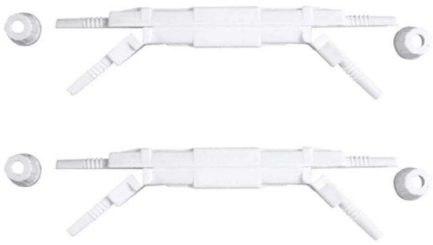
Case Study of Long-Distance Optical Cable Line Damage



Overview

Extended Physical Layer Degradation Case StudyThis case study examines performance issues in a long-distance DWDM fiber-optic link between Chennai and Beng.

Key Takeaways

Long-distance optical cable failures often result from mechanical stress, installation errors, or environmental factors, and can be effectively monitored using distributed sensing technologies.

Submarine HVDC Interconnector Case

A ±320 kV, 700 MW HVDC submarine interconnector spanning over 300 km between two European countries experienced potential risks typical of long-distance optical cables. To ensure continuous operation and rapid fault detection, Distributed Acoustic Sensing (DAS) was deployed along the cable route.

Two DA

S instruments monitored 150 km and 25 km sections, respectively, using low-loss fiber and range extenders to maintain signal quality over extreme distances. This setup allowed real-time detection of mechanical disturbances, water ingress, or other anomalies, safeguarding uninterrupted power transmission and critical infrastructure reliability.

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Hybrid Overhead and Underground Cable Circuit

In a 132 kV AC double circuit with four cable sections, the most challenging section started 44. 9 km from the nearest substation. Passive optical sensing was used to acquire current transformer (CT) measurements at cable/OHL transition points without active electronics.

Twelve three-phase CTs were installed to enable sub-cycle differential protection. The system successfully discriminated between faults on cable sections and overhead lines, allowing auto-reclose for OHL faults while blocking it for cable faults. Optical amplifiers and careful sensor design ensured signal integrity over long distances.

Field Damage Case: Optical Drop CableA practical field example involved an optical drop cable damaged during the installation of a new metallic cable in a conduit. The damage included severe bends, split jackets, and trench marks, causing service interruption. Investigation revealed that improper handling during rod and string installation led to mechanical stress on the optical fibers.

This case highlights the importance of careful installation practices and monitoring at transition points.

Common Causes of Long-

Distance Cable Failures

Mechanical Stress: Microbends and macrobends from tight routing, friction, or crushing can cause signal loss. Adhering to bend-radius guidelines and using bend-insensitive fibers mitigates this risk. Water Ingress: Moisture penetration in loose-tube or slotted-core cables can freeze and damage fibers.

Water-blocking features and sealed closures are essential for underground or submarine cables. Connector and Splice Failures: Poorly cleaned or misaligned connectors and splices can introduce reflection and attenuation. Fusion splicing and protective enclosures are recommended.

Environmental and Operational Hazards: Rodent attacks, temperature extremes, and accidental impacts during construction can compromise cable integrity.

Monitoring and Mitigation Strategies

Distributed Acoustic Sensing (DAS): Provides continuous, real-time monitoring over hundreds of kilometers, detecting vibrations, bends, or intrusion events.

Optical Time-

Domain Reflectometry (OTDR): Baseline and periodic testing detect attenuation spikes or reflective events indicating damage.

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Optical Amplifiers and Low-

Loss Fiber: Maintain signal quality over long distances, especially in submarine or remote installations. Redundant Paths and Optical Line Protection (OLP): Backup paths and 1+1 protection switches ensure continuity in case of fiber failure. Preventive Installation Practices: Proper conduit handling, bend-radius adherence, and protective enclosures reduce mechanical damage risk.

ConclusionLong-distance optical cable failures can arise from mechanical, environmental, or installation-related factors. Case studies demonstrate that advanced monitoring technologies like DAS, OTDR, and passive optical sensing, combined with careful installation and protective measures, are critical for early fault detection, rapid response, and maintaining reliable communication or power transmission over extensive distances.

Article Content

Extended Physical Layer Degradation Case Study

This case study examines performance issues in a long-distance DWDM fiber-optic link between Chennai and Bengaluru, highlighting how physical layer degradations such as attenuation, noise,

Case Study_Long Range Cable Monitoring_2025_EN

Undetected events, such as cable damage or potential sabotage, could result in significant financial losses and operational disruptions, highlighting the necessity of a robust and reliable monitoring

Fault Cases and Countermeasures for Optical Fiber Cables in Optical ...

We describe here a fault case involving the interruption of optical telecommunication service via an aerial optical fiber cable damaged by fire six years previously.

A Fault Location Analysis of Optical Fiber Communication Links

Breakage and damage of fiber optic cable fibers seriously affects the normal operation of fiber optic networks, and it is important to quickly and accurately determine the type and location of

Analyzing vulnerability of optical fiber network considering ...

Abstract With the development of optical transmission technology, optical fiber networks have become critical infrastructures in supporting information transmission on the Internet. However,

Impact of adverse cable handling on lifetime of optical fiber

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Optical fiber cable is designed to protect fibers from handling damages. Necessary strength members are included in cable to carry external forces applied during cable handling & transportation, cable

Analysis and solutions of common faults of optical fiber and cable

According to the fault analysis, there are many problems in the connector box for optical cable failure caused by non-external forces. The reasons for fiber breakage or increase attenuation

Distributed fibre optic sensing and novel data processing method for ...

Recently, distributed fibre optic sensing (DFOS) has emerged as a promising tool for monitoring civil structures by providing spatially continuous strain measurements using fibre optic

A comprehensive analysis of common faults in communication fiber

Communication fiber optic cables are the backbone of modern telecommunication networks, enabling high-speed data transmission over long distances. However, these cables are

Fault Cases and Countermeasures for Optical Fiber Cables in Optical ...

Fault Cases and Countermeasures for Optical Fiber Cables in Optical Network Facilities Abstract This article introduces case studies of failures that have occurred in optical fiber cables as well as some

What are the most common fiber optics problems?

Avoiding signal loss in fiber optics Fiber optic communication uses pulses of light to transmit data along thin strands of glass or plastic. Because the

Top Causes Of Fiber Optic Cable Damage & Interference

Fiber optic cables have the ability to transmit huge amount of data through long distance at lightning speed.Though fiber optics is known for reliability, it is not

NTT Technical Review, Jun. 2014, Vol. 12, No. 6

One case involved an optical drop cable that was damaged during the installation of a new metallic cable along a conduit line. We investigated the cause of the damage to the optical drop cable.

What Damages Fiber-Optic Cables? Key Risks and Mitigation Strategies

Learn the top causes of fiber-optic cable damage (mechanical stress, environmental hazards, wildlife, human error) and how to protect your fiber infrastructure from costly outages.

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What happens if fiber optic cable is damaged?

If a fiber optic cable is damaged, it can result in decreased transmission performance or a complete loss of transmission. Damage to the cable itself, such as twisting or crushing, can cause the core or

Optical cable line failure treatment

The interruption of the optical cable line caused by external factors or the optical fiber itself, which affects the communication service, is called the optical cable line fault. The interruption

FOA Guide

All networks are susceptible to problems that affect communications. A consequence of fiber optic systems'' high bandwidth, long distance capability and

Troubleshooting Fiber

Optical Fault Finders While VFLs work well for exposed lengths of fiber by illuminating bad connections and breaks, they are not very helpful for long cable

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