Overview

This chapter provides an overview of the ML1000-2 and ML100T-12 cards for the ONS 15454 (SONET) and ONS 15454 SDH. It lists Ethernet and SONET/SDH capabilities and Cisco IOS and Cisco Transport Controller (CTC) software features, with brief descriptions of selected features.

This chapter contains the following major sections:

ML-Series Card Description

The ML-Series cards are independent Gigabit Ethernet (ML1000-2) or Fast Ethernet (ML100T-12) Layer 3 switches that process up to 5.7 Mpps. The cards are integrated into the ONS 15454 SONET or the ONS 15454 SDH. An ONS 15454 SONET with a 10-Gigabit Cross-Connect card (XC10G) can host the card in any traffic card slot, but an ONS 15454 SONET with a Cross-Connect card (XC) or Cross Connect Virtual Tributary card (XCVT) can only host the ML-Series card in the four traffic slots. An ONS 15454 SDH can host the card in any traffic card slot with any cross-connect card.

The card ships loaded with Cisco IOS Release 12.1(20)EO, and the Cisco IOS command-line interface (CLI) is the primary user interface for the ML-Series card. Most configuration for the card, such as Ethernet port, bridging, and VLAN, can be done only via the Cisco IOS CLI.

But Cisco Transport Controller (CTC), the ONS 15454 SONET/SDH graphical user interface (GUI), also supports the ML-Series card. SONET/SDH circuits cannot be provisioned through Cisco IOS, but must be configured through CTC (or TL1 on the ONS 15454 SONET). CTC offers ML-Series card status information, SONET/SDH alarm management, Cisco IOS Telnet session initialization, Cisco IOS configuration file management, provisioning, inventory, and other standard functions.

The ML100T-12 features 12 RJ-45 interfaces, and the ML1000-2 features two Small Form Factor Pluggable (SFP) slots supporting short wavelength (SX) and long wavelength (LX) optical modules. The ML100T-12 and the ML1000-2 use the same hardware and software base and offer the same feature sets. For detailed card specifications, refer to the “Ethernet Cards” chapter of the *Cisco ONS 15454 Reference Manual* or the *Cisco ONS 15454 SDH Reference Manual*.

The card features two virtual Packet over SONET/SDH (POS) ports, which function in a manner similar to OC-N card ports. The SONET/SDH circuits are provisioned through CTC in the same manner as standard OC-N card circuits. The ML-Series POS ports supports virtual concatenation (VCAT) of SONET/SDH circuits and a software link capacity adjustment scheme (SW-LCAS).

ML-Series Feature List

This section lists the features of the ML100T-12 and the ML1000-2 cards.

- Layer 1 data features
  - 10/100BASE-TX half-duplex and full-duplex data transmission
  - 1000BASE-SX, 1000BASE-LX full-duplex data transmission
- SONET/SDH features
  - Two POS virtual ports
  - LEX, Cisco high-level data link control (HDLC) or point-to-point protocol/bridging control protocol (PPP/BCP) encapsulation for POS
  - VCAT with SW-LCAS
  - PPP
  - G-Series card compatible (with LEX encapsulation only)
- Layer 2 bridging features
  - Transparent bridging
  - MAC address learning, aging, and switching by hardware
  - Protocol tunneling
  - Multiple Spanning Tree (MST) protocol tunneling
  - 255 active bridge group maximum
  - 60,000 MAC address maximum per card and 8,000 MAC address maximum per bridge group
  - Integrated routing and bridging (IRB)
  - IEEE 802.1P/Q-based VLAN trunking
  - IEEE 802.1Q VLAN tunneling
  - IEEE 802.1D Spanning Tree Protocol (STP) and IEEE 802.1W Rapid Spanning Tree Protocol (RSTP)
  - IEEE 802.1D STP instance per bridge group
  - Resilient packet ring (RPR)
  - Dual RPR Interconnect (DRPRI)
  - Ethernet over Multiprotocol Label Switching (EoMPLS)
  - VLAN-transparent and VLAN-specific services (Ethernet Relay Multipoint Service (ERMS))
- Fast EtherChannel (FEC) features (ML100T-12)
  - Bundling of up to four Fast Ethernet ports
  - Load sharing based on source and destination IP addresses of unicast packets
  - Load sharing for bridge traffic based on MAC addresses
  - IRB
  - IEEE 802.1Q trunking
  - Up to 6 active FEC port channels
- Gigabit EtherChannel (GEC) features (ML1000-2)

  - Bundling the two Gigabit Ethernet ports
  - Load sharing for bridge traffic based on MAC addresses
  - IRB
  - IEEE 802.1Q trunking
- POS channel
  - Bundling the two POS ports
  - LEX encapsulation only
  - IRB
  - IEEE 802.1Q trunking
- Layer 3 routing, switching, and forwarding
  - Default routes
  - IP unicast and multicast forwarding
  - Simple IP access control lists (ACLs) (both Layer 2 and Layer 3 forwarding path)
  - Extended IP ACLs in software (control-plane only)
  - IP and IP multicast routing and switching between Ethernet ports
  - Reverse Path Forwarding (RPF) multicast (not RPF unicast)
  - Load balancing among equal cost paths based on source and destination IP addresses
  - Up to 18,000 IP routes
  - Up to 20,000 IP host entries
  - Up to 40 IP multicast groups
  - IRB routing mode support
- Supported routing protocols
  - Virtual Private Network (VPN) Routing and Forwarding Lite (VRF Lite)
  - Intermediate System-to-Intermediate System (IS-IS) Protocol
  - Routing Information Protocol (RIP and RIP II)
  - Enhanced Interior Gateway Routing Protocol (EIGRP)
  - Open Shortest Path First (OSPF) Protocol
  - Protocol Independent Multicast (PIM)—Sparse, sparse-dense, and dense modes
  - Secondary addressing
  - Static routes
  - Local proxy ARP
  - Border Gateway Protocol (BGP)
  - Classless interdomain routing (CIDR)
- Quality of service (QoS) features
  - Service level agreements (SLAs) with 1-Mbps granularity
  - Input policing
  - Guaranteed bandwidth (weighted round-robin [WDRR] plus strict priority scheduling)
  - Low latency queuing support for unicast Voice over IP (VoIP)

  - Class of service (CoS) based on Layer 2 priority, VLAN ID, Layer 3 Type of Service/DiffServ Code Point (TOS)/(DSCP), and port
  - CoS-based packet statistics
- Additional protocols
  - Cisco Discovery Protocol (CDP) support on Ethernet ports
  - Dynamic Host Configuration Protocol (DHCP) relay
  - Hot Standby Router Protocol (HSRP) over 10/100 Ethernet, Gigabit Ethernet, FEC, GEC, and Bridge Group Virtual Interface (BVI)
  - Internet Control Message Protocol (ICMP)
- Management features
  - Cisco IOS
  - CTC
  - Remote Network Monitoring (RMON)
  - Simple Network Management Protocol (SNMP)
  - Transaction Language 1 (TL1)
- System features
  - NEBS3 compliant
  - Multiple Microcode Images
- CTC features
  - Standard STS/STM and VCAT circuit provisioning for POS virtual ports
  - SONET/SDH alarm reporting for path alarms and other ML-Series card specific alarms
  - Raw port statistics
  - Standard inventory and card management functions
  - J1 Path Trace
  - Cisco IOS CLI Telnet sessions from CTC
  - Cisco IOS startup configuration file management from CTC

Key ML-Series Features

This section describes selected key features and their implementation on the ML-Series card.

Cisco IOS

Cisco IOS controls the data functions of the ML-Series card and comes preloaded on the ONS 15454 SONET/SDH Timing Communications and Control 2 Card (TCC2) card. Users cannot update the ML-Series Cisco IOS image in the same manner as the Cisco IOS system image on a Cisco Catalyst Series. An ML-Series Cisco IOS image upgrade is accomplished only through the ONS 15454 SONET/SDH CTC, and Cisco IOS images for the ML-Series card are available only as part of an

ONS 15454 SONET or SDH software release. This Cisco IOS image is included on the standard ONS 15454 SONET/SDH System Software CD under the package file name M_I.bin and full file name ons15454m-i7-mz. The images are not available for download or shipped separately.

DRPRI

The bridge-group protocol DRPRI is an RPR mechanism that interconnects rings for protection from ONS node failure. The protocol provides two parallel connections of the rings linked by a special instance of RSTP. One connection is the active node and the other is the standby node. During a failure of the active node, link, or card, a proprietary algorithm detects the failure and causes a switchover to the standby node. DRPRI provides a less than 200-msec recovery time for Layer 2 bridged traffic when the ML-Series card uses the enhanced microcode image. The Layer 2 recovery time is up to 12 seconds for other microcode images. The recovery time for Layer 3 unicast and multicast traffic also depends on the convergence time of the routing protocol implemented regardless of the microcode image used.

EoMPLS

EoMPLS provides a tunneling mechanism for Ethernet traffic through an MPLS-enabled Layer 3 core. It encapsulates Ethernet protocol data units (PDUs) inside MPLS packets and using label stacking forwards them across the MPLS network. EoMPLS is an Internet Engineering Task Force (IETF) standard-track protocol based on the Martini draft. EoMPLS allows service providers to offer customers a virtual Ethernet line service or VLAN service using the service provider's existing MPLS backbone.

Link Aggregation (FEC, GEC, and POS)

The ML-Series offers Fast EtherChannel, Gigabit EtherChannel, and POS channel link aggregation. Link aggregation groups multiple ports into a larger logical port and provides resiliency during the failure of any individual ports. The ML-Series supports a maximum of four Ethernet ports in Fast EtherChannel, two Ethernet ports in Gigabit EtherChannel, and two SONET/SDH virtual ports in POS channel. POS channel is only supported with LEX encapsulation.

Traffic flows map to individual ports based on MAC source address (SA)/destination address (DA) for bridged packets and IP SA/DA for routed packets. There is no support for policing or class-based packet priorities when link aggregation is configured.

POS Ports

On the ONS 15454 SONET, ML-Series cards feature two SONET virtual ports with a maximum combined bandwidth of STS-48. Each port carries an STS circuit with a size of STS-1, STS-3c, STS-6c, STS-9c, STS-12c, or STS-24c. For step-by-step instructions on configuring an ML-Series card SONET STS circuit, refer to the “Create Circuits and VT Tunnels” chapter of the *Cisco ONS 15454 Procedure Guide.*

On the ONS 15454 SDH, ML-Series cards feature two SDH virtual ports with a maximum combined bandwidth of VC4-16c. Each port carries an STM circuit with a size of VC3, VC4, VC4-2C, VC4-3C, VC4-4C or VC4-8C. For step-by-step instructions on configuring an ML-Series card SDH STM circuit, refer to the “Create Circuits and Tunnels” chapter of the *Cisco ONS 15454 SDH Procedure Guide.*

RPR

RPR is an emerging network architecture designed for metro fiber ring networks. This new MAC protocol is designed to overcome the limitations of STP, RSTP, and SONET in packet-based networks. RPR convergence times are comparable to SONET and much faster than STP or RSTP. RPR operates at the Layer 2 level and is compatible with Ethernet and protected or unprotected SONET circuits.

RMON

The ML-Series card features remote monitoring (RMON) that allows network operators to monitor the health of the network with a network management system (NMS). The ML-Series card Ethernet interfaces support RMON for statistics, utilization, and history.For general information about using Cisco IOS to manage RMON, refer to the "Configuring RMON Support" chapter of the Cisco IOS Configuration Fundamentals Configuration Guide.

The MIBs supported are:

- RFC-2819—RMON MIB
- RFC-2358—Ether-Like-MIB
- RFC-2233—IF MIB

SNMP

Both the ONS 15454 SONET/SDH and the ML-Series cards have SNMP agents and support SNMP Version 1 (SNMPv1) and SNMP Version 2c (SNMPv2c) sets and traps. The ONS 15454 SONET/SDH accepts, validates, and forwards get/getNext/set requests to the ML-Series through a proxy agent. The ML-Series requests contain the slot identification of the ML-Series card to distinguish the request from a general ONS 15454 SNMP request. Responses from the ML-Series are relayed by the ONS 15454 to the requesting SNMP agents.

The ML-Series card SNMP support includes:

- Spanning Tree Protocol (STP) traps from Bridge-MIB (RFC 1493)
- Authentication traps from RFC 1157
- Link-up and link-down traps for Ethernet ports from IF-MIB (RFC 1573)
- Export of QoS statistics through the CISCO-PORT-QOS-MIB extension

1 The ML-Series card CISCO-PORT-QOS-MIB extension includes support for COS-based QoS indexing. It does not support configuration objects.

For more information on how the ONS 15454 or ONS 15454 SDH implements SNMP, refer to the "SNMP" chapter of the *Cisco ONS 15454 Reference Manual* or the *Cisco ONS 15454 SDH Reference Manual*. For more information on specific MIBs, refer to the Cisco SNMP Object Navigator at http://www.cisco.com/pcgi-bin/Support/Mibbrowser/unity.pl.

SONET/SDH Alarms

On the ONS 15454 SONET, the ML-Series card reports Telcordia GR-253 SONET alarms in the Alarms panel of CTC and in the Cisco IOS CLI. The card reports SONET Path alarms, including path alarm indication signal (AIS-P), path loss of pointer (LOP-P), path unequipped (UNEQ-P), path remote

fault indication (RFI-P), path trace identifier mismatch (TIM-P), path payload level mismatch (PLM-P), path payload defect indication (PDI-P), bit eror rate-signal failure (BER-SF-B3), and bit error rate-signal degrade (BER-SD-B3). It also reports other alarms, including BPU/COM Fail, Board Fail, port link-down, and no-config. The ML-Series also supports path trace, path, and raw port statistics on CTC. For more information on alarms and alarm definitions, refer to the "Alarm Troubleshooting" chapter of the *Cisco ONS 15454 Troubleshooting Guide* and the "Manage Alarms" chapter of the *Cisco ONS 15454 Procedure Guide*.

On the ONS 15454 SDH, the ML-Series card reports SDH alarms on the Alarms panel of CTC and other alarms, including BPU/COM Fail, Board Fail, port link-down, and no-config. The ML-Series also supports path trace, path, and raw port statistics on CTC. For more information on alarms, refer to the "Alarm Troubleshooting" chapter of the *Cisco ONS 15454 SDH Troubleshooting Guide* and the "Manage Alarms" chapter of the *Cisco ONS 15454 SDH Procedure Guide*.

SONET/SDH Port Encapsulation (HDLC, PPP/BCP, and LEX)

The ML-Series supports three forms of SONET/SDH port encapsulation: Cisco HDLC, PPP/BCP, and LEX. Cisco HDLC is standard on most Cisco data devices. It does not offer VLAN trunking support. PPP/BCP is a popular standard linked to RFC 2878. It supports VLAN trunking via BCP. LEX is a protocol used by the G-Series cards. This protocol supports VLAN trunking and is based on PPP over HDLC.

The SONET/SDH port encapsulation allows the ML-Series to connect to the OC-N ports of switches and routers supporting POS, as well as the G-Series Ethernet cards on the ONS 15454 SONET, ONS 15454 SDH, and ONS 15327. All three formats support bridging and routing, standard SONET/SDH payload scrambling, and HDLC frame check sequence.

SW-LCAS

LCAS increases VCAT flexibility by allowing the dynamic reconfiguration of VCAT groups without interrupting the operation of non-involved members. SW-LCAS is the software implementation of a LCAS-type feature. SW-LCAS differs from LCAS because it is not errorless and uses a different handshaking mechanism. SW-LCAS on the ML-Series card allows the automatic addition or removal of a VCAT group member in the event of a failure or recovery on two-fiber BLSR. The protection mechanism software operates based on ML-Series card link events. SW-LCAS allows service providers to configure VCAT member circuits on the ML-Series as protection channel access (PCA). This PCA traffic is dropped in the event of a protection switch, but is suitable for excess or noncommited traffic and can double total available bandwidth on the circuit.

For step-by-step instructions on configuring SW-LCAS, refer to the "Create Circuits and VT Tunnels" chapter of the *Cisco ONS 15454 Procedure Guide* or the "Create Circuits and Tunnels" chapter of the *Cisco ONS 15454 SDH Procedure Guide.* For more general information on SW-LCAS, refer to the "Circuits and Tunnels" chapter of the *Cisco ONS 15454 Reference Manual* or the *Cisco ONS 15454 SDH Reference Manual.*

TL1

For the ONS 15454 SONET, the TL1 on the ML-Series card can be used for card inventory, fault or alarm management, card provisioning, and retrieval of status information for both data and SONET ports. TL1 can also be used to provision SONET STS circuits and transfer a Cisco IOS startup configuration file to the TCC2 card memory. For specific TL1 commands and general TL1 information, refer to the *Cisco ONS 15454 and Cisco ONS 15327 TL1 Command Guide*.

Note TL1 is not available on the ONS 15454 SDH system.

VCAT

VCAT significantly improves the efficiency of data transport by grouping the synchronous payload envelopes (SPEs) of SONET/SDH frames in a nonconsecutive manner into VCAT groups. VCAT group circuit bandwidth is divided into smaller circuits called VCAT members. The individual members act as independent circuits. Intermediate nodes treat the VCAT members as normal circuits that are independently routed and protected by the SONET/SDH network. At the terminating nodes, these member circuits are multiplexed into a contiguous stream of data. VCAT avoids the SONET/SDH bandwidth fragmentation problem and allows finer granularity for provisioning of bandwidth services.

In Software Release 4.6, a VCAT circuit originating from an ML-Series card must terminate on another ML-Series card. The VCAT circuit must also be routed over common fiber and be both bidirectional and symmetric. The ML-Series card supports a maximum of two VCAT groups, with each group corresponding to one of the POS ports. Each VCAT group can contain two circuit members. On the ONS 15454 SONET, an ML-Series card supports STS-1c-2v, STS-3c-2v and STS-12c-2v. On the ONS 15454 SDH platform, an ML-Series card supports VC-3-2v, VC-4-2v and VC-4-4c-2v.

VCAT circuits are provisioned through CTC, TL1, or Cisco Transport Manager (CTM). The Cisco IOS CLI is not used. For step-by-step instructions on configuring an ML-Series card SONET VCAT circuit, refer to the "Create Circuits and VT Tunnels" chapter of the *Cisco ONS 15454 Procedure Guide.* For step-by-step instructions on configuring an ML-Series card SDH VCAT circuit, refer to the "Create Circuits and Tunnels" chapter of the *Cisco ONS 15454 SDH Procedure Guide.* For more general information on VCAT circuits, refer to the "Circuits and Tunnels" chapter of the *Cisco ONS 15454 Reference Manual* or the *Cisco ONS 15454 SDH Reference Manual.*

Note ML-Series cards purchased prior to Software Release 4.6 need to have the FPGA image upgraded to support the 4.6 VCAT circuit feature. If a non-upgraded ML-Series card is used with Software Release 4.6, non-VCAT features will function normally, but a message will appear in the Cisco IOS CLI warning the user that the VCAT feature will not function with the current FPGA image. An upgraded FPGA image is compatible with all earlier versions of ML-Series card IOS software. Customers should contact TAC for instructions on performing the FPGA image upgrade, see "Obtaining Technical Assistance" section on page xxiii for more information.

Note ML-Series card POS interfaces normally send PDI-P to the far-end when the POS link goes down or RPR wraps. ML-Series card POS interfaces do not send PDI-P to the far-end when PDI-P is detected, when RDI-P is being sent to the far-end or when the only defects detected are GFP LFD, GFP CSF, VCAT LOM or VCAT SQM.

VRF Lite

VPN Routing/Forwarding Lite (VRF Lite) is an ML-Series card-specific implementation of a VPN routing/forwarding instance (VRF). Unlike standard VRF, VRF Lite does not contain Multi-Protocol internal BGP (MP-iBGP).

Standard VRF is an extension of IP routing that provides multiple routing instances and separate IP routing and forwarding tables for each VPN. VRF is used in concert with internal MP-iBGP. MP-iBGP distributes the VRF information between routers to provide Layer 3 MPLS-VPN.

VRF Lite stores VRF information locally and does not distribute the VRF information to connected equipment. VRF information directs traffic to the correct interfaces and subinterfaces when the traffic is received from customer routers or from service provider router(s).

VRF Lite allows an ML-Series card, acting as customer equipment, to have multiple interfaces and subinterfaces with service provider equipment. The customer ML-Series card can then service multiple customers. Normal customer equipment serves a single customer.

Ethernet Clocking Versus SONET/SDH Clocking

Ethernet clocking is asynchronous. IEEE 802.3 clock tolerance allows some links in a network to be as much as 200 ppm (parts or bits per million) slower than other links (0.02%). A traffic stream sourced at line rate on one link may traverse other links which are 0.02% slower. A fast source clock, or slow intermediate clocks, may limit the end-to-end thoughput to only 99.98% of the source link rate.

Traditionally, Ethernet is a shared media that is under utilized except for brief bursts which may combine from multiple devices to exceed line-rate at an aggegration point. Due to this utilization model, the asynchronous clocking of Ethernet has been acceptable. Some Service Providers accustomed to loss-less TDM transport may find the 99.98% throughput guarantee of Ethernet surprising.

Clocking enhancements of ML-Series and G-Series cards ensure Ethernet transmit rates that are at worst 50 ppm slower than the fastest compliant source clock, ensuring a worst-case clocking loss of 50 ppm - a 99.995% throughput guarantee. In many cases, the ML-Series or G-Series clock will be faster than the source traffic clock, and line-rate traffic transport will have zero loss. Actual results will depend on clock variation of the traffic source transmitter.