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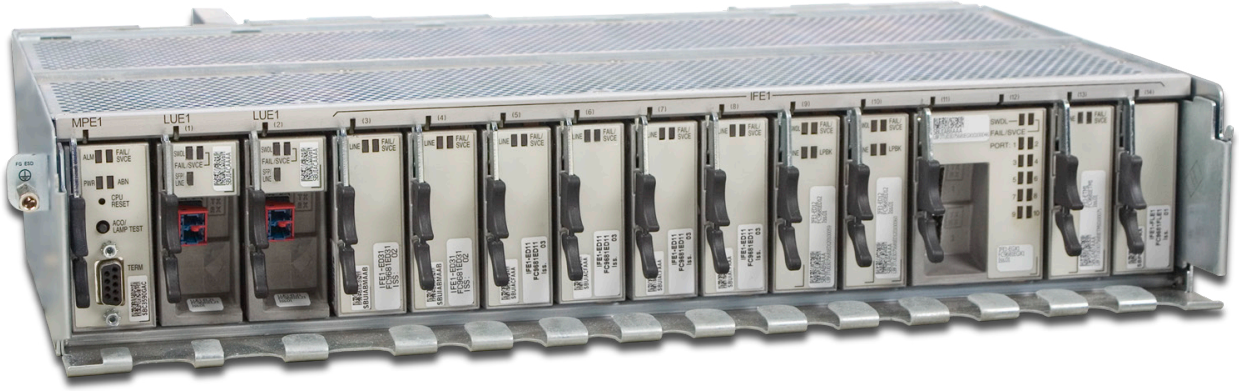
FLASHWAVE® 4100 ES

Micro Packet Optical Networking Platform



CARRIER ETHERNET
MEF
Certified Compliant

The FLASHWAVE 4100 ES Micro Packet Optical Networking Platform (Packet ONP) is ideal for Ethernet and TDM access service delivery and aggregation over networks up to OC-192 using full band tunable optics. Offering high reliability in extreme environments, its modular, 2RU chassis provides pay-as-you-grow flexibility, minimizing capital outlay.

FLASHWAVE® 4100 ES

Micro Packet Optical Networking Platform

Optimal for the Network Edge or Customer Premises

FLASHWAVE® 4100 platforms are in service across tens of thousands of locations, such as central offices, cell sites, outside-plant cabinets and cable distribution networks. The platform is also widely deployed on customer premises in rack, cabinet and wall-mount configurations.

Configured in conjunction with a FLASHWAVE 4000 series Multiservice Provisioning Platform (MSPP) or FLASHWAVE 7000 series Wavelength Division Multiplexing (WDM) system, the FLASHWAVE 4100 ES platform improves slot cost-to-value ratio. Used with the FLASHWAVE 9500 Packet ONP EoX Gateway configuration, the platform provides a complete backhaul, aggregation and service delivery solution over Ethernet or SONET network facilities.

Key Platform Features

The FLASHWAVE 4100 ES Micro Packet Optical Networking Platform (Packet ONP) is the optimal solution for the network edge or customer premises, offering:

- 10G access network element using OC-192 with full band tunable optics
- Smooth, economical migration from legacy SONET to next-generation packet optical networking
- Service delivery for high concentrations of 100FX and GE Connection-Oriented Ethernet (COE), DS1, DS3, EC1, OC-3, OC-12 and OC-48 services
- Flexible COE over Ethernet and SONET resulting in long-term investment protection
- Complete solution for high-performance 2G/3G/4G cell site access and aggregation deployments, mobile/business backhaul and utility telecom applications
- Environmentally hardened 2RU all industrial-grade platform with modular flexibility that cost-effectively addresses a broad range of demanding applications
- Metro Ethernet Forum (MEF)-compliant Ethernet Private Line (EPL) and Ethernet Virtual Private Line (EVPL) services

One Platform Combines COE, TDM Access, Self-Healing Resilient Hardware, and Aggregation

The COE and TDM capabilities of the FLASHWAVE 4100 ES system are optimized for 2G/3G/4G mobile backhaul, wholesale Ethernet access, high-density metro Ethernet business services, and backhaul of triple play services, including broadband Internet access from DSLAM, PON or CMTS equipment, ensuring the highest standards of reliability and service transport.

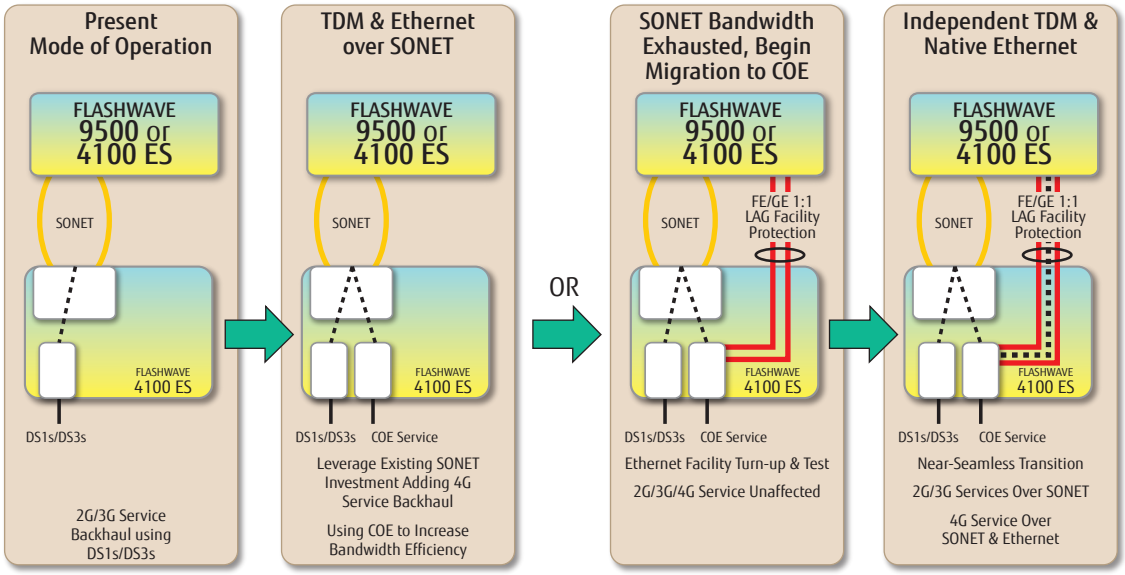
COE Service Unit

The COE service unit combines SONET attributes such as extremely low-latency, jitter and frame loss with the flexibility, scalability and dynamic bandwidth allocation of Ethernet. The unit provides:

- Guaranteed bandwidth (CIR) per Ethernet Virtual Connection (EVC)
- Four classes of service with dynamic bandwidth allocation between services
- Integrated Y.1731 fault management and performance measurement responder eliminates external NIDs at remote locations
- Ethernet service multiplexing (aggregation) with resilient hardware
- VLAN ID mapping/translation
- COE network operation on any port with optional 1:1 LAG facility protection
- Metro Ethernet Forum (MEF)-certified Ethernet Private Line (EPL) and Ethernet Virtual Private Line (EVPL) services

FLASHWAVE 4100 ES Micro Packet ONP with multiple service options

Optimized for Efficiency



A smooth migration path to next-generation services

Cost-Effective, Smooth Migration to Packet Optical Networking

The FLASHWAVE 4100 ES platform controls costs with flexible options to reuse existing resources. This strategy maintains TDM service performance, while offering dynamic bandwidth allocation resulting in optimal efficiency for differentiated services over existing SONET equipment. As SONET bandwidth becomes exhausted, COE services can be scaled over new Ethernet network facilities using an available port on the existing COE service unit, without adding shelves or common equipment.

COE: Ethernet with Advanced Traffic Engineering

Ethernet, fundamentally a connectionless technology, is now the method of choice for delivering high-bandwidth data services. However, next-generation mobile backhaul, high-definition video distribution and mission-critical enterprise services require deterministic, high-performance, high-availability connections. These kinds of connections are only possible in a connection-oriented environment. The frame delay, packet loss and service protection performance of connectionless networks are unacceptable for critical voice, video and storage applications. The answer: COE, the basis for carrier-class high-reliability, simple-to-manage integrated networks that support packet, optical, and TDM networks.

Multiple Levels of Fault Tolerance and Management

The FLASHWAVE 4100 ES platform provides multiple levels of fault tolerance and management, including resilient hardware and redundant power, Ethernet facility protection using IEEE 802.3ad link aggregation, card and network protection using SONET 50 ms path protection. Integrated Y.1731 fault management and performance measurement offers early warning of service impairments to ensure non-stop operation. The Fujitsu NETSMART® 1500 Management System simplifies service assurance, leveraging the product's integrated 802.3ah link OAM and connection admission control for EVC CIR bandwidth reservation.

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Micro Packet Optical Networking Platform

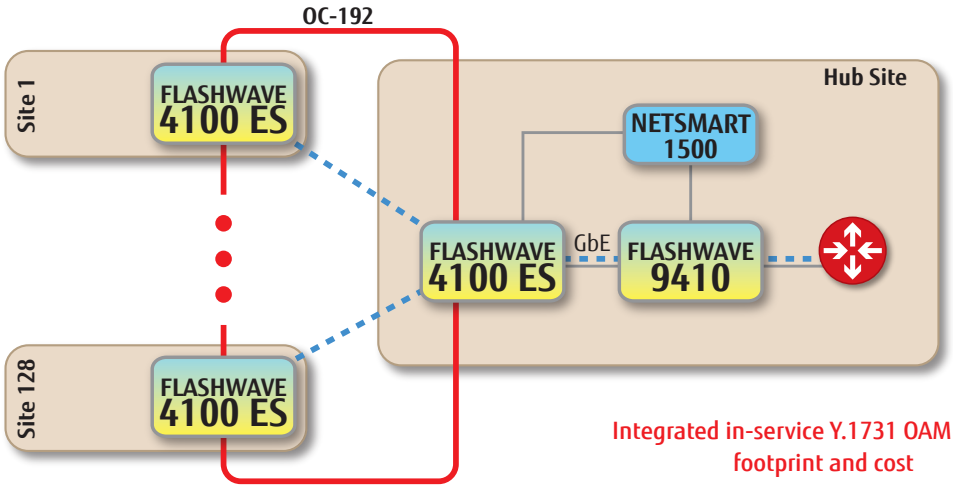
Convergence and Resiliency

Integrated DS1 Network Interface Unit (NIU) Functionality

The FLASHWAVE 4100 ES DS1 service card with integrated NIU condenses trouble ticket resolution time and expedites installation. Its extensive loopback capabilities, NPRM, 30-day PM binning, CI alarm recognition and integrated multi-pattern Bit Error-Rate Testing (BERT) provide a powerful tool set to expedite installation, mitigate service issues and reduce truck rolls. As a result, operational expenses are reduced.

Integrated In-Service Y.1731 OA&M

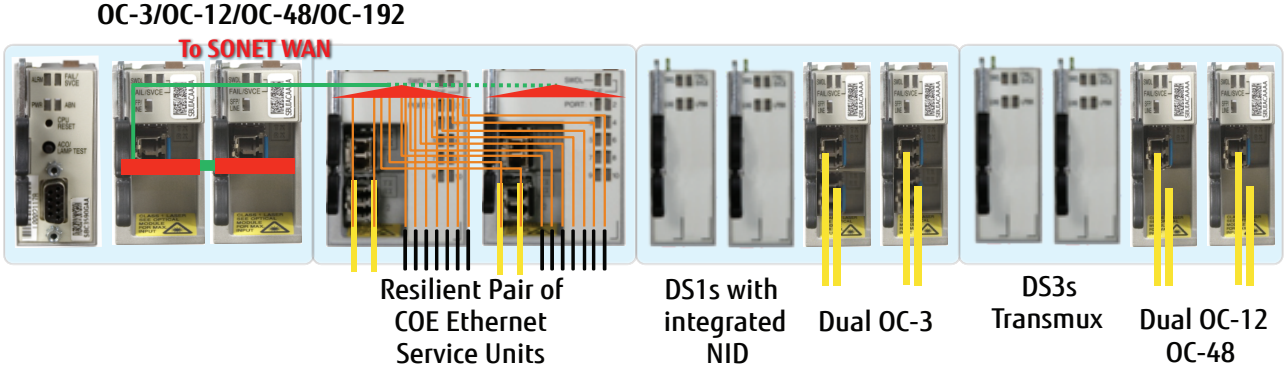
The FLASHWAVE 4100 ES system eliminates the need for an external Ethernet NID, shrinking both footprint and cost when using the FLASHWAVE 4100 ES integrated Y.1731 responder along with a test head such as the FLASHWAVE 9410 system or equivalent. Network operators provision in-service performance measurements including delay, delay variation and frame loss, without affecting production data.



Integrated in-service Y.1731 OAM reduces footprint and cost

High Availability Resilient Card Pair

Carrier-class networks require high availability with no single point of failure. The COE Ethernet service unit offers multiple provisioning options for self-healing resilient hardware operation. Client interfacing options include IEEE 802.3ad link aggregation (LAG), optical Y-cable and dual Ethernet. The LAG option splits working and protect Ethernet segments across the resilient card pair, offering both facility and hardware resiliency. The optical Y-cable option provides high-availability hardware resiliency by interfacing optical ports to early model devices not supporting IEEE 802.3ad LAG. Dual Ethernet mode operates with client ports active on both cards where EVCs automatically fail over to one card in the event of hardware impact.

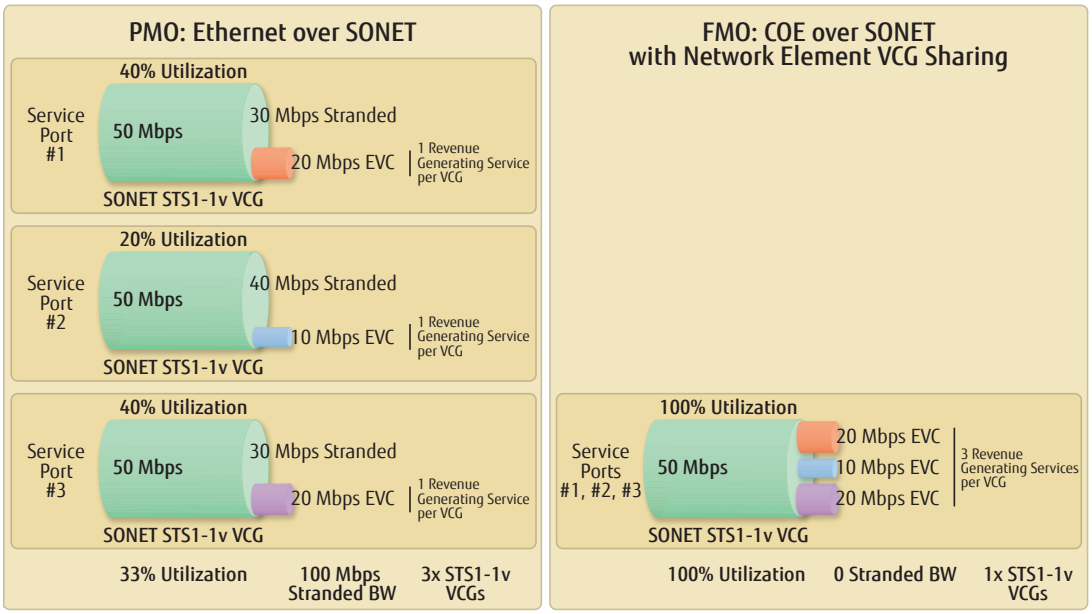


A wide range of flexible interface options

A Wide Array of Applications

COE Over SONET with Network Element VCG Sharing

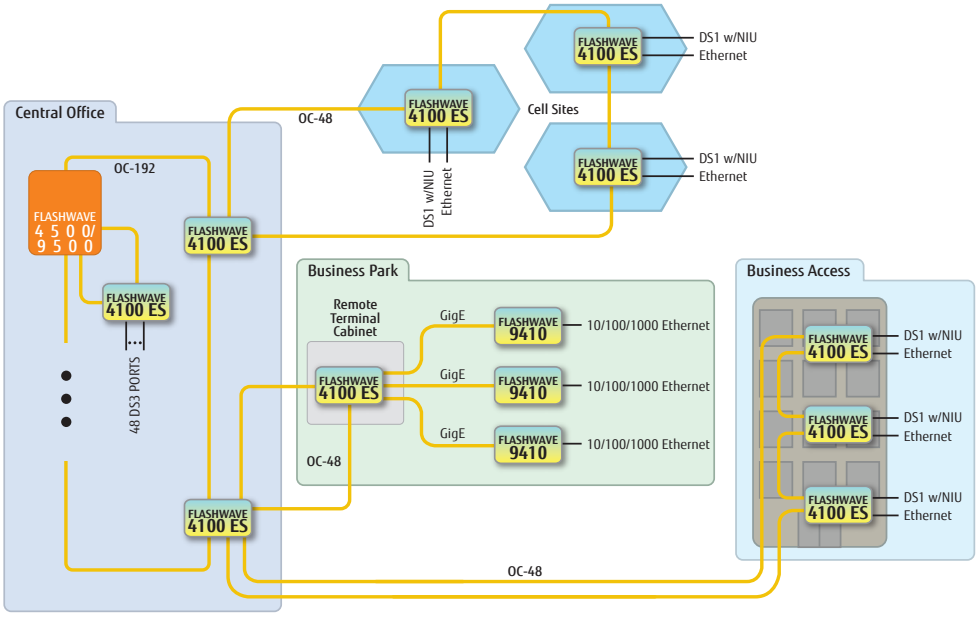
In contrast to traditional EoS implementations where each port is transported over a single SONET VCG, the FLASHWAVE 4100 ES platform offers the option to multiplex multiple ports and EVCs over a single SONET VCG. This advanced technology significantly improves SONET bandwidth efficiency within the shelf. Network element VCG sharing enables more flexible Ethernet bandwidth options when two or more ports are transported to the same destination, which overcomes the limitations of fixed 50 Mbps bandwidth increments per-port. For example, if a customer wants to lease three Ethernet service ports each at 20 Mbps, 10 Mbps and 20 Mbps respectively, the service provider would have to allocate three STS1-1v VCGs each by stranding 30 Mbps, 40 Mbps and 30 Mbps respectively. Instead, all three ports can share a single STS1-1v VCG. FLASHWAVE 4100 ES COE over SONET with network-element VCG sharing. This increases bandwidth utilization up to 100%, in comparison to the traditional method at 33% using three STS1-1v VCGs. The maximum shared VCG capacity is STS1-24v.



Improve bandwidth utilization with COE

Optical Hubbing

For aggregation sites, the FLASHWAVE 4100 ES Micro Packet ONP supports optical hubbing of multiple OC-48 rings. This enables traffic aggregation and grooming across multiple networks in a DCS-type application. Integrated transmux units allow M13 multiplexing, providing DS1 to DS3 traffic grooming.



Optical hubbing with the FLASHWAVE 4100 ES

FLASHWAVE® 4100 ES

Micro Packet Optical Networking Platform

Ideal for Mobile Backhaul

Demand for higher speed wireless data services continues to surge as new applications proliferate. To tap into this revenue opportunity, wireless service providers are deploying 3G and 4G wireless technologies, increasing the number of cell sites and boosting the bandwidth capacity of the backhaul network.

While these new technologies are expanding, there are still approximately 190,000 existing cell sites in the US that require T1 TDM backhaul. This large installed base will remain in operation for many years, resulting in a continued need to provide T1 mobile backhaul transport.

Complete Backhaul Support

The compact 2RU FLASHWAVE 4100 ES Micro Packet ONP is ideal for mobile backhaul applications due to its integral support for T1 and Ethernet service delivery. Existing FLASHWAVE 4100 ES cell site deployments currently providing T1 backhaul for legacy 2G/3G services can be upgraded to deliver the high-performance COE capabilities required for Ethernet-based 3G and 4G wireless services. The platform is environmentally hardened to operate within the harsh environment of a cell site outside plant (OSP) cabinet, and can operate over standard –48 V DC or +24 V DC through its auto-sensing on-board power system.

The FLASHWAVE 4100 ES Micro Packet ONP provides a complete end-to-end solution at the cell tower, aggregation site, or MSC where backhaul providers can:

- Provision core rings up to OC-192
- Integrate seamlessly with existing 2G/3G TDM backhaul networks
- Provision 3G/4G backhaul with COE service units
- Increase SONET backhaul bandwidth efficiency by leveraging COE over SONET with network element VCG sharing
- Transition from Ethernet over SONET to native Ethernet at their own pace while maintaining their original capital equipment investment
- Integrate line-of-sight microwave cell sites at DS3, EC1, 100Base-T/X Ethernet, OC-3, OC-12 and OC-48
- Aggregate 2G/3G TDM traffic onto OC-3/OC-12 facilities for DCS interconnection
- Service multiplex (aggregate) and map 3G/4G services from odd and even EVCs onto separate GbE facilities for redundant router Interconnection

Each COE service unit supports up to 10x SONET HO-VCGs for service multiplexing aggregation. Up to six non-redundant and three redundant pair COE service units are supported per chassis. Once HO-VCGs are translated, Ethernet VLANs are mapped to any COE Ethernet service unit port or card with optional resiliency. This feature set is ideal for small-scale aggregation sites. For larger scale aggregation sites, the FLASHWAVE 4500 MSPP or FLASHWAVE 9500 Packet ONP offer an ideal network solution for backhaul of mobile traffic.

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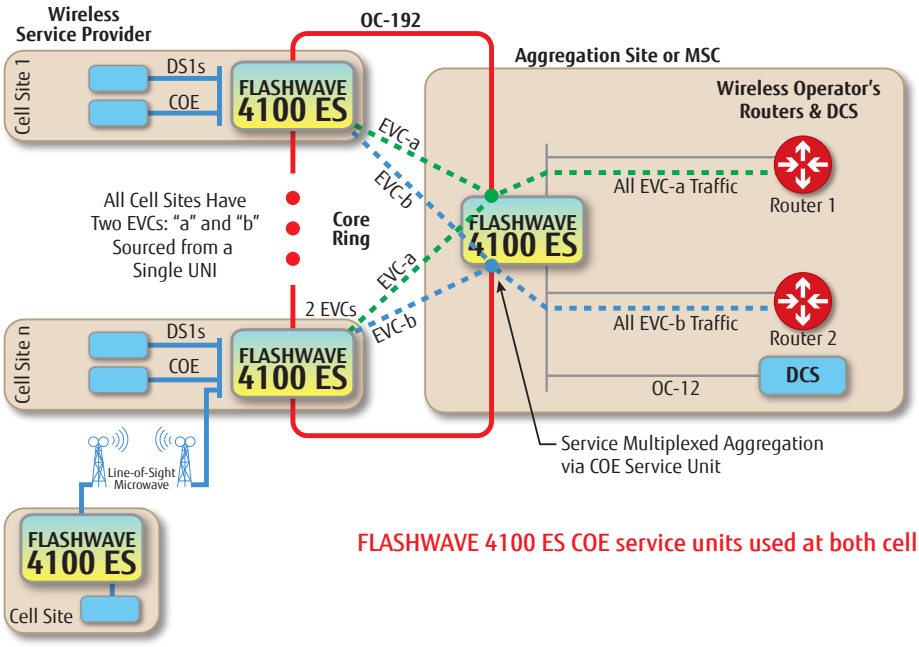

FLASHWAVE 4100 ES COE service units used at both cell and MSC sites

FLASHWAVE® 4100 ES
Micro Packet Optical Networking Platform

Features and Specifications

Architectures

- Terminal (1+1)
- Linear ADM (1+1)
- Unidirectional Path Switched Ring (UPSR)
- 0:2 Both line cards working and unprotected
- Ethernet with 1:1 LAG facility protection

WAN Interfaces

- 10/100 Base-T and FE/GE Base-X
- OC-3, OC-12 OC-48 and OC-192 line interfaces
- Optical SFP- and XFP-based with LC connectors
- 1310 or 1550 nm wideband
- OC-3, OC-12, OC-48, OC-192 and GigE CWDM SFP and XFP optics
- OC-3, OC-12, OC-48, 100FX and GigE Bi-Di SFP optics
- OC-48 and OC-192 DWDM SFP and XFP optics
- OC-192 full band tunable DWDM optics

Service (Client) Interfaces

- 10/100Base-T with RJ-45 connectors
- 100Base-X (SFP) with LC connectors
- 1000Base-X (SFP) with LC connectors
- DS1 with 64-pin Amphenol® connectors
- DS3/EC1 with BNC connectors
- DS3 Transmux with BNC connectors
- OC-3, OC-12 and OC-48 (SFP) with LC connectors
- 1310 or 1550 nm wideband
- OC-3, OC-12, OC-48 and GigE CWDM SFP optics
- OC-3, OC-12, OC-48, 100FX and GigE Bi-Di SFP optics

Maximum Number of Service Interfaces

	Ports/Card	Unprotected Ports/Shelf	Protected Ports/ Shelf
DS1	28	168	168
DS3	3	18	18
High-density DS3/EC1	8	48	48
DS3 Transmux	3	18	18
OC-3	2	24	12
OC-12	2	24	12
OC-48	1	12	6
10/100Base-T	8	48	-
100Base-X	2	24	-
1000Base-X	2	24	-
COE 10/100Base-T	7	42	21
COE 100Base-X	2	12	6
COE 1000Base-X	2	12	6

Protection Options

DS1	1:1 or unprotected
DS3/EC1	1:1 or unprotected
DS3 Transmux	1:1 or unprotected
SONET	1+1, UPSR or 0:2 dual working
COE Ethernet	1+1 EoS protection with 802.3ad (inter-card) LAG, optical Y-cable or dual Ethernet provisioning options
BITS Output	1+1 redundant output

SONET Switching

	STS-1 TSI	VT1.5 TSI
OC-3 Dual Line Interface	48 x 48	1344 x 1344
OC-12 Line Interface	168 x 168	4704 x 4704
OC-48 Line Interface	240 x 240	6720 x 6720
OC-192 Line Interface	960 x 960	6720 x 6720

COE Service Unit Ethernet Features

- MEF Certified Ethernet Private Line (EPL) and Ethernet Virtual Private Line (EVPL) services
- Ethernet tag switching implementation of Connection-Oriented Ethernet (COE)
- Y.1731 responder for in-service fault management and performance measurement
- Supports VLAN ID push/pop/swap with multiple tag stacking options for maximal flexibility
- Unlimited scalability through reuse of VLAN IDs across a COE domain
- Ingress classification on port, VLAN ID or IEEE 802.1p priority code points
- Ingress bandwidth profiles per EVC or EVC per CoS
- 4 Class of Service queues defined via 16 unique CoS profiles
- Connection Admission Control (CAC) to guarantee CIR bandwidth for each EVC
- Supports RFC 2698 and MEF 10.1 TCM policers
- IEEE 802.3ah Link OAM
- IEEE 802.3ad Link Aggregation
- Supports LACP or static LAG configurations
- Up to 250 EVCs per card
- Synchronization
- DS1 Building Integrated Timing Supply (BITS) primary and secondary clock input and output ports
- Line timing
- Synchronization Status Messaging (SSM)
- Internal Stratum 3 timing source

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Features and Specifications

Operations
• TL1 protocol over OSI/Ethernet or IP/Ethernet
• SNMP Monitoring
• SSH/SFTP
• NETSMART® 500 Element Manager
• NETSMART 1500 Management System
• TCP/IP gateway functionality
• Software download and remote memory backup/restore
• Interoperable with all Fujitsu transmission products
• Telcordia™ OSMINE supported
• NEBS Level 3 certified
• UL listed

Operating Environment	
Temperature	–40 to +65 °C (–40 to +149 °F)
Humidity	5 to 95% (non-condensing)
Power Consumption	
Maximum Power Consumption	281 W
Heat Dissipation	959 BTU/hr
Power Input	+24 V DC or –48 V DC
Physical Characteristics	
Shelf Dimensions (H x W x D)	3.5 x 17.5 x 13.5" (8.9 x 44.5 x 34.3 cm)
Weight (fully-loaded)	22.4 lb (10.2 kg)

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