Integrating digital optical long-haul networks with the metro edge

By Paul R. Morkel

OVERVIEW

New technology brings digital benefits to the metro edge of the optical network. The result reduces network costs, simplifies operations, and provides efficient sub-wavelength management and transport across an integrated end-to-end network.

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Digital optical network technology has long provided high-density transport with integrated bandwidth management, a flexible architecture, reconfigurable add/drop capability, network simplification, reliability, and integrated bandwidth management in long-haul and regional networks. These benefits can now be extended to the metro edge to enable end-to-end service and bandwidth management with subwavelength granularity.

This article provides a brief overview of the existing digital optical network technology, describes how its benefits apply to the metro network, and offers applications examples in both integrated and standalone deployments.

Leveraging digital optical networks

Digital optical network technology implements a high level of component integration into an efficient long-haul and regional transport and bandwidth management system using photonic integrated circuits. It provides integrated 2.5-Gbps granularity digital switching and grooming, full digital performance monitoring, service protection, and end-to-end provisioning to support up to 160 wavelengths per fiber. Density is further improved with optical multiplexing on a compact line card.

A key advantage of the digital optical network approach over all-optical reconfigurable optical add/drop multiplexer (ROADM)-based systems has been its ability to provide bit-transparent services with frequent and comprehensive digital performance monitoring. The PIC technology provides highly cost-effective optical-electrical-optical (OEO) conversion of the optical signals as they transit the network, allowing bit-error-rate (BER) performance monitoring wherever required and control-plane-based service provisioning across the network.

There are significant benefits to a digital optical network platform when compared to its all-optical counterparts. They include greater density, simplicity of operation, and unique bandwidth virtualization for flexible allocation of network resources to meet any service need, using flexible "any service, any port" service adaptation.

Many carriers using digital optical network platforms for long-haul and regional networks want to extend their core networks toward the metro edge. However, core and edge equipment are generally subject to different optimization criteria. Optimization for the edge requires efficient single-wavelength termination capability, which is generally not the case in the core network. The edge network technology must then be cost efficient in these applications and provide integrated handoff to the core network for true end-to-end network interoperation.

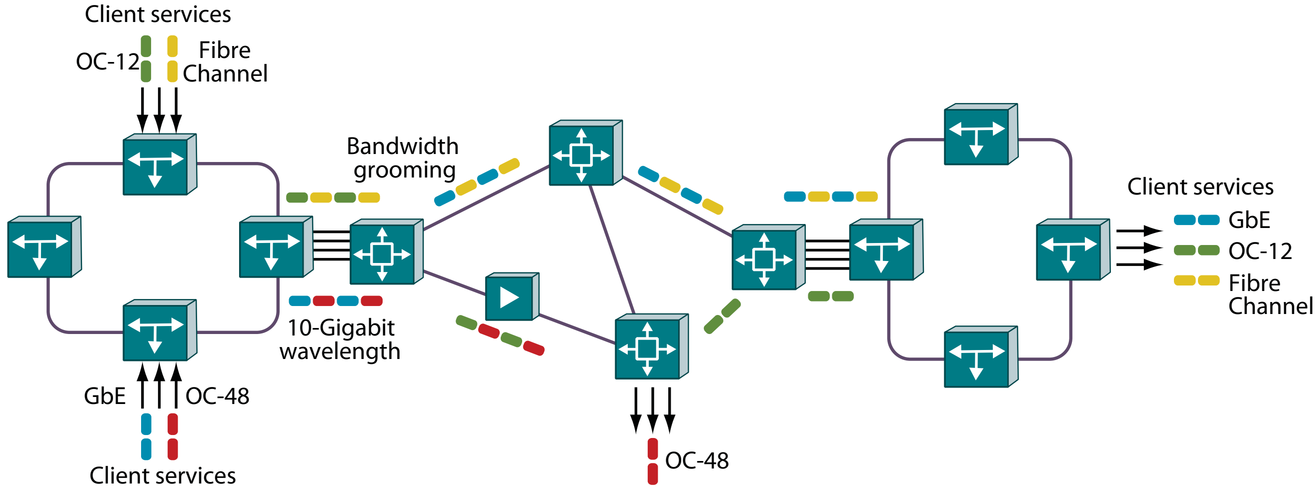

FIGURE 1. Using an intelligent metro edge WDM platform, a wide range of services can be aggregated onto wavelengths and transported across the metro network for handoff to the digital optical core network—without the need for transponders at the interconnection points.

Intelligence for the metro edge

New intelligent metro edge technology provides digital optical network CWDM/DWDM aggregation and transport with up to 40 wavelengths of 10-Gbps scalability, either as a standalone edge transport system or integrated within a digital optical core network. Either applications adds a very cost-effective, space-saving, and power-efficient WDM-based transport capability to the metro, extending the core network or in a "second mile" scenario.

The hybrid end-to-end approach enables the digital optical core and the metro edge to interoperate with optimization for each distinct segment of the network. For example, if there are just a few wavelengths at the edge, an intelligent metro edge platform with its shorter reach, cost-effectiveness, lower power consumption, and space efficiency is clearly a good fit. But in the network core with its longer distances, very high capacity, and bandwidth management requirements, the digital optical network core platform works best. Bringing both platforms together in a way that works for either application is essential to satisfying carrier expectations.

Typically, a telecom carrier builds an end-to-end optical network today using a combination of platforms. Three distinct components are required: the core or long-haul network, the metro transport network, and a bandwidth management function. There is virtually no integration at the network level other than the client interfaces and some level of common network management.

However, for carriers deploying a digital optical network approach for their core network, the intelligent metro edge platform now makes it possible to gain additional functionality using only two components. The intelligent edge platform delivers common end-to-end bandwidth management that enables efficient service provisioning and aggregation from the ingress to the egress of the network, regardless of whether the service originates or terminates at the

LINKS TO MORE INFORMATION

LIGHTWAVE: *Digital Optical Networks Simplify Architectures*

LIGHTWAVE ONLINE: *Heavy Reading: Photonic Integration to Drive NG Optical Development*

LIGHTWAVE: *Bandwidth Virtualization Enables a Programmable Optical Network* core or metro areas of the network (see Fig. 1).

Automated discovery of interconnected equipment and network topologies using control plane technology simplifies integrated network management. Typically, as a carrier connects equipment from various vendors, connections between equipment types must be manually entered into the management system database. That means every connection across the network must also be manually managed. An intelligent metro edge platform simplifies interoperability from a resource and topology management perspective along with service-level management. End-to-end provisioning across the network can be enabled, thus speeding and simplifying turn-up of new revenue-generating services.

Since the digital optical network architecture has built-in bandwidth management through an electrical switch fabric at every node, the end-to-end infrastructure can also take advantage of integrated bandwidth management. Using common multiplexing and framing protocols, a wide range of services can be aggregated onto an integrated wavelength and transported across the metro edge network for handoff to the digital optical core network—without the need for a transponder at the interconnection point, and with handoff at the aggregated rate, as shown in Fig. 1. Services are then transported across the digital optical core network with multipoint distribution as required.

Building bandwidth-managed networks without separate standalone equipment is a clear advantage when compared to using combinations of multiple types of equipment to gain similar functionality. Applying the same architecture from the metro edge to the network core and out to other remote metro edges provides a very cost-effective end-to-end infrastructure.

Applications—integrated and standalone

The intelligent metro edge component is effectively used in many applications, both as a standalone platform or integrated with the digital optical core network system. Typical applications include long-haul/regional networks (see Fig. 2), metro core extension, broadband backhaul, and data center connectivity.

In Fig. 2, for example, an intelligent metro edge WDM platform integrates a digital optical core network with the metro edge. The subtending rings connect several large enterprises and small distribution offices at the metro edge to the regional core network. This provides both connectivity and aggregation for a range of services from customer locations to the regional point-

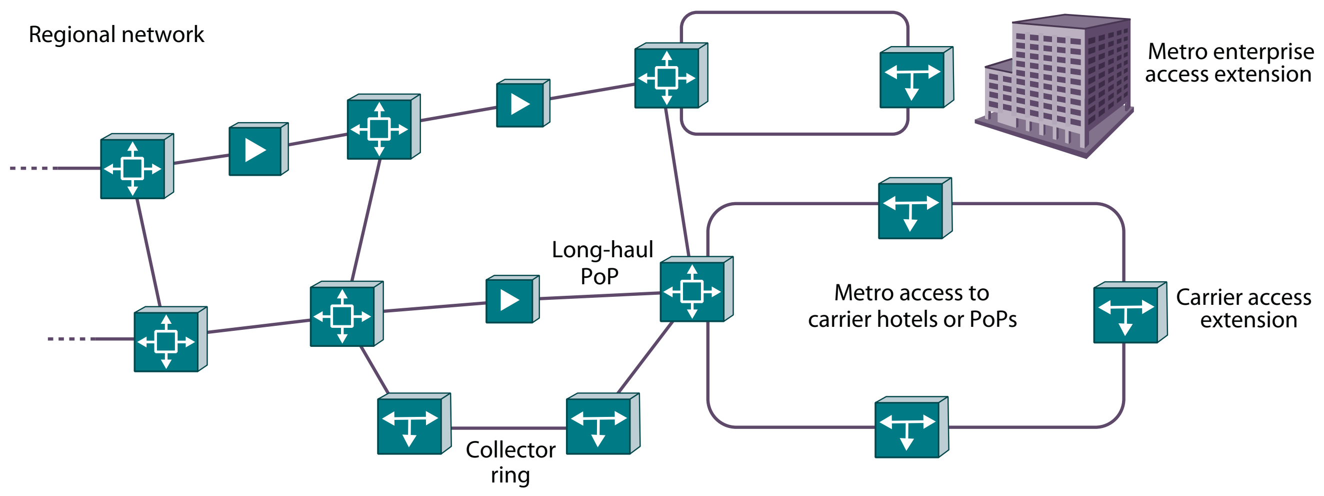

FIGURE 2. **The intelligent metro edge WDM platform extends the reach of a regional core network into metro enterprises and distribution offices.**

of-presence (PoP). This application can be used by traditional carriers or multiservice operator networks.

CWDM and DWDM options may be used, depending on reach and scalability requirements. The key benefit to carriers using digital optical network architectures is the ability to manage circuits from end to end, while avoiding back-to-back equipment at interconnect points.

Another application that may not require long-haul network interworking is high-capacity data center connectivity. In this application, cost-effective transport and aggregation of Gigabit Ethernet, 10-Gigabit Ethernet, and SAN protocols can be accomplished easily and efficiently with the same platform. The intelligent metro edge WDM platform provides space and power efficiency, simplified operations, flexible bandwidth scalability, and reach in these types of applications, and supports seamless integration with the digital optical network core when needed.

To sum it up

The intelligent metro edge technology creates a much simpler transport system, using just two integrated components versus three components (core system, metro WDM system, and a bandwidth management function) from multiple vendors. Simplified end-to-end provisioning across the entire system, with service activation measured in seconds instead of days, provides more efficient service to customers while cutting costs for the carrier.

Integrating the digital optical core network with the metro edge through an intelligent metro WDM platform extends the benefits of digital optical network technology to both ends of the network. Capital is reduced, along with cost of ownership, while operations are simplified for wavelength-level switching and sub-wavelength transport.