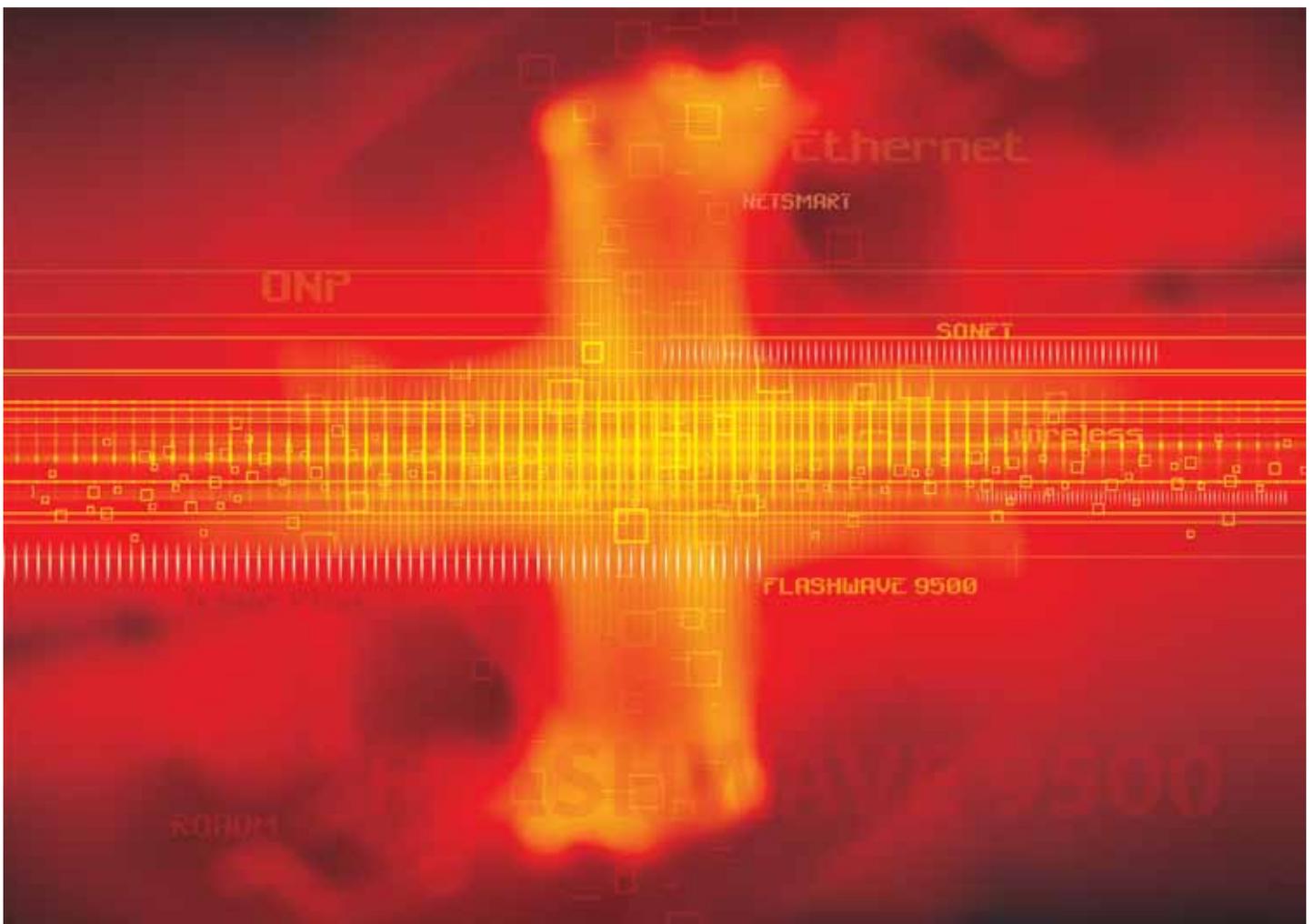


FLASHWAVE® 9500— The Definitive Packet Optical Networking Platform



Introduction

Residential and enterprise users desire high-bandwidth, real-time, multimedia packet services which provide their Connected Experience. This desire for the Connected Experience drives significant new requirements onto service provider networks—requirements for delivering cost effective bandwidth and stringent QoS in a streamlined operations environment that deals with multiprotocol requirements.

Fujitsu is defining a new generation of optical networking equipment known as the Packet ONP. This new platform creates a solid foundation for delivering the Connected Experience by providing manageable scalability through the modular integration of Ethernet, ROADM, and SONET transport technologies on a single addressable optical networking class element.

Fujitsu is introducing the definitive implementation of the Packet ONP in its new optical networking flagship, the FLASHWAVE® 9500 platform. The system incorporates time-tested optical networking technology heritage to address aggregation and transport needs created by emerging high-bandwidth, high-quality services, such as on-demand high definition television, multimedia Internet experiences, and interactive enterprise collaboration.

The Next Evolution of Optical Networking—The Packet Optical Networking Platform

Recent breakthroughs in ROADM integration, high performance ASIC technology, and packet-centric NPUs enable the realization of a truly modular integration of Ethernet, ROADM and SONET transport technologies on a single addressable optical networking element—the Packet ONP.

Optical networking elements have always been the cost and manageability leaders in providing metro aggregation and transport. Highly distributed, low-cost optical elements have allowed service providers to build a cost-optimized and scalable network architecture that delivers traffic efficiently to a smaller number of feature-rich service elements.

The Packet ONP is the next evolution of optical networking elements to uniquely meet these same aggregation and transport needs for manageable scalability, only now in a packet-centric environment. Conventional packet-based systems have been optimized for upper layer service delivery and are expensive from both an operational and a capital perspective for providing simple aggregation and transport. Traditional TDM and photonic systems are excellent at bulk transport, but struggle with efficient aggregation for packet traffic. The Packet ONP is the first type of network element that delivers both packet aggregation agility and bulk transport scalability.

"Packet Optical Networking Platforms such as the Fujitsu FLASHWAVE 9500 system are a whole new class of optical networking equipment that delivers the infrastructure for the new high-bandwidth, high-quality, packet-centric multi-media services."

Erin Dunne
Director of Research Services,
Vertical Systems Group

As packet-centric services dominate in delivering the Connected Experience, service providers can deploy Packet ONP-based networks to enjoy the same cost and manageability benefits that optical networking has always provided—only now for the service environment of the Connected Experience.

FLASHWAVE 9500—the Definitive Packet ONP

The FLASHWAVE 9500 Packet ONP is a completely modular system that allows network providers to configure exactly what they need for a particular application with no cost penalties. The FLASHWAVE 9500 platform can be equipped in SONET-only, ROADM-only, or Ethernet-only configurations without requiring the user to pay a cost premium. However, when you combine these capabilities in a single FLASHWAVE 9500 shelf, its true potential is maximized.

The FLASHWAVE 9500 patent-pending universal switch fabric technology is central to providing this modularity. This innovative switch fabric technology allows both SONET-based traffic and packet-based traffic to be switched, groomed, and managed in its native format without any form of circuit-emulation technology. The universal fabric allows for the entire system capacity to be switched in SONET form, packet form or combinations of the two. The FLASHWAVE 9500 architecture separates inexpensive universal switching functionality onto the centralized fabric while distributing the more costly packet processing functionality onto the relevant interface units, allowing the system cost to scale gracefully.

Since the platform is new from the ground up, the combination of Ethernet, ROADM, and SONET capabilities was anticipated at the origin of the design. As a result, the shelf is designed to support universal cards, allowing any slot to be equipped for SONET, Ethernet, or ROADM functionality. The system exists in stark contrast to competing products that are simply a retrofit of existing architectures that were designed several years ago.

The architecture requires minimal common equipment—only two part numbers: one for the management complex and one for the switch fabric—to equip a shelf. As one would expect of optical networking equipment, the platform features fully redundant common equipment with a transport-grade management complex. Working/standby units ensure that the system remains operational in the unlikely event of a management complex hardware failure.

The FLASHWAVE 9500 platform is the industry's densest optical networking platform, supporting a two-degree, 40G-ready ROADM in as small as 1/4 of a shelf, and support for 480G of SONET or packet bandwidth in only 1/3 of a rack. That represents a 5–10X density improvement over current generation MSPP platforms.

“Service providers are looking for purpose-built packet optical platforms with lower costs that complement feature-rich service platforms to help create scalable multimedia networks. Fujitsu has delivered a solid architectural implementation with their FLASHWAVE® 9500 Packet ONP. This integrated-fabric architecture marries Ethernet, SONET/SDH and Optics in a scalable and manageable platform that top tier providers have been requesting for their next-generation networks.”

Eve Griliches
Program Manager for Telecom Equipment,
IDC

The FLASHWAVE 9500 system supports pseudowire and MPLS technologies to deliver connection-oriented Ethernet that provides guaranteed QoS in a unified Ethernet services network.

The FLASHWAVE 9500 platform provides for a seamless NGADM extension. There are over one million SONET and NGADM systems deployed in North America today. This system goes beyond interoperating with those networks, providing complete traffic and operational behavior uniformity with those very large existing networks.

An Optical Networking Heritage

The FLASHWAVE 9500 is built on an optical networking heritage that provides the following elements as it continues to be the foundation for scalable, profitable networks.

- Deterministic data plane
- Precision fault management and sectionalization
- Robust management interface
- Software upgradeability
- Network protection
- Equipment redundancy

Platform Flexibility Creates Many Application Opportunities

There are several applications for the FLASHWAVE 9500 Packet Optical Networking Platform, including those applications that are top-of-mind for metro aggregation and transport.

1. **Triple-Play Networks** – The FLASHWAVE 9500 Packet ONP is well suited for metro transport and aggregation networks for triple-play services. This leverages the platform's integrated ROADM transport for bulk bandwidth delivery and high capacity packet aggregation, eliminating several costly elements from today's network architectures.
2. **Consolidated Core Metro/Regional Networking** – The platform integrates and collapses complete ROADM and NGADM devices into a single network element with next-generation grooming capabilities for general purpose, high capacity core networking. At the same time, the system provides more scalable support for a growing Ethernet infrastructure.
3. **Consolidated Ethernet Services Networks** – The system supports the full range of E-Line and E-LAN, services as well as today's popular Ethernet over SONET services allowing service providers to consolidate their Ethernet services infrastructure.
4. **Wireless Backhaul** – Wireless/mobile backhaul networks are in the middle of a transition from TDM-based networks toward Ethernet-based facilities. The challenge for carriers has been supporting the strict latency requirements of the wireless traffic as it shifts from TDM to Ethernet transport. The FLASHWAVE 9500 Packet ONP with support for native TDM as well as connection-oriented Ethernet provides an ideal vehicle to manage latency-sensitive applications regardless of technology.

A Complete Range of Services and Interfaces

The FLASHWAVE 9500 platform supports a complete range of service interfaces including multiservice, multirate SONET interfaces, Ethernet packet interfaces, and transponder and muxponder interfaces as shown in Figure 1.

SONET interfaces include a very dense dual-port OC-192 wideband card and a single-port OC-192 narrowband card with optical interfaces that can connect directly to an embedded ROADM network such as one built using the FLASHWAVE 7500 platform or connect directly onto the ROADM in the FLASHWAVE 9500 system. A flexible eight-port, multirate, multiservice unit provides significant density and utilization improvements over multiport fixed-protocol cards. Each of the interfaces can be configured on a per-port basis as OC-3, OC-12, OC-48, or Gigabit Ethernet running Ethernet over SONET. Service providers can hit the appropriate cost point regardless of whether they require a variety of port types or a large number of identical port types.

Ethernet interfaces include a two-port 10GigE wideband unit or a one-port 10 GigE narrowband unit that can be used as an alien wavelength input into an existing ROADM network, such as one that features the FLASHWAVE 7500 platform, or can be input into the ROADM on the FLASHWAVE 9500 platform. In addition, there's an ultra-dense 20-port Gigabit Ethernet unit. Each Ethernet card features advanced Ethernet functionality and full packet processing capabilities so they are capable of delivering all of the E-Line and E-LAN service flavors.

Transponder interfaces include a flexible single-port, 10G universal transponder that supports OTU2, 10 GigE LAN PHY, 10 GigE WAN PHY, and OC-192 client interfaces. Additional transponder interfaces will also be available.

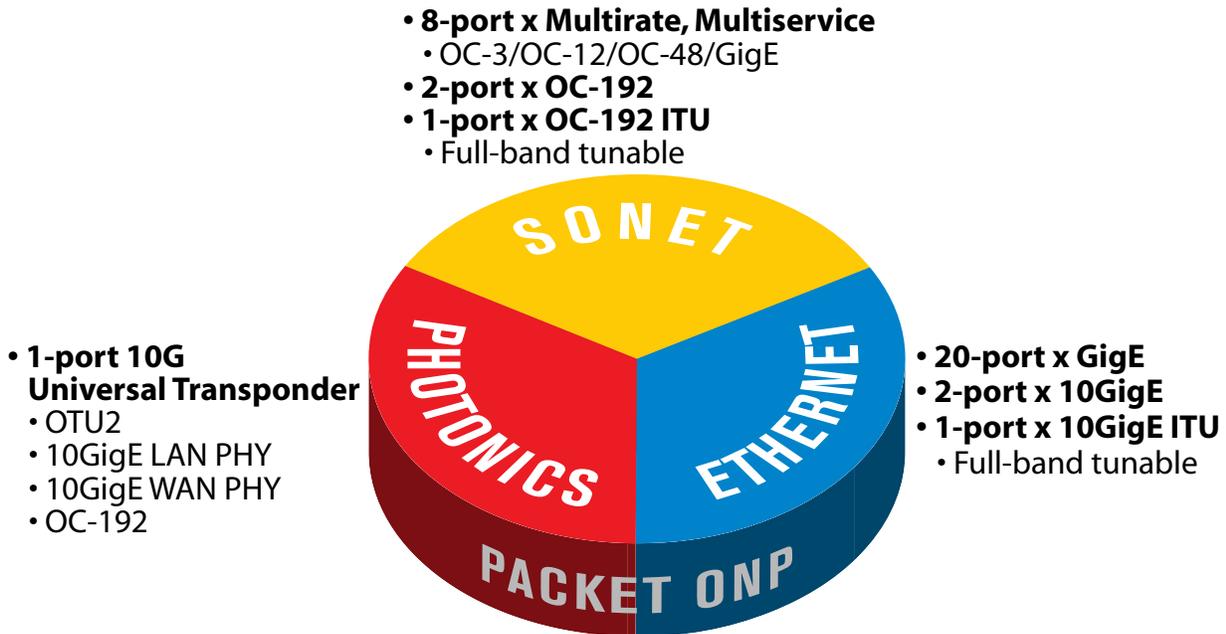


Figure 1: FLASHWAVE 9500 Interface Card Menu

The Power of Connection-Oriented Ethernet

Users of metro Ethernet services are looking for a private line equivalent quality of service for Ethernet which requires a connection-oriented approach.

The FLASHWAVE 9500 platform is designed to operate on a standards-based pseudowire/MPLS-based Ethernet encapsulation for point-to-point Ethernet transport. This provides three significant benefits:

- Resource reservation and CAC to guarantee network resources and guarantee SLAs for all Ethernet connections
- 50 ms protection switching on a per-connection basis
- Sectionalized fault management using pseudowire/MPLS layer OAM

The system provides both CIR and EIR Ethernet bandwidth profile options, multiple CoS options for latency and latency variation, and sophisticated traffic management including flow-based queuing, classification and policing, hierarchical shaping and other capabilities. The FLASHWAVE 9500 platform supports a larger number of Ethernet flows and MAC addresses to allow the system to be deployed as an Ethernet services delivery platform. The system also supports full 802.1ad provider bridging to peer with existing switched Ethernet networks.

Because of the unique architecture of the system, all of these sophisticated traffic management and control plane protocols are integrated into the Ethernet cards themselves. This capability allows service providers to configure a Layer 1-only system without paying a cost penalty for these sophisticated Ethernet traffic management capabilities.

Today, some service providers operate separate Ethernet services networks as shown in Figure 2. They run a switched Ethernet network that provides both E-Line and E-LAN services—often using a ROADM to form the backbone of that network. Alongside that switched network they operate a SONET NGADM network to support E-Line services for very demanding customers that may be looking for access network redundancy, 50 ms switching, and a very high level of security.

With the FLASHWAVE 9500 Packet ONP, those separate consolidated onto a single network that delivers both E-Line and E-LAN services, as well as Ethernet over SONET services. This type of consolidated network further integrates ROADM-based optical transport so the carrier doesn't have to deploy a separate ROADM to interconnect the different service elements. This consolidated network can peer with existing SONET-based networks and existing switched networks. With its integrated photonic capability, this new network adds 10GigE service capability over the same infrastructure as 10 Mbps, 100 Mbps, and GigE service offerings.

"Connection-oriented Ethernet is critical for delivering the reliability and connection performance that end-users require to entice them to move away from TDM circuits."

Michael Kennedy
Co-founder and Managing Partner,
Network Strategy Partners

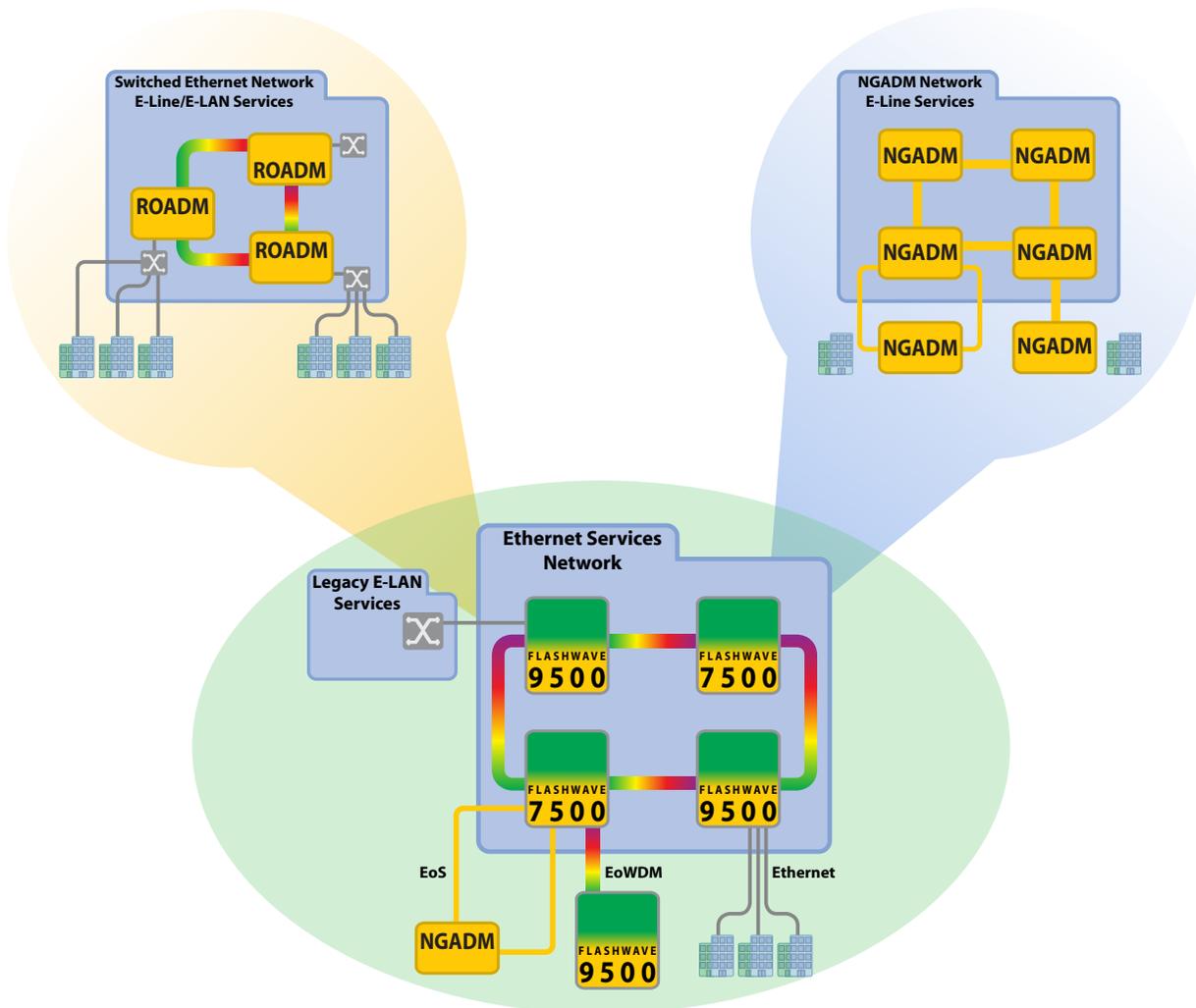


Figure 2: Consolidated Metro Ethernet Services Network

An Advanced ROADM Solution at Breakthrough Density and Cost

To deliver low-cost, high capacity bulk bandwidth, the FLASHWAVE 9500 Packet ONP includes industry-leading ROADM functionality.

FLASHWAVE 9500 ROADM configurations are packaged for industry-leading density and cost performance. The system supports a full 40G-ready ROADM in as little as ¼ of a shelf, which then leaves a full 360G of client add/drop capacity in that same shelf.

For ROADM configurations, the FLASHWAVE 9500 platform employs an innovative mix of passive, offboard functionality and active functionality that plugs directly into the shelf. This innovative mix optimizes the cost, density and manageability of the ROADM.

The Power and Operational Stability of Today's NGADM

In addition, the FLASHWAVE 9500 system provides complete network compatible NGADM functionality that goes well beyond interoperability to provide full operational behavior compatibility. Over the years, as NGADM technology has been deployed by a number of carriers, the wish list for operational features has continued to grow and the FLASHWAVE 9500 platform includes all of those advanced operational features, including:

- Multirate, multiservice interfaces
- UPSR, BLSR and 1+1 protection architectures
- Software download, remote memory backup and restore capabilities
- OS GNE and SDCC functionality
- Power system redundancy with standard fusing
- Ethernet over SONET with VCAT, LCAS and GFP for EPL and multiplexed EPL services
- Full-featured fault and performance management
- BITS, line and loop timing plus Ethernet synchronization support
- Full support by traditional NGADM management tools including the NETSMART® 500 craft interface, NETSMART 1500 EMS, and the Telcordia suite of management systems

Comprehensive Management Tools

The FLASHWAVE 9500 platform is supported by a variety of network management tools from the Fujitsu NETSMART toolkit. The NETSMART 1500 EMS provides comprehensive control over all Fujitsu optical networking elements. Fujitsu has sold over 325,000 optical networking elements in North America, and over 150,000 of those elements are managed by the NETSMART 1500 EMS. Several new features have been added to the NETSMART 1500 EMS to support the advanced Ethernet functionality of the FLASHWAVE 9500 platform, including support for different Ethernet QoS levels, and the ability to reserve Ethernet resources. The NETSMART 2000 optical network design planning tool that supports the FLASHWAVE 7500 ROADM supports the ROADM functionality on the FLASHWAVE 9500 platform. The same NETSMART 500 graphical craft interface tool that supports local management across a variety of FLASHWAVE products is available to support the FLASHWAVE 9500 Packet ONP.

Summary

The Packet ONP is the next evolution of optical networking elements to uniquely meet aggregation and transport needs for Manageable Scalability in the packet-centric environment of the Connected Experience. Conventional packet-based systems have been optimized for upper layer service delivery and are expensive from both an operational and a capital perspective for providing simple aggregation and transport. Traditional TDM and photonic systems are excellent at bulk transport, but struggle with efficient aggregation for packet traffic. The Packet ONP is the first type of network element that delivers both packet aggregation agility and bulk transport scalability.

The FLASHWAVE 9500 is the definitive Packet ONP. Its unique hardware and software architecture integrates Ethernet, ROADM and SONET technology in a single shelf that can drive cost out of today's metro network.

As high-bandwidth, high-quality multimedia packet-centric services dominate, service providers can deploy FLASHWAVE 9500 based networks to enjoy the same cost and manageability benefits that optical networking has always provided—only now for the service environment of the Connected Experience.

Acronym	Descriptor
ADM	Add/Drop Multiplexer
ASIC	Application Specific Integrated Circuit
BITS	Building Integrated Timing Supply
BLSR	Bidirectional Line Switched Ring
CAC	Connection Admission Control
CIR	Committed Information Rate
CoS	Class of Service
EIR	Excess Information Rate
EMS	Element Management System
EPL	Ethernet Private Line
GFP	Generic Framing Procedure
GigE	Gigabit Ethernet
GNE	Gateway Network Element
HDT	High Density Tributary
LAN	Local Area Network
LCAS	Link Capacity Adjustment Scheme
MAC	Medium Access Control
MEF	Metro Ethernet Forum
MPLS	Multiprotocol Label Switching
MSPP	Multiservice Provisioning Platform
NGADM	Next-Generation Add Drop Multiplexer
NPU	Network Processor Unit
OAM	Operations, Administration and Management
ONP	Optical Networking Platform
OS	Operating System
QoS	Quality of Service
ROADM	Reconfigurable Optical Add Drop Multiplexer
SDCC	Section Data Communications Channel
SLA	Service Level Agreements
SONET	Synchronous Optical Networking
TDM	Time Division Multiplexing
UPSR	Unidirectional Path Switched Ring
VCAT	Virtual Concatenation
WAN	Wide Area Network

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 Configuration requirements for certain uses are described in the product documentation.

