Cisco ONS 15454 Product Overview

Introduction

The Cisco ONS 15454 provides efficient bandwidth delivery and management in fiber-optic transport networks. It is a flexible, SONET add/drop multiplexer that offers service aggregation and high-bandwidth transport of voice and data traffic on a single platform. The ONS 15454 allows users to easily manage services and quickly increase capacity without disrupting service.

Figure 1   Cisco ONS 15454

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The ONS 15454 is a NEBS-compliant shelf assembly that contains 17 card (module) slots, a backplane interface, a fan tray, a front panel with an LCD, and alarm indicators. The ONS 15454 carries traditional time-division multiplexing (TDM) and high-speed data traffic—a variety of card configurations offer incremental bandwidth increases as needed and support EC-1, DS-1, DS-3, OC-3, OC-12, OC-48, OC-192, and 10/100/1000 Ethernet and Gigabit Ethernet speeds.

Workstations can connect to the ONS 15454 using direct, network (LAN and WAN), or DCC connections. The ONS 15454 supports TL1 and Cisco Transport Controller (CTC). CTC, the ONS 15454 software interface, provides easy card, node, and network-level provisioning and troubleshooting. The ONS 15454 deploys a variety of network configurations, including point-to-point systems or linear add-drop multiplexers (ADMs), unidirectional path switched rings (UPSRs), two-fiber and four-fiber bidirectional line switched rings (BLSRs), subtending rings, and path-protected mesh networks (PPMNs). The ONS 15454 can be combined with the Cisco ONS 15327 in several network configurations.

Card Slots and Types

The ONS 15454 has 17 card slots numbered 1–17. All slots are card-ready—when you plug in a card it automatically boots up and becomes ready for service. The cards offer bandwidth in modular increments, making it efficient to deploy the system in low-density applications and add bandwidth as needed. The ONS 15454 houses five types of cards: Common Control, Alarm Interface Controller (AIC), Electrical, Optical, and Ethernet. The common control cards include the TCC+ and the cross-connect cards (XC, XCVT, and XC10G).

TCC+ Card

The TCC+ houses the central intelligence of the ONS 15454, including the ONS 15454 OAM&P software interface (CTC).

Figure 2   TCC+ card faceplate
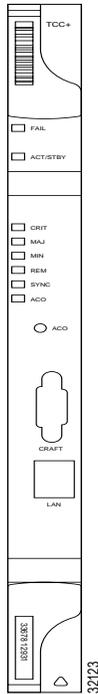
As the main processing center of the ONS 15454, the TCC+ combines timing, control, and switching functions:

- System initialization
- Provisioning
- Alarm reporting
- Maintenance
- Diagnostics

- IP address detection and resolution

- Timing

- SONET data communications channel (DCC) termination

- System fault detection

The CRIT, MAJ, MIN, and REM alarm LEDs on the TCC+ faceplate indicate whether a Critical, Major, Minor, or Remote alarm is present anywhere on the ONS 15454 or on a remote node in the network.

In-Service Software Upgrade

The node name, configuration database, IP address, and system software (CTC) are stored in the TCC+ card's non-volatile memory, which allows quick recovery if power or card failures occur. You can upgrade system software without affecting traffic on the ONS 15454 if dual TCC+ cards are used. The upgrade takes place first on the standby TCC+ card. The system verifies that the upgrade is successful and switches from the active TCC+ card running the older release to the upgraded standby TCC+ card running the newer release. After the switch, the second TCC+ card undergoes the upgrade. The TCC+ then loads new software to each of the installed line (traffic) cards.

Database Revert

The increased memory of the TCC+ allows it to store and revert to the previous configuration database. After a software upgrade, the TCC+ copies the current working database and saves it in a reserved location in the TCC+ flash memory. If you later need to revert to the original working software load, the saved database will activate automatically when you initiate the revert process. There is no need to restore the database manually.

XC, XCVT, and XC10G Cards

The cross-connect card is the central switching element in the ONS 15454. The ONS 15454 offers three cross-connect cards: the XC, XCVT, and XC10G. You provision cross-connect (circuit) information using CTC or TL1; the TCC+ then establishes the proper internal cross-connect information and relays the setup information to the cross-connect card.

Note For protection purposes, Cisco recommends duplex operation. Duplex cross-connect cards must be the same type (e.g. two XCs, two XCVTs, or two XC10Gs).

XC Card

The XC card establishes connections and performs time division switching (TDS) at the STS-1 level between ONS 15454 traffic cards.

The switch matrix on the XC card consists of 144 STS-1 bidirectional ports. Network operators can concentrate or groom low-speed traffic from line (traffic) cards onto high-speed transport spans and to drop low-speed traffic from transport spans onto line cards.

XCVT Card

The XCVT card provides the same STS capability as a standard XC card but adds VT1.5 cross-connect capability.

The switch matrix on the XCVT card consists of 144 STS-1 bidirectional ports and adds a VT matrix that can manage up to 336 bidirectional VT1.5s. The VT1.5-level signals can be cross connected, dropped, or rearranged.

XC10G Card

The XC10G card supports STS-192 signal rates. The switch matrix on the XC10G consists of 576 STS-1 bidirectional ports and its VT matrix can manage up to 336 bidirectional VT1.5s. The XC10G is required to operate the OC-192 card or the OC-48 any-slot cards.

Figure 3   XC10G faceplate

AIC Card

The optional Alarm Interface Controller (AIC) card provides user-provisionable alarm capability and supports local and express orderwire. Nodes without an AIC card can pass the orderwire through to other nodes in the same topology.

Figure 4   AIC card faceplate
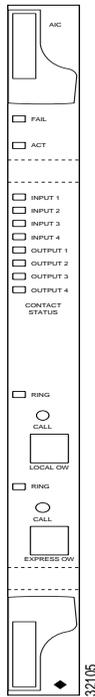
The AIC card provides input/output alarm contacts for user-defined alarms. You can define up to four external alarms and four external controls using the backplane wire-wrap field to make the physical connections.

Electrical Cards

Slots 1–6 and 12–17 host any electrical card. Each card has faceplate LEDs showing active, standby, or alarm status, and you can also obtain the status of all electrical card ports using the LCD screen on the ONS 15454 fan-tray assembly.

Electrical cards (EC-1, DS-1, DS-3, DS3E, and DS3XM) require electrical interface assemblies (EIAs) to provide the cable connection points for the shelf assembly. In most cases, EIAs are ordered with the ONS 15454 and come pre-installed on the backplane. BNC, High-Density BNC, AMP Champ, and SMB are the four types of EIAs that work with the ONS 15454.

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> **Note** Optical cards and Ethernet cards have faceplate rather than backplane connections. E1000-2, E1000-2-G, and G1000-4 (Ethernet) cards require gigabit interface converters (GBICs) that plug into the card faceplate.

EC1-12 Card

The EC1-12 card provides 12 Telcordia-compliant, GR-253 STS-1 ports per card. Each port operates at 51.840 Mbps over a single 75 ohm 728A or equivalent coaxial span.

The EC1-12 terminates the twelve selected working STS-1 signals from the backplane. The EC1-12 maps each of the twelve received EC1 signals into 12 STS-1s with visibility into the SONET path overhead.

DS1-14 and DS1N-14 Cards

The DS1-14 card provides 14 Telcordia-compliant, GR-499 DS-1 ports. Each port operates at 1.544 Mbps over a 100 ohm twisted pair copper cable. The DS1-14 card can function as a working or protect card in 1:1 protection schemes and as a working card in 1:N protection schemes. The DS1N-14 card is identical to the DS1-14 and can also operate as a protect card in a 1:N protection group.

The traffic from an entire DS1-14 card can be grouped and mapped to a single STS-1. Individual DS-1 ports can be mapped to a VT1.5.

DS3-12 and DS3N-12 Cards

The DS3-12 card provides 12 Telcordia-compliant, GR-499 DS-3 ports per card. Each port operates at 44.736 Mbps over a single 75 ohm 728A or equivalent coaxial span. The DS3-12 card operates as a working or protect card in 1:1 protection schemes and as a working card in 1:N protection scheme. The DS3N-12 card is identical to the DS3-12 and operates as a protect card in a 1:N protection group.

DS3-12E and DS3N-12E Cards

The twelve-port DS3-12E and DS3N-12E cards provide enhanced performance monitoring functions. By monitoring additional overhead in the DS-3 frame, subtle network degradations are detected.

Figure 5   DS3-12E card faceplate
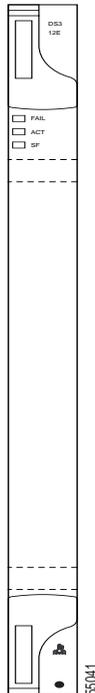
The DS3N-12E can operate as the protect card in a 1:N protection group. The DS3-12E card can only function as the protect card for one other DS3-12E card. If Software Release 3.0 or higher is used, the card uses all enhanced performance monitoring functions. With software prior to Release 3.0, the card operates with the same functions as the older DS-3 card.

With Software R3.1, R3.2, and R3.3 you can perform an in-service upgrade from the DS3-12/DS3N-12 card to the DS3-12E/DS3N-12E card to take advantage of enhanced PM functions without disrupting service.

DS3XM-6 Card

The DS3XM-6 card, commonly referred to as a transmux card, provides six Telcordia-compliant, GR-499-CORE M13 multiplexing functions. The DS3XM-6 converts six framed DS-3 network connections to 28x6 or 168 VT1.5s.

Optical Cards

The optical cards, with the exception of the original OC-48s and the OC-192, reside in Slots 1– 6 and 12 – 17. The OC-48 and OC-192 cards reside in Slots 5, 6, 12, and 13. OC-48 Any Slot cards can reside in the same slots as all other optical cards. You can provision an optical card as a drop card or span card in a linear ADM (1+1), UPSR, or BLSR protection scheme.

Each card faceplate has three card-level LED indicators. When illuminated, the red FAIL LED represents a hardware problem, the amber SF LED represents a signal failure or condition (for example, a loss of frame or a high bit error rate), and the green ACT LED indicates that the card is operational.

ONS 15454 optical cards have SC fiber connectors on the card faceplate.

OC3 IR 4 1310 Card

The OC3 IR 4 1310 card provides four intermediate- or short-range, Telcordia-compliant, GR-253 SONET OC-3 ports. The port operates at 155.52 Mbps over a single-mode fiber span. Each card supports VT and non-concatenated or concatenated payloads at the STS-1 or STS-3c signal levels. The OC-3 card provides port-to-port protection.

OC12 IR 1310 Card

The OC12 IR 1310 card provides one intermediate- or short-range, Telcordia-compliant, GR-253 SONET OC-12 port. The port operates at 622.08 Mbps over a single-mode fiber span and supports VT and non-concatenated or concatenated payloads at STS-1, STS-3c, STS-6c, or STS-12c signal levels.

OC12 LR 1310 Card

The OC12 LR 1310 card provides one long-range, Telcordia-compliant, GR-253 SONET OC-12 port per card. The port operates at 622.08 Mbps over a single-mode fiber span. The card supports VT and non-concatenated or concatenated payloads at STS-1, STS-3c, STS-6c, or STS-12c signal levels.

OC12 LR 1550 Card

The OC12 LR 1550 card provides one long-range, Telcordia-compliant, GR-253 SONET OC-12 port per card. The port operates at 622.08 Mbps over a single-mode fiber span. The card supports VT and non-concatenated or concatenated payloads at STS-1, STS-3c, STS-6c, or STS-12c signal levels.

OC12 IR/STM4-4 1310 Card

The OC12 IR/STM4-4 1310 card provides four intermediate- or short-range, Telcordia-compliant, GR-253 SONET/SDH OC-12 ports per card. Each port operates at 622.08 Mbps over a single-mode fiber span. The card supports VT and non-concatenated or concatenated payloads at the STS-1, STS-3c, STS-6c, or STS-12c signal levels.

OC48 IR 1310 Card

The OC48 IR 1310 card provides one intermediate-range, Telcordia-compliant, GR-253 SONET OC-48 port per card. The port operates at 2.49 Gbps over a single-mode fiber span. The card supports VT and non-concatenated or concatenated payloads at STS-1, STS-3c, STS-6c, STS-12c, or STS-48c signal levels.

OC48 IR/STM16 SH AS 1310 Card

The OC48 IR/SMT16 SH AS 1310 card provides the same capability as the OC48 IR 1310 card but can be installed in any traffic slot. The OC48 IR 1310 card is restricted to slots 5, 6, 12, and 13.

OC48 LR 1550 Card

The OC48 LR 1550 card provides one long-range, Telcordia-compliant, GR-253 SONET OC-48 port per card. The port operates at 2.49 Gbps over a single-mode fiber span. The card supports VT and non-concatenated or concatenated payloads at STS-1, STS-3c, STS-6c, STS-12c, or STS-48c signal levels.

OC48 LR/STM16 LH AS 1550 Card

The OC48 IR/SMT16 SH AS 1550 card provides the same capability as the OC48 LR 1550 card but can be installed in any traffic slot. The OC48 LR 1550 card is restricted to slots 5, 6, 12, and 13.

OC48 ELR 200 GHz DWDM Cards

Eighteen distinct OC48 ITU 200GHz dense wavelength division multiplexing (DWDM) cards provide the ONS 15454 DWDM channel plan. Each OC-48 DWDM card provides one Telcordia-compliant, GR-253 SONET OC-48 port. The port operates at 2.49 Gbps over a single-mode fiber span. The card supports VT and concatenated or non-concatenated payloads at STS-1, STS-3c, STS-6c, STS-12c, or STS-48c signal levels.

Nine of the cards operate in the blue band with spacing of 200 GHz on the ITU grid. The other nine cards operate in the red band with spacing of 200 GHz on the ITU grid. These cards are also designed to interoperate with the Cisco ONS 15216 DWDM solution.

OC48 ELR/STM16 EH 100 GHz DWDM Cards

Thirty-seven distinct OC48 ITU 100GHz dense wavelength division multiplexing (DWDM) cards provide the ONS 15454 DWDM channel plan. Each OC-48 DWDM card has one Telcordia-compliant, GR-253 SONET OC-48/SDH STM-16 ITU-T G.692 and ITU-T G.958 port. The port operates at 2.49 Gbps over a single-mode fiber span. The card supports VT and concatenated or non-concatenated payloads at STS-1, STS-3c, STS-6c, STS-12c, or STS-48c signal levels.

Nineteen of the cards operate in the blue band with spacing of 100 GHz on the ITU grid. The other eighteen cards operate in the red band with spacing of 100 GHz on the ITU grid.

OC192 LR/STM64 LH 1550 Card

The OC192 LR/STM64 LH 1550 card provides one long-range, Telcordia-compliant, GR-253 SONET OC-192 port per card. The port operates at 9.95 Gbps over a single-mode fiber span. The card supports VT and non-concatenated or concatenated payloads at STS-1, STS-3c, STS-6c, STS-12c, STS-48c, or STS-192c signal levels.

Figure 6   OC-192 card faceplate
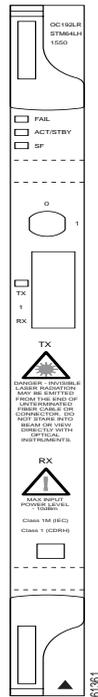
Ethernet Cards

The Ethernet cards eliminate the need for external Ethernet aggregation equipment and provide efficient transport and co-existence of traditional TDM traffic with packet-switched data traffic. Multiple Ethernet cards installed in an ONS 15454 can act as a single switch (EtherSwitch) supporting a variety of SONET port configurations.

E100T-12/E100T-G Card

The ONS 15454 uses E100T-12/ E100T-G cards for Ethernet (10 Mbps) and Fast Ethernet (100 Mbps). Each card provides twelve switched, IEEE 802.3-compliant, 10/100 Base-T Ethernet interfaces that can independently detect the speed of an attached device (auto-sense) and automatically connect at the appropriate speed. The ports auto-configure to operate at either half or full duplex and can determine whether to enable or disable flow control. You can also configure Ethernet ports manually.

The E100T-G card operates with the XC, XCVT, and XC10G cross-connect cards. The E100T-12 operates with the XC or XCVT; it is incompatible with the XC10G.

E1000-2/E1000-2-G Card

The ONS 15454 uses the E1000-2 and E1000-2-G cards for Gigabit Ethernet (1000 Mbps).They provide two ports of IEEE-compliant, 1000 Mbps interfaces for high-capacity customer LAN interconnections. Each interface supports full-duplex operation.

The E1000-2-G card operates with the XC, XCVT, and XC10G cross-connect cards. The E1000-2 operates with the XC and XCVT; it is incompatible with the XC10G.

The E1000-2 and E1000-2-G cards use gigabit interface converter (GBIC) modular receptacles for the optical interfaces. GBICs are hot-swappable input/output devices that plug into a Gigabit Ethernet port to link the port with the fiber-optic network. Cisco provides two GBIC models: one for short reach applications and one for long-reach applications. The short reach model connects to multimode fiber and the long reach model requires single-mode fiber.

Figure 7   Gigabit interface converter


Receiver   Transmitter
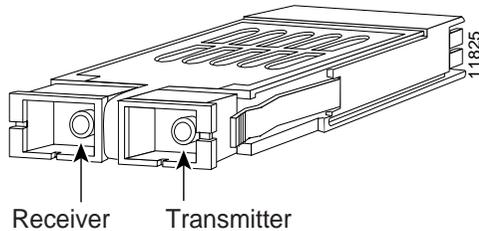
G1000-4 Card

Like the E1000-2 and E1000-2-G cards, the G1000-4 card provides IEEE-compliant, 1000 Mbps ports for full-duplex operation and requires a GBIC as its optical interface. However, the G1000-4 has four ports rather than two and requires the XC10G as its cross-connect card. The additional ports give the ONS 15454 a practical limit of 40 Gigabit Ethernet ports per node. The G1000-4 operates on layer 1 and is used only for point-to-point circuits. OC-48 is the maximum bandwidth on each G1000-4 card.

Card Protection

The ONS 15454 provides 1:1 and 1:N electrical protection and 1+1 optical protection methods. This section describes the protection options and explains protection switching in the ONS 15454. For a description of Ethernet protection, see the "Spanning Tree Protocol" section on page 32.

Figure 8   1:1 electrical card protection in the ONS 15454
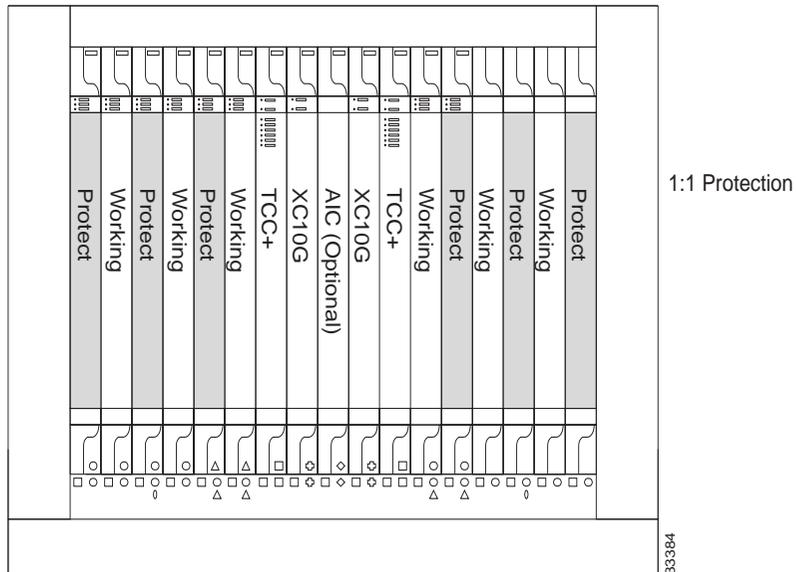
Electrical Protection

1:N protection allows a single card to protect several working cards. A DS1N-14 card provides protection for up to five DS1-14 cards, and a DS3N-12/DS3N-12E card protects up to five DS3-12/DS3-12E cards. The standard DS1-14 card and DS3-12 card provide 1:1 protection only.

1:N protection operates only at the DS-1 and DS-3 levels. The 1:N protect cards must match the levels of their working cards. For example, a DS1N-14 protects only DS1-14 or other DS1N-14 cards, and a DS3N-12 protects only DS3-12 or other DS3N-12 cards. 1:N cards have added circuitry to act as the protection card in a 1:N protection group. Otherwise, the card is identical to the standard card and can serve as a normal working card. 1:1 and 1:N protection in the ONS 15454 supports revertive and non-revertive switching.

Optical Protection

The ONS 15454 supports 1+1 protection to create redundancy for optical cards and spans. With 1+1 protection, one optical port can protect another optical port; therefore, in any two high-speed slots a single working card and a single dedicated protect card of the same type (for example, two OC-48 cards) can be paired for protection. If the working port fails, the protect port takes over. 1+1 span protection can be either revertive or non-revertive.

Because the OC-3 card is a multiport card, port-to-port protection is available. The ports on the protect card support the corresponding ports on the working card.

Protection Switching

The ONS 15454 supports revertive and non-revertive, unidirectional or bidirectional switching for optical signals. 1:N electrical protection is always revertive and bidirectional; 1:1 electrical protection is also bidirectional but provides the revertive or non-revertive option.

When a failure occurs and automatic protection switching (APS) switches the signal from the working card to the protect card, non-revertive switching does not revert the traffic to the working card automatically when the working card reverts to active status. When a failure is cleared, revertive switching automatically switches the signal back to the working card after the provisionable revertive time period has elapsed.

When a failure occurs to a signal that is provisioned as bidirectional, both the transmit and receive signals are switched away from the point of failure (the port or card). A unidirectional signal switches only the failure direction, either transmit or receive.

Cisco Transport Controller

Cisco Transport Controller (CTC) is a software program that is automatically downloaded from the TCC+ card to your workstation when you connect to the ONS 15454. CTC gives you control of Operation, Administration, Maintenance, and Provisioning (OAM&P) activities for the ONS 15454.

Graphical User Interface

The CTC graphical user interface (GUI), also called the CTC window, provides three primary views, or modes, that include:

- Network view—Provides information about the ONS 15454 network and displays a graphic of the United States with ONS 15454 nodes represented by colored icons. The color of the icon represents the node status, and you can perform network management tasks or display any node. See the "Customized Network View" section on page 20 for information about changing the default network map and adding domains.

- Node view—Provides information about the node and displays a graphic of the ONS 15454 shelf. This is the default view displayed each time you log into CTC, and you perform node management tasks in this view. The cards are color-coded to show the status of the physical cards and ports.

- Card view—Provides information about individual ONS 15454 cards and displays a graphic of the selected card. You perform card and port-specific maintenance tasks in this view. The information that displays and the tasks you can perform depend on the card.

Figure 9   CTC GUI (window) in node view
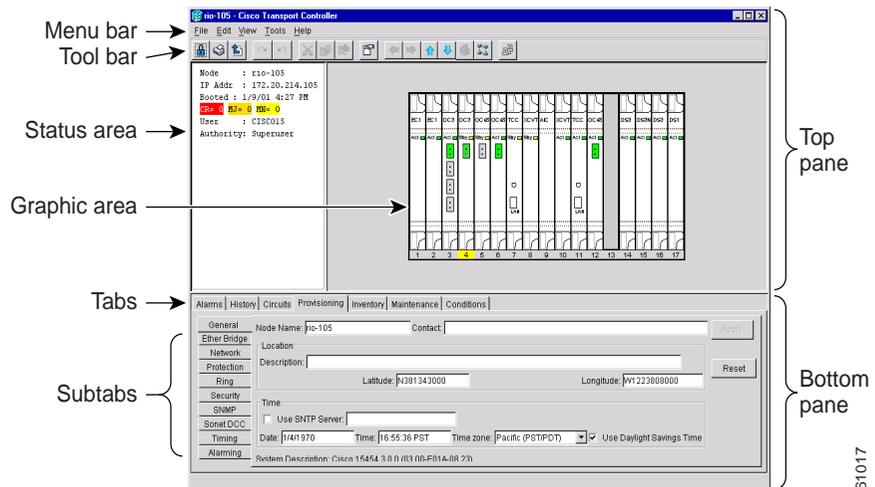
The CTC GUI displays tabs and subtabs. From the tabs you can perform all the OAM&P tasks, such as provisioning cards, circuits, and rings; creating protection groups; setting timing parameters; viewing and clearing alarms; provisioning DCCs; backing up and restoring the database; and troubleshooting, including creating diagnostic files and performing loopbacks.

Proxy Server Features

The proxy server feature set allows CTC to access ONS 15454s while restricting unauthorized IP connectivity. It can also be used to reduce the amount of network provisioning required for external routers and CTC workstations.

The proxy server feature set consists of the following:

- ARP sniffing—Also known as automatic host detection, this feature allows a CTC workstation on a different subnet than the target ONS 15454 to directly connect and launch CTC.

- Proxy server—When this feature is enabled, one ONS 15454 will act like a as a network proxy for other DCC-connected nodes that do not have direct IP connectivity.

- Firewall—When this feature is enabled, certain IP communications are restricted between an ONS 15454's SDCC channels and the TCC+ card's Ethernet port. This prevents CTC workstations from using the ONS 15454's SDCC communication path to access other workstations on the data communications network.

Password Security

CTC employs password complexity rules to enhance login security, including the following rules:

- The user ID and password cannot be identical, nor can the password contain the user ID sequence of characters.

- Newly created passwords must comply with Telcordia GR-815, which requires that passwords be at least 6 characters long, and contain at least one alphabetic character, one numeric character, and one special character (+, #, or %). CTC will display a warning for previously created passwords that do not meet these requirements but permits the user to continue.

Customized Network View

With CTC you can install a custom map for the network view. The map can be any map you choose, such as a regional map (Figure 10) or even a street map. You can drag and drop nodes to move their location on the map.

To further customize the CTC network view, you can create domains that manage the display of multiple nodes on the network map. Domains appear as a cloud on the network view. A single domain can have any number of nodes, and you can drill into the domain and display or log into any node.

Figure 10   Customized network topology map

Circuit Provisioning and Management

CTC enables automated circuit provisioning across ONS 15454 networks and between ONS 15454s and ONS 15327s, including STS and VT1.5 circuits and VT tunnels, as well as multiple drop and monitor circuits. From the CTC GUI, select a source and destination ONS 15454 or ONS 15327 to create an end-to-end circuit.

CTC automatically calculates a circuit path between the source and destination. You select the circuit type, circuit size, bidirectional or unidirectional status, and path-protection or protected drops restrictions. You can also route circuits manually, for example, to force traffic onto a particular path. See the "Ethernet Circuits" section on page 34 for a description of Ethernet circuits.

Figure 11   Creating circuits with the CTC Circuit Creation dialog box
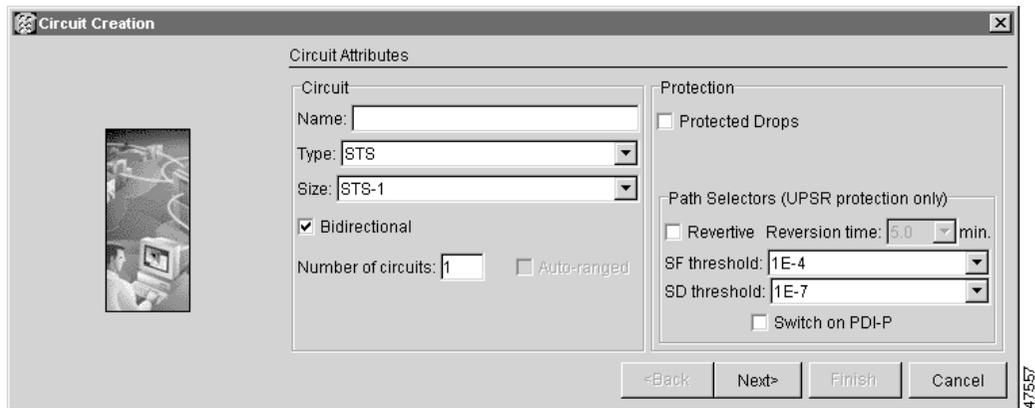
Auto Range

CTC provides an auto-range feature that automatically creates sequential circuits, which prevents you from needing to individually build circuits of the same type. Specify the number of circuits you need, create one circuit, and CTC automatically creates additional sequential circuits.

Detailed Circuit Map

The detailed circuit map provides an end-to-end view of circuits rather than simply nodes and their spans. Specifically the circuit map shows ports, drops, spans, and selectors for UPSR circuits.

Figure 12   Detailed circuit map
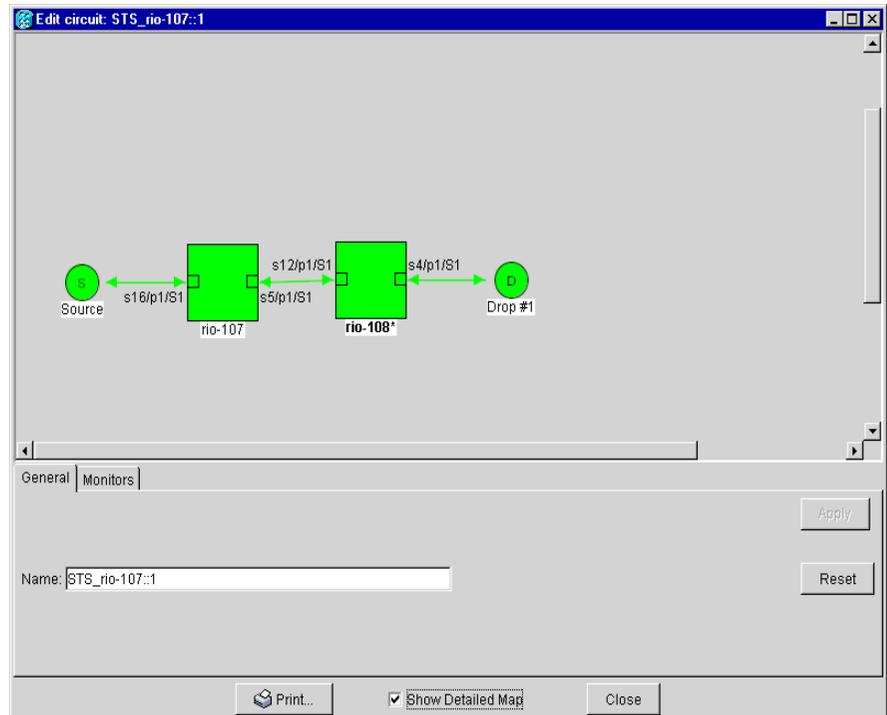
Performance Monitoring

CTC displays section, line, and path performance monitoring for optical, electrical, and Ethernet statistics, as defined in GR-253-CORE and GR-820-CORE. For each statistic, you can display 31 previous 15-minute intervals and the current 15-minute interval, as well as the previous 24-hour and current 24-hour interval.

The *Cisco ONS 15454 Reference Guide*, *Release 3.3*, provides detailed performance monitoring information for each card.

Login Options

The ONS 15454 offers network management flexibility. You can choose to see the login node, nodes with DCC-connectivity to the login node, and nodes that are not DCC-connected to the node.

DCC Connectivity

The ONS 15454 uses SONET data communication channels (SDCCs) for CTC connectivity, automated circuit provisioning, and alarm reporting from remote nodes. Using a node's SDCC, CTC automatically finds and recognizes other ONS 15454s. However, during login you can choose to exclude DCC-connected nodes from auto-discovery, which speeds up login time and reduces clutter on the network map.

Login Node Groups

When you log into an ONS 15454 node, only ONS 15454s with DCC connectivity to the node are autodiscovered and displayed in network view. However, you can create a login node group to view and manage ONS 15454s that have an IP connection but no DCC-connectivity to the login node.

For example, in Figure 13, if you logged into Node 1 you would see Node 2 and Node 3 because they have DCC connectivity to Node 1. You would not see Nodes 4, 5, and 6 because DCC connections do not exist. To view all six nodes at once, create a login node group with the IP addresses of Nodes 1, 4, and 5. Those nodes, and all nodes optically connected to them, will display when you log into any node in the group.

Figure 13   Viewing non-DCC nodes using a login node group
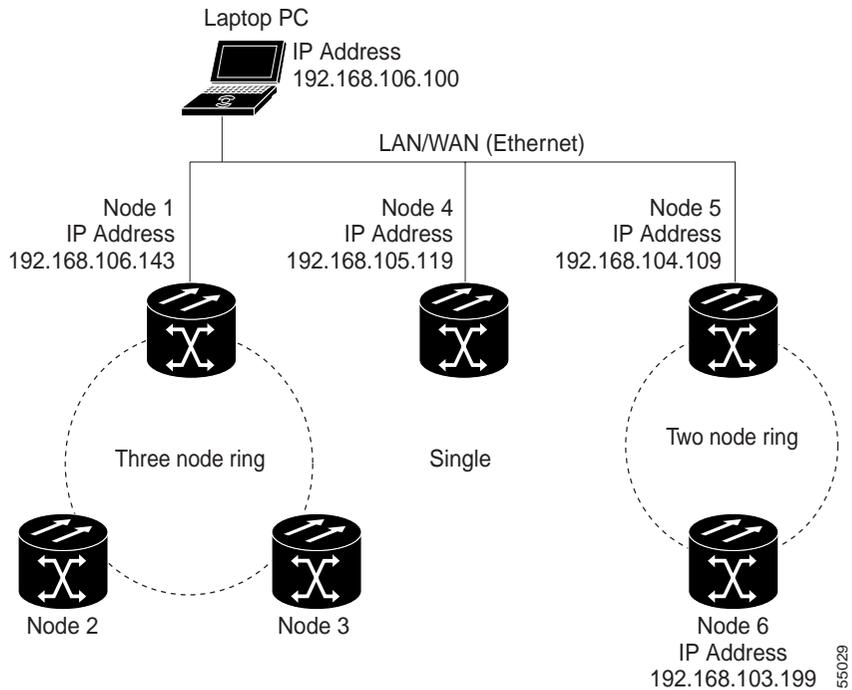
In-Service Span Upgrades

A span is the optical-fiber connection between two ONS 15454 nodes. In a span upgrade, the transmission rate of a span is upgraded from a lower to a higher OC-N signal but all other span configuration attributes remain unchanged. With multiple nodes, a span upgrade is a coordinated series of upgrades on all nodes in the ring or protection group. You can perform in-service span upgrades for the following ONS 15454 cards:

- OC-12 to OC-48

- OC-12 to OC-192

- OC-48 to OC-192

To perform a span upgrade, the higher-rate optical card must replace the lower-rate card in the same slot. The protection configuration of the original lower-rate optical card (two-fiber BLSR, four-fiber BLSR, UPSR, and 1+1) is retained for the higher-rate optical card. The Span Upgrade Wizard automates all steps in the manual span upgrade procedure for all protection configurations.

TL1

The ONS 15454 supports up to twenty concurrent TL1 sessions that provide the full range of TL1 commands for provisioning and managing ONS 15454 nodes. The *Cisco ONS 15454 and Cisco ONS 15327 TL1 Command Guide, Release 3.3* provides a complete list of commands, including specific sections devoted to ring provisioning and alarms and errors.

TL1 Communication

You can enable TL1 in three ways:

- Launch CTC and open a TL1 session to enter TL1 commands.

- Use port number 2361, 3082, or 3083 to access TL1 commands using a telnet session.

- Use the backplane craft interface or the nine-pin RS-232 port on the TCC+ to open a VT100 emulation window and enter TL1 commands.

TL1 Gateway and TL1 Test Access

TL1 Gateway enables you to issue TL1 commands to multiple nodes using a single connection. This means you can now provision other nodes in the network from the workstation where you are logged in.

TL1 Test Access enables you to monitor and test circuits. Commands to connect, disconnect, and change the test access (TACC) connections are available.

Alarm Collection and Display

The ONS 15454 has several methods to alert you to possible problems with the node.The ONS 15454 faceplate has LEDs that alert you to critical, major, minor, or remote alarms on the node. The LCD provides this information but on a port and card level also. CTC displays alarms and events on a card or node level for all nodes in the network. You can also use TL1 to view and troubleshoot the same alarm messages that appear in CTC.

Front Panel LEDs

The Critical, Major and Minor alarm LEDs on the fan tray front panel indicate whether a critical, major, or minor alarm is present anywhere on the ONS 15454 assembly. These LEDs are viewable through the front door so that you can quickly determine if any alarms are present on the assembly. These LEDs are independent of the Slot, Status, and Port indicators on the LCD.

LCD Alarm Indicators

The ONS 15454 LCD screen provides slot and port-level information for all ONS 15454 card slots, including the number of Critical, Major, and Minor alarms.

Figure 14   Using the LCD
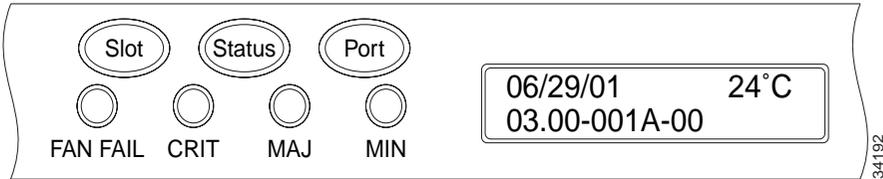
CTC Display

Alarms are displayed in one of five background colors to quickly communicate the alarm severity. You can control the display of current and cleared alarms generated on the node. The alarm and event screens include date, time, severity, reporting node, reporting object, service-affecting status, and a description.

*Figure 15   Viewing alarms for the current session*

CTC displays historical alarm data and shows events (non-alarmed occurrences) such as performance monitoring threshold crossings or protection switching events. CTC presents two alarm history views:

- A Session subtab presents alarms and events for the current CTC session. When you log off, the alarm list generated during the CTC session disappears.

- A Node subtab shows the alarms and events that occurred at the node since the CTC software installation. The ONS 15454 can store up to 256 critical alarms, 256 major alarms, 256 minor alarms, and 256 events. When the limit is reached, the ONS 15454 discards the oldest alarms and events.

Alarm Profiles

The ONS 15454 includes an alarm profile feature. This allows you to change the default alarm severities (for example, change an alarm severity from minor to major) and apply the new severities at the card, port, or node level.

Figure 16   Creating alarm profiles with the Alarm Profiles tab
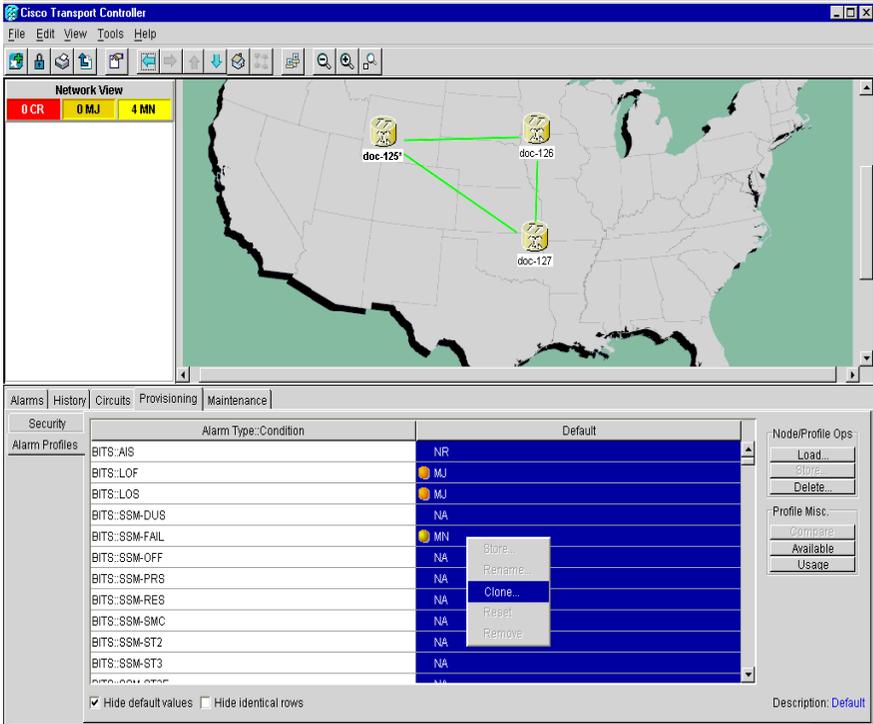
Every alarm has a default severity. To create a new profile, clone the default in CTC, rename it, and choose the severity settings for the new profile.

Alarm Suppression

From the card view you can suppress alarms on specific ports. From the node view, you can suppress alarms on specific cards or the entire node.

If alarms are suppressed, they do not appear on the CTC Alarm screen. On the History screen a message states that the alarms are suppressed, and the Conditions tab shows alarm suppression conditions. The node sends out autonomous messages to clear any raised alarms. When alarm suppression is turned off, the node sends out autonomous messages to raise any suppressed alarms.

Alarm Cutoff

Visual and audible (user-defined) alarms are typically wired to trigger an alarm light or sound at a central alarm collection point when the corresponding contacts are closed. The alarm cutoff (ACO) function stops (turns off) the transmission of the alarm signal to the alarm collection point. To activate the ACO function, press the ACO button on the AIC card faceplate. The ACO button clears all audible alarm indications. The alarm is still active in CTC and needs to be cleared.

Customer-Defined External Alarms and Controls

The AIC card allows you to provision four external alarms and four external controls. Use external alarms for open doors, temperature sensors, flood sensors, and other environmental conditions. Use external controls to drive visual or audible devices such as bells and lights. The alarm-triggering conditions for the external controls can be user-defined external input alarms, remote alarms, or severity-based alarms (for example, alarms that trigger when any Major alarm happens).

Figure 17 shows a diagram of the input and output process for external alarms and controls.

Figure 17   External alarm input and output
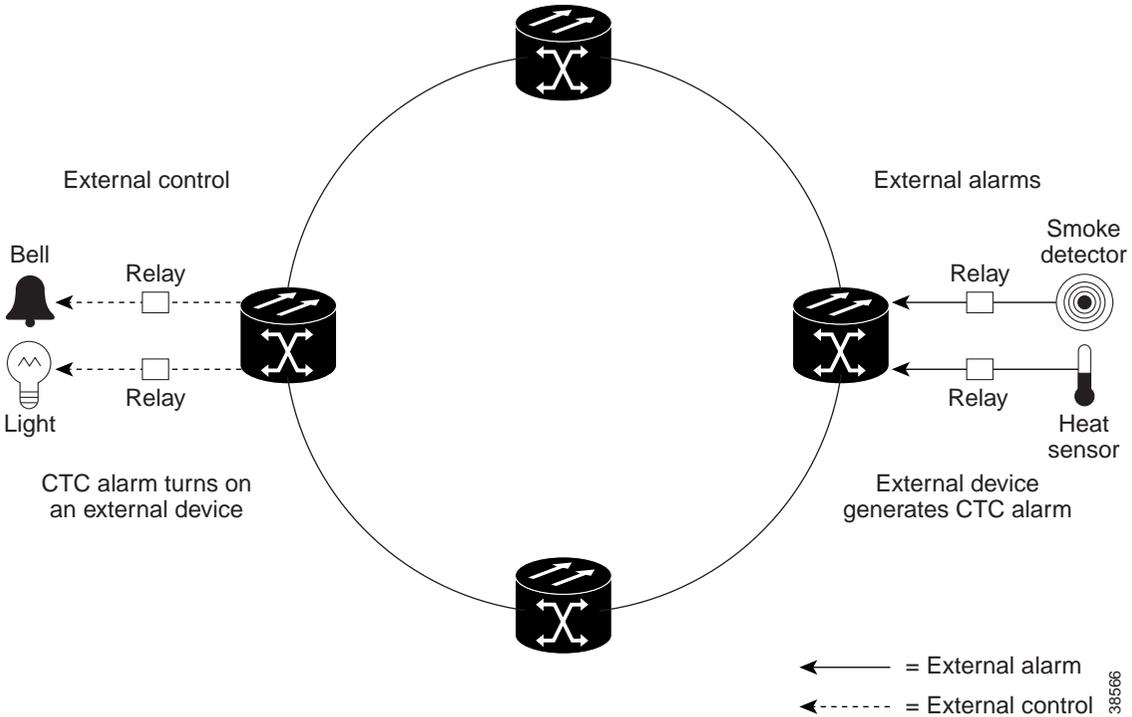
Provisioning external alarms and controls provides a "virtual wires" option that you can use to route alarms and controls from different nodes to one or more alarm collection centers. For example, in Figure 18, smoke detectors are provisioned as external alarms at Nodes 1, 2, 3, and 4. The alarms are assigned to Virtual Wire 1, and Virtual Wire 1 is provisioned as the trigger (control) for an external bell at Node 1.

Figure 18   External alarms and controls using a virtual wire configuration
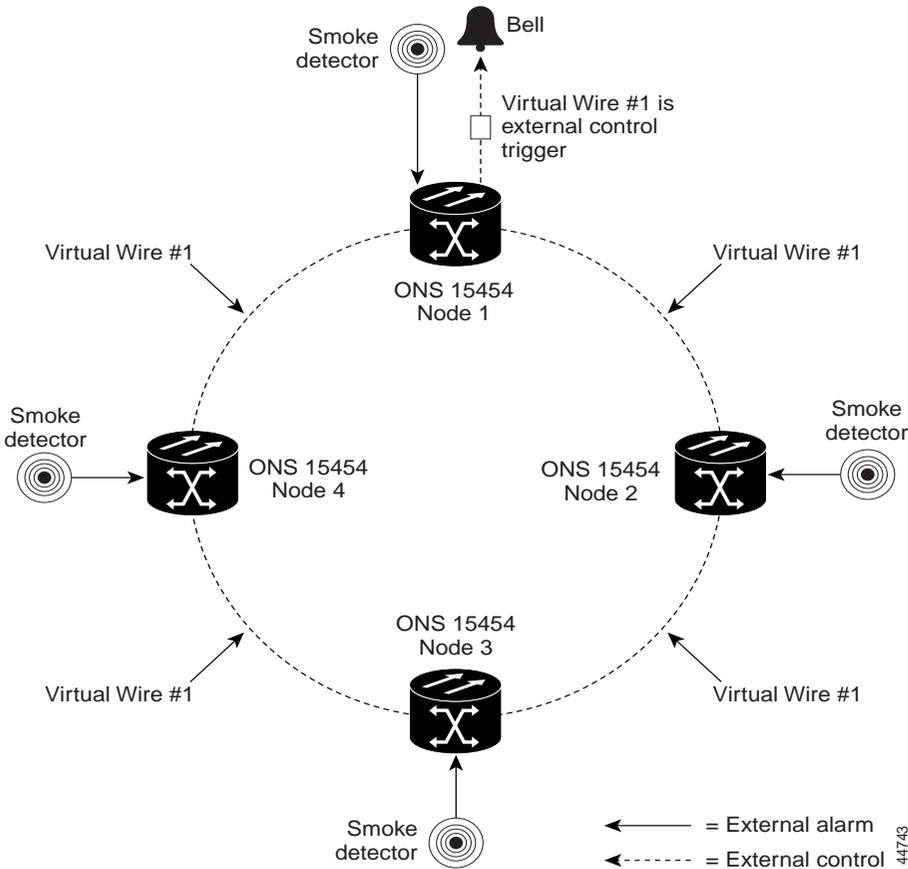
Ethernet

The ONS 15454 integrates Ethernet access into the same SONET platform that transports voice traffic. Service providers use Ethernet over SONET to augment TDM services while delivering data traffic over existing facilities. The ONS 15454 supports layer 2 switching and the ability to classify Ethernet traffic as defined in the IEEE

802.1 Q-tag standard. You can switch tagged traffic onto separate SONET STS channels to engineer bandwidth by traffic class. The ONS 15454 can also concentrate Ethernet ports into one or more STS-N circuits to use bandwidth more efficiently.

Priority Queuing

Networks without priority queuing handle all packets on a first-in-first-out basis. Priority queuing, which is supported by the ONS 15454, reduces the impact of network congestion by mapping Ethernet traffic to different priority levels. The ONS 15454 takes the eight priorities specified in IEEE 802.1Q and maps them to two queues. Q-tags carry priority queuing information through the network.

VLAN Service

The ONS 15454 works with Ethernet devices that do and do not support IEEE 802.1Q tagging. The ONS 15454 supports virtual LANs that provide private network service across a SONET backbone. You can define specific Ethernet ports and SONET STS channels as a VLAN group. VLAN groups isolate subscriber traffic from users outside the VLAN group and keep "outside" traffic from "leaking" into the virtual private network (VPN). Each IEEE 802.1Q VLAN represents a different logical network.

Spanning Tree Protocol

The ONS 15454 uses the IEEE 802.1D standard to provide spanning tree protocol (STP). STP detects and eliminates network loops; the ONS 15454 uses spanning tree protocol internally and externally. Internally, it detects multiple circuit paths between any two network ports and blocks ports until only one path exists. The single path eliminates possible bridge loops.

Externally, you can enable spanning tree at the Ethernet-port level to allow parallel connections to external networking equipment. Spanning tree will only allow one connection to be used at any given time. You can disable spanning tree protection on a circuit-by-circuit basis on unstitched Ethernet cards in a point-to-point configuration.

Single-Card and Multicard EtherSwitch

The ONS 15454 supports single-card and multicard EtherSwitch.

When you provision single-card EtherSwitch, each Ethernet card is a single switching entity within the ONS 15454. This option allows STS-12c of bandwidth between two Ethernet circuit points. Single-card EtherSwitch supports one STS-12c, two STS-6c, four STS-3c, or twelve STS-1 circuits.

Figure 19   Single-card EtherSwitch
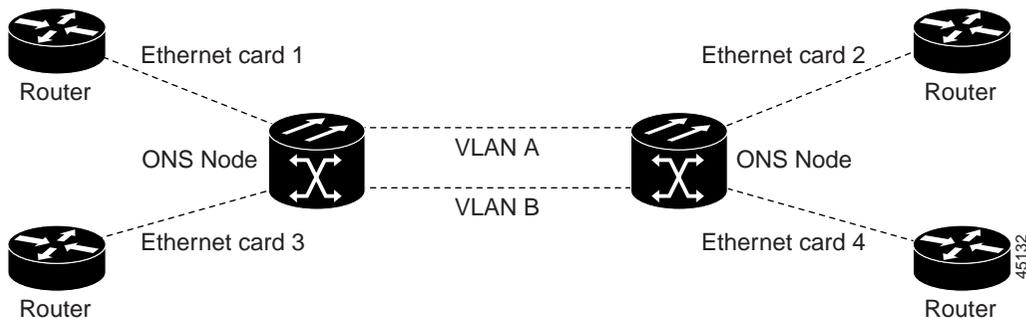
When you provision multicard EtherSwitch, two or more Ethernet cards act as a single layer 2 switch. Multicard EtherSwitch supports one STS-6c shared packet ring, two STS-3c shared packet rings, or six STS-1 shared packet rings. The bandwidth of the single switch formed by the Ethernet cards matches the bandwidth of the provisioned Ethernet circuit up to STS-6c worth of bandwidth.

Figure 20   Multicard EtherSwitch
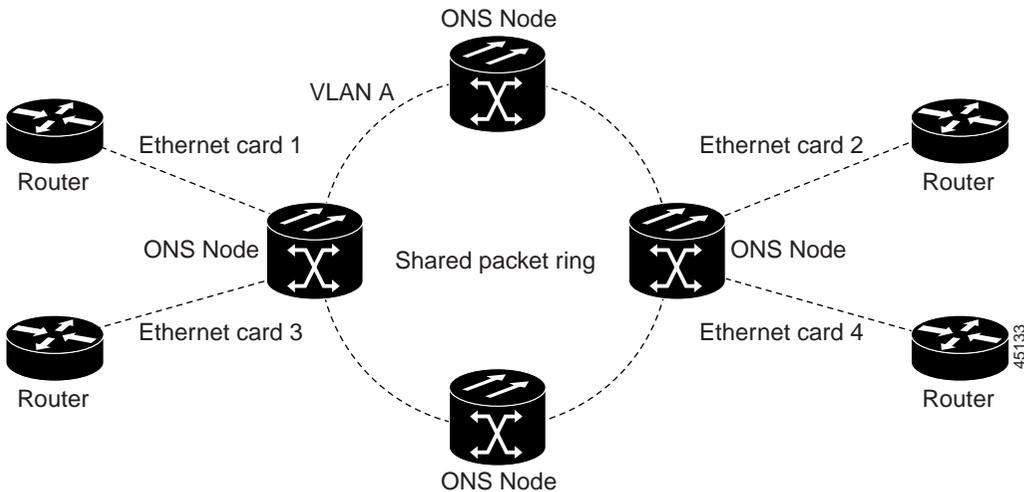
Ethernet Circuits

The ONS 15454 has three common methods for configuring Ethernet circuits between ONS nodes: a point-to-point circuit configuration, a shared packet ring configuration (Multicard EtherSwitch only), and a hub-and-spoke configuration. Two nodes usually connect with a point-to-point circuit configuration. More than two nodes usually connect with a shared packet ring or a hub and spoke configuration. You can also manually cross connect individual Ethernet circuits to an STS channel on the ONS 15454 optical interface.

Network Management

The ONS 15454 is compatible with several network management protocols, such as Simple Network Management Protocol (SNMP), Proxy Address Resolution Protocol (ARP), and Open Shortest Path First (OSPF) protocol. If OSPF is not available, static routes can also connect to ONS 15454s through routers. DCC tunneling is provided for interoperability with other vendors' equipment.

Simple Network Management Protocol

Simple Network Management Protocol (SNMP) is an application-layer Internet Protocol (IP) that enables network devices to exchange management information. Network administrators can manage network performance, find and solve network problems, and plan for network growth. The ONS 15454 supports SNMP Version 1 (SNMPv1) and SNMP Version 2c (SNMPv2c); SNMPv2c offers additional protocol operations.

The ONS 15454 uses SNMP to communicate segments of the CTC information model to network management systems, such as HP OpenView Network Node Manager (NNM) or Open Systems Interconnection (OSI) NetExpert. SNMP conveys information required for node-level inventory, fault, and performance management of the ONS 15454 node, and for generic read-only management of DS-1, DS-3, SONET, and Ethernet.
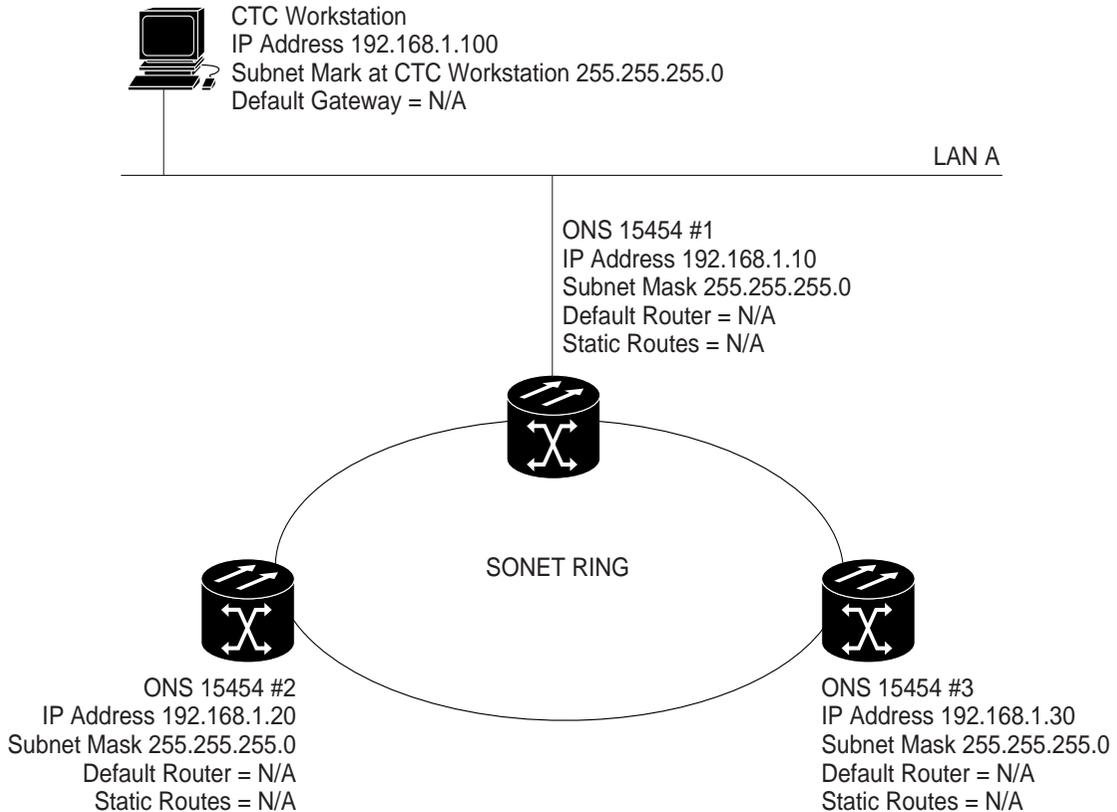
The ONS 15454 incorporates SNMP Remote Monitoring (RMON) to allow network operators to monitor the ONS 15454 Ethernet cards. RMON operates transparently with a network management application, but you can provision RMON alarm thresholds with CTC.

Proxy ARP

Proxy ARP enables a LAN-connected gateway ONS 15454 to automatically handle ARP requests for remote non-LAN ONS 15454s connected by a DCC to the gateway ONS 15454. Proxy ARP requires no manual configuration in CTC.

Proxy ARP has a single LAN-connected ONS 15454 stand in (proxy) for remote ONS 15454s. If a device on the LAN sends an ARP request intended for one of the DCC-connected ONS 15454s, the gateway ONS 15454 returns its own MAC address to the LAN device. The LAN device then sends the datagram intended for the remote ONS 15454 to the MAC address of the proxy ONS 15454. The proxy ONS 15454 forwards this data to the remote 15454 using its own ARP table.

Figure 21   Proxy ARP configuration (all nodes on the same subnet)

CTC Workstation
IP Address 192.168.1.100
Subnet Mark at CTC Workstation 255.255.255.0
Default Gateway = N/A

LAN A

ONS 15454 #1
IP Address 192.168.1.10
Subnet Mask 255.255.255.0
Default Router = N/A
Static Routes = N/A

SONET RING

ONS 15454 #2
IP Address 192.168.1.20
Subnet Mask 255.255.255.0
Default Router = N/A
Static Routes = N/A

ONS 15454 #3
IP Address 192.168.1.30
Subnet Mask 255.255.255.0
Default Router = N/A
Static Routes = N/A

33159

Open Shortest Path First

If ONS 15454s are connected to Open Shortest Path First (OSPF) networks, ONS 15454 network information can be automatically communicated across multiple LANs and WANs.

OSPF is a link state Internet routing protocol. Link state protocols use a "hello protocol" to monitor their links with adjacent routers and test their links to their neighbors. Link state protocols advertise their directly-connected networks and their active links. Each link state router captures the link state "advertisements"

and puts them together to create a topology of the entire network or area. From this database, the router calculates a routing table by constructing a shortest path tree. Routes are continuously recalculated to capture ongoing topology changes.

You can enable OSPF on the ONS 15454s so that the ONS 15454 topology is sent to OSPF routers on a LAN. Advertising the ONS 15454 network topology to LAN routers eliminates the need to manually provision static routes for ONS 15454 subnetworks.

Static Route Provisioning

The ONS 15454 uses CTC to provision static network routes. Static routes allow workstations to connect to ONS 15454s through routers. Static routes also make it possible to have multiple CTC sessions, with different destination IP addresses, on a network of ONS 15454s that all lie on the same subnet. For example, a network operations center (NOC) can remotely monitor an ONS 15454 through CTC concurrently with an on-site employee logged into a network ONS 15454 with a separate CTC session. If OSPF is connected and running, static routes are unnecessary.

DCC Tunneling

You can tunnel third-party SONET equipment DCCs across ONS 15454 networks. A DCC tunnel is a series of connection points that map a third-party equipment DCC to ONS 15454 DCCs. A DCC tunnel end point is defined by the slot, port, and DCC type. To create a DCC tunnel, you connect the tunnel end points from one ONS 15454 optical port to another. DCC traffic is forwarded transparently, byte-for-byte, across the ONS 15454 network.

Network Configuration

The ONS 15454 supports unidirectional path switched rings (UPSRs), bidirectional line switched rings (BLSRs), subtending rings, linear add-drop multiplexer (ADM) supporting 1+1 protection, and mixed configurations. You can also create path-protected mesh networks (PPMNs).
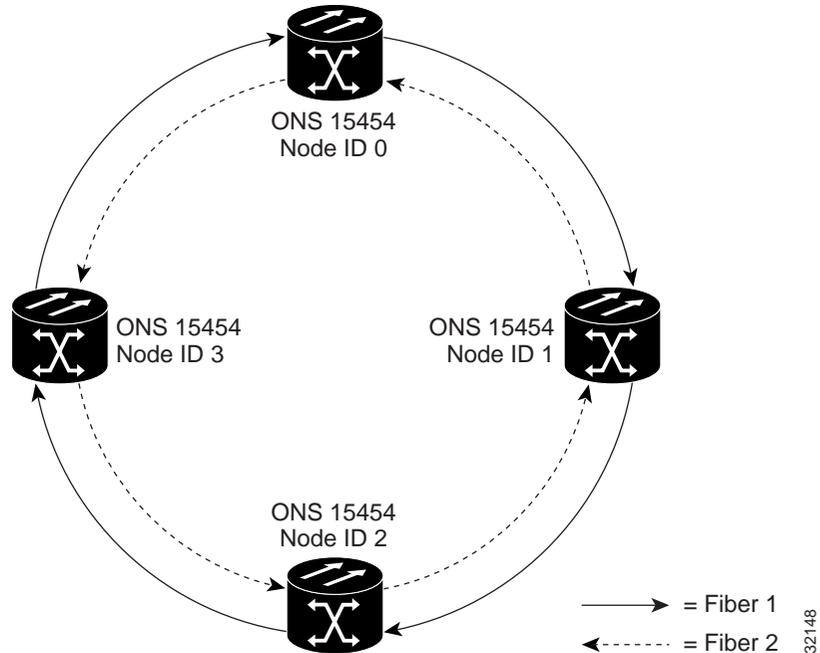
Unidirectional Path Switched Ring

The default protection scheme for an ONS 15454 is the UPSR. A UPSR is a closed-loop, two-fiber transport architecture that survives cable cuts and equipment failure because it provides duplicate fiber paths for each service. Nodes in the ring are connected using a single pair of optical fibers. Working traffic flows in one direction on the ring and the second fiber provides a protection path flowing in the opposite direction. If a problem occurs in the working traffic path, the receiving node switches to the path coming from the opposite direction.

Services can originate and terminate on the same UPSR or can be passed to an adjacent access or interoffice ring for transport to the service-terminating location. Because each traffic path is transported around the entire ring, UPSRs are best suited for networks where traffic concentrates in one or two locations and is not widely distributed.

Figure 22 shows a basic UPSR configuration. If Node ID 0 sends a signal to Node ID 2, the working signal travels on the working traffic path through Node ID 1. The same signal is also sent on the protect traffic path through Node ID 3. If a fiber break occurs, Node ID 2 switches its active receiver to the protect signal coming through Node ID 3.

*Figure 22   Unidirectional path switched ring*

Bidirectional Line Switched Ring

The ONS 15454 supports two-fiber and four-fiber BLSRs with up to 16 ONS 15454 nodes. BLSRs work well for distributed traffic applications, such as interoffice networks.

Two-fiber BLSRs allocate half the available fiber bandwidth for protection. In a two-fiber OC-48 BLSR, for example, STSs 1–24 are allocated to working traffic, and STSs 25–48 are allocated for protection. If a break occurs on one fiber, working traffic switches to the protection bandwidth (STSs 25–48) on the other

fiber. Working traffic travels in one direction on STSs 1–24 on one fiber, and on STSs 1–24 in the opposite direction on the second fiber. You can create OC-12, OC-48, and OC-192 two-fiber BLSRs.

Figure 23   Four-fiber bidirectional line switched ring
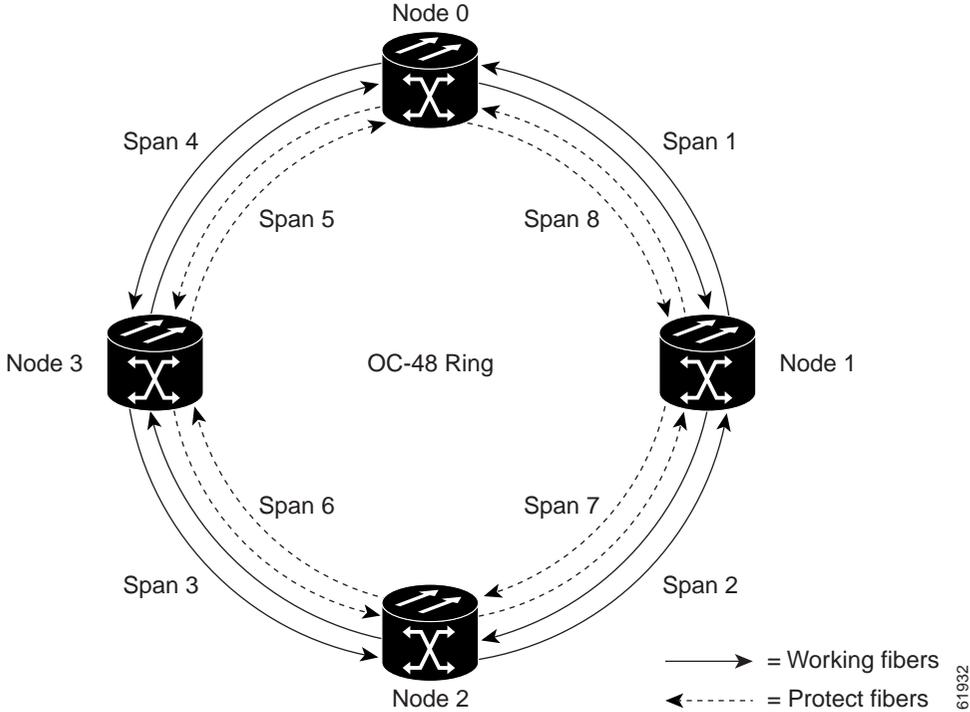
Four-fiber BLSRs double the bandwidth of two-fiber BLSRs by dedicating a second optical card for protection rather than reserving half of the active card for protection. If one fiber is cut, the ring does not switch because the other fiber carries the traffic for the broken span. A ring switch occurs if both the working and protect fibers fail. You can create OC-48 and OC-192 four-fiber BLSR.

Subtending Rings

UPSRs and BLSRs can be subtended from one another using one shared node; the node can terminate and groom any one of the following ring combinations:

- 5 UPSRs, or

- 4 UPSRs and 1 BLSR, or

- 3 UPSRs and 2 BLSRs

Subtending rings from an ONS 15454 reduces the number of nodes and cards required, and reduces external shelf-to-shelf cabling. Figure 24 shows an ONS 15454 with multiple subtending rings.

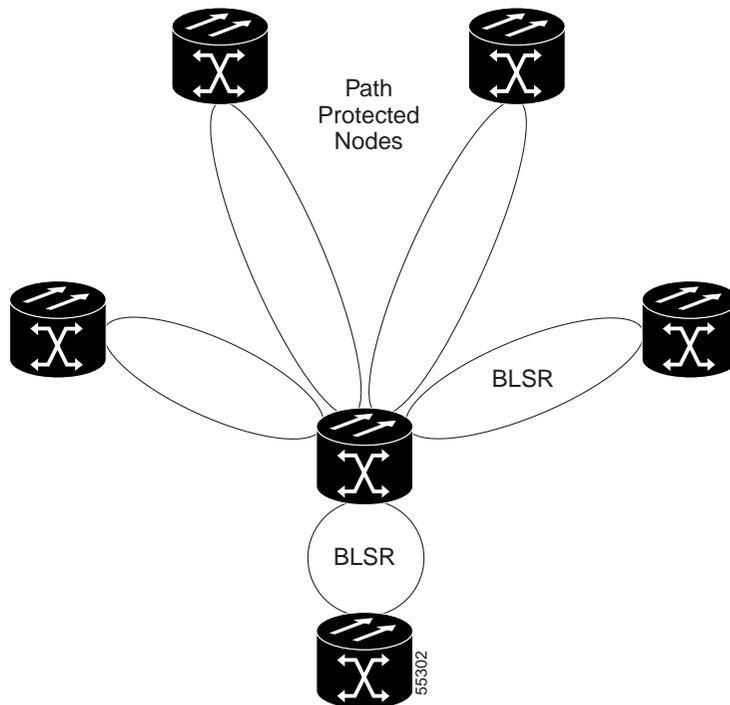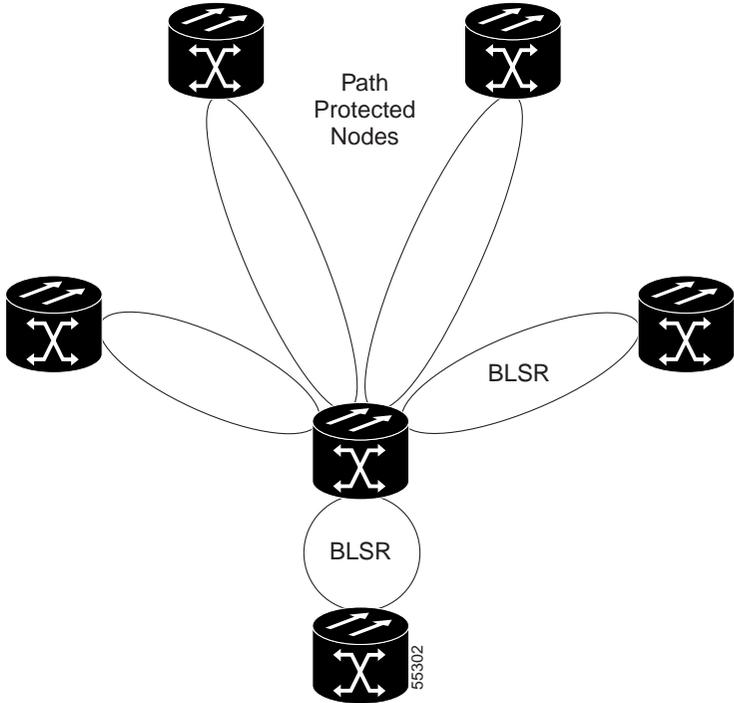*Figure 24   An ONS 15454 with multiple subtending rings*

Figure 25 shows a UPSR subtending from a BLSR. In this example, Node 3 is the only node serving both the BLSR and UPSR. Optical cards in Slots 5 and 12 serve the BLSR, and optical cards in Slots 6 and 13 serve the UPSR.

Figure 25   UPSR subtending from a BLSR


Linear Add/Drop Multiplexer Mode

In ADM configuration, intermediate nodes have direct access to eastbound or westbound STS channels along a fiber route, and can connect any STS to any other STS for transport along the network. ADM configurations eliminate the need for costly "back-to-back" terminal configurations and can be enhanced with 1+1 protection for any or all transport spans in the system. Figure 26 shows an ADM configuration.

Figure 26   Linear ADM configuration
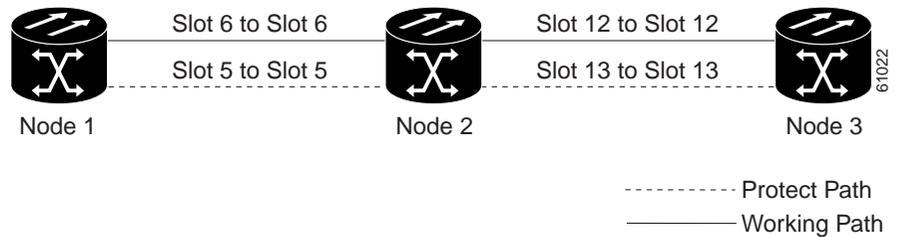
The ONS 15454 supports a full range of line rates as well as TDM and Ethernet/IP access tributary interfaces at every node in ADM configuration. The cross-connect helps to maximize bandwidth allocation by making it possible to map any tributary STS channel to any eastbound or westbound SONET span or to any other access tributary interface.

Terminal Point-to-Point

In terminal point-to-point configuration, one node is physically connected to another node with no intermediate nodes. The add-drop multiplexing feature is usually provided but not used in this configuration.

Figure 27   Point-to-point configuration
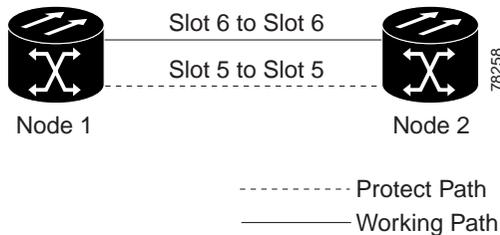
Path-Protected Mesh Network

ONS 15454 networks give you the option of setting up path-protected mesh networks (PPMNs). PPMN extends the protection scheme of UPSR from the basic ring configuration to the meshed architecture of several interconnecting rings. Typical UPSR protection creates two separate routes between source and destination nodes on a single UPSR. PPMN does this for source and destination nodes that do not lie on the same ring but link together through a network of meshed connections. When applied to a single ring, PPMN uses the same paths as the UPSR.

PPMN connects the source and destination of a circuit over two diverse paths through a network of single or multiple meshed rings. These two paths form a circuit-level UPSR. The source sends traffic on each of the diverse paths to the destination node, where the destination node uses the active path or switches to the standby path. CTC can automatically route circuits across the PPMN, or you can manually route circuits.

Figure 28 shows an example of a PPMN. In the example, Node 3 is the source and Node 9 is the destination. CTC automatically determines that the shortest route between the two end nodes passes through Node 8 and Node 7, shown by the dotted line. Cross-connections are automatically created at nodes 3, 8, 7, and 9 to provide a working-traffic route.

Figure 28   Path-protected mesh network
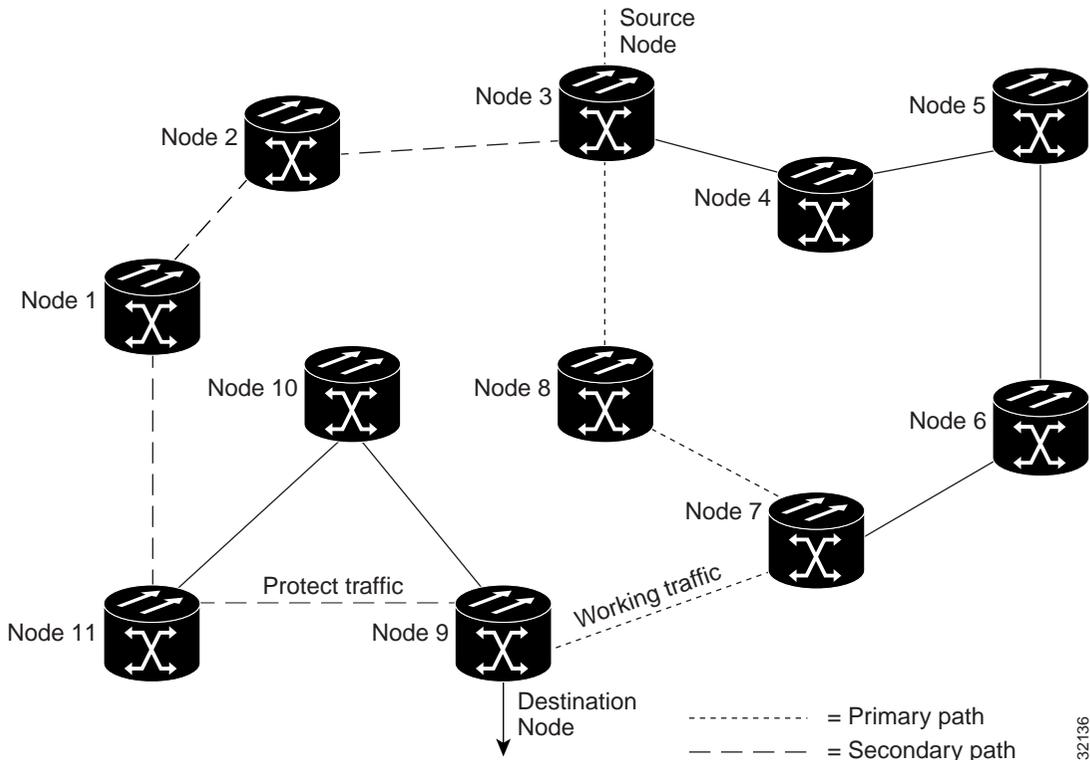
If you check the protected circuit box in CTC, PPMN establishes a second unique route between Nodes 3 and 9 and automatically creates cross-connections at nodes 3, 2, 1, 11, and 9, shown by the dashed line. If a signal failure occurs on the primary path, traffic switches to the second, protected circuit path. In this example, Node 9 switches from the traffic coming in from Node 7 to the traffic coming in from Node 11 and service resumes. The switch occurs within 50 milliseconds.

PPMN also allows spans of different SONET line rates to be mixed together in "virtual rings." Figure 29 shows Nodes 1, 2, 3, and 4 in a standard OC-48 ring. Nodes 5, 6, 7, and 8 link to the backbone ring through OC-12 fiber. The "virtual ring" formed by Nodes 5, 6, 7, 8 uses both OC-48 and OC-12.

Figure 29   PPMN virtual ring
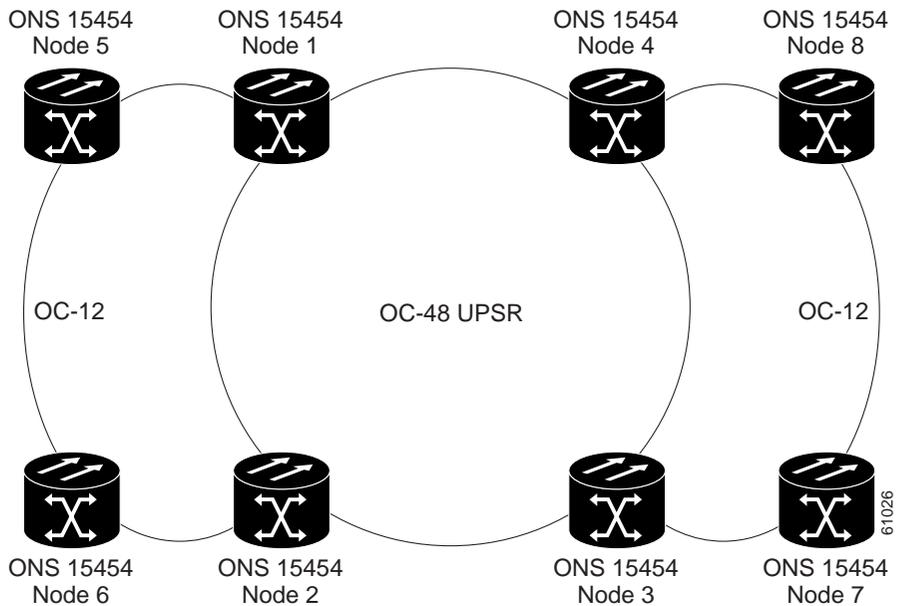
ONS 15454 and ONS 15327 Mixed Configurations

The ONS 15454 can mix BLSR, UPSR, and PPMN configurations in any combination and with ONS 15327s. For example, an BLSR-configured ONS 15454 node can be linked to an ONS 15327 UPSR.

Figure 30 shows an ONS 15327 subtended from an ONS 15454 UPSR or BLSR.

Figure 30   *ONS 15454s and ONS 15327s in a mixed configuration (subtended ring)*
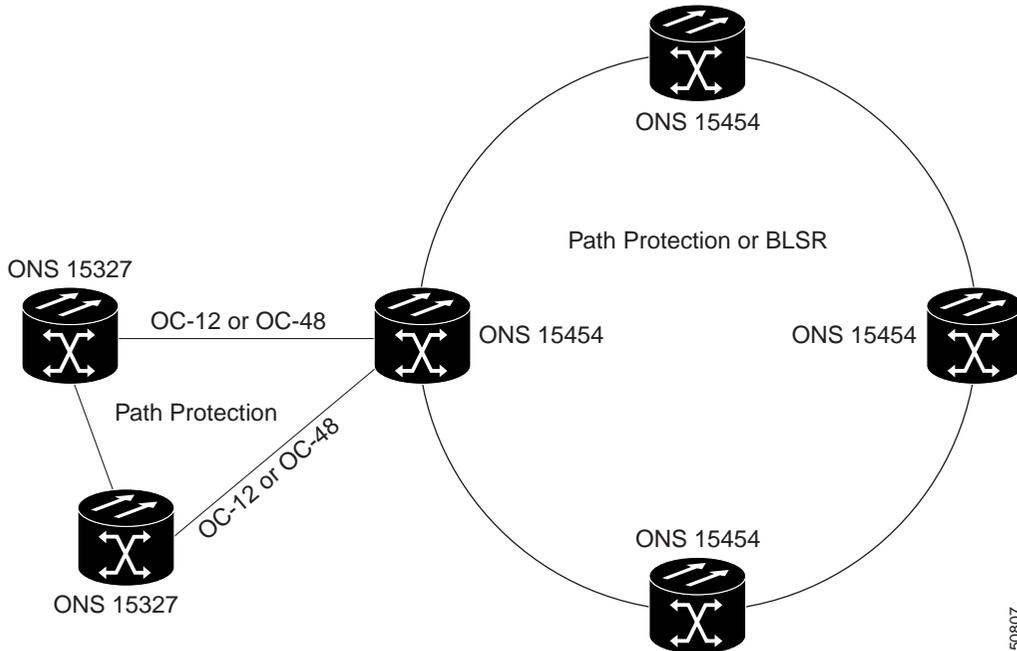
Timing

The TCC+ card performs all system-timing functions for each ONS 15454. The TCC+ card selects a recovered clock, a BITS, or an internal Stratum 3 reference as the system-timing reference. You can provision any of the clock inputs as a primary or secondary timing source. If you identify two timing references, the secondary reference provides protection. A slow-reference tracking loop allows the TCC+ to synchronize to the recovered clock, which provides holdover if the reference is lost.

Timing Parameters

You must set the SONET timing parameters for each ONS 15454. ONS 15454 timing is set to one of three modes: external, line, or mixed. An externally-timed node derives its timing from a BITS source wired to the BITS inputs on the backplane. The BITS source, in turn, derives its timing from a Primary Reference Source (PRS) such as a Stratum 1 clock or GPS signal. A line-timed node derives its timing for an incoming optical signal on one of the OC-N cards.

Figure 31 shows an example of an ONS 15454 network-timing setup. Node 1 is set to external timing. Two references are set to BITS, and the third reference is set to internal. The BITS output pin on the backplane of Node 3 provides timing to outside equipment, such as a digital access line access multiplexer.

Synchronization Status Messaging

Synchronization status messaging is a mechanism for managing synchronization (or network timing) in SONET networks. It allows BITS timing sources, nodes, and combinations of the two to exchange information about the quality of timing sources. SSM enables SONET devices such as the ONS 15454 to automatically select the highest quality timing reference and to avoid timing loops (particularly in ring architecture). Synchronization status messages are carried in the S1 byte of the SONET line overhead (Line layer) and as a bit-patterned message in the Extended Super Frame (ESF) datalink of the BITS DS-1. The ONS 15454 supports BITS inputs with or without SSM.

Figure 31   ONS 15454 timing example
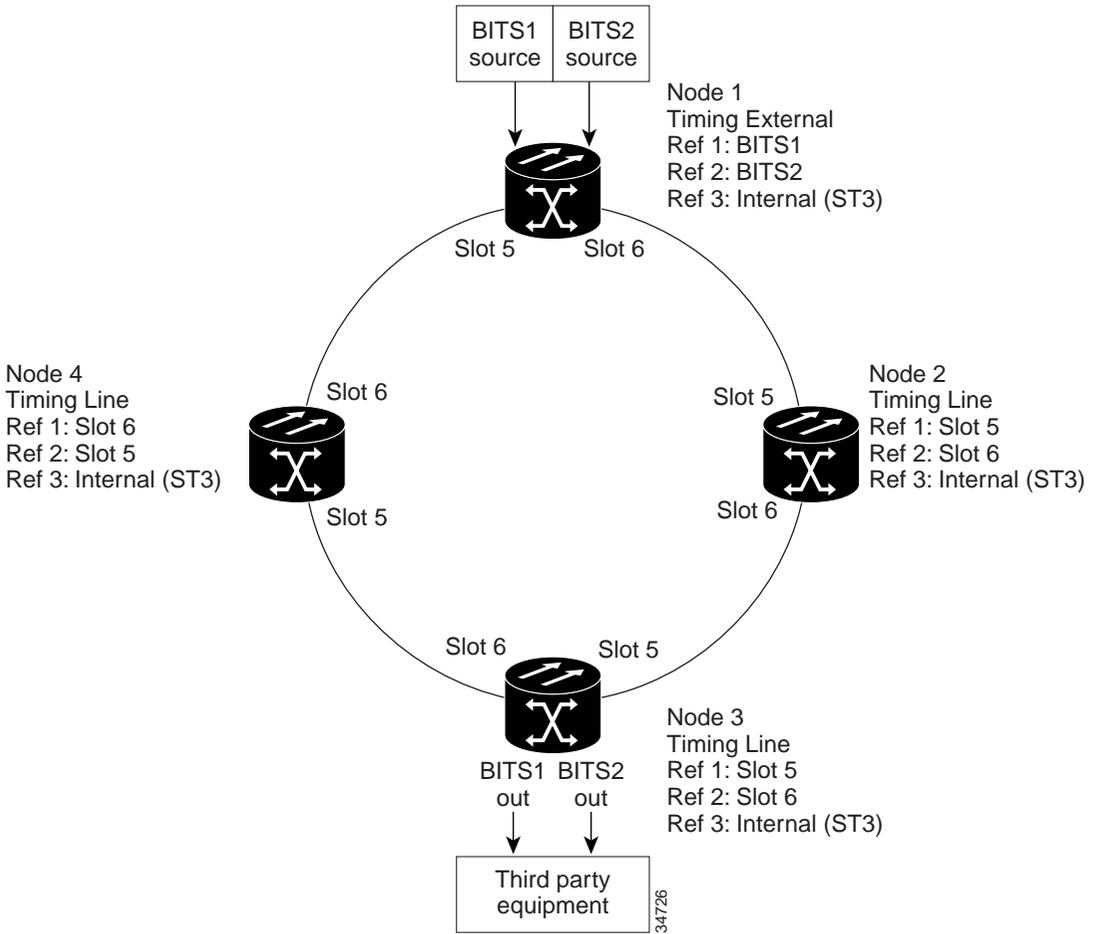
Hardware

You can mount the ONS 15454 in a 19- or 23-inch rack. The shelf assembly weighs approximately 55 pounds with no cards installed and features a front door for added security, a fan tray module for cooling, and extensive fiber-management space.

Cisco offers an ONS 15454 Bay Assembly (OPT-BIC) that provides pre-installed ONS 15454 shelf assemblies in a seven-foot rack. The Bay Assembly is available in a three- or four-shelf configuration.

LCD

The ONS 15454 LCD screen provides slot and port-level information for all ONS 15454 card slots, including the number of Critical, Major, and Minor alarms.

You can use the LCD screen to set the IP address, subnet mask, and default router for the node. This allows you to accomplish these basic operations without a computer. In CTC you can lock out the LCD to other users by choosing to prevent LCD IP configuration. Users can still view information on the LCD, but cannot perform any provisioning.

Figure 32   ONS 15454 LCD
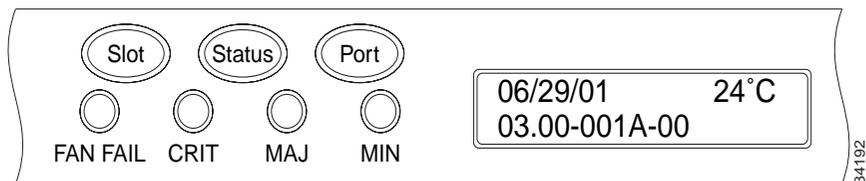
Backplane

The backplane provides access to alarm contacts, external interface contacts, power terminals, LAN connections, the BITS clock, and cable connectors.

Electrical Interface Assemblies

EIAs provide electrical cable connection points on the ONS 15454 backplane. EIAs are available with SMB and BNC connectors for DS-3 or EC-1 cards. DS-1 cards use AMP Champ connectors or SMB connectors with wire-wrap baluns. You can install EIAs on one or both sides of the ONS 15454 backplane in any combination.

Alarm Interface Panel

The alarm interface panel (AIP) is located on the lower section of the backplane. The AIP provides surge protection for the ONS 15454 and an interface from the backplane to the fan-tray assembly and LCD. The panel has a non-volatile memory chip that stores the unique node (MAC) address.

Fan-Tray Assembly

The fan-tray assembly is located at the bottom of the ONS 15454 front compartment. The fan-tray is a removable drawer that holds fans and fan control circuitry for the ONS 15454. After the fan tray is installed, it only needs to be accessed if a fan failure occurs or to replace or clean the fan-tray air filter.

Figure 33   ONS 15454 fan-fray assembly

LCD   Fan tray
           assembly
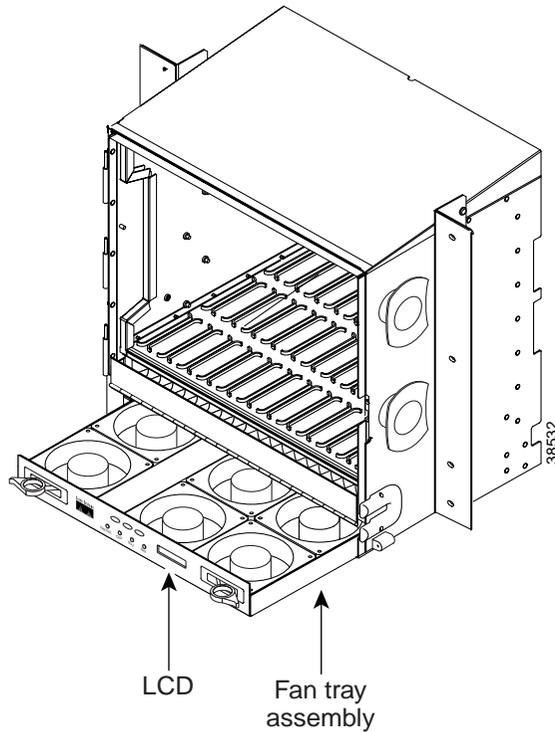
Shelf Assembly Specifications

This section provides detailed shelf assembly specifications for the ONS 15454.

Bandwidth

- Total bandwidth: 240 Gbps
- Data plane bandwidth: 160 Gbps
- SONET plane bandwidth: 80 Gbps

Slot Assignments

- Total card slots: 17
- OC-48 AS cards: any slot
- All traffic cards, excluding OC-48 and OC-192: Slots 1 – 4, 14 – 17
- Any traffic card: Slots 5, 6, 12, 13
- TCC+ (Timing Communication and Control): Slots 7, 11
- XC/XCVT/XC10-G (Cross-Connect): Slots 8, 10
- AIC (Alarm Interface Card): Slot 9

Cards

- TCC+
- XC
- XCVT
- XC10G
- AIC
- EC1-12
- DS1-14
- DS1N-14
- DS3-12
- DS3N-12
- DS3-12E
- DS3N-12E
- DS3XM-6
- OC3 IR 4 1310
- OC12 IR 1310
- OC12 LR 1310
- OC12 LR 1550
- OC48 IR 1310

- OC48 IR/STM16 SH AS 1310

- OC48 LR 1550

- OC48 LR/SM16 LH AS 1550

- OC48 ELR 200 GHz DWDM Cards

- OC48 ELR/STM16 EH 100 GHz DWDM Cards

- OC192 LR/ STM64 LH 1550

- E100T-12/E100-12-G

- E1000-2/E1000-2-G

- G1000-4

Configurations

- Terminal mode

- Add-drop multiplexer

- Two-fiber BLSR

- Four-fiber BLSR

- Two-fiber UPSR

- PPMN

Cisco Transport Controller

- 10 Base-T

- TCC+ access: RJ-45 connector

- Backplane access: LAN pin field

External LAN Interface

- 10 Base-T Ethernet

- Backplane access: LAN pin field

TL1 Craft Interface

- Speed: 9600 bps
- TCC+ access: RS-232 DB-9 type connector
- Backplane access: CRAFT pin field

Alarm Interface

- Visual: Critical, Major, Minor, Remote
- Audible: Critical, Major, Minor, Remote
- Alarm contacts: 0.045mm, -48V, 50 mA
- Backplane access: Alarm pin fields

EIA Interface

- SMB: AMP #415504-3 75 Ohm 4 leg connectors
- BNC: Trompeter #UCBJ224 75 Ohm 4 leg connector
- AMP Champ: AMP#552246-1 with #552562-2 bail locks

Nonvolatile Memory

64 MB, 3.0V FLASH memory

BITS Interface

- 2 DS-1 BITS inputs
- 2 derived DS-1 outputs
- Backplane access: BITS pin field

System Timing

- Stratum 3 per Telcordia GR-253-CORE
- Free running accuracy: 4.6 ppm

- Holdover Stability: 3.7 x10^{-7}/day, including temperature (< 255 slips in first 24 hours)
- Reference: External BITS, line, internal

Power Specifications

- Input Power: -42 to -57 VDC
- Power Consumption: 58W, FTA2; 95W, FTA3; 1060W (maximum draw with cards)
- Power Requirements: -42 to -57 VDC
- Power terminals: #6 Lug

Environmental Specifications

- Operating Temperature: 0 to +55 degrees Celsius
- Operating Humidity: 5 - 95% non-condensing
- I- Temp: -40 to 65 C

Dimensions

- Height: 18.5 inches (40.7 cm)
- Width: 19 or 23 inches (41.8 or 50.6 cm) with mounting ears attached
- Depth: 12 inches (26.4 cm) (5 inch projection from rack)
- Weight: 55 lbs. (empty)