Fiber Optic Communication and PCIe Communication



Overview

How to Implement PCI Express®-over-Optics in In a new white paper, authors from Samtec and Dolphin ICS explain the use of PCIe for backplane expansion usin.

Key Takeaways

PCIe over fiber optics enables high-speed, low-latency, and long-distance interconnects for modern computing systems. OverviewPCIe over fiber optics replaces traditional copper connections with optical links, allowing PCIe devices to communicate over longer distances while maintaining high bandwidth and low latency. This approach is particularly valuable in data centers, high-performance computing (HPC), and embedded systems, where multiple hosts or accelerators need to be interconnected efficiently.

Benefits

Extended Range: Optical links can span several meters, far beyond the limitations of copper PCIe cables, which degrade at higher data rates. High Bandwidth: Demonstrations of PCIe Gen3 over fiber have achieved 64 Gbps (128 Gbps bidirectional), while PCIe 6. 0 and 7.

0 over optics can reach 64 GT/s and 128 GT/s, respectively. Low Latency: Optical links reduce signal degradation and allow coherent splitting of compute resources between processors and accelerators, supporting real-time processing. Power Efficiency: Optical interconnects can lower power consumption compared to long copper traces, reducing total cost of ownership in large-scale deployments.

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Flexibility: PCIe over fiber supports remote expansion of PCIe peripherals, enabling external chassis or backplane configurations without additional software or driver changes.

Technical Implementation

Transceivers and Cables: Systems use SFP, SFP+, QSFP transceivers, Active Optical Cables (AOC), or Direct Attach Cables (DAC) to connect PCIe endpoints.

FPG

A and Switch Integration: FPGA-based modules or PCIe switches (e.g., PLX PEX8609) route PCIe lanes to optical interfaces, supporting multiple configurations such as single-channel or quad-channel ports. Compatibility: PCIe over fiber is designed to be transparent to the host system, so standard PCIe cards operate as if locally installed. Future Trends: The industry is exploring optical-based card electromechanical connectors (CEM) and integration with Universal Chiplet Interconnect Express (UCIe) for higher bandwidth density and energy efficiency.

Applications

Data Centers and HPC: High-speed optical PCIe links enable AI training clusters and large-scale unstructured data processing. Embedded Systems: Remote PCIe expansion over fiber allows SoCs, microcontrollers, and multiple host systems to interconnect efficiently while maintaining low latency.

Radiation-

Hardened Environments: Optical PCIe links can be adapted for environments requiring high reliability, such as space or nuclear applications. SummaryPCIe over fiber optics represents a transformative evolution of the PCIe standard, combining the high-speed, low-latency characteristics of PCIe with the long-distance and power-efficient advantages of optical communication. It is increasingly relevant for AI, HPC, embedded systems, and remote PCIe expansion, and ongoing developments in PCIe 7.

0 and optical CEM connectors promise even higher performance and broader adoption in the near future.

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Article Content

How to Implement PCI Express®-over-Optics in

In a new white paper, authors from Samtec and Dolphin ICS explain the use of PCIe for backplane expansion using fiber optics, including its

PCIe Over Fiber Optics in FPGA-Based Systems

The main objective is to explore how PCIe technology can be effectively extended over long distances using fiber optics, while maintaining high throughput and low latency, essential for supporting the

PCIe Over Fiber Optics in FPGA-Based Systems

This thesis explores the implementation of PCI Express (PCIe) over fiber optics as a solution for the architectural needs of medical devices, specifically targeting high-bandwidth and low-latency data

PCI Express Over Fiber Optic Extensions

PCI Express over fiber optic extension allows standard PCI Express cards to operate remotely from the host computer. No additional programming or drivers

PCIe OVER FIBER GUIDE

Unlike other optical based solutions, these Active Optical Cables are truly interchangeable with existing copper cables as they support PCIe® auxiliary signals (CPWRON, CPERST#, CPRSNT# and

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ECOC Exhibition 2026

The ECOC Exhibition is Europe''s largest exhibition in the fibre optic communication technology industry and in 2019, will once

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PCIe Over Optics Explained: PCIe 7.0 & Beyond | Synopsys Blog

At the recent Optical Fiber Communication Conference and Exposition (OFC) in San Diego, Synopsys and OpenLight brought two data center energy-efficient solutions to life. In the first

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Investor Relations Sustainability Test and Measurement Advanced wireless, optical, digital and IP test solutions for the equipment, handsets, modules and electronic components in communication systems.

PCIe-based network architectures over optical fiber links: An insight ...

PCI Express based innovative architectures designed for datacentre connections are proposed exploiting fiber communications for remote very high-speed connectivity. According with the ADVENT

Fiber optics | Definition, Inventors, & Facts | Britannica

Fiber optics, the science of transmitting data, voice, and images by the passage of light through thin, transparent fibers. In telecommunications, fiber optic technology is used to link

What embedded protocols can you use for optical connectivity?

This FAQ reviews some of the factors that impact the decision to use a wired or optical transport layer for connectivity and then presents several common embedded communications

PCIe Over Fiber Optics in FPGA-Based Systems

Abstract This thesis addresses the growing demand for faster and more reliable data transfer solutions in data-intensive applications, with a strong emphasis on scalability and flexibility. The research

Limitations of intra datacentre communications exploiting optical PCIe ...

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We demonstrate, by physical layer measurements, the compliance to the PCIe standard in terms of eye diagram mask and jitter for both Gen3 and Gen4 optical PCIe links, considering up to 10

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