

Switch Interconnection Optical Modules



Overview

Its core concept is to move the optical components from traditional pluggable modules into the switch itself.

Key Takeaways

Optical modules interconnect with switches to convert electrical signals to optical signals and vice versa, enabling high-speed, long-distance data transmission while maintaining signal integrity and efficiency. Traditional Pluggable Optical Modules

In conventional network switches, optical modules are pluggable transceivers that connect to switch ASICs via high-speed electrical channels on the PCB. The switch generates electrical signals, which travel through the PCB and connectors to the optical module, where they are converted into optical signals for fiber transmission. The reverse occurs at the receiving end. This architecture, while flexible, introduces long electrical paths, leading to signal loss, higher power consumption (up to 30W per interface), and potential reliability issues due to multiple connection points. High-speed channels like 400G or 800G Ethernet exacerbate these challenges, requiring complex DSP and active components to maintain signal integrity.

Co-Packaged Optics (CPO)



CPO integrates the optical module directly with the switch ASIC in the same package, drastically shortening electrical paths to millimeter-scale distances. This approach reduces power loss, improves signal integrity, and lowers overall power consumption, while freeing front-panel space . By placing optical components around the ASIC and using silicon photonics interfaces, CPO eliminates the need for long PCB traces and connectors, which are the main sources of loss and latency in traditional designs. This architecture is particularly advantageous for large-scale AI clusters and high-bandwidth data centers, where 400G, 800G, or 1.6T Ethernet links are common .

Coherent Pluggable Optical Modules

For data center interconnects (DCIs) spanning tens to hundreds of kilometers, coherent pluggable optics can be deployed directly in switch ports. These modules combine silicon photonics, low-power DSP ASICs, and advanced optoelectronic packaging to implement functions traditionally handled by chassis-based DWDM transponders in a pluggable form factor. This reduces cost, power, and footprint, while enabling high-speed 400G links over distances up to 1,000 km with optional amplification . The modules are standardized and compatible with open line systems, simplifying network automation and management.

Functional Interdependence

Optical modules and switches form a symbiotic relationship: switches act as the "command center," forwarding data frames, while optical modules serve as the "bridge," converting electrical signals to optical signals for long-distance transmission and back . Proper performance matching between the switch and optical module is critical to avoid bottlenecks or resource waste, ensuring high-speed, stable, and reliable data transmission.

Summary

The interconnection of optical modules in switches has evolved from pluggable transceivers with long electrical paths to co-packaged optics and coherent pluggable solutions, addressing challenges of signal integrity, power efficiency, and scalability. These architectures are essential for modern high-speed data centers, AI clusters, and long-distance interconnects, enabling efficient, high-bandwidth optical networking .

Article Content

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