C H A P T E R **3**

SDH Transport Over SONET

As with SONET TDM and data services, Synchronous Digital Hierarchy (SDH) traffic can also be aggregated and transported across an ONS 15454 network. STM-1 to STM-64 payloads can be transported over SONET from any port on a Cisco ONS 15454 OC-N card provisioned to support SDH signals. This chapter explains how the ONS 15454 transports SDH traffic over SONET.

The following topics are covered in this chapter:

Provisioning OC-N Ports for SDH

All ports on Cisco ONS 15454 OC-N cards support both SONET and SDH signals. Once an OC-N port is provisioned as an SDH signal, through the port-provisioning screen in CTC, the optical card processes the received signal as follows:

- Termination of the incoming SDH signal [RSOH, MSOH and AU pointer(s)]

Note   The SS byte value is not checked.

- Pointer(s) processing to locate the J1 byte, the 1st byte of the VC-3 or VC-4 POH (Au3 or Au4)
- VC-4-Nc mapping into a STS-Mc where M=3xN or VC-3 mapping into a STS-1 for Au3 SDH

Note   The POH and payload are not touched since that path is not terminated.

- STS-Mc insertion into an OC-M facility where the SPE pointer is created and the S1S0 bits of the H1 byte are set to 00 (received as 10 from the SDH line)

At the far end of a SDH circuit, the reverse process takes place, transitioning the signal from SONET to SDH as follows:

- Drop STS-Nc from OC-N facility (SPE pointer processed and J1 byte of the HO-POH located)
- STS-Nc mapping into a VC-4-Nc where M=3xN
- AU pointer creation with the value 10 for the SS bits as required for SDH
- STM-N signal generation with MSOH and RSOH

During this process, the only bytes modified are the H1, H2 and H3 bytes. All the other bytes are passed transparently. The H bytes are modified to allow 1) pointer justifications that may be necessary and 2) the SS bits are set to 10 when the frame leaves the OC-N card provisioned as SDH.

> **Note**   If any connected SDH equipment is using any different interpretation of SS bits, LOP may result.
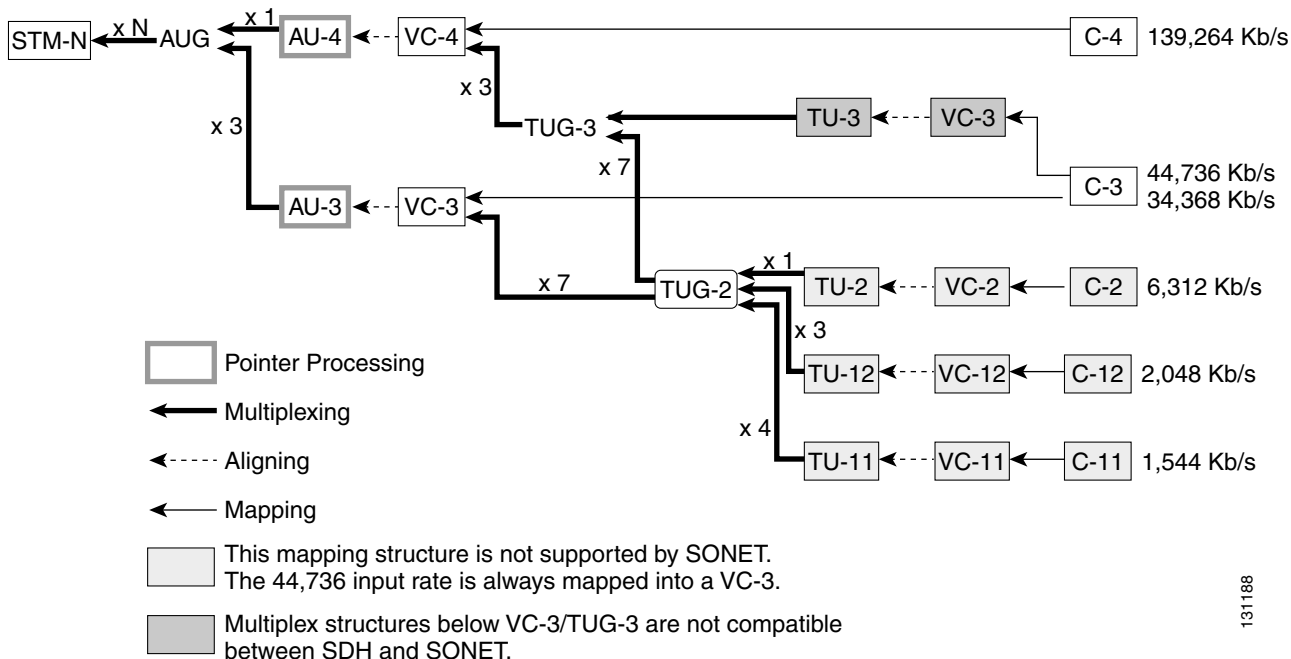
SDH to SONET Mapping

The SDH to SONET mapping depends on the SDH payload type being transported and is manually set by the user during the creation of the SONET circuits used to transport the SDH traffic. For example, an STM-4 port can be mapped in a number of alternative ways, depending upon the content of the signal including:

- One STS-12c circuit to transport a 622Mb/s concatenated data payload.
- Four (4) STS-3c circuits for an Au4 mapped SDH interface (see Table 3-1).
- Twelve (12) STS-1 circuits for an Au3 mapped SDH interface (see Table 3-2).

Figure 3-1 shows how the SDH and SONET multiplexing structures meet at AU4 (i.e., STS-3c) by byte interleaving 3 STS-1s. The STM-1 (i.e., OC-3c) granularity corresponds to the minimum rate where both SONET and SDH systems share. Multiplex structures below VC-3 and/TUG-3 are not compatible between SDH & SONET. Services carried below VC-3 (i.e., E1) need SDH based ADMs to be added or dropped onto the fiber network.

Figure 3-1   SDH and SONET Multiplexing Structures

The appropriate circuit type selection is required to allow the transport of sub-structured signals from a STM-M port. This circuit selection, detailed in Table 3-1 and Table 3-2, enables the system to keep track of all Au4 or Au3 pointers and enable the visibility and access to the sub-structure once the signal is converted back to SDH at the end optical interface.

Table 3-1   *SDH to SONET Circuit Type Mapping for Au4 SDH*

Optical Card	Provisioned SDH Interface	SONET Circuit Type Mapping	Equivalent Au4 SDH Circuits
OC-3/STM-1	STM-1 optical	STS-3c	VC-4
OC-12/STM-4 OC-12-4/STM-4	STM-4 optical	4 x STS-3c or STS-12c depending on payload type	4 x VC-4 or VC-4-4c depending on payload type
OC-48/STM-16 High speed slot	STM-16 optical	16 x STS-3c or 4 x STS-12c or STS-48c or any STS-12c / STS-3c mix depending on payload type	16 x VC-4 or 4 x VC-4-4c or VC-4-16c or any VC-4-4c /VC-4 mix depending on payload type
OC-48/STM-16 Any slot	STM-16 optical	16 x STS-3c or 4 x STS-12c or STS-48c or any STS-12c / STS-3c mix depending on payload type	16 x VC-4 or 4 x VC-4-4c or VC-4-16c or any VC-4-4c / VC-4 mix depending on payload type
OC-192/STM-64	STM-64 optical	64 x STS-3c or 16 x STS-12c or 4 x STS-48c or STS-192c or any STS-48c / STS-12c / STS-3c mix depending on payload type	64 x VC-4 or 16 x VC-4-4c or 4 x VC-4-16c or VC-4-64c or any VC-4-16c / VC-4-4c / VC-4 mix depending on payload type

Table 3-2   *SDH to SONET Circuit Type Mapping for Au3 SDH*

Optical Card	Provisioned SDH Interface	SONET Circuit Type Mapping	Equivalent Au4 SDH Circuits
OC-3/STM-1	STM-1 optical	3 x STS-1 or STS-3c depending on payload type	3 x VC-3s or VC-4
OC-12/STM-4 OC-12-4/STM-4	STM-4 optical	12 x STS-1 or 4 x STS-3c or STS-12c or any STS-3c / STS-1 mix depending on payload type	12 x VC-3 or 4 x VC-4 or VC-4-4c or any VC-4 / VC-3 mix depending on payload type
OC-48/STM-16 High Speed Slot	STM-16 optical	48 x STS-1 or 16 x STS-3c or 4 x STS-12c or STS-48c or any STS-12c / STS-3c / STS-1 mix depending on payload type	48 x VC-3 or 16 x VC-4 or 4 x VC-4-4c or VC-4-16c or any VC-4-4c / VC-4 / VC-3 mix depending on payload type

Table 3-2   SDH to SONET Circuit Type Mapping for Au3 SDH (continued)

Optical Card	Provisioned SDH Interface	SONET Circuit Type Mapping	Equivalent Au4 SDH Circuits
OC-48/STM-16 Any slot	STM-16 optical	48 x STS-1 or 16 x STS-3c or 4 x STS-12c or STS-48c or any STS-12c / STS-3c / STS-1 mix depending on payload type	48 x VC-3 or 16 x VC-4 or 4 x VC-4-4c or VC-4-16c or any VC-4-4c / VC-4 / VC-3 mix depending on payload type
OC-192/STM-64	STM-64 optical	192 x STS-1 or 64 x STS-3c or 16 x STS-12c or 4 x STS-48c or STS-192c or any STS-48c / STS-12c / STS-3c / STS-1 mix depending on payload type	192 x VC-3 or 64 x VC-4 or 16 x VC-4-4c or 4 x VC-4-16c or VC-4-64c or any VC-4-16c / VC-4-4c / VC-4 /VC-3 mix depending on payload type

Synchronization

Cisco ONS 15454 nodes used to transport SDH over SONET should be provisioned for Line timing from an incoming SDH signal.

Protection

SDH configured ports should be provisioned as part of 1+1 linear protection group for interconnection with SDH network terminating equipment. The ONS 15454 supports both unidirectional and bidirectional APS signaling for maximum networking flexibility. SNCP and MS-SPRing are not supported.

Alarm Reporting

When the OC-N ports have been provisioned for SDH, the OC-N card will continue to report alarms and performance measurements (PMs) in the same manner as if they were provisioned for standard SONET transport. This allows an ONS 15454 node supporting SDH transport to report alarms in a consistent manner with the rest of the SONET nodes in the network.

When an OC-12/STM-4 (IR, 1310 LR and 1550 LR) or an OC-48/STM-16 high-speed (IR and LR) port is provisioned to support SDH, path alarming is not supported due to improper B3 byte calculation. The signal degrade alarm at the path level (SD-P) must be disabled on the port in order to suppress these unreliable alarm notifications. Additionally, the PM data at the path level will not be reliable and thus the associated threshold values must be set to 0 in order to avoid threshold crossing alerts (TCA) notification on that port.   This limitation does not exist with the OC-3/STM-1, OC-48/STM-16 AS (any slot), and OC-192/STM-64 cards.
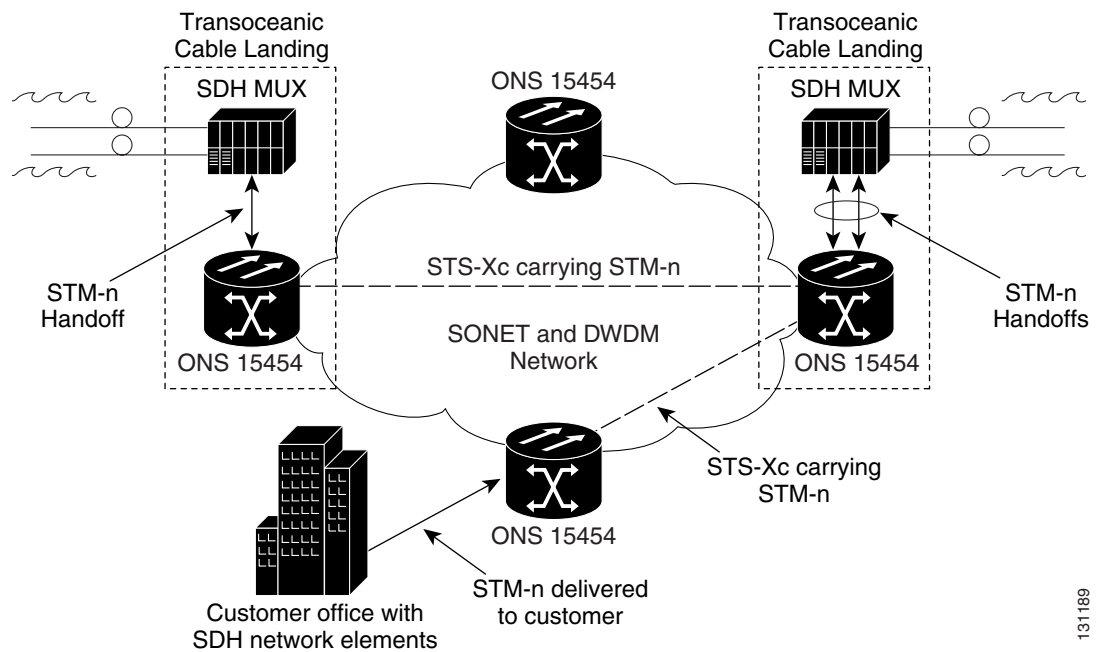
SDH Over SONET Applications

The SDH transport feature of the ONS 15454 addresses a variety of applications, with three applications depicted in Figures 3-1, 3-2 and 3-3:

- STM-n handoffs.

- SDH signal aggregation, which allows the user to consolidate lower speed SDH signals into higher speeds, i.e. STM-1s and STM-4s signals into STM-16 or STM-64 signal.

- Hybrid interfaces including SONET, SDH, Asynchronous TDM and Ethernet traffic with Au3 SDH mapping only.

STM-N Handoffs

Transoceanic cable landings typically have a mixture of both SDH and SONET transmission equipment. These network elements provide drop interfaces of either STM-N or OC-N. If a pass-through transport element is not available, then a dedicated fiber would be required to transport a foreign optical interface inland. With a pass-through optical transport system, the lower order tributary may be mapped into a fraction of the fiber's capacity and efficiently transported inland. Figure 3-2 illustrates a typical mixed SONET/SDH system (for an STM-n hand-off). The Cisco ONS 15454 will be able to drop SDH type interfaces (i.e., STM-1, STM-4) in addition to SONET and Traditional TDM based services. The SDH traffic is seamlessly transported within the 15454 nodes with an AU-4 (STS-3c) granularity.

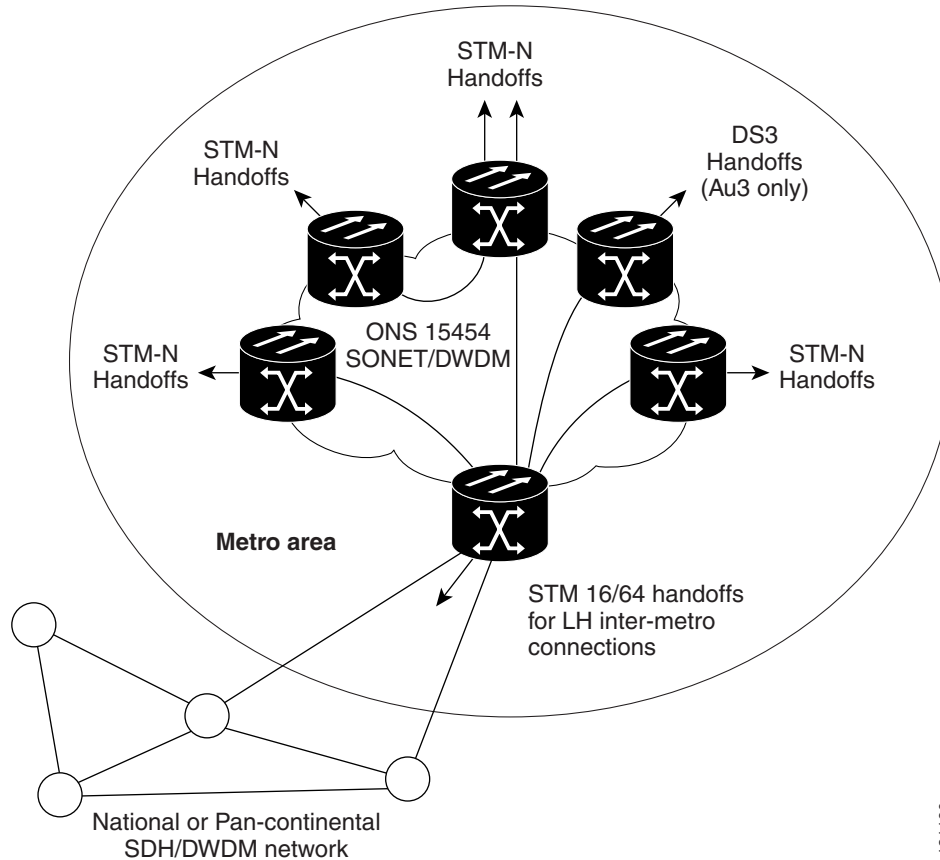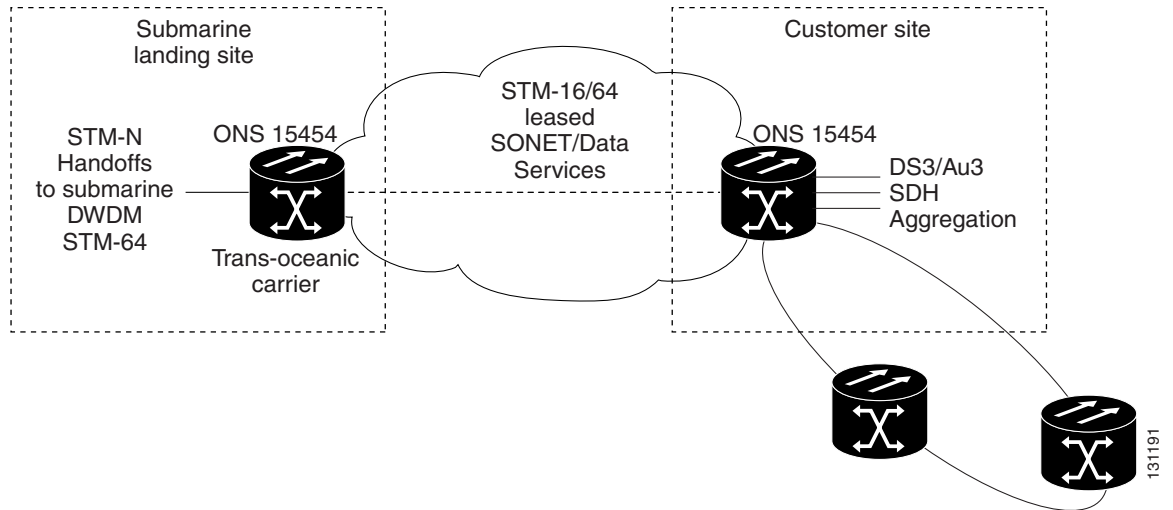*Figure 3-2   Transoceanic STM-N Handoff Application*

SDH Aggregation

Service providers positioned in SDH markets to deliver STM-1 and higher speed services can benefit from the Cisco ONS 15454. An ONS 15454 based network can be used to deliver high-speed leased line services to customers leveraging its SDH aggregation and tunneling capability. As illustrated in Figure 3-3, an ONS 15454 network enables service providers to differentiate themselves by offering high-speed native Ethernet connectivity, along with more traditional private line STM-based services. STM-N leased lines can be offered within the Metro network as well as between Metro Area Networks (MANs), leveraging the aggregation capability of SDH payloads for long haul transport. This application is valid for both Au4 and Au3 SDH multiplexing schemes.

Figure 3-3   SDH Aggregation Applications

Hybrid Au3 SDH Aggregation

To reduce the cost of leased lines, the aggregation of lower order circuits is mandatory for service providers. The ONS 15454 enables service providers to efficiently aggregate mixed service types, including DS1, DS3, and Ethernet signals, into an STM-n interface for transport across a DWDM or other transport network. This capability allows you to fully utilize a leased circuit to transport various payloads without the need for additional multiplexing equipment. Figure 3-4 displays an example of the capability of a DS3/Au3 aggregation application.

Figure 3-4   SDH and SONET Multiplexing Structures

SDH Hairpinning

Some rules must be followed when an ONS 15454 is used in an SDH "hairpinning" application. SDH hairpinning applies when a cross-connected circuit is set-up between SDH configured optical cards on the same ONS 15454 node. Table 3-3 shows the optical cards that can be used to hairpin circuits between two SDH configured optical ports on the same ONS 15454 node.
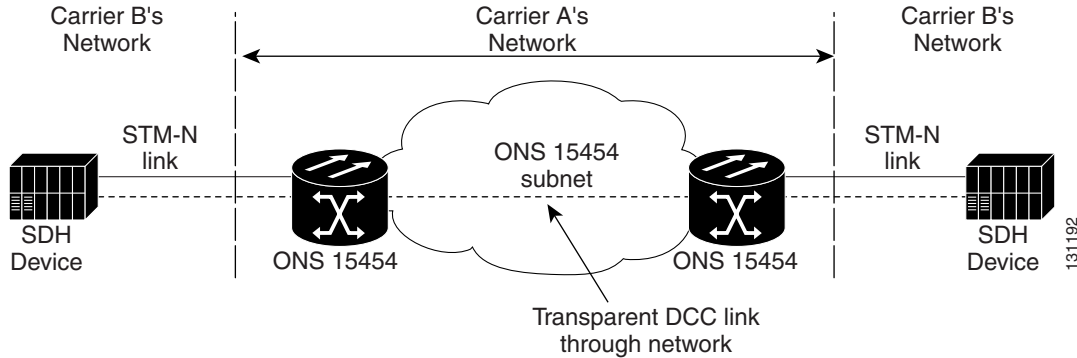
Table 3-3   SDH Hairpinning Compatibility Table

Optical Cards	STM-1	STM-16 HS	STM-16 AS	STM-64
OC-3/STM-1	Yes	Yes	Yes	Yes
OC-12/STM-4	Yes	Yes	Yes	No
OC-48/STM-16 High-Speed slot versions	Yes	Yes	No	No
OC-48/STM-16 Any-slot versions	Yes	No	No	Yes
OC-192/STM-64	Yes	No	No	Yes

Managing Third-Party Network Equipment

You can use the DCC tunneling feature of the Cisco ONS 15454 to provide the ability to transparently interconnect third party management channels of the connected SDH networks (see Figure 3-5).

Figure 3-5   Transparent DCC Management

The DCC tunnels from third party SDH devices pass through ONS 15454 nodes without the need for understanding DCC message content. This is possible because the SONET protocol provides four data communication channels (DCCs) for network element operations, administration, maintenance, and provisioning (OAM&P). One data channel is in the SONET section overhead layer (D1-D3 bytes) and three data channels are in the SONET line overhead layer (D4-D12 bytes). The ONS 15454 system allows you to leverage the line overhead to transport the third party's Section DCC (SDCC) overhead. Thus, in the example shown in Figure 3-5, Carrier A can provide Carrier B with both a private line circuit and a DCC tunnel for network visibility between the interconnected networks.