

# Best Practices for Testing FTTH Deployments

Deploying fiber to the home requires learning a new set of network testing practices. Here's a quick summary of what operators need to know – and when they need to know it.

By Gregory Lietaert ■ *JDSU Communications*

Service providers are deploying next-generation networks delivering high-bandwidth data, voice and video services at an unprecedented rate. Stimulus funding and the growth of bandwidth-intensive applications such as video streaming and peer-to-peer sharing are expected to serve as the catalyst for the next leap forward in broadband deployment. Running optical fiber much deeper into the access network, in some cases all the way to the customer premises, is an important part of the strategy of nearly every service provider.

The appeal of fiber to the home (FTTH) is that it offers the potential for practically unlimited bandwidth and also facilitates greater control over the operation, administration and provisioning of the access system. The ability to quickly and efficiently diagnose problems is critical to successful deployment and maintenance of broadband networks. This article offers a high-level view of some practical test and measurement best practices that help ensure success in planning, installing and troubleshooting FTTH networks.

## FIBER INSTALLATION TESTING

Fiber connectors are widely known as the weakest points in a network. The more connections in a network, the greater is the potential for problems caused by improper handling during installation, operation, expansion and maintenance. Before mating any connectors, follow this simple inspection process to ensure that fiber end faces are clean.



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**Step 1: Inspect.** Use a probe microscope to inspect the fiber. If the fiber is dirty, go to Step 2. If the fiber is clean, go ahead and connect.

**Step 2: Clean.** If the fiber is dirty, use a cleaning tool to clean the fiber end face.

**Step 3: Inspect.** Use a probe microscope to re-inspect and confirm that the fiber is clean. If the fiber is still dirty, go back to Step 2. If the fiber is clean, go ahead and connect.

In a passive optical network (PON) application – the most common FTTH flavor – the optical cable containing the fibers is laid using one of three methods: direct-burial installation, duct installation or aerial installation. Feeder cable and the distribution sections then may be spliced in an enclosure, either to join two cables or to divide one large cable into multiple smaller cables to diverge to different locations.

After each splice, perform optical time domain reflectometry (OTDR) measurements from the central office (CO) at 1310 nm and 1550 nm to verify splice quality. Measuring from both sides of the cable is necessary to determine the optical loss of each fusion splice.

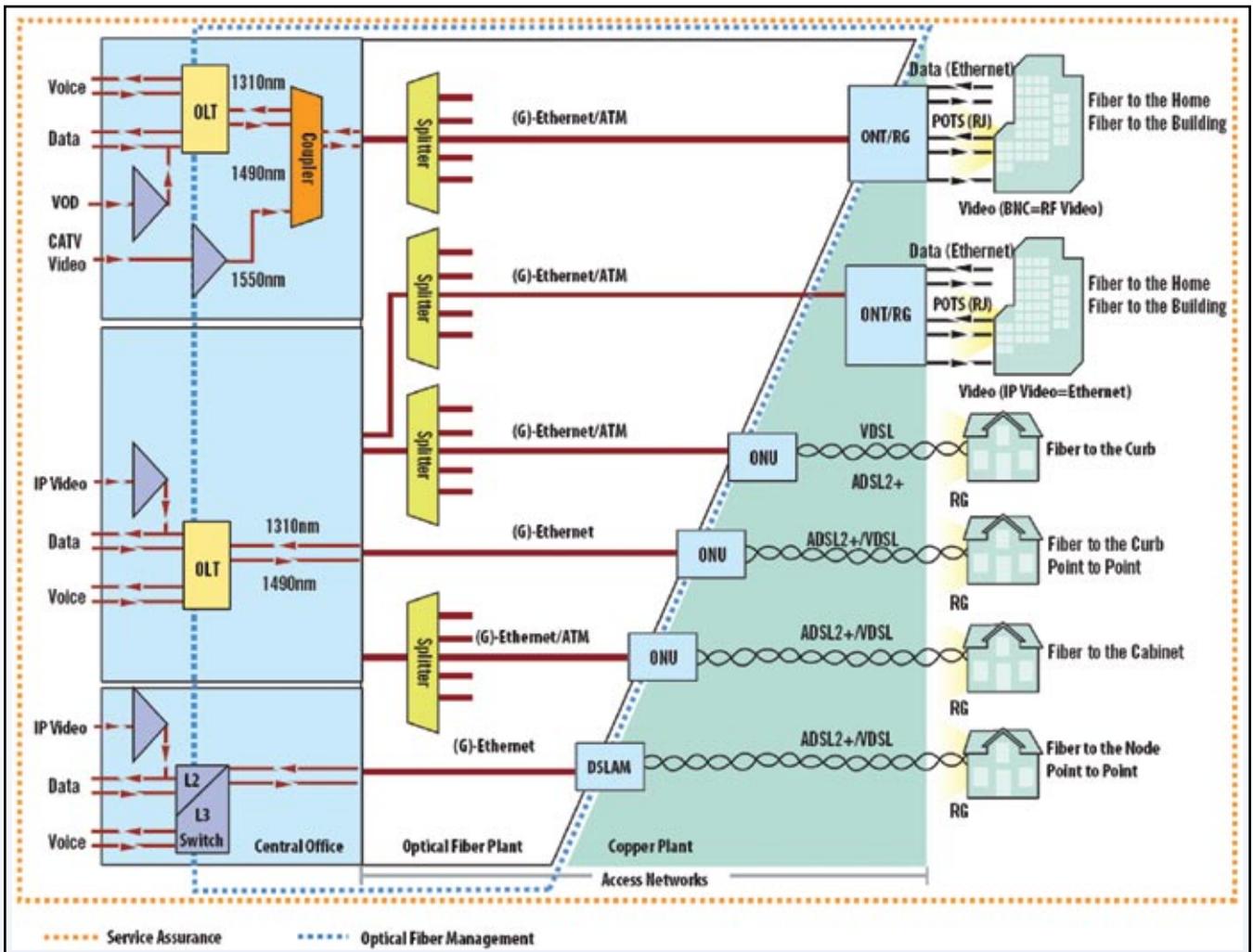
## FRAME INSTALLATION AND ACCEPTANCE TESTING

After feeder and distribution cable construction is complete, the system is ready for frame installation. The first frame is the fiber distribution hub (FDH), typically housed in an outside cabinet that also contains splitters. At the FDH, all fibers coming from the CO are connectorized or spliced to the splitters. Splitter outputs are placed in the parking lot, with pigtails stored in a separate path to reduce fiber congestion.

The second frame, the access or drop terminal, which is located close to the

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Typical FTTx infrastructures.

customer premises, consists of a splice enclosure located either on a pole or in a manhole. Several fibers – usually four, six, eight or 12 – are extracted from the cable and spliced to be connected to drop cables.

The third frame installed is usually the fiber distribution frame (FDF) cabinet of the optical line terminal (OLT), which is located at the CO. As in the other frames, the fiber is spliced to a pig-tail to be connected to the patch panel.

At the end of this process, the feeder and distribution network is complete and ready for end-to-end acceptance testing, including overall distance, insertion loss (IL) and optical return loss (ORL) tests. Before acceptance testing can begin, technicians must ensure that the connectors and patch cords (both those used to test and those used in the

network) meet network operator requirements for IL and reflectance.

They may then perform acceptance testing with either an OTDR (1310 nm/1550 nm) or a source/power meter/ORL meter (1310 nm/1550nm) combination. Each operator will have specific requirements for loss, distance and ORL based on the fiber cable network design.

If the splitter is connectorized, testers should perform separate feeder and

distribution network acceptance tests using test equipment connected at the FDF. They should measure from the FDF to the OLT and from the FDF to the customer premises. If the splitter is spliced, testers should perform end-to-end measurement from the customer premises to the OLT.

In large networks, other FDFs may be located on the feeder to distribute the

***After all the frames have been installed, acceptance testing can begin. Acceptance tests include insertion loss, optical return loss and overall distance tests.***

different cables. The same process should be performed on these frames. Testers should then compare results to the requirements and take corrective action when needed. If the issue involves connections or jumpers, they should test the corrective action with the same loss-test tools. Each result should be recorded in the unit and also on a customer network database for maintenance purposes.

The final acceptance test consists of characterizing the complete optical network. It includes continuity checks, IL and ORL measurements of the end-to-end network through analysis of the transmission optical wavelengths. Testers select a minimum of two wavelengths (usually 1310 nm and 1550 nm) to identify any macrobends along the network, a common fault in short-distance and high-fiber-count networks.

With a combination source, power meter and ORL meter, the operator can perform automatic continuity checks and measure end-to-end IL as well as end-to-end ORL. ORL testing is particularly important if the operator is using analog video at 1550 nm, a technology sensitive to reflectance.

## TURN-UP TESTS

After acceptance testing, the optical network terminals (ONTs) can be installed in the customer premises. With PON technology, an ONT's 1310 nm wavelength is activated only by the 1490 nm signal from the OLT. Therefore, to measure the output power of all wavelengths, the OLT and ONT must be connected. A power meter with two ports, called a selective through-mode power meter, is used to connect the fibers coming from the OLT and the ONT at the same time so testers can perform tests from the ONT.

If the tests show that some but not all ONTs are working, the problem is either in the distribution network or the ONTs. In this case, "in-service" OTDR at 1625 nm or 1650 nm can locate the fault without disturbing the working customers.

On the other hand, when all ONTs are out of service, the technician should check the OLT to verify whether it is transmitting the correct power levels. If



In turning up IP voice service, field technicians need to verify service provisioning and connectivity to signaling gateways.

it is not, the OLT should be replaced. If the OLT is transmitting correctly, there is an outage in the fiber network. Testers should perform an OTDR measurement (1310 nm/1550 nm) from the OLT connection toward the FDH to locate a possible break or bend in the feeder.

## TURNING UP SERVICES

Video service quality is ultimately determined by the end user or subscriber. Video quality of experience (QoE) is a subjective concept with components that are nearly impossible to measure in a practical, operational manner. Yet a service provider can make objective measurements on a set of parameters that can be used to judge the perfor-

mance of the network. A model for mapping objectively measurable metrics to QoE is the basis for good installation and troubleshooting procedures.

Video quality of service (QoS) testing results displayed on the field technician's test device should show all the critical parameters that affect video flows. If the program clock reference (PCR) jitter is high, for example, the decoder cannot properly decode the video payload. Trouble with IGMP latency affects the time it takes to change broadcast video channels and, therefore, is an important component of customer experience. The number of lost packets in the video transport stream, as measured by the continuity error indicator, is the most



Example of an OTDR trace on the JDSU T-BERD/MTS-4000 Multiple Services Test Platform.

critical. Setting pass/fail thresholds in test devices for each of these parameters helps promote consistency in operational practices and improve service assurance processes for IP video services.

When turning up VoIP service, field technicians should verify service provisioning and connectivity to signaling gateways. They must also verify call quality by placing test calls both within the network and to the public switched telephone network. Critical test call parameters include packet delay, packet loss and jitter. However, the mean opinion score (MOS) will be the most critical service-level agreement (SLA) metric used to measure overall VoIP quality.

To verify Internet data services, field technicians must verify FTTH physical layer performance, ISP connectivity and data service throughput. This is accomplished using a test tool with Web browser and FTP throughput test capabilities. Using selectable test file sizes and both upload and download testing,

***An all-in-one testing instrument saves capital outlay, reduces technician training time and integrates all testing results into a single report.***

FTP throughput tests establish performance of the link that models actual use cases more closely than simple download tests. Performing an HTTP test using a Web browser to ensure end users' ISP access and connectivity is also wise.

#### **ADVANTAGES OF AN ALL-IN-ONE INSTRUMENT**

Deploying FTTH requires technicians to master new terminology, technology and testing procedures to ensure that services are correctly provisioned and installed. This process can be expedited if technicians have a single instrument that can perform all required tests. This

approach reduces the number of instruments that need to be purchased, reduces technician training time and integrates all testing results into a single report.

Systematically implementing test and measurement best practices enables technicians to quickly diagnose and isolate FTTH problems impacting QoS and QoE for fast correction. A broad line of test equipment makes it possible to arm technicians and engineers with an optimized tool set that will enable them to quickly and efficiently diagnose problems at an affordable cost. **BBP**

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