CHAPTER 9

SDH Topologies and Upgrades

Note The terms "Unidirectional Path Switched Ring" and "UPSR" may appear in Cisco literature. These terms do not refer to using Cisco ONS 15xxx products in a unidirectional path switched ring configuration. Rather, these terms, as well as "Path Protected Mesh Network" and "PPMN," refer generally to Cisco's SNCP feature, which may be used in any topological network configuration. Cisco does not recommend using its SNCP feature in any particular topological network configuration.

This chapter explains Cisco ONS 15310-MA SDH topologies and upgrades. To provision topologies, refer to the *Cisco ONS 15310-MA SDH Procedure Guide*.

Chapter topics include:

9.1 Subnetwork Connection Protection Configurations

Subnetwork Connection Protection (SNCP) configurations provide duplicate fiber paths around the ring. Working traffic flows in one direction and protection traffic flows in the opposite direction. If a problem occurs with the working traffic path, the receiving node switches to the path coming from the opposite direction.

CTC automates ring configuration. Subnetwork Connection Protection traffic is defined within the ONS 15310-MA SDH on a circuit-by-circuit basis. If a path-protected circuit is not defined within a 1+1 line protection scheme and Subnetwork Connection Protection is available and specified, CTC uses Subnetwork Connection Protection as the default.

A Subnetwork Connection Protection circuit requires two data communications channel (DCC)-provisioned optical spans per node. Subnetwork Connection Protection circuits can be created across these spans until their bandwidth is consumed.

Note If a Subnetwork Connection Protection circuit is created manually by TL1, DCCs are not needed. Therefore, Subnetwork Connection Protection circuits are limited by the cross-connection bandwidth or the span bandwidth, but not by the number of DCCs.

Because each traffic path is transported around the entire ring, Subnetwork Connection Protection configurations are best suited for networks where traffic concentrates at one or two locations and is not widely distributed. Subnetwork Connection Protection capacity is equal to its bit rate. Services can originate and terminate on the same Subnetwork Connection Protection configuration, or they can be passed to an adjacent access or interoffice ring for transport to the service-terminating location.

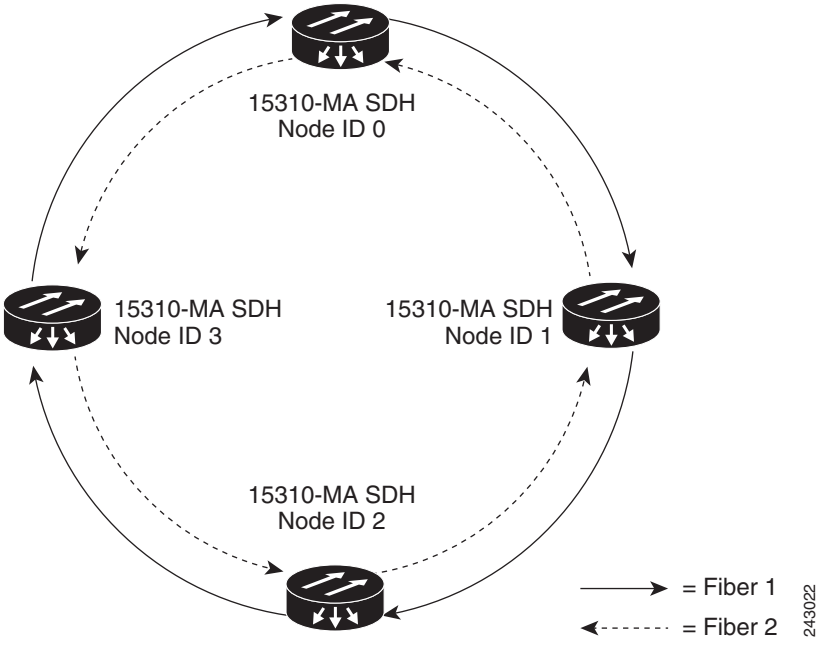
9.1.1 Subnetwork Connection Protection Bandwidth

The span bandwidth consumed by a Subnetwork Connection Protection circuit is two times the circuit bandwidth, because the circuit is duplicated. The cross-connection bandwidth consumed by a Subnetwork Connection Protection circuit is three times the circuit bandwidth at the source and destination nodes only. For the ONS 15310-MA SDH, the spans can be STM1, STM4, or STM16.

9.1.2 Subnetwork Connection Protection Application Example

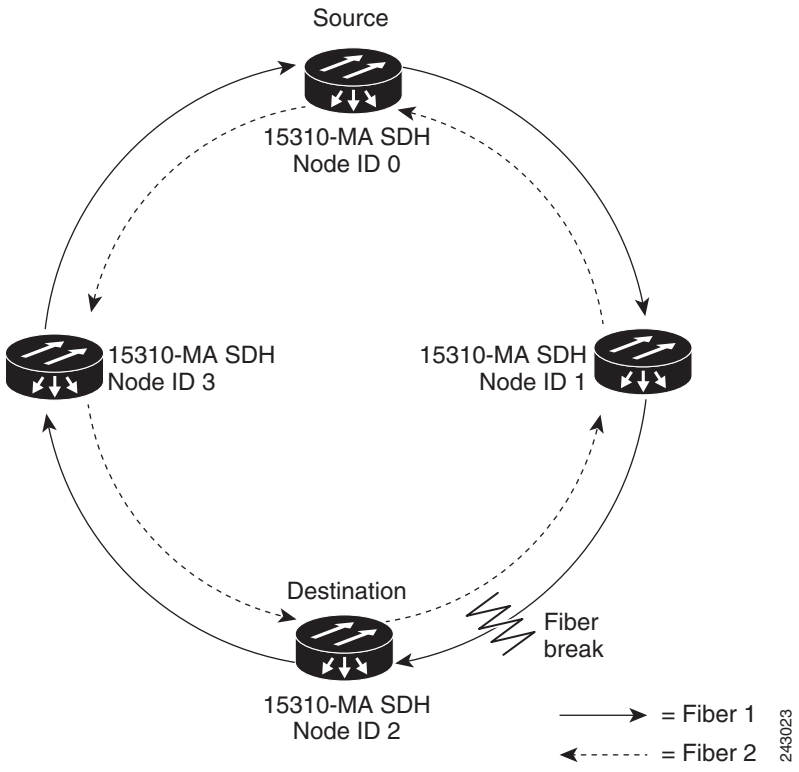
Figure 9-1 shows a basic Subnetwork Connection Protection configuration. If Node ID 0 sends a signal to Node ID 2, the working signal travels on the working traffic path through Node ID 1. The same signal is also sent on the protect traffic path through Node ID 3.

Figure 9-1 Basic Four-Node SNCP Ring



If a fiber break occurs (Figure 9-2), Node ID 2 switches its active receiver to the protect signal coming through Node ID 3.

Figure 9-2 Subnetwork Connection Protection with a Fiber Break



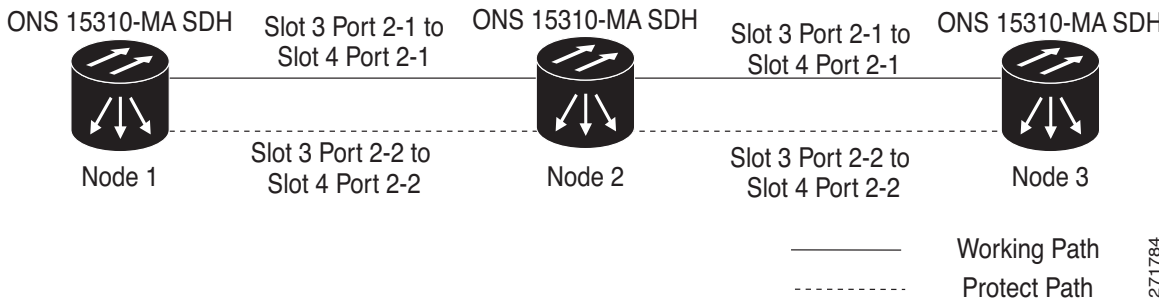
9.2 Terminal Point-to-Point and Linear ADM Configurations

You can configure Cisco ONS 15310-MAs in a terminal point-to-point network (two nodes) or as a line of add/drop multiplexers (ADMs) (3 or more nodes) by configuring the STMN ports as the working path and a second set as the protect path. Unlike rings, terminal and linear ADMs require that the STMN port at each node be in 1+1 protection to ensure that a break to the working line is automatically routed to the protect line.

Note In a linear ADM configuration, two STMN ports in 1+1 protection are connected to two STMN ports in 1+1 protection on a second node. On the second node, two more STMN ports are connected to a third node. The third node can be connected to a fourth node, and so on, depending on the number of nodes in the linear ADM. The 15310-MA SDH has four optical ports, so it can operate either as a terminal or intermediate node in a linear ADM network.

Figure 9-3 shows three ONS 15310-MAs in a linear ADM configuration. In this example, working traffic flows from Node 1/Slot 3/Port 2-1 to Node 2/Slot 4/Port 2-1, and from Node 2/Slot 3/Port 2-1 to the Node 3/Slot 4/Port 2-1. You create the protect path by placing Slot 3/Port 2-1 in 1+1 protection with Slot 4/Port 2-2 at Nodes 1 through 3.

Figure 9-3 ONS 15310-MA SDH Linear ADM Configuration



9.3 Interoperability

The ONS 15310-MA SDH supports up to four SDH SDCCs and two Subnetwork Connection Protection configurations per node. You can install ONS 15310-MA SDH nodes into a network comprised entirely of ONS 15310 MA nodes or into a network that has a mix of ONS 15310-MA SDH, and ONS 15454 nodes. The ONS 15310-MA SDH nodes interoperate with the ONS 15454 nodes in linear or Subnetwork Connection Protection configurations. Because connection procedures for these types of nodes are the same (for example, adding or dropping nodes from a Subnetwork Connection Protection or linear configuration, or creating DCCs), follow the instructions in the "Add and Remove Nodes" chapter of the *Cisco ONS 15310-MA SDH Procedure Guide* whenever you make connections between ONS 15310-MA SDH, and ONS 15454 nodes.

9.3.1 Subtending Rings

Subtending rings reduce the number of nodes and cards required and reduce external shelf-to-shelf cabling. Figure 9-4 shows an ONS 15454 SDH with two subtending rings using ONS 15310-MA SDH nodes.

Figure 9-4 ONS 15454 SDH with Two ONS 15310-MA SDH Nodes Subtending Linear Multiplex Section Protection Configurations

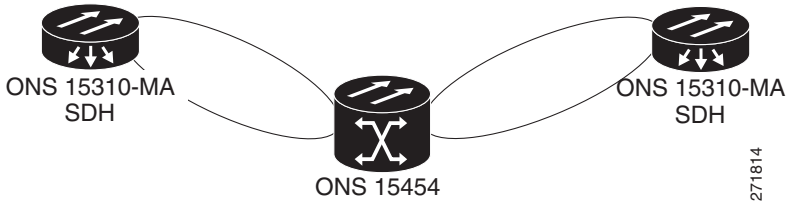


Figure 9-5 shows an ONS 15310-MA SDH with two subtending rings Linear Multiplex Section Protection configurations.

Figure 9-5 ONS 15310-MA SDH with Two Subtending Linear Multiplex Section Protection Configurations

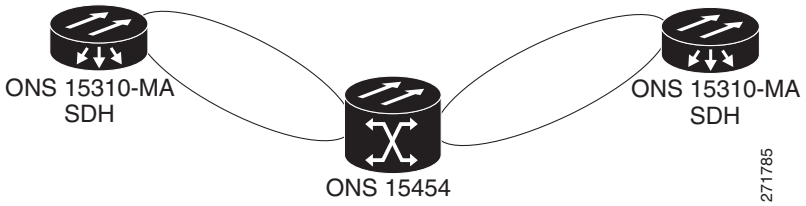
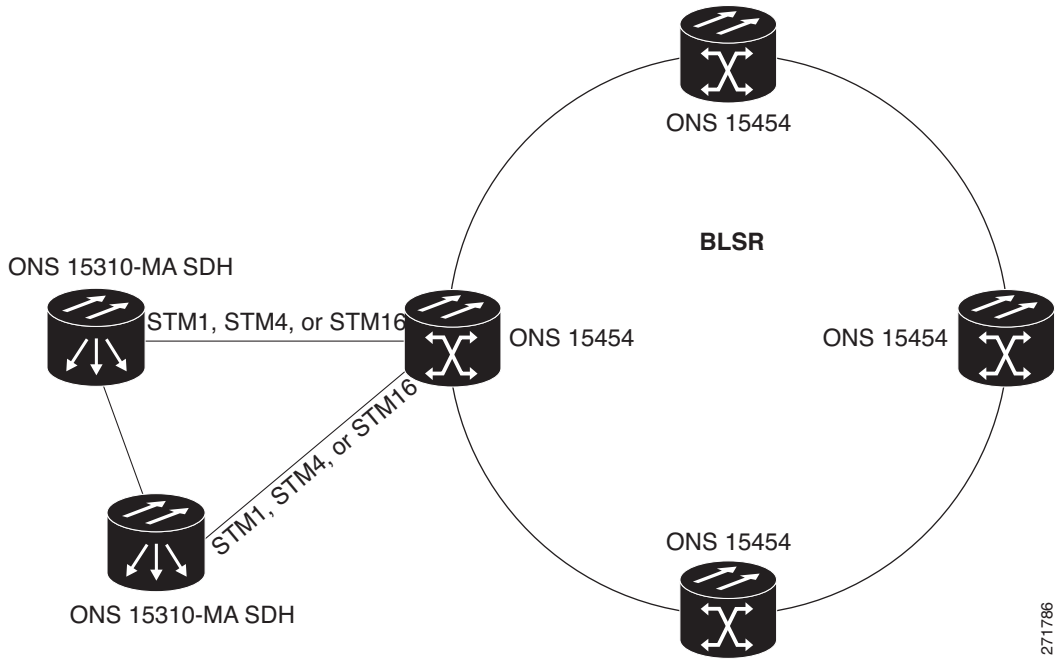


Figure 9-6 shows a ring of ONS 15310-MA SDH nodes subtended from a ring of ONS 15454 nodes.

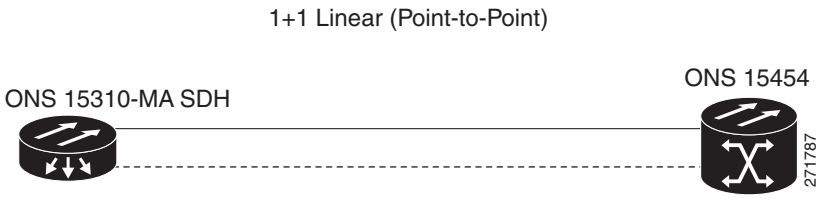
Figure 9-6 ONS 15310-MA SDH Ring Subtended from an ONS 15454 Ring



9.3.2 Linear Connections

Figure 9-7 shows a basic linear or Linear Multiplex Section Protection connection between ONS 15454 nodes.

Figure 9-7 Linear or Linear Multiplex Section Protection Connection Between ONS 15454 and ONS 15310-MA SDH Nodes



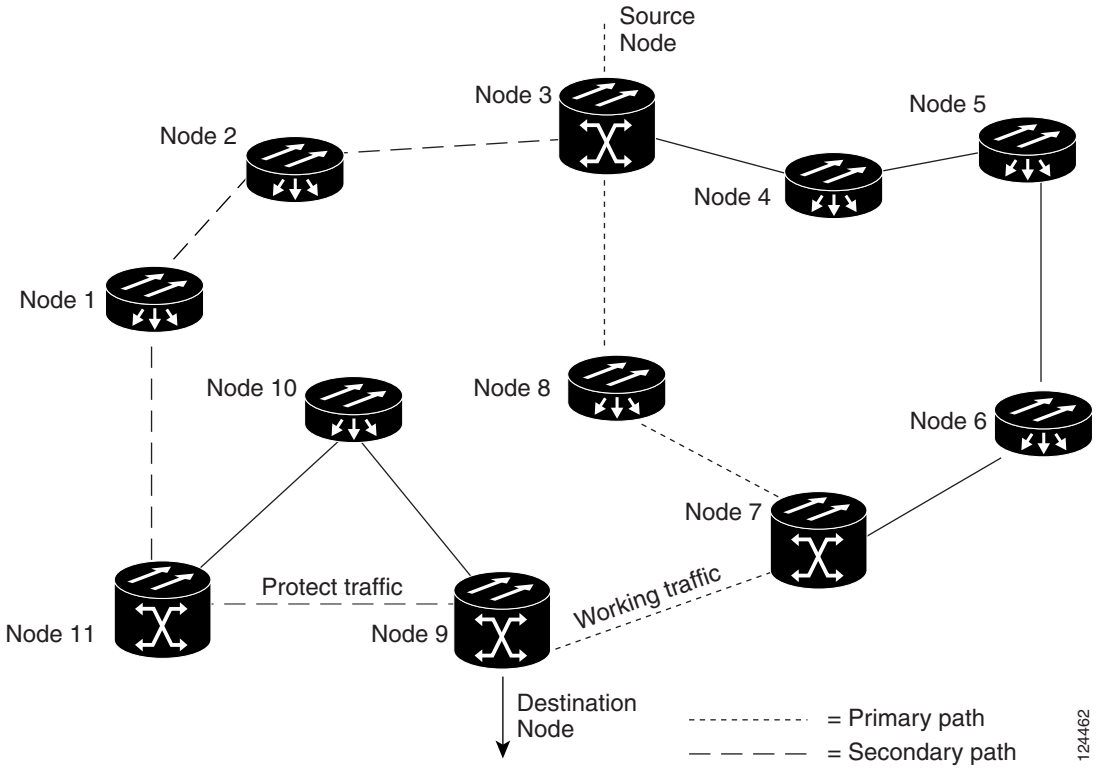
9.4 Path-Protected Mesh Networks

In addition to single Linear Multiplex Section Protection (LMSP) configurations, terminal point-to-point or linear ADMs, you can extend ONS 15310-MA SDH traffic protection by creating path-protected mesh networks (PPMNs). PPMNs include multiple ONS 15310-MA SDH topologies and extend the protection provided by a single LMSP configuration to the meshed architecture of several interconnecting rings. In a PPMN, circuits travel diverse paths through a network of single or multiple meshed rings. When you create circuits, CTC can automatically route circuits across the PPMN or you can manually route them. You can also choose levels of circuit protection. For example, if you choose full protection, CTC creates an alternate route for the circuit in addition to the main route. The second route follows a unique path through the network between the source and destination and sets up a second set of cross-connections.

For example, in Figure 9-8, a circuit is created from the ONS 15454 shown at Node 3 to the ONS 15454 shown at Node 9. CTC determines that the shortest route between the two nodes passes through Node 8 and Node 7, shown by the dotted line, and automatically creates cross-connections at Nodes 3, 8, 7, and 9 to provide the primary circuit path.

If full protection is selected, CTC creates a second unique route between Nodes 3 and 9 which, in this example, passes through Nodes 2, 1, and 11. Cross-connections are automatically created at Nodes 3, 2, 1, 11, and 9, shown by the dashed line. If a failure occurs on the primary path, traffic switches to the second 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 ms.

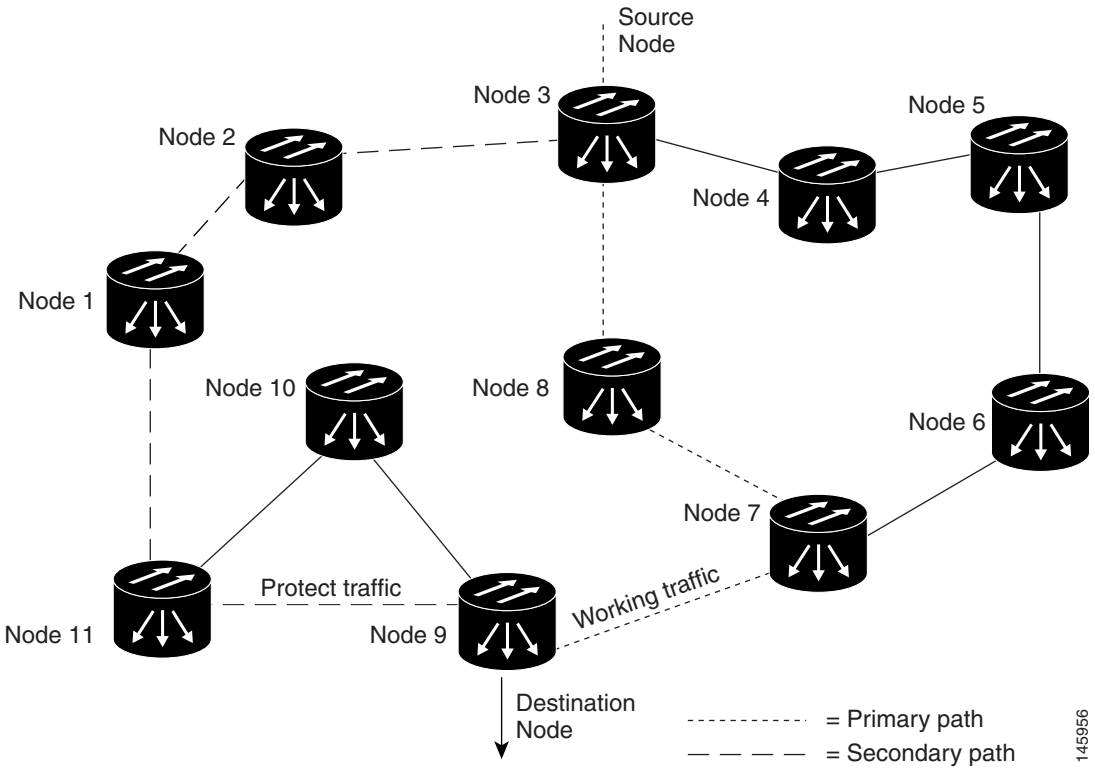
Figure 9-8 Path-Protected Mesh Network for ONS 15310-MA SDHNodes



For example, in Figure 9-9, a circuit is created from Node 3 to Node 9. CTC determines that the shortest route between the two nodes passes through Node 8 and Node 7, shown by the dotted line, and automatically creates cross-connections at Nodes 3, 8, 7, and 9 to provide the primary circuit path.

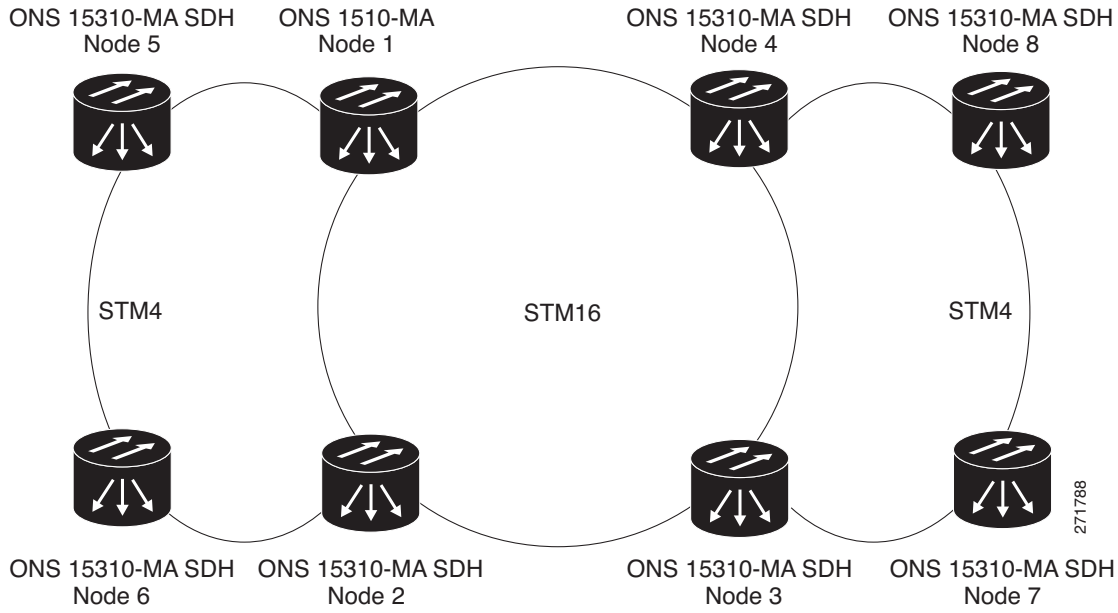
If full protection is selected, CTC creates a second unique route between Nodes 3 and 9 which, in this example, passes through Nodes 2, 1, and 11. Cross-connections are automatically created at Nodes 3, 2, 1, 11, and 9, shown by the dashed line. If a failure occurs on the primary path, traffic switches to the second 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 ms.

Figure 9-9 Path-Protected Mesh Network for ONS 15310-MA SDH Nodes



PPMN also allows spans with different SDH speeds to be mixed together in "virtual rings." Figure 9-10 shows an ONS 15310-MA SDH with Nodes 1, 2, 3, and 4 in a standard STM16 ring. Nodes 5, 6, 7, and 8 link to the backbone ring through the STM4 fiber. The virtual ring formed by Nodes 5, 6, 7, and 8 use both the STM16 and STM4 cards.

Figure 9-10 Virtual Ring for ONS 15310-MA SDH



9.5 Four Node Configurations

You can link multiple ONS 15310-MA SDH nodes using their STMN ports (also known as creating a fiber-optic bus) to accommodate more access traffic than a single ONS 15310-MA SDH can support. You can link nodes with STMN fiber spans as you would link any other two network nodes. The nodes can be grouped in one facility to aggregate more local traffic.

9.6 STMN Speed Upgrades

A span is the optical fiber connection between two ONS 15310-MA SDH nodes. In a span (optical speed) upgrade, the transmission rate of a span is upgraded from an STM1 to STM4 signal (ONS 15310-MA SDH), from an STM4 to STM16 signal (ONS 15310-MA SDH only), or from an STM1 to STM16 signal (ONS 15310-MA SDH only), 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. The ONS 15310-MA SDH nodes support the span upgrade wizard if you are upgrading two ONS 15310-MAs with 1+1 protection from STM1 to STM4, STM4 to STM16, or STM1 to STM16.

To perform a span upgrade, the higher-rate pluggable port module (PPM) must replace the lower-rate PPM in the same slot. If you are using a multi-rate PPM, you do not need to physically replace the PPM. All spans in the network must be upgraded. The 1+1 protection configuration of the original lower-rate PPM is retained for the higher-rate PPM.

When performing span upgrades, Cisco recommends that you upgrade all spans in a network consecutively and in the same maintenance window. Until all spans are upgraded, mismatched PPM types will be present.

If you are upgrading two ONS 15310-MA SDH nodes with 1+1 protection from STM1 to STM4, STM4 to STM16, or STM1 to STM16, Cisco recommends using the Span Upgrade Wizard to perform span upgrades. Although you can also use the manual span upgrade procedures, the manual procedures are

mainly provided as error recovery for the wizard. The Span Upgrade Wizard and the manual span upgrade procedures require at least two technicians (one at each end of the span) who can communicate with each other during the upgrade. Upgrading a span is non-service affecting and will cause no more than three switches, each of which is less than 50 ms in duration. To initiate the span upgrade, right-click the span and choose Span Upgrade.

Note Span upgrades do not upgrade SDH topologies (for example, a 1+1 group to a Linear Multiplex Section Protection configuration). Refer to the "Convert Network Configurations" chapter of the *Cisco ONS 15310-MA SDH Procedure Guide* for topology upgrade procedures.

9.6.1 Span Upgrade Wizard

The Span Upgrade Wizard automates all steps in the manual 1+1 span upgrade procedure, if you are upgrading two ONS 15310-MA SDH nodes. The wizard can upgrade both lines of a 1+1 group. The Span Upgrade Wizard requires that spans have DCCs enabled.

The Span Upgrade Wizard provides no way to back out of an upgrade. In the case of an error, you must exit the wizard and initiate the manual procedure to either continue with the upgrade or back out of it. To continue with the manual procedure, examine the standing conditions and alarms to identify the stage in which the wizard failure occurred.

9.6.2 Manual Span Upgrades

Manual span upgrades are mainly provided as error recovery for the Span Upgrade Wizard, but they can be used to perform span upgrades. You can perform a manual span upgrade on a 1+1 protection group, if you are upgrading two ONS 15310-MA SDH nodes.

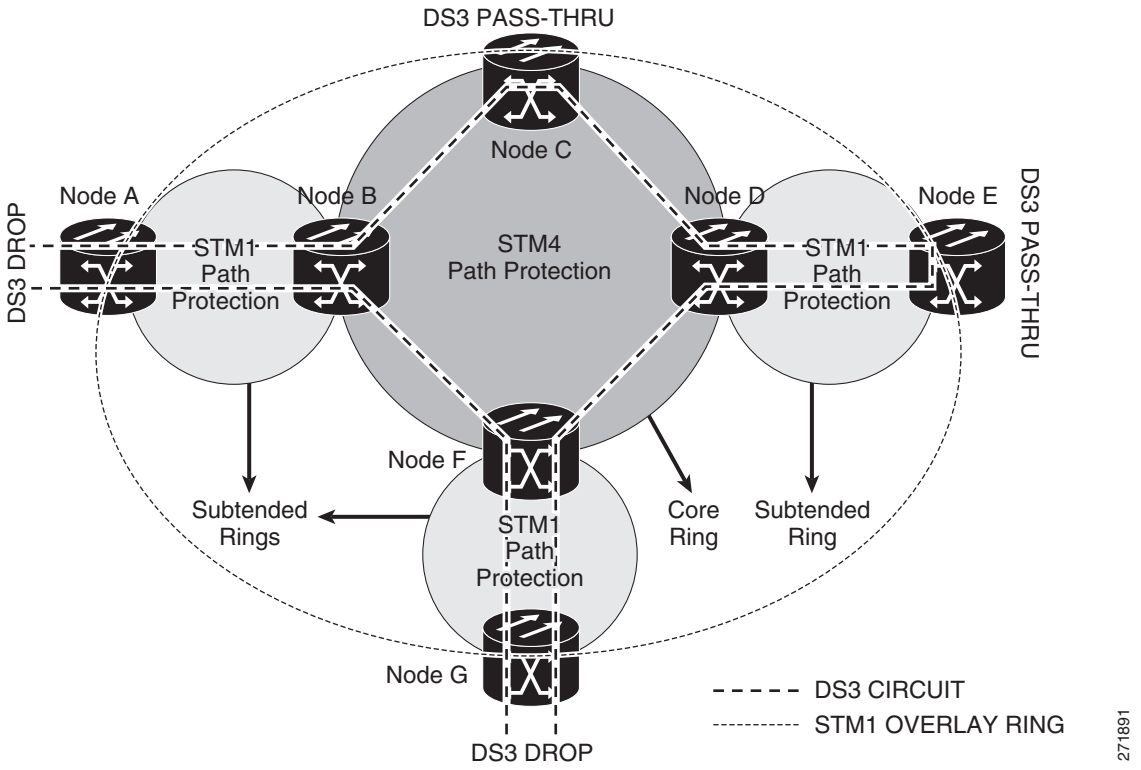
Downgrading can be performed to back out of a span upgrade. The procedure for downgrading is the same as upgrading except that you provision a lower-rate PPM (STM1 or STM4 for the 15310-MA SDH) and install a lower-rate PPM (if you are not using a multi-rate PPM). You cannot downgrade if circuits exist on the VCs that will be removed (the higher VCs).

9.7 Overlay Ring Circuits

An overlay ring configuration consists of a core ring and subtended rings (Figure 9-11). An Overlay Ring Circuit routes traffic around multiple rings in an overlay ring configuration, passing through one or more nodes more than once. This results in multiple cross-connections on the nodes connecting the core ring to the subtended rings. For example, a customer having a core ring with cross-connects provisioned using TL1 can create create cross-connects on subtended rings, due to a business need, without having to hamper the existing cross-connects on the core ring. This circuit can be either protected or unprotected.

A typical path protected overlay ring configuration is shown in Figure 9-11, where the circuit traverses the nodes B, D, and F twice resulting in two cross-connections on these nodes for the same circuit. In Figure 9-11, the circuits on the STM4 path are unprotected. The DS3 drop traffic is protected on the drop nodes by provisioning a primary and secondary destination, making it a path protected circuit.

Figure 9-11 Overlay Ring Circuit



Overlay ring supports circuit sizes; VC-3, VC4, VC4-2c, VC4-3c, VC4-4c, VC4-8c, VC4-12c, VC4-16c, and VC4-64c. Both unidirectional and bidirectional circuits are supported. Overlay ring circuits are contiguous concatenated (CCAT) and not virtual concatenated (VCAT) circuits.

Manual routing is mandatory while provisioning the overlay ring circuit. Overlay ring circuits created using Transaction Language 1 (TL1) are discovered by CTC and the status "DISCOVERED" is displayed.

If the overlay ring circuit is deleted, the cross-connects on the core ring and subtended rings get deleted. Cross-connects on a subtended ring can be deleted through TL1 but would reflect as a partial overlay ring circuit in CTC, i.e. core ring will continue having cross-connects.