

The High-Availability Business

How a Simpler Network Can Meet the Demands of Business-Critical Applications

Enterprise Networks are Changing, Again

Emerging applications like VoIP, video, Web services, and data replication are placing unprecedented performance demands on enterprise Metropolitan and Wide Area Networks (MANs/WANs). And in many businesses, quick time-to-market for new applications has become critical to success. How can enterprises meet these requirements and still keep networking costs under control?

By consolidating all inter-site traffic on IP Virtual Private Networks (VPNs), enterprises can simplify operations and reduce costs, as shown in Figure 1. However, IP VPNs cannot meet the performance requirements of real-time video, storage replication, and other important applications. Hop-by-hop Layer 3 routing in the service provider network creates bandwidth bottlenecks and adds unacceptable latency and jitter.

As a result of the limited choices for supporting real-time applications, enterprises are attempting to meet rigorous application performance requirements by maintaining multiple networks: an IP VPN for ordinary Local Area Network (LAN)-based applications; frame relay or ATM for legacy applications; a private line network for delay-sensitive voice and video; and perhaps SONET private lines for high-volume storage replication. But operating multiple networks

drives up maintenance and management costs and complexities, and increases the time it takes to provision new network services to applications and end-users.

The Optical Solution – Reducing Costs and Complexity while Increasing Performance

Optical networking offers a solution to this dilemma. A well-designed private or managed optical network can eliminate the need for multiple networks by consolidating and converging multiple network services over one network without degradations in network performance or availability, as shown in Figure 2. By consolidating inter-site traffic on a state-of-the-art optical network, an enterprise can reduce maintenance, management, and connectivity costs while satisfying the performance requirements of the most demanding applications.

With a converged optical solution, network operations are simpler, more economical, and more responsive. Advanced optical technology creates the highest performance and lowest latency interconnection between sites. Demanding applications, including real-time data replication and video, get the high bandwidth and low latency they require. Lower priority applications, including VPNs and other IP traffic, perform better because optical links eliminate the

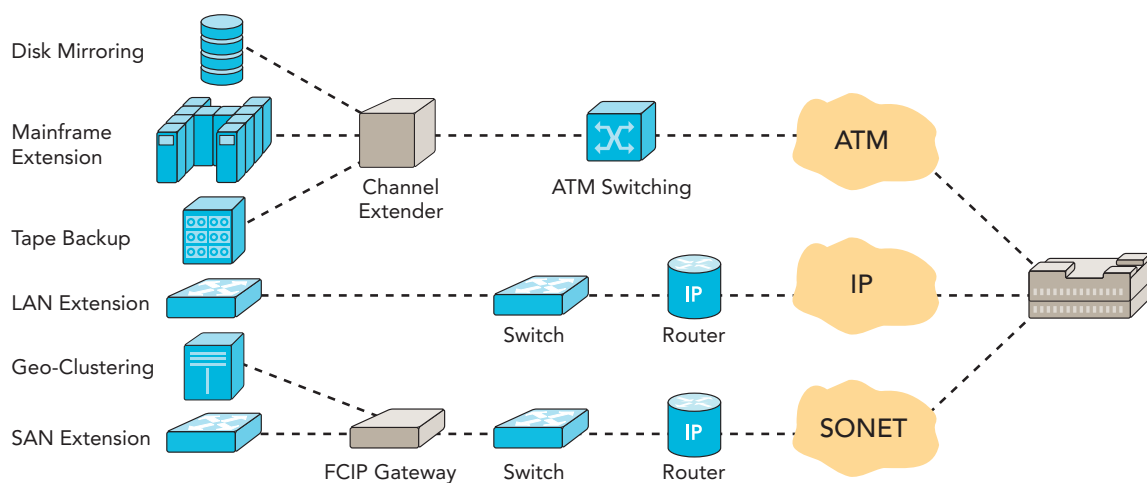


Figure 1. Multiple networks increase costs and management complexities

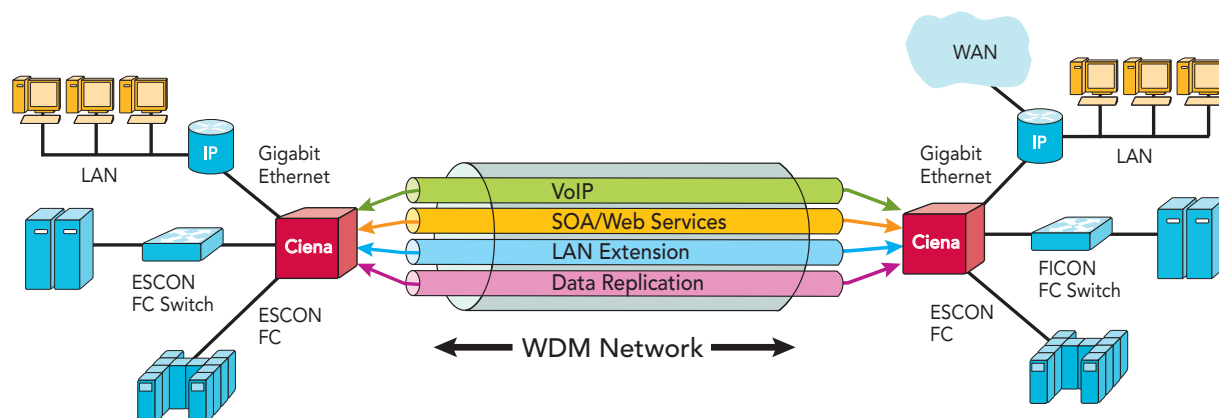


Figure 2. By consolidating traffic on an optical network, enterprises can improve application performance while reducing operating expense

congestion and latency of Layer 3 routing. And while an enterprise optical network offers immediate benefits with today's applications, the benefits become even more valuable as application bandwidth and performance requirements continue to increase.

But even with an optical network, there are factors that affect the cost and flexibility of the overall solution. How efficiently does the network use inter-site bandwidth? How easily does it adapt to application changes? Will the network scale economically as traffic grows? Does it provide cost-effective support for emerging WAN transport options such as Ethernet? Can it support numerous high-speed storage interfaces like Fibre Channel (FC), ESCON® and FICON® on the same platform? Does the overall solution include effective management tools beyond basic Fault-management, Configuration, Accounting, Performance, and Security (FCAPS)? And most importantly, how reliable is the network? Will it survive cable cuts and other outages?

Many optical networks fall short on one or more of these dimensions. For example, many networks lack the bandwidth management and compression features required to let diverse applications share bandwidth efficiently. And many strand large amounts of bandwidth by allocating lightpaths in rigid, oversized increments, when only smaller amounts are needed. Some optical solutions require different hardware modules for each type of protocol or interface, making them expensive to scale or reconfigure. Some solutions require separate, standalone switches to support Ethernet traffic, driving up both capital and operating expense. And many optical networks lack the tools needed to monitor and manage not only connectivity but also application-level service quality.

The Ciena Enterprise Optical Network Solution

Ciena's advanced FlexSelect™ Architecture network solution lets enterprises realize economic, operational and strategic benefits beyond those offered by other optical networking technologies. With a Ciena optical network, any combination of applications and protocols can share inter-site links flexibly and efficiently. Network operators can tailor bandwidth allocation for the most cost-effective fit, optimize the performance of IP, storage replication, and other types of traffic, and respond to changing application requirements with minimum incremental cost. Support for the Optical Transport Network (OTN) standard provides SONET-like performance monitoring and protection and allows mapping of each traffic flow to transport bandwidth that most economically fits its data rate—a unique Ciena feature. Finally, Ciena's advanced power efficiencies typically mean lower operating costs and a more environmentally friendly "carbon footprint" than other solutions.

Standard OTN Support

Ciena support for OTN "digital wrappers" improves optical network performance and simplifies network management. Known officially as the ITU-T G.709 standard, OTN was designed specifically for efficient transport of packet- and circuit-based traffic over optical links, as shown in Figure 3. Compact headers and forward error correction squeeze more transport capacity out of the same optical bandwidth than SONET/SDH while maintaining longer reach. OTN supports SONET-like resiliency with millisecond recovery from outages, making it the ideal technology for carrying Ethernet and virtually any storage or data center protocol reliably over a converged Wavelength Division Multiplexing (WDM) network.

Unlike the SONET/SDH hierarchy and other WDM solutions, Ciena's implementation of OTN allows lightpaths of any size in increments of 155 Mb/s. As a result, multiple ESCON, FICON, SONET/SDH, Gigabit Ethernet (GbE) and FC connections can sit side by side on a 10 Gb/s wavelength with much more efficient multiplexing and bandwidth utilization, as shown in Figure 3.

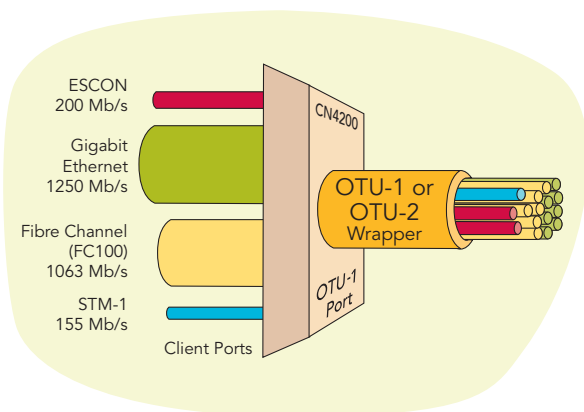


Figure 3. OTN efficiently multiplexes diverse connections over a shared wavelength

FlexiPort Technology and ROADM Support

With Ciena's FlexiPort technology, network interfaces are not tied to a single protocol or purpose, but are software configurable to support a variety of networking functions. Each interface can be configured for any supported protocol, including SONET/SDH, Ethernet, GbE, FC, ESCON and FICON. Individual ports can be reconfigured at any time without physically replacing the hardware, as shown in Figure 4.

Utilizing FlexiPort technology, network operators have complete control over application connections and can provision support for new applications in minutes. Plus, FlexiPort technology

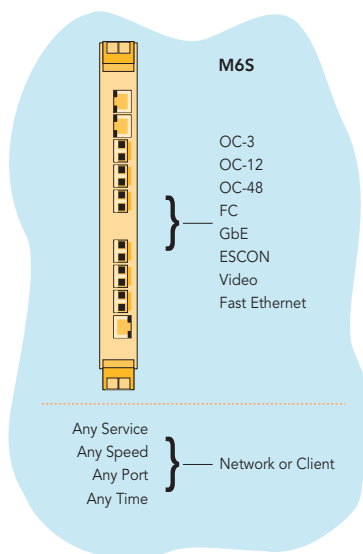


Figure 4. FlexiPort technology supports a rich set of software-configurable interfaces and protocols

reduces overall hardware and sparing costs, and decreases the time and complexity required to provision new network services by utilizing a single card to support any service, protocol, or interface speed. Other optical providers typically require one card per service, increasing the total cost of ownership to the enterprise.

In a similar fashion, Reconfigurable Optical Add/Drop Multiplexer (ROADM) support brings flexibility to WDM lightpaths, enabling on-demand reconfiguration of any service, anywhere on the network, using a dynamic wavelength routing module. This capability, together with OTN support, uniquely enables integrated switching of lightpaths of any size from 10 Gb/s and below on a common network platform.

Integrated Ethernet Switching

While other optical network technologies offer only basic transport services, the Ciena solution also provides integrated Ethernet switching, including both point-to-point E-Line and multipoint-to-multipoint E-LAN services. Integrated Ethernet switching—at speeds from 10 Mb/s to 10 Gb/s—allows enterprises to attach routers, servers, and other devices directly to the Ciena network, rather than deploying separate, standalone Ethernet switches. By aggregating Ethernet flows on a common backbone, integrated Ethernet switching drives higher network utilization, simplifies network operation, and reduces or eliminates the cost and management burden of standalone switches.

Automated Design and Service Layer Management

In addition to the usual FCAPS capabilities, Ciena's ON-Center® Network and Service Management Suite features a powerful Service Layer Manager (SLM). With ON-Center SLM, network managers can pinpoint affected customers and services rapidly, and proactively predict failures—before the cost of a failure is incurred. Managers also can isolate issues faster and with less effort, and plan maintenance windows with a better understanding of the impact on users.

In addition, the Ciena solution automates service provisioning. Point-and-click design and provisioning eliminates errors and saves human resources that would otherwise be spent on configuring each network node manually. Plus, when wavelengths are added or disconnected, automated power management maintains optical signal levels without manual node-by-node tuning. Altogether, ON-Center network management ensures more efficient use of network bandwidth, higher user satisfaction, lower operator training costs, and lower overall cost of network ownership.

Dynamic Bandwidth Assignment and Hardware-Based Compression

Dynamic Bandwidth Assignment (DBA), another unique feature of the Ciena solution, ensures maximum efficiency by giving enterprises complete control over bandwidth use. With DBA, network operators can “right-size” application connections, setting minimum and maximum bandwidth parameters for each flow. To promote high utilization, operators can even oversubscribe available bandwidth. DBA makes sure each application gets at least its minimum bandwidth allocation and allows connections to burst to full rate when bandwidth is available.

The Ciena solution provides hardware-based, protocol-independent compression with negligible added latency. This highly effective technology commonly enables bandwidth improvements of 3:1 or more. Together, DBA and data compression can reduce recurring bandwidth costs by up to 70 percent, as shown in Figure 5.

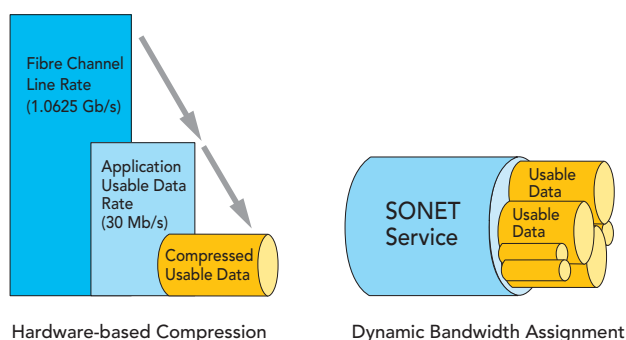


Figure 5. Two components of the Ciena solution

Assured Architecture

Ciena’s industry-leading FlexSelect Architecture includes comprehensive support for network resilience, secure operations, and trusted systems, forming an assured foundation for business-critical applications. Carrier-grade design, redundant configurations, automated restoration, and an automated control plane ensure the highest service level availability. An array of security features prevents unauthorized access to network elements and protects important management plane traffic in transit. Ciena’s emphasis on thorough product evaluation, qualification, validation, and continuous improvement ensure that network elements operate as expected without disruption to business operations or data integrity.

UNIQUE FEATURES AND BENEFITS OF CIENA NETWORK SOLUTIONS

Ciena Feature	Benefit
Standard OTN support	Improved optical network performance Simpler network management Minimal stranded bandwidth SONET-like resiliency
FlexiPort technology and ROADM support	Support for a wide range of applications and protocols Quick response to changing application requirements Reduced sparing and provisioning costs Simplified network operation and maintenance
Integrated Ethernet switching	Higher network utilization Simplified network operation Reduced capital expense
Automated design and SLM	Increased network “up-time” Reduced staffing requirements Lower training costs
DBA and hardware-based compression	Complete control over bandwidth use Quick response to changing application requirements Up to 70% reduction in bandwidth costs
Assured architecture	Increased network reliability and availability Secure network operations Trusted business operations and data integrity
Extensible high-capacity interfaces	Cost-effective scalability Economical upgrades Investment protection
Energy efficiency	Reduced operating costs Reduced heating and cooling requirements Reduced carbon footprint

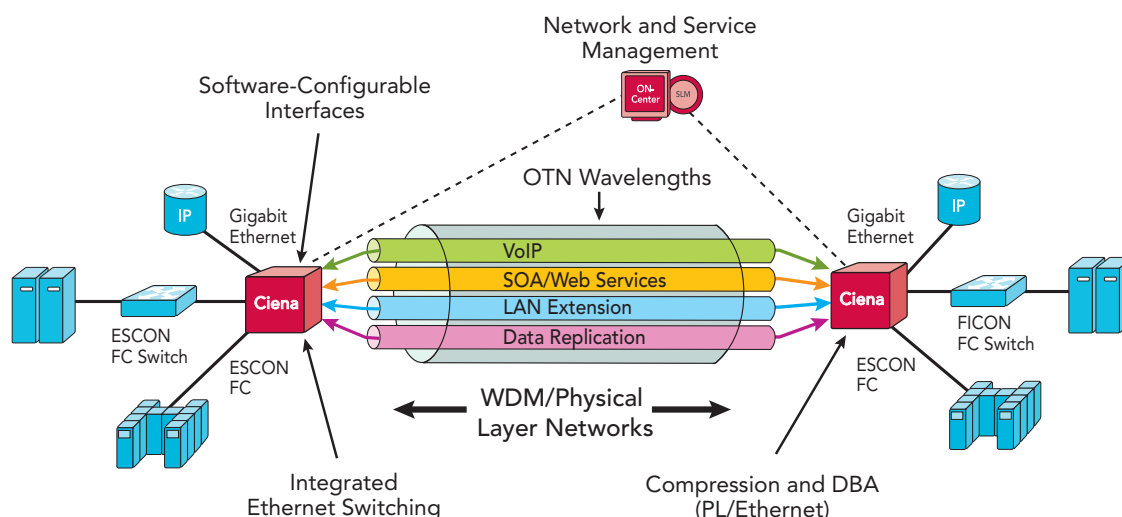


Figure 6. Ciena's FlexSelect Architecture is the industry's most flexible, cost-effective, and reliable architecture for enterprise optical networking

Extensible High-Capacity Interfaces

With a Ciena solution, enterprises can be confident their networks will grow and adapt over time without requiring expensive "forklift upgrades." To provide ample bandwidth for future applications, Ciena platforms support wavelengths scalable to 40 and even 100 Gb/s. And the enterprise can add more wavelengths easily for even greater capacity. High-speed GbE, 10GbE, FC, and FICON interfaces keep up with the most demanding enterprise applications. Also, software-based FlexiPort technology will allow enterprises to download future interface definitions, such as native support for video protocols and Infiniband®, with minimal incremental hardware cost.

Energy Efficiency

Ciena enterprise solutions boast more compact packaging and lower energy consumption than other major optical product lines. While typical energy consumption of competing devices ranges as high as 650 watts in a basic configuration, with maximum consumption over 1,100 watts fully burdened, typical consumption of the CN 4200—the primary backbone element in Ciena enterprise optical networks—is only 170 watts in a comparable basic configuration, with maximum consumption of just 450 watts in most fully burdened configurations. Compared to other major optical offerings, Ciena solutions deliver over 25 percent lower operating cost, reduced heating and cooling requirements, and faster payback of hardware costs.

Conclusion

The future of enterprise networking is clear. As more high-bandwidth and real-time applications and protocols continue to emerge, demands for performance and reliability will continue to grow. Network consolidation will become increasingly important, both to simplify operations and to contain costs—but not at the expense of performance and flexibility.

Ciena enterprise network solutions represent an optimized service portfolio and a unique FlexSelect Architecture that offers valuable advantages both for "ordinary" LAN-based applications and high-bandwidth, high-performance applications like video and storage replication:

- » Lower overall connectivity charges and maximized application performance through deterministic use of network bandwidth, sized to fit application requirements most efficiently
- » Flexibility and investment protection to meet new and future protocol and connectivity requirements with minimal incremental cost, lead time, or impact on the network
- » Maximum assurance of critical information and services based on carrier-class platforms that form resilient networks
- » Design efficiencies with automation that reduces Total Cost of Ownership (TCO) through reduced maintenance and management costs

LEADERSHIP OF FLEXSELECT ARCHITECTURE FOR ENTERPRISE OPTICAL NETWORKING

	Other Optical Architectures	FlexSelect Architecture
Lightpath efficiency	No OTN support, or OTN support in over-allocated and inefficient bandwidth increments	Full OTN support Bandwidth allocation in 155 Mb/s increments
Interface configuration and flexibility	Different hardware module for each interface type Interface change requires hardware change Lightpath reconfiguration requires hardware change	One module supports a variety of interfaces and protocols Software-based FlexiPort interface reconfiguration ROADM support for easy lightpath reconfiguration
Ethernet support	Transport only switching Requires standalone Ethernet switches	Integrated E-Line and E-LAN switching No standalone switches needed
Service provisioning and management	Manual design and provisioning Manual power tuning Connection-level management only	Automated design and provisioning Automated power management Connection-level and SLM
Efficient bandwidth utilization	Limited bandwidth allocation increments No data compression	"Right-size" per-application DBA Hardware-based data compression
Investment protection	One-to-one hardware per new service costs Higher connectivity costs, less efficient usage of bandwidth Slow provisioning; complex management	One-to-any flexible hardware supports multiple services and interfaces Compression and efficient bandwidth allocation and lower connectivity costs Flexible platform delivers new network services with simple programming changes; not truck rolls
Energy efficiency	Up to 650 W in a basic configuration energy consumption Up to 1,110 W max energy in most configurations	170 W typical energy consumption in a basic configuration 450 W max energy consumption in most configurations 25% lower operating cost

With optical network solutions from Ciena, enterprises can satisfy the most bandwidth-hungry, delay-sensitive applications. They can optimize the performance of IP, storage, and other types of traffic, simplify operations, dramatically reduce operating costs, and still keep pace with changing requirements.

As illustrated to the left, Ciena's FlexSelect Architecture is one of the industry's most flexible, cost-effective, and reliable architectures for enterprise optical networking.

Appendix

Ciena Solution Building Blocks

The CN 4200® FlexSelect Advanced Services Platform Family is the primary building block of the Ciena enterprise network solution. CN 4200 platforms groom traffic from a variety of application interfaces onto dedicated fiber or private WDM wavelengths between sites. The CN 4200 is most appropriate for aggregate bandwidth needs of 10 Gb/s and up. For smaller networks or where WDM is not economical, the CN 2000® Storage and LAN Extension Platform concentrates application traffic onto SONET/SDH, GbE or DS3 inter-site links. All Ciena enterprise network solutions deliver unique features and benefits that are not available with other enterprise optical networks.

CN 4200 FlexSelect Advanced Services Platform

With its unique FlexiPort technology and advanced multiplexing capabilities, the CN 4200 goes far beyond the

functionality of traditional WDM systems and SONET/SDH Multiservice Provisioning Platforms (MSPPs). The CN 4200 allows network operators to groom, switch, and transpond a diverse range of client services, such as OC-3/12/48 and STM-1/4/16, GbE, FC, FICON, and ESCON into higher-speed OTU-1 (2.7 Gb/s), OTU-2 (10.7 Gb/s), and OTU-3 (43 Gb/s) transport streams. CN 4200 platforms also can transpond a variety of 10 Gb/s services—such as OC-192/STM-64, 10GbE LAN/WAN PHY and 10 Gb/s FC—into OTU-2, and 40 Gb/s services such as OC-768/STM-256 into OTU-3.

The CN 4200 is the only transport platform on the market that offers innovative timeslot technology based on ITU G.709 OTN. This "digital wrapper" technology allows network operators to aggregate up to 64 different service types into a single OTU-2 wavelength, or 16 services into a single OTU-1 wavelength. Each individual service is carried with full transparency and management and can be delivered at any location on the network for optimal wavelength utilization.

To optimize transport cost and efficiency in all areas of the network, Ciena offers the CN 4200 in three chassis sizes designed for complete deployment flexibility from the customer premises, where space and power are critical, all the way to the metropolitan/regional core, where the need for high capacity and scalability becomes essential.

CN 2000 Storage and LAN Extension Platform

The CN 2000 Storage and LAN Extension Platform is designed to connect data centers and other high-bandwidth locations over long-distance, dedicated bandwidth such as SONET/SDH private line or Ethernet services. The CN 2000 reduces recurring bandwidth charges by up to 70 percent through hardware compression and DBA. The CN 2000 supports up to eight physically isolated FC, ESCON, FICON, and GbE ports and is up to 80 percent less expensive than traditional channel extenders and FCIP-based devices.

The CN 2000 allows a variety of applications, such as Storage Area Networking (SAN), disk mirroring, remote backup, mainframe, LAN, clustering, and Network-Attached Storage (NAS) to share a single wide-area connection, simplifying network design and dramatically increasing bandwidth efficiency. Supporting WAN interfaces from DS3 through OC-48/STM-16 and GbE, the CN 2000 meets the most demanding enterprise requirements with the ability to scale as an enterprise's requirements change.

The CN 2000's compact footprint and plug-and-play design simplifies network operations. And Ciena's ON-Center CN 2000 Manager brings powerful network monitoring capabilities to inter-data center connectivity, enabling enterprises to easily view, analyze and report on the performance of the specific channels and the MAN or WAN.



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