ML-Series: Enabling Multi-Layer Services
for **Metro** Optical Ethernet

The ML-Series interface cards provide Ethernet switching and IP routing capabilities unmatched in any multiservice provisioning platform (MSPP) available today. Cisco has coupled the ONS 15454's market-leading optical capabilities with Cisco's proven IOS software to deliver profitable metro Ethernet and IP solutions over a multiservice network architecture.

Background

Information connectivity in today's world is becoming increasingly more ubiquitous and commonplace as businesses and consumers look to improve their productivity. Access to this information can be over a wide variety of networks including the many forms of wire-line (DSL, T1, E1, dial-up, cable TV modem, etc.) and wireless (cell, PCS, 802.11b, etc.) vehicles. The key benefit to this information connectivity is user access to a wide variety of information that can be located anywhere in the world.

Ethernet technology has become ubiquitous as the protocol of choice for the LAN environment. It is also becoming increasingly commonplace in the MAN, with the release of fast- and Gigabit-Ethernet interfaces on DSLAMs, fixed wireless, and PBXs. Thus, the service provider is being driven to create tariffs to efficiently interconnect to and transport the user's data traffic via Ethernet hand-offs and must deploy metro transport equipment that will enable them to deliver these services cost-effectively and with the reliability required by their Service-Level Agreements SLAs. Although Ethernet-based services are growing, they are still not the dominant share of the market demand. Therefore, the SP's metro networking equipment must support both the traditional TDM-based services as well as newer Ethernet-based services, without a forklift upgrade, and is why the multiservice provisioning platform has taken hold of the metro marketplace.

Product Overview

The Cisco ML-Series cards for the ONS 15454 MSPP are the industry's highest performance Ethernet and IP switching modules ever integrated into a SONET/SDH optical transport platform. The ML-Series cards further extend the multiservice capabilities and flexibility offered by the Cisco ONS 15454 platform. Through the integration of the industry's most widely deployed and tested Ethernet and IP technology, Cisco IOS, with the

Figure 1

ML-Series Cards for ONS 15454

industries most successful multiservice provisioning platform, the Cisco ONS 15454, service providers and enterprise customers are provided with a single integrated platform for delivering true carrier-class metro Ethernet, TDM, and Optical transport services and applications.

The Cisco ONS 15454 ML-Series consists of two interface cards, models ML100T-12 and ML1000-2. The ML100T-12 is a 12-port, 10/100 Mbps Ethernet module. The ML1000-2 is a two-port gigabit Ethernet module utilizing SFP optical interface modules. The ML-Series cards use a common hardware and software base, providing the same Layer 2 and Layer 3 feature set. These single-slot cards can be installed in any of the 12 multiservice interface slots in an ONS 15454 shelf assembly, and can be mixed and matched within the assembly or network to enable flexible architectures to meet the user's application. Each card has "virtual" interfaces that are mapped to SONET/SDH optical interfaces for transport with other services between network elements over 155 Mbps to 10 Gbps optical line rates. Packet transport bandwidth over the chosen optical interface is provisionable, enabling efficient matching and scalability of ingress to transport traffic requirements, based upon over-subscription requirements.

The ML-Series cards offer an advanced set of quality of service (QoS) features to allow the network administrator to fine-tune the network and enable the creation and support of a wide range of SLAs. Some of the features and benefits are captured below:

Feature	Benefit
Flexible packet classification	Classify packets based upon input port, VLAN, CoS, IP Precedence, or IP differentiated services code points (DSCP). This enables the service provider to tailor the packet handling based upon the user's traffic.
Policing	Highly granular input port policing allows the service provider to contain a user to the SLA bandwidth requirements. Reduces the possibility of a user flooding the network.
Priority marking	Provides a mechanism, when using either .1Q or Q in Q features for a service provider to reclassify (mark) a packet with a wrapper Ethernet 802.1p value, enabling downstream nodes to treat the packet differently. This feature enables the packet's original CoS bits to be transported transparently across a service provider network.
Per class queuing	Provides fair access to excess network resources, allows allocation of bandwidth to support SLAs, and ensures applications with high network resource requirements are adequately serviced.
Weighted deficit round robin (WDRR) Scheduling	Adds additional weighting capabilities to deficit round robin scheduling to provide fair access to excess bandwidth as well as guaranteed throughput to each class.
Admission control	During service provisioning, the ML-Series card verifies that QoS resources have not been accidentally over-committed.

The ML-Series cards offer key advantages in service provider network architectures, enabling new, profitable services as well as simplifying service activation. Some of these capabilities are outlined below:

| Feature	Benefit
Network scaling and flexibility	The ML-Series cards support VLAN-ID translation. This capability enables the service provider to change the ingress VLAN tags (802.1Q or 802.1Q in.1Q) to avoid VLAN collisions within their network (resulting from different customers using the same VLAN-ID) and translate them back at the egress of the network.
Packet over SONET Virtual ports (POS) support	POS support enables the service provider to transport Ethernet traffic originating on an ML-Series card over an optical interface and terminate the signal on an optical port of existing L2/L3 equipment. Eliminates the need to bookend the ML-Series cards within the network.
Lower interface costs	The use of the ML-Series cards and shared bandwidth transport allows the service provider to leverage the benefits of statistically multiplexing the edge traffic before handing off a more efficiently filled interface to the core router or switch.

Applications

The Cisco ONS 15454 ML-Series cards provide the flexibility to meet the demands of a wide variety of network applications found within many service providers' transport networks. The following diagrams outline a few of the applications that can be met using the ML-Series cards.

Inter-Office Facility (IOF) Networks

All traditional local exchange carriers (LEC) have utilized SONET/SDH technology to interconnect their central offices (see Figure 2). With the explosion of data-related services and the growth of termination equipment, with integrated Ethernet interfaces and protocols, these carriers have a growing need to transport data traffic more efficiently. Leveraging the ML-Series cards to interconnect data traffic between the remote terminal equipment and the central core router will allow transport bandwidth efficiency by statistically multiplexing and aggregating traffic for efficient router port utilization, reducing the quantity of core router interfaces. Management benefits are garnered through the integration of data switching into the optical platform, reducing data communication network (DCN) ports.

Figure 2
IOF Transport Network
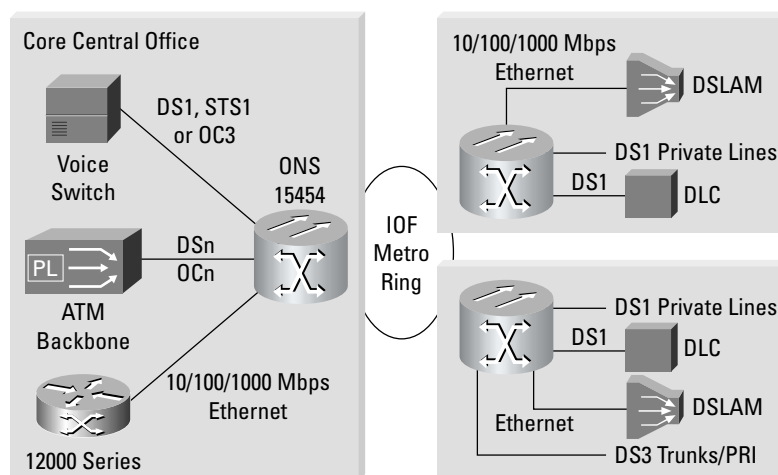
Metro Data Services Network

Metropolitan networks deliver services to end user customers. As such, a metropolitan network that supports a wide range of service capabilities will allow the service provider to offer a tariff mix to meet the customers needs. The Cisco ONS 15454 provides the foundation for building an advanced multiservice network over an extremely reliable SONET/SDH infrastructure (see Figure 3). Data services delivery, such as transparent LAN services (TLS) or Internet access, are supported by the ONS 15454 ML-Series cards through the use of 802.1Q in .1Q VLAN protocol, VLAN translation, input rate limiting and the advanced QoS features, including queue bandwidth control and traffic priority marking. These flexible features enable the service provider to build, control, and guarantee the delivery of the SLAs offered for each service type. It is also very important for the network to be manageable and usable by the service provider's technicians. As such, the ML-Series cards integrate Cisco IOS, the industry's most well known Layer 2/Layer 3 technology, reducing training time and cost.

Figure 3
Metro Data Services Network
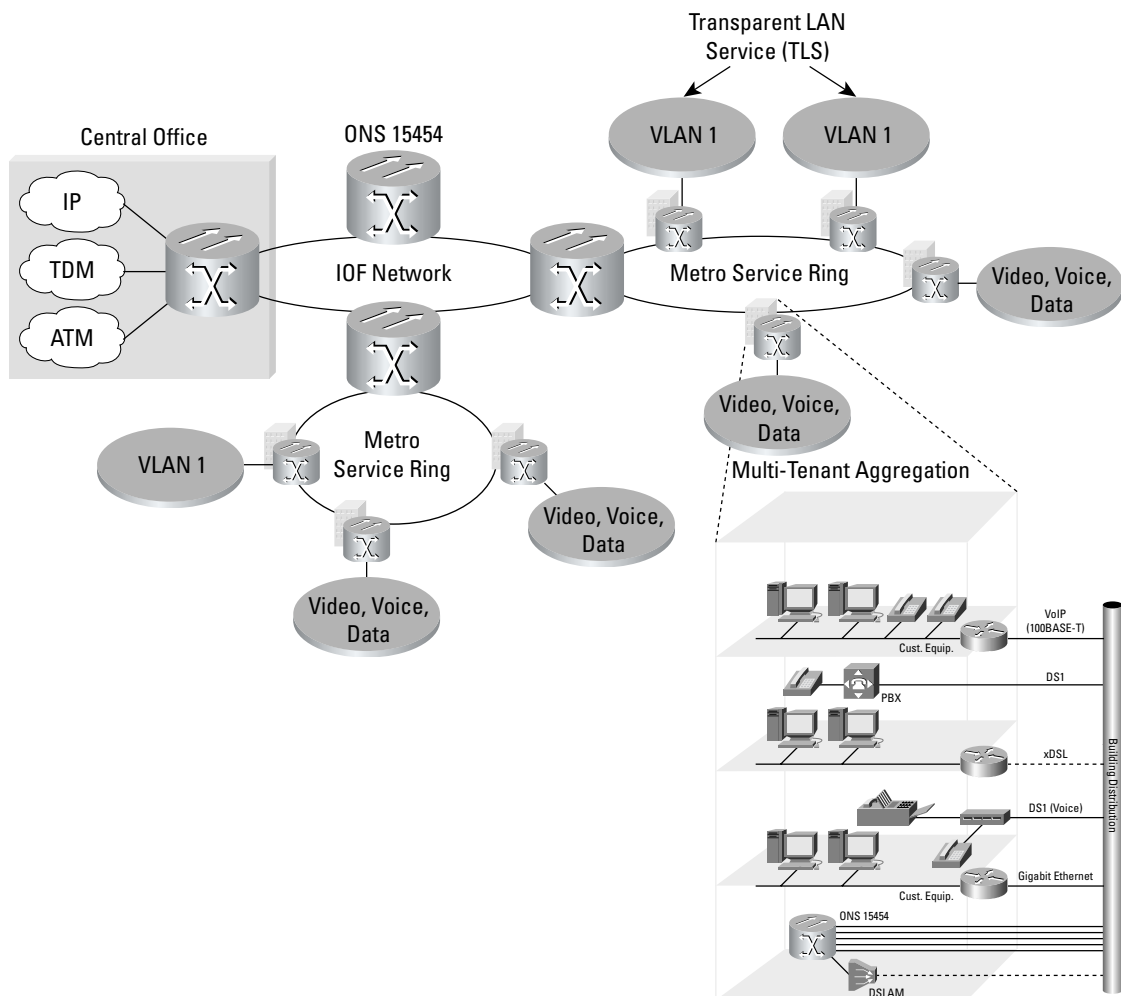
Cable Television Data Transport

Cable television operators are experiencing rapid growth of subscribers to their data services. According to the National Cable Television Association (NCTA), data cable subscriptions grew 337 percent from January 2000 to January 2002. The Cisco ONS 15454 with ML-Series cards provides a solution to efficiently transport the growing data requirements of the cable television networks. The Cisco solution will enable the cable operator to aggregate data traffic, using the ML-Series cards, from multiple secondary headends (SHE) and statistically multiplex it onto shared transport bandwidth for handoff to a core router at the master headend (see Figure 4). Cable modem traffic is bursty in nature, and the sharing of bandwidth enables better utilization of optical transport resources versus dedicated point-to-point connections. The ML-Series cards' advanced QoS capabilities enable the cable network engineer to architect the network to support the type of services being offered such as Web browsing, Voice over IP, or video on demand (VOD). The ML-Series cards allow the user to build traffic queues and associate priority and

bandwidth to each queue type, allowing the transport demands of each service to be met. The ONS 15454 platform supports in-service bandwidth upgrades and enables the transport network to scale from 155 Mbps to 320 Gbps leveraging DWDM so meeting growth demands should be easily met.

Figure 4
Cable Television Data Networking
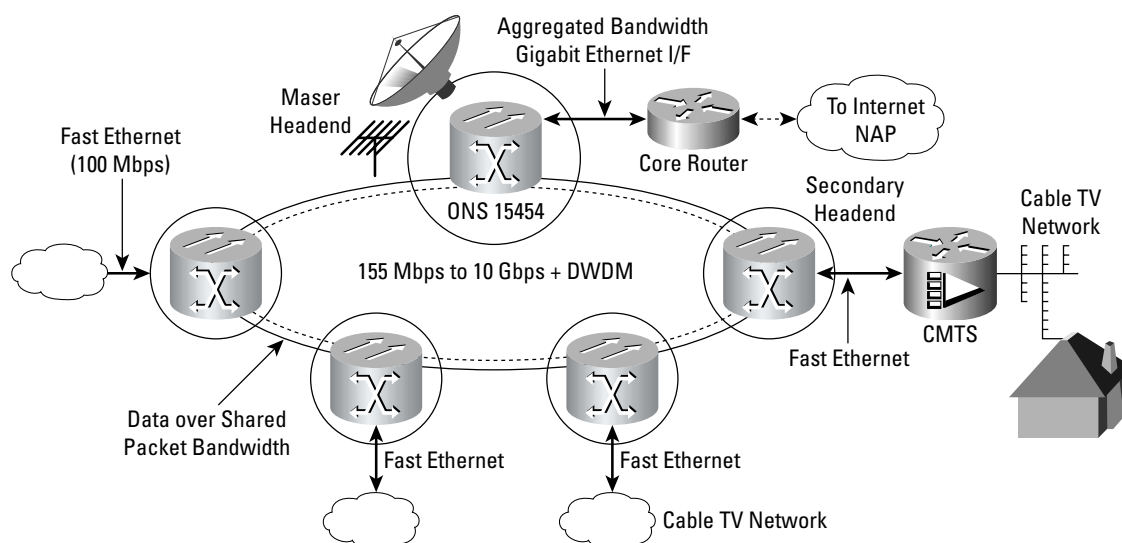
The above are just a few of the applications that can be cost-effectively deployed leveraging the ONS 15454 with the ML-Series cards.

The Cisco Advantage

The Cisco ONS 15454 MSPP solution offers significant advantages over traditional optical network elements combined with external Layer 2 and Layer 3 devices, including:

Integrated Multiservice Capabilities:

Enables support for traditional TDM-based, private line services (for example, DS1/E1, DS3/E3, and OC-N/STM-N, etc.) along with advanced Ethernet based services, simplifying the service provider's migration to new data tariff or interface flexibility for enterprise users.

Flexible Architectures:

The ONS 15454 platform supports two- or four-fiber BLSR/MS-SPR, UPSR /SNCP, linear APS/SNC, and path-protected mesh networking (PPMN). The ML-Series services cards can be deployed over any of these architectures and protection schemes, enabling the service provider to build a network meeting the customer's SLA requirements. The platform enables in-service optical bandwidth expansion via card upgrades, allowing customers to grow their networks to match demand without a forklift replacement. And allows network expenditures to better match revenues or bandwidth requirements.

Efficient Network Management:

Management is simplified through a common DCN network connection and user access for Ethernet and optical functionality.

Unified Software Load:

One software load supports transport and data capabilities, eliminating unnecessary guesswork for ordering, installation, and upgrades.

Familiar, Proven Cisco IOS Technology:

The ML-Series cards incorporate Cisco's IOS technology, the leading Ethernet and IP delivery vehicle. Most data networking professionals are well trained on Cisco's IOS, reducing training and improving service deployment timelines.

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.

ONS 15454 ML-Series Ethernet Cards Features and Specifications

Compact Design

- Single width card slot design for increased shelf flexibility and scalability
- Up to 12 ML-Series cards per shelf assembly

Data Architecture Options

- Hub and spoke
- Point-to-point
- Shared packet ring

Optical Transport Options

- UPSR/SNCP
- 2F- and 4F-BLSR/MS-SPR
- APS/SNC (1+1 uni- or bidirectional)
- PPMN
- Unprotected (0+1)

Network Architecture Flexibility

- Ring
- Multiple rings
- Linear add/drop multiplexer
- Terminal

Regulatory Compliance

SONET/ANSI System	SDH/ETSI System
Countries	
• Canada	• EU
• USA	• Australia
• Mexico	• New Zealand
• Korea	• Singapore
• Japan	• China
• EU	• Mexico
	• Hong Kong
	• Korea
EMC Emissions (Radiated, conducted)	
• ICES-003	• EN 300 386-TC
• GR-1089-CORE	• EN50081-1
• 47CFR15	• EN55022
• VCCI V-3/2000.04	• AS/NZS3548, Amendment 1 + 2 1995
• CISPR24	
EMC Immunity	
• GR-1089-CORE	• EN300-386-TC
• CISPR24	• EN55024
• EN50082-2	
Safety	
• CAN/CSA-C22.2 No. 60950-00 Third Ed., 12/1/2002	• UL 60950 Third Ed., 12/1/2000
• GR-1089-CORE	• EN60950 (to A4)
• GR-83-CORE	• IEC60950/EN60950, 3rd Ed.
• TS001	• AS/NZS3260 Supplement 1, 2, 3, 4, 1997
Environmental	
• GR-63-CORE	• ETS 300-019 (Class 3.1E) (Note 2)
• AT&T Network Equipment	
Structural Dynamics	
• GR-63-CORE	• ETS 300-019 (Class 3.1E) (Note 2)
• AT&T Network Equipment	
Power and Grounding	
• SBC (TP76200MP)	• ETS 300-253 (grounding)
• ETS 300-132-1 (DC power)	

Table 1 System Requirements

Component	ONS 15454 SONET	ONS 15454 SDH
Processor	TCC+, TCC2	TCC2
Cross-Connect	XC, XC-VT, XC-10G	XC-10G, XC-VXL-10G, XC-VXL-2.5G
Shelf Assembly	NEBS/NEBS3E/ANSI versions with appropriate fan tray assembly	ETSI version with SDH 48V fan tray assembly
System Software	R4.0.0 or greater	R4.0.0 or greater
Slot Compatibility	XC and XC-VT: slots 5, 6, 12, 13 XC-10G: slots 1 to 6, 12 to 17	XC-10G, XC-VXL-2.5G, XC-VXL-10G: slots 1 to 6, 12 to 17

Table 2 Specifications—ML-Series Cards

Attribute	ML100T-12	ML1000-2
Client Interfaces		
Ports – Card – Shelf (max 12 cards) – Rack (max 4 shelves)	12 RJ-45 Up to 144 Up to 576	2 SFP slots (SX or LX SFP) Up to 24 Up to 96
Speed	10/100 Mbps	1000 Mbps
Auto negotiation of duplex mode	Yes	Yes
Flow control pause	Yes	Yes
SONET/SDH Virtual Interfaces		
Ports	2	2
Speed	SONET: STS-1, -3c, -6c, -9c, -12c, -24c SDH: VC-3, -4, -4-2c, -4-3c, -4-4c, -4-8c	SONET: STS-1, -3c, -6c, -9c, -12c, -24c SDH: VC-3, -4, -4-2c, -4-3c, -4-4c, -4-8c
Maximum Card Bandwidth	SONET: STS-48 SDH: VC-4-16	SONET: STS-48 SDH: VC-4-16
Encapsulation	Cisco HDLC PPP (RFC 2615)/BCP (RFC 2878) LEX	Cisco HDLC PPP (RFC 2615)/BCP (RFC 2878) LEX
Protocols		
Layer 3 Switching	IP switching, static routes, routing information protocol (RIPv2), enhanced interior gateway routing protocol, (EIGRP), open shortest path first (OSPF), border gateway protocol (BGP), intermediate system to intermediate system (ISIS), hot standby routing protocol (HSRP), VPN routing and forwarding (VRF-lite with OSPF, BGP, RIP), quality of service (QoS), IP multicast (PIM-DM, PIM-SM, IGMP, SSM, MSDP, MBGP)	

Table 2 Specifications—ML-Series Cards

Attribute	ML100T-12	ML1000-2
Layer 2 Switching	Ethernet switching and bridging (802.1D), VLAN (802.1Q), priority (802.1p), spanning tree (802.1-D), rapid spanning tree (RSTP, 802.1w), flow control (802.3x), fast EtherChannel (FEC), gigabit EtherChannel (GEC), PoS Channel (PEC), 802.1-Q in 802.1-Q, per VLAN rapid spanning tree (PVRSTP)	
QoS		
Classifiers (ingress—254 classes)	IP Precedence Input interface (port) Bridge group (VLAN) Priority (802.1p) Differentiated service code points (DSCP)	IP Precedence Input interface (port) Bridge group (VLAN) Priority (802.1p) Differentiated service code points (DSCP)
Policing	1 Mbps rate limiting (sustained rate and burst) Single leaky bucket (port) Admission control to prevent over commitment	1 Mbps rate limiting (sustained rate and burst) Single leaky bucket (port) Admission control to prevent over commitment
Queuing	400+ scheduling queues Load and committed bandwidth based buffer control, 4000 packet buffers, tail drop Low latency queues	400+ scheduling queues Load and committed bandwidth based buffer control, 4000 packet buffers, tail drop Low latency queues
Schedulers	Weighted deficit round robin (WDRR)	Weighted deficit round robin (WDRR)
Cisco's Modular QoS CLI	Supported	Supported
Statistics		
Ethernet Ports • Receive	Bytes, packets, unicast packets, multicast packets, broadcast packets, giants, FCS errors, runts, jabber, alignment errors	
• Transmit	Bytes, packets, unicast packets, multicast packets, broadcast packets, giants, collisions	
Virtual ports (POS) • Receive	Pre-HDLC bytes, post HDLC bytes, packets, short, runts, long, CRC errors, input drop packet, input abort packet	
• Transmit	Pre-HDLC bytes, post HDLC bytes, packets, port drop counter	
Security		
Access control list (ACL)	Standard IP on input and output of routed packets Standard IP on input of bridged packets Extended IP for limiting control-plane access 4000 entries per card	

Table 2 Specifications—ML-Series Cards

Attribute	ML100T-12	ML1000-2
Ethernet		
Bridge groups (card)	255	255
Supported 802.1q VLAN Range	1 to 4096	1 to 4096
Hierarchical VLANs (.1q in .1q)	255	255
Spanning tree instances (802.1d)	255	255
per VLAN rapid spanning tree (PVRST) instances	255	255
MTU sizes	64 to 9000 bytes	64 to 9000 bytes
Link Aggregation • Client Interfaces • Virtual Interfaces (PosChannel)	 Fast EtherChannel (max 4 links per group) 2 ports/link or 1 link	 Gigabit Etherchannel (max 2 links per group) 2 ports/link or 1 link
Performance		
Layer 2/Layer 3 Switching	Up to 3.7 Mpps	Up to 3.7 Mpps
Management Interfaces		
Data	Cisco IOS command line interface (CLI) through either console port, Telnet, configured user (client) port or Cisco transport controller (CTC) window SNMP traps	
Transport (SONET/SDH)	Cisco transport controller (CTC) or TL-1 via Telnet or serial port SNMP traps and TL-1 autonomous messages	
ML-Series Card • Console Port	 RJ-11 jack, DCE	 RJ-11 jack, DCE
TCC Card • LAN Access and Cisco Transport Controller • Serial port	 RJ-45 jack, 10BASE-T DB-9 jack	 RJ-45 jack, 10BASE-T DB-9 jack
Security	Multilevel access control, data, and transport planes	
Card LEDs • Failure (FAIL) • Status (ACT) Port LEDs (per port) • Link (LINK) • Activity (ACT)	 Red Green Green Amber (flash)	 Red Green Green Amber (flash)

Table 2 Specifications—ML-Series Cards

Attribute	ML100T-12	ML1000-2
Performance Monitoring		
SONET (Virtual ports))	Path termination device (PTE) The following SONET/SDH path alarms are supported: • Alarm indication signal (AIS) • Loss of pointer (LoP) • Unequipped (UNEQ) • Remote failure indicator (RFI) • Trace identifier mismatch (TIM) • Bit error rate signal fail/signal degrade (SF/SD) Path trace (J1 byte)—Transmit and receive	
SNMP Traps	Spanning Tree Protocol traps: Bridge-MIB (RFC 1493) Authentication trap: RFC 1157 Link-up and Link-down traps for Ethernet ports: IF-MIB (RFC 1573) and SONET/SDH MIB (RFC 2558)	
Power		
Card	53 Watts	49 Watts
Physical		
Size	Single card slot 32.13 H x 1.83 W x 22.86 D (cm) 12.65 H x 0.72 W x 9.00 D (in.)	Single card slot 32.13 H x 1.83 W x 22.86 D (cm) 12.65 H x 0.72 W x 9.00 D (in.)
Weight	1.17 kg 2.59 lbs	1.12 lg 2.48 lbs
Operating environment		
Temperature	–5 to +55°C 23 to +131°F	–5 to +55°C 23 to +131°F
Humidity	5 to 95%, non-condensing	5 to 95%, non-condensing
Storage environment		
Temperature	–40 to +85°C –40 to +185°F	–40 to +85°C –40 to +185°F
Humidity	5 to 95%, non-condensing	5 to 95%, non-condensing

Table 3 Specifications—Small Form Factor Pluggable Gigabit Ethernet Optical Modules

Attribute	SX – Short Reach	LX – Long Reach
Connector	LC—Duplex	LC—Duplex
Nominal wavelength	850 nm	1300 nm
Fiber type	Multimode (MMF)	Single-mode (SMF)
Fiber distance (dispersion limited)	550 m	10 km
Transmit power	–4.0 to –9.5 dBm	–3.0 to –9.5 dBm
Receiver sensitivity	–17.0 dBm	–20.5 dBm

Table 4 Table 4. Ordering Information

Part Number	Description
15454-ML100T-12	10/100 Mbps Ethernet card, 12 ports, RJ-45, L2/L3 switching, SONET/ANSI system, includes console cable
15454E-ML100T-12	10/100 Mbps Ethernet card, 12 ports, RJ-45, L2/L3 switching, SDH/ETSI system, includes console cable
15454-ML1000-2	1000 Mbps Ethernet card, 2 SFP slots, L2/L3 switching, SONET/ANSI system
15454E-ML1000-2	1000 Mbps Ethernet card, 2 SFP slots, L2/L3 switching, SDH/ETSI system
15454-SFP-LC-SX	1000BASE, SX, short-reach, multimode, small form factor pluggable (SFP), LC connectors
15454-SFP-LC-LX	1000BASE, LX, long-reach, single mode, SFP, LC connectors
15454-CONSOLE-02	Cable, console, ML-Series, RJ-11 plug to RJ-45 jack, 22″/55.9cm long, SONET/ANSI system
15454E-CONSOLE-02	Cable, console, ML-Series, RJ-11 plug to RJ-45 jack, 22″/55.9cm long, SDH/ETSI system

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