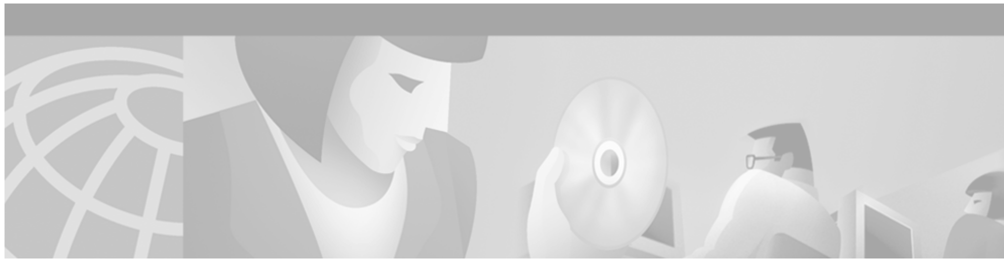
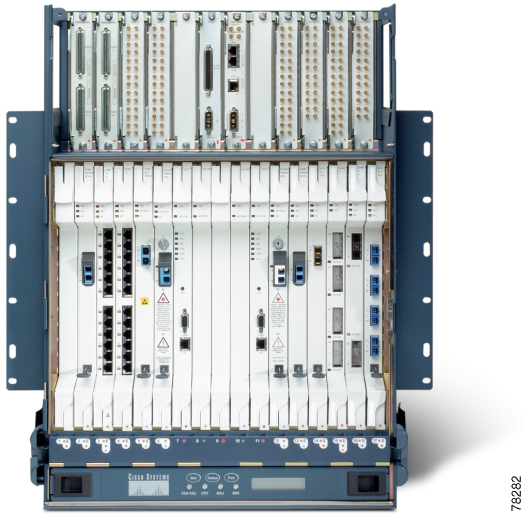


Cisco ONS 15454 SDH Product Overview

Introduction

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

Figure 1 Cisco ONS 15454 SDH



The ONS 15454 SDH shelf assembly contains 17 card (module) slots in the lower shelf, 12 front mount electrical connection (FMEC) slots in the upper shelf, a fan tray, a front panel with an LCD, and alarm indicators. All card and electrical connections are accessible from the front of the chassis. The ONS 15454 SDH carries traditional time-division multiplexing (TDM) and high-speed data traffic—a variety of card configurations offer incremental bandwidth increases as needed and support E-1, E-3, DS-3i, STM-1, STM-4, STM-16, STM-64, and 10/100 Ethernet and Gigabit Ethernet speeds.

PCs and workstations can connect to the ONS 15454 SDH using direct, network (LAN and WAN), or DCC connections. The ONS 15454 SDH supports Cisco Transport Controller (CTC). CTC, the ONS 15454 SDH software interface, provides easy card, node, and network-level provisioning and troubleshooting. The ONS 15454 SDH deploys a variety of network configurations, including point-to-point 1 + 1 linear multiplex-section protection systems or linear add-drop multiplexers (ADMs), subnetwork connection protection rings (SNCPs), two-fiber and four-fiber multiplex-section shared protection rings (MS-SPRings), subtending rings, and extended SNCP mesh networks.

Card Slots and Types

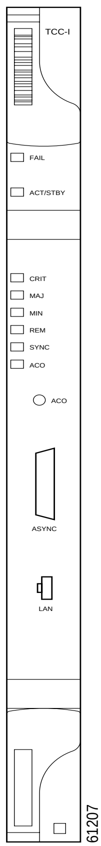
The ONS 15454 SDH lower shelf assembly has 17 card slots numbered 1–17. When you plug in a card, it automatically boots up and becomes ready for service. The cards offer bandwidth in modular increments, making it efficient to deploy the system in low-density applications and add bandwidth as needed. The ONS 15454 SDH lower shelf assembly houses four types of cards: Common Control, Electrical, Optical, and Ethernet. The common control cards include the TCC-I and the cross-connect cards (XC10G). Slot number 9 is reserved for the AIC-I card, available in an upcoming release.

The upper shelf assembly has 12 Front Mount Electrical Connection (FMEC) slots numbered 18–29. FMECs provide serial ports, LAN ports, a modem connection for future use, electrical connections, redundant power supplies, timing connections, and alarm connections for the future AIC-I card.

TCC-I Card

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

Figure 2 TCC-I card faceplate



As the main processing center of the ONS 15454 SDH, the TCC-I combines timing, control, and switching functions:

- System initialization
- Provisioning

- Alarm reporting
- Maintenance
- Diagnostics
- IP address detection and resolution
- Timing
- SDH data communications channel (DCC) termination
- System fault detection

The CRIT, MAJ, MIN, and REM alarm LEDs on the TCC-I faceplate indicate whether a Critical, Major, Minor, or Remote alarm is present on the ONS 15454 SDH 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-I 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 SDH, if dual TCC-I cards are used. The upgrade takes place first on the standby TCC-I card. The system verifies that the upgrade is successful and switches from the active TCC-I card running the older release to the upgraded standby TCC-I card running the newer release. After the switch, the second TCC-I card undergoes the upgrade. The TCC-I then loads new software to each of the installed line (traffic) cards.

Database Revert

The increased memory of the TCC-I allows it to store and revert to the previous configuration database. After a software upgrade, the TCC-I copies the current working database and saves it in a reserved location in the TCC-I 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.

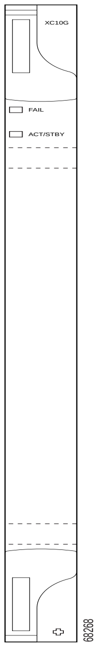
XC10G Cards

TheXC10G cross-connect card is the central switching element in the ONS 15454 SDH. You provision cross-connect (circuit) information using CTC; the TCC-I 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 two XC10Gs.

The XC10G card cross-connects standard VC4, VC4-4c, VC4-16c and VC4-64c signal rates and the non standard VC4-2c, VC4-3c and VC4-8c signal rates providing a maximum of 384 x 384 VC4 cross connections. Any VC4 on any port can be connected to any other port, meaning that the VC cross connection capacity is non blocking. The XC10G card manages up to 192 bidirectional VC4 cross-connects.

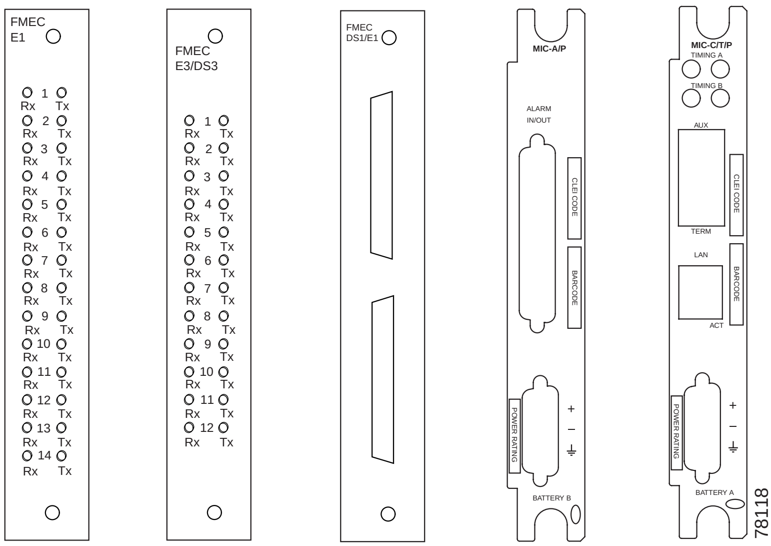
Figure 3 XC10G faceplate



FMECs

FMECs provide serial ports, LAN ports, a modem connection for future use, electrical connections, redundant power supplies, timing connections, and alarm connections for the future AIC-I card. The upper shelf assembly has 12 FMEC slots numbered 18–29. FMEC slots 18-22 support slots 1-5 for electrical cards in the lower shelf. FMEC slots 25-29 support slots 13-17 for electrical cards in the lower shelf. FMEC slot 23 is used for the alarm and power card called the MIC-A/P, and FMEC slot 24 supports the timing, craft, and power card called the MIC-C/T/P.

Figure 4 FMEC Faceplates for the E1, E3/DS3, DS1/E1, MIC-A/P, and MIC-C/T/P cards



E1 FMEC

The E1 FMEC card allows the user to terminate unbalanced E1 interfaces. The E1 FMEC card provides front mount electrical connection for fourteen ITU-compliant, G.703 E-1 ports.

DS1/E1 FMEC

The DS1/E1 FMEC card allows the user to terminate balanced E1 interfaces. The DS1/E1 FMEC card provides front mount electrical connection for fourteen ITU-compliant, G.703 E-1 ports.

E3/DS3 FMEC

The E3/DS3 FMEC card allows the user to terminate E3 interfaces. The E3/DS3 FMEC card provides front mount electrical connection for twelve ITU-compliant, G.703 E-3 or DS-3 ports.

BLANK FMEC

The BLANK card covers empty FMEC slots and fulfills EMC requirements.

MIC-A/P FMEC

The MIC-A/P FMEC card provides system power and alarm connections for the TCC-I and the AIC-I card available in a future release. The MIC-A/P card also provides storage of manufacturing and inventory data. For proper system operation, the MIC-A/P FMEC card must be installed in the shelf.

MIC-C/T/P FMEC

The MIC-C/T/P FMEC card provides front panel access for the Timing A and Timing B connectors, two system power connectors at 48 volts and two standard eight pin modular LAN connectors for each TCC-I card. For proper system operation, the MIC-C/T/P FMEC card must be installed in the shelf.

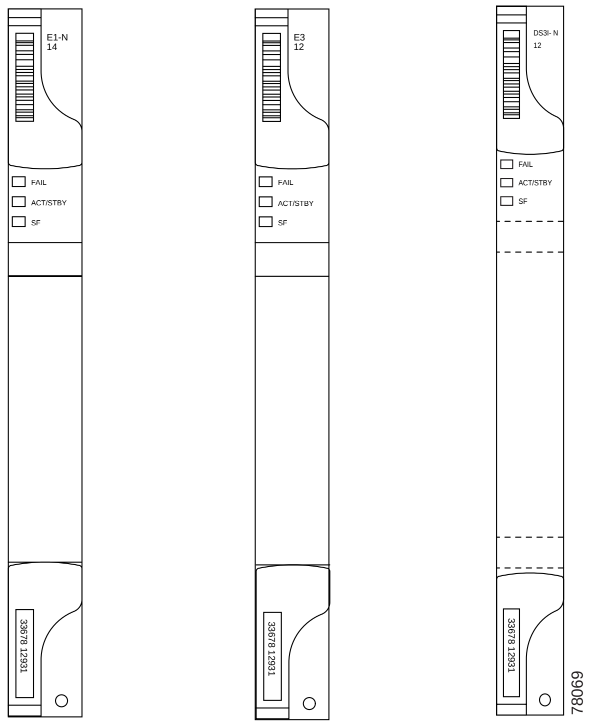
Electrical Cards

Slots 1–5 and 13–17 host any electrical card (E-1, E-3, and DS-3i). 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 SDH fan-tray assembly. Figure 5 shows the E-1, E-3, and DS-3i faceplates.

The upper shelf assembly has 12 FMEC slots numbered 18–29. FMEC slots 18-22 support slots 1-5 for electrical cards in the lower shelf. FMEC slots 25-29 support slots 13-17 for electrical cards in the lower shelf.

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

Figure 5 Faceplates for the E1-N-14, E3-12 and DS-3i cards



E1-N-14 Card

The E1-N-14 card provides fourteen ITU-compliant, G.703 E-1 ports. Each port operates at 2.048 MBits/s (Mbps) over a 120Ω twisted-pair copper cable with the DS1/E1 FMEC, or over a 75Ω unbalanced coaxial cable with the E1 FMEC.

The E1-N-14 card can be used as a working or protect card in 1:1 or 1:N protection schemes. If you use the E1-N-14 as a standard E-1 card in a 1:1 protection group, you can install the E1-N-14 card in any multispeed or high-speed card slot on the ONS 15454 SDH. If you use the card's 1:N functionality, you must install an E1-N-14 card in Slot 3 or Slot 15.

E3-12 Card

The E3-12 card provides twelve ITU-compliant, G.703 E-3 ports per card. Each port operates at 34.368 MBits/s (Mbps) over a 75Ω coaxial cable with the E3/DS3 FMEC. The E3-12 card can be used as a working or protect card in 1:1 protection schemes. When creating circuits, the E3 card must use port grouping with VC low-order path tunnels. Three ports form one port group. For example, in 1 E3 card, there are 4 port groups: Ports 1-3 = PG1, ports 4-6 = PG2, ports 7-9 = PG3 and ports 10-12 = PG4.

DS-3i Cards

The DS3i-N-12 card provides twelve ITU-T G.703, GR-499, ITU-T G.704 compliant DS-3 ports per card. Each port operates at 44.736 MBits/s (Mbps) over a 75Ω coaxial cable with the E3/DS3 FMEC. The twelve-port DS3i-N-12 card provides enhanced performance monitoring functions. By monitoring additional overhead in the DS-3 frame, subtle network degradations are detected. The DS3i-N-12 can operate as the protect card in a 1:N (N≤4) DS-3 protection group. It can protect up to four working DS3i-N-12 cards. When creating circuits, the DS3i-N-12 card must use port grouping with VC low-order path tunnels.

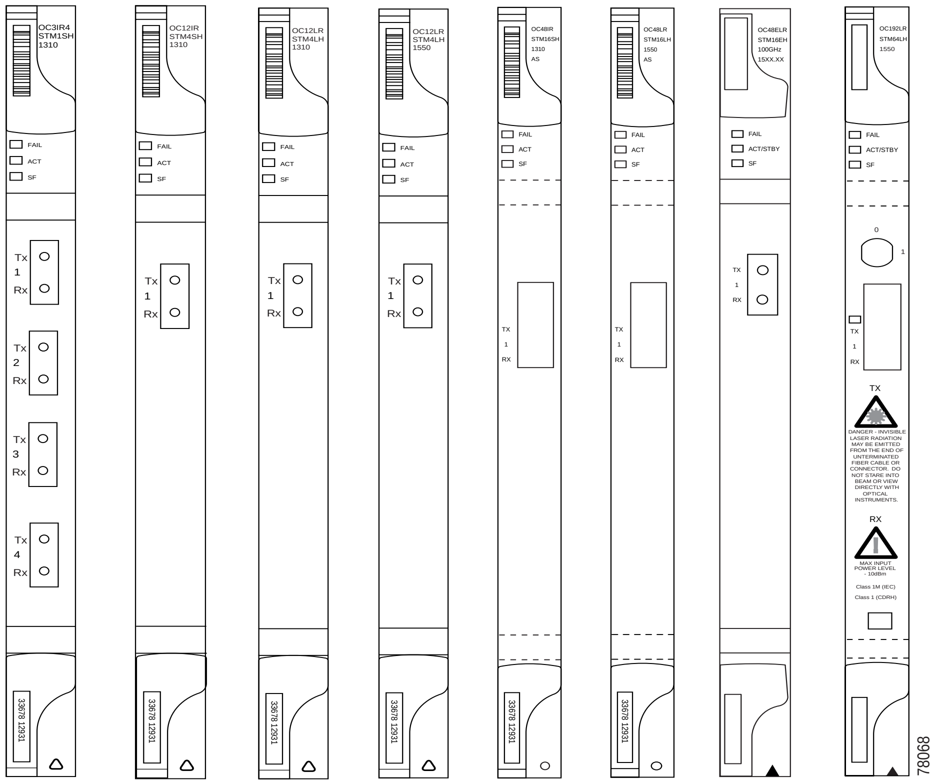
Optical Cards

The optical cards, with the exception of the STM-64, reside in Slots 1– 6 or 12 – 17. The STM-64 cards reside in Slots 5, 6, 12, or 13. You can provision an optical card as a drop card or span card in a linear ADM (1+1), SNCP, or MS-SPRing 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 SDH optical cards have SC fiber connectors on the card faceplate. Figure 6 shows the STM-1, STM-4, STM-16 and STM-64 faceplates.

Figure 6 Faceplates for the STM-1, STM-4, STM-16, and STM-64 cards



STM-1 SH Card

The OC3 IR 4/STM1 SH 1310 card provides four intermediate or short range ITU-T G.707 and G.957 compliant ports. Each port operates at 155.52 MBits/s (Mbps) over a single-mode fiber span. The card supports concatenated or non-concatenated VC4 payloads.

STM-4 SH Card

The OC12 IR/STM4 SH 1310 card provides one intermediate or short range ITU-T G.707and G.957 compliant port per card. The port operates at 622.08 MBits/s (Mbps) over a single-mode fiber span. The card supports concatenated or non-concatenated VC4 payloads.

STM-4 LH Card

The OC12 LR/STM4 LH 1310 card provides one long-range ITU-T G.707, ITU-T G.957compliant port per card. The port operates at 622.08 MBits/s (Mbps) over a single-mode fiber span. The card supports concatenated or non-concatenated VC4 payloads.

STM-4 LH 1550 Card

The OC12 LR/STM4 LH 1550 card provides one long-range ITU-T G.707 and G.957 compliant port per card. The port operates at 622.08 MBits/s (Mbps) over a single-mode fiber span. The card supports concatenated or non-concatenated VC4 payloads.

STM-16 SH AS 1310 Card

The OC48 IR/STM16 SH AS 1310 card provides one intermediate-range ITU-T G.707 and G.957 compliant port per card. The port operates at 2.488 GBits/s (Gbps) over a single-mode fiber span. The card supports concatenated or non-concatenated VC4 payloads.

STM-16 LH AS 1550 Card

The OC48 IR/STM16 SH AS 1550 card provides one long-range ITU-T G.707, and G.957 compliant port per card. The port operates at 2.488 GBits/s (Gbps) over a single-mode fiber span. The card supports concatenated or non-concatenated VC4 payloads.

STM-16 EH 100 GHz DWDM Card

Eighteen distinct STM-16 ITU 100 GHz dense wavelength division multiplex (DWDM) cards provide the ONS 15454 SDH DWDM channel plan. Although the ONS 15454 SDH uses 200 GHz spacing, the STM-16 EH 100 GHz cards also work in 100 GHz capable systems. Each STM-16 DWDM card provides one ITU-T G.692, G.707, G.957, and G.958 compliant port per card. The port operates at 2.488 GBits/s (Gbps) over a single-mode fiber span. The card supports concatenated or non-concatenated VC4 payloads.

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

STM-64 LH 1550 Card

The OC192 LR/STM64 LH 1550 card provides one long-range, ITU-T G.707, ITU-T G.957-compliant port per card. The port operates at 9.95 GBits/s (Gbps) over unamplified distances up to 80 km with different types of fiber such as C-SMF or dispersion compensated fiber limited by loss and/or dispersion. The card supports concatenated or non-concatenated VC4 payloads.

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 E-series Ethernet cards installed in an ONS 15454 SDH can act as a single switch (EtherSwitch) supporting a variety of SDH port configurations.

E100T-G Card

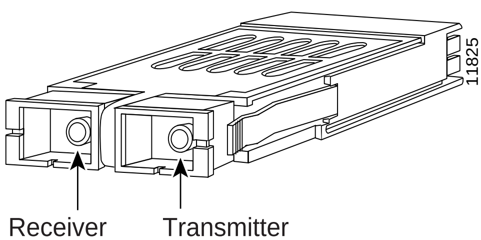
The ONS 15454 SDH uses E100T-G cards for Ethernet (10 Mbps) and Fast Ethernet (100 Mbps). Each card provides twelve switched, IEEE 802.3-compliant, 10/100 Base-T Ethernet interfaces that can independently detect the speed of an attached device (auto-sense) and automatically connect at the appropriate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

E1000-2-G Card

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

The 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. The E1000-2-G card supports SX and LX GBICs. The short reach (SX) model connects to multimode fiber and the long reach (LX) model requires single-mode fiber.

Figure 7 Gigabit interface converter



G1000-4 Card

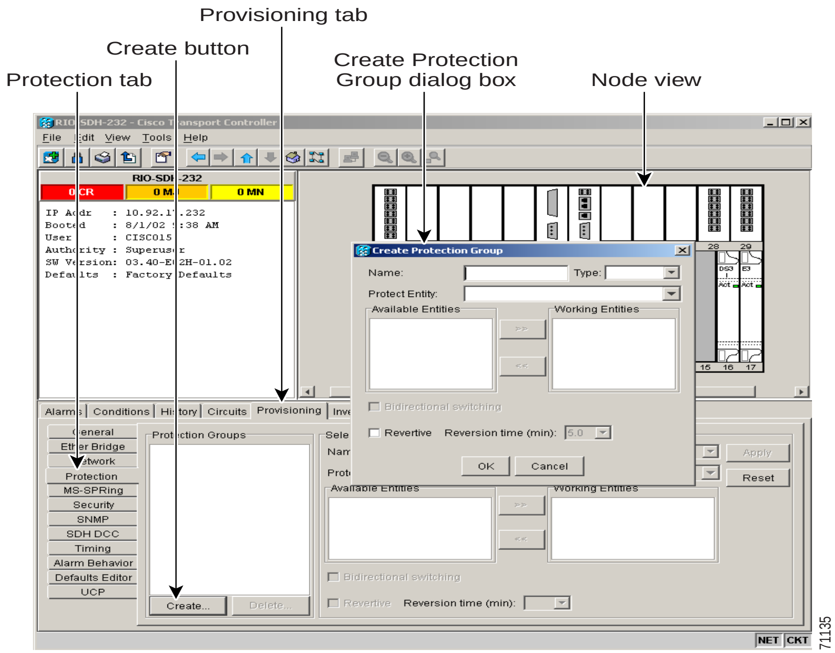
The G-1000 is a high capacity Ethernet card enhanced for high-bandwidth private line interconnects. Like the E1000-2-G card, the G1000-4 provides IEEE-compliant, 1000 Mbps ports for full-duplex operation and requires a GBIC as its optical interface.

The G1000-4 card supports three types of standard Cisco GBICs; SX, LX and ZX. The G1000-4 has four ports rather than two. The additional ports give the ONS 15454 SDH a practical limit of 40 Gigabit Ethernet ports per node. STM-16 is the maximum bandwidth on each G1000-4 card.

Card Protection

The ONS 15454 SDH 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 SDH. For a description of E-series Ethernet protection, see the “Spanning Tree Protocol” section on page 28.

Figure 8 Creating card protection groups



Electrical Protection

In 1:1 protection, a working card is paired with a protect card of the same type. If the working card fails, the traffic from the working card switches to the protect card. When the failure on the working card is resolved, by default traffic automatically reverts to the working card.

1:N protection operates only at the E-1 and DS-3 levels. The 1:N protect cards must be the same speed as their working cards. For example, an E1-N-14 protects E1-N-14 cards, and a DS3i-N-12 protects DS3i-N-12 cards. Each side of the shelf assembly has only one card protecting all of the cards on that side.

Optical Protection

The ONS 15454 SDH 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 STM-16 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 STM-1 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 SDH 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 bidirectional signal fails, both the transmit and receive signals switch 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

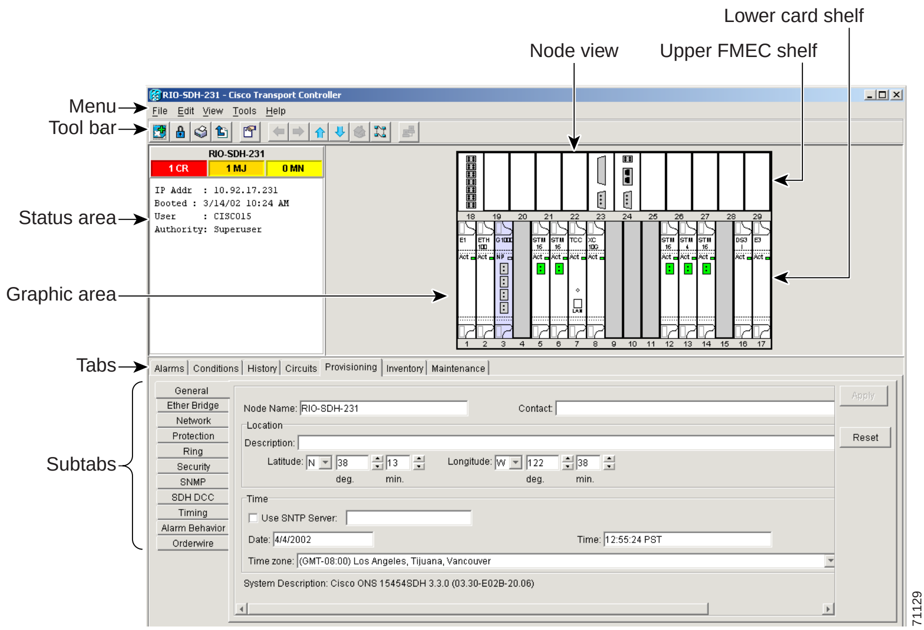
Cisco Transport Controller (CTC) is a software program that is automatically downloaded from the TCC-I card to your workstation when you connect to the ONS 15454 SDH. CTC gives you control of operation, administration, maintenance, and provisioning (OAM&P) activities for the ONS 15454 SDH.

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 SDH network and displays a user-defined map with ONS 15454 SDH 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 19 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 SDH 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 SDH 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



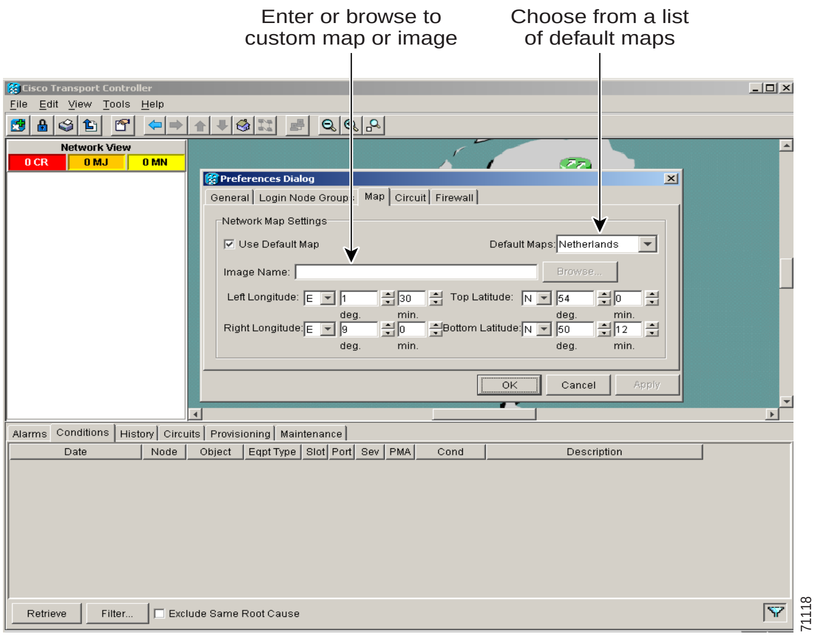
The CTC GUI displays tabs and subtabs. From the tabs you can perform all the OAM&P tasks, such as provisioning cards, circuits, and rings; creating protection groups; setting timing parameters; viewing and clearing alarms; provisioning DCCs; backing up and restoring the database; and troubleshooting,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

Note The FMECs in the upper shelf cannot be pre-provisioned.

Customized Network View

With CTC you can choose a list of default maps (Germany, Japan, Netherlands, South Korea, United Kingdom, and United States) or create a custom map from the Image Name field in the Edit > Preferences menus. The map can be any image you choose, such as a regional map or even a street map. You can drag and drop nodes to move their location on the map.

Figure 10 Choose from a list of default maps



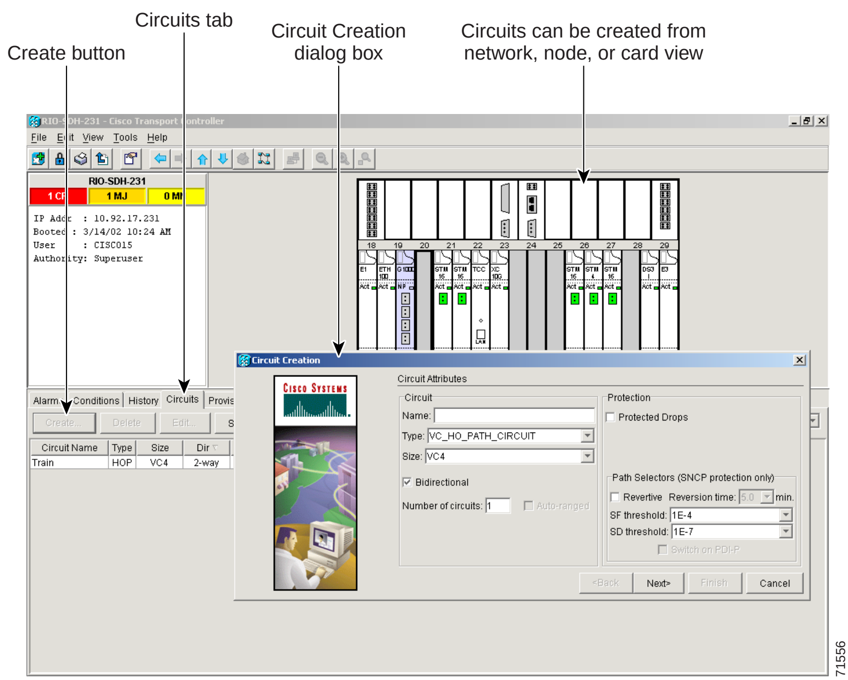
To further customize the CTC network view, you can create domains that manage the display of multiple nodes on the network map. Domains appear as a cloud on the network view. A single domain can have any number of nodes, and you can drill into the domain and display or log into any node.

Circuit Provisioning and Management

CTC enables automated circuit provisioning across ONS 15454 SDH networks and between ONS 15454 SDHs, including VC4 high-order path circuits and VC low-order path tunnels, as well as multiple drop and monitor circuits. From the CTC GUI, select a source and destination ONS 15454 SDH 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 high-order path circuits manually, for example to force traffic onto a particular path. See the "Ethernet Circuits" section on page 30 for a description of Ethernet circuits.

Figure 11 Creating circuits with the CTC Circuit Creation dialog box



Auto Range

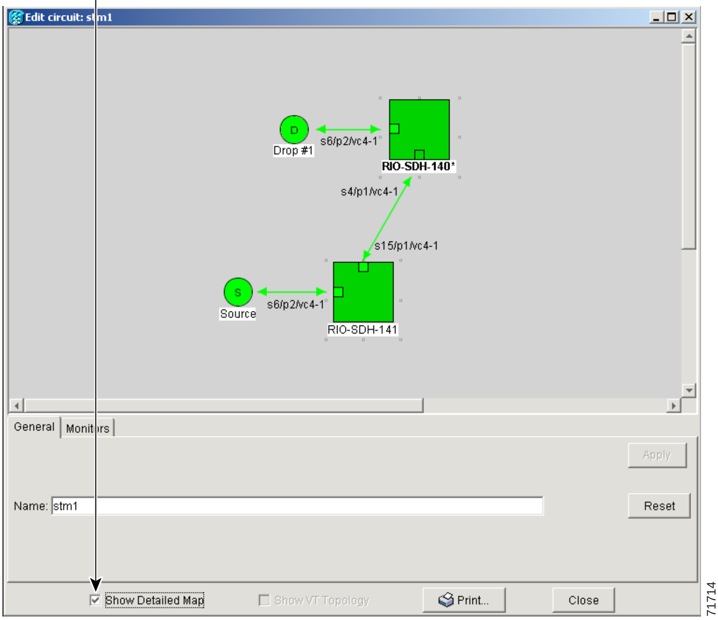
CTC provides an auto-range feature that automatically creates sequential circuits, which prevents you from needing to individually build circuits of the same type. Specify the number of circuits you need, create one circuit, and CTC automatically creates additional sequential circuits.

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 SNCP circuits.

Figure 12 Detailed circuit map

From nodeview, choose Circuits, Edit, Show Detailed Map



Performance Monitoring

Performance monitoring parameters (PMs) are used by service providers to gather, store, threshold, and report performance data for early detection of problems. CTC displays section, line, and path performance monitoring for optical, electrical, and Ethernet statistics, as defined in ITU's G.826, and

Telcordia's GR-820-CORE, and GR-253-CORE. For each statistic, you can display 31 previous 15-minute intervals and the current 15-minute interval, as well as the previous 1 day and the current 1 day interval.

The *Cisco ONS 15454 SDH Installation and Operations Guide*, *Release 3.3*, provides detailed performance monitoring information for each card.

Login Options

The ONS 15454 SDH 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, but have an IP connection.

DCC Connectivity

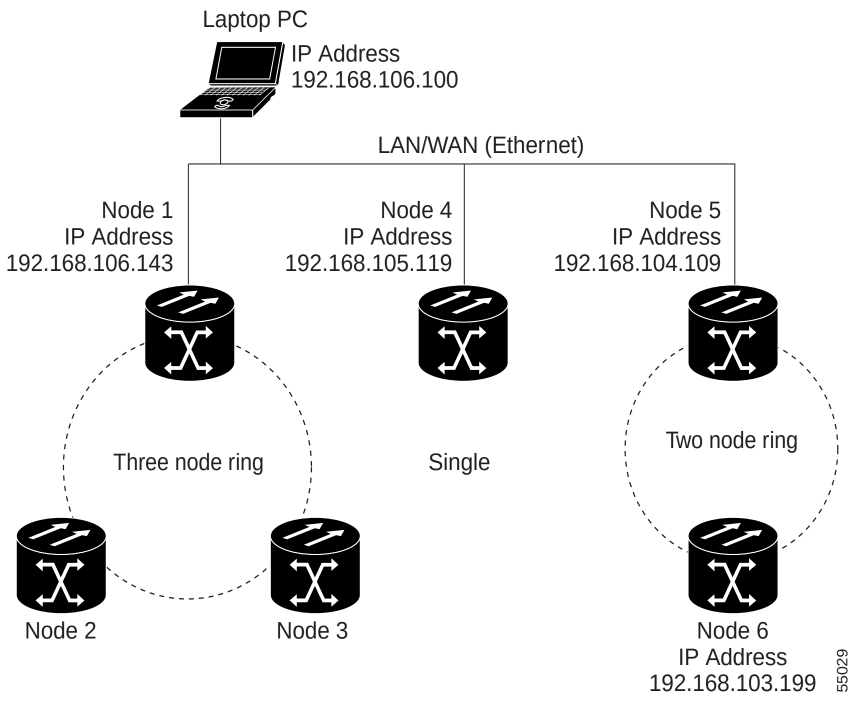
The ONS 15454 SDH uses SDH data communication channels (SDCCs) for CTC connectivity, automated circuit provisioning, and alarm reporting from remote nodes. Using a node's SDCC, CTC automatically finds and recognizes other ONS 15454 SDHs. However, during login you can choose to exclude DCC-connected nodes 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 SDH node, only ONS 15454 SDHs 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 15454 SDHs 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 SDH nodes. In a span upgrade, the transmission rate of a span is upgraded from a lower to a higher STM-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 SDH cards:

- STM-4 to STM-16
- STM-4 to STM-64
- STM-16 to STM-64

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 MS-SPRing, four-fiber MS-SPRing, SNCP, and 1+1) is retained by the higher-rate optical card. The Span Upgrade Wizard automates all steps in the manual span upgrade procedure for all protection configurations.

Alarm Collection and Display

The ONS 15454 SDH has several methods to alert you to possible problems with the node. The ONS 15454 SDH 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.

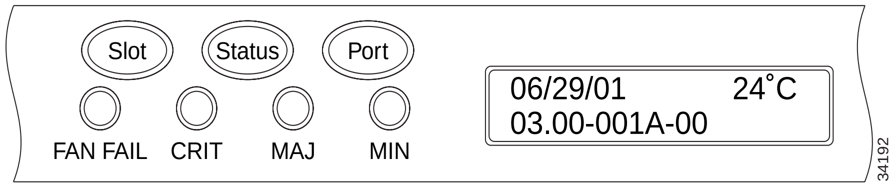
Front Panel LEDs

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

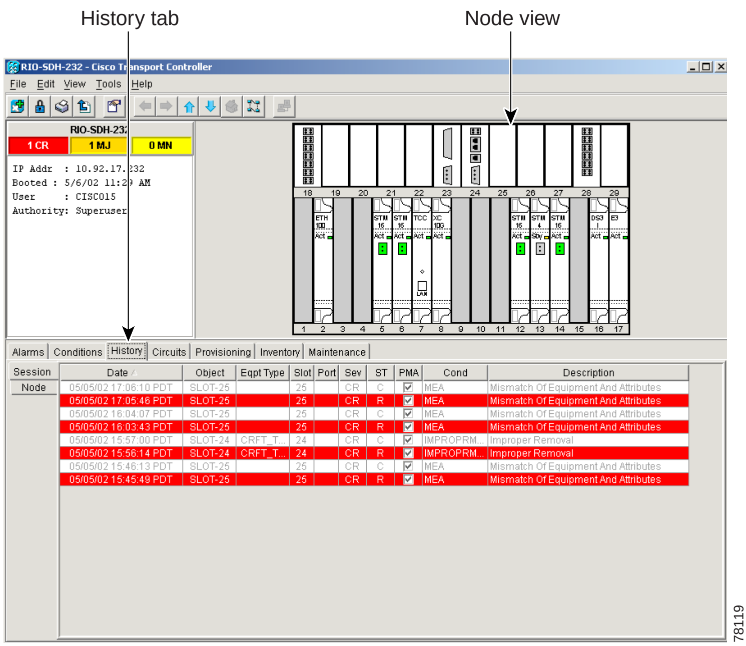
Figure 14 Using the LCD



CTC Display

Alarms display 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 SDH can store up to 256 critical alarms, 256 major alarms, 256 minor alarms, and 256 events. When the limit is reached, the ONS 15454 SDH discards the oldest alarms and events.

Alarm Profiles

From the network view, the ONS 15454 SDH 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. 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 the suppressed alarms. 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.

Ethernet

The ONS 15454 SDH integrates Ethernet access into the same SDH platform that transports voice traffic. Service providers use Ethernet over SDH to augment TDM services while delivering data traffic over existing facilities. The ONS 15454 SDH 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 SDH VC4 channels to engineer bandwidth by traffic class. The ONS 15454 SDH can also concentrate Ethernet ports into one or more VC4 circuits to use bandwidth more efficiently.

Note The E series cards (E100T-G, E1000-2-G) support layer 2 switching, while the G series card (G1000-4) does not.

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 SDH, reduces the impact of network congestion by mapping Ethernet traffic to different priority levels. The ONS 15454 SDH 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 SDH works with Ethernet devices that do and do not support IEEE 802.1Q tagging. The ONS 15454 SDH supports virtual LANs that provide private network service across an SDH backbone. You can define specific Ethernet ports and SDH VC4 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 SDH uses the IEEE 802.1D standard to provide spanning tree protocol (STP) on the E-series cards. STP detects and eliminates network loops; the ONS 15454 SDH 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 allows only one connection to be used at any given time.

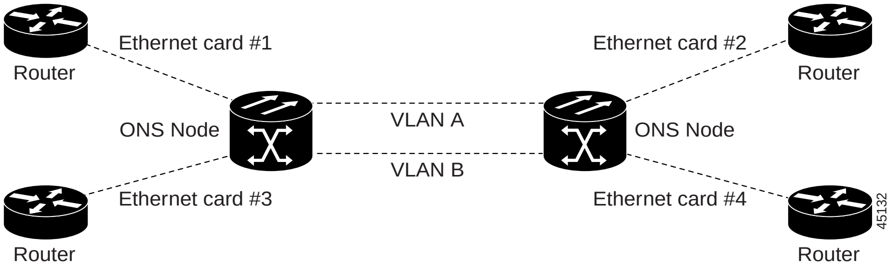
Single-Card and Multicard EtherSwitch

The ONS 15454 SDH supports single-card and multicard EtherSwitch on the E-series Ethernet cards.

When you provision a single-card EtherSwitch, each Ethernet card is a single switching entity within the ONS 15454 SDH. This option allows a full VC4-4c worth of bandwidth between two Ethernet circuit points. Single-card EtherSwitch supports one VC4-4c, two VC4-2c, one VC4-2c + two VC4s, four VC4s.

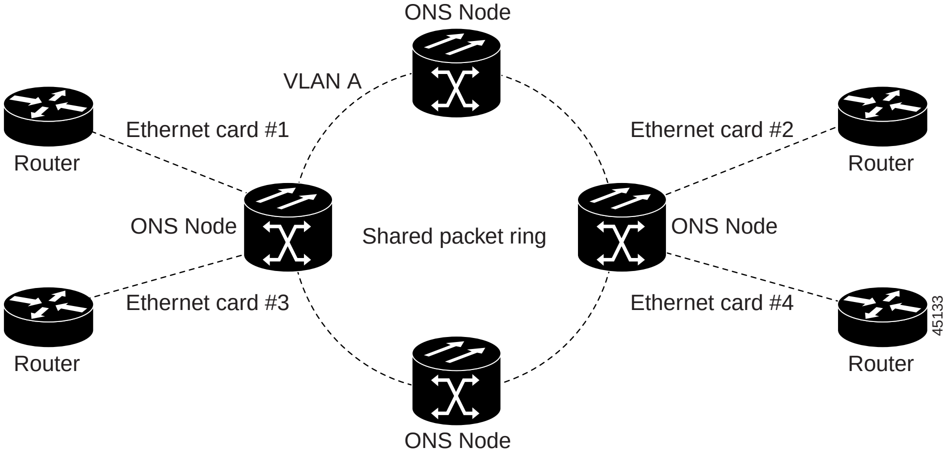
Note When configuring one VC4-2c + two VC4s, the VC4-2c must be provisioned before either of the VC4 circuits.

Figure 16 Single-card EtherSwitch



When you provision multicard EtherSwitch, two or more Ethernet cards act as a single layer 2 switch. It supports one VC4-2c circuit or two VC4 circuits. The bandwidth of the single switch formed by the Ethernet cards matches the bandwidth of the provisioned Ethernet circuit up to VC4-2c worth of bandwidth.

Figure 17 Multicard EtherSwitch



Ethernet Circuits

The ONS 15454 SDH 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 STM channel on the ONS 15454 SDH optical interface.

Network Management

The ONS 15454 SDH 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 15454 SDHs 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 SDH supports SNMP Version 1 (SNMPv1) and SNMP Version 2c (SNMPv2c); SNMPv2c offers additional protocol operations.

The ONS 15454 SDH 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 SDH node, and for generic read-only management of E-1, E-3, SDH, and Ethernet.

The ONS 15454 SDH incorporates SNMP Remote Monitoring (RMON) to allow network operators to monitor the ONS 15454 SDH 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 SDH to automatically handle ARP requests for remote non-LAN ONS 15454 SDHs connected by a DCC to the gateway ONS 15454 SDH. Proxy ARP requires no manual configuration in CTC.

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

Open Shortest Path First

If ONS 15454 SDHs are connected to Open Shortest Path First (OSPF) networks, ONS 15454 SDH 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 15454 SDHs so that the ONS 15454 SDH topology is sent to OSPF routers on a LAN. Advertising the ONS 15454 SDH network topology to LAN routers eliminates the need to manually provision static routes for ONS 15454 SDH subnetworks.

Proxy Server Feature

The ONS 15454 proxy server is a set of functions that allows you to network ONS 15454 SDHs in environments where visibility and accessibility between ONS 15454s and CTC computers must be restricted. For example, you can set up a network so that field technicians and network operating center (NOC) personnel can both access the same ONS 15454 SDHs while preventing the field technicians from accessing the NOC LAN. To do this, one ONS 15454 SDH is provisioned as a gateway NE (GNE) and the other ONS 15454 SDHs are provisioned as element NEs (ENEs). The GNE ONS 15454 SDH tunnels connections between CTC computers and ENE ONS 15454 SDHs, providing management capability while preventing access for non-ONS 15454 SDH management purposes.

Static Route Provisioning

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

DCC Tunneling

You can tunnel third-party SDH equipment DCCs across ONS 15454 SDH networks. A DCC tunnel is a series of connection points that map a third-party equipment DCC to ONS 15454 SDH 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 SDH optical port to another. DCC traffic is forwarded transparently, byte-for-byte, across the ONS 15454 SDH network.

Network Configuration

The ONS 15454 SDH supports subnetwork connection protection rings (SNCPs), multiplex-section shared protection rings (MS-SPRings), subtending rings, linear add-drop multiplexer (ADM) supporting 1+1 protection, and mixed configurations. You can also create extended SNCP mesh networks (extended SNCPs).

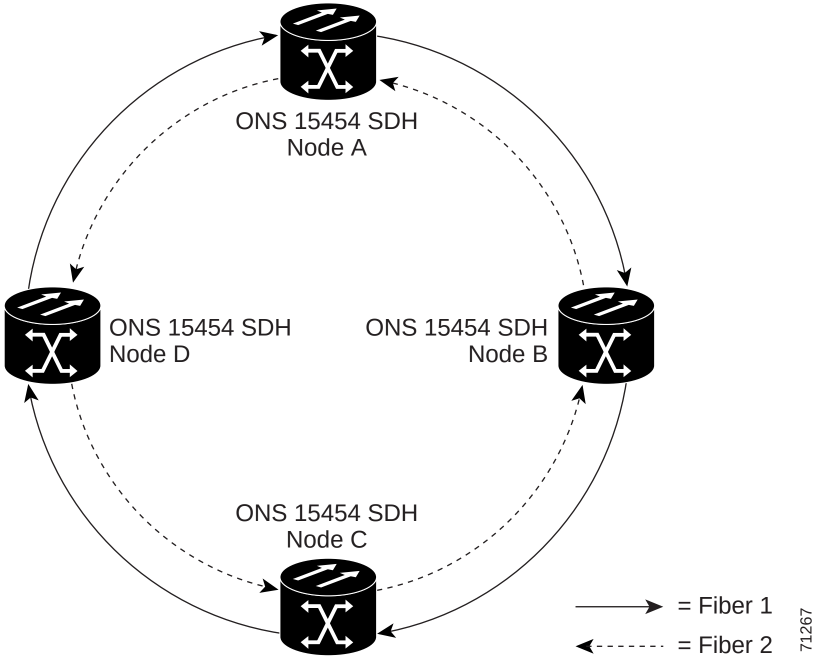
Subnetwork Connection Protection Ring

The default protection scheme for an ONS 15454 SDH is the SNCP. An SNCP 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 SNCP 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, SNCPs are best suited for networks where traffic concentrates in one or two locations and is not widely distributed.

Figure 18 shows a basic SNCP ring configuration. If Node A sends a signal to Node C, the working signal travels on the working traffic path through Node B. The same signal is also sent on the protect traffic path through Node D. If a fiber break occurs, Node C switches its active receiver to the protect signal coming through Node D.

Figure 18 A basic four-node SNCP ring

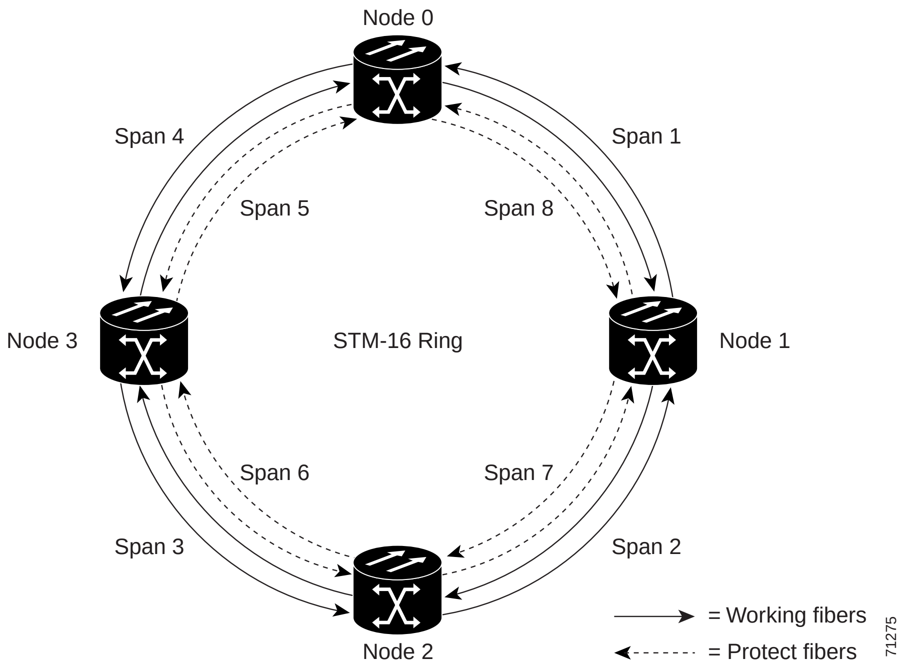


Multiplex-Section Shared Protection Ring

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

Two-fiber MS-SPRings allocate half the available fiber bandwidth for protection. In an STM-16 MS-SPRing, for example, VC4s 1 – 8 carry the working traffic, and VC4s 9 – 16 are reserved for protection. Working traffic (VC4s 1 – 8) travels in one direction on one fiber and in the opposite direction on the second fiber. You can create STM-4, STM-16, and STM-64 two-fiber MS-SPRings.

Figure 19 A four-node, four-fiber MS-SPRing



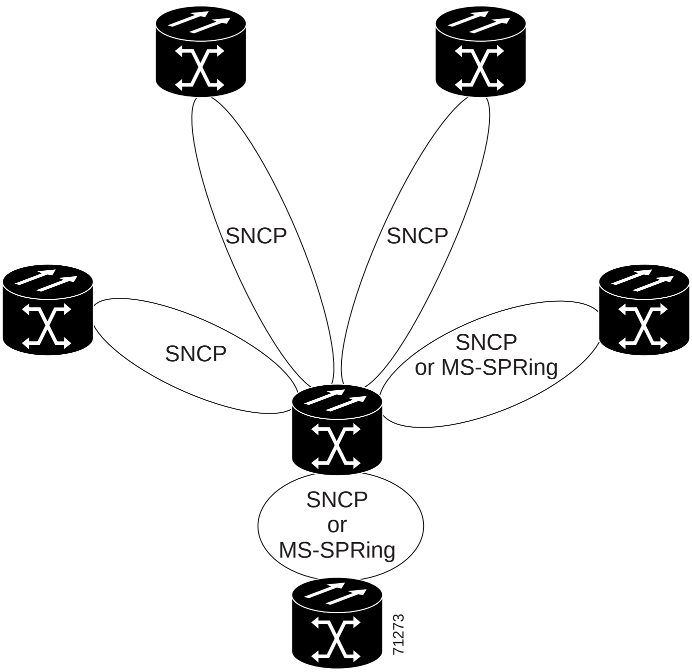
Four-fiber MS-SPRings double the bandwidth of two-fiber MS-SPRings by dedicating a second optical card for protection rather than reserving half of the active card for protection. If one fiber is cut, the ring does not switch because the other fiber carries the traffic for the broken span. A ring switch occurs if both the working and protect fibers fail. You can create STM-16 and STM-64 four-fiber MS-SPRings.

Subtending Rings

The ONS 15454 SDH supports up to ten SDH DCCs. Therefore, one ONS 15454 SDH node can terminate and groom any ring combination as long as the total DCC usage is equal to or less than 10 DCCs.

Subtending rings from a ONS 15454 SDH reduces the number of nodes and cards required, and reduces external shelf-to-shelf cabling. Figure 20 shows an ONS 15454 SDH with multiple subtending rings. In this example, Node 3 is the only node serving both the MS-SPRing and SNCP. Optical cards in Slots 5 and 12 serve the MS-SPRing, and optical cards in Slots 6 and 13 serve the SNCP.

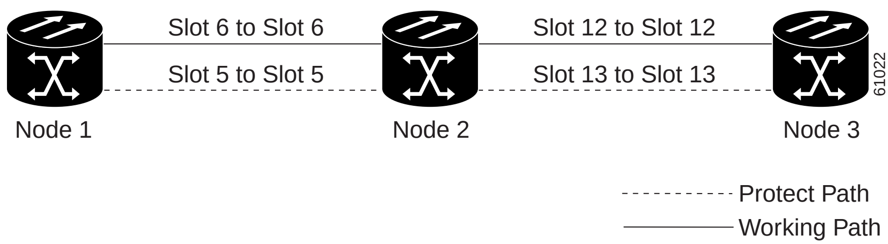
Figure 20 An ONS 15454 SDH with multiple subtending rings



Linear Add/Drop Multiplexer Mode

In ADM configuration, each node has direct access to eastbound or westbound STM channels at intermediate sites along a fiber route. ADM configurations eliminate the need for costly "back-to-back" terminal configurations and can be enhanced with protection spans for any or all transport spans in the system. Figure 21 shows an ADM configuration.

Figure 21 Linear ADM configuration



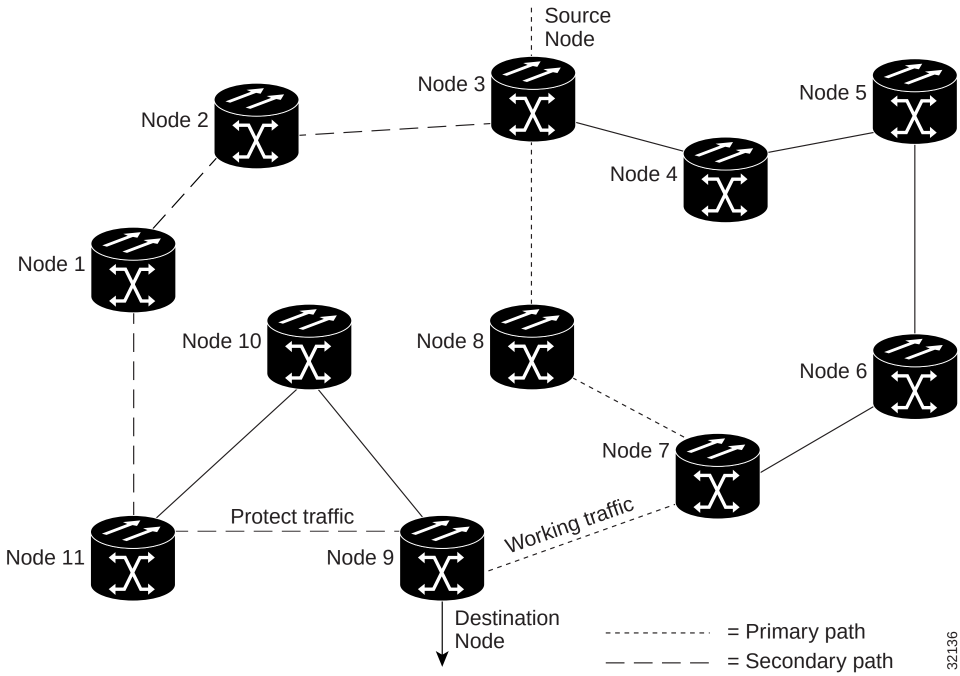
Extended SNCP Mesh Network

ONS 15454 SDH networks give you the option of setting up an extended SNCP mesh networks (extended SNCPs). Extended SNCP extends the protection scheme of SNCP from the basic ring configuration to the meshed architecture of several interconnecting rings. Typical SNCP protection creates two separate routes between source and destination nodes on a single SNCP. Extended SNCP 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, extended SNCP uses the same paths as the SNCP.

Extended SNCP 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 SNCP. 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 extended SNCP, or you can manually route circuits.

Figure 22 shows an example of an extended SNCP. 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.

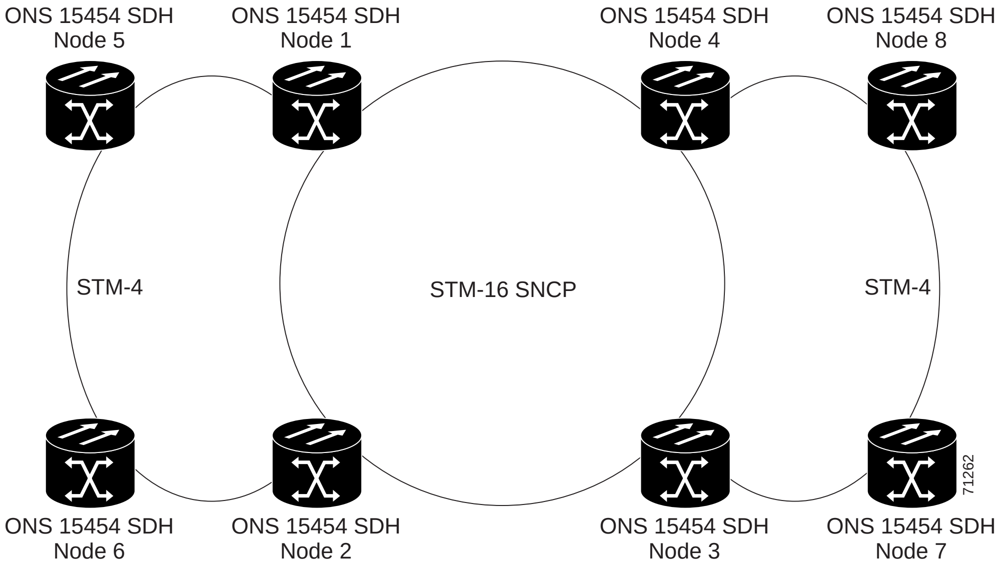
Figure 22 An extended SNCP mesh network



If you check the protected circuit box in CTC, extended SNCP 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.

Extended SNCP also allows spans of different SDH line rates to be mixed together in “virtual rings.” Figure 23 shows Nodes 1, 2, 3, and 4 in a standard STM-16 ring. Nodes 5, 6, 7, and 8 link to the backbone ring through STM-4 fiber. The “virtual ring” formed by Nodes 5, 6, 7, 8 uses both STM-16 and STM-4.

Figure 23 An extended SNCP virtual ring



Timing

The TCC-I card performs all system-timing functions for each ONS 15454 SDH. The TCC-I 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-I to synchronize to the recovered clock, which provides holdover if the reference is lost.

Timing Parameters

You must set the SDH timing parameters for each ONS 15454 SDH. ONS 15454 SDH timing is set to one of three modes: external, line, or mixed.

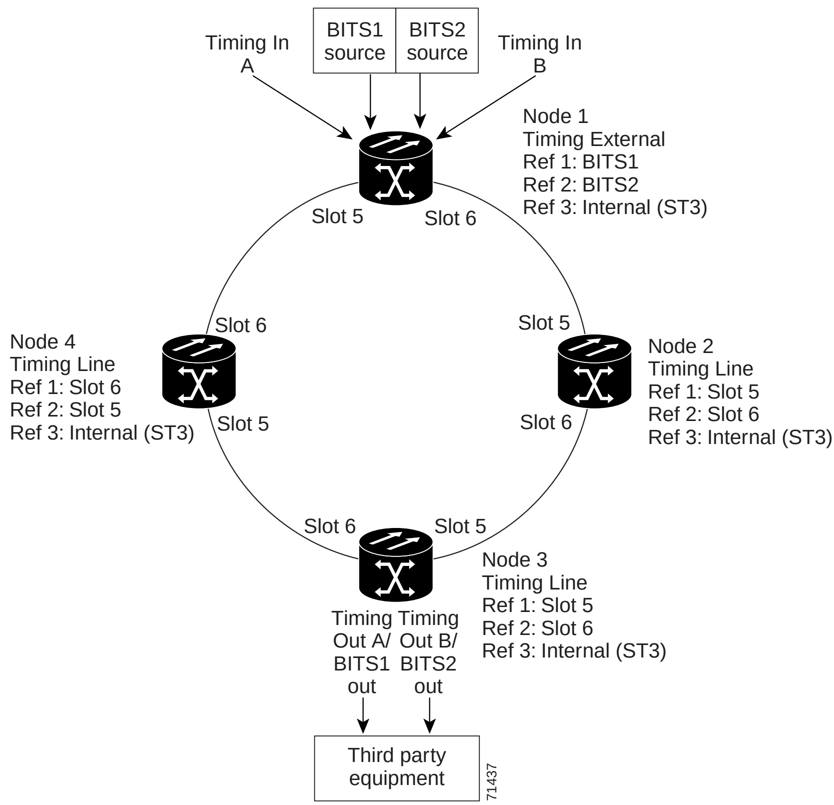
Each ONS 15454 SDH independently accepts its timing reference from one of three sources: The timing connectors on the MIC-C/T/P FMEC, an STM-N card that receives timing through a BITS source, or the internal ST3 clock on the TCC-I card.

Note CTC software refers to Timing A and Timing B as BITS (Building Integrated Timing Supply) 1 and BITS 2.

If timing is coming from the MIC-C/T/P FMEC timing connector, set ONS 15454 SDH timing to external. If the timing comes from an STM-N card, set the timing to line. An externally-timed node derives its timing from a BITS source connected to the timing A and B connectors on the MIC-C/T/P FMEC. 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 STM-N cards.

Figure 24 shows an example of an ONS 15454 SDH 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 Timing Out B connector on the FMEC of Node 3 provides timing to outside equipment, such as a digital access line access multiplexer.

Figure 24 An ONS 15454 SDH timing example



Synchronization Status Messaging

Synchronization status messaging is a mechanism for managing synchronization (or network timing) in SDH networks. It allows BITS timing sources, nodes, and combinations of the two to exchange information about the quality of timing sources. SSM messages are carried on bits 5 to 8 of SDH overhead byte S1. SSM enables SDH devices such as the ONS 15454 SDH to automatically select the highest quality timing reference and to avoid timing loops (particularly in ring architecture).

Hardware

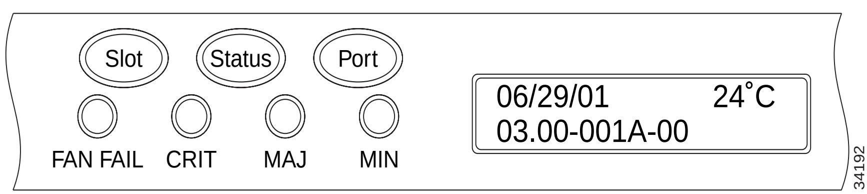
You can mount the ONS 15454 SDH in an ETSI rack. This ETSI rack is not supplied by Cisco. The shelf assembly weighs approximately 23 kilograms (50.7 pounds) without cards installed. The rack has two front doors for added security, a fan tray module for cooling, and extensive fiber-management space.

LCD

The ONS 15454 SDH LCD screen provides slot and port-level information for all ONS 15454 SDH 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 25 ONS 15454 SDH LCD



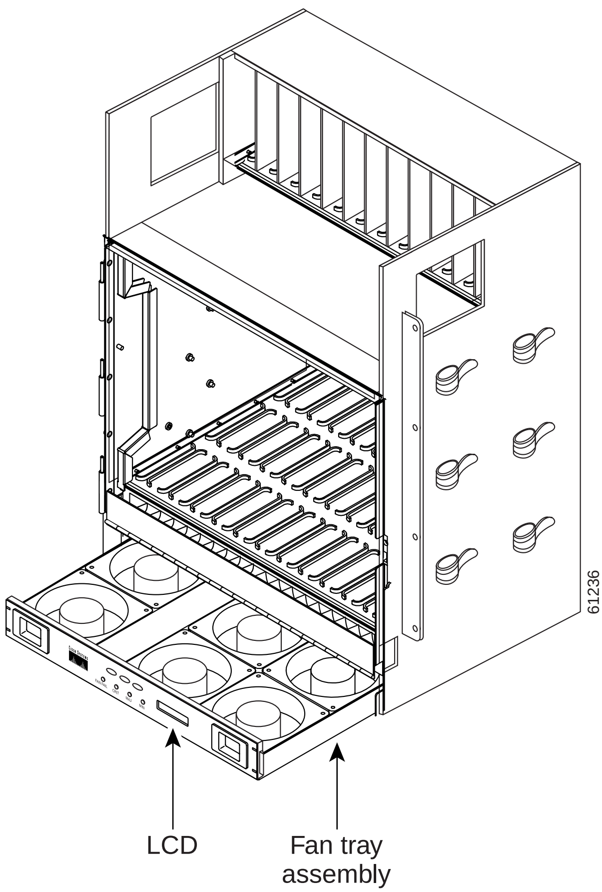
Electrical Facility Connection Assembly

The electrical facility connection assembly in the rack provides access to alarm contacts, external interface contacts, and power terminals, LAN connections, the BITS clock, and cable connectors.

Fan-Tray Assembly

The fan-tray assembly is located at the bottom of the ONS 15454 SDH front compartment. The fan-tray is a removable drawer that holds fans and fan control circuitry for the ONS 15454 SDH. 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 26 ONS 15454 SDH fan-fray assembly



Shelf Assembly Specifications

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

Bandwidth

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

Slot Assignments

- Total card slots: 29
  Lower Shelf: 17 slots (1 to 17) for common control cards, electrical cards, and optical cards
  Upper Shelf: 12 slots (18 to 29) for FMECs
- TCC-I: Slots 7 and 11
- XC-10G (Cross-Connect): Slots 8 and 10
- Slot 9 is reserved for future use with the AIC-I card
- Multispeed slots 1 – 4, 14 – 17 (any card speeds up to STM16)
- High-speed slots 5, 6, 12, 13 (any card speeds up to STM64)
- Slots 6 and 12 are not to be used for electrical cards because they have no corresponding FMEC slots.
- FMEC slots 18-22 support electrical card slots 1-5 in the lower shelf.
- FMEC slots 25-29 support electrical card slots 13-17 in the lower shelf.
- FMEC slot 23 is used for the alarm and power card called the MIC-A/P.
- FMEC slot 24 supports the timing, craft, and power card called the MIC-C/T/P.

FMEC Cards in the Upper Shelf Assembly

- FMEC-E1

- FMEC-E3/DS3
- FMEC-DS1/E1
- MIC-A/P
- MIC-C/T/P
- BLANK-FMEC (Faceplate)

Cards in the Lower Shelf Assembly

- TCC-I
- XC10G
- E1-N-14
- DS3i-N-12
- E3-12
- OC3 IR 4/STM1 SH 1310
- OC12 IR/STM4 SH 1310
- OC12 LR/STM4 LH 1310
- OC12 LR/STM4 SH 1550
- OC48 IR/STM16 SH AS 1310
- OC48 LR/STM16 LH AS 1550
- OC48 ELR/STM16 EH 100 GHz
- OC192 LR/STM64 LH 1550
- E100T-G
- E1000-2-G
- G1000-4
- BLANK (Faceplate)

Configurations

- Digital Cross-Connect
- Terminal mode

- Linear Add/Drop Multiplexer
- Two-Fiber MS-SPRing
- Four-Fiber MS-SPRing
- Subnetwork Connection Protection (SNCP)
- Extended SNCP

Cisco Transport Controller

- 10 Base-T
- TCC-I access: RJ-45 connector
- EFCA access: LAN RJ-45 connector

External LAN Interface

- 10 Base-T Ethernet
- EFCA access: LAN pin field

Alarm Interface

- Visual: Critical, Major, Minor, Remote
- Audible: Critical, Major, Minor, Remote
- Alarm Contacts: open contact max. 60V DC, closed contact 2mA
- EFCA Access: Alarm-pin fields, 62-pin DB connectors

Timing Interface

- 2 x coaxial inputs
- 2 x coaxial outputs
- EFCA access: BITS 1.0/2.3 miniature coax connector

System Timing

- Stratum 3 E, per ITU-T G.813
- 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 Voltage: -48 V DC (Future release will support -60 VDC)
- Power Consumption: configuration dependent, 53 W for fan-tray
- Power Requirements:
  - Nominal: -48 V DC
  - Tolerance Limits: -40.5 to -57.0 V DC
- Power Terminals: 3WK3 Combo-D Power Cable Connector

Environmental Specifications

- Operating Temperature: 0 to +40 degrees Celsius
- Operating Humidity: 5 - 95%, noncondensing

Dimensions

- Height: 616.5mm (24.27 inches)
- Width: 535mm (17 inches) without mounting ears attached
- Depth: 280mm (11.02 inches)
- Weight: 26kg empty (57.3 lbs.)