Best practices for RFoG optical testing

white paper

EXFO

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Introduction

With all the talk about EPON, GPON and next-generation PON, it might be easy to forget that **radio frequency over glass (RFoG)** remains a viable option for operators who want to reach subscribers with fiber. This white paper will look at RFoG testing challenges and provide a high-level overview of the best practices for RFoG optical testing.

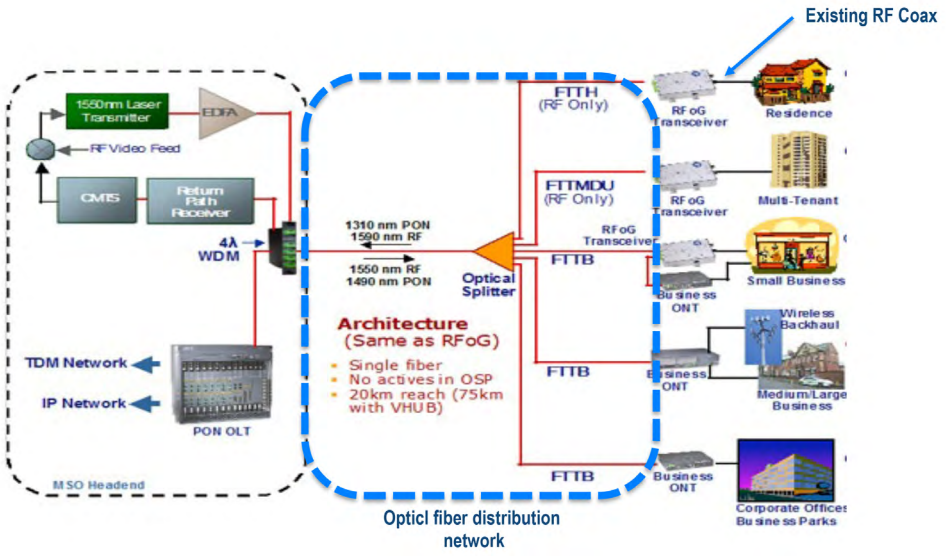


Figure 1. Typical RFoG architecture.

What is RFoG?

RFoG is a simple way for multiple system operators (MSOs) to bring fiber to the home using their existing infrastructure. One fiber can carry multiple wavelengths so that multiple technologies can coexist on the network. The good news is that RFoG shares the same base as fiber to the home (FTTH). This means that tools for testing and building RFoG networks already exist. They first hit the FTTH market in 2002, so even if you are new to RFoG technology, you can rely on the tried-and-tested tools and expertise developed in the FTTH market.

Even though there are a lot of similarities between RFoG and GPON or EPON deployments, and tools already exist, there are still a few **new challenges** that come with RFoG.

RFoG is a simple way for multiple system operators to bring fiber to the home using their existing infrastructure.

RFoG testing challenges

The optical splitter

RFoG introduces a new component into the optical distribution network—**the optical splitter**, which is located between the headend and the micronode in the RF section. The optical splitter divides the signal from a single fiber into multiple outputs reaching multiple subscribers, in a point-to-multipoint system. The optical splitter causes high loss and can be a serious failure point in the network. Also, multiplying the components and equipment in the field brings about its own challenge: multiple optical connections. Every new optical connection or component represents a new point of potential failure.

Return loss

Having multiple connections generates **connector reflectance**, otherwise known as **return loss**. Return loss is the portion of light that reverses back to the transmitter when transmitting to a connector. High return loss can create, among other things, fluctuations in laser power or drift, which may create bit error rate. That's why tracking and limiting return loss is so important.

Multiple technologies and wavelengths

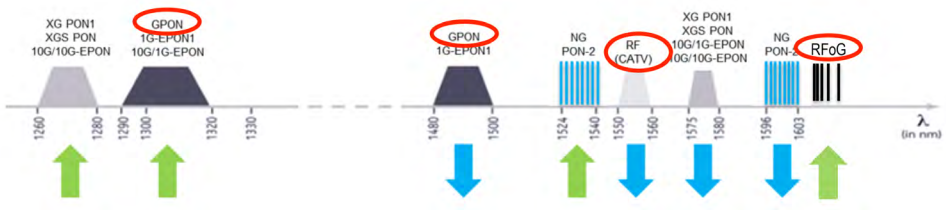
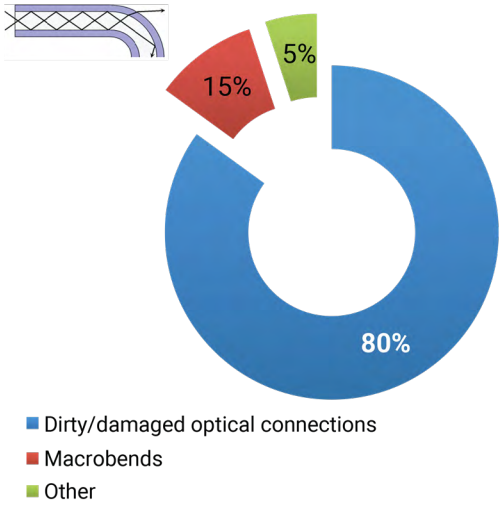
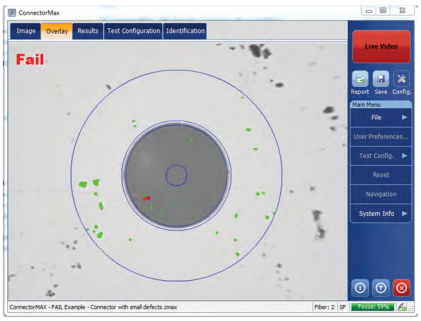


Figure 2. The different wavelengths that travel through the optical cable.

With multiple technologies and wavelengths going through the same fiber, it becomes difficult to pinpoint the source of a failure and determine how to test it.

Top threats to your network





Defective connector failing acceptance criteria.

Figure 3. Top threats to your network

According to an EXFO survey among service providers, 80 percent of fiber optic network issues stem from **dirty connectors**. In fact, dirty connectors are the No.1 threat to fiber optic networks. So, the more connectors and jumpers you have, the more potential points of failure you will have.

Bad connectors can have a serious impact on the performance of a link, creating fluctuations in the laser and ultimately affecting the user experience. In some cases, the damage can be permanent, due to the high-power signals traveling at 1550 nm.

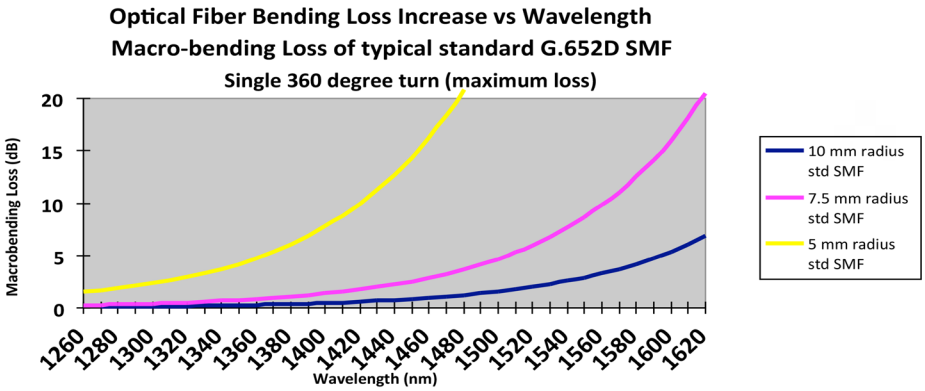


Figure 4. Bend loss vs. wavelength and radius

Dirty connectors are the No.1 threat to fiber optic networks.

The survey also revealed that 15 percent of network issues are due to macrobends: a kink or bend in the fiber that can cause a loss of light and signal attenuation. Figure 4 shows the impact of macrobends on network services and reach. The tighter the bend in the fiber, the higher the loss. The blue line shows a minimal bend in the fiber resulting in a limited loss of light that may not interrupt the signal. The purple and yellow lines however, which represent more severe bends or kinks, show the loss skyrocketing. Even five, ten or fifteen dB of loss for just one band in the network is unacceptable and can be devastating for a business.

The horizontal line in Figure 4 represents the wavelength. The higher the wavelength, the more attenuation there will be, i.e., the more impact on your signal, created by macrobends. The return path wavelength is at 1610 nm, to the right of the spectrum. It is a very high frequency, and therefore will be at higher risk from macrobends. The best practice would be to test your links at 1310/1550/1625 nm during construction, as this would provide a clear view of potential macrobends that could affect your 1550 nm video signals or 1610 nm return path.

Best practices for successful fiber optic deployments: 3 steps

1. Ensure connector cleanliness with a fiber inspection probe

A fiber inspection probe is the essential tool to pinpoint and prevent network issues during the initial construction phase. It is best practice to clean and inspect every connector endface in the network. Inspection probes range from manual to fully automated, and user-friendly probes, such as EXFO's ConnectorMax inspection probe series, feature a pass or fail LED indicator for immediate diagnosis of connector health. This very simple, basic step is critical to the health of your network, especially when you consider that 80% of network issues can be traced backed to connector cleanliness.

2. Verify wavelengths with a PON power meter

Using a PON power meter is your best bet for assessing multiple wavelengths during the turn-up and activation phase, as it can isolate the different wavelengths. The PON power meter can measure both downstream and upstream signals if we're running GPON or EPON over the RFoG system. For example, if the RFoG node is working at 1610 nm, you need to make sure that this micronode will be disconnected, so it doesn't impact the other signals during the measurement of your E/GPON signals. First you measure the EPON and GPON signals, and then connect the micronode and trig it with an RF trigger to measure the upstream path or upstream signal.

The idea is to test the power level before leaving the site, thereby preventing problems before they occur.

EXFO's OTDRs combine intelligence and accuracy with user-friendliness that accelerates workflow in the field.

3. Troubleshoot a live network with an OTDR

With RFoG, GPON and EPON networks, as soon as one customer is live, all the fibers that are connected to that same link will be also active. You need a special tool to troubleshoot such a network—an optical time domain reflectometer (OTDR). The OTDR sends light into the fiber to inspect all the components in the network—every point, connector, splice and splitter—and displays results on screen for the technician.

For this type of troubleshooting, the OTDR must feature a live or filtered port using a 1650 nm out-of-band signal. This port can block downstream signals, allowing technicians to test without turning down the entire network—that is, without losing 32 or 62 customers while troubleshooting just one.

iOLM - OTDRs made simple

People often shy away from OTDRs because of their complex technology. EXFO's OTDRs combine intelligence and accuracy with user-friendliness that accelerates workflow in the field. With EXFO's iOLM, users simply connect and push a button to get a green or a red icon indicating where and what the problem is, enabling untrained technicians to become test experts in no time.

Some final recommendations

Four steps to successful optical deployments

1. Complete optical training

- EXFO recommends complete optical training on fiber optics and testing equipment for your teams, including hands-on workshops.

2. Create your MOP

- Provide your team with a proper **method of procedures** to ensure consistency of results across different teams, especially if you work with contractors.

3. Clean your connectors

- This very basic step will save you a lot of issues. Use an inspection probe to check each connector.

4. Document

- Protect your investment by storing and managing your information, so that when you upgrade your network in the future, you can refer to your data and avoid retesting the entire network.

Learn more

Learn about our products:

PPM-350D
iOLM
FIP-400B

Conclusion

RFoG is worth considering as it allows you to take advantage of existing infrastructure and proven, mature tools methods developed for the FTTH market, thus avoiding common pitfalls.

By following best practices and taking a few simple steps during construction, installation and turn-up, you can save big in the long run and ensure a successful deployment and troubleshooting of your RFoG network.