Choosing between Optical Loss and Optical Time Domain Reflectometry? Choose both.

As fiber grows more common, network owners, network technicians and network installers are paying more attention to the two crucial devices for certifying fiber optical cable: the Optical Loss Test Set (OLTS) and the Optical Time Domain Reflectometer (OTDR). While the measurements taken by these instruments seem similar, they perform distinct yet important roles in the fiber certification process. This paper explains how each product works and how they complement each other to prevent network problems.

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An Optical Loss Test Set is a mainstay for testing fiber optic cabling. The OLTS tests for the total amount of light loss on the fiber link. The test is performed with a light source which produces a continuous wave at specific wavelengths connected to one end of the fiber. A power meter with a photo detector is connected to the opposite end of the fiber link. The detector measures optical power at the same wavelengths produced by the light source. Working in concert, these devices determine the total amount of light lost.

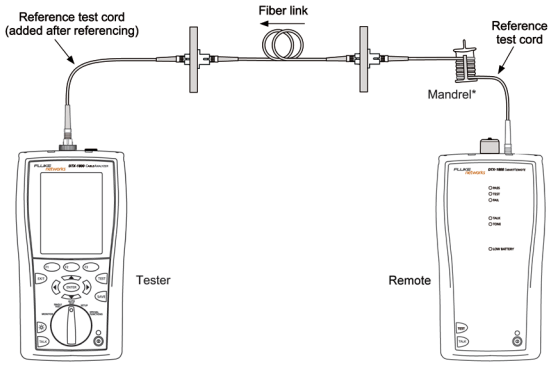

Figure 1: Optical loss measurements use a light source on one end of the link and a power meter on the other. Together they determine the total amount of light lost on a link.

The measured loss is compared to a specified loss budget for the link to determine if it passes this "Basic" or "Tier 1" certification. Tier 1 certification is described in standards such as Telecommunications Industry Association's (TIA's) TSB140 bulletin entitled "Additional Guidelines for Field-Testing Length, Loss and Polarity of Optical Fiber Cabling Systems." Tier 1 certification is required for virtually all fiber optic links today.

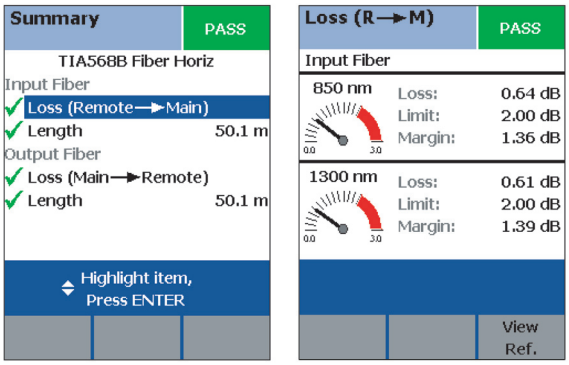

Figure 2: Results provided by an OLTS show the length of the fiber and the overall light loss, expressed in dB.

A recent development in OLTS solutions is the availability of OLTS modules for copper cable analyzers. These modules can test two fibers at a time to verify polarity as well as test for loss in each direction.

The operation and benefits of an OTDR

Fiber networks have ever-tighter loss budgets and less room for error, so network owners and designers are setting not only overall loss budgets, but also loss budgets for individual splices and connectors. Because OLTS products cannot test at this level, standards organizations are recommending "Extended" or "Tier 2" fiber certification.

Tier 2 certification involves acquiring a trace from an OTDR. An OTDR trace finds and characterizes reflective and non-reflective events in a fiber run. This pinpoints the location of any fault and certifies the workmanship of an installation. Tier 2 certification ensures that there are no unplanned loss events due to poor cable management or errors in installation.

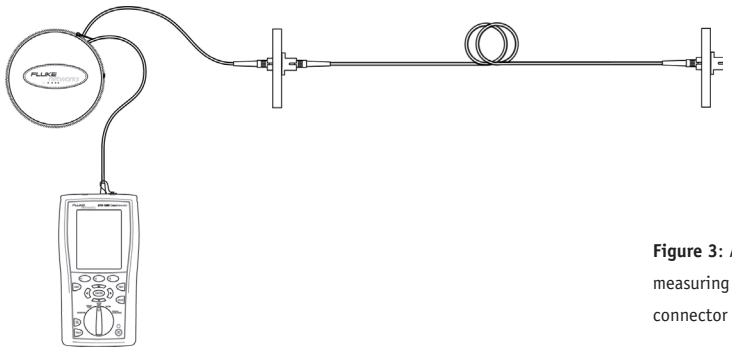

Figure 3: An OTDR is a single-ended test, measuring the light loss at every splice and connector on a link.

OTDRs use special pulsed laser diodes to transmit high-power light pulses into a fiber. As the pulses travel down the fiber, most of the light travels in that direction. High-gain light detectors measure any light that is reflected from each pulse. The OTDR uses these measurements to detect events in the fiber that reduce or reflect the power in the source pulse.

For example, a small fraction of the pulse light is scattered in a different direction due to the normal structure of fiber and small defects in the glass. This phenomenon of light scattered by impurities in the fiber is called Rayleigh backscattering. A certain amount of backscatter is expected based on a fiber's attenuation coefficient specification.

When a pulse of light meets connections, breaks, cracks, splices, sharp bends or the end of the fiber, it reflects due to the change in the refractive index. These reflections are called Fresnel (pronounced frA-NEL) reflections. The amount of light reflected, not including the backscatter, relative to the source pulse is the called reflectance. It is expressed in units of dB and is usually expressed as a negative value for passive optics, with values closer to 0 representing larger reflectance, poorer connections and greater losses.

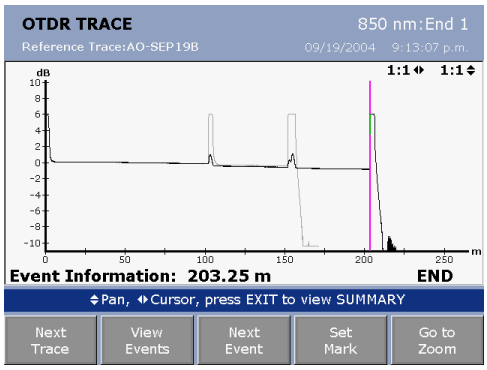

Figure 4: Typical OTDR trace, showing length (203.25 m), a gradual decline in light strength, and two events (connectors, splices or disturbances) at 100 m and 150 m.

OTDRs display trace results by plotting reflected and backscattered light versus distance along the fiber as shown in figure 4. The Y axis represents power level and the X axis shows distance. When you read the plot from left to right, the backscatter values decrease because the loss increases as the distance increases.

OTDR traces have several common characteristics. Most traces begin with an initial input pulse that is a result of a Fresnel reflection occurring at the connection to the OTDR. Following this pulse, the OTDR trace is a curve sloping downward and interrupted by gradual shifts. The gradual decline results from backscattering as light travels along the fiber. This decline may be interrupted by sharp shifts that represent a deviation of the trace in the upward or downward direction. Loss events appear as a step down on the plot. These shifts or point defects are usually caused by connectors, splices or breaks. The end of the fiber can be identified by a large spike after which the trace drops dramatically down the Y axis. Finally, the output pulse at the end of the OTDR trace results from reflection occurring at the output of the fiber-end face.

An OTDR trace is valuable because it makes it possible to certify that the workmanship and quality of the installation meets the design and warranty specifications, for current and future applications. For example, common requirements are that the loss associated with a splice should be no larger than 0.3 dB and that associated with a connector should be no more than 0.75 dB. These event losses are completely invisible to an OLTS. With an OTDR, the performance of each splice and connector can be measured. If they do not meet specification, they can be corrected during the installation process, not afterwards when the network is live. Many contractors perform Tier 2 certification as preventative maintenance and to document their workmanship on a completed installation.

Another recent development in fiber optic testing is the availability of OTDR modules for copper cable analyzers. OTDR modules greatly simplify the task of performing Tier 2 testing of fiber links. Anyone familiar with copper certification can now easily perform Tier 2 fiber certification because they see a familiar user interface, commands, and diagnostics. This shortens the learning curve and extends the value of the existing copper tester.

The OLTS and OTDR team

One may ask, if an OTDR is used is an OLTS still necessary? The answer is yes because an OLTS directly measures total fiber losses and length while these values can only be inferred from an OTDR. Products that perform Tier 1 and Tier 2 tests make it easier to offer total fiber certification.

Fiber test strategies

Datacom contractors should develop a test strategy based upon the requirements set by the consultant, system designer or network owner and their own resources, equipment and tolerance for risk.

Technicians should perform certification with tools that are easy to use and capable of delivering test results and reports in an easy-to-understand format. Tier 1 certification with a light source and power meter ensures that the system meets the loss budget for the immediate applications. Tier 2 certification proves the cabling and connections were done correctly. It is a good practice to perform both of these tests in both directions and at multiple wavelengths on a fiber.

Conclusion

The increasing proportion of network installation jobs involving fiber makes it critical for contractors to understand the technologies for fiber testing and develop an appropriate test strategy. Contractors, network owners and fiber system designers need to understand the difference between OLTS and OTDR testing and the benefits both provide. These technologies serve different purposes and perform a complementary rather than mutually exclusive role in the fiber certification process.

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