Advanced Intelligence in Cisco Multiservice Transport Product

The advent of reconfigurable optical add/drop multiplexer (ROADM) technology and mesh optical networks challenges the operating model for transport service providers, with SONET/SDH moving to the edge and even being replaced by Layer 2 and Layer 3 traffic. Traditional point-to-point wavelength-division multiplexing (WDM) becomes complex all-optical networking, eliminating the need for large digital cross-connect (DXC) switch points.

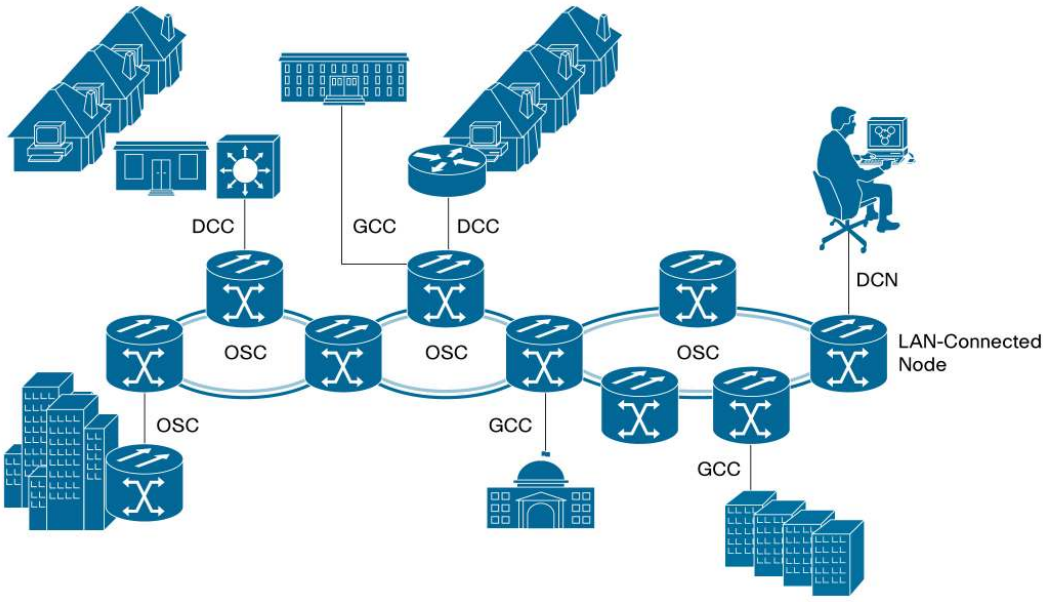
While the capital expenditure (CapEx) savings resulting from the lack of optical-to-electrical-to-optical (OEO) point of presence (POP) is allowing service providers to reduce network costs, operating costs are increasing because the new technology is complex to manage and new to the field technicians. It exposes low-level complexity that makes operation difficult.

The superior optical intelligence brought to the field by the Cisco ONS 15454 Multiservice Transport Platform (MSTP) reverses the whole paradigm, making the all-optical network easier to operate than standard traditional SONET/SDH OEO-based technology.

Network Topology Discovery

As a result of the unique discovery technology based on Layer 3 routing protocols implemented over the dense wavelength-division multiplexing (DWDM) control channel, optical supervisory channel (OSC), generic communications channel (GCC), and data communications channel (DCC), Cisco ONS 15454 MSTP networks are capable of auto-discovery. Nodes, links and network resources are automatically provided within a defined Open Shortest Path First (OSPF) Protocol area. The immediate advantage is that the management system needs to know the IP address of one LAN-connected node only in a management network (Figure 1).

Figure 1. DWDM Network Topology Discovery



The management system, Cisco Transport Controller, Cisco Transport Manager, or even a Transaction Language 1 (TL1) based operations support system (OSS) need the IP address of only one of the LAN-connected nodes – that is, one of the nodes connected to the data communications network (DCN). The other nodes have been automatically discovered by the OSPF Protocol running over the OSC, GCC, and DCC. The network topology discovery mechanism provides the management system with the set of nodes, links, and network resources.

If no OSC, GCC, or DCC connectivity exists among two nodes, the Cisco ONS 15454 MSTP offers a variety of links that can be manually provisioned taking part to the mechanism for future discovery.

Network Craft Interface off the Shelf – No Installation Code

Cisco Transport Controller is a revolutionary craft application GUI that provides broad control and full Fault, Configuration, Accounting and Performance (FCAPS) capabilities (Figure 2). In addition, no installation code is needed on the user workstation.

Figure 2. Cisco Transport Controller

It offers these features:

- Provides integrated craft GUI system
- Provides GUI available from node
- Auto-discovers systems and networks
- Provides an interface superior to the older command-line interface (CLI) craft interface
- Offers a full GUI, with no commands to remember
- Manages sub-network (OSC and GCC based) and multiple sub-networks
- Provides auto-routed AZ circuit provisioning for DWDM and SONET/SDH
- Provides a task-oriented tool targeted at installation and turn-up, maintenance and troubleshooting, provisioning, and control of a sub-network
- Handles transport and data functions

Automatic Power Control

The capability to adjust the power of the amplifiers in the DWDM network to respond to network failures and degradation is one of the most important topics in photonic systems.

The Cisco ONS 15454 MSTP can respond to network events in two ways:

- Automatic gain control
- Automatic power adjustment

Automatic gain control is the capabilities of the amplifiers to work in constant gain mode, to help ensure that added traffic in an optical add/drop multiplexer (OADM) survives to a fiber cut in the span before. The Cisco ONS 15454 MSTP amplifiers provide fast transient suppression. They immediately react to any short term variation in the input power, adjusting their output as a result of the given gain. This characteristic is useful to help ensure that traffic in DWDM networks survives.

However, during the life of the DWDM network, the aging of the fibers and components and changes in operating conditions may also impair the traffic capabilities. A constant gain system is not usually capable of reacting to these slow events. The Cisco ONS 15454 MSTP has a control plane that calculates and distributes new settings to the amplifiers across the network in such a way that slow variation of the network is easily compensated. The Cisco ONS 15454 MSTP is the only DWDM system that combines the behaviors of constant gain and constant power systems.

The major advantage of the automatic power control is that no field intervention is required during the life of the network; the network settings are adjusted automatically.

Wavelength Management Over Mesh Network

Setting up services on DWDM mesh networks requires smart provisioning systems that can provide all the network resources necessary to support the traffic flowing from the DWMD ingress port to the DWDM egress port. Typically, service providers offer two kinds of services:

- Wavelength services – Regardless of the application, the DWMD can be designed to support transmission at 2.5, 10, or 40 Gigabits (or more) per second. The case of alien wavelength management is discussed later in this document.
- Application-specific services – For example, systems can support SONET/SDH, storage access networks (SANs), and the LAN physical interface (LAN PHY).

An intelligent DWDM system has to work with both the types of services, taking into account that an application-specific service is always carried on a wavelength.

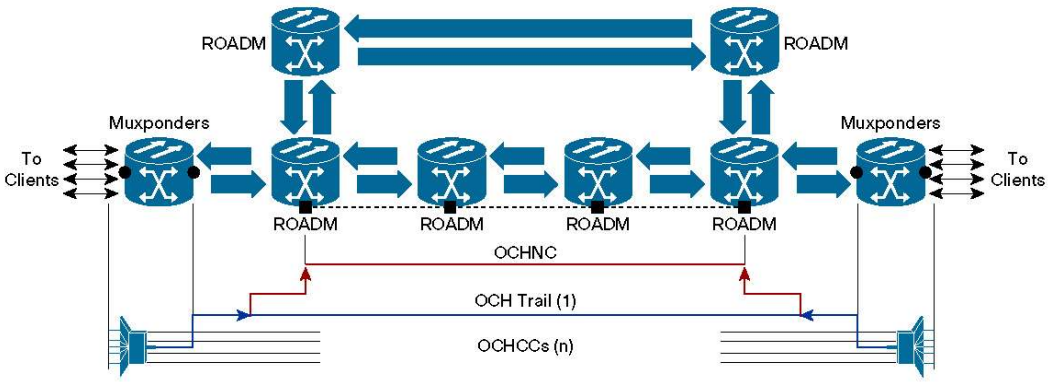
The optical standards (ITU-T G.872) describe and model the wavelengths, which are referred to as optical channel network connections (OCHNCs). Their characteristic information is the wavelength itself. They typically start at an optical channel (OCH) ingress port of a Degree-N ROADM and end at an OCH egress port of another ROADM in the network and can be unidirectional or bidirectional.

Any type of service can be carried on an OCHNC, at almost any bit rate with any protocol. After the service provider provides a given service with a given bit rate and protocol to a client application, an optical channel client connection (OCHCC) is created and managed.

However, to share a high-bit-rate wavelength among a variety of lower-bit-rate services, a suitable multiplexing scheme is necessary. Typical multiplexing methods adopted in multiple transponder (muxponder) cards are SONET/SDH, generic framing procedure (GFP) mapping, and G.709. Whatever multiplexing scheme is adopted (typically a mix of methods), multiple OCHCCs are served over a single wavelength. The end-to-end connection between the network (trunk) sides of the multiplexing card is modeled in the standard as OCH trail.

Cisco ONS 15454 MSTP allows the creation and management of OCHNC, OCHCC, and OCH trails as traditional transport circuits (Figure 3).

Figure 3. OCH Circuits



As shown in Figure 3, multiple OCHCCs can share the same OCH trail, which starts at the network port of the muxponders. The OCH trail is still in the electrical domain, and the OCHNC is a strict optical connection. The Cisco Transport Controller network application facilitates the management of all these types of circuits.

Autoturn-up

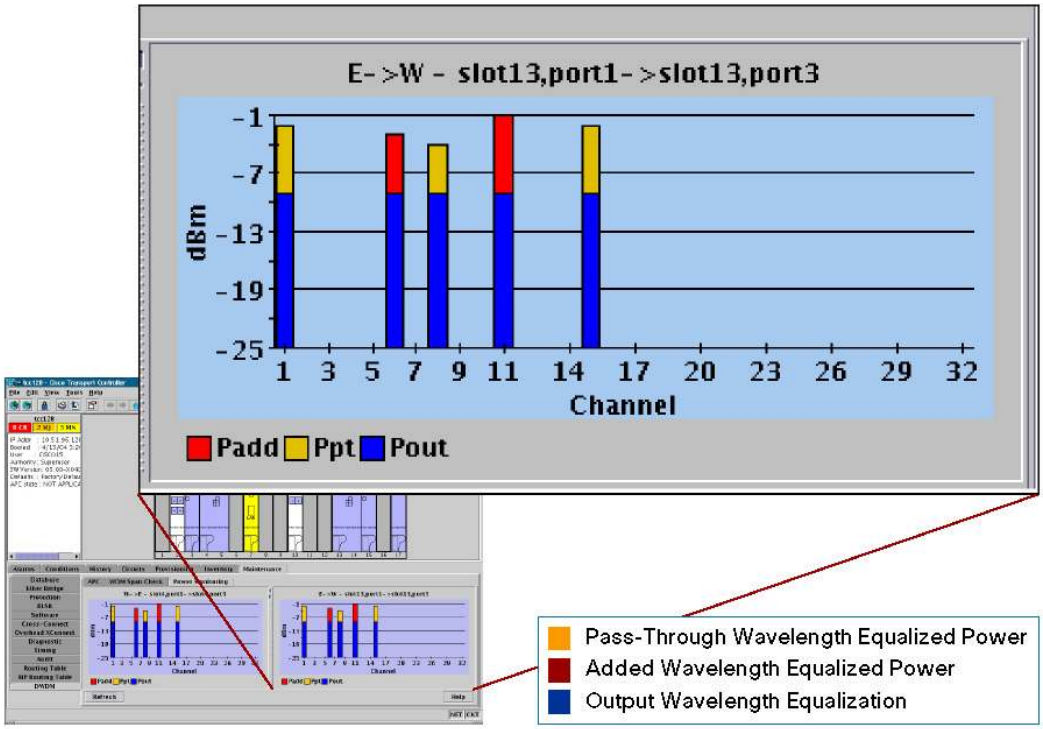
The Cisco ONS 15454 MSTP can automatically calculate the optical settings needed to perform a node autoturn-up. Using in-service span loss monitoring, the node can compute the settings for variable optical attenuators, amplifier gain, and expected power thresholds and apply them to correctly turn up the optical node. This capability reduces the work of the installation team, which only has to mount racks and shelves, plug in the cards, and connect the patch cords. Initial provisioning task are reduced to a minimum.

Alien Wavelength Management

Cisco ONS 15454 MSTP is designed to work with any stable ITU-T source. Whatever is the source, the Cisco ONS 15454 MSTP can monitor it along the network, tracking the path and the power level at each ROADM node.

The alien wavelength is a special case of an OCHNC, where the source is not part of the Cisco ONS 15454 MSTP management domain. Service providers do not like this kind of situation as they cannot control the traffic. However, the Cisco Transport Controller and the Cisco ONS 15454 MSTP allow management of the alien wavelengths as OCHNCs and also provide the capability to monitor them at the intermediate nodes of the mesh network (Figure 4).

Figure 4. Alien Wavelength Monitoring



Network-Level Alarm Correlation

One alarm per failure in the network – that is, the root cause of the problem spontaneously advertised to the management system and thus to the network operations center (NOC) – is the service provider's goal. It is usually attained with a sophisticated OSS capable of correlating failure notifications coming from all the nodes of the network, but this is far from an optimal method for suppressing irrelevant notifications and symptoms.

First, it is node-version dependent – that is, an OSS reimplementation is required each time any capabilities or features are added to the node. In addition, the DCN can get congested by alarm flooding, preventing the NOC from being properly notified.

Therefore, alarm correlation at the OSS level is usually preferable across domains, but it cannot correctly perform the fault management function for the DWDM network.

The Cisco ONS 15454 MSTP solves the problem directly at the network level with a standard alarm correlation capability that works at both the node and network levels.

Each Cisco ONS 15454 MSTP node has a rich set of monitoring points, from variable optical attenuators (VOAs) to photo detectors, going to the rich termination function of the transponders (SONET/SDH, G.709, and SAN) to detect each kind of failure. However, the system can demote all the derived alarms to simple conditions and notify the root cause only to each of the management interfaces. The correlation function works within the reference standards for time-stamping and set and unset alarm declaration and thus is interoperable with any standard OSS.

A node-level alarm correlation function, however, is not enough. In ROADM-based mesh networks, where intermediate optical path monitoring functions are implemented, a fault in a node or link may result in thousands of failure detections on nodes downstream. Some vendors reduce the number of monitoring points to prevent this alarm flooding, but this the wrong way to proceed. Real failures

that occur at this point of the network will be actually detected at the termination points, making troubleshooting almost impossible.

As a result of its unique implementation of ITU-T G.798 Optical Transport Section (OTS) and Optical Multiplex Section (OMS) Payload Missing Indication (PMI) and OCH Forward Defect Indication (FDI) signaling, the Cisco ONS 15454 MSTP DWDM can suppress alarms on downstream nodes in the network, presenting one alarm only for each unidirectional failure. Each time a failure at the OCH level is detected, an OCH FDI is signaled downstream, telling all the nodes to demote the related detected failures (usually loss of light or loss of signal payload). Whenever a failure at the OMS or OTS is detected, a PMI is signaled downstream, telling all the nodes to demote the related section alarms (usually loss of light).

The result of the combined node and network alarm correlation is that the node detecting the actual failure sends one notification to the management interface, and all the other nodes are prevented from doing so and provide the alarm list on demand only.

Conclusion

Easy node and network setup, rapid troubleshooting, no need for service calls, and a sophisticated management function with new added-value services such as alien wavelength management make the Cisco ONS 15454 MSTP superior to competing solutions. The Cisco ONS 15454 MSTP is specifically designed to hide the DWDM complexity from the user while providing a rich set of management functions.

The combination of these capabilities, called intelligent optical transmission, is the basis for the success of the Cisco ONS 15454 MSTP in the market.

For More Information

For more information about the Cisco ONS 15454 MSTP, please refer to http://www.cisco.com/en/US/prod/collateral/optical/ps5724/ps2006/ps5320/product_data_sheet09186a00801849e7.html.

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