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## Test and Measurement Questions for 2017 and Beyond

*By Stephen Hardy*

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# Test and Measurement Questions for 2017 and Beyond

Major test and measurement trends aren't difficult to spot or describe. We continue to see smaller, lighter, more modular, more flexible and easier to use test instruments for field technicians. Test procedures have become increasingly automated and simplified as well.

Meanwhile, trends in the networks that test instruments must enable and troubleshoot are just as easily uncovered. Such trends, of course, often create new test requirements. Let's look at three such trends, some of which may pose questions that test instrument developers are still trying to answer.

## Enabling DOCSIS 3.1

With a growing number of operators readying field trials and even commercial deployments of DOCSIS 3.1, test instrument vendors have scrambled to add the necessary capabilities to their installation certification meters. The need for these upgrades derives in large part from the use in DOCSIS 3.1 of such new technologies



Test functions continue to become more automated. And emerging network technologies may make such automation essential.

as orthogonal frequency division multiplexing (OFDM) modulation downstream and orthogonal frequency division multiple access (OFDMA) in the upstream.

The use of OFDM/OFDMA can make DOCSIS 3.1 testing interesting. For example, OFDM enables signals to be transmitted on a variety of subcarriers, each with its own

modulation format. Fortunately, a profile can be created for each subcarrier that defines the modulation form in use. Profile A is the boot profile, which each DOCSIS 3.1 modem must be able to use to reach higher OAMs with the other profiles. Therefore, the field technician needs to know, in addition to Profile A, which subcarriers are in use and the characteristics of each of their profiles to know what to test.

As described in Reference 1, testing the power level of OFDM carriers can trip up technicians accustomed to single-channel OAM transmission. The inclination might be to test power across the entire 192-MHz OFDM carrier. However, the total power of an OFDM carrier

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is equal to that of a 6-MHz carrier, plus the channel bandwidth. So, the OFDM carrier's total power is significantly different from that of a typical 6-MHz carrier. In fact, the OFDM power levels must be measured and compared to the power in a 6-MHz carrier to make accurate power level adjustments.

Overall, proper OFDM operation requires that the average power level be in the proper range, the modulation error ratio (MER) must be satisfactory, and noise levels must be as low as possible.

Operators now have a variety of sources for instruments with which to ensure these factors are in line. Dan Dillon, director of product management at Trilithic, reviewed the variety of tests technicians could and should perform during DOCSIS 3.1 installations using such instruments in [the February 2017 edition](#) of the SCTE/ISBE LiveLearning Webinars™ for Professionals series, produced in partnership with BTR.

Dillon suggested that five areas provide the key to proper performance testing when certifying DOCSIS 3.1 installations:

1. PHY link channel (PLC) performance
2. OFDM channel performance
3. Default profile performance
4. Modem connectivity and performance
5. Advanced profile statistics

Therefore, the building blocks appear to be in place for installation verification and certification for DOCSIS 3.1. The question is what happens when Full Duplex DOCSIS 3.1 comes on the scene. Fortunately, it appears vendors have time to prep further upgrades to their instruments.

## A Coherent Approach to Optical Testing

Until recently, few if any U.S. cable operators other than Comcast needed to think about how to support the use of 100-Gbps optical wavelengths created via coherent transmission technology. Most didn't aggregate enough business services or other traffic to need such 100-Gbps capabilities.

However, the recent spate of operator consolidations has created more service providers with the necessary regional and near-national footprints to pursue large-scale enterprise customers with greater capacity demands. Meanwhile, [CableLabs has discussed an initiative](#) to apply coherent transmission technology to the fiber-based feeder network that will support DOCSIS 3.1 deployments, particularly Full-Duplex DOCSIS 3.1.

All of which could lead network planners to ponder whether it's time to pay attention to coherent transmission test requirements. The natural inclination would be to look toward their telco competition, who have used coherent

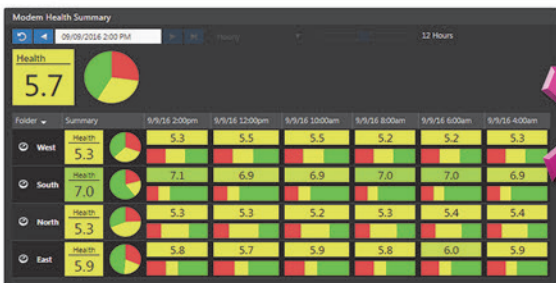


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01020357C1B9	Nominal	-28.05	0.0075	0.8	1.0	-26.3	551 ft - 709 ft	Microreflections	Stable
01020357C1BA	Nominal	-30.45	0.0045	0.8	1.0	-26.4	551 ft - 709 ft	Microreflections	Stable
01020357C1BB	Critical	-21.45	0.0225	1.2	3.0	-24.4	551 ft - 709 ft	Microreflections	Upward
01020357C1BC	Nominal	-21.45	0.0095	0.8	1.0	-26.9	551 ft - 709 ft	Microreflections	Stable
01020357C1BD	Critical	-21.45	0.0525	3.3	4.0	-27.4	551 ft - 709 ft	Microreflections	Upward
01020357C1BE	Nominal	-28.05	0.0075	1.1	3.0	-26.6	79 ft - 256 ft	Microreflections	Stable
01020357C1BF	Critical	-18.45	0.0455	2.2	4.0	-27.9	79 ft - 256 ft	Microreflections	Upward
01020357C1C0	Nominal	-26.05	0.0215	0.8	0.0	-26.3	79 ft - 256 ft	Microreflections	Stable
01020357C1C1	Critical	-18.45	0.0525	2.6	5.0	-26.5	79 ft - 256 ft	Microreflections	Upward
01020357C1C2	Nominal	-26.55	0.0225	1.1	2.0	-27.0	79 ft - 256 ft	Microreflections	Stable
01020357C1C3	Critical	-22.45	0.0255	1.8	3.0	-25.8	79 ft - 256 ft	Microreflections	Upward

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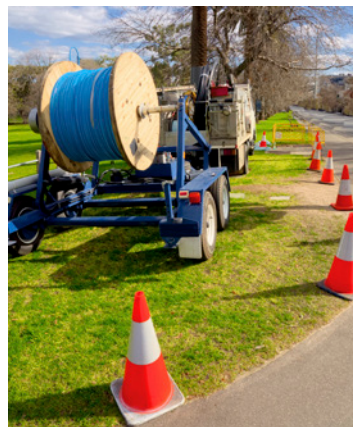


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transmission technology for several years. And those who follow that inclination find...not a lot of coherent network test equipment.

There are three primary reasons for the lack of field coherent transmission test systems. First, instrument technology hasn't advanced sufficiently to enable portable and reasonably priced systems. Coherent transmission testing in the lab still requires very high-end oscilloscopes (generally real-time variants), optical modulation analyzers, arbitrary waveform generators, and other units – and that's just to characterize the receive end of the transmission. While a field test system likely wouldn't require capabilities that matched lab requirements, an integrated, reasonably priced system – or any kind of field system – remains unavailable.

Second, and a factor that partially explains why instrument vendors haven't made much of an effort to overcome the lack just described, the telco service providers who pioneered the deployment of coherent



As operators ponder coherent optical transmission, and CableLabs considers it for access applications, what are the ramifications for test?

transmission quickly decided such systems would be pointless. Coherent transmission requires highly advanced, and complex, digital signal processing (DSP). And while industry groups such as the Optical Internetworking Forum have established guidelines for such signal processing elements as forward error correction schemes, individual vendors have added enough “secret sauce” to their coherent DSP approaches that telco technicians realized that even if they could characterize transmissions to that level, they wouldn't know what to do with the information without an engineer from their transport system supplier of choice by their side.

Therefore, telco technicians left it to their vendors to perform most initial system installation and certification functions (often with the help of test and measurement capabilities integrated into the transport hardware). Confirmation and ongoing maintenance then took the form of plugging Optical Transport Network (OTN) test equipment into the client ports of the coherent transport systems. If the traffic looked as good coming out on one side as it did going in on the other, great; if not, the telco either replaced the line card or called the vendor to perform further troubleshooting.

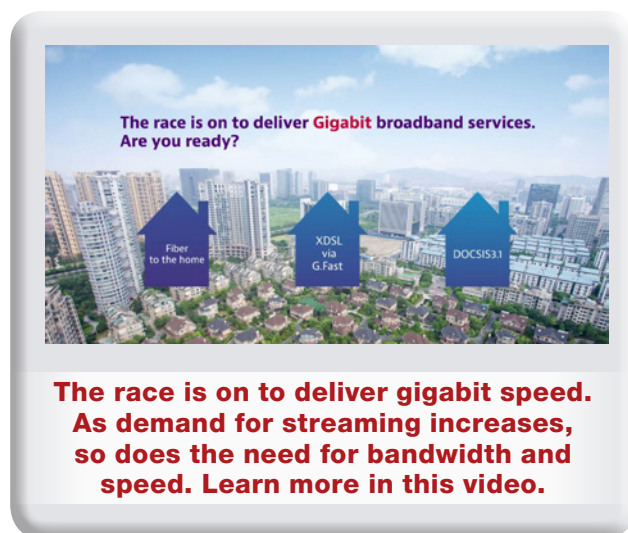
Third, it turns out that coherent transmission's properties render typical methods of performing optical signal-to-noise ratio (OSNR) measurements ineffective. Instrument vendors have spent

years attempting to find a solution to this problem. Finally, last year, Viavi Solutions

demonstrated a method at the European Conference on Optical Communications that appears to work. Company sources at the time said Viavi would submit the procedure to the International Electrotechnical Commission (IEC) for potential standardization.

So the advent of a new transmission format hasn't created a market for new test equipment. In fact, it may have created less of a demand. In addition to the built-in test capabilities of their platforms, some aggressive systems salespeople suggested that, since coherent DSP devices are designed to overcome the effects of chromatic and polarization mode distortion, there was no need to measure such parameters anymore on coherent-enabled routes. Test vendors, of course, begged to differ.

While cable operators likely will want to keep their distortion measurement instruments handy (particularly if coherent and non-coherent traffic will share the same fiber), they should feel fairly confident that adoption of coherent transmission in their regional and long-haul networks won't require a significant investment in new test gear. The potential use of coherent in the access is probably too far in the future to enable a guess about the test needs in such a scenario.



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But there's reason to think that operators can be equally optimistic there as well.

## Virtual Test of Virtual Functions


Network functions virtualization (NFV) represents another technology on the horizon that may have technicians pondering test ramifications. Testing stationary physical hardware is difficult enough; how do you test a virtual network function (VNF) whose location could change on a moment's notice?

Operators and vendors have some time to figure this out, of course, as the use of VNFs is in its early stages and limited to a small number of service blocks, such as firewalls. Still, talk continues to grow about the desirability of virtualized gateways and other CPE, as well as leveraging virtualization for Distributed Access Architecture (DAA) deployments. Eventually, NFV proponents believe, operators will want the flexibility and automation that a software-defined network (SDN) that controls and provisions VNFs should provide.

So it seems clear that any test and monitoring approach to virtualized functions will need to enable a pathway toward operating in a full SDN environment. In such an environment, operators will need a way to know the current state of the network and its elements (legacy, real and virtual), enable the confirmation that SDN-enacted network changes have successfully taken place, and automatically discover – and predict – network trouble spots.

A robust network monitoring system provides the foundation upon which to build such a test and measurement capability, numerous test vendors have told BTR. Several vendors have begun to articulate their visions of such a system. The approaches generally involve a

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\*Source: Frost & Sullivan, fiber optic test equipment market study.





The increasing use of virtual network functions poses challenges for test, measurement and monitoring.

network of physical and virtual probes that can monitor and measure traffic and the operation of hardware- and software-based functions, then feed that data to a central data repository and analysis location. Such a monitoring system will leverage open application programmable interfaces (APIs) to interact with physical and virtualized network elements from a variety of vendors, as well as enable operators to apply apps from third parties or that they've developed themselves. Such apps likely will help to analyze the data the system collects and enable network function or performance changes based on that analysis.

Meanwhile, we've seen test vendors take some elements of SDN and apply it to their physical field systems. Software programmability and

automated test procedures, uplink of results to a centralized location, and cloud-based connectivity with other units all mirror both the enablement of SDN and NFV as well as the benefits operators expect these emerging concepts to provide. Vendors have even made some virtualized test functions available that can reside on servers, just like network VNFs.

DOCSIS 3.1, coherent optical transmission, and SDN/NFV represent only three of several emerging technologies that have and will require investigation when it comes to test, measurement and monitoring. As test capabilities become more sophisticated, perhaps a DevOps model in which service assurance planning goes hand-in-hand with new service and function development will come to pass, making such investigations easier and more efficient.

## REFERENCES

1. ["DOCSIS 3.1: Best Practices for Peak Performance,"](#) Viavi Solutions whitepaper.
2. ["Deploying and Maintaining DOCSIS 3.1,"](#) SCTE/ISBE LiveLearning Webinars™ for Professionals in partnership with BTR, February 2017.



*Stephen Hardy is editorial director of Broadband Technology Report.*

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