VIRTUAL OPTICAL NETWORKS
USING FLEXIBLE, COST EFFECTIVE, COLORLESS/DIRECTIONLESS SWITCHING

Based on our highly reliable, piezo-electric optical switching and patented beam steering technology, Polatis develops and manufactures the world's lowest loss optical switching products for service providers. Polatis is the only company that offers both multimode and single mode optical switches.

Our switches provide:

- *Typical low optical loss of <1dB*
- *Fast switching times of <17ms*
- *Support for dark fiber switching and bidirectional operation*
- *Protocol and data rate agnostic platforms (10, 40, 100Gbps)*
- *Eco-friendly, low power consumption*
- *Small 3RU form factor*
- *Web-based programmable GUI*
- *SNMP and TL1 support*

Polatis optical switch technologies enable service providers to migrate from legacy copper and electrical switch infrastructures to faster, simpler, and more resilient optical systems.

Series 2000 enables Virtual Private Optical Networks (VPoN™)

VIRTUALIZATION—THE GOAL

TCP/IP and its ability to share or "virtualize" network infrastructure has transformed service provider and enterprise networks and has touched off an explosion in server and storage virtualization as well. Virtualization's well known benefits of cost savings, flexibility, resilience, scalability, and manageability have enabled service providers to offer a variety of very profitable transport and application services. However, the benefits of network virtualization have not yet been fully realized in one key area of service provider networks—the optical core.

Although technologies such as DWDM (Dense Wave Division Multiplexing) and ROADMs (Reconfigurable Optical Add-drop Multiplexers) have allowed service providers to lower network costs, increase the scale, flexibility, and reliability of the network and increase its manageability, optical networks remain "semi-virtual".

And, while ROADM's have made it possible to add, drop, or bypass wavelengths without Optical-Electrical-Optical (O-E-O) translations, wavelengths are still tied to specific transponders, limiting the ability of network architects to design and implement resilient, meshed networks. Additionally, new customers or services or changes to existing services continue to require manual intervention.

Achieving a virtual optical network, and realizing the cost, scale, flexibility, resilience, and manageability benefits that virtualization brings, requires true colorless/directionless wavelength switching.

With colorless/directionless switching, service providers can:

- Perform hitless reroutes of wavelengths for network optimization and resource reallocation
- Eliminate O-E-O conversions due to wavelength contention in the network
- Provide additional resiliency through alternate protection paths
- Minimize stranded network bandwidth
- Increase network scalability
- Provision new customers and services faster and more profitably

Service providers can virtualize their optical network.

TODAY'S OPTICAL NETWORK

Colorless add/drop allows any color wavelength on a WDM (Wave Division Multiplexed) fiber to be dropped to any transponder on a node (or customer connection). Unlike existing WDM systems, wavelengths are hardwired to specific transponders. Using external O-E-O switches, some switching can be provided however, the wavelength is still physically hardwired to a specific transponder. This means that service providers must still perform a truck roll should a customer transponder or wavelength experience an outage. Colorless add/drop can be extended to "directionless" if switching is extended to multiple fibers coming from different directions (see Figure 1).

INITIAL APPROACH TO OPTICAL NETWORK VIRTUALIZATION

Some service providers have used Wavelength Selective Switches (WSS) and splitter combiners to implement colorless/directionless capabilities in a small portion of the network. Although this is reasonable approach for very small add/drop networks, (in which only a small number of WSS's are required), the WSS solution can become very complex and difficult to manage in larger implementations. Additionally, the high loss associated with large numbers of WSS's often requires the addition of amplifiers that increases the capital cost of the solution.

POLATIS—ENABLING THE ENHANCED VIRTUAL OPTICAL NETWORK

By inserting a Polatis optical switch (O-O-O) between the ROADM and the WDM transponders, service providers can quickly and easily implement true colorless switching in their optical network—and realize the benefits of network virtualization (see Figure 2).

Colorless switching can be extended across multiple fibers to add directionless capabilities. Initially, colorless only switching can be deployed, then as new services or service requirements such as enhanced SLA's (Service Level Agreements) are required, multi-degree directionless switching can be added.
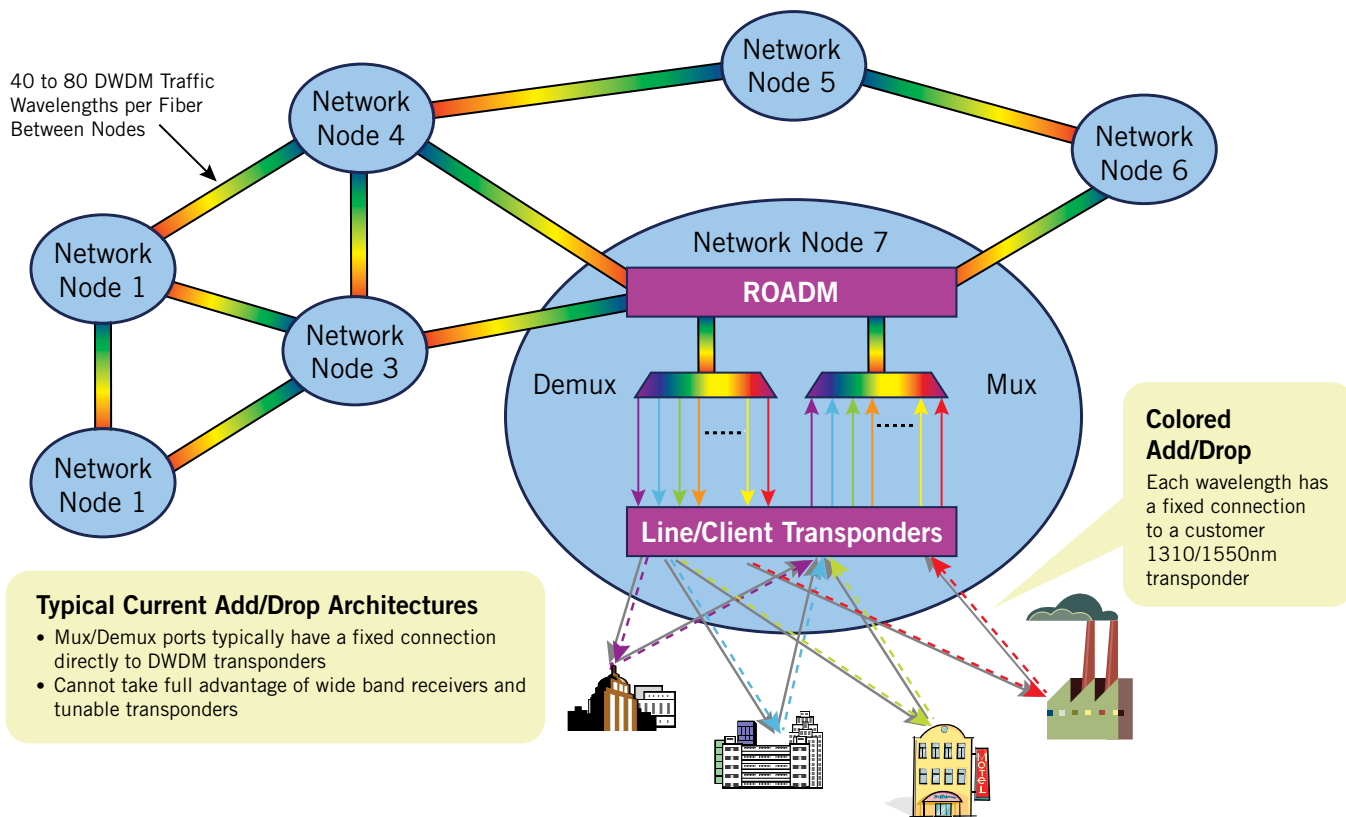

40 to 80 DWDM Traffic Wavelengths per Fiber Between Nodes

Network Node 5
Network Node 4
Network Node 6
Network Node 1
Network Node 3
Network Node 1

Network Node 7
ROADM
Demux
Mux
Line/Client Transponders

Colored Add/Drop
Each wavelength has a fixed connection to a customer 1310/1550nm transponder

Typical Current Add/Drop Architectures
- Mux/Demux ports typically have a fixed connection directly to DWDM transponders
- Cannot take full advantage of wide band receivers and tunable transponders

FIGURE 1: Current Optical Architecture

Polatis' switches ultra-low insertion loss (0.9dB typical), low wavelength dependent loss of <0.3 dB over C+L bands, high repeatability and signal stability, and very low polarization dependent loss (PDL) and very low polarization mode dispersion (PMD) minimize network impairments and ensure that additional amplifiers or signal regenerators will not be required. And, Polatis switches can even accommodate 40 Gbps and 100 Gbps speeds without hardware upgrades, can incorporate dark fiber switching into resiliency implementations, and comes in a compact, 3RU form factor that requires only 75 Watts of power (in an 80x80 switch configuration).

Furthermore, Polatis switches include an easy to understand and operate graphic user interface (GUI), eliminating the need for truck rolls to add a customer or change a service. Polatis' DirectLight™ beam-steering technology in concert with our web-based management system (of any TL-1 or SNMP compatible system), allows service providers to install, change, or upgrade wavelengths with just a few mouse clicks (see Figure 3). Additionally, Polatis' software-based system reduces the potential for human error by maintaining an accurate record of additions and changes to the optical topology.

VIRTUALIZING THE OPTICAL NETWORK

Virtualization has made service provider networks more cost effective, scalable, flexible, resilient, and manageable. Isn't it time for the optical core to realize its virtual potential as well?

Using Polatis optical switches, optical networks can maximize their profit potential. Polatis delivers not only best in class optical switches, and an optical management solution that delivers unmatched performance and flexibility —Polatis makes optical network virtualization a reality.
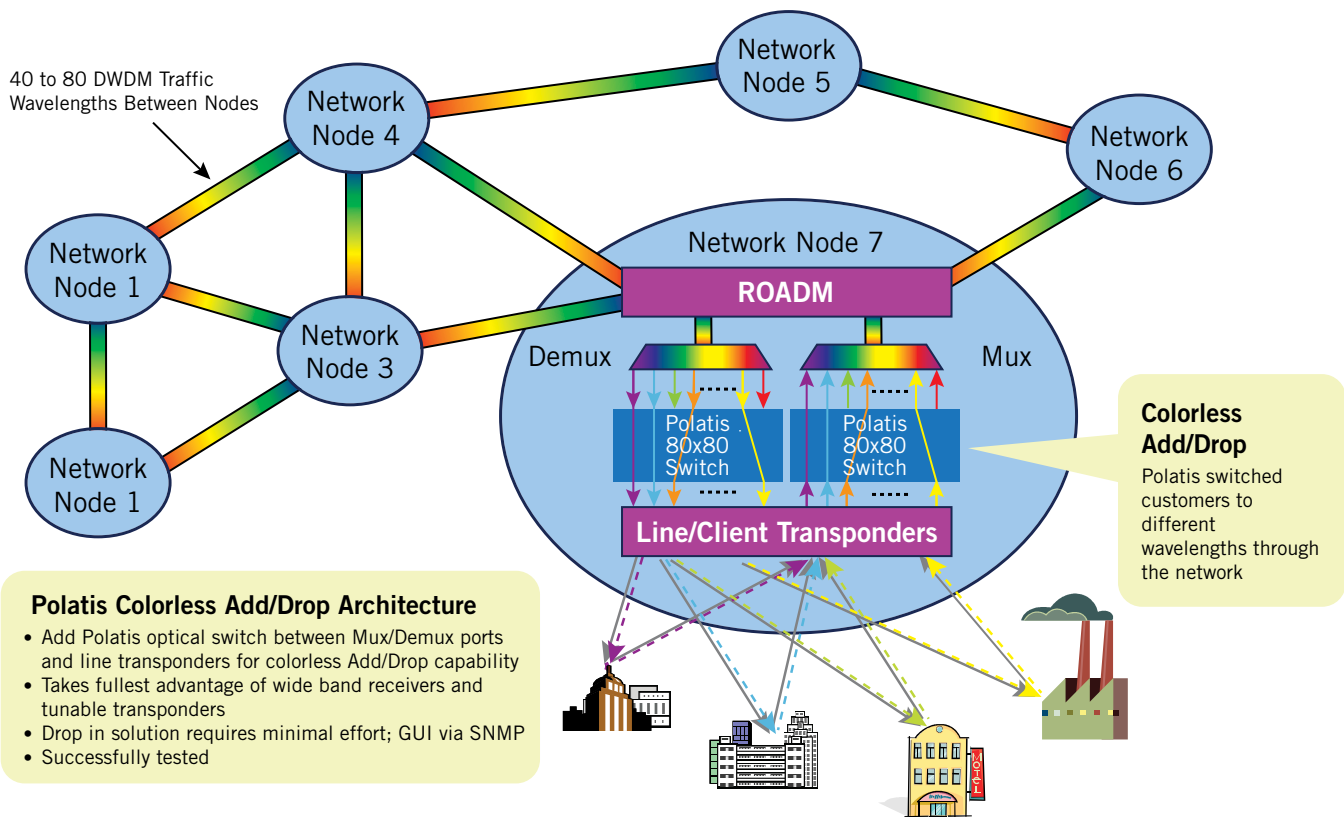

FIGURE 2: Optical Architecture with Polatis

TABLE 1: Enhanced ROADM Benefits

	ROADM Only	ROADM with Polatis
Customer Adds, Moves, Changes	Manual, Some Automation	Automated
Physical Link Asset Automated	Manual, Some Automation	Tracking
Network Resiliency	Standard	Enhanced, Includes Dark Fiber Monitoring
Optical Mesh	Limited	Unlimited
Hitless Wavelength Reroute	No	Yes
O-E-O Conversions at Ring Interconnections Required	Yes	No
Maximize Optical Resources, Eliminate Stranded Bandwidth	No	Yes

To learn more, please review technical product data sheets on our web site or call us to schedule a consultative technical session.
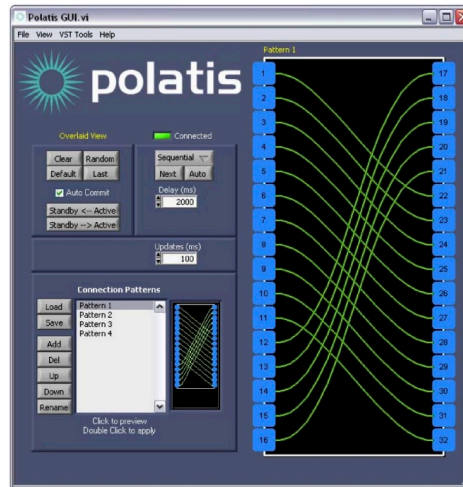
FIGURE 3: Polatis GUI

VIRTUAL PRIVATE OPTICAL NETWORKS VPoN™

Polatis' GUI and management tools also include the ability to securely partition the optical switch into smaller "virtual" switches (see Figure 4). This ability enables service providers to implement revenue producing virtual private optical network services. Optical wholesale services for multiple carriers or very large enterprises can be quickly and easily implemented and managed. This gives the optical network the flexibility and additional profit potential of existing Layer 3 implementations.

For government, Polatis management software enables multiple agencies to securely share expensive optical resources. Polatis optical switches give government agencies the ability to add bandwidth, new routes (on existing network infrastructure), or network resiliency fast, flexibly and cost-effectively.
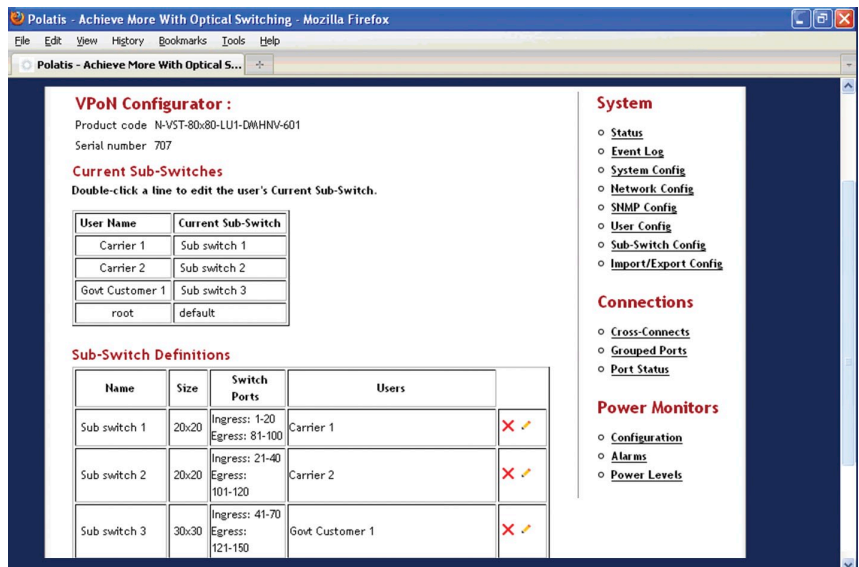

FIGURE 4: VPoN Configurator