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-

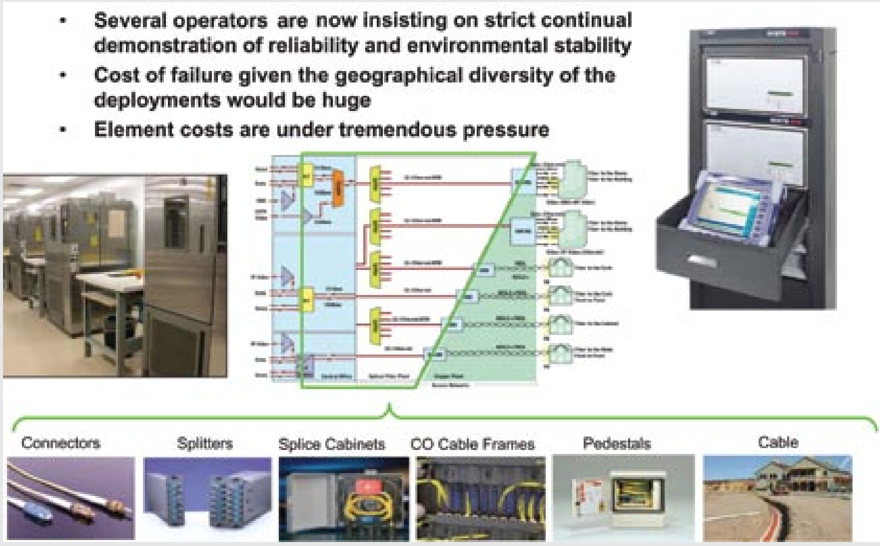

Fig 1. Carrier-class reliability requires frequent testing, even though fiber is inherently highly reliable and has low maintenance expenses.

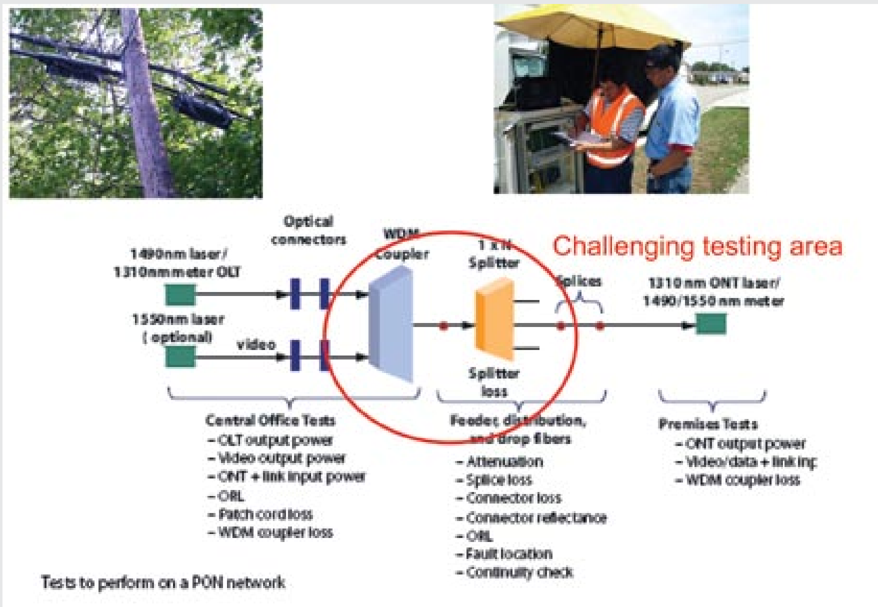

Fig 2. Choice of tests varies with network architecture. Splitters in a PON network make it difficult to test an entire network at once.

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

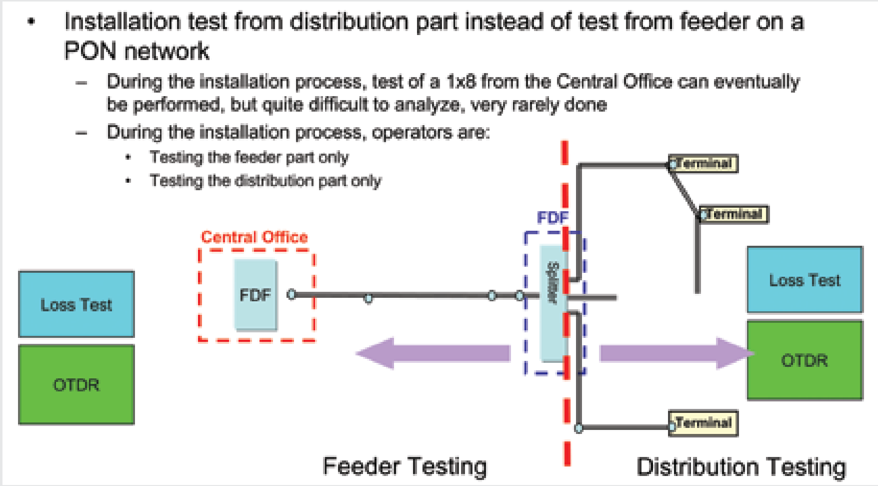

Fig 3. The trick is to test before and after the splitters, separately.

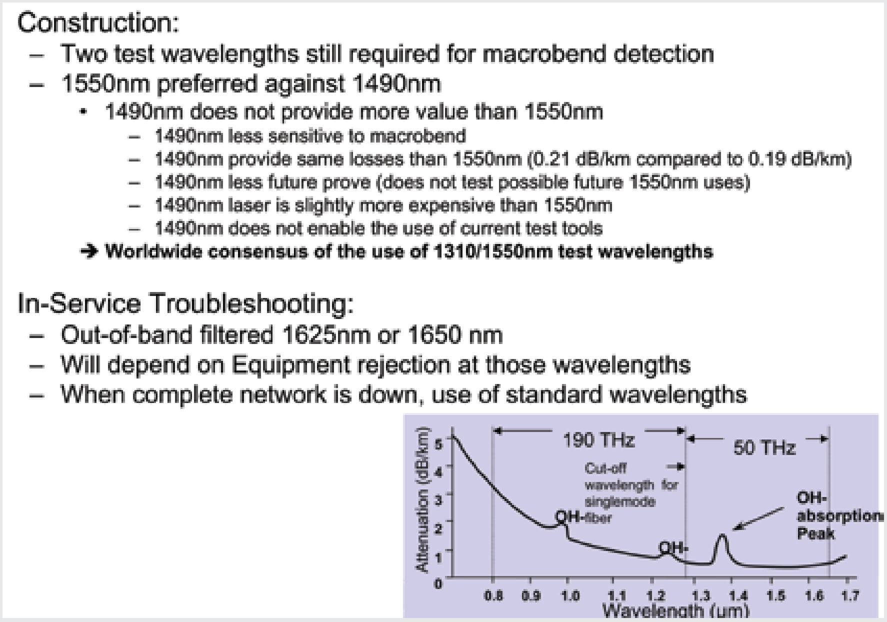

Fig 4. A worldwide consensus has developed about the wavelengths at which testing should be performed.

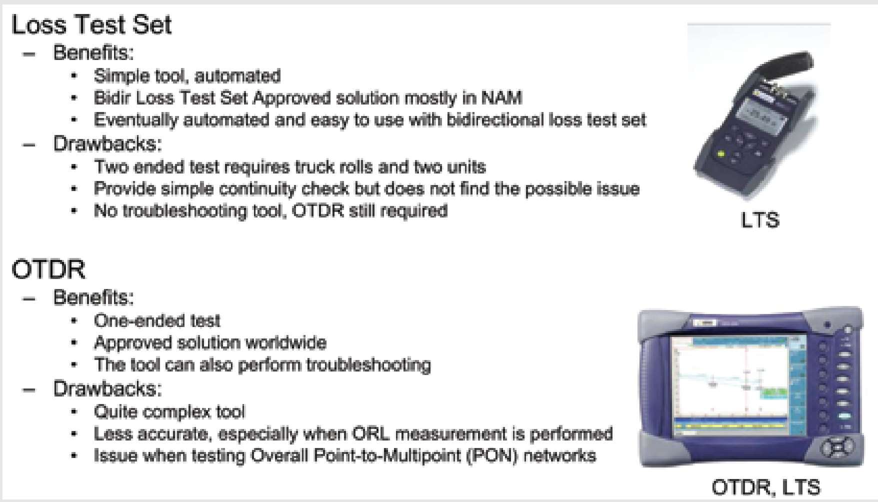

Fig 5. When do you use an OTDR and when do you use a loss test set?

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 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*

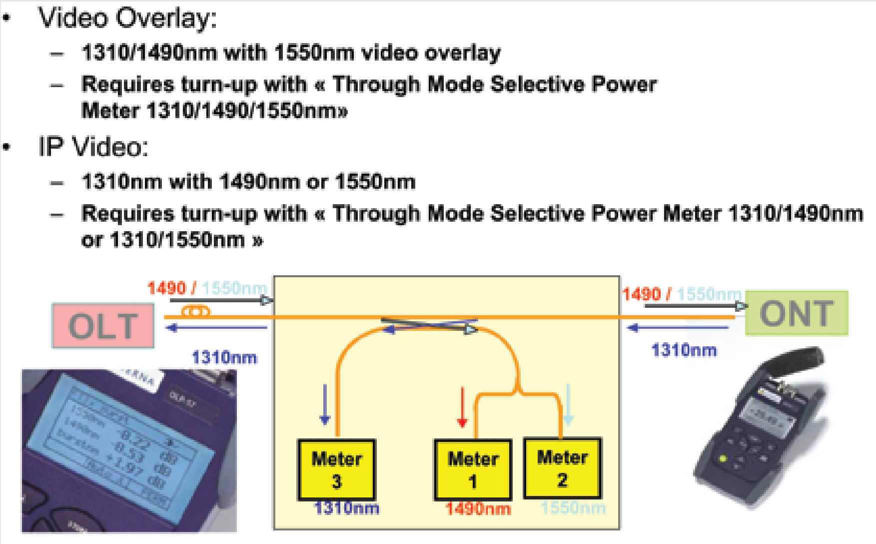

Fig 6. Using RF rather than IP for video complicates matters; RF travels on a different wavelength than does IP data.

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

BroadbandProperties summit08

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

A Towns&Technologies EVENT

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.

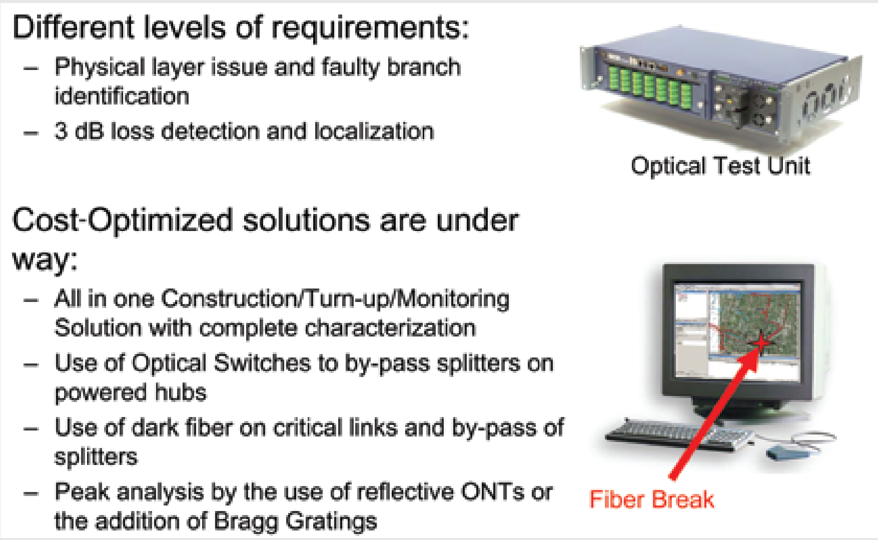

Fig 7. For continuous remote monitoring, there are versions of the test equipment that can be "built in" to the network, and even better equipment is coming soon. Timing the light pulses often allows problems to be mapped down to a few meters.

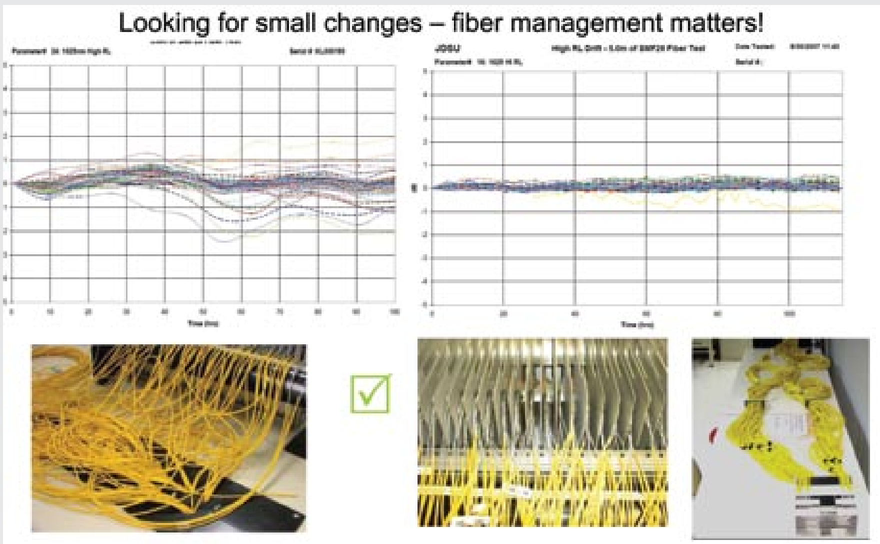

Fig 8. As with all cabling, neatness counts. The standard tests show that clearly, as the area is cycled through temperature changes.

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**

About the Author

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