

Testing the Outside Plant

From the OLT at the central office to the ONT at the user end, FTTH networks are typically tested using field-based instruments. Here's how they work.

By Jérôme Laferrière ■ JDSU

With fiber-to-the-home deployment taking place throughout the world over the last several years, service providers are now becoming aware of the test requirements for FTTH networks. This includes equipment testing, testing fiber prior to installation, and an end-to-end FTTH network certification test, which involves, at minimum, a fiber continuity test and measurements of loss and optical return loss (ORL).

The need to test at 1550 nm on top of the classical 1310 nm transmission wavelengths should also be considered, and the shortcomings of 1490 nm wavelengths should be understood.

This article provides a complete overview of the optical test methods performed by key worldwide service providers, including variations in methods due to the different FTTH network topologies.

Due to ever-evolving capex and opex cost reduction methods in the installation, turn-up and maintenance of those networks, new concepts such as preconnectorized cable as well as new construction methods and procedures are emerging. As a result, new FTTH test equipment is becoming available – for example, the selective “through mode” power meter.

Taking all elements of the FTTH landscape into consideration, this article provides a complete overview of the

optical test methods performed by key worldwide service providers, including variations in methods due to the differ-

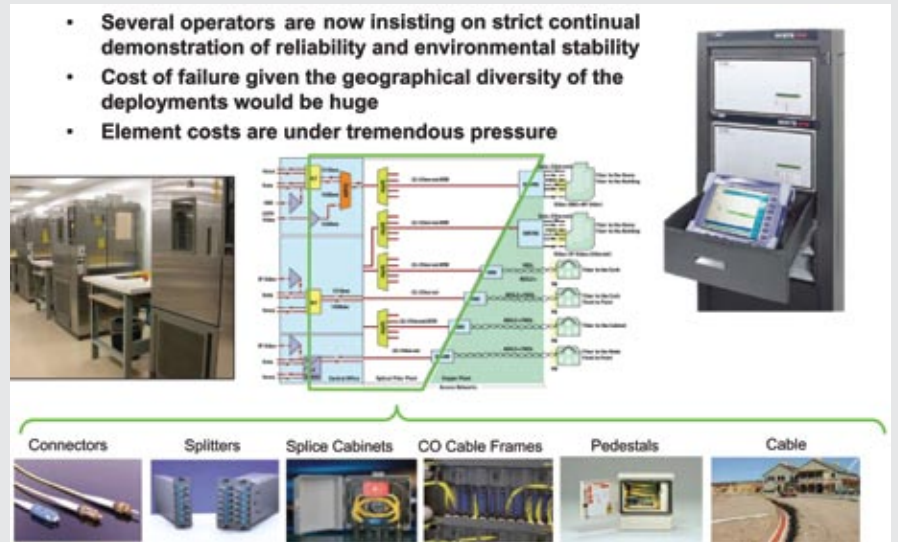


Fig 1. Carrier-class reliability requires frequent testing, even though fiber is inherently highly reliable and has low maintenance expenses.

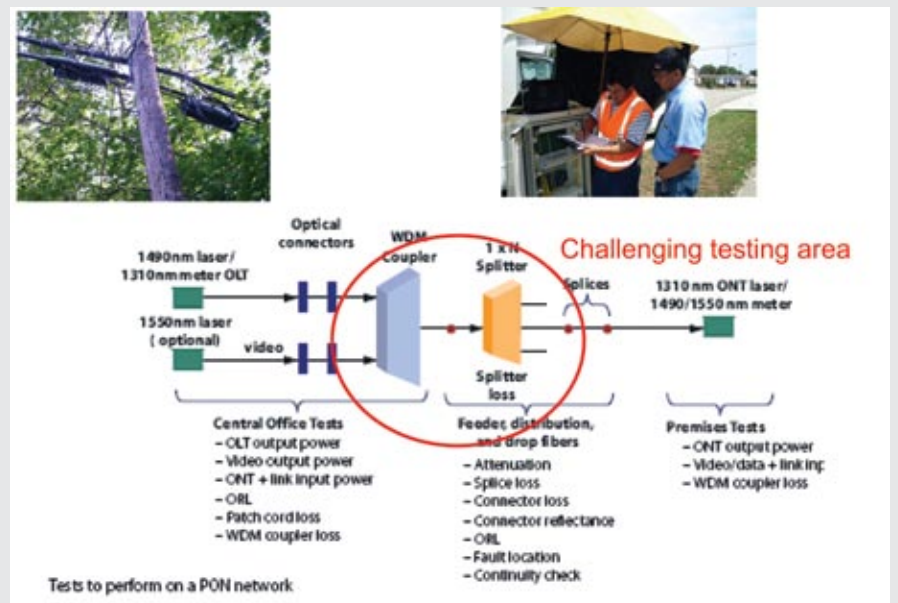


Fig 2. Choice of tests varies with network architecture. Splitters in a PON network make it difficult to test an entire network at once.

ent FTTH network topologies (point-to-point, point-to-multipoint, EPON/GePON, GPON, WDM-PON). The article also reviews emerging test trends.

EQUIPMENT AND FIBER RELIABILITY TESTING

Historically, network equipment was localized in central offices and strictly controlled by the network operators.

In FTTH networks, this clearly is no longer the case. Some critical elements (hubs, access terminals, ONTs) are now located anywhere along the fiber link and have their own environmental constraints. As a result, many operators are insisting on strict continual demonstration of reliability and environmental stability.

The major reason for this is the extreme cost of failure given the geographical diversity of the deployments. All elements must be qualified, and this applies to the fiber cable, connectors, splitters, splice cabinets, central office cable frames and pedestals.

An added complication is that because of cost considerations, tests must be fully automated with optimized tools.

All elements must be qualified, and this applies to the fiber cable, connectors, splitters, splice cabinets, central office cable frames and pedestals.

TEST IMPACTS OF NETWORK ARCHITECTURE CHOICE

The same basic tests are required for all FTTH architectures:

Central office tests:

- OLT output power
- Video output power
- ONT and link input power
- Optical return loss
- Patch cord loss
- WDM coupler loss

Installation test from distribution part instead of test from feeder on a PON network

- During the installation process, test of a 1x8 from the Central Office can eventually be performed, but quite difficult to analyze, very rarely done
- During the installation process, operators are:
 - Testing the feeder part only
 - Testing the distribution part only

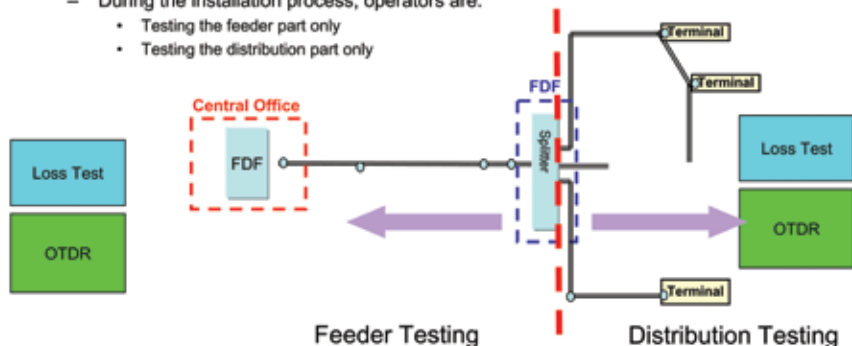


Fig 3. The trick is to test before and after the splitters, separately.

Construction:

- Two test wavelengths still required for macrobend detection
 - 1550nm preferred against 1490nm
 - 1490nm does not provide more value than 1550nm
 - 1490nm less sensitive to macrobend
 - 1490nm provide same losses than 1550nm (0.21 dB/km compared to 0.19 dB/km)
 - 1490nm less future prove (does not test possible future 1550nm uses)
 - 1490nm laser is slightly more expensive than 1550nm
 - 1490nm does not enable the use of current test tools
- **Worldwide consensus of the use of 1310/1550nm test wavelengths**

In-Service Troubleshooting:

- Out-of-band filtered 1625nm or 1650 nm
- Will depend on Equipment rejection at those wavelengths
- When complete network is down, use of standard wavelengths

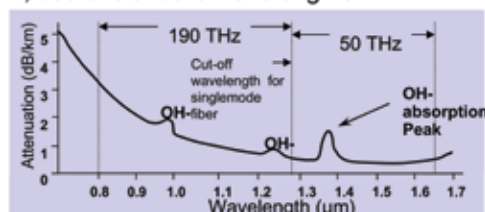


Fig 4. A worldwide consensus has developed about the wavelengths at which testing should be performed.

Loss Test Set

- Benefits:
 - Simple tool, automated
 - Bidir Loss Test Set Approved solution mostly in NAM
 - Eventually automated and easy to use with bidirectional loss test set
- Drawbacks:
 - Two ended test requires truck rolls and two units
 - Provide simple continuity check but does not find the possible issue
 - No troubleshooting tool, OTDR still required



OTDR

- Benefits:
 - One-ended test
 - Approved solution worldwide
 - The tool can also perform troubleshooting
- Drawbacks:
 - Quite complex tool
 - Less accurate, especially when ORL measurement is performed
 - Issue when testing Overall Point-to-Multipoint (PON) networks



Fig 5. When do you use an OTDR and when do you use a loss test set?

Feeder, distribution and drop fiber tests:

- Attenuation
- Splice loss
- Connector loss
- Connector reflectance
- Optical return loss
- Fault location
- Continuity check

Premises tests:

- ONT output power
- Video/data and link input power
- WDM coupler loss

However, some tests are dependent on the type of network architecture. For example, point-to-point FTTH networks (which are common in Europe) can easily be tested with standard loss test sets or OTDRs, which is not the case with point-to-multipoint networks (such as are more typical in the United States).

Very few operators perform OTDR tests from the OLT, measuring downstream through the splitter and analyzing

• Video Overlay:

- 1310/1490nm with 1550nm video overlay
- Requires turn-up with « Through Mode Selective Power Meter 1310/1490/1550nm »

• IP Video:

- 1310nm with 1490nm or 1550nm
- Requires turn-up with « Through Mode Selective Power Meter 1310/1490nm or 1310/1550nm »

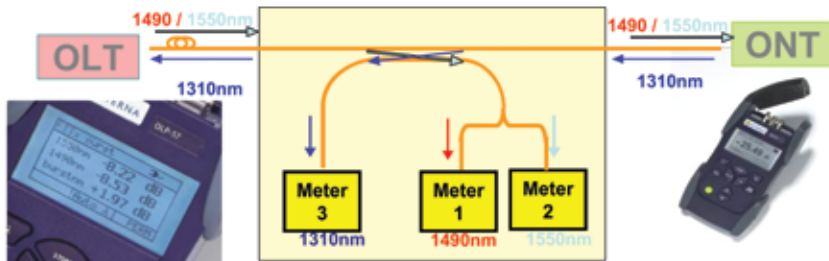


Fig 6. Using RF rather than IP for video complicates matters; RF travels on a different wavelength than does IP data.

ing the different branches to different users. Analyzing the results becomes complex and dependent on the vagaries

of a particular network. (A detailed description of this analysis can be found in the *JDSU Triple Play Service Deployment*

The **Fiber-to-the-Home Council** & Broadband Properties Magazine

Invite You To The Broadband Properties Summit 2008

April 28 – 30

GET CONNECTED AT THE SUMMIT

BROADBAND PROPERTIES
Summit 08

Making the Business Case For Fiber

WHO SHOULD ATTEND?

Developers • Property Owners • Municipal Officials • Independent Telcos
• Economic Development Professionals • Town Planners

Dallas, Texas

To Exhibit or Sponsor, contact:

Irene Gonzales: irene@broadbandproperties.com

OR CALL: 877-588-1649

www.bbpmag.com



book, available for download at www.jdsu.com).

Some operators are performing OTDR tests from the ONT, measuring upstream through the splitter. However, most service providers are splitting the test process into two parts, testing the feeder first and then the distribution. This streamlines the test process and is the most common way of qualifying a PON network. The tests are done using either an OTDR or a loss test set.

During the first round of FTTH trials, some years ago, there were frequent arguments about the selection of the

wavelengths for testing. In order to reduce the testing time and the test tool cost, was it possible to test the fiber using only one wavelength?

Also, because most networks are using at least 1310 nm and 1490 nm transmission wavelengths (others add 1550 nm as well), was it necessary to test at those specific wavelengths?

There now seems to be a worldwide consensus on this issue. To understand this consensus, it is first helpful to understand macrobending, one of the major faults in FTTH networks.

A macrobend is a bend of the fiber that occurs during construction. This provides a very well-defined fault: At the macrobend location, the loss increases as the wavelength increases. Macrobends can also reduce the long-term reliability of the fiber in use.

In order to detect this fault, it is mandatory to use two wavelengths to show that it is not a "normal" event such as splice, which does not vary according to wavelength. Having a test tool with single wavelength functionality cannot uniquely identify and flag macrobends. Thus, all FTTH test tools must be able to test at least two wavelengths.

Of course, one could also use three wavelengths. However, for cost reasons, service providers generally select just two. Testing at 1310 nm is near-universal, but there has been some controversy about also using 1490 nm or 1550 nm to determine the most relevant second wavelength.

Most service providers now select 1550 nm for the following reasons:

- 1490 nm is less sensitive to macrobend.
- 1490 nm provides, on short FTTH distances, losses very similar to 1550 nm (0.21 dB/km compared to 0.19 dB/km).
- 1490 nm is less future-proof, because it does not test possible future 1550 nm uses
- The 1490 nm laser light source for the test device is slightly more expensive than 1550 nm laser.
- 1490 nm does not allow the use of most current test tools.

For in-service troubleshooting, some equipment vendors are making the OLT or ONT impervious to 1625 nm or 1650 nm light, with a high signal rejection. Thus, those wavelengths can be used to troubleshoot faulty fiber from the ONT, while the network is being used by other customers. **BBP**

Different levels of requirements:

- Physical layer issue and faulty branch identification
- 3 dB loss detection and localization



Optical Test Unit

Cost-Optimized solutions are under way:

- All in one Construction/Turn-up/Monitoring Solution with complete characterization
- Use of Optical Switches to by-pass splitters on powered hubs
- Use of dark fiber on critical links and by-pass of splitters
- Peak analysis by the use of reflective ONTs or the addition of Bragg Gratings



Fiber Break

Fig 7. For continuous remote monitoring, there are versions of the test equipment that can be "built in" to the network, and even better equipment is coming soon. Timing the light pulses often allows problems to be mapped down to a few meters.

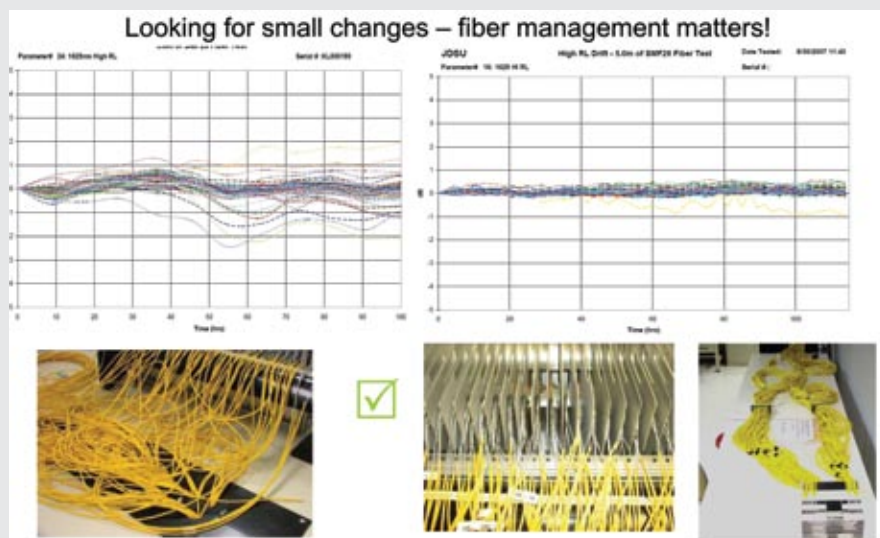


Fig 8. As with all cabling, neatness counts. The standard tests show that clearly, as the area is cycled through temperature changes.

About the Author

Jérôme Laferrrière is Global Fiber Optic Product Manager at JDSU. His phone number is +33-47-747-8914. For more information, see www.jdsu.com/test.