



Cisco ONS 15454 SDH Product Overview

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. An ONS 15454 SDH is shown in Figure 1.

Figure 1 Cisco ONS 15454 SDH



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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 a liquid crystal display (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, 10/100 Ethernet, and Gigabit Ethernet speeds.

PCs and workstations can connect to the ONS 15454 SDH using direct, network (LAN and WAN), or data communications channel (DCC) connections. Cisco Transport Controller (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, point-to-point 1+1 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 to 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 Timing Communications and Control–International card (TCC-I) and the 10 Gigabit Cross Connect card (XC10G). Slot number 9 is reserved for the Alarm Interface Controller–International card (AIC-I).

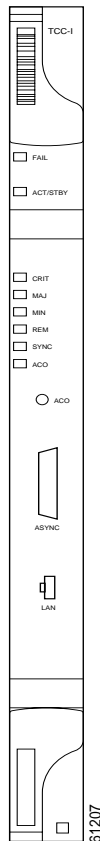
The upper shelf assembly has 12 FMEC slots numbered 18 to 29. FMECs provide serial ports, LAN ports, a modem connection for future use, electrical connections, redundant power supplies, timing connections, and alarm connections for the AIC-I card.

ONS 15454 SDH cards, when installed in a system, comply with IEC 60950, EN 60950, UL 60950, CSA C22.2 No. 60950, TS 001, and AS/NZS 3260 safety standards.

TCC-I Card

The TCC-I houses the central intelligence of the ONS 15454 SDH, including the ONS 15454 SDH Operation, Administration, Maintenance and Provisioning (OAM&P) software interface (CTC). The TCC-I card faceplate is shown in Figure 2.

Figure 2 TCC-I card faceplate



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

- System initialization

- Provisioning
- Alarm reporting
- Maintenance
- Diagnostics
- IP address detection and resolution
- Timing
- SDH 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 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 Card

The XC10G 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.

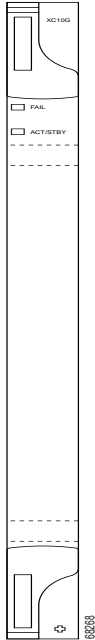


Note

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 nonblocking. The XC10G card manages up to 192 bidirectional VC4 cross-connects. The XC10G card faceplate is shown in Figure 3.

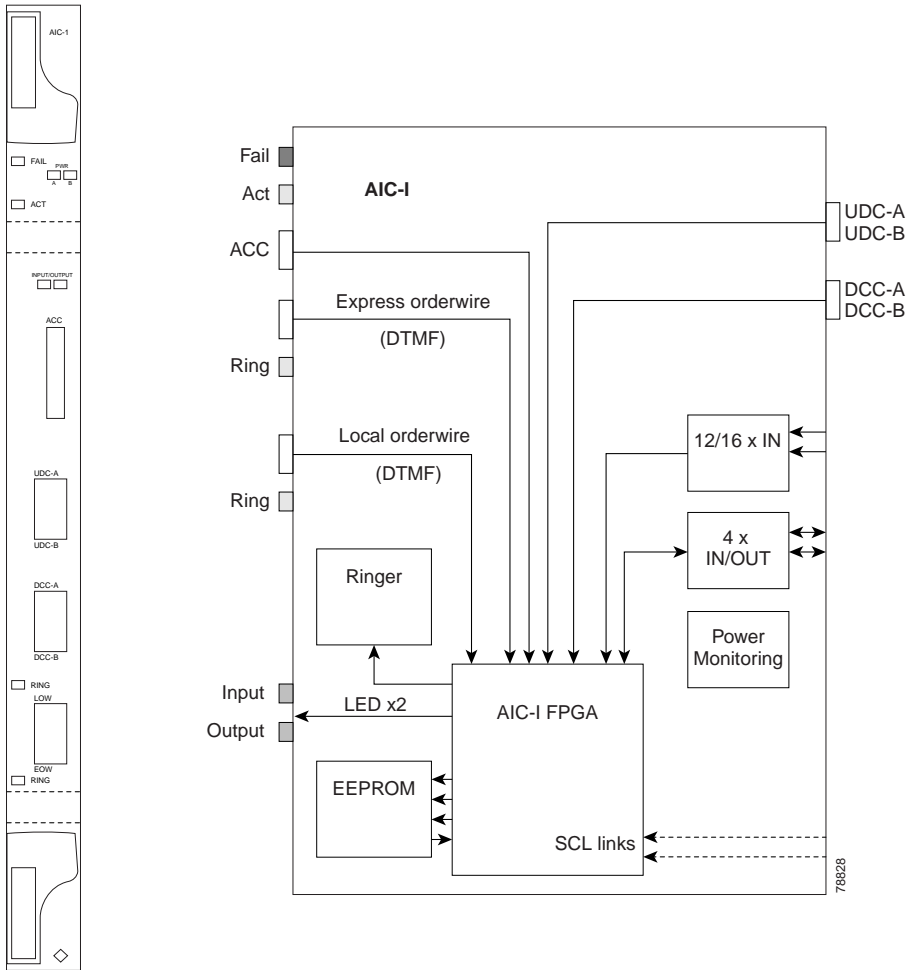
Figure 3 XC10G card faceplate



AIC-I Card

The optional AIC-I card provides customer-defined alarm input/output (I/O) and supports user data and local and express orderwire. Figure 4 shows the AIC-I faceplate and block diagram.

Figure 4 AIC-I faceplate and block diagram



User-Defined Alarms

The AIC-I card provides input/output alarm contact closures. You can define up to sixteen external alarm inputs and four external, user-configurable, alarm inputs/outputs. The physical connections are made using the MIC-A/P. The alarms are defined using CTC and TL1. LEDs on the front panel of the AIC-I indicate the status of the alarm lines.

Orderwire

Orderwire allows a craftsman to plug a phoneset into an ONS 15454 SDH and communicate with craftspeople working at other ONS 15454 SDHs or other facility equipment. The ONS 15454 SDH supports up to four orderwire channel terminations per shelf. The orderwire ports are standard RJ-11 receptacles.

The AIC-I allows simultaneous use of both local (section overhead signal) and express (line overhead channel) orderwire channels on a SONET/SDH ring or particular optics facility. Express orderwire also allows communication via regeneration sites when the regenerator is not a Cisco device. Orderwire is provisioned from the CTC network view Provisioning > Overhead Circuits tabs.

User Data Channel

The user data channel (UDC) features four dedicated data channels. Each AIC-I card supports the following UDCs:

- Two F-UDCs, carried by the F1 byte of the regenerator section of the SDH overhead. Each F-UDC provides a 64 KBit/s (kbps) point-to-point connection between two nodes in an ONS 15454 SDH network. The F-UDCs are connected to the AIC-I through two RJ-11 connectors on the front panel.
- Two MS-UDCs, carried by the D4 to D12 bytes of the multiplex section of the SDH overhead. The MS-UDC provides one 576 KBit/s (kbps) point-to-point connection between two nodes in an ONS 15454 SDH network. Each UDC can be routed to an individual and separate optical interface on the ONS 15454 SDH system. The MS-UDCs are connected to the AIC-I through RJ-45 connectors on the front panel.

All of the UDCs are provisioned from the CTC network view Provisioning > Overhead Circuits tabs.

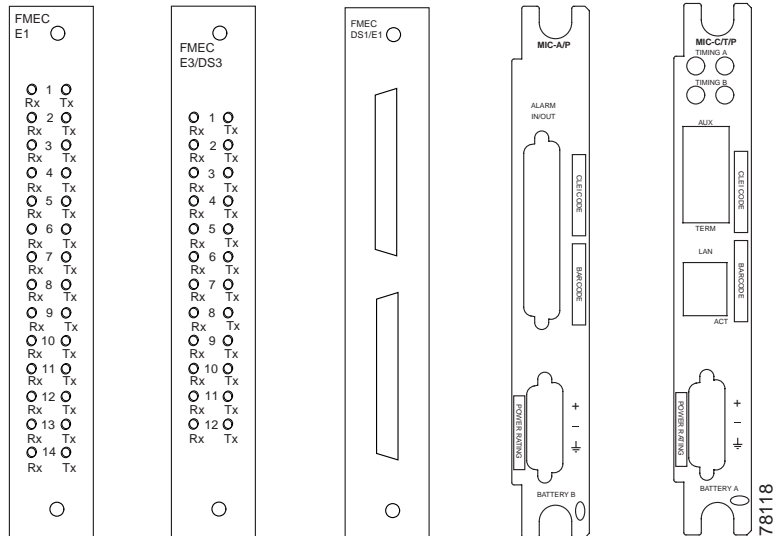
Data Communication Channel

The data communications channel (DCC) features a dedicated data channel of 576 kBit/s (D4 to D12 bytes) between two nodes in an ONS 15454 SDH network. Each AIC-I card provides two DCCs, DCC-A and DCC-B, through separate RJ-45 connectors on the front of the AIC-I. Each DCC can be routed to an individual optical interface in the ONS 15454 SDH system. DCC connection cannot be provisioned if DCC tunneling is configured on this span.

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 AIC-I card. The upper shelf assembly has 12 FMEC slots numbered 18 to 29. FMEC Slots 18 to 22 support the electrical cards in Slots 1 to 5 of the lower shelf. FMEC Slots 25 to 29 support the electrical cards in Slots 13 to 17 of the lower shelf. FMEC Slot 23 is used for the MIC-A/P alarm and power card. FMEC Slot 24 supports the MIC-C/T/P timing, craft, and power card. FMEC faceplates for the E1, E3/DS3, DS1/E1, MIC-A/P, and MIC-C/T/P cards are shown in Figure 5.

Figure 5 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 AIC-I cards. The MIC-A/P card also stores manufacturing and inventory data. For proper system operation, the MIC-A/P FMEC card must be installed in the shelf.

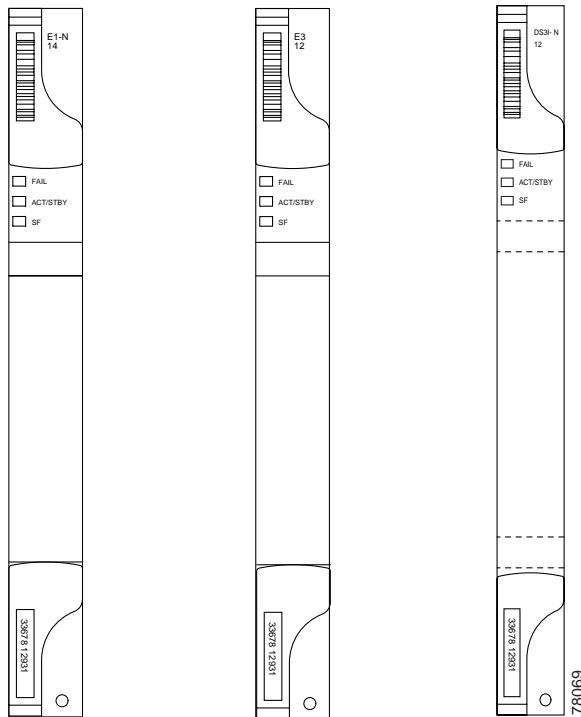
MIC-C/T/P FMEC

The MIC-C/T/P FMEC card provides front-panel access for the Timing A and Timing B connectors, two system power connectors at $-48V$, 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 to 5 and 13 to 17 host all electrical cards (E-1, E-3, and DS-3i). Each card has faceplate LEDs showing active, standby, or alarm status. You can also obtain the status of all electrical card ports using the LCD screen on the ONS 15454 SDH fan-tray assembly. Figure 6 shows the E-1, E-3, and DS-3i faceplates.

Figure 6 Faceplates for the E1-N-14, E3-12 and DS3-N 12 cards



The upper shelf assembly has 12 FMEC slots numbered 18 to 22, and 25 to 29. These slots support the electrical cards in Slots 1 to 5 and 13 to 17 of the lower shelf. Each FMEC slot supports the electrical card in a specific slot of the lower shelf. For example, FMEC Slot 18 supports only the electrical card in Slot 1 of 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.

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 120-ohm twisted-pair copper cable with the DS1/E1 FMEC, or over a 75-ohm 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. To use the 1:N functionality of the card, 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 75-ohm 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 to 3 = PG1, Ports 4 to 6 = PG2, Ports 7 to 9 = PG3, and Ports 10 to 12 = PG4.

DS-3i Card

The DS3i-N-12 card provides twelve DS-3 ports per card, compliant with ITU-T G.703, Telcordia GR-499, and ITU-T G.704. Each port operates at 44.736 MBits/s (Mbps) over a 75-ohm 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 ($N \leq 4$) 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 to 6 or 12 to 17. The STM-64 cards reside in Slot 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 signal failure (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 7 shows the STM-1, STM-4, STM-16 and STM-64 faceplates.

Figure 7 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 ports compliant with ITU-T G.707 and G.957. 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 port per card, compliant with ITU-T G.707 and G.957. The port operates at 622.08 MBits/s (Mbps) over a single-mode fiber span. The card supports concatenated or non-concatenated VC4 payloads.

STM4-4 SH Card

The OC12 IR/STM4 SH 1310-4 card provides four intermediate- or short-range port per card, compliant with Telcordia GR-253 IR-1, Telcordia GR-2918-CORE, ITU-T G.707, and ITU-T G.957. Each 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 port per card, compliant with ITU-T G.707 and G.957. 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 port per card, compliant with ITU-T G.707 and G.957. 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 port per card, compliant with ITU-T G.707 and G.957. 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 LH AS 1550 card provides one long-range port per card, compliant with ITU-T G.707 and G.957. 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 OC48 ELR/STM16 EH 100 GHz dense wavelength division multiplexing (DWDM) cards provide the ONS 15454 SDH DWDM channel plan. Although the ONS 15454 SDH uses 200-GHz spacing, these cards also work in 100-GHz-capable systems. Each STM-16 DWDM card provides one port per card, compliant with ITU-T G.692, G.707, G.957, and G.958. 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 port per card, compliant with ITU-T G.707 and G.957. The port operates at 9.95 GBits/s (Gbps) over unamplified distances of 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

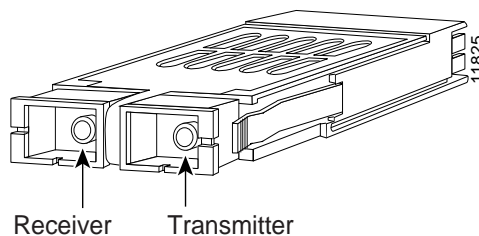
The ONS 15454 SDH uses E100T-G cards for Ethernet 10 Mbits/s (Mbps) and Fast Ethernet 100 Mbits/s (Mbps). Each card provides twelve switched, IEEE 802.3-compliant, 10/100BaseT Ethernet interfaces that can independently detect (auto-sense) the speed of an attached device and automatically connect at the appropriate speed. The ports determine whether to enable or disable flow control and auto-configure to operate at either half or full duplex. 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 Mbits/s (Mbps). Each card provides two ports of IEEE-compliant, 1000 Mbits/s (Mbps) interfaces for high-capacity customer LAN interconnections. Each interface supports full-duplex operation.

The E1000-2-G cards use GBIC modular receptacles for the optical interfaces (Figure 8). 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 short-reach (SX) and long-reach (LX) GBICs. The SX model connects to multimode fiber and the LX model requires single-mode fiber.

Figure 8 Gigabit Interface Converter



G1000-4 Card

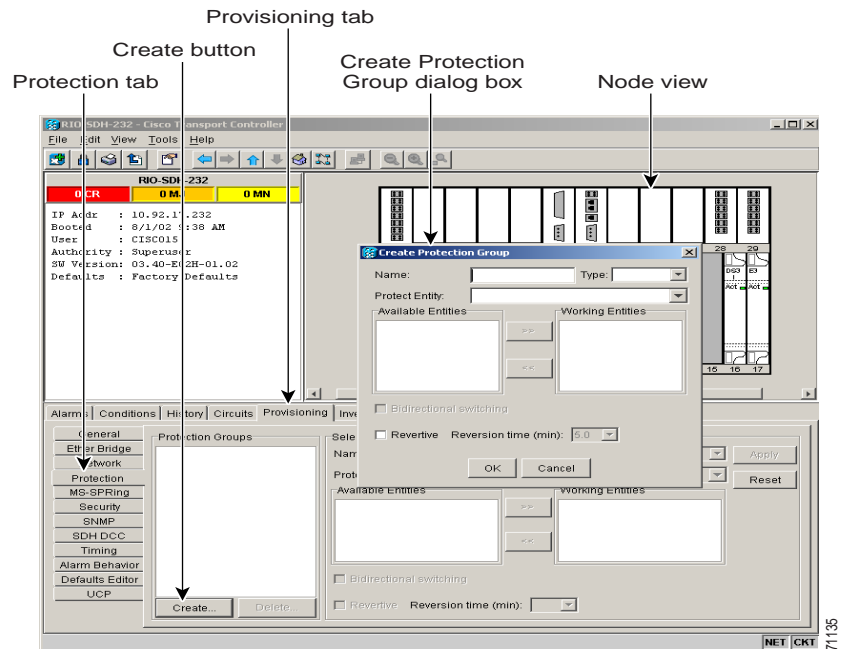
The G-1000 is a high-capacity Ethernet card enhanced for high-bandwidth private line interconnects. Like the E1000-2-G card, the G1000-4 provides IEEE-compliant, 1000 Mbits/s (Mbps) ports for full-duplex operation and requires a GBIC as its optical interface.

The G1000-4 card supports three types of standard Cisco GBICs: SX, LX, and extended reach (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. This section describes the protection options and explains protection switching in the ONS 15454 SDH. Figure 9 shows the CTC tools used to create card protection groups. For a description of E-series Ethernet protection, see the “Spanning Tree Protocol” section on page 34.

Figure 9 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 card protects E1-N-14 cards, and a DS3i-N-12 card protects DS3i-N-12 cards. Each side of the shelf assembly has only one card that protects 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, revertive switching automatically switches the signal back to the working card after the provisionable revertive time period has elapsed. With non-revertive switching, traffic does not automatically revert to the working card when the working card reverts to active status.

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.

Protection Channel Access (PCA)

1:1 and 1+1 protection configurations utilize only a portion of ring bandwidth. The remaining bandwidth is idle until a switch occurs. PCA circuits run through the idle bandwidth on 2-fiber and 4-fiber MS-SPRings. Since they are considered to be lower priority, PCA circuits are pre-empted when a switch occurs to make room for the protected circuits. They are restored when the protected circuit is no longer needed. PCA circuits help you to utilize networks more efficiently by lowering overall network cost per bit, leveraging untapped network bandwidth, and sharing network costs across a larger service base. ONS 15454 SDH PCA circuits are compliant with Telcordia GR-1230-CORE Section 3.4.

Cisco Transport Controller

Cisco Transport Controller (CTC) is a software program that gives you control of OAM&P activities for the ONS 15454 SDH. The program is automatically downloaded from the TCC-I card to your workstation when you connect to the ONS 15454 SDH. CTC also provides a setup wizard that installs the files needed to use CTC on a PC or Solaris workstation.

Graphical User Interface

The CTC graphical user interface (GUI), also called the CTC window, provides three primary views, or modes. These modes 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. You can perform network management tasks or display any node in this view. See the “Customized Network View” section on page 24 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 (Figure 10 on page 23). The cards are color-coded to show the status of the physical cards and ports. This is the default view displayed each time you log into CTC. You can perform node management tasks in this view. Figure 10 shows the CTC software in node view.
- Card view—Provides information about individual ONS 15454 SDH cards and displays a graphic of the selected card. The information that appears and the tasks you can perform depend on the card. You can perform card and port-specific maintenance tasks in this view.

The CTC GUI displays tabs and subtabs. From the tabs you can perform all of the OAM&P tasks. These tasks include 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.

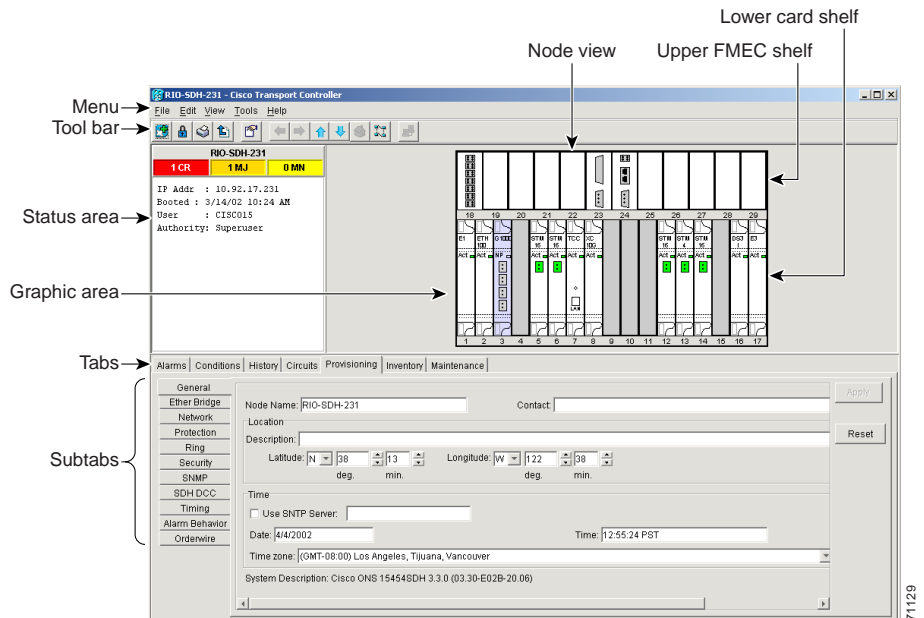
You can filter the display of circuits in any of the CTC views. Circuits can be filtered by name, direction, circuit status (active, incomplete, or upgradable), slot, port, type (high-order circuit, low-order circuit, or low-order tunnel), or size. You can also view the circuits that belong to a particular span.



Note

The FMECs in the upper shelf cannot be preprovisioned.

Figure 10 CTC in node view



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Security

Several CTC security enhancements have been implemented in ONS 15454 SDH Release 3.4. These include enforced password complexity, prevention of consecutive password reuse, and a login warning screen that can be provisioned by the user (with Superuser access level).

You can add up to 500 users to one ONS 15454 SDH. Each ONS 15454 SDH user is assigned one of the following security levels:

- Retrieve—Can retrieve and view CTC information but cannot set or modify parameters.
- Maintenance—Can access only the ONS 15454 SDH maintenance options.
- Provisioning—Can access provisioning and maintenance options.

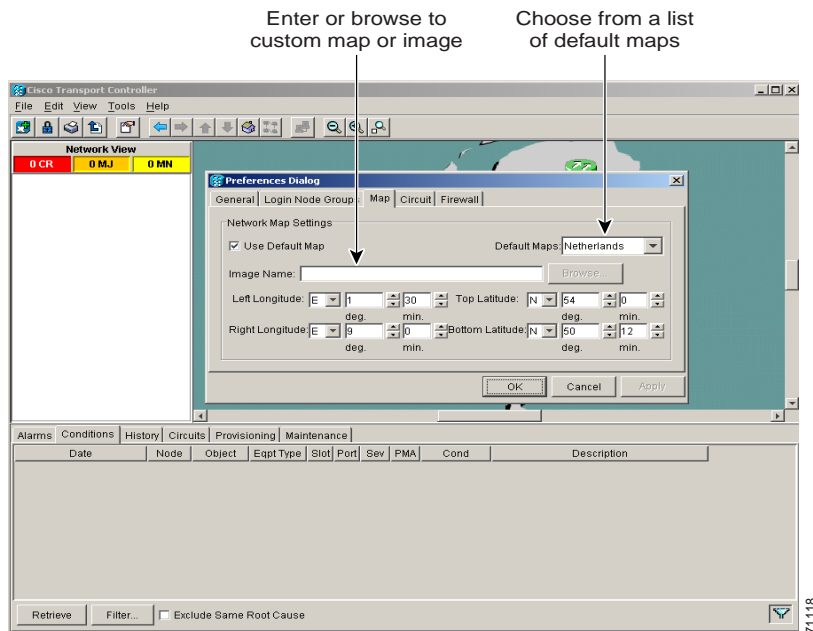
- Superusers—Can perform all of the functions of the other security levels. They can also set names, passwords, and security levels for other users.

Customized Network View

With CTC, you can choose from a list of default maps (Germany, Japan, Netherlands, South Korea, United Kingdom, and United States) or import a custom map using the Edit > Preferences menu option (Figure 11). 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.

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 clouds on the network view. A single domain can have any number of nodes. From a domain, you display or log into any node that it contains.

Figure 11 Choose from a list of default maps



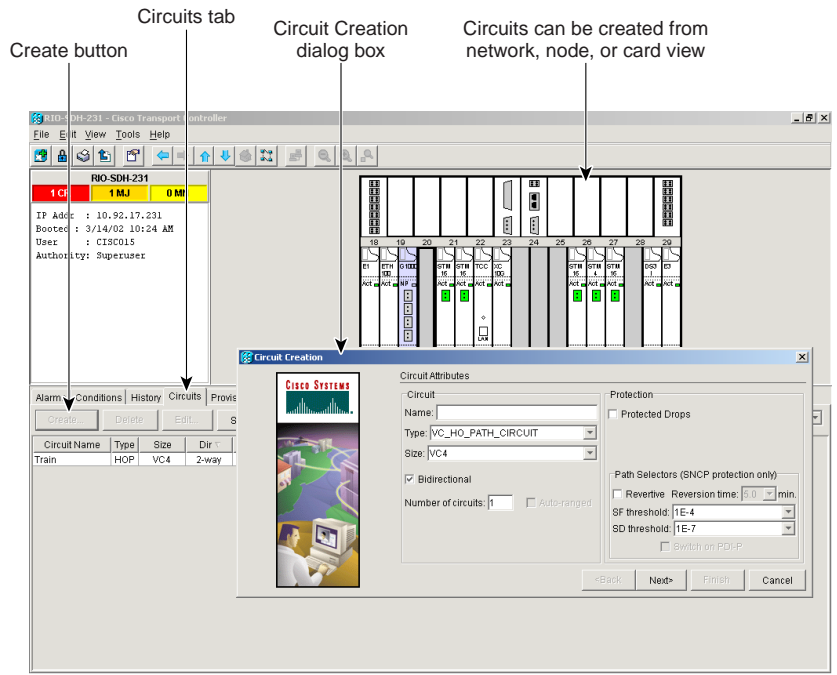
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Circuit Provisioning and Management

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. You can also create a half circuit, from a drop to an STM-N card on the same node.

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. Figure 12 shows the CTC tools used to create circuits. See the “Ethernet Circuits” section on page 35 for a description of Ethernet circuits.

Figure 12 *Creating circuits with the CTC Circuit Creation dialog box*



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Auto Range

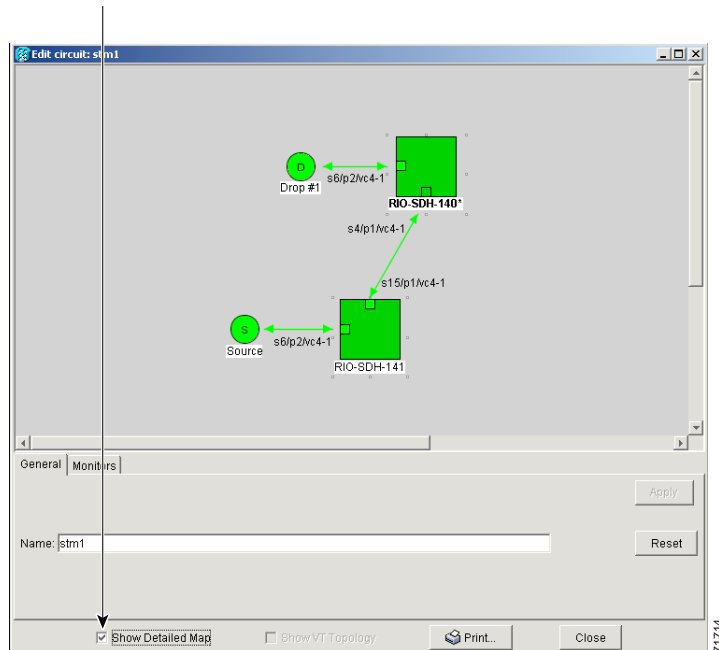
CTC provides an auto-range feature that automatically creates sequential circuits. Specify the number of circuits you need, create one circuit, and CTC automatically creates additional sequential circuits. This feature allows you to create multiple circuits of the same type without having to individually build each one.

Detailed Circuit Map

The detailed circuit map (Figure 13) allows you to see an end-to-end view of circuits, including ports, drops, spans, and selectors for SNCP circuits. This differs from the node view, which shows nodes and spans but no circuit details.

Figure 13 Detailed circuit map

From nodeview, choose Circuits,
Edit, Show Detailed Map



Performance Monitoring

Performance monitoring (PM) parameters are used by service providers to gather, store, set thresholds for, 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-T G.826 and Telcordia GR-820-CORE and GR-253-CORE. For each parameter, you can display statistics about the 31 previous 15-minute intervals and the current 15-minute interval, as well as statistics for the previous 1-day interval and the current 1-day interval.

The *Cisco ONS 15454 SDH Installation and Operations Guide, Release 3.4*, 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

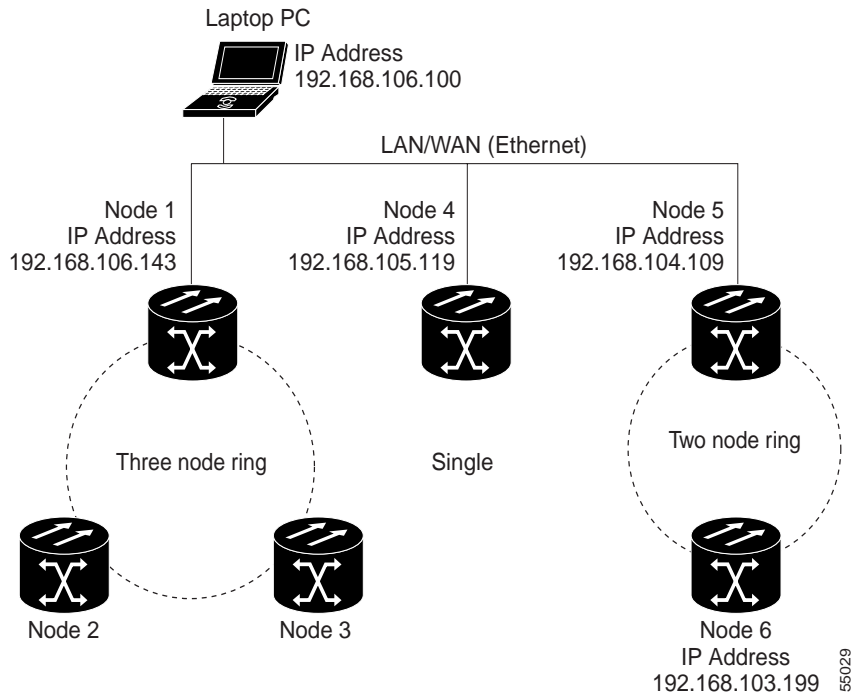
The ONS 15454 SDH uses regenerator section data communication channels (DCCs) for CTC connectivity, automated circuit provisioning, and alarm reporting from remote nodes. CTC uses a node's SDCC to automatically find and recognize other ONS 15454 SDHs. You also have the option to exclude DCC-connected nodes from autodiscovery during login. This 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.

Refer to the example in Figure 14. 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 that contains the IP addresses of Nodes 1, 4, and 5. When you log into any node in the group, all optically connected nodes are displayed.

Figure 14 Viewing non-DCC-connected nodes using a login node group



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System Maintenance

ONS 15454 SDH equipment can be placed in one of four different service states. These states make the equipment available for maintenance or service. Span upgrades can be performed without removing cards from service.

Service States

ONS 15454 SDH cards, ports, and circuits can be placed in any of the following service states:

- **In Service (IS)**—The card, port, or circuit is fully available for operation (working or protect).
- **Out of Service (OOS)**—The card, port, or circuit is not available for operation.
- **Out of Service for Maintenance (OOS-MT)**—The port or circuit has been temporarily taken out of service for maintenance. Alarms are not reported autonomously, but they can be retrieved. This state is not available for cards.
- **Out of Service—Auto In Service (OOS-AINS)**—The card, port, or circuit is currently out of service, but will automatically be placed in service when a valid card is plugged into the preprovisioned slot and fully initialized.

Use the CTC Provisioning >Line tabs or the CTC Maintenance > Line tabs to transition ports from state to state. The user can also transition the port into different states from the State tab in the Edit Circuit window.

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. 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, or 1+1) is retained by the higher-rate optical card. The Span Upgrade Wizard automates the 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, and remote alarms on the node. The LCD provides alarm information on a port and card level in addition to node level. CTC displays alarms and events on a port, card, or node level for all nodes in the network. CTC can also highlight the circuits that are affected by a particular alarm.

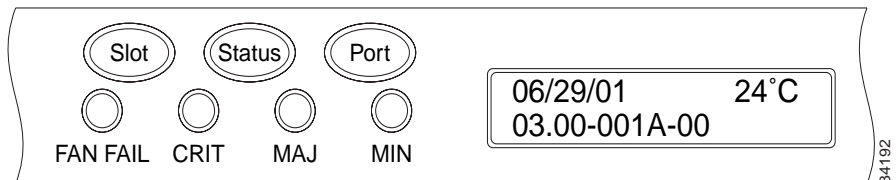
Front Panel LEDs

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 (Figure 15) provides slot- and port-level alarm information for all ONS 15454 SDH card slots, including the number of critical, major, and minor alarms.

Figure 15 Using the LCD



CTC Display

Alarms (cleared or active), conditions, and events 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. Information displayed includes the date, time, severity, reporting node, reporting object, service-affecting status, and description of the alarm or event (Figure 16).

Figure 16 Viewing alarms for the current session

The screenshot shows the CTC interface for a node named RIO-SDH-232. The top section displays the node's status: 1 CR, 1 MJ, and 0 MN. Below this, the node's IP address (10.92.17.232), boot time (5/6/02 11:29 AM), user (CISCO15), and authority (Supervisor) are listed. The main area shows a node view with a grid of slots (1-28) and ports (1-16). The bottom section displays the alarm history table.

Session	Date	Object	EqptType	Slot	Port	Sev	ST	PMA	Cond	Description
Node	05/05/02 17:06:10 PDT	SLOT-25		25		CR	C	<input checked="" type="checkbox"/>	IMEA	Mismatch Of Equipment And Attributes
	05/05/02 17:05:46 PDT	SLOT-25		25		CR	R	<input checked="" type="checkbox"/>	IMEA	Mismatch Of Equipment And Attributes
	05/05/02 16:03:43 PDT	SLOT-25		25		CR	R	<input checked="" type="checkbox"/>	IMEA	Mismatch Of Equipment And Attributes
	05/05/02 15:57:00 PDT	SLOT-24	CRFT_T	24		CR	C	<input checked="" type="checkbox"/>	IMPROPRM	Improper Removal
	05/05/02 15:56:14 PDT	SLOT-24	CRFT_T	24		CR	R	<input checked="" type="checkbox"/>	IMPROPRM	Improper Removal
	05/05/02 15:46:13 PDT	SLOT-25		25		CR	C	<input checked="" type="checkbox"/>	IMEA	Mismatch Of Equipment And Attributes
	05/05/02 15:45:49 PDT	SLOT-25		25		CR	R	<input checked="" type="checkbox"/>	IMEA	Mismatch Of Equipment And Attributes

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

- **Session subtab**—Presents alarm and event messages for the current CTC session. When you log off, the alarm list generated during the CTC session disappears.

- Node subtab—Shows alarm and event messages that occurred at the node since the CTC software installation, and also alarm and event messages for the current CTC session. The ONS 15454 SDH can store up to 640 critical alarm raise/clear messages, 640 major alarm raise/clear messages, 640 minor alarm raise/clear messages, and 640 events. When the limit is reached for a category, the ONS 15454 SDH discards the oldest alarms and event-level raise/clear/transient messages in that category.

Alarm Profiles

The ONS 15454 SDH includes an alarm profile feature, accessible from the CTC network view. This feature allows you to change the default alarm severities (for example, from minor to major) and apply the new severities at the card, port, or node level. Alarm profiles for a given card can be viewed in the Alarm Behavior tab in the CTC card view.

CTC also has a network element (NE) default feature that allows you to change port and card level default settings for the ONS 15454 SDH from one convenient location. This feature can be accessed from the Provisioning > Defaults Editor tabs in the node view.

In addition to user-defined profiles, CTC stores a default profile that sets severities to standard ITU-T G.783 settings. 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 on 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 that are still active.

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, but the G-series card (G1000-4) does not.

Priority Queuing

Networks without priority queuing handle all packets on a first-in, first-out (FIFO) 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 whether they support IEEE 802.1Q tagging or not. The ONS 15454 SDH supports virtual LANs (VLANs) 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 external 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 both 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 STP at the Ethernet port level to allow parallel connections to external networking equipment. STP 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.

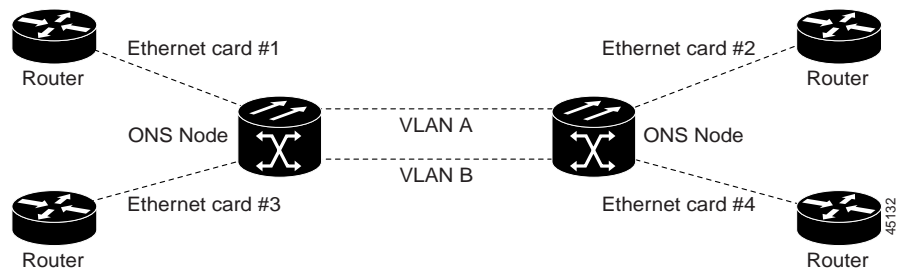
When you provision a Single-card EtherSwitch (Figure 17), each Ethernet card is a single switching entity within the ONS 15454 SDH. This option allows a full VC4-4c worth of bandwidth between two Ethernet circuit points. Single-card EtherSwitch supports one VC4-4c, two VC4-2c, one VC4-2c plus two VC4s, or four VC4s.



Note

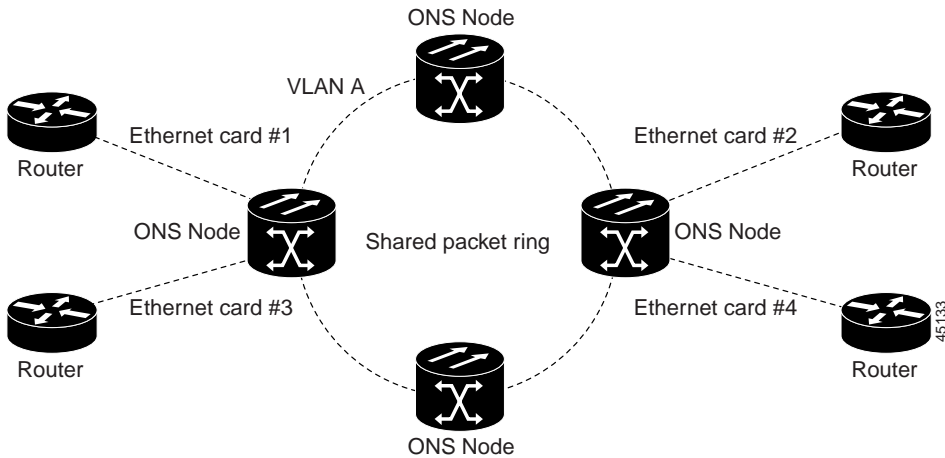
When configuring one VC4-2c plus two VC4s, the VC4-2c must be provisioned before either of the VC4 circuits.

Figure 17 Single-card EtherSwitch



When you provision Multicard EtherSwitch (Figure 18), 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 18 *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. A point-to-point circuit configuration is usually used to connect two nodes. 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), Open Shortest Path First (OSPF) protocol, and Routing Information Protocol (RIP). 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

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 the Hewlett-Packard 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 OSPF networks, ONS 15454 SDH network information can be automatically communicated across multiple LANs and WANs. Use CTC to view and configure OSPF area information for the nodes that the OSPF network controls.

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 operations 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 end 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.

Routing Information Protocol

RIP is an interior gateway protocol, which means that it performs routing within a single autonomous system. It is widely used to route traffic in the global Internet.

RIP routers maintain only the best route (the route with the lowest metric value) to a destination. After updating its routing table, the router immediately begins transmitting routing updates to inform other network routers of the change. These updates are sent independently of the regularly scheduled updates that RIP routers send.

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 are all on the same subnet. For example, a NOC can remotely monitor an ONS 15454 SDH through CTC while an onsite employee is logged into a network ONS 15454 SDH through 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 endpoint is defined by the slot, port, and DCC type. To create a DCC tunnel, connect the tunnel endpoints 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 (SNCP) rings, multiplex section-shared protection rings (MS-SPRings), subtending rings, linear add/drop multiplexers (ADMs) that support 1+1 protection, and mixed configurations. You can also create extended SNCP mesh networks (extended SNCP).

Circuit protection can be configured in CTC. You can also use CTC to specify the nodes and spans to use for the protect path.

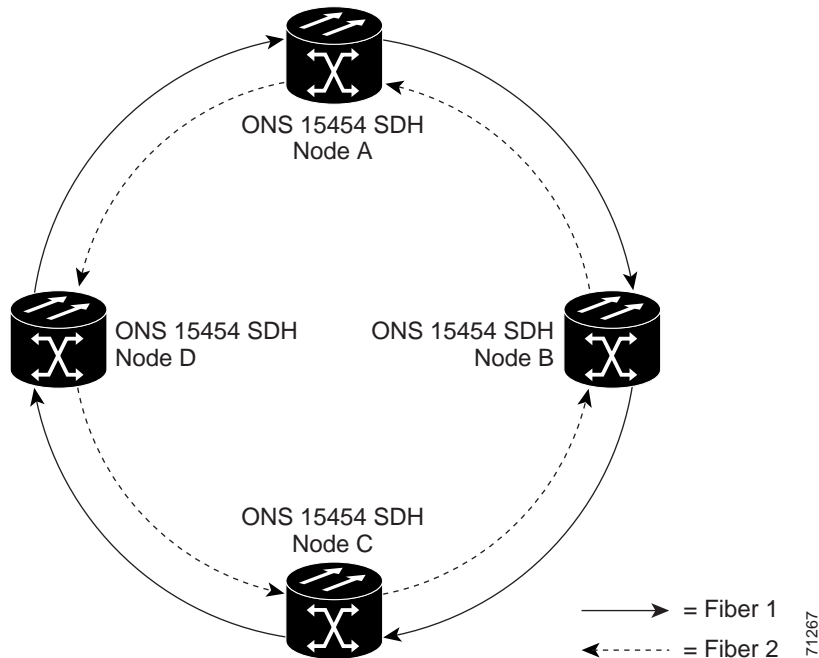
Subnetwork Connection Protection Ring

The default protection scheme for an ONS 15454 SDH is the SNCP ring. An SNCP ring 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. SNCP signal thresholds—the levels that determine when the SNCP path is switched—are set at the circuit level.

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. You can also create an SNCP bridge-selector circuit entry point in a multivendor SNCP. 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 19 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 19 Basic four-node SNCP ring



Multiplex Section–Shared Protection Ring

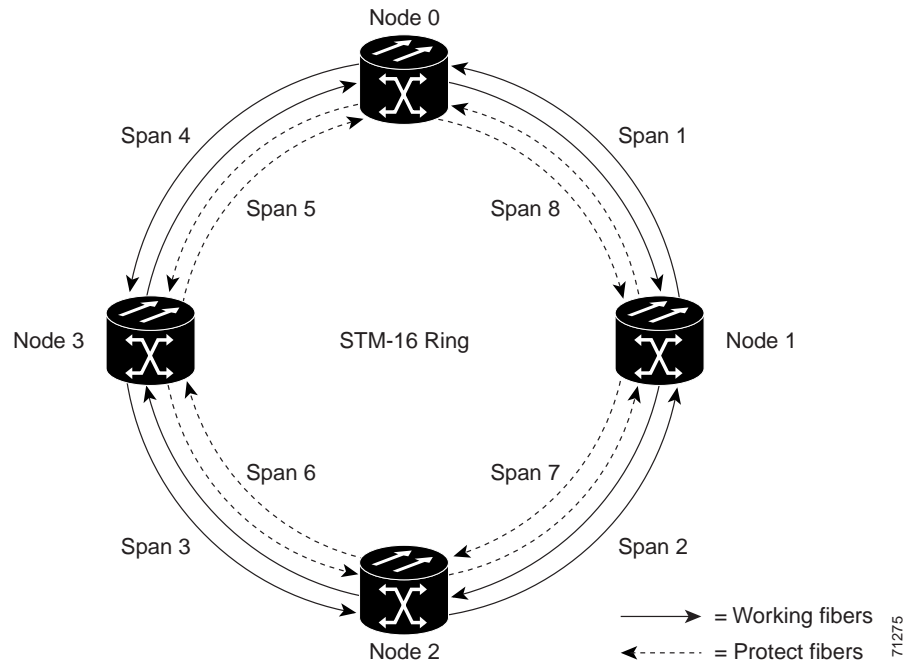
The ONS 15454 SDH supports two-fiber and four-fiber MS-SPRings with up to 16 ONS 15454 SDH nodes. MS-SPRings work well for distributed traffic applications, such as interoffice networks.

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

Four-fiber MS-SPRings (Figure 20 on page 41) 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.

Figure 20 Four-node, four-fiber MS-SPRing



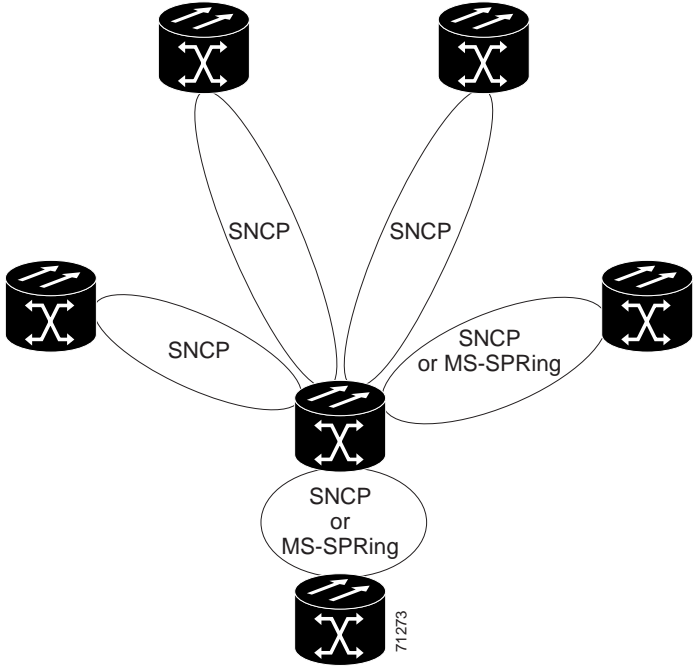
ONS 15454 SDH Release 3.4 contains an MS-SPRing Provisioning Wizard, accessed through the Provisioning tab in the network view. The wizard allows you to easily create, edit, and delete MS-SPRings at the network level, using the CTC interface. The wizard not only reduces common errors in ring creation, it also helps you to create, edit, and delete MS-SPRings much faster than it takes to perform the same operations on a node-by-node basis.

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 21 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 ring. Optical cards in Slots 5 and 12 serve the MS-SPRing, and optical cards in Slots 6 and 13 serve the SNCP.

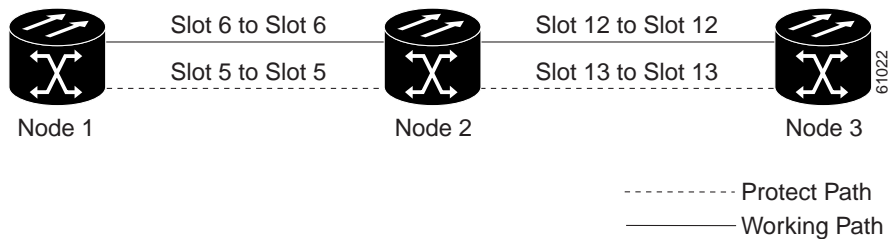
Figure 21 ONS 15454 SDH with multiple subtending rings



Linear Add/Drop Multiplexer Mode

In a linear 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 22 shows an ADM configuration.

Figure 22 Linear ADM configuration



Extended SNCP Mesh Network

With ONS 15454 SDH, you can set up extended SNCP mesh networks (extended SNCP). Extended SNCP extends the protection scheme of SNCP from the basic ring configuration to the meshed architecture of several interconnecting rings. Typical SNCP creates two separate routes between source and destination nodes on a single SNCP. Extended SNCP does this for source and destination nodes that are not on the same ring but link together through a network of connections. When applied to a single ring, extended SNCP uses the same paths as the SNCP.

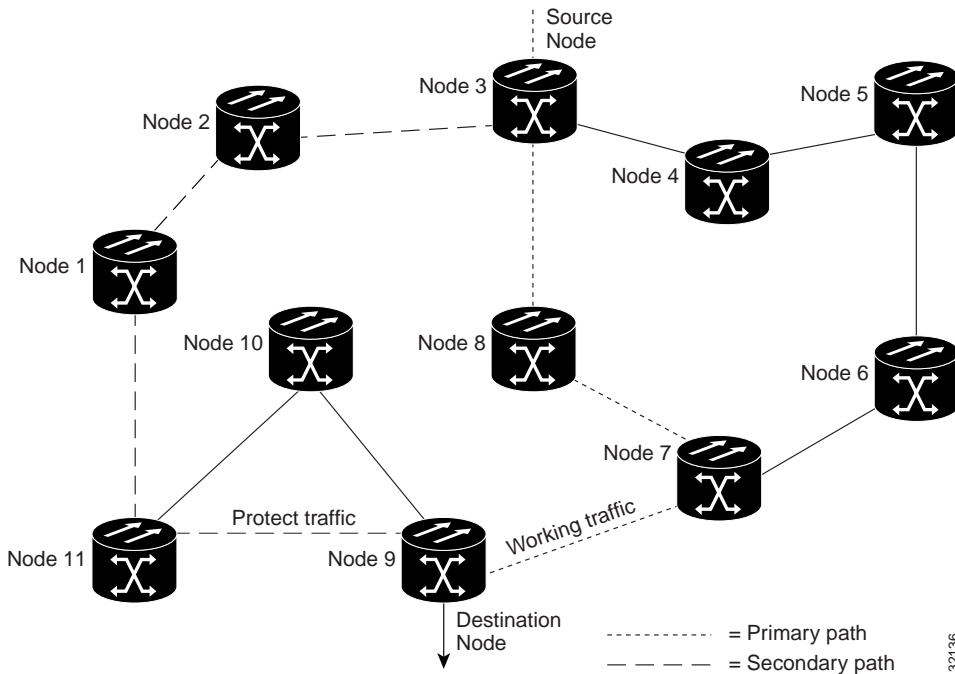
Extended SNCP connects the source and destination of a circuit over two diverse paths through a network of single or multiple meshed rings. These two paths form a circuit-level SNCP. The source sends traffic on each of the diverse paths to the destination node, and the destination node uses the active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

You can set the level of node diversity for the extended SNCP portions of the path. When CTC calculates the path, it makes sure the computed path traverses the required set of nodes and links and does not traverse excluded nodes and links. Users can choose between the following levels:

- Nodal Diversity Required—Ensures that the primary and alternate paths of each extended SNCP domain use diverse nodes.
- Nodal Diversity Desired—CTC looks for a node diverse path; if a node diverse path is not available, CTC finds a link diverse path for each extended SNCP domain.
- Link Diversity Only—Creates a link diverse path for each extended SNCP domain.

Figure 23 shows a sample 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.

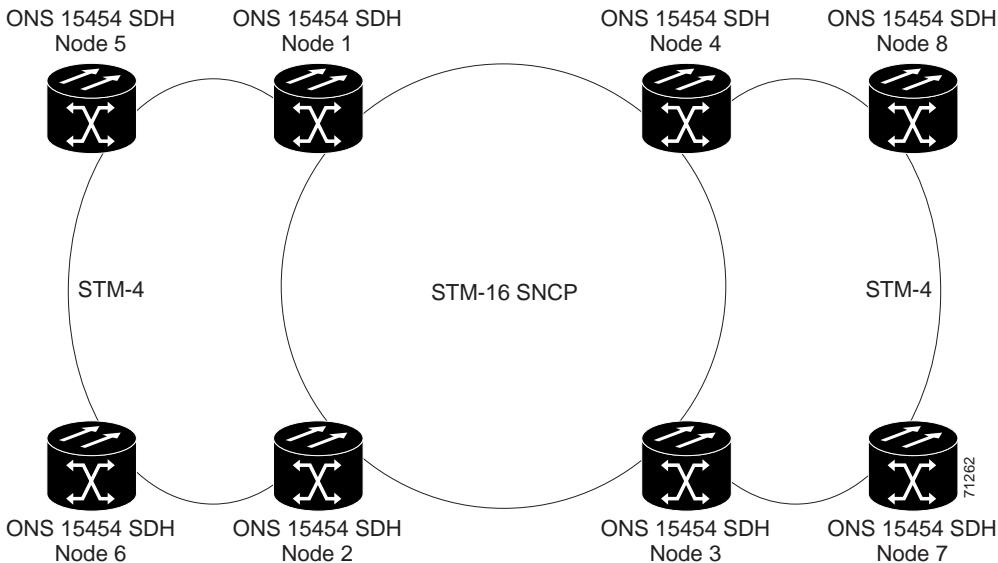
Figure 23 Extended SNCP mesh network



If you check the Fully Protected Path check 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 secondary, protect circuit path. In the example, Node 9 stops receiving traffic from Node 7 and starts receiving traffic from Node 11. Service resumes within 50 milliseconds.

Extended SNCP also allows spans of different SDH line rates to be mixed together in virtual rings. Figure 24 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, and 8 uses both STM-16 and STM-4.

Figure 24 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 building integrated timing supply (BITS), or an internal Stratum 3E reference as the system-timing reference. You

can provision any of the clock inputs as a primary, secondary, or tertiary timing source. If you identify more than one timing reference, the additional references provide 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 Stratum 3E clock on the TCC-I card.



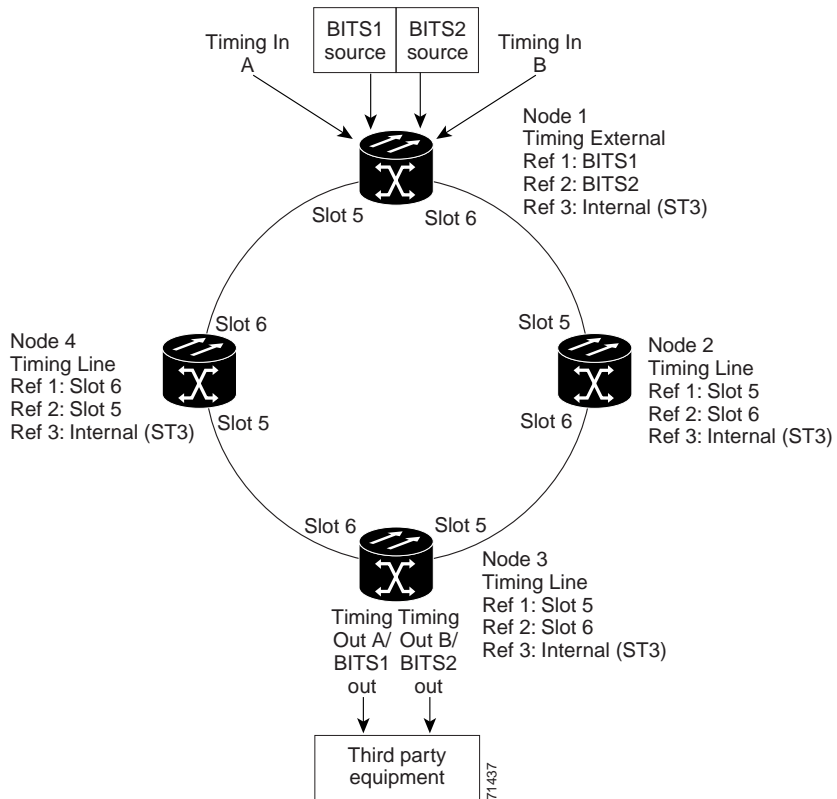
Note

CTC software refers to Timing A and Timing B as BITS 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 Timing 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 global positioning satellite (GPS) signal. A line-timed node derives its timing from an incoming optical signal on one of the STM-N cards.

Figure 25 on page 47 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 25 ONS 15454 SDH timing example



Synchronization Status Messaging

Synchronization status messages (SSMs) are used as 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. SSMs are carried on bits 5 to 8 of SDH overhead byte S1. SSMs enable 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

The European Telecommunications Standards Institute (ETSI) rack can hold up to three ONS 15454 SDHs and two air ramps. Although the ETSI rack is not typically supplied by Cisco, you can order shelf assemblies pre-installed in an ETSI rack.

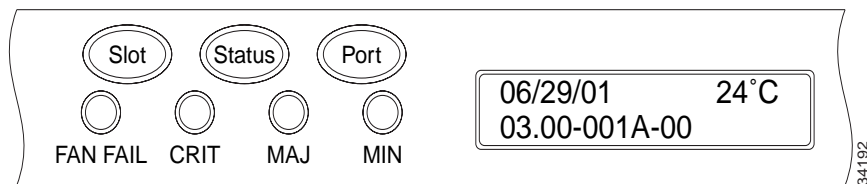
The shelf assembly weighs approximately 26 kilograms (57.3 pounds) without cards installed. The rack has two front doors for added security, a fan-tray module for cooling, and extensive fiber routing and management facilities.

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 limit use of the LCD by other users by choosing to prevent LCD IP configuration. Users can still view information on the LCD, but cannot perform any provisioning. The ONS 15454 SDH LCD is shown in Figure 26.

Figure 26 ONS 15454 SDH LCD



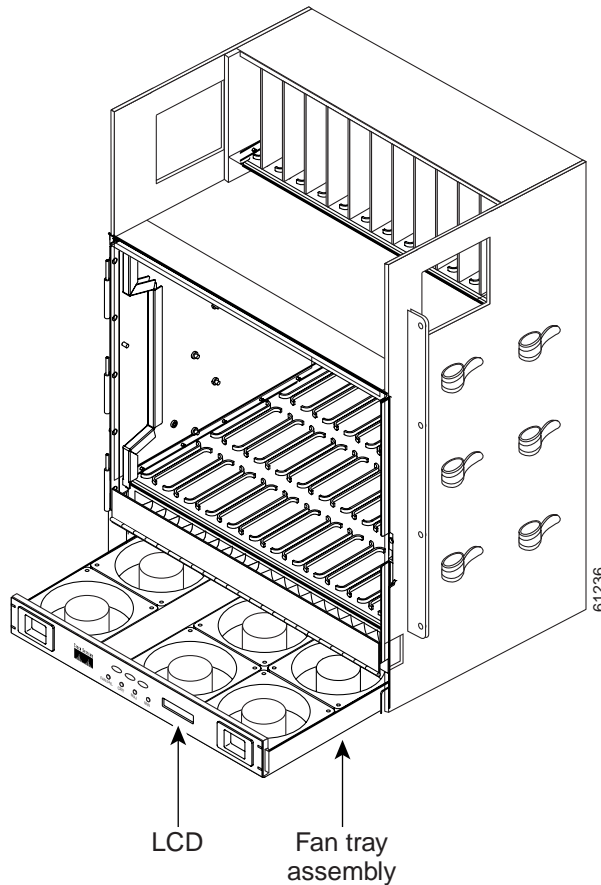
Electrical Facility Connection Assembly

The Electrical Facility Connection Assembly (EFCA) 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 (Figure 27). 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 27 ONS 15454 SDH fan-tray assembly



Shelf Assembly Specifications

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

Bandwidth

The ONS 15454 SDH bandwidth is utilized as follows:

- Total bandwidth: 240 GBits/s (Gbps)
- Data plane bandwidth: 160 GBits/s (Gbps)
- SDH plane bandwidth: 80 GBits/s (Gbps)

Slot Assignments

The ONS 15454 SDH backplane has 29 total card slots. The slots are assigned according to the following parameters:

- 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

The lower shelf has the following specific card assignments:

- TCC-I: Slots 7 and 11
- XC-10G (cross-connect): Slots 8 and 10
- AIC-I: Slot 9
- Multispeed slots: 1 to 4, 14 to 17 (card speeds up to STM16)
- High-speed slots: 5, 6, 12, and 13 (card speeds up to STM64)



Note

Slots 6 and 12 must not be used for electrical cards because they have no corresponding FMEC slots.

The upper shelf has the following FMEC card assignments:

- FMEC Slot 18 supports an electrical card in Slot 1 in the lower shelf.
- FMEC Slot 19 supports an electrical card in Slot 2 in the lower shelf.

- FMEC Slot 20 supports an electrical card in Slot 3 in the lower shelf.
- FMEC Slot 21 supports an electrical card in Slot 4 in the lower shelf.
- FMEC Slot 22 supports an electrical card in Slot 5 in the lower shelf.
- FMEC Slot 23 is used for the MIC-A/P alarm and power card.
- FMEC Slot 24 supports the MIC-C/T/P timing, craft, and power card.
- FMEC Slot 25 supports an electrical card in Slot 13 in the lower shelf.
- FMEC Slot 26 supports an electrical card in Slot 14 in the lower shelf.
- FMEC Slot 27 supports an electrical card in Slot 15 in the lower shelf.
- FMEC Slot 28 supports an electrical card in Slot 16 in the lower shelf.
- FMEC Slot 29 supports an electrical card in Slot 17 in the lower shelf.

FMEC Cards in the Upper Shelf Assembly

The ONS 15454 SDH uses the following 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

The ONS 15454 SDH uses the following cards in the lower shelf assembly:

- TCC-I
- XC10G
- AIC-I
- E1-N-14
- DS3i-N-12
- E3-12

- STM1 SH 1310
- STM4 SH 1310-4
- STM4 SH 1310
- STM4 LH 1310
- STM4 SH 1550
- STM16 SH AS 1310
- STM16 LH AS 1550
- STM16 EH 100 GHz
- STM64 LH 1550
- E100-G
- E1000-2-G
- G1000-4
- BLANK (Faceplate)

Configurations

The ONS 15454 SDH can be configured in the following ways:

- Digital cross-connect
- Terminal mode
- Linear add/drop multiplexer
- Two-fiber MS-SPRing
- Four-fiber MS-SPRing
- Multi-ring interconnection
- Subnetwork connection protection (SNCP) ring
- Extended SNCP
- Virtual rings
- Hybrid SDH network topology
- Regenerator mode
- Wavelength multiplexer

Cisco Transport Controller

CTC has the following connection specifications:

- 10BaseT
- TCC-I access: RJ-45 connector
- EFCA access: LAN RJ-45 connector

External LAN Interface

The ONS 15454 SDH external LAN interface has the following parameters:

- 10BaseT Ethernet
- EFCA access: LAN pin field

Modem Interface

The ONS 15454 SDH modem interface has the following parameters:

- 10BaseT
- EFCA access: MODEM RJ-45 connector

Alarm Interface

The ONS 15454 SDH alarm interface has the following specifications:

- Visual: Critical, major, minor, and remote
- Audible: Critical, major, minor, and remote
- Alarm contacts: Open contact maximum 60 VDC, closed contact 2 mA
- EFCA Access: Alarm pin fields, 62-pin DB connectors

Database Storage

The ONS 15454 SDH has 128 MB of 3.0V nonvolatile Flash memory.

Timing Interface

The ONS 15454 SDH timing interface has the following specifications:

- 2 x coaxial inputs
- 2 x coaxial outputs
- EFCA access: BITS 1.0/2.3 Miniature Coax connector

System Timing

The ONS 15454 SDH system timing has the following specifications:

- Stratum 3E, per ITU-T G.813
- Free-running accuracy: 4.6 ppm
- Holdover stability: 3.7×10^{-7} per day, including temperature (< 255 slips in first 24 hours)
- Reference: External BITS, line, internal

Power Specifications

The ONS 15454 SDH has the following power specifications:

- Input Voltage: -48 VDC (future release will support -60 VDC)
- Power Consumption: Configuration dependent, 53W for fan tray
- Power Requirements:
 - Nominal: -48 VDC
 - Tolerance Limits: -40.5 to -57.0 VDC
- Power Terminals: 3WK3 Combo-D Power Cable Connector

Environmental Specifications

The ONS 15454 SDH has the following environmental specifications:

- Operating temperature: 0 to +40 degrees Celsius
- Operating humidity: 5 to 95%, noncondensing

Dimensions

The ONS 15454 SDH has the following dimensions:

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

