White Paper

Understanding Path-Protected Mesh Networks (PPMN)

Abstract

This document discusses a synchronous optical network/synchronous digital hierarchy (SONET/SDH) protection scheme for meshed networks. Examples in this document will use SONET, although path-protected mesh networks (PPMN) over SDH are also fully supported.

Meshed networks fall outside the common, Telecordia-specified protection schemes of bidirectional line-switched ring (BLSR) and unidirectional line-switched ring (UPSR). As a result, legacy SONET equipment manufacturers have not offered viable solutions for meshed networks. With PPMN capability, Cisco has extended the simple concept of path protection on a SONET ring to meshed networks, offering service providers a new degree of flexibility in designing their networks.

Introduction

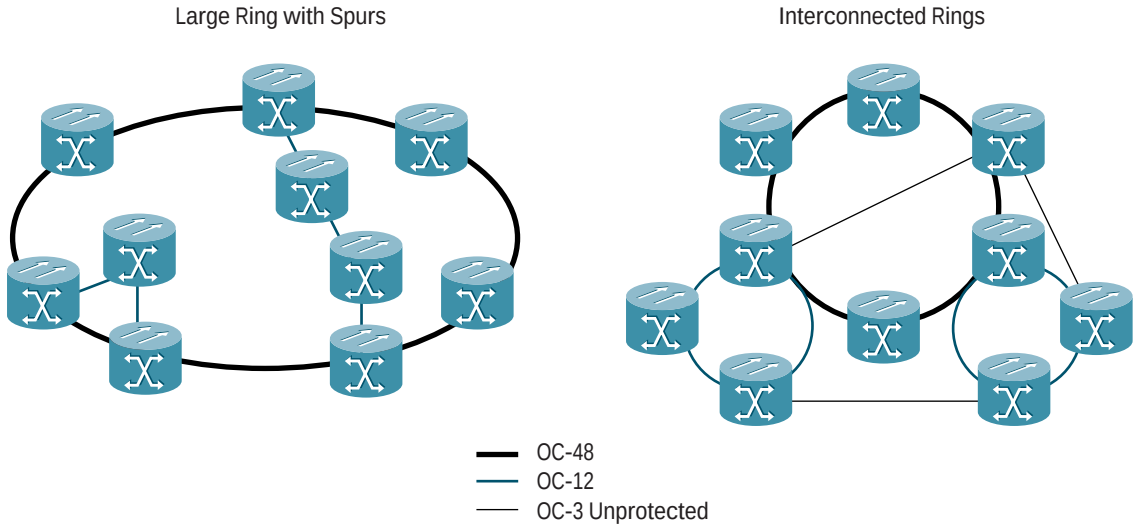
In the past, most large carriers have focused their time division multiplexing (TDM) protection on ring architectures. no standards-based TDM protection solution currently exists, and as a result, legacy TDM equipment manufacturers have not offered viable solutions for meshed networks. At best, such solutions have been complex and proprietary. With PPMN, Cisco has extended the simple UPSR concept of ring-based path protection to meshed networks, offering service providers a new degree of flexibility in designing their networks.

With PPMN, a network planner can design a mesh that utilizes both protected and unprotected spans at various line rates. In the event of a failure on one route, connection is reestablished through another path in the mesh in less than 50 milliseconds (ms). This offers network planners flexibility they can use for mesh networks today.

By using path protection, PPMN simply extends UPSR beyond the basic ring topology to a meshed architecture. The software locates two diverse routes in the network between the source and destination. These two routes form a logical ring for that circuit's path and behave exactly as UPSR. The source bridges its traffic onto each of the diverse paths, and the destination selects between the two paths. A failure on the active path causes the destination to switch to the standby path within 50 ms. Because of its strict adherence to SONET standards, a PPMN logical ring is no different from the standard Telecordia-specified UPSR.

"Meshed networks" refers to any number of sites arbitrarily connected together with at least one loop. That is, each node has two or more links connected to it. In Layer 1 Transport architectures, TDM-based meshed networks are often large rings with a number of spurs or a series of rings that have become meshed over time, as shown in Figure 1.

Figure 1
Real-world TDM Meshed Networks



With PPMN, a network planner can design this mesh with unprotected spans and various line rates. In the event of a failure on one route, connection is reestablished through another path in the mesh within SONET's 50 ms restoration time.

Benefits of PPMN

PPMN gives network planners a great deal of flexibility, since the 50 ms restoration can be applied to networks other than rings. Also, because non-ring architectures can be used, it is possible to have protection over a series of unprotected spans. This means that if a network planner needs additional bandwidth, a single fiber pair can be pulled between sites, rather than building a whole new ring. This saves both time and money. In addition, it allows the planner to take advantage of pockets of unused spans throughout a network, increasing network utilization. As long as there are two paths between nodes, any span can be used for PPMN.

In addition to providing a network planner with added flexibility, Cisco's management system, the Cisco Transport Controller (CTC), makes provisioning within a meshed network as simple as clicking a mouse button, thanks to its Java-based GUI. All the nodes on the network begin the process of auto-discovery as soon as they are turned up. Within minutes, each node has a full description and status of the other nodes and connections throughout the network. This is possible because Cisco uses Internet Protocol (IP) and Open Shortest Path First (OSPF) protocols for data communications channel (DCC) communications.

Creating a circuit is then accomplished simply by specifying the source and destination—another Cisco innovation called A-Z Provisioning. Software determines the shortest path through the network and establishes all the intermediate cross connections. A check box determines whether the circuit is to be protected or not. When it is checked, PPMN is enabled: a protect circuit is established on the second shortest path through the network between the source and destination, and a second set of cross connections are created. With this capability, turn-up and provisioning of circuits can be done in a matter of minutes, rather than hours or days.

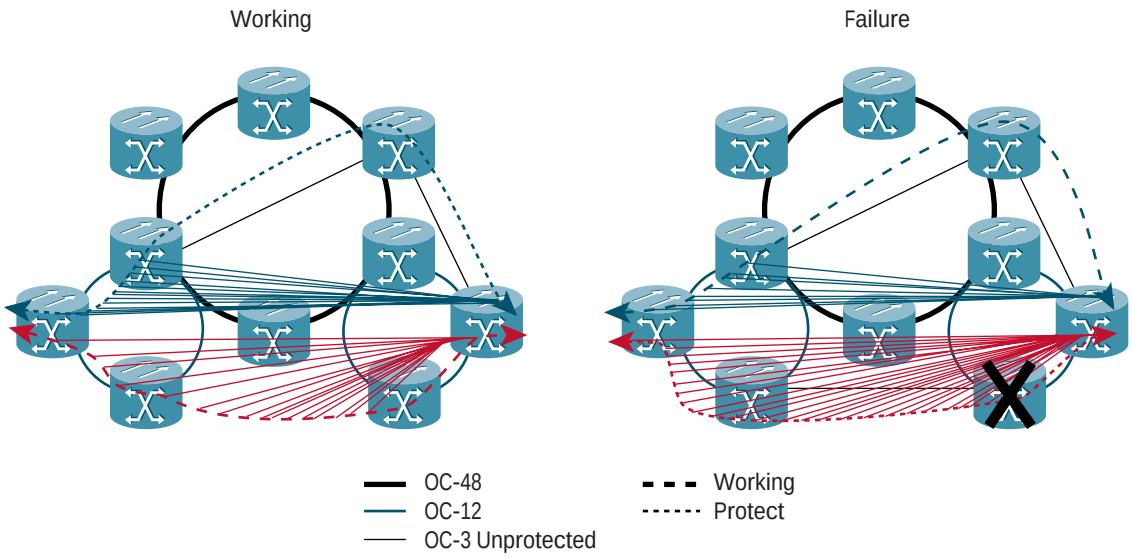
If necessary, the automatic route selections can be overridden and manual paths can be chosen. As with UPSR, the user is prompted for the following parameter settings:

- Revertive—Set for traffic to revert to the working path when the conditions that diverted it to the protect path are repaired.
- Reversion time—Set the reversion time. This is the amount of time that will elapse before the traffic reverts to the working path. Traffic can revert when conditions causing the switch are cleared.
- SF threshold—Set the UPSR path-level signal failure bit error rate (BER) thresholds.
- SD threshold—Set the UPSR path-level signal degrade BER thresholds.
- Switch on PDI-P—Set if traffic is to be switched when a path payload defect indicator is received.

PPMN Example

In Figure 2, a path needs to be set up between nodes A (left) and Z (right). The PPMN software will determine the shortest two routes between A and Z. Cross connections between A and Z will automatically be created over diverse routes. In the event of a fiber cut or other failure on the primary route, either node A or node Z will switch to the protection path, as shown here.

Figure 2
This needs a caption.]



Conclusion

Cisco's PPMN gives the service provider's network planner an added degree of flexibility and enables the service provider the ability to quickly turn up services utilizing PPMN and A-Z Provisioning. A–Z Provisioning enables the user to simply specify the beginning and ending points of a new circuit (shelf, slot, and port), and PPMN automatically selects an open path through the network, setting up the appropriate cross connections at intermediate nodes in the network. This reduces the time to deliver services and generate new revenues. By seamlessly integrating PPMN into the suite of protection schemes, Cisco has taken one more step in revolutionizing SONET/SDH transport.

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