

# Optical Fiber vs Copper in Core Network Switching - Strategic Asset Procurement Evaluation Report

## STRATEGIC HARDWARE POSITIONING

In the evolving landscape of carrier-grade core networking, the choice between optical fiber and copper interconnects represents a critical architectural decision impacting scalability, performance, and operational expenditure. This document serves as a formal procurement evaluation report for network infrastructure engineers, CTOs, and strategic asset managers, assessing the comparative advantages of optical fiber versus copper for core network switching hardware. The analysis focuses on the high-density, non-blocking switching platforms designed for metro-core and regional data center interconnection, utilizing the latest generation of 400GbE and 800GbE application-specific integrated circuits (ASICs).



## TCO EFFICIENCIES

The Total Cost of Ownership (TCO) differential between optical and copper-centric switching architectures reveals a strategic inflection point. While initial hardware acquisition costs for optical transceivers (particularly DWDM and coherent modules) typically exceed those of high-speed copper direct-attach cables (DACs) by a factor of 3:1 to 8:1, the operational advantages of optical fiber in core networks deliver substantial long-term savings.

- **Power Consumption**: Optical fiber interfaces operating at 400G+ typically consume 20-30% less power per gigabit transmitted over distances beyond 5 meters compared to active copper cabling, which requires significant signal conditioning at higher baud rates.
- **Cooling Requirements**: The reduced thermal footprint of fiber optic

transceivers contributes to lower cooling costs, allowing for increased port density per rack unit. The hardware specifications demonstrate a thermal design power reduction of up to 15W per port when utilizing QSFP-DD optical modules versus equivalent copper-based solutions.

- **Cable Management**: Optical fibers enable higher-density cabling, reducing physical space requirements for cable trays and facilitating superior airflow management.

## SCALABILITY ADVANTAGES

Core network switching hardware leveraging optical fiber interconnects provides an inherent scaling advantage essential for modern data center architectures:

- **Distance Independence**: While copper interfaces are typically limited to sub-5-meter connections for high-speed signaling, optical fiber supports multimode distances of 100 meters and single-mode reach exceeding 10 kilometers without signal degradation.

- **Bandwidth Upgrades**: Optical interfaces allow for future wavelength upgrades without replacing physical cabling infrastructure, supporting 800G and 1.6T evolution through simple transceiver swaps. This "optical plumbing" approach provides investment protection for the physical layer.

- **\*\*Latency Consistency\*\***: Optical fiber provides deterministic, low-latency performance, with propagation delays remaining stable across varying cable lengths, ensuring predictable performance for high-frequency trading and real-time analytics.

## SPECIFICATION REPORT

### HARDWARE PERFORMANCE SUMMARY:

- Forwarding Capacity: 25.6 Tbps, non-blocking fabric, full-duplex
- Port Density: 64 x 400GbE QSFP-DD ports, 128 x 100GbE capable
- Latency (64-byte frames): Sub-500 nanoseconds, cut-through switching
- Buffer Capacity: 80 MB, intelligent dynamic allocation
- MAC Address Table: 256,000 entries

### OPTICAL TRANSCEIVER SUPPORT (RECOMMENDED):

- 400GBase-SR8, 400GBase-FR4, 400GBase-LR8
- 100G CWDM4, 100G LR4, 100G DR1
- 40GBase-SR4, 40GBase-LR4, 40GBase-ER4

### COPPER INTERFACE (LEGACY COMPATIBILITY):

- 10GBase-T (RJ45) module support
- 40GBase-CR4 / 100GBase-CR4 DAC

Parameter	Optical Implementation	Fiber	Copper Implementation
Maximum Reach (400G)	10 km (SMF, LR8)		5 m (DAC)
Power per Port (400G)	12W - 15W		18W - 25W
Latency per Meter	~4.9 ns		~5.2 ns
Cable Bend Radius	10 mm (minimum)		40 mm (minimum)
Upgrade Path	Wavelength Transceiver	&	Entire cable replacement
EMI Susceptibility	Immune		Susceptible

## SAFETY CERTIFICATIONS

The proposed hardware infrastructure has been rigorously tested and certified across all major international regulatory standards to ensure interoperability, safety, and environmental compliance:

- **Safety**: UL/CSA 60950-1, IEC 60950-1, EN 60950-1 (CE Mark)
- **EMI/EMC**: FCC Part 15 Class A, EN 55032 Class A, EN 55024, VCCI Class A
- **Environmental**: RoHS Directive 2011/65/EU, WEEE Directive 2012/19/EU, REACH Compliance

- **Network Equipment Building Systems (NEBS)**: GR-63-CORE (Level 3), GR-1089-CORE
- **Telcordia**: SR-3580 (NEBS) and SR-332 (Reliability Prediction) compliant

## VISUAL DEPLOYMENT SUMMARY

A recommended deployment architecture is structured to maximize the benefits of optical fiber interconnectivity. The core switching cluster is positioned within a central data hall, directly connected to spine and border leaf switches via a structured cabling matrix utilizing Single-Mode Fiber (SMF) and MTP/MPO-24 ribbon assemblies. This design minimizes latency, reduces physical layer complexity, and enables rapid capacity scaling. The implementation of dark fiber and DWDM technology further optimizes utilization, allowing multiple services to traverse a single fiber pair. Copper interfaces are retained solely for management plane connections and out-of-band network access.

