The growth in Internet Protocol (IP) services has fueled demand for an efficient, manageable long haul high-capacity transport infrastructure. Service providers are challenged to design and build large backbone networks that can meet their customers' needs today and well into the foreseeable future. Rapid growth, an unpredictable service mix, and changing traffic patterns all combine to make flexibility and scalability critically important in network design.

**Figure 1. OPTera Long Haul product architecture**

Nortel Networks OPTera Long Haul 1600 offers carriers a proven platform in order to build the high capacity, multi-service optical backbone network they need. The OPTera Long Haul 1600 provides up to 80 channels x 10 Gbps capacity on a single optical fiber pair and transparently handles a broad mix of services in multi-vendor environments.

Nortel Networks industry-leading OPTera Long Haul Optical Line Systems offer survivable, multiservice backbone solutions with open optical interfaces and scalable dense wavelength division multiplexing (DWDM). The OPTera Long Haul 1600 provides up to 80 channels x 10 Gbps capacity on a single optical fiber pair and transparently handles a broad mix of services in multi-vendor environments.

This bulletin provides a technical overview of the platform.
Flexible backbone solutions using OPTera Long Haul 1600

The open optical interfaces provided by OPTera Long Haul 1600 enable transparent, wavelength-based transport of a wide range of IP, Asynchronous Transfer Mode (ATM), and SONET/SDH services. These interfaces are specifically designed to interwork easily with sub-tending systems of virtually any type without regard to equipment vendor. OPTera Long Haul 1600 also offers additional capital and operational efficiencies when deployed as part of an integrated network solution with the Preside Optical network management platform and other members of the Nortel Networks OPTera family such as OPTera Metro and OPTera Connect.

OPTera Long Haul 1600 may be configured to provide many different functional blocks, as needed to enable next-generation all-optical backbone networks. These building blocks include Wavelength Translator, Wavelength Combiner, optical amplifier, regenerator, optical add/drop, and optical protection ring switching. Because all of these building blocks have been designed by Nortel Networks to work together in harmony, carriers are assured of backbone solutions that deliver reliable, robust optical performance.

A fully expanded OPTera Long Haul 1600 solution employing Optical Amplifiers supports a maximum of 80 wavelengths. This translates to a scalable, single-fiber capacity of 800 Gbps at the 10-Gbps line rate. And for optimum application flexibility, the system supports all optical fiber types and both unidirectional and bidirectional DWDM arrangements. A modular architecture compatible with any existing fiber plant allows wavelengths to be easily added as needed, thereby keeping today’s costs in line with current capacity requirements.

OPTera Long Haul 1600 also supports Raman optical amplification technology, which allows operational and capital equipment savings by increasing system reach and reducing the number of optical regenerators in the network.

With the deployment of all the same building blocks detailed in this document, the OPTera Long Haul 1600 also supports single stretched span applications up to 350 km.

Wavelength Translators

OPTera Long Haul 1600 Wavelength Translators extend the fiber savings and capacity advantages of DWDM technology to a highly varied mix of network element types and services. These building blocks condition 2.5/10-Gbps channels, 10-Gigabit Ethernet, and short reach (SR) services for DWDM long haul transport in an open, multi-vendor environment. Translated optical signals are regenerated, reshaped, and retimed for optimum optical performance over a long haul backbone. Direct support for 10-Gigabit Ethernet seamlessly integrates data networks with the optical backbone at the 10-Gbps line rate.

Wavelength Combiners

These building blocks augment the service transparency features of a Wavelength Combiner with the ability to aggregate multiple independent lower speed channels (e.g. 2.5-Gbps SONET/SDH or Gigabit Ethernet) into a single 10-Gbps signal. Transmission at the 10-Gbps rate offers many bandwidth efficiencies such as greater traffic throughput per fiber, better utilization of available wavelengths, and deferred need for expensive network expansions.

Figure 2. Wavelength Translators and Wavelength Combiners
**Optical add/drop**

The OPTera Long Haul 1600 optical add/drop multiplex (OADM) capability enables direct optical layer access to local traffic while avoiding the costs and complexity of unnecessary termination of express channels. Local traffic can then be fed to subtending equipment (from Nortel Networks or other vendors) via open optical interfaces.

Wavelength add/drop introduces low loss so it does not materially affect either optical link budgets or the number of fiber spans supported. This affords a high degree of network flexibility that helps carriers handle changing traffic patterns, provide fast turnup of new services, and avoid the need for costly network reconfigurations.

**Carrier-class service quality and availability**

OPTera Long Haul 1600 offers a full portfolio of carrier-class service quality features without compromising service transparency. These include virtually error-free transmission (guaranteed 10E-15 bit error rate), proactive section/optical layer performance monitoring, and optical layer diagnostics. With the ability to provide a superior level of service quality, carriers are well positioned to deliver highly profitable premium-grade services while containing network support costs.

For full-time, “five 9s” service availability, OPTera Long Haul 1600 offers the Optical Dedicated Protection Ring (ODPR), a self-healing ring architecture optimized for DWDM backbones, high-bandwidth services, and all-optical networks. The ODPR’s full route diversity and wavelength-based protection switching are ideal for the transport of future high-margin IP services.

**Carrier-class service quality features without compromising service transparency**

OPTera Long Haul 1600 also supports unprotected operation for use in conjunction with SONET/SDH and IP data layer protection methods.

**Network management**

OPTera Long Haul 1600 has been designed with the special challenges of service transparency and the optical layer in mind. Powerful optical layer management tools serve as a natural extension to existing SONET/SDH network management methods and strategies. In addition, the Nortel Networks Preside optical network management platform offers consolidated, value-added management capabilities for an entire network consisting of OPTera Long Haul 1600 and other systems from Nortel Networks.

Preside addresses end-to-end service and network management across all domains/technologies including the optical, SONET/SDH, and packet layers. All management functions are seamlessly integrated and easily accessible from a simple point-and-click user interface. A consolidated network management platform offers consolidated, value-added management capabilities for an entire network consisting of OPTera Long Haul 1600 and other systems from Nortel Networks.
view automates trouble notification and diagnosis across all layers, including passive components in the optical layer. Other powerful "expert system" tools automate optical amplifier setup and maintenance and wavelength path management.

**OPTera Long Haul 1600 bay layouts**

**Wavelength Translator bay**
Up to 30 single-card 2.5-Gbps Wavelength Translator building blocks or up to 13 two-card 10-Gbps Wavelength Translators can be deployed in one bay as shown in Figure 5 below. If required, up to four slots are available in the main optical transport shelf for optional Multi-Wavelength Optical Repeater (MOR) Plus optical amplifiers. This optical amplifier plug-in type supports DWDM applications employing up to 32 wavelengths.

Mixed combinations of 2.5 and 10-Gbps services can be supported from the same shelf, as needed to optimize current and future application flexibility. On an optional basis, up to eight passive optical components (such as DWDM couplers, OADM couplers, and dispersion/slope compensation modules) may be installed at the bottom of the Wavelength Translator bay.

Although the Translator and Combiner bay are detailed in two separate sections, note that service providers can deploy a single terminal bay equipped with a mix of Translator and Combiner cards.

---

**Figure 5. Wavelength Translator bay layouts**
**Wavelength Combiner bay**

Up to three Wavelength Combiner building blocks can be deployed in a single bay along with up to eight passive optical components installed at the bottom of the bay—or a maximum of five combiners without passive components (Figure 6). This translates into an aggregate bay capacity of up to 50 Gbps. Note that each combiner consists of a 10-Gbps DWDM interface plug-in plus four sub-rate modules (2.5 Gbps or Gigabit Ethernet) for a total of five circuit packs per Wavelength Combiner. Four slots are reserved in the main optical transport shelf for optional MOR Plus optical amplifiers.

A hybrid configuration that offers a mix of 2.5 Gbps and Gigabit Ethernet ports combined into a single 10 Gbps wavelength is supported.

**OPTera Long Haul 1600G Optical Amplifier bay**

OPTera Long Haul 1600 applications employing more than 32 wavelengths are addressed by the OPTera Long Haul 1600G Optical Amplifier. As illustrated in Figure 7, a single bay supports up to two independent OPTera Long Haul 1600G Optical Amplifier configurations (referred to as Group “0” and Group “5”). This configuration provides a unidirectional, two fiber DWDM building block that can transport up to 80 wavelengths in the C (1530 to 1561 nm) and L (1570 to 1603 nm) bands.

*Figure 6. Wavelength Combiner bay layouts*

*Figure 7. Typical unidirectional 1600G Optical Amplifier bay configuration*
**Regenerator bay**
Up to 30 single-card 2.5-Gbps regenerators or up to 15 two-card 10-Gbps regenerators (Figure 8) can be installed in an individual bay, for a total capacity of up to 30 x 2.5 Gbps or 15 x 10 Gbps bi-directional channels. If required, up to four slots are available for optional MOR Plus optical amplifiers. Also, up to eight passive optical components may be installed in the bottom of the bay.

**ODPR bay**
As shown in Figure 9, up to six dedicated 10-Gbps optical protection ring building blocks can be placed in a single bay. As with other OPTera Long Haul 1600 applications, four slots are available for MOR Plus optical amplifiers and up to eight passive optical components may be installed in the bottom of the bay.

In addition to the dedicated ODPR bay configuration of Figure 9, OPTera Long Haul 1600 also supports a hybrid arrangement that includes ODPR, Wavelength Translator, and regenerator building blocks.
**General specifications**

**Supported services (fully transparent)**
- Up to 80 x 10 Gbps
- Up to 320 x 2.5 Gbps, maximized for the 10-Gbps rate, single card
- Up to 640 x 1.25 Gbps (Gigabit Ethernet), maximized for the 10-Gbps rate
- Up to 80 x 10-Gigabit Ethernet WAN PHY
- Concatenated service support at 2.5 and 10 Gbps
- Short reach (SR) interfaces

**DWDM configurations**
- Uni/Bidirectional (Bi:MOR+ L-Band overlay)

**Supported configurations and protection**
- 1+1 unidirectional non-revertive optical layer protection
- Dedicated ODPR
- Unprotected point to point
- SONET/SDH rings in conjunction with S/DMS TransportNode
- Mesh in conjunction with OPTera Connect family

**Optical connectors**
- Pigtail fiber type, single mode
- Universal Connector Assembly (FC, ST, and SC adaptors)

**Synchronization**
- Synchronization Status Messaging (SSM)
- 1+1 non-revertive timing protection
- Through timing
- BITS timing
- External timing synchronization interface (ESI)
- Timing deviation detection
- Accepts reference timing from up to five sources
- Six timing distribution members available

**DWDM passive bay**
OPTera Long Haul 1600 also offers a stand-alone passive components bay (*Figure 10*) to accommodate the many passive optical devices typically required in today’s high-capacity DWDM backbone networks. These passive devices include DWDM multiplex (MUX) and demultiplex (DEMUX) modules, dispersion/slope compensation modules, and OADM modules.

As shown in *Figure 10*, the OPTera Long Haul 1600 DWDM passive bay provides up to six 4-slot shelves for passive components plus up to 13 Fiber Management Trays. Thus, a maximum of 24 passive components can be placed in a single bay. Four shelves are typically dedicated to MUX and DEMUX modules with the remaining two shelves housing other passive devices. Each DWDM MUX module and DEMUX module supports up to ten individual wavelengths.

**OPTera Long Haul 1600 key technical specifications**

*Figure 10. Typical DWDM passive bay layout*
Environmental specifications

Normal operation  
Temperature range from 0 to +40 degrees C (+32 to +104 degrees F), relative humidity from 10 to 85 percent

Short-term operation  
Temperature range from –8 to +50 degrees C (+18 to +122 degrees F), relative humidity from 5 to 95 percent or 0.024 kg water/kg dry air

Earthquake  

Laser safety  
Compliant with Exchange Carrier Standards Association (ECSA) T1X1.4 and T1X1.5 requirements

Physical bay characteristics  
Width: 598 mm (23.5 in.)  
Height: 2.125 m (83.7 in.)  
Depth: 298 mm (11.7 in.)  
Weight: 369.5 kg (814.5 lbs), fully loaded  
Cable Access: Front

Operations interfaces

Craft interfaces  
- RS-232 DCE port (9-pin D subminiature connector)  
- RS-232 DTE port (9-pin D subminiature connector)  
- TL-1 user interface

Orderwire  
- VF300 port  
- Public switched telephone network (PSTN) port  
- Ethernet wayside port (2-Mbps data channel)

Office alarms  
- Critical, major, minor, remote alarms  
- Normally open and normally closed contacts  
- Visual and audible alarms, shelf LEDs

User defined alarms  
- 64 telemetry inputs  
- 16 outputs  
- Form C relay  
- 120 VAC/120 VDC, 1 A

Operations system interfaces  
- TL-1 over X.25 and via an X.25/X.3 PAD, up to 32 switched virtual circuits (SVCs)/incoming switched virtual circuits (IVCs)/outgoing switched virtual circuits (OVCs)  
- TL-1 over true TCP/IP and via Telnet TCP/IP  
- Optional redundant TL-1 link  
- Three network element Ethernet ports (overhead bridging)  
- Central office (CO) LAN  
- Subminiature 9-pin Ethernet connector  
- Security features (password aging, new default user, login/logout logs, and improper login detection)

Nortel Networks is an industry leader and innovator focused on transforming how the world communicates and exchanges information. The Company is supplying its service provider and enterprise customers with communications technology and infrastructure to enable value-added IP data, voice and multimedia services spanning Wireless Networks, Wireline Networks, Enterprise Networks, and Optical Networks. As a global Company, Nortel Networks does business in more than 150 countries. More information about Nortel Networks can be found on the Web at:

www.nortelnetworks.com

For more information, contact your Nortel Networks representative, or call 1-800-4 NORTEL or 1-800-466-7835 from anywhere in North America.

*Nortel Networks, the Nortel Networks logo, and the globemark design are trademarks of Nortel Networks. All other trademarks are the property of their owners.

Copyright © 2002 Nortel Networks. All rights reserved. Information in this document is subject to change without notice. Nortel Networks assumes no responsibility for any errors that may appear in this document.