

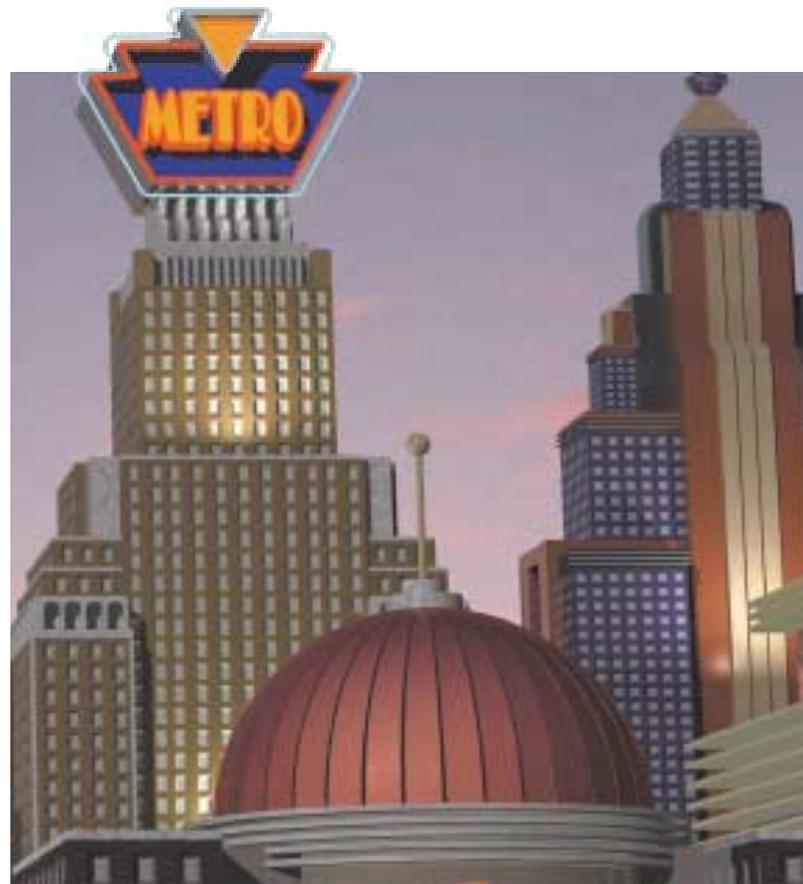
# The METRO RAILWAY

**CISCO IP+OPTICAL SOLUTIONS FOR METROPOLITAN-AREA NETWORKS MEET A VARIETY OF APPLICATION AND INFRASTRUCTURE REQUIREMENTS.**

**T**HE HIGH-SPEED VIRTUAL RAILWAY FOR Internet commuters is the metropolitan-area network (MAN), or metro. With most major cities laying and lighting fiber, the metro network is the local route to long-haul networks via local points of presence (POPs). Often, commuter traffic enters the metro through broadband access services instead of traditional, low-speed WAN or dial lines. And POPs are growing beyond their traditional roles of aggregation and multiplexing to include content-driven services. The increase in access bandwidth combined with the demand for high-volume content services housed in POPs means that the metro now carries a rapidly growing percentage of traffic on public networks. Consequently, metropolitan service providers are looking for ways to cost-effectively scale their MAN networks to handle the increased load.

Traditionally, most metro traffic was predictable time-division multiplexing (TDM) voice services carried over SONET/SDH networks. The Internet changed that. Data now outweighs voice both in traffic volume and growth rates. In light of exponential data growth, traditional SONET/SDH networks have proven slow to provision, complex to manage, and expensive to operate. Service providers need more efficient ways to increase capacity in the optical MAN.

Cisco provides several solutions for the optical MAN, giving



service providers the choices they need to meet their particular infrastructure and transport requirements. According to Dell'Oro Group, Cisco is the fastest-growing optical networking vendor and is now the leader in OC-48 SONET.

Ethernet has emerged as a popular broadband access technology, so Cisco enables direct Ethernet connections to SONET/SDH, Dynamic Packet Transport (DPT), and dense wavelength-division multiplexing (DWDM) networks. In areas with existing SONET/SDH metro networks or to carry integrated data, voice, and video traffic, Cisco “supercharged” SONET/SDH solutions lower costs and increase service velocity. In places where the Internet is prevalent, Cisco DPT solutions provide direct IP-over-fiber connections using Spatial Reuse Protocol (SRP). Where fiber exhaust is imminent, Cisco offers DWDM solutions optimized and priced for the metro to increase fiber capacity.

#### Ethernet as Broadband

An emerging trend in broadband access service is Ethernet to the metro ring. Ethernet is relatively inexpensive and enterprise customers understand it. Cisco enables seamless Ethernet-to-optical connectivity through many of its IP+Optical platforms, such as the new Cisco 7600 Optical Services Router (OSR), the Cisco 12000 series Internet router, the Cisco ONS 15454 Optical Transport Platform, the Cisco ONS 15327 Metro Edge Optical Transport, and the Cisco Metro 1500 series.

#### Supercharged Metro Optical Transport

One of the reasons that traditional SONET/SDH networks are slow to provision and expensive to manage is the number of boxes required, one for each type of interface or multiplex step. To transmit a DS1 signal up to an OC-48 ring requires a minimum of four boxes. Upgrading a SONET/SDH ring to a higher speed requires an entirely new set of boxes with the higher-speed interface. Further, traditional SONET/SDH rings must dedicate half the backbone bandwidth to traffic protection, thus strangling precious capacity. “In an Internet-speed economy requiring rapid response to changing requirements, the tedium of such old-world methods impairs service velocity and harms competitive advantage,” says Christopher Vallee, product marketing manager in the Optical Transport Business Unit at Cisco.

Data networks have long enjoyed the benefits of modular components and interfaces for rapid upgrades, and that paradigm entered the SONET world with the introduction of the Cisco ONS 15454 Optical Transport Platform. Its modular chassis supports a wide variety of interfaces, delivering supercharged SONET transport by supporting any optical-carrier line rate, integrated optical networking such as DWDM and ITU wavelengths, and unprecedented service flexibility with Ethernet, TDM, and ATM interfaces.

*Written by Gail Meredith (gmeredit@sonic.net), a contributing editor for Packet magazine.*

“We’re able to achieve very rapid turnup times with very high-speed bandwidth.”

—BILL EUSKE, CTO, SIGMA NETWORKS

Sigma Networks, based in San Jose, California is delivering massive metro network capacity to its carrier customers in major metropolitan areas of the United States. The metro network is based on the multiservice flexibility of the Cisco ONS 15454 Optical Transport Platform and the DWDM capacity of the Cisco 15200 series DWDM system. “We have been told that our approach is rather unique in the architecture we’ve chosen to achieve very rapid turnup times with very high speed bandwidth. Like all startups, we

like to think outside the box. Our challenges are somewhat unique. We found Cisco very willing to work with us to produce a hybrid solution that is optimal for our needs,” says Bill Euske, chief technology officer at Sigma. “An access switch is important because it must connect anything to anything as opposed to having a rigid hierarchy. The Cisco ONS 15454 embodies all the forward-looking elements that a SONET service needs. We can use it in ways that provide up to double the capacity—ports and aggregate speed—of similar add/drop

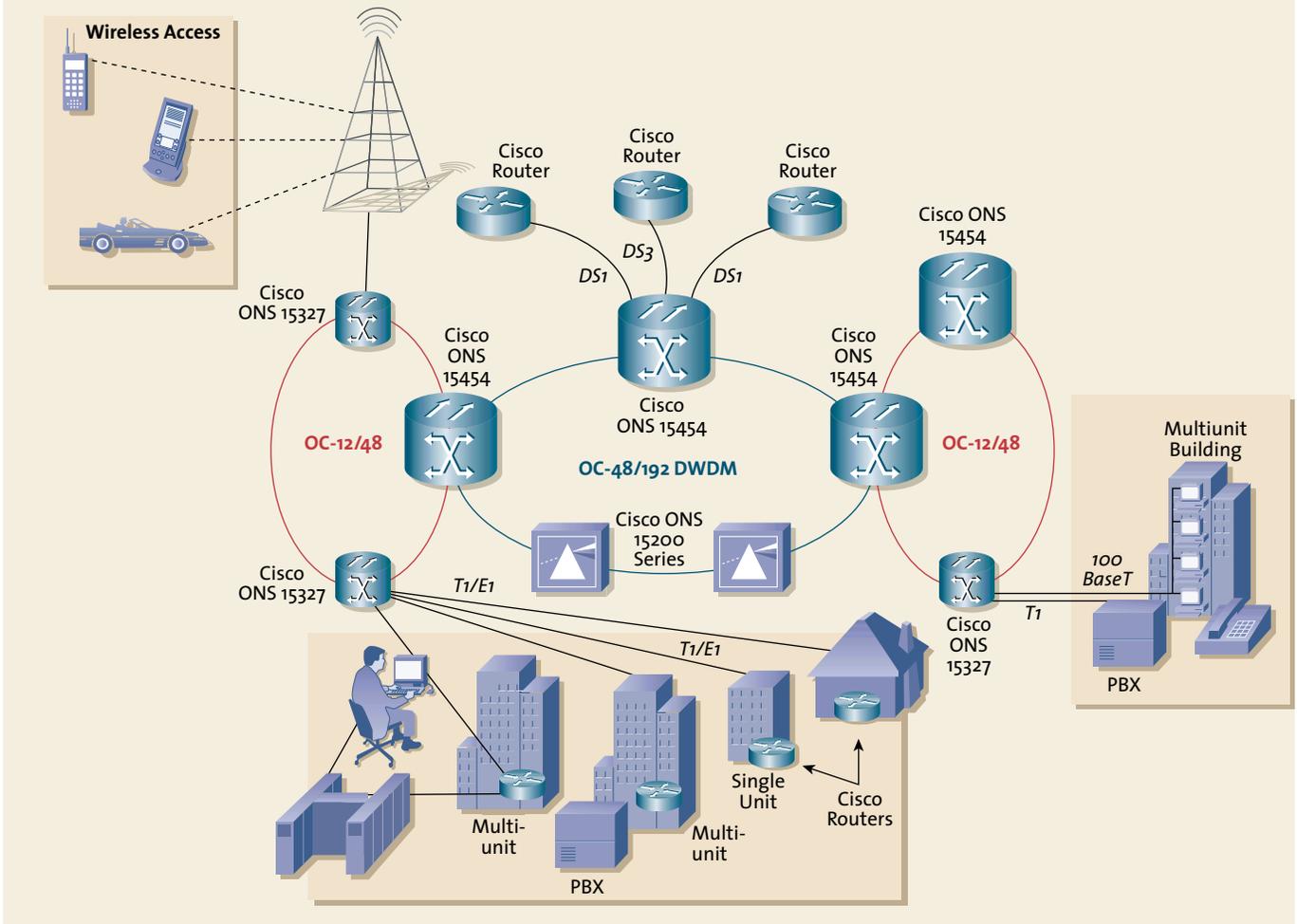
multiplexers. It’s non-hierarchical, which makes it flexible for our changing needs as we go forward. The Cisco ONS 15454 can be configured to support two trunk rings. Typical products on the market in the add/drop SONET technology can only support one ring because they have hierarchy.”

The supercharged flexibility of the Cisco ONS 15454 platform dramatically reduces the number of boxes in the network, which speeds service velocity and lowers operational expenses, both key requirements for transporting IP packets. Along with a full cross-connect capability, integrated packet switching, statistical multiplexing, and a small footprint, the Cisco ONS 15454 platform means big savings for service providers. A Cisco study indicates that deployment costs of a Cisco ONS 15454 solution saves approximately 83 percent over traditional add-drop multiplexers (ADMs). The study also demonstrates that operational costs of a Cisco ONS 15454 network are about one-fifth the cost of a traditional ADM network.

Because the metro environment is extremely competitive, service providers must weigh the need for local market presence, or footprint, with the costs of establishing the network. Although the ONS 15454 is a cost-effective box compared to other offerings, it is when service providers begin weighing the additional enhancements and feature offerings of the ONS 15454 that its real advantages win the day. “By decreasing the cost-to-market proposition,” says Vallee, “service providers find they can enter markets that they had previously thought they’d have to wait to grow.”

With the introduction of the Cisco ONS 15327 Metro Edge Optical Transport Platform, Cisco makes supercharged SONET networks even more cost-effective. The new platform offers the same benefits as the Cisco ONS 15454 platform but in a smaller size optimized for metro edge applications. “And where traditional SONET services take weeks or even months

SUPERCHARGED METRO OPTICAL TRANSPORT



**FIGURE 1:** Cisco's supercharged metro optical transport solutions enable unprecedented service flexibility for the metropolitan-area network. Consolidating multiple interfaces into fewer boxes such as the Cisco ONS 15454 Optical Transport Platform and Cisco ONS 15327 Metro Edge Optical Transport Platform streamlines the architecture to lower deployment and operations costs.

to turn up, providers can install the Cisco ONS 15327 and turn up service in as little as 20 minutes," says Vallee.

Cisco ONS 15327 platforms can gather traffic from enterprise customers via routers, switches, or wireless towers and pass them to the primary transport ring comprised of Cisco ONS 15454 for multiplexing into TDM or IP data service POPs (Figure 1).

The Cisco ONS 15454 platform now supports SDH interfaces to appeal to service providers outside the US. The Cisco ONS 15327 platform initially supports SONET interfaces, but will have SDH interfaces available in the near future. The

entire supercharged metro optical transport solution is managed via Cisco Transport Manager (CTM).

**Dynamic Packet Transport**

In IP-centric environments, an alternative to SONET/SDH infrastructures is DPT. A direct IP-over-optical technology, DPT allows service providers to build transport networks on fiber rings without the use of ATM or SONET/SDH technologies for protection or switching. DPT enables service providers to build next-generation, packet-based metro networks that deliver scalable Internet services, reliable IP-aware optical transport, and simplified network operations.

As a data-optimized, IP+Optical technology, DPT is ideal for Internet applications. DPT is at home in service POPs and Internet data centers where IP is prevalent, but is also a key component for building next-generation, packet-based MANs. "With DPT, we can extend the benefits of the Internet into the metro," says Jeff Baher, senior manager in the Metropolitan IP Access Business Unit at Cisco. "It enables an entirely new architecture that eliminates today's metro bottleneck. DPT delivers scalable, cost-effective IP services without compromising reliability."

The foundation of DPT is SRP, a Media Access Control (MAC) layer proto-

col that operates over a dual-ring topology. It marries the intelligence and scalability of IP with the bandwidth capacity of optics. It enables scalable bandwidth and node numbers along with ring survivability features. As a media-independent protocol, SRP can be deployed over a wide array of underlying physical layer technologies, including DWDM, SONET/SDH, and dark fiber.

An SRP architecture consists of two counter-rotating fiber rings concurrently supporting data and control packets. Unlike traditional, voice-era SONET/SDH rings, which require 50 percent dedicated bandwidth for protection, SRP utilizes all available bandwidth in both rings. A key feature of the SRP protocol is intelligent protection switching (IPS), which provides protection similar to automatic protection switching (APS) for SONET/SDH rings. IPS enables 50-ms IP service restoration without routing protocol reconvergence.

Cisco's high-end 12000 series Internet routers (including the new 12410 and 12416) support DPT at OC-12/STM-4 and OC-48/STM-16 speeds, and Cisco 7500 and 7200 series routers support OC-12/STM-4 DPT interfaces.

The complementary Cisco ONS 15190 IP Transport Concentrator also provides DPT connectivity at OC-12/STM-4 and OC-48/STM-16 speeds. The concentrator enhances the reliability of DPT networks with features such as enhanced intelligent protection switching (E-IPS). Optical power monitoring and sophisticated node management features further reduce operational complexities and simplify network management.

Eastern Multimedia Group (EMG) is a cable television and next-generation telecommunications provider in Taiwan. Its network uses the Cisco 12000 Internet router platform and DPT instead of ATM. "The cross operation between cable television and telecommunications has made telecommunications services-on-cable one of the biggest opportunities in the IT industry," says Chen Quan-Yih, general manager of EMG. "More than 70 percent of the households in Taiwan use cable television service. Because our existing ATM

network architecture hasn't been able to meet the needs of the new telecommunications era, EMG has purchased Cisco's carrier-class, high-end routers and switches to deploy Cisco's DPT ring architecture to enhance the overall backbone bandwidth.

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—CHEN QUAN-YIH, GENERAL MANAGER  
EASTERN MULTIMEDIA GROUP, TAIWAN

Combining Cisco's technologies with EMG's existing broadband network architecture and competitive advantages in television broadcasting, and print and online media, we will be able to provide high-quality, cost-effective networks and carrier-class broadband services."

#### DWDM in the Metro

With the rapid increase in metropolitan-area traffic volumes, there is a threat of fiber exhaust in many areas. Rather than dig and lay more fiber at considerable expense, service providers can deploy DWDM in the metro. DWDM exponentially increases transport capacity by enabling simultaneous transmission of several signals in a single fiber, all at different wavelengths.

DWDM is familiar to long-haul optical cores, but until recently has been too expensive for metro deployments. Cisco offers innovative DWDM solutions designed and priced specifically for the metro network, along with short-reach optical interfaces for its DWDM, DPT, and supercharged metro optical transport platforms.

"Wavelength-division multiplexing is flexible because it's compatible with any

higher-layer technology such as Ethernet, POS [packet over SONET], or SONET," says Tom Gallaway, manager of metro business solutions in the Optical Transport Business Unit at Cisco. "It cost-effectively enables both high-density aggregation and high-volume services such as storage-area networking."

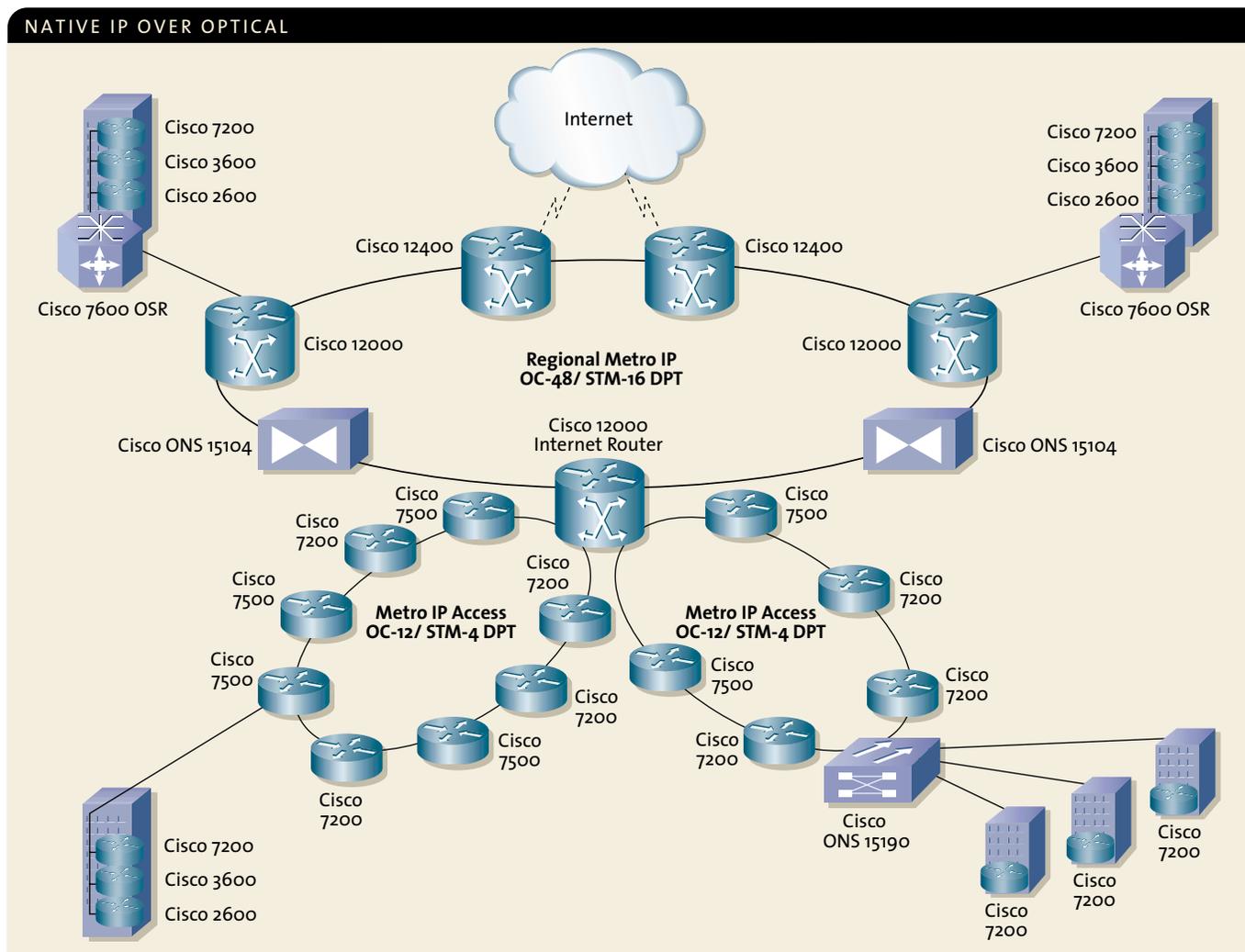
The Cisco ONS 15200 series DWDM system connects to any Cisco IP+Optical platform to enable flexible traffic-gathering architectures in Ethernet, supercharged SONET/SDH, DPT, and ITU wavelength deployments.

"The single-rack unit ONS 15201 platform supports single-wavelength add/drop transmission, making it ideal for the customer premises," says Vik Khandelwal, ONS 15200 series product manager in the Optical Transport Business Unit at Cisco, "while the ONS 15252 supports up to 32 add/drop wavelengths and is designed to handle massive traffic flow at hub or gateway locations." The platform delivers unamplified fiber span up to 100 km at rates ranging from 100-Mbps Ethernet to 2.5 Gbps (OC-48/STM-16).

For point-to-point DWDM services, the Cisco Metro 1500 series MAN DWDM platform is optimized for enterprise protocols ranging from Ethernet to ATM, POS, Enterprise System Connection (ESCON), and Fibre Channel. The platform supports up to 32 channels per fiber pair at speeds up to 2.5 Gbps, making it ideal for high-volume transport applications such as storage-area networking.

"Our carrier customers are going to want to buy the highest speed we can run," says Euske at Sigma. "When that was OC-48, they'd want to buy OC-48. Today it's OC-192, and they want to buy OC-192. So we have to go in a different direction to make the economics of our business work, and that direction is dense wavelength-division multiplexing. We've blended the best features of the Cisco ONS 15454 and the Cisco ONS 15200, and since they both share the same ITU grid for DWDM, we can mix and match for economic service benefit."

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**FIGURE 2:** Cisco enables direct IP-over-fiber internetworking with its DPT technology on the Cisco 12000 series Internet routers and Cisco ONS 15190 IP Transport Concentrator platforms, along with DPT interface support for Cisco 7500 and 7200 series routers. DPT provides high-bandwidth capacity for IP with SONET-quality protection.

Connected to the Cisco ONS 15454 platform, the Cisco ONS 15216 Terminal Filter enables DWDM transport in supercharged SONET networks. Designed for ease of installation, the ONS 15216 requires no special skills or optical field technicians to deploy. “The ONS 15216 is dummy proof,” says Vallee. “It can be bolted up by regular field staff.”

**Light-Speed Railways**

In conjunction with Cisco IP+Optical solutions for the service POP and the long-haul core, Cisco’s light-speed metro railway is the optical network solution that helps service providers prepare for the

demands and opportunities of the Internet. Its value goes far beyond flexible, consolidated interfaces and multiplexing to enable the new generation of content-driven services at ever-higher speeds. ▲▲

**FURTHER READING**

To learn more about the topics discussed in this article, visit *Packet Online* at [cisco.com/go/packet/metro](http://cisco.com/go/packet/metro).

- Cisco IP+Optical metro solutions
- Cisco 12000 series Internet router
- Dense wavelength-division multiplexing
- Dynamic Packet Transport
- Next-generation SONET/SDH