White Paper

VIAVI Solutions

Utilizing Fiber Optic Sensing Technology to Detect Exposed Direct-Buried Telecom Cables

Abstract

Fiber optic sensing technology has revolutionized the way we monitor and manage buried fiber optic cables. By converting optical fibers into thousands of virtual sensors, we can detect changes in temperature, strain, and other critical parameters. In this whitepaper, we explore how various distributed fiber optic sensing technologies can be employed to identify exposed sections of direct buried cables. By analyzing temperature variations along the fiber, we can pinpoint potential risks without the need for physical inspections, reducing costs and enhancing safety.

Background

In scenarios where duct infrastructure is absent, armored fiber optic cables are directly buried into the ground using trenches or vibratory plows. However, natural events such as heavy rainfall, landslides, or ground movement can erode the soil around the cable, leading to cable exposure. Exposed cables are susceptible to damage from debris impact, animal bites, and human activities. Telecom operators and providers traditionally perform periodic physical inspections (via helicopters, drones, or trekking) to identify exposed direct buried cables, but this approach is time-consuming, costly, and poses safety risks.

Temperature Measurement on Direct Buried Cable

- **Logical Condition:** An exposed buried cable section exhibits a higher or lower temperature than a properly buried cable.
- **Solution:** By leveraging Raman Optical Time Domain Reflectometry (Raman-OTDR) or Brillouin Optical Time Domain Reflectometry (Brillouin-OTDR), we can pinpoint the location of cable segments that are potentially not buried underground. These technologies allow us to measure temperature variations along the fiber without physically inspecting the cable.
- **Benefits:**
  - **Reduced Truck Rolls:** Instead of dispatching field technicians for physical inspections, we can remotely identify exposed buried cable sections.
  - **Enhanced Safety:** Minimizing physical inspections reduces safety hazards associated with fieldwork.
  - **Preventing Service Outages:** Early detection of exposed cables prevents unnecessary service disruptions.

Equipment

Distributed Temperature Sensing (DTS)/Raman-OTDR

- An instrument for measuring temperature along an optical fiber cable from a single end.
- VIAVI Raman OTDR uses a differential attenuation compensation method, via patented dual-laser source design, for high temperature measurement accuracy.

Distributed Temperature and Strain Sensing (DTSS)/Brillouin-OTDR

- An instrument for measuring temperature and strain along an optical fiber cable.
- VIAVI Brillouin-OTDR allows simultaneous temperature and strain measurement from a single end and using a single fiber only, data is analyzed individually via patented decorrelation method.

Method/Process for Fiber Optic Cable Evaluation

The testing scope involves two fibers under examination, both within the same cable and oriented in the same direction. Specifically, one fiber connects to a Distributed Temperature Sensing (DTS) system, while the other links to a Distributed Temperature and Strain Sensing (DTSS) system. The testing regiment spans a 3-day period, with tests conducted every 2 hours. Each individual test session lasts approximately 30 minutes.

Results

- **High Peaks Correlation:** High peaks in the temperature profile were correlated with landmarks such as joints and pits. However, high peaks without correlated landmarks indicate potential exposed buried cable locations (marked by BLUE arrows). See Figure 1.
- **Known Exposed Cable Locations:** Our tests identified a known exposed cable located at approximately 51.5 km along the fiber route. See Figure 2.
- **Temperature Changes:** We observed temperature changes at different timings on the known exposed cable locations.

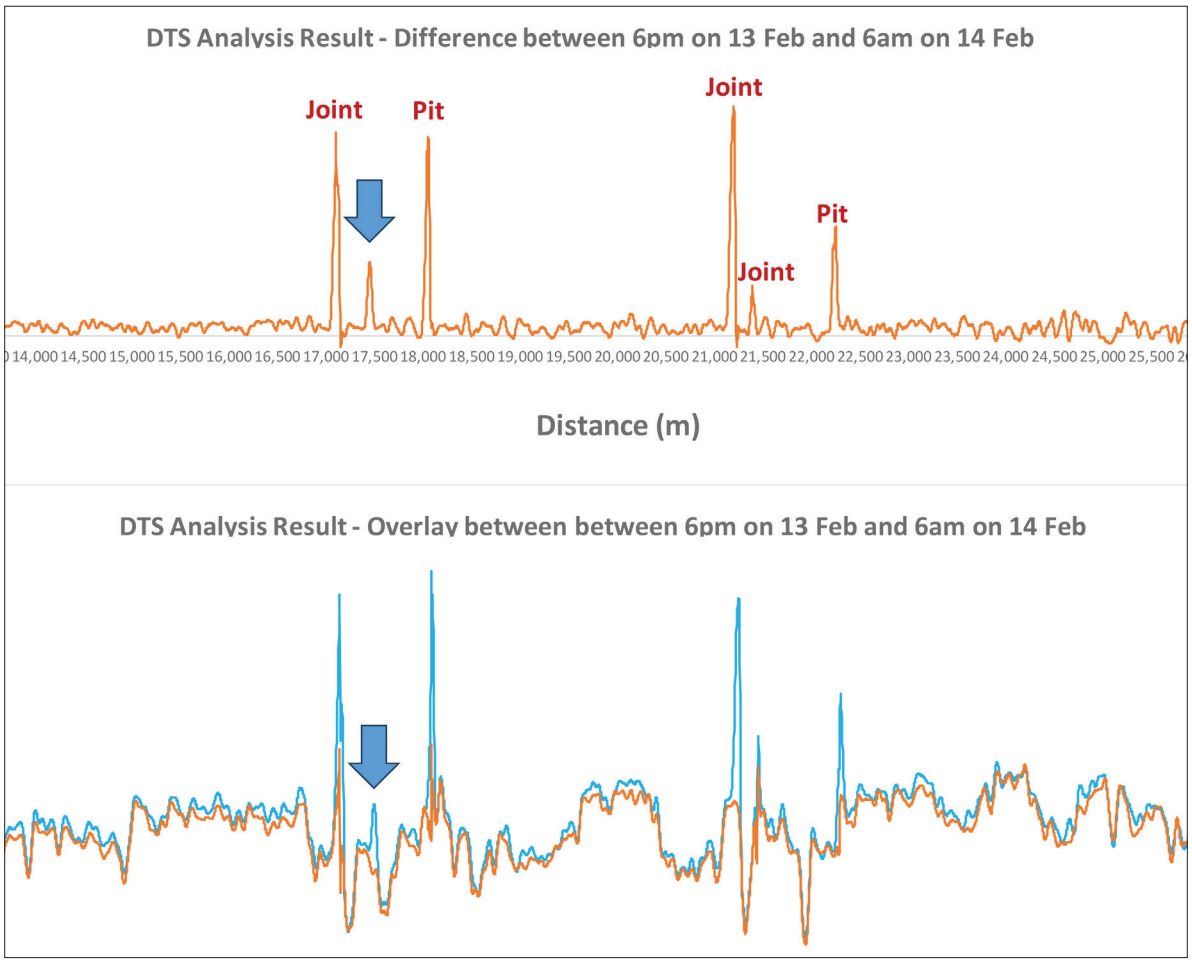

Figure 1: DTS/Raman-OTDR Test Result

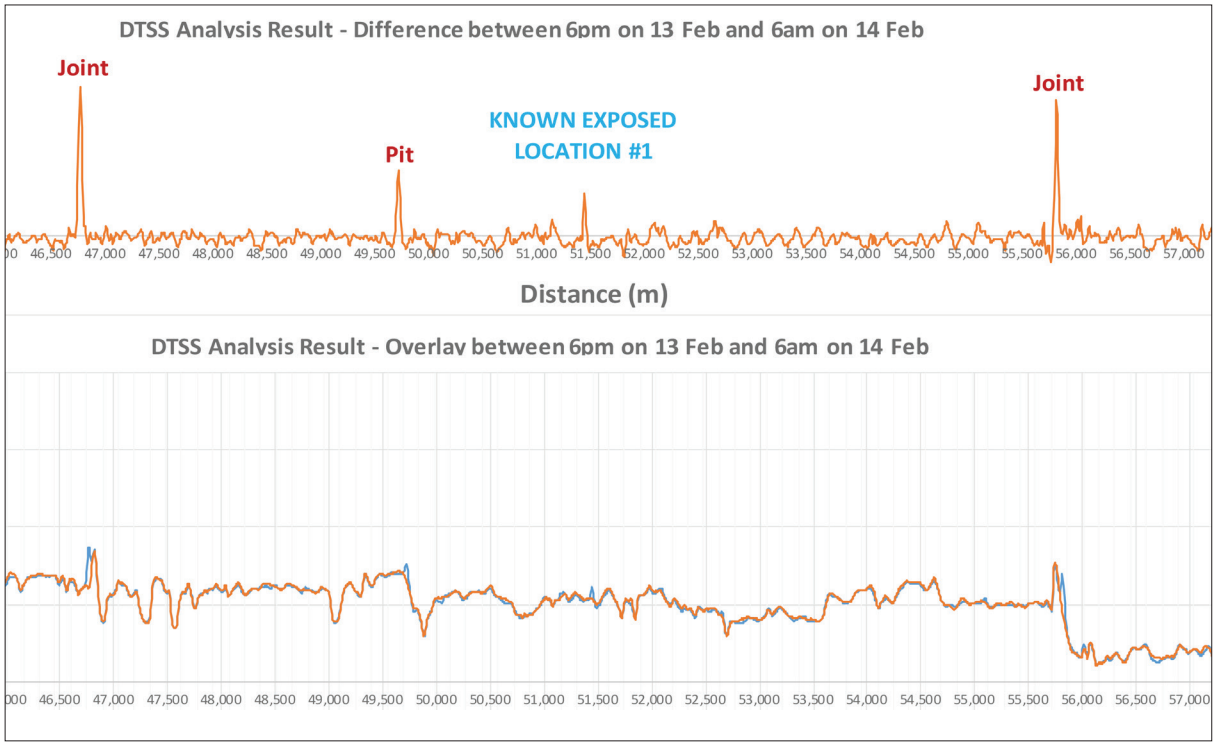

Figure 2: DTSS/Brillouin-OTDR Test Result

Conclusion

During these tests, the telecom operator found several pits or splice enclosures that were not updated in the as-built records. Record mismatches between as-built documentation and actual in-operation conditions for telecom cables can cause significant impacts on mean-time-to-repair (MTTR).

- **Successful Trials:** Our trials demonstrate the effectiveness of Raman-OTDR and Brillouin-OTDR in measuring temperature differences along fiber circuits.
- **Temperature Patterns:**
  - Buried cables exhibit minimal temperature differences.
  - Joints, pits, and exposed cables show significant temperature variations.

By adopting fiber optic sensing technology, telecom operators and providers can proactively manage their buried cable infrastructure, reduce operational costs, and enhance network reliability. The ability to remotely identify exposed sections without physical inspections is a game-changer in the industry.

For more information on fiber optic sensing solutions from VIAVI please refer to the website.

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