48-IR 15454-SFP-L.16.1	OC-48/STM-1 SFP optics module, intermediate-reach/short-haul, 1310-nm, single-mode, LC connectors
15216-CS-SM-Y=	Y-cable splitter/combiner module, single-mode, single-width module, installs in Cisco FlexLayer shelf assembly (15216-FL-SA)
15216-CS-MM-Y=	Y-cable splitter/combiner module, multimode, single-width module, installs in Cisco FlexLayer shelf assembly (15216-FL-SA)
15216-FL-SA=	Shelf assembly, 4 module slots, 1 rack-unit high, 19- or 23-inch rack mounting, Cisco FlexLayer platform

4. The letter "E" in the part number (for example, 15454E-) indicates SDH/ETSI system compatibility.

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