

## Designing IP NGNs with Cisco ONS 15454 MSTP and Cisco TransportPlanner

The Cisco<sup>®</sup> ONS 15454 Multiservice Transport Platform (MSTP) is the industry benchmark for dense wavelength-division multiplexing (DWDM) solutions, offering a comprehensive approach for designing, provisioning, and maintaining an optical network with the help of the Cisco TransportPlanner network design tool and the complete flexibility of multi-degree reconfigurable optical add/drop multiplexer (ROADM) technology.

### Summary

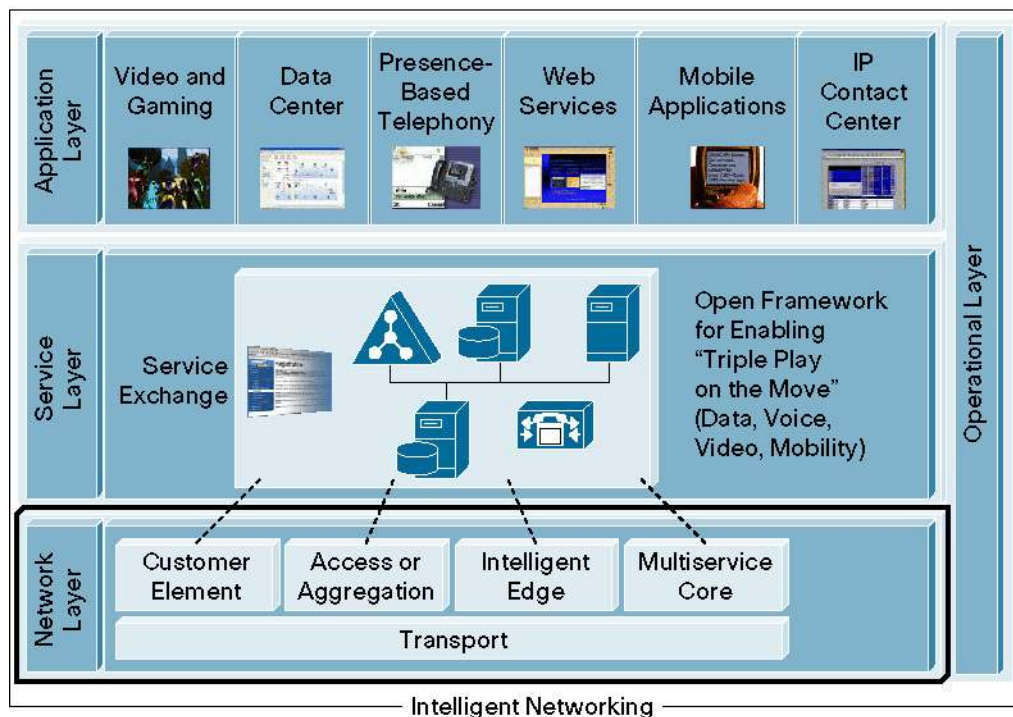
The network layer is the foundation for a dynamic, secure, flexible, and scalable IP next-generation network (IP NGN) that supports the business-critical functions of the service layer and the revenue streams of the application layer (Figure 1). The integrity, manageability, and scalability of the network layer are determined early in the planning and design phase. Cisco brings these critical variables under control through a combination of innovative element solutions, comprehensive management software, and intelligent network design tools that accelerate the provider's path to deployment and return on investment (ROI).

The Cisco TransportPlanner is a fully comprehensive DWDM network design and design-management tool (for example, Delta Planning, rack layout definition, cabling procedure) that allows Cisco ONS 15454 MSTP customers to concentrate on service definition and availability while radically simplifying the process of comparing alternative service-delivery and investment scenarios. Cisco TransportPlanner uses the latest in optical transport technologies from the Cisco Optical portfolio, featuring the Cisco ONS 15454 MSTP with fully integrated multi-degree ROADM technology, to help engineer the optimal DWDM infrastructure capable of any-to-any service delivery for linear, ring, multi-ring, and mesh networks.

The output from Cisco TransportPlanner provides content beneficial to both the design and deployment phases, including system performance reporting, bill-of-materials (BoM) generation, graphical layouts of racks and shelf configurations, optical connections between nodes, and downloadable provisioning and configuration settings for each optical node.

The benefits of designing with Cisco TransportPlanner extend beyond deployment to the in-service phase supported by MSTP features that significantly reduce the operating expenses (OpEx) traditionally associated with wavelength-division multiplexing (WDM) networks and optical add/drop multiplexers (OADM) by automating labor-intensive operations. The intelligent DWDM functionalities of the Cisco ONS 15454 MSTP dynamically monitor and adjust wavelength power and signal conditions to help ensure optimal compliance with service-level agreements, giving providers proactive control over a customer's service experience.

This paper outlines the key features and functions supported by the Cisco ONS 15454 MSTP and Cisco TransportPlanner to deliver a completely integrated ROADM-based solution for DWDM networks.

**Figure 1.** Network Layer, the Foundation of the Cisco IP NGN Architecture

### Challenge

Designing DWDM networks has always been a complex task because of the intrinsic nature of optical transmission, which is based on analog technology despite the transport of digital signals. Many different parameters have to be accounted for because of linear and nonlinear effects. Linear effects include noise accumulation, optical power budget, and chromatic dispersion effects; nonlinear effects include cross-phase modulation, self-phase modulation, and four-wave mixing. Metro and metro-regional DWDM networks, which usually require many add/drop locations, have an additional layer of complexity because the same network supports different optical paths that must use the same common optical units (such as optical amplifiers and dispersion compensation units).

The design and optimization of a DWDM network is an interactive process that requires considering all the constraints of the system:

- Distance and insertion loss of the network spans
- Type and number of services required in each network location

Based on these constraints, a DWDM network design should optimize the hardware placement in the different network nodes to minimize the cost of the design. When fixed OADM units are used for capacity add/drop in the different sites of the network, the design needs to optimize the number and type of units used in each node to reduce overall network cost.

ROADM in DWDM networks is expected to provide complete flexibility in the traffic pattern. This flexibility needs to be accounted for and supported by the network design tool to verify and support the different optical paths existing in the network.

## Solution

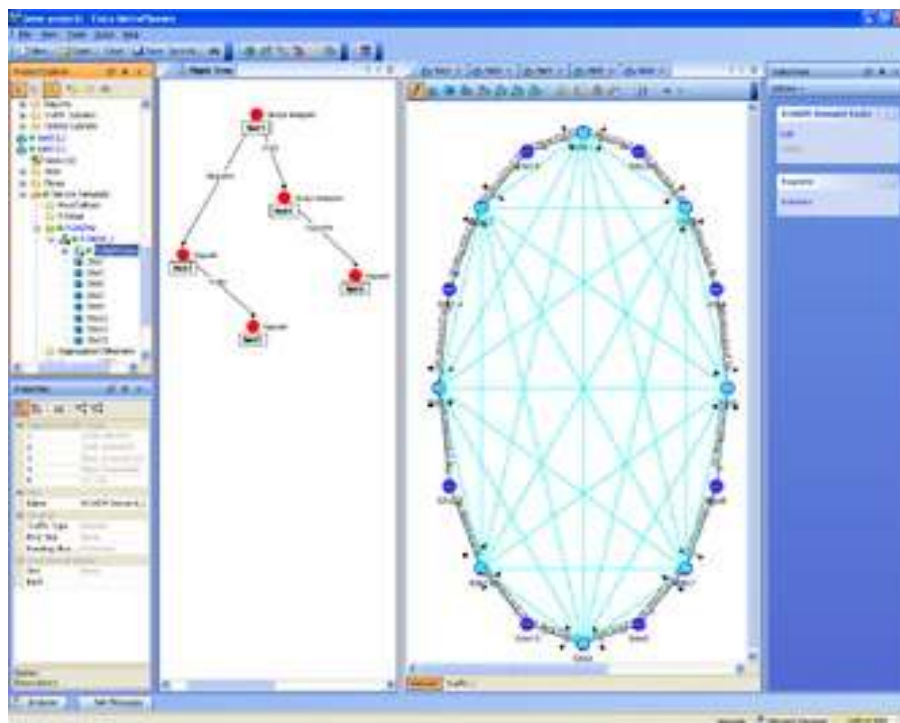
The Cisco ONS 15454 MSTP offers a complete solution for designing, provisioning, and maintaining an optical DWDM network, including:

- Cisco TransportPlanner – This Java-based application helps users model and design DWDM networks based on the Cisco ONS 15454 MSTP.
- DWDM units – A complete set of DWDM transport and aggregation units helps deliver simple, fast, and intelligent optical capabilities.
- Intelligent optical transmission software – Each network element can automatically support transport functionalities in the DWDM domain similar to those in the SONET, SDH, and data domain, defining what is now considered next-generation DWDM transport.
- Cisco Transport Controller – This integrated tool can be used to support installation and provisioning at the network level.

These benefits surpass those that are available from a simple hardware-based solution. The Cisco ONS 15454 MSTP solution helps users design, maintain, and optimize their DWDM networks to maximize network performance and save on operational costs.

The Cisco TransportPlanner tool supports the user from the design phase to the deployment phase of a DWDM network. This tool was originally developed to help create BoMs for customer-specific designs. The latest release of the tool (Release 8.0) has evolved significantly from the original, simpler version, to support the new functionalities provided by the Cisco ONS 15454 MSTP. Figure 2 shows the Release 8.0 GUI.

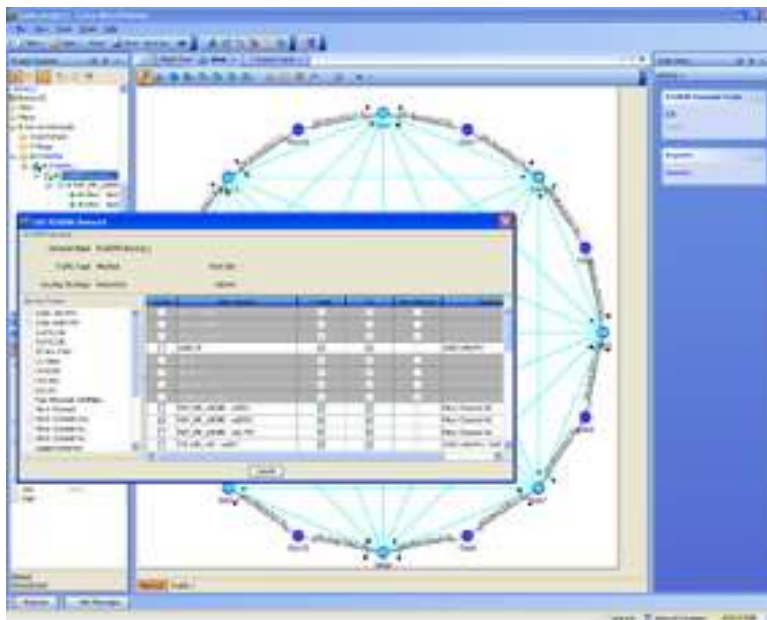
**Figure 2.** Cisco TransportPlanner DWDM Network Design Tool



Key features and functionalities of the latest release of Cisco TransportPlanner (Release 8.0) include:

- GUI-based tool to optimize DWDM layer design – Users normally have the availability of different locations in the network besides those where traffic add/drop is required. The Cisco TransportPlanner helps users determine the type and quantity of equipment to be used not only for the locations where add/drop is required but also for all the other locations. The tool accounts for the network topology, the fiber types and lengths, and current and future traffic demand.
- Any-to-any, fully flexible network design – Taking advantage of the availability of ROADM units in the Cisco ONS 15454 MSTP, the Cisco TransportPlanner helps users design a DWDM network with complete flexibility in terms of both source-destination patterns and interfaces and services (Figure 3).
- ROADM optimization – Taking advantage of the availability of multiple ROADM solutions in the Cisco ONS 15454 MSTP, Cisco TransportPlanner automatically optimizes the number of channels (for example, 32 channels vs. 40 channels) and the configuration (for example, degree-2 vs. multi-degree) of the ROADMs in the network. Cisco TransportPlanner can also manage the scalability requirements and enable an in-service upgrade to add new directions and new traffic patterns to an existing design.

**Figure 3.** Any-to-Any Design Options in Cisco TransportPlanner



Cisco TransportPlanner provides flexible design options by controlling which and how many of the nodes will be equipped with ROADM. In addition, users can determine which of the nodes in the network shall be equipped with multi-degree ROADM functions. Users can also select the traffic and connectivity types to be used to route traffic among the nodes, for an any-to-any design, which can also be supported in multi-ring and mesh networks – giving users complete control to accommodate different network scenarios and minimize the overall cost of the design.

- Complete set of DWDM interface options – The Cisco ONS 15454 MSTP is the transport DWDM platform for all Cisco units and platforms equipped with a DWDM colored interface. Cisco TransportPlanner can support the design of networks where the optical signals are

coming from any of the available Cisco devices. The user simply selects the client service type or forces the specific unit to be used for any given service. The flexibility of the platform and the Cisco TransportPlanner help users evaluate the cost of various options.

- Custom-defined DWDM interfaces – The Cisco ONS 15454 MSTP manages direct interconnection of DWDM interfaces to help reduce capital expenditures (CapEx) associated with interfacing different equipment through gray optics. From the network design perspective, Cisco TransportPlanner can also accommodate third-party DWDM interfaces by allowing the user to input interface-specific parameters and then using this interface in the network design.
- Support for network design changes – One of the most useful services the Cisco TransportPlanner gives Cisco ONS 15454 MSTP users is to assist them in the evaluation and definition of changes requested to scale and evolve an existing network (Delta Planning). Although this clearly helps when fixed OADM units are used for the design, Delta Planning allows the user to add and remove ROADMs from a design, add new services to the network, and change the flexibility associated with an existing or a planning design. Delta Planning also gives the user a complete set of reporting features to help determine what needs to be changed and where, at the node and network level.
- Detailed system performances results report – For each of the services defined at the network level, the Cisco TransportPlanner provides the relevant optical parameters required to understand whether or not the traffic could be supported. The tool gives users a quick indication of the results based on color-coded icons as well as the opportunity to view comprehensive reports. Reporting on overall latency for service types that may be affected by this parameter is available as well.
- Complete node and network BoM – Overall cost is one of the most critical parameters to control when designing optical networks. Cisco TransportPlanner can synchronize the price of each item from the Cisco.com Website and, based on this information, can generate a complete BoM for the network and for each node in the design. This information can be used to evaluate different scenarios, using multiple options and constraints for the network design. The latest release of the Cisco TransportPlanner (Release 8.0) also supports custom pricing lists that can be saved, exported, and exchanged among users.
- Comprehensive support from design to installation – Cisco TransportPlanner supports both the design and the commissioning phases of a DWDM network. The tool provides a graphical layout of the racks, shelves, and units of each network location, so this information can be available during the planning or installation of the network. In addition, Cisco TransportPlanner provides a complete list of the optical path cords that have to be installed between the different units to allow the proper signal flow at the node and network levels. Cisco TransportPlanner can also be used to support situations in the field when the fiber parameters may differ from those considered in the original design. In this case, it is possible to run the tool in “install mode,” which validates the design against the new fiber data without changing the overall BoM.
- Automatic data exchange between design and Cisco ONS 15454 MSTP – Cisco TransportPlanner can be used to accelerate the installation and commissioning phase of the Cisco ONS 15454 MSTP in the field. The tool can generate provisioning files, which are then used to configure the relevant optical parameters at the node level. Starting with the latest release of Cisco TransportPlanner (Release 8.0), the same file can also be used to pre-provision the individual cards in the nodes of the network, allowing users to make sure

the installation in the field has been properly done, even before the first DWDM wavelength is provisioned across the nodes of the network.

The direct data exchange between Cisco TransportPlanner and the Cisco ONS 15454 MSTP is an important functionality, allowing a very simple approach to DWDM network design and deployment. All the relevant design parameters used by Cisco TransportPlanner to configure and validate the optical connections in the network can provide the Cisco ONS 15454 MSTP with required reference levels. These references are then automatically used by each network node to support the following intelligent optical transmission features:

- Automatic node setup – This feature automatically sets and maintains all the optical paths available in a DWDM node. This automatic control is provided directly by the node controller unit and requires neither human intervention nor the use of management interfaces.
- Automatic power control – This feature operates at two different levels in the network so it can react to both catastrophic (fast) events and (slow) degrades. Catastrophic events are managed directly at the optical amplifiers level to help ensure the fastest reaction possible to a sudden change in the number of channels passing through the units. Degrades (such as additional fiber loss or aging) are managed at the network level as an additional automatic system reaction to changes in the network operating conditions. The DWDM nodes exchange power-levels data and can adjust amplifier gain if the measured optical power level differs too much from the expected value. This multilayered control mechanism helps assure that the optical network is always operating optimally, despite changes at the physical layer.
- Wavelength path provisioning – This feature allows the Cisco ONS 15454 MSTP to manage DWDM connections the same way SONET, SDH, and data circuits are managed by the Cisco ONS 15454 MSPP. The user can create Optical Channel Network Connections (OCHNCs) as well as Optical Channel Client Connections (OCHCCs) and then manage them as MSPP circuits. One of the primary advantages of wavelength path provisioning is that all ROADMs in the optical path are automatically set and maintained upon circuit creation, without ever requiring manual operation. OCHNCs are normally used to provision optical circuits when DWDM interfaces are not part of the Cisco ONS 15454 MSTP. An example of this provisioning is when Layer 2 or Layer 3 line cards are directly interfaced with the Cisco ONS 15454 MSTP. OCHCCs are normally used to provision optical circuits between the near- and the far-end client port of Cisco ONS 15454 MSTP Transponder or Muxponder units. In this case the user can manage every client service, even if the service is aggregated with other services and transported across the network as part of a higher-bit-rate optical channel trail (OCH-Trail).

With its multiservice capability, innovative optical technology, automatic optical power management, and MSPP-like ease of use, the Cisco ONS 15454 MSTP transforms how DWDM networks are built and managed. Combining multiple services and intelligent DWDM, the Cisco ONS 15454 MSTP significantly reduces both CapEx and OpEx for today's optical networks.



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