Supercomputing Center and Optical Module

Article Overview

Optical modules are critical components in supercomputing centers, enabling ultra-fast, low-latency data transfer between CPUs, GPUs, and storage systems to support AI, scientific simulations, and big data analytics.

Role of Supercomputing Centers

Supercomputing centers, such as the Leibniz Supercomputing Centre (LRZ), host high-performance systems like SuperMUC-NG, which features over 311,000 computing cores and 720 terabytes of memory, capable of performing 26.9 petaflops per second. These centers support research in astrophysics, climatology, medicine, and engineering, and increasingly integrate GPU and CPU hybrid architectures to accelerate AI workloads . Efficient interconnects are essential to prevent idle compute resources and ensure rapid data exchange across large clusters.

Importance of Optical Modules

Optical modules convert electrical signals into light pulses and back, enabling high-bandwidth, low-latency communication across HPC nodes . They overcome the physical limitations of copper cabling, such as attenuation and crosstalk, especially over distances beyond a few meters at multi-gigabit speeds. Key advantages include:

o Extreme Bandwidth: Modern modules support 200G, 400G, and 800G speeds using wavelength division multiplexing (WDM), allowing terabits per second of aggregate bandwidth .
o Ultra-Low Latency: Light travels faster than electrons, minimizing delays critical for AI training and real-time simulations .
o Long Reach: Single-mode fibers enable connections over kilometers, supporting distributed training and disaggregated rack-scale designs .
o High Density & Scalability: Compact form factors like QSFP-DD and OSFP allow hundreds of ports per switch, essential for scaling massive GPU clusters .

Deployment in AI and HPC

In intelligent computing centers, optical modules connect servers, switches, and storage systems to maximize network efficiency and reliability. For example, NVIDIA DGX H100 clusters use 400G OSFP DR4/VR4 modules to interface with 800G Quantum-2 switches, enabling real-time multi-GPU communication . Long-distance single-mode modules facilitate multi-site AI model training, while protocols like RoCE (RDMA over Converged Ethernet) and InfiniBand rely on optical transceivers for high-speed data transport .

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Advanced Optical Technologies

Recent innovations, such as 800G Linear Pluggable Optics (LPO), optimize power efficiency and latency by eliminating DSP chips, reducing power consumption by up to 50% compared to traditional 800G DSP-based modules . These modules are particularly suited for AI and HPC data centers, balancing high-speed performance with energy efficiency.

Conclusion

Optical modules are indispensable in modern supercomputing centers, enabling exascale computing, AI training, and large-scale simulations by providing high-bandwidth, low-latency, and energy-efficient interconnects. Their deployment ensures that massive GPU and CPU clusters operate at full capacity, supporting the next generation of scientific discovery and AI innovation .

OFC 2025 made one thing clear: The transition to Co-Packaged Optics (CPO) switches in data centres is inevitable,

Turning to the data center, we review the requirements for scaling and improved resource utilization and the need for high-bandwidth

Generative AI and large models have driven the exponential growth of computing power, and supercomputing centers have shifted

Modular Supercomputing S The NASA Advanced Supercomputing Division"s innovative modular approach to expand

Video 1. NVIDIA Vera Rubin platform overview video This system-level overview sets the foundation for understanding

For the next generation of AI supercomputing, OCS is not merely an alternative to electronic switching--it is the only

In a world-first for high-performance computing, the Leibniz Supercomputing Centre (LRZ) in

Discover Shenzhen HTFuture"s AI optical modules driving advancements in AI, quantum

ABSTRACT With the expansion of high-end computing resources needed to support NASA"s increasing

demands for physics-based

Explore the 800G OSFP SR8 optical module with key features, advantages, and

With AI computing rapidly advancing, data center network infrastructures are under increasing pressure. At GTC 2025

At SC24, Samtec presented several live product demonstrations that showcased our next-generation, high

Explore the ultimate guide to optical modules. Learn types, functions, performance metrics

Lightmatter has joined the NVIDIA NVLink Fusion ecosystem, bringing our photonic interconnects to the AI infrastructure powering

Enter Co-Packaged Optics (CPO), a transformative architecture where the optical engine moves inside the switch ASIC

Liquid-cooled optical modules are particularly well-suited for high-power consumption

Web: https://www.in-au.co.za