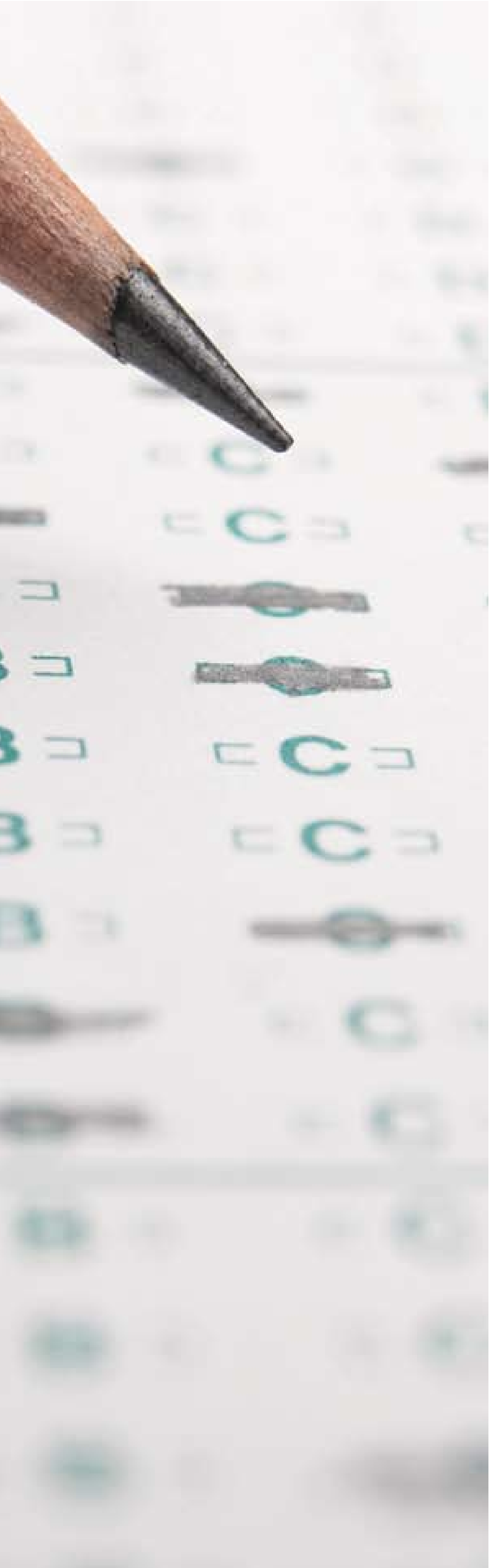


OLTS and OTDR: A Complete Testing Strategy

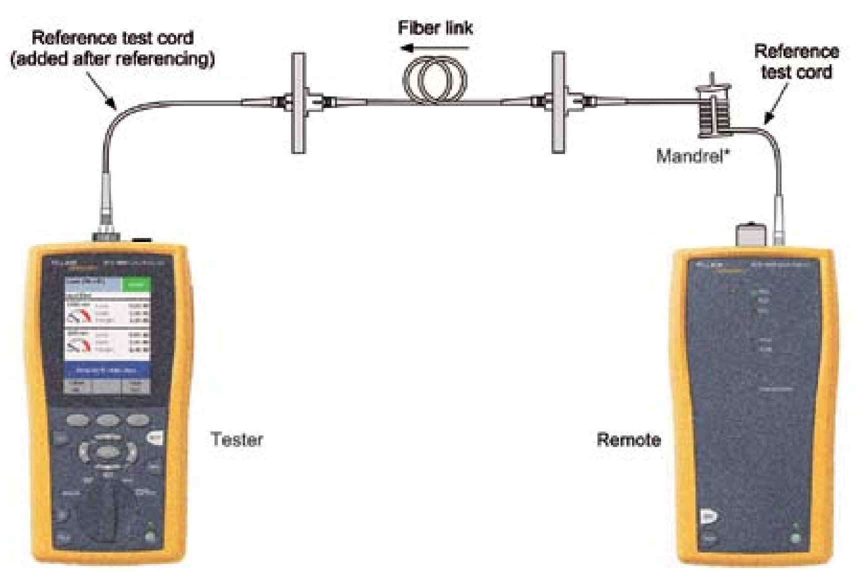
By Harley Lang, III, RCDD

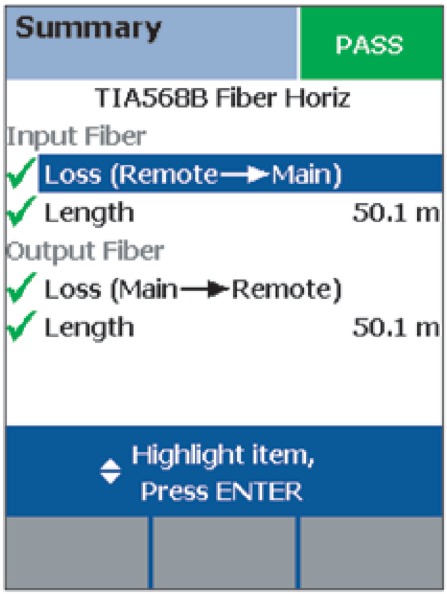
Fiber is playing an increasing role in the majority of network installation contracts. The result is that more attention is being focused on the primary tools for certifying fiber optical cable, Optical Loss Test Sets (OLTS) and Optical Time Domain Reflectometers (OTDR). While the measurements taken by these instruments are similar, they typically perform different roles in the certification process. Rather than being competitive, OLTS and OTDR are actually complementary tools that both play a role in the majority of fiber installation projects. This article will explain how each method works, describe its advantages, and provide some suggestions for contractors on how to develop a testing strategy to maximize customer satisfaction.

GROWTH IN FIBER CABLING

The increasing role played by high-bandwidth applications is driving growth in the deployment of fiber optic cabling systems. According to a report entitled, "Structured Cabling Systems" by FTM Consulting, fiber-cabling revenues will exceed unshielded twisted pair (UTP) revenues for the first time in 2008. While copper has dominated the market up to now, fiber will establish a larger market share in structured cabling system applications, such as data centers, campuses and fiber-to-the-zone. In addition, fiber will continue to be the dominant cabling used in riser systems. On the other hand, this study predicts that copper will continue to dominate the horizontal subsystem market.

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





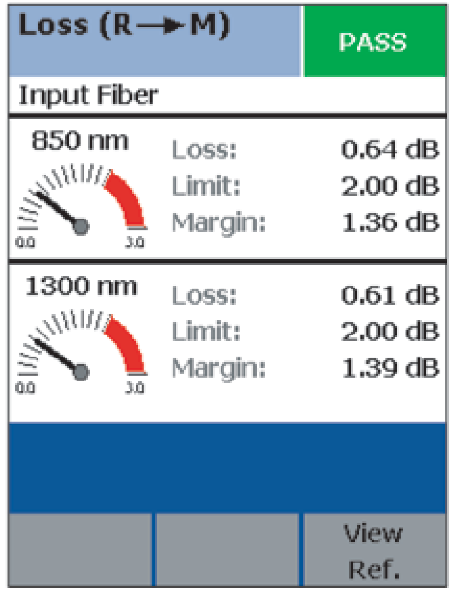


Figure 2: Results provided by an OLTS show the length of the fiber and the overall light loss, expressed in dB.

OLTS OPERATION AND BENEFITS

The increasing role, played by fiber, means that it is becoming more important than ever to understand and take advantage of the primary methods used to test and certify fiber-cabling systems. OLTS has long been the primary method of testing premises fiber optic cabling. The test is designed to determine the total amount of light loss over the fiber link. Other terms used to refer to this technology are loss/length and power meter/light source (PMLS). The test is performed with a stable light source that produces a continuous wave at specific wavelengths. The light source is connected to one end of the fiber. A power meter with a photo detector is installed at the opposite end of the fiber link. The detector measures optical power at the same wavelengths as the light source. These two devices determine the total amount of light loss. This loss/length certification is described in certification standards such as Telecommunications Industry Association's (TIA's) TSB-140 bulletin entitled, "Additional Guidelines for Field-Testing Length, Loss and Polarity of Optical Fiber Cabling Systems," as basic or Tier 1 certification that is required for all fiber optic cabling links. The Tier 1 tests are attenuation (insertion loss), length and polarity.

A key innovation in recent years is

JDSU INTRODUCES NEW OTDRS FOR FTTX AND ACCESS NETWORKS

JDSU recently announced the latest generation of its MTS/T-BERD fiber optic test line, the MTS/T-BERD 6000 LITE. A highly integrated, non-modular, compact Optical Time Domain Reflectometer (OTDR) ideally suited for the construction, fault location and troubleshooting/maintenance of FTTx and access networks, the MTS/T-BERD 6000 LITE offers even inexperienced field service technicians a high-performance tool for broadband network quality and reliability. The tester was introduced at the 2007 FTTH Conference & Expo in Orlando, FL.

The new product, which exceeds Telcordia GR-196-CORE specifications (including ruggedness, drop testing, and extended battery life), is marketed as the T-BERD 6000 LITE in North America and the MTS-6000 LITE throughout Europe, Asia and other regions.

The MTS/T-BERD 6000 LITE troubleshoots any event that can degrade fiber link quality using proprietary, one-key functionality that pinpoints any fault on the network in a fraction of a second. The MTS/T-BERD 6000 LITE also detects any fiber bending in the network and improves response rate with an instantaneous traffic detection function. For installation and maintenance, the MTS/T-BERD 6000 LITE provides a compact test unit and displays on its color screen all relevant information required for fiber qualification. The OTDR trace and table are displayed simultaneously, improving troubleshooting in FTTx/access networks by identifying terminations and splice points. All features usually available in dedicated, larger construction OTDR units are available in the compact MTS/T-BERD 6000 LITE.

The MTS/T-BERD 6000 LITE also has a connection check option, which can include a Visual Fault Locator (VFL), a power meter, a continuous wave light source and a video inspection probe. The tester's large screen enables easy analysis of the connector quality.

JDSU's OTDR product line also includes the MTS/T-BERD 8000 platform, which features a Very Long Range (VLR) OTDR module that combines several features into one first-of-its-kind OTDR tester for access and metro network optical applications. The module design has first-of-its kind fiber network characterization capabilities and complements

(continued on page 33)

the availability of fiber loss/length modules that can be attached to copper test sets to make them function as an OLTS. Some of these instruments can test two fibers at a time in order to verify polarity, certify the actual length of the fiber being tested and reduce the time required for certification. The copper tester mainframe with fiber loss/length module is used at one of the fiber and the remote at the other end. A reference power level is set using test reference cords before separating the two instruments and plugging each end of the fiber to be tested into them. Then with the press of a single button, both fibers are tested at two wavelengths to measure their length and loss and determine a pass or fail status in less than 12 seconds. The polarity can be quickly reversed to provide bi-directional results. The approach provides an efficient and accurate method to certify that the fiber link meets the loss budget for a specific application such as 10 Gb/s Ethernet.

OTDR OPERATION AND BENEFITS

With tighter loss budgets and less room for error in high-bandwidth fiber backbones, network owners and designers are now setting specifications not only for overall loss budgets, but also all for individual splices and connectors. Because light sources and power meters are not able to perform this type of test so many standards organizations, such as TIA and the International Organization for Standardization (ISO), are recommending Extended or Tier 2 certification. This involves the acquisition of a trace from an OTDR. An OTDR can pinpoint the location of faults on a fiber link and certify the workmanship involved in an installation. OTDRs find and characterize both reflective and non-reflective events in optical fiber runs. The result is that the OTDR is able to certify every fiber optic connector and splice and ensure that there are no unplanned loss events due to poor cable management or installation. OTDRs are also very powerful troubleshooting tools.

OTDRs use specialized pulsed laser diodes to transmit a series of very short high-power light pulses into a fiber. As the pulse of the OTDR travels down the fiber, most of the light travels in the direction of the fiber. High-gain light detectors measure the light that is reflected or backscattered as each pulse travels down the fiber. 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 light is scattered in a different direction due to the normal structure of and small defects in the glass that makes up the fiber. The phenomenon of light being scattered by impurities in the fiber is called “Rayleigh scattering.” A certain amount of backscatter is expected for a specific length of fiber based on the 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 sudden change in the refractive index. These reflections are called “Fresnel” (pronounced frA-NEL) reflections. The amount of light reflected, not including the backscatter from the fiber itself, relative to the source pulse is the called “reflectance.” It is expressed in units of dB (decibels) and is usually expressed as a negative value for passive optics with values closer to 0 representing larger reflectance that indicates poorer connections with greater losses.

OTDRs display results using a plot or trace of reflected and backscattered light power, versus distance along the fiber as shown in Figure 4. The Y-axis displays the 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 Fresnel reflection, occurring at the connection to the OTDR. Following this pulse, the OTDR trace is a gradual curve sloping downward and interrupted by gradual shifts. The gradual decline results from Rayleigh scattering as light travels along each fiber section. This decline is interrupted by sharp shifts that represent a local deviation of the trace in the upward or downward direction. Loss events appear as a step down on the plot. Connectors, splices or breaks cause these shifts, or point defects. 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 Fresnel reflection occurring at the output of the fiber end face.

An OTDR trace 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, a common requirement is 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. The losses associated with individual events are invisible to an OLTS. If an individual splice or connector does not meet the design spec, the installer can correct it while still on-site.

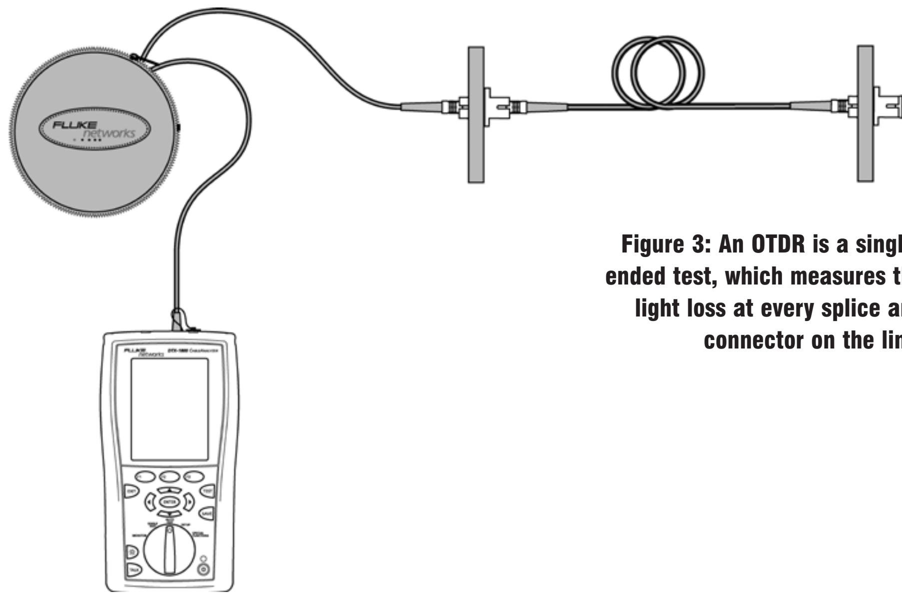
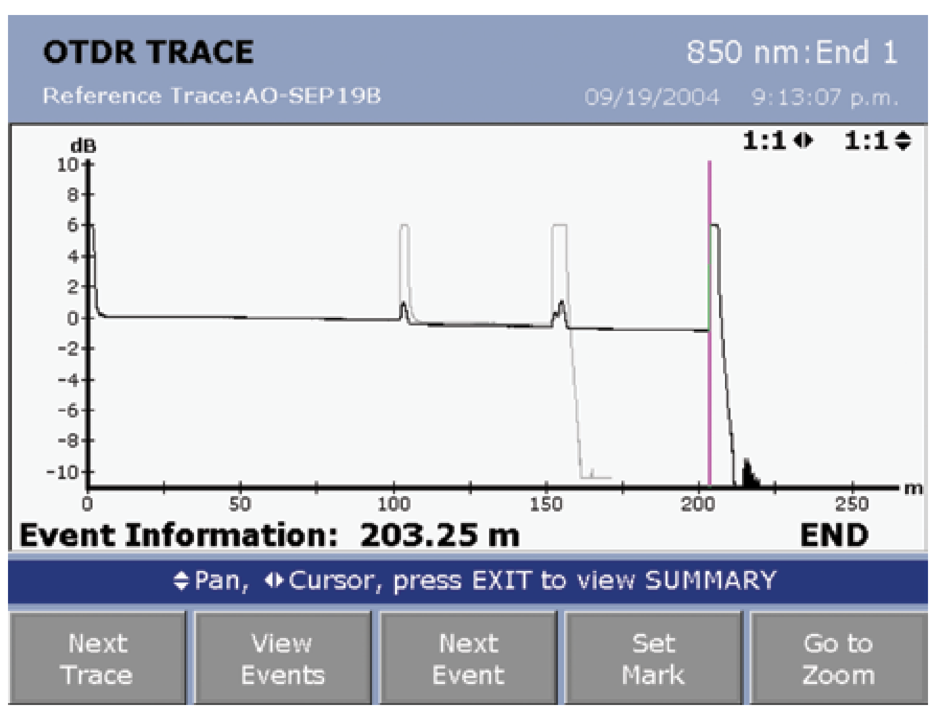


Figure 3: An OTDR is a single-ended test, which measures the light loss at every splice and connector on the link.

This explains why Tier 2 testing is becoming a requirement of many installation projects. A complete Tier 1 and Tier 2 fiber certification provides the most comprehensive picture of the fiber installation and proof of a quality installation. Even where Tier 2 testing is not required, many contractors prefer to perform it because it documents the workmanship of the complete installation process. Tier 2 testing demonstrates that every connector was left in good condition. If there are any problems later, the contractor normally will not be obligated to fix them without charge.

Since an OTDR plot or trace can also be used to measure the attenuation and transmission loss between any two points on the cable plant, it is possible to

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



compare Tier 1 test results with Tier 2. In the past, there was significant inconsistency between the test results of OLTS and OTDRs. This has been eliminated with improvements in controlling launch conditions. The term "launch condition" refers to the way the light source is actually propagated to the fiber, Even though they use completely different technologies, with consistent launch conditions, the latest generation of OLTS and OTDR instruments show only a difference of 0.1 dB average for a single connector loss. This close correlation can be attributed to the work that test equipment manufacturers have done in conjunction with TIA, ISO and the International Electrotechnical Commission (IEC) to develop instrumentation standards that help ensure consistent results.

ARE BOTH OLTS AND OTDR TESTS NEEDED?

This raises the question: if an OTDR is used, is an OLTS still necessary? The answer is that an OLTS measurement is still required in nearly every application because it provides a direct measurement of the fiber plant losses and length, while these values can only be inferred from an OTDR measurement.

Traditionally, OTDR testing has been performed with stand-alone instruments that cost a significant amount of money and have their own unique and often complex user interface. These stand-alone instruments provide obstacles to equipping technicians to perform Tier 2 fiber certification.

New OTDR modules are available that enable complete Tier 2 testing of fiber links using the same instrument and interface normally used for copper testing. These greatly simplify the task of providing Tier 1 and Tier 2 testing of fiber links. The new generation of OTDR modules enable contractors, who are familiar with copper certification, to perform extended fiber certification. Users see the familiar copper tester interface, test command, stored setup values and expert diagnostics. With the OTDR module, a single test from one end of the fiber checks every connector and splice on a link to be sure the fiber cabling meets the defined specification. This shortens the learning curve and extends the value of the existing copper tester.

DEVELOPING A FIBER CERTIFICATION STRATEGY

Datacom contractors should develop a testing strategy based upon the requirements set by the consultant, system designer or network owner and the contractor's available resources, equipment and tolerance for risk. Some system designers or end users will require only basic testing and others will require both basic and extended testing.

Inspection and verification tools should be used during installation to minimize simple problems, such as dirty or poorly terminated connectors that slow down certification testing. Secondly, technicians should systematically perform certification testing with tools that are easy to use and capable of delivering the needed information including test results and reports in an easy-to-understand format. Performing basic Tier 1 certification with a light source and power meter ensures that the system meets the loss budget for the immediate applications. Extended Tier 2 certification proves that 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 the fiber.

The increasing volume of fiber installation, as well as the higher margins usually associated with fiber installation, provides a tremendous opportunity to contractors. Contractors now have the opportunity to generate additional revenues by equipping the same technicians that are now performing copper certification to perform fiber certification, as well. Technicians can leverage their existing knowledge of the instrument so relatively little training is required to certify the fiber plant. Reporting is delivered in the same format as the other reports, so the expense of reformatting to match the copper test reports is eliminated. The cost of the new modules is also considerably lower than a stand-alone instrument and they are also much more compact.

CONCLUSION

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

Harley Lang, III, RCDD, is Fluke Networks Product Manager for Fiber Optic Tools. Lang's experience encompasses product management roles in the Fiber Optic group, Enterprise Networks group as well as in the Access Networks group. Lang received his bachelor's degree in business administration from University of Washington in Bothell, WA. He is a BICSI Registered Communications Distribution Designer (RCDD) and a former U.S. Marine Corps Reservist.