Optical Cross-Connect (OXC) Hardware Deep-Dive and Performance Specification

PRODUCT IDENTIFICATION AND SYSTEM OVERVIEW

This document provides a comprehensive systems engineering technical reference for the Optical Cross-Connect (OXC) Platform, a next-generation, all-optical switching solution designed for the hyper-scale data center, metro core, and long-haul network segments. The OXC leverages advanced Micro-Electro-Mechanical Systems (MEMS) and Wavelength Selective Switch (WSS) technologies to enable dynamic, protocol-transparent, and colorless, directionless, and contentionless (CDC) optical layer switching. As a cornerstone of the software-defined networking (SDN) transport architecture, this platform delivers unprecedented operational agility, reducing manual patching and accelerating service provisioning from weeks to milliseconds. Its chassis-based design supports high-density fiber terminations and integrates seamlessly into existing DWDM infrastructures, ensuring a future-proof investment for operators transitioning to fully automated, disaggregated optical networks.

SYSTEM HARDWARE TOPOLOGY AND CHASSIS DESIGN

The OXC system is architected around a modular, high-density chassis that serves as the central switching fabric. The physical topology is divided into three primary domains: the optical switching matrix, the line interface cards, and the system control & management plane.

At the heart of the system is a fully non-blocking, 3D MEMS-based optical switching array. This matrix is partitioned into multiple switching planes to provide inherent hardware redundancy. In the event of a single MEMS module failure, traffic is seamlessly rerouted through an alternate plane without impacting active optical paths. Surrounding the switch matrix are the line card cages, which support a variety of hot-swappable interface modules. These modules are equipped with integrated tunable laser optics and

high-performance digital signal processors for advanced forward error correction (FEC).

The backplane is a high-isolation, low-loss photonic wiring layer that provides ultra-low insertion loss between the line cards and the central matrix. This design eliminates the need for complex fiber management within the chassis, significantly improving cooling efficiency and system reliability. The control plane is powered by a 1+1 redundant pair of route processors that manage the optical connection database, handle protocol signaling, and interface with external SDN controllers via NETCONF and RESTCONF APIs.

DATA, CONTROL, AND OPTICAL PLANE CAPABILITIES

The OXC architecture distinctly separates the data forwarding (optical), control, and management planes to enhance stability and security. The data plane operates strictly at the optical layer, performing photonic switching based on wavelength and port. No optical-to-electrical-to-optical (OEO) conversion occurs in the data path, ensuring sub-millisecond latency and unlimited protocol transparency for 1G/10G/40G/100G/400G/800G Ethernet, Fibre Channel, and OTN signals.

The control plane, executing on the active Route Processor (RP), utilizes a

hardened real-time operating system to maintain the network state. It employs protocols such as GMPLS (Generalized Multiprotocol Label Switching) for dynamic path computation and optical restoration. The RP continuously monitors the health of all optical components, adjusting gain in the erbium-doped fiber amplifiers (EDFAs) to compensate for attenuation and maintain optimal signal integrity. In addition, an intelligent maintenance feature allows for hitless software upgrades, ensuring that control plane updates do not interrupt forwarding services.

COMPONENT BREAKDOWN AND FIELD REPLACEABLE UNITS (FRUS)

The system is composed of the following key FRUs:

1. Optical Switch Chassis: A 4RU or 5RU mechanical enclosure providing structural support, cable management, and power distribution. It features a side-to-side airflow cooling design.
2. MEMS Switching Core Modules: These are the central photonic components, available in variants supporting up to 576x576 fibers or higher. Dual-core modules provide cross-plane redundancy.
3. WSS Line Cards: Each card aggregates up to 32 or 40 bidirectional ports. They are equipped with a 1xN WSS (N up to 9) to enable dynamic add/drop of wavelengths.

4. Amplifier and Rack Mounting Units: Integrated EDFAs and Raman amplifiers are available as pluggable modules to compensate for span losses.

5. Control and Management Modules: The active/standby RP modules provide the compute capability for system control, plus a management Ethernet port.

6. Cooling Fan Trays: Redundant, variable-speed fan trays regulate temperature based on ambient and component sensors.

OPERATIONAL SPECIFICATIONS MATRIX

The OXC platform is designed to operate under stringent carrier-grade environmental and performance constraints. Key operational specifications include:

Operating Temperature Range: 0°C to +45°C (short term); -5°C to +55°C (extended temperature support variant).

Humidity: 5% to 85% (non-condensing).

Input Voltage: -48 VDC nominal (-40.5 to -57 VDC) or 100-240 VAC (50/60 Hz).

Power Consumption: Nominal 600W (fully loaded), peaking at 950W.

Optical Insertion Loss: < 6.5 dB (through the switch fabric).

Channel Spacing: 50 GHz and 100 GHz grid compatible.

Wavelength Range: 1529.16 nm to 1567.13 nm (C-band).

Parameter	Specification
Form Factor	4RU / 5RU Modular Chassis
Switching Capacity	Up to 576x576 Fibers (Non-Blocking)
Power Supply	1+1 Redundant DC (-48V) or AC (100-240V)
Wavelength Range	C-Band (1529.16 nm – 1567.13 nm)
Channel Spacing	50 GHz / 100 GHz Flexible Grid
Per Port Insertion Loss	< 6.5 dB (Across Fabric)
Latency	Sub-500 ns (Photonic Switching)
Operating Temperature	0°C to +45°C (Ambient)
Humidity	5% to 85% Non-Condensing
MTBF (Mean Time Between Failures)	> 250,000 Hours (Telcordia SR-332)
Management Interfaces	CLI, SNMP, NETCONF/RESTCONF
FEC Support	Integrated Soft-Decision FEC on Transceivers

REGULATORY COMPLIANCE AND SAFETY CERTIFICATIONS

The Optical Cross-Connect (OXC) platform has been rigorously tested and certified to meet global telecommunications, safety, and environmental standards. Compliance ensures seamless integration and deployment across

diverse geographies.

Telecom Equipment Standards: NEBS (Network Equipment Building Systems) Level 3 certified (GR-63-CORE and GR-1089-CORE), ensuring robustness for central office environments.

EMC/EMI: FCC Part 15 Class A, EN 55032 Class A, EN 55035, and CISPR 32.

Safety Standards: IEC/EN 60950-1 (2nd Edition) and IEC/EN 62368-1 (3rd Edition), ensuring operational safety for personnel.

Environmental Regulations: Fully compliant with RoHS (Restriction of Hazardous Substances) and WEEE (Waste Electrical and Electronic Equipment) directives.

Laser Safety: Class 1M laser product per IEC 60825-1, indicating the device is safe under normal operating conditions with optical instrumentation.

Accessibility: ISO 7779 and ETSI 300 753 standards for acoustic noise (typically < 7.0 Bels at 25°C).


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