How about optical interconnects in data centers



Overview

How Optical Interconnects Are Powering the Data CenterExplore the necessary shift to light-based signaling. Understand how optical interconnects fundamenta.

Key Takeaways

Optical interconnects use light to transmit data, offering higher bandwidth, lower latency, and greater energy efficiency than traditional electrical connections, making them essential for modern high-performance and disaggregated data centers.

Overview and Components

Optical interconnects transmit data using photons instead of electrons, typically through optical fibers or silicon waveguides. The main components include a light source (like a laser), a modulator, an optical channel, and a photodetector that converts light back into electrical signals. This approach avoids the resistive heating, signal attenuation, and electromagnetic interference that limit copper-based electrical interconnects, enabling longer distances and higher data rates.

Advantages

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High Bandwidth and Data Rates: Optical interconnects can support 100 Gbps per channel and scale to terabits per second using Wavelength Division Multiplexing (WDM), where multiple data streams are transmitted simultaneously on different light wavelengths. Low Latency: Light travels faster than electrical signals in copper, reducing latency, which is critical for AI workloads and high-performance computing. Energy Efficiency: Optical links consume less power than electrical interconnects, especially over long distances, reducing overall data center energy costs.

High Bandwidth Density: Optical interconnects allow more data to be transmitted in a smaller physical footprint, supporting rack-to-rack and room-to-room connectivity. Applications in Modern Data CentersTop-of-Rack (TOR) and Rack-to-Rack Links: Optical interconnects are increasingly used within racks and between racks to handle high-bandwidth, low-latency traffic, particularly for AI and hyperscale workloads. Optical Circuit Switching (OCS): This technology establishes direct, reconfigurable optical circuits, reducing the need for power-intensive optical-to-electrical-to-optical conversions and improving performance for east-west traffic in AI clusters.

Disaggregated Architectures: Optical interconnects enable data center disaggregation, where compute, storage, and networking resources are separated and connected optically. This allows dynamic allocation of resources, minimizing waste and improving efficiency.

Industry Examples

Companies like Google have developed custom optical switches using free-space optics to reduce latency and power consumption, achieving 30% higher throughput, 40% lower power usage, and 50x less downtime in their networks. Such innovations highlight the growing importance of optical interconnects in high-performance, AI-driven data centers.

Future Directions

The trend is moving toward co-packaged optics, intra-rack optical links, and integration with processors and accelerators, further embedding optical communication into the core of data center infrastructure. As data volumes continue to grow, optical interconnects will be critical for scaling bandwidth, reducing latency, and improving energy efficiency in next-generation data centers.

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Article Content

How Optical Interconnects Are Powering the Data Center

Explore the necessary shift to light-based signaling. Understand how optical interconnects fundamentally boost data center speed, capacity, and efficiency.

Data Center Optical Interconnects for AI and

Learn how optical interconnects power AI-driven data centers with massive bandwidth, ultra-low latency, and sustainable scalability.

How optical interconnect and optical processing are changing data

Although optics has been used in data centers for decades, it is now reaching further and further into the beating heart of the data center - the processors and accelerators that run the data

All AI Data Center Interconnects Will Be Optical Within 5 Years

Optical will change the data center architecture and the architecture of CMOS chips in the data center. Winning CMOS execs will learn how to co-operate with optics and maximize their

Optical Interconnects for Data Centers

Optical interconnects have emerged as a promising solution, offering significant advantages over traditional electrical interconnects. In this article, we will explore the benefits,

Optical Interconnects for Data Centers

Presents a comprehensive review of all the key aspects of deploying optical interconnects in data centers, from materials and components, to circuit boards and methods for integration

Optical Interconnect

Optical interconnects are an essential part of today''s compute infrastructure, both within and between data centers (DCs) as well as enabling connectivity over transcontinental distances and to users.

Optical Interconnect Technology Analysis: LPO, NPO, CPO

Exploring optical interconnects for AI data centers: LPO for low-power, short-distance links, NPO for high-density, near-package connections, and CPO for ultra-high-bandwidth co

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Optical Interconnects for Data Centers reviews key developments in the use of optical interconnects in data centres and the current state of the art in transforming this technology into a reality.

LPO vs NPO vs CPO: Optical Interconnects in AI Data Centers

Explore the differences between LPO, NPO, and CPO optical interconnect technologies and how they enable high-bandwidth, low-latency networking for next-generation AI and HPC data centers.

AI data centers hit a new bottleneck: Optical interconnects

Background As AI data centers scale to handle larger workloads, the physical infrastructure connecting chips inside those facilities has become a limiting factor. Optical interconnects, which use ...

AI Data Centers Ignite a Laser Shortage Wave; Nvidia''s Strategic

TrendForce''s recent research indicates that high-speed optical interconnects are now central to performance and scalability, especially as AI data centers grow into large clusters. The

CPO vs LPO vs Silicon Photonics: Optical Interconnects for AI Data ...

Compare CPO, LPO, and silicon photonics for AI data centers. Learn how power, cost, and compatibility impact optical interconnect selection.

GlobalFoundries Accelerates Adoption of Co-Packaged Optics for

GlobalFoundries today announced the introduction of its SCALE optical module solution for co-packaged optics (CPO). GF''s SCALE solution, or Silicon photonics Co-packaged Advanced

Marvell Optical DSPs | Powering the Future of AI Infrastructure

Discover how Marvell''s Optical DSPs enable high-speed, energy-efficient connectivity for AI workloads, data center interconnects, and cloud infrastructure.

Marvell to Acquire Celestial AI, Accelerating Scale-up Connectivity for ...

Celestial AI: Breakthrough Photonic Fabric Technology Platform for Scale-Up Interconnect As bandwidth and reach continue to increase, every connection point in the data center must move

NVIDIA Strategic Investments in Optical Interconnects

These investments directly align with how next-generation AI infrastructure will be built, with optical technologies replacing copper

OFC 2026: Arista Leads XPO MSA Launch for 12.8T AI

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Discover the major industry shift at OFC 2026 as Arista Networks and global leaders unveil the XPO MSA, Open CPX, and OCI MSA to solve AI

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