

10-Gbps Full-Band Tunable Multirate Enhanced Transponder Card for the Cisco ONS 15454 Multiservice Transport Platform

The Cisco® ONS 15454 Multiservice Transport Platform (MSTP) supports a 10-Gbps Full-Band Tunable Multirate Enhanced Transponder Card which simplifies the integration and transport of 10 Gigabit Ethernet, 10 Gigabit Fibre Channel, and OC-192/STM-64 interfaces and services into enterprises or service provider optical networks (Figure 1).

Figure 1. 10-Gbps Full-Band Tunable Multirate Transponder Card



Background

Optical 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 dense wavelength-division multiplexing (DWDM) platforms were designed for optical signals from OC-3/STM-1 to OC-192/STM-64, including Gigabit and 10 Gigabit Ethernet. Unfortunately, deploying multiple platforms (including DWDM and SONET ADMs) to support multiple services is not cost-effective for many service provider and enterprise networks. The Cisco ONS 15454 MSTP with transponder, muxponder and Xponder cards 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 10-Gbps Full-Band Multirate Transponder Card can transport 10 Gigabit Ethernet WAN physical layer (PHY) and LAN PHY, 10-Gbps Fibre Channel (10G FICON), SONET OC-192, and SDH STM-64 services over a 50-GHz spaced, 50-GHz stabilized, ITU-compliant wavelength. The transponder card is a plug-in module to the Cisco ONS 15454 MSTP, enabling a cost-effective architecture for delivering high-rate 10-Gbps services as well as low-rate services down to 1.5 Mbps. The 10-Gbps Full-Band Tunable Transponder Card architecture contains a single client interface that is mapped to a single line interface, without accessing the Cisco ONS 15454 shelf cross-connect fabric.

The client interface supports 10 Gigabit Ethernet LAN PHY, 10 Gigabit Ethernet WAN PHY, 10 Gigabit Fibre Channel, SONET OC-192, and SDH STM-64 signals. The interface is based on 10 Gigabit Small Form-Factor Pluggable (XFP) Multisource Agreement (MSA). Different XFP interfaces are available:

- A 10GE Base-SW / Base-SR, 850-nanometer (nm) Multi Mode (MM) optical interface using LC connectors supporting fiber distance of up to 300 meters (m) (with or without the Y-protection option)
- A short-reach/intra-office, 1310-nm Single Mode (SM) optical interface using LC connectors supporting fiber distances of up to 2 kilometers (km) (with or without the Y-protection option)
- An intermediate-reach/short-haul, 1550-nm SM optical interface using LC connectors supporting fiber distances of up to 20 km (with or without the Y-protection option).
- A long-reach/long-haul, 1550-nm SM optical interface using LC connectors supporting fiber distances of up to 80 km (with or without the Y-protection option).

The line interface provides one 10-Gbps, long-reach, ITU-compliant, 50-GHz-spaced optical interface using LC connectors supporting OTU-2 G.709 digital wrapper, OC-192, STM-64, 10 Gigabit Fibre Channel, 10 Gigabit Ethernet LAN PHY, or 10 Gigabit Ethernet WAN PHY interfaces. Two different units are available: one with output line interface tunable across 82 adjacent 50-GHz wavelengths, enabling support for C-Band DWDM networks via single card type, and a second with output line interface tunable across 80 adjacent 50-GHz wavelengths, enabling support for L-Band DWDM networks via single card type. When operated within the outlined specifications, each card will transport the 10-Gbps signal with a maximum bite error rate (BER) of 10E-15.

The 10-Gbps Full-Band Tunable Transponder Card incorporates both a client and DWDM line interface on the same card. The 10-Gbps full-band tunable transponder 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 enables the platform to support hybrid applications, containing transparent 10-Gbps services as well as aggregation of other services supported by the Cisco ONS 15454 platform. The only required common card is the appropriate timing, communications, and control card (TCC).

The 10-Gbps Full-Band Tunable Transponder Card provides many carrier-class features and advanced capabilities necessary to deliver 10-Gbps services, including the protocol transparency, wavelength tunability, flexible protection mechanisms, flow-through timing, management, and performance monitoring capabilities outlined below.

Enhanced FEC Capability

An important feature of the 10-Gbps Full-Band Tunable Enhanced Transponder Card is the availability to configure the Forward Error Correction (FEC) in three modes: NO FEC, FEC, and E-FEC. The output bit rate will depend by the bit rate of the incoming signal but the digital wrapper will be always as defined in G.709.

- 10.70923 Gbps in case of OC-192/STM-64/10 Gigabit Ethernet WAN
- 11.095 Gbps in case of 10 Gigabit Ethernet LAN PHY (over-clocking mode)
- 11.3168 Gbps in case of 10 Gigabit Fibre Channel (over-clocking mode)

Error coding performance can be provisioned:

- NO FEC: no Forward Error Correction
- FEC: standard G.975 Reed-Salomon algorithm
- E-FEC: standard G.975.1 two orthogonally concatenated BCH super FEC code. This FEC scheme contains three parameterizations of the same scheme of two orthogonally interleaved block codes (BCH). The constructed code is decoded iteratively, to achieve the expected performance.

Protocol Transparency

The 10-Gbps Full-Band Tunable Transponder Card provides transparent wavelength services on the Cisco ONS 15454 platform. For SONET- or SDH-based client payloads, when provisioned in transparent operating mode, the card will pass all of the SONET/SDH overhead bytes transparently. The card monitors important SONET/SDH overhead bytes, such as B1 (section BIP-8) and J0 (section trace), to allow fault isolation and performance monitoring capabilities. Termination of the line data communications channel (LDCC) is user-provisionable, to enable the platform processor to route the DCC information for intracarrier networking or to allow the DCC information to be transported untouched, via the digital wrapper's general communications channel (GCC), for intercarrier networking. For 10 Gigabit Ethernet and OC-192/STM-64 payloads, digital wrapper technology (G.709) is used to add a management wrapper to the service, allowing the transponder card to transparently forward the payload while enabling performance metrics to be derived to ensure circuit service quality.

The transponder card is transparent to the embedded payload and does not access the Cisco ONS 15454 platform's cross-connect. It can carry any type of concatenated SONET/SDH payloads (STS-Nc or VC-4-Mc); nonconcatenated payloads on an STS-1, VC-4, VC-3, VC-12, or VT1.5 basis; and 10 Gigabit Ethernet LAN or WAN PHY payloads.

Wavelength Tunability

The 10-Gbps Full-Band Tunable transponder cards operate on the 50-GHz ITU grid and are tunable across full-band 50-GHz channels per card (one for C and one for L band). The incorporation of tunability into the 10-Gbps transponder cards reduces the customer's inventory required to cover all of the wavelengths for deployment and spares. Tunability is software-provisionable.

Flexible Protection Mechanisms

The 10-Gbps Full-Band Tunable Transponder Card provides flexible protection capabilities for both client and DWDM line interfaces, enabling support for numerous network configurations required to deliver the various service-level agreements (SLAs) for customer applications (Table 1).

Table 1. Protection Formats

Protection Type	Capabilities	Figure
Unprotected client and line	No client terminal interface, transponder card, or DWDM line protection. The client signal is transported over a single unprotected transponder card. This configuration is suitable for transporting client payloads over a DWDM network that is being protected via unidirectional path switched ring/subnetwork connection protection (UPSR/SNCP) or bidirectional line switched ring/multiplex section shared protection ring (BLSR/MS-SPR) protocols.	2
1+1 protected client	Enables protection for both the client terminal interfaces and the transponder cards. Two client terminal interfaces operating 1+1 automatic protection switching/multiplex section protection (APS/MSP) switching are passed through 2 transponder cards, with switching managed between client terminal equipment interfaces.	3
Y-cable client interface	Provides transponder equipment protection without client terminal equipment interface protection. A single client interface is split to 2 transponder cards using a Y-protection device.	4

Figure 2. Unprotected Configuration

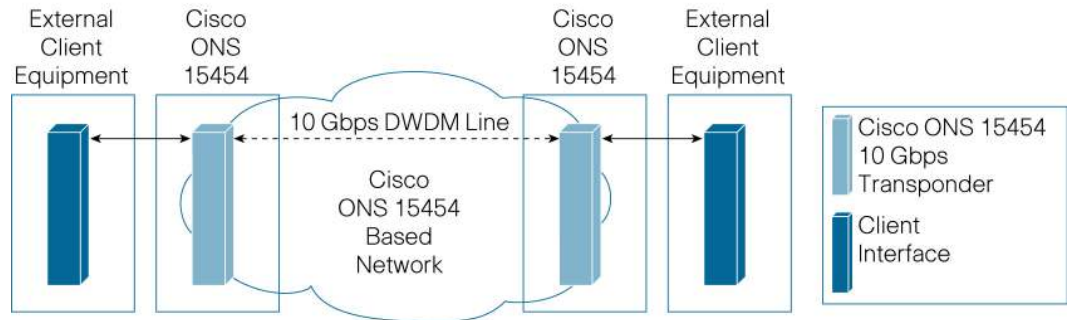


Figure 3. 1+1 Configurations

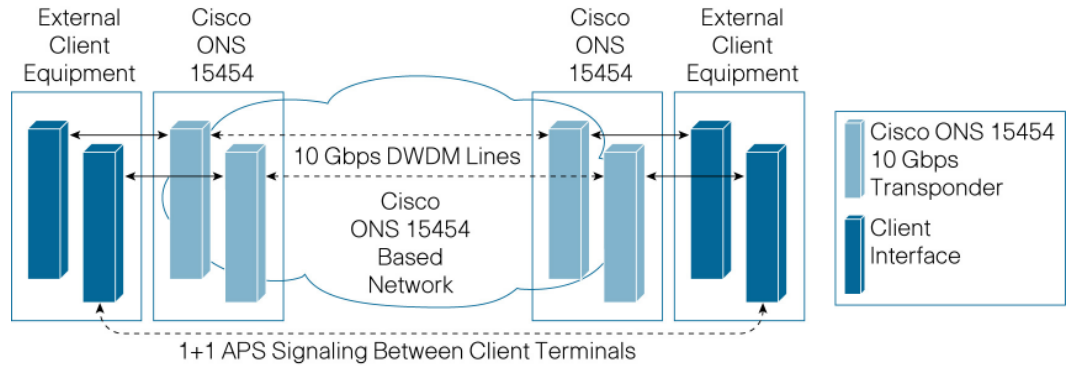
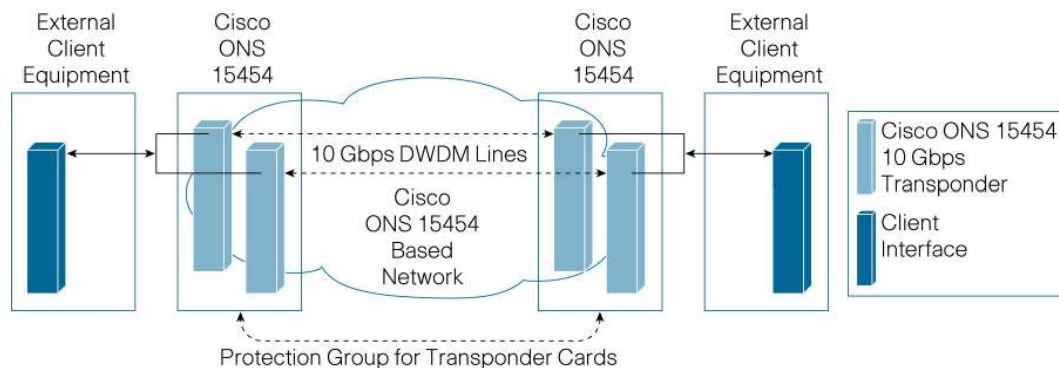


Figure 4. Y-Cable Configuration



Flow-Through Timing

The transponder card allows the timing to “flow through” from client to line optical interfaces. Receive timing from one interface (client or line) is used to time the other transmitter interface (line or client). This flow-through timing enables the transported signal to remain independent from the node timing.

Management

The Cisco ONS 15454 MSTP provides comprehensive management capabilities to support the operations, administration, monitoring, and provisioning (OAM&P) capabilities through the integrated Cisco Transport Controller craft interface with support from the Cisco Transport Manager element management system (EMS). The 10-Gbps Full-Band Tunable Transponder Card incorporates provisionable digital wrapper (G.709) functions, providing per-wavelength performance management capabilities, especially for services being transported transparently across the network. Without the digital wrapper functions, 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 GCC enables a separate communications channel on a per-wavelength basis, versus the section DCC/regenerator section DCC (SDCC/RSDCC) in SONET/SDH signals that is used by the platform when transparent signals are transported. This GCC enables the Cisco ONS 15454 to extend its advanced network auto-discovery capabilities to DWDM-based services. The integrated Cisco ONS 15454 Transport Controller craft manager and the Cisco Transport Manager EMS provide the user with OAM&P access for the system.

Configurable Far-End-Laser-Off Behavior

The 10-Gbps Full-Band Tunable Multirate Enhanced Transponder Card offers the flexibility to provision the Far-End-Laser-Off behavior. You can use Cisco Transport Controller to configure how the remote client interface will behave following a fault condition. It is possible to configure the remote client to squelch or to send an alarm indication signal (AIS).

Performance Monitoring

The performance-monitoring capabilities of the 10-Gbps Full-Band Tunable Transponder Card provide support for both transparent and nontransparent signal transport. For SONET/SDH-terminated signals, standard performance-monitoring and threshold-crossing conditions and alarms are supported per Telcordia GR-474, GR-2918, ITU G.783, and ETS 300 417-1 standards. For 10 Gigabit Ethernet signals, standard performance parameters for transmit and receive signals are based on RFC 2819. Each digital wrapper channel will be monitored per ITU-T digital wrapper requirements (G.709). Optical parameters on the DWDM line interface are supported, including

laser bias, transmit optical power, and receiver optical power. Calculation and accumulation of the performance monitoring data will be in 15-minute and 24-hour intervals.

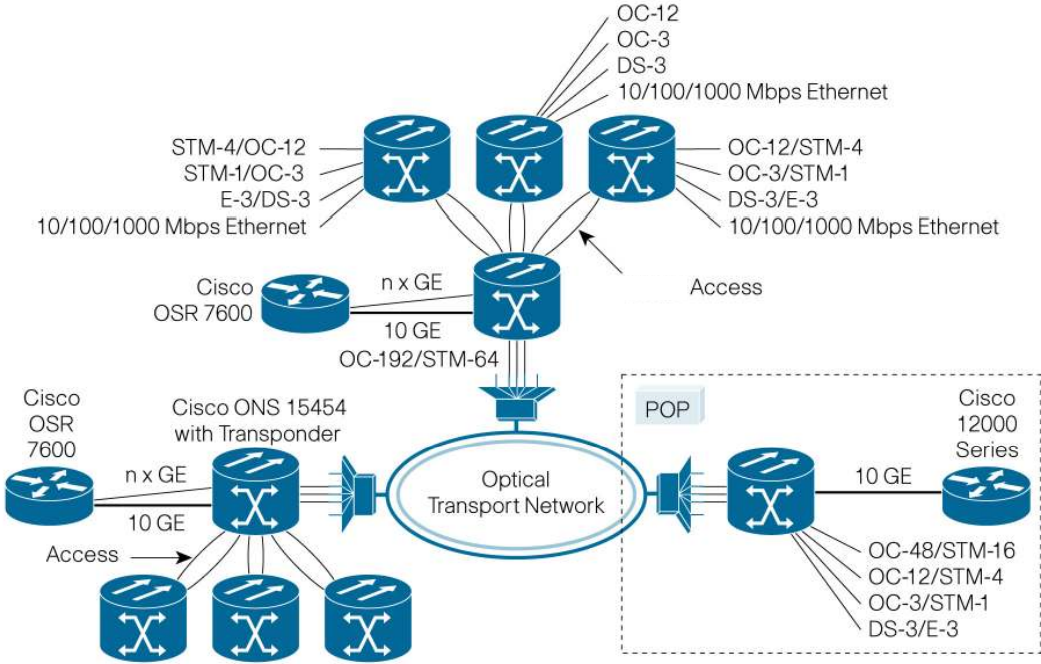
The 10-Gbps Full-Band Tunable Transponder Card incorporates faceplate-mounted LEDs to provide a quick visual check of the operational status of the card. An orange circle is printed on the faceplate, indicating the shelf slots the card can be installed.

Application Description

The 10-Gbps Full-Band Tunable Transponder Card adds several new applications to an already flexible Cisco ONS 15454 platform. These include metro 10 Gigabit Ethernet connectivity, STM-64 transport for cable-landing service extension, and OC-192/STM-64 transport for carrier services.

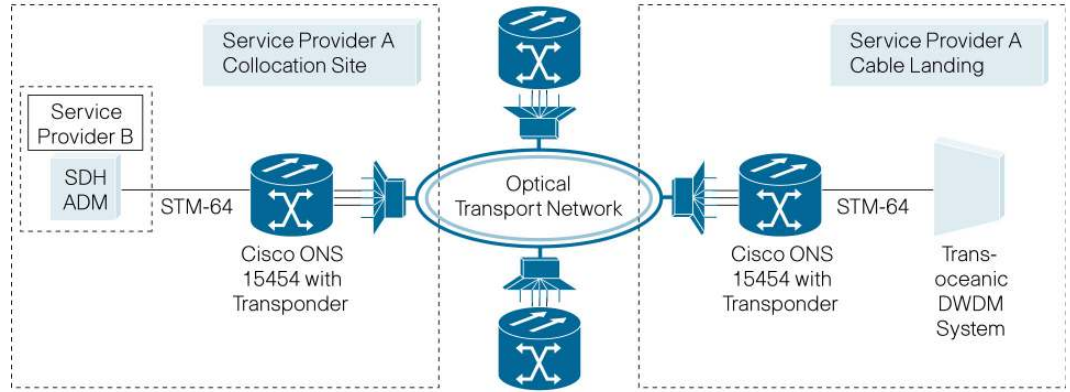
10 Gigabit Ethernet connectivity (Figure 5): With the addition of 10 Gigabit Ethernet on data terminals, the need for service providers to add a 10 Gigabit Ethernet transport service becomes critical to provide a complete metro service portfolio to their customer base. The 10-Gbps transponder card helps enable service providers to cost-effectively integrate 10 Gigabit Ethernet into their service mix over a multiservice network, reducing the need to deploy an overlay DWDM platform, and reducing the cost to deploy the service.

Figure 5. 10 Gigabit Ethernet Connectivity



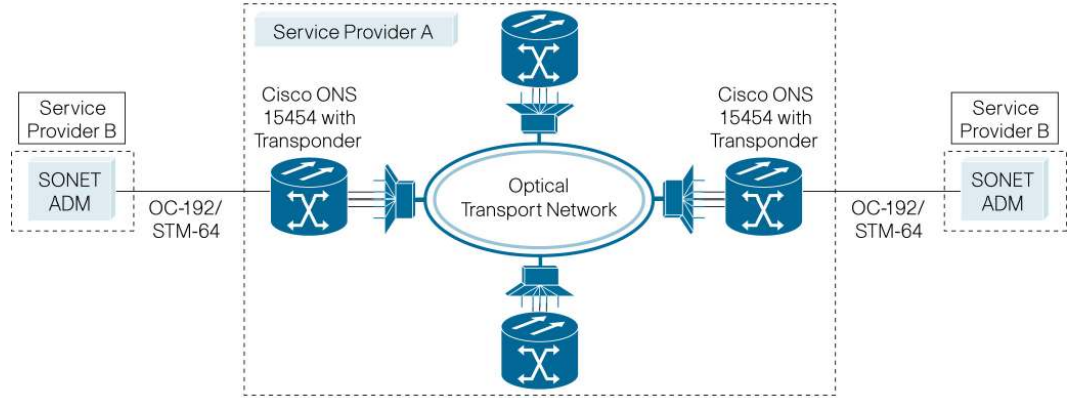
STM-64 transport for cable-landing service extension (Figure 6): A second application is the capability of a carrier’s service provider (Service Provider A) to transport STM-64 payloads from a transoceanic cable-landing site to another service provider’s international gateway site (Service Provider B).

Figure 6. STM-64 Transport for Cable Landing Service Extension



OC-192/STM-64 transport for carrier services (Figure 7): The OC-192/STM-64 transport for a carrier's carrier services application is similar to the application outlined in Figure 6.

Figure 7. OC-192/STM-64 Transport for a Carrier's Carrier Services



In each of these applications, the user can provide several service types, from DS-1/E1 to 10-Gbps services using a single transport platform such as the Cisco ONS 15454 MSTP, reducing system complexity, capital expenditures, and operational expenses related to technician training.

The Cisco Advantage

The Cisco ONS 15454 10-Gbps Full-Band Tunable Transponder Card complements and extends the service capabilities of the Cisco ONS 15454 MSTP. The 10-Gbps Full-Band Tunable Transponder Card enables carriers 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. This solution reduces the need to deploy an overlay DWDM platform to transport a mixture of services (Figure 8 and Figure 9).

Figure 8. Today's DWDM Architectures

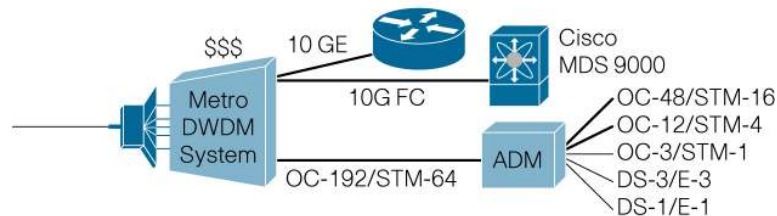
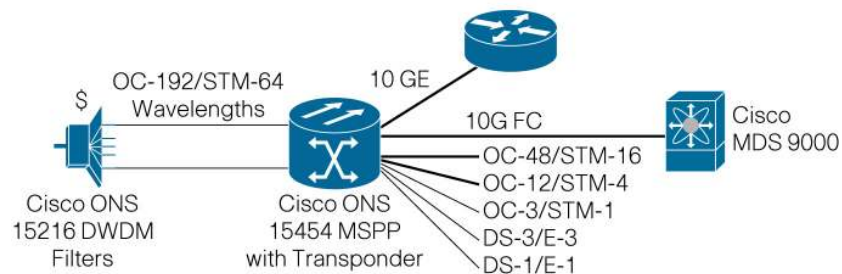


Figure 9. Cisco ONS 15454 Hybrid DWDM Architectures



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 12 10-Gbps interfaces per node. When the platform is installed in a typical central office bay frame, a bay can support up to 48 10-Gbps interfaces. These industry-leading densities are attainable because of the single-slot footprint of the 10-Gbps transponder interface card.

Multiple Restoration Types

The Cisco ONS 15454 platform supports 2- or 4-fiber BLSR/MS-SPR, UPSR/SNCP, linear APS/SNC, 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

Optical line cards are not restoration-type-dependent, which reduces sparing costs and technician confusion. Additionally, as networks and customer interface demands evolve, you can easily redeploy optical circuit packs as necessary.

Single Software Load

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.

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 (for example, OC-3/STM-1 or OC-12/STM-4) and categorize platforms by restoration mechanisms (for example, 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 functionality 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.

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 optical transport platform, delivers supercharged SONET/SDH transport, integrated optical networking, unprecedented multiservice interfaces, and competitive economic benefits.

Cisco ONS 15454 10-Gbps Full-Band Tunable Multirate Transponder Card Features and Specifications

Compact Design

- Single-width card slot design for high-density, 10-Gbps solutions
- Up to 12 10-Gbps transponder cards per shelf assembly (120 Gbps), and 48 cards per bay (480 Gbps)

Flexible Restoration Options

- Transparent support for UPSR/SNCP, BLSR/MSP, and 1+1 APS/MSP
- Client Y-protection
- Unprotected (0+1)

Tables 2 and 3 list the regulatory compliance and system requirements for the transponder card. Tables 4 and 5 list product specifications and ordering information.

Regulatory Compliance¹

Table 2. Regulatory Compliance

SONET/ANSI System	SDH/ETSI System
Countries Supported	
<ul style="list-style-type: none"> • Canada • United States • Mexico • Korea • Japan • European Union 	<ul style="list-style-type: none"> • European Union • Australia • New Zealand • Singapore • China • Mexico • Hong Kong • Korea
EMC (Class A)	
<ul style="list-style-type: none"> • ICES-003 Issue 4 (2004) • GR-1089-CORE, Issue 4 (Type 2 and Type 4 equipment) • GR-1089-CORE - Issue 03 (Oct 2002) (Objective O3-2 – Section 3.2.1 - Radiated Emissions requirements with all doors open) • FCC 47CFR15, Class A subpart B (2006) 	<ul style="list-style-type: none"> • EN 300 386 v1.3.3 (2005) and v1.4.1 (2007) • CISPR 22 – Fifth edition (2005-04) Class A and the amendment 1 (2005-07) • CISPR 24 – First edition (1997-09) and amendment 1 (2001-07) and amendment 2 (2002-10) • EN 55022:1998 Class A – CENELEC Amendment A2:2003 • EN 55024:1998 – CENELEC Amendment A1:2001 and Amendment A2:2003
Safety	
<ul style="list-style-type: none"> • CAN/CSA-C22.2 No.950-95, 3rd Edition • GR-1089-CORE, Issue 4 (Type 2 and Type 4 equipment) 	<ul style="list-style-type: none"> • UL/CSA 60950 –1 First Edition (2003) • IEC 60950-1 (2001/10) / Amendment 11:2004 to EN 60950-1:2001, 1st Edition (with all country deviations)
Optical Safety	
<ul style="list-style-type: none"> • EN or IEC-60825-2 Third edition (2004-06) • EN or IEC 60825-1 Consol. Ed. 1.2 - incl. am1+am2 (2001-08) • 21CFR1040 (2004/04) (Accession Letter and CDRH Report) • IEC-60825-2 Third edition (2004-06) • ITU-T G.664 (2006) 	

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.

SONET/ANSI System	SDH/ETSI System
Environmental	
<ul style="list-style-type: none"> GR-63-CORE, Issue 3 (2006) 	<ul style="list-style-type: none"> ETS 300-019-2-1 V2.1.2 (Storage, Class 1.1) ETS 300-019-2-2 V2.1.2 (Transportation, Class 2.3) ETS 300-019-2-3 V2.1.2 (Operational, Class 3.1E) EU WEEE regulation EU RoHS regulation
Optical	
<ul style="list-style-type: none"> GR-253-CORE - Issue 04 ITU-T G.691 	<ul style="list-style-type: none"> ITU-T G.709 ITU-T G.975
Quality	
<ul style="list-style-type: none"> TR-NWT-000332, Issue 4, Method 1 calculation for 20-year mean time between failure (MTBF) 	
Miscellaneous	
<ul style="list-style-type: none"> AT&T Network Equipment Development Standards (NEDS) Generic Requirements, AT&T 802-900-260, Issue 3, December 1999 SBC TP76200MP, May 2003 	<ul style="list-style-type: none"> Verizon SIT.NEBS.NPI.2002.010, October 2002 Worldcom ESD requirement

Table 3. System Requirements

Component	Cisco ONS 15454 ANSI	Cisco ONS 15454 ETSI
Processor	TCC2P/TCC2	TCC2P/TCC2
Cross-connect	All (not required)	All (not required)
Shelf assembly	15454-SA-HD or 15454-SA-HD-DDR shelf assembly with FTA3 or CC-FTA version fan-tray assembly	15454-SA-ETSI shelf assembly with FTA-48V or CC-FTA fan-tray assembly
System software	Release 7.0.0 ANSI or greater	Release 7.0.0 ETSI or greater
Slot compatibility	1-6, 12-17	1-6, 12-17

Table 4. Client Side Specifications

Specification	SR XFP	LR XFP	IR XFP ²	MM XFP ³
Compliance				
Telcordia GR-253-Core	SR1	LR2	IR2	
ITU G.691	I-64.1	L-64.2	S-64.2	
ITU-T G.959.1	P111-2D1	P1L1-2D2	P1S1-2D2	
IEEE 802.3	10GBASE-LR / -LW	10G BASE-ZR	10GBASE-ER / -EW	10G BASE-SR / -SW
10GFC Rev 3.5 T11	1200-SM-LL-L			1200-MX-SN-I
Automatic laser shutdown and restart	ITU-T G.664	ITU-T G.664	ITU-T G.664	ITU-T G.664
Unamplified targeted fiber distance, SMF28 ⁴ (FD ^{smf28})				
<ul style="list-style-type: none"> SONET/SDH 10GE/10G FC 	2 km 10 Km	80 km 80 km	40 km 40 km	300 m
Nominal wavelength (λ_{Tnom})	1310 nm	1550 nm	1550 nm	850 nm
Optical transmitter				
Spectral range (λ_{Tmin} to λ_{Tmax})				
<ul style="list-style-type: none"> SONET/SDH 10GE/10G FC 	1290-1330 nm 1260-1355 nm	1530-1565 nm	1530-1565 nm	840-860 nm

² This XFP is supported only with Release 8.5 SW or greater. 10GE is supported only with Release 8.5.2 SW or greater.

³ This XFP is supported only with Release 9.0 SW or greater

⁴ Fiber distance of $\langle FD_{smf28} \rangle$ km in SMF28 of equivalent $\langle SR_{olb} \rangle$ dB optical link budget. Assumes $D_{1550} = 17$ ps/nm/km, $D_{1310} = 3.3$ ps/nm/km; fiber+splice+connector loss at 1550 nm = 0.275 dB/km and 1310 nm = 0.55 dB/km; including $\langle P^0 \rangle$ dB dispersion penalty at $\langle D_{L, Rlong-reachmax} \rangle$ ps.

Specification	SR XFP	LR XFP	IR XFP ²	MM XFP ³
Type	Distributed feedback, direct modulation (DFB/DM) ⁵	Electro absorption (EML)	Electro absorption (EML)	Vertical Cavity Surface Emitting Laser Device (VCSEL)
Output power (P_{Tmin} to P_{Tmax})	-8.2 to 0.5 dBm	0 to +4 dBm	-1 to +2 dBm	-7.3 to -1 dBm
Minimum required optical return loss <ul style="list-style-type: none"> SONET/SDH 10GE/10G FC 	24 dB 12 dB	24 dB 12 dB	24 dB 12 dB	12 dB
Minimum extinction ratio (r_{eminx})	6 dB	9 dB	8.2 dB	3 dB
Laser safety class	1	1	1	1
Optical receiver				
Type	PIN	PIN	PIN	PIN
Sensitivity @ BER (P_{Rmin} to P_{Rmax}) <ul style="list-style-type: none"> SONET/SDH 10 GE/10G FC 	-11 to -1 dBm -14.4 to +0.5 dBm	-24 to -7 dBm -24 to -7 dBm	-14 to 2 dBm -15.8 to -1 dBm	-9.9 to -1 dBm
Chromatic dispersion tolerance (D_{SRmax})	6.6 ps/nm (SONET/SDH)	1600 ps/nm (SONET/SDH)	800 ps/nm (SONET/SDH)	N/A
Minimum BER (BER_{min})	10E-12	10E-12	10E-12	10E-12
Maximum receiver reflectance	-14 dB	-14 dB	-14 dB	-12 dB
Input wavelength bandwidth ($\lambda_{c,rx}$)	1290-1335 nm ⁶	1260-1565 nm	1530-1565 nm ⁷	840 to 860 nm
Connector type (Tx/Rx)	LC, duplex	LC, duplex	LC, duplex	LC, duplex

Table 5. DWDM Specifications

Specification	DWDM Line Interface
DWDM Line Interface	
Bit Rate	9.9532 ±50 ppm 10.3125 ±100 ppm 10.518 ±100 ppm 10.7092 ±100 ppm 11.0957 ±100 ppm 11.3168 ±100 ppm
Automatic laser shutdown and restart	ITU-T G.664 (06/99)
Nominal wavelengths (λ_{Tnom})	Full Tunable from 1529.55 to 1561.84 (C-Band – 50 GHz) Full Tunable from 1570.83 to 1604.03 (L-Band – 50 GHz)
Spectral width @ 20dB ($\lambda_{\Delta 20}$)	≤25 GHz
Optical transmitter	
Type	Lithium niobate external modulator
Output power (P_{Tmin} to P_{Tmax})	+3 dBm, +6 dBm
Required optical return loss, minimum (ORL _{min})	27 dB
Extinction ratio, minimum (r_{eminx})	>10.5 dB
Laser safety class	1
Optical receiver	
Type	Avalanche photo diode (APD)
Chromatic dispersion tolerance (DLR _{max})	Up to ±1200 ps/nm

⁵ DFB/DM is typical but other technologies may be substituted if specifications are met.

⁶ Acceptable input wavelength range is 1290 to 1605 nm, but receiver sensitivity is guaranteed only for the indicated range.

⁷ Acceptable input wavelength range is 1260 to 1565 nm, but receiver sensitivity is guaranteed only for the indicated range.

Specification	DWDM Line Interface
Minimum BER (BER _{min}) <ul style="list-style-type: none"> FEC off FEC on E-FEC on 	10E-12 10E-15 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})	1290 nm to 1605 nm
Connector type (Tx/Rx)	LC, duplex (shuttered)

Table 6. DWDM Receive Side Optical Performances

OSNR	FEC Type	Pre-FEC BER	Post-FEC BER	Input Power Sensitivity	CD Tolerance
23 dB	OFF	<10E(-12)	-	-8 to -20 dBm C-Band -8 to -19 dBm L-Band	±1200 ps/nm
19 dB	OFF	<10E(-12)	-	-8 to -20 dBm C-Band -8 to -19 dBm L-Band	±1000 ps/nm
19 dB	OFF	<10E(-12)	-	-8 to -22 dBm C-Band -8 to -21 dBm C-Band	-
10 dB	STD	<10E(-5)	<10E(-15)	-8 to -18 dBm	±800 ps/nm
8.5 dB	STD	<10E(-5)	<10E(-15)	-8 to -18 dBm	-
19 dB	ENH	<7x10E(-4)	<10E(-15)	-8 to -26 dBm	±800 ps/nm
19 dB	ENH	<7x10E(-4)	<10E(-15)	-8 to -27 dBm	-
8 dB	ENH	<7x10E(-4)	<10E(-15)	-8 to -18 dBm L-Band	±800 ps/nm
7 dB	ENH	<7x10E(-4)	<10E(-15)	-8 to -20 dBm C-Band	±800 ps/nm
6 dB	ENH	<7x10E(-4)	<10E(-15)	-8 to -18 dBm L-Band	-
5 dB	ENH	<7x10E(-4)	<10E(-15)	-8 to -20 dBm C-Band	-

Table 7. Card Specifications

Specification	
Management	
Card LEDs Failure (FAIL) Active/standby (ACT/STBY) Signal fail (SF)	Red Green/yellow Yellow
Client Port LEDs (per port) Active input signal	Green
DWDM Port LEDs Active input signal Output wavelength	Green Green
Power (including worst case pluggable)	
Typical	35W
Maximum	50W
Physical	
Dimensions	Occupies one slot
Weight	1.4 Kg (3.1 lbs)
Reliability and Availability	
Mean Time Between Failures (MTBF)	236,765 hrs

Specification	
Latency (End to End)	
G.709 Off / NO FEC:	1 microsecond
G.709 On – Standard FEC	5 microseconds
G.709 On – Enhanced FEC	150 microseconds
Environment Conditions	
Storage Temperature	-40°C to 70°C (-40°F to 158°F)
Operating Temperature	
Normal	0°C to 55°C (32°F to 131°F)
Short Term ¹	-5°C to 55°C (23°F to 131°F)
Relative Humidity	
Normal	5% to 85%, non condensing
Short Term ¹	5% to 90% but not to exceed 0.024 kg water/kg of dry air

¹ Short-term refers to a period of not more than 96 consecutive hours and a total of not more than 15 days in 1 year. (This refers to a total of 360 hours in any given year, but no more than 15 occurrences during that 1-year period.)

Table 8. Ordering Information

Part Number	Description
15454-10E-L1-C=	10-Gbps E-FEC multirate transponder card, 1x XFP-based client interface, full C-band tunable on 50-GHz ITU wavelengths (Odd and Even), DWDM line with LC connectors
15454-10E-L1-L=	10-Gbps E-FEC multirate transponder card, 1x XFP-based client interface, full L-band tunable on 50-GHz ITU wavelengths, DWDM line with LC connectors
ONS-XC-10G-S1=	OC-192/STM-64/10 GE/10-Gbps Fibre Channel XFP optics module, short-reach, 1310-nm, single-mode, LC connector
ONS-XC-10G-L2=	OC-192/STM-64 XFP optics module, long-reach, 1550-nm, single-mode, LC connector (see NOTE)
ONS-XC-10G-I2=	OC-192/STM-64 IR2/10 GE XFP optics module, intermediate-reach, 1550-nm, single-mode, LC connector
ONS-XC-10G-SR-MM=	10 GE/10-Gbps Fibre Channel XFP optics module, short-reach, 850-nm, multi-mode, LC connector

NOTE: Transponders equipped with LR2 XFP need mandatory to be placed in High Speed Slot (5,6,12 and 13) if shelf is equipped with FTA-3 or FTA-48V Fan Tray. No limitation if the shelf is using CC-FTA Fan tray.



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