



# Avoiding Disaster: 64G Fibre Channel Extensions over DWDM for superior network performance

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As data demands continue to grow exponentially, the need for robust and reliable high-speed data transport solutions is paramount. 64G Fibre Channel (64GFC) technology is becoming a critical tool in the arsenal of modern data centers, offering enhanced performance, scalability, and security. It's powering shared storage arrays in large organizations, low-latency financial service transactions, and scientific research, among many others. This chapter explores the latest advancements in 64GFC, highlights its integration with Dense Wavelength Division Multiplexing (DWDM) systems, and describes best practices for its deployment in mission-critical environments.

## Fibre Channel vs. Ethernet for Data Center Interconnects

While Ethernet interconnections are popular in data centers, Fibre Channel remains a preferred and even necessary choice for storage applications in mission-critical environments such as banking, government, and healthcare due to its reliability, deterministic low latency, and robust performance. Fibre Channel networks are designed specifically to achieve the lossless and in-order data delivery that storage applications require, and that Ethernet cannot consistently guarantee. Additionally, Fibre Channel's unique addressing scheme is separate and distinct from IP routing, making Fibre Channel fabrics not reachable from IP networks. This shields the fabric from IP network-based cyber threats and increases security, making Fibre Channel a resilient option for sensitive data transport. When combined with DWDM transport, Fibre Channel can operate over distances of 100km or more.

## The Advantages of 64G Fibre Channel and DWDM

64GFC technology delivers a significant leap in performance over 32GFC, providing ultra-low latency and doubling data transfer speeds. These attributes make it particularly well-suited for applications requiring high-speed storage, real-time analytics, synchronous replication, and disaster recovery. The integration of 64GFC with modern Optical Transport Network (OTN) DWDM systems enhances these capabilities, allowing for greater scalability, geographic diversity, and operational efficiency.

## Maintaining Data Integrity with Fibre Channel Extensions

Fibre Channel is designed to deliver data with unmatched reliability and integrity for mission-critical applications. By using link-based forward error correction and end-to-end error detection and recovery mechanisms, Fibre Channel ensures that data is received accurately and without loss. Unlike many other transport protocols, Fibre Channel guarantees consistent in-order delivery, eliminating the risk of data corruption due to out-of-order reception.

When extended over well-designed DWDM systems, Fibre Channel continues to maintain this high level of data integrity. Modern DWDM systems apply their own error correction schemes and are transparent to Fibre Channel's native error-checking protocols, allowing data to traverse long distances without degradation.

## Enhanced Security Through Double Encryption


Security is a critical concern when extending Fibre Channel networks, especially when data traverses outside of secure environments. Encryption provides a strong defense against data breaches and unauthorized access. With DWDM, users can benefit from independent SAN switch encryption and DWDM layer-1 encryption, enhancing overall security through a layered Defense-in-Depth approach.

DWDM layer-1 encryption is capable of encrypting multiple FC rates as well as other data protocols that may be transported on the data center interconnect (DCI) network. It does so without reducing throughput, transparent to the higher-layer protocols, allowing for independent FC protocol encryption.

In multi-tenant environments where the DWDM system encrypts the traffic of all tenants, this double encryption approach provides additional assurance that data remains secure even if one layer is compromised. This strategy also addresses potential vulnerabilities where only frame payloads are encrypted, leaving headers or metadata exposed. By encrypting at additional layers, Fibre Channel extensions safeguard all components of the data, including metadata that could otherwise be exploited.

## Robustness Against Fiber Cuts and Network Failures

Fibre Channel extensions over DWDM benefit from enhanced protection mechanisms. They are designed with robustness and reliability in mind, particularly in the face of physical network disruptions like fiber cuts. DWDM systems that conform to OTN standards implement rapid failover and protection schemes that significantly minimize downtime and data loss.



If a fiber cut occurs, OTN devices automatically forward the Non-Operational Signal (NOS) to downstream devices, prompting the SAN switch to perform the Link Init protocol and eventually recalculate fabric topology if it becomes necessary. This automatic response helps maintain the integrity of the fabric by swiftly indicating to the switch that a link is no longer operational and enabling the switch to use its native Fibre Channel methods to re-establish the link, reroute traffic and react to a persistent change in topology.

Additionally, DWDM systems can be deployed with fiber-path redundancy using protection schemes that can restore the connectivity of Inter-Switch Links (ISLs) within milliseconds after a fiber cut, allowing restoration of connectivity before the Link Init protocol becomes necessary, further reducing recovery time and maintaining high availability.

For environments without path redundancy, or in cases where the protection system has failed to restore the signal, shutting off the laser on the affected port can signal a hard failure, prompting recalculation of fabric topology to minimize impact. However, deploying DWDM systems with path protection is recommended where possible, as this provides an affordable and effective means to handle fiber cuts and maintain network stability.

### **Inter-Switch Link (ISL) DWDM Integration**

For optimal performance, DWDM systems should be configured to be transparent to all Physical Coding Sublayer (PCS) characters on the ISL, supporting standard Fibre Channel traffic as well as vendor-specific implementations.

Latency, including total and differential latency, should be minimized to maintain high performance and support a wide range of applications. Planning DWDM fiber paths with an understanding of application requirements is essential to maximize the performance of ISL features.

### **Summary**

The 64GFC rate is setting new standards for performance and reliability in data center interconnects. By integrating 64GFC with DWDM and adhering to best practices for encryption, link management, and redundancy, organizations can ensure their data centers are equipped to handle the demands of modern, high-speed data environments. Using DWDM extension of 64G Fibre Channel offers a set of robust, secure, scalable, and efficient transport solutions, enabling mission-critical applications across interconnected data centers, allowing fabrics to scale between facilities, and playing an indispensable role in supporting business continuity and disaster recovery objectives.