SPECIAL REPORT

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Vendors weigh in on developments in optical communications technology and test solutions

By Mike Hockett, Editor-in-Chief

While 5G will undoubtedly do wonders for the massive amount of anticipated electronic devices in the next few years, the transmission speeds of its radio frequency-based wireless mobile technologies are limited by the available regulated RF spectrum.

Because of this, optical communications technology will remain a crucial counterpart to wireless RF, as considerable advancements in optical system capacity, network reach, and user base size make it an attractive commercial solution. Optical wireless communication (OWC) systems are attractive as a broadband access technology due to their high speeds, capacity, and the cost-effectiveness of meeting bandwidth requirements of different services and applications of next-generation networks. Optical wireless communications can also serve as an alternative or complementary technology for current wireless RF solutions.

OWCs' applications range from broadband services to space missions, where their high bandwidth capacity enables scientists to send much more data to Earth than possible through RF. Also, the optical communications spectrum has not been regulated, so those creating technology with it don't need to worry about available allocations. Last but not least, OWCs are considerably smaller, lighter, and consume less power than RF packages.

Gains in optical communications capacity come primarily from three sources: increased spectrum efficiency via higher modulation density, higher symbol rate, and more carriers via techniques like polarization and multicarrier orthogonal frequency-division multiplexing (OFDM) modulation.

"Testing these higher-order systems with data rates close to 1 Tbps requires test equipment capable of clean signal generation and analysis and a measurement bandwidth of at least 20 GHz, to be sure the measurements represent system performance, not the limitations of the test equipment," Keysight Technologies explained in a 2017 application note. "The instruments must offer the flexibility to address many different modulation schemes on 4 synchronized channels for a dual-polarization I/Q signal. Traditionally, receiver tests such as phase noise, observed signal-to-noise ratio and polarization tests have been performed using a 'gold' transmitter, giving a view of the device but lacking completely deterministic knowledge."[1]

▲ Keysight's M8290A Optical Modulation Analyzer and High-speed Digitizer.

Optical coherent transmission technology was originally used in long-haul transmissions, but now encompasses metropolitan networks and data center interconnects. Keysight's application note goes on to say the key challenges in making measurements on coherent optical systems are in providing known, repeatable, clean, and distorted test signals at data rates above 32 GBd and with the flexibility to support diverse modulation formats.

To dive deeper into the topic of optical communications technology and the testing involved, we at *Evaluation Engineering* gathered input from several vendors about trends they're seeing, challenges, customer needs, and what newer solutions are available. Here's what they told us.

What's trending?

What technology or market trends are vendors seeing in the area of optical communications test?

Hiroshi Goto, business development manager at Anritsu Company: "Data center and network traffic volumes are increasing exponentially as 5G networks are rolled out and Big Data applications expand. The result is that physical-layer devices must accommodate ultra-high-speed data transmissions using technologies such as PAM4 to transport 100 Gbps per lane or per wavelength."

Heike Tritschler, marketing segment lead - optical & electrical networking, and Pavel Zivny, domain expert - serial data measurements at Tektronix: "The optical test spans 26 GBd devices and 53 GBd devices, majority of them multiple lanes—up to eight lanes. This is a large number of devices/lanes to test."

Challenges

What key challenges are optical communications test vendors or their partners facing today?

Goto, Anritsu Co.: "The integration of 100 Gbps PAM4 data with Forward Error Correction (FEC) means that a new test metrology must be established. Test solutions need improved sensitivity to accurately analyze PAM4 signals because those signals automatically lose 10 dB optical signal-to-noise ratio (OSNR) compared to NRZ signals. In addition to ONSR, the signal integrity of PAM4 affects the eye closure of the PAM4 signal."

Tritschler and Zivny, Tektronix: "The methodology changes, in particular the TDECQ test, came just at the same time as the big change in architecture (PAM4). This created a lot of uncertainty that has been worked through."

What are customers asking for?

What features or innovations are customers asking for in optical communications test?

Goto, Anritsu Co: "Engineers need a test solution that is simple to operate and can analyze and characterize PAM4 signals and data quickly. They also need instruments that can conduct optical stressed eye testing for 100 Gbps PAM4."

Tritschler and Zivny, Tektronix: "Users need fast compliance testing on many channels; and users are asking for help interpreting the results."

Areas of focus

Optical communications test spans applications from datacenters, to 5G-related networks, to photonic integrated circuits, and beyond. Here's what vendors told us they're focusing on.

Goto, Anritsu Co.: "With our MP1900A, Anritsu is focused on verifying the design and manufacture of high-speed data center interconnects and backplanes such as active optical cable (AOC) and QSFP-DD optical modules. The MP1900A BERT supports high-speed computer bus interfaces, such as PCI Express 5.0 and USB 3.2, as well as next-generation 400G Ethernet communications interfaces."

Tritschler and Zivny, Tektronix: "We see a lot of overlap in the key areas—datacenter attracts the PIC suppliers just as much as it does the traditional optics vendors. A new focus for us is the backhaul for 5G."

Compliance/Regulatory

What recent or upcoming compliance, regulatory, or compatibility issues—if any—are impacting technology in optical communications test?

Goto, Anritsu Co.: "IEEE 802.3bs (200GAUI-4 and 400GAUI-8), 802.3cd (CR4, KR4), and OIF-CEI-56G-VSR/MR/LR, OIF-CEI-112G-VSR address 100G PAM4 optical signal characterization, while InfiniBand Trade Association (IBTA) HDR establishes standards to verify 200G interconnects. Anritsu has been involved in industry associations and standards bodies, which has allowed the MP1900A to support standards-based specifications."

Tritschler and Zivny, Tektronix: "Tektronix is participating in the work at the IEEE 802.3. As with any new technology, there is a learning cycle and this is impacts our direction. We see our work with IEEE as a very productive involvement, which is enabling rather than burdening our work."

Now on the market

Here's what vendors shared as newer solutions or accessories they've recently introduced in the area of optical communications test, and their key features.

▼ Anritsu Company's MP1900A BERT was recently enhanced with four PAM4 BERT options.

Goto, Anritsu Co.: "Anritsu recently enhanced its MP1900A BERT with four PAM4 BERT options that add multi-channel synchronization, multilane FEC

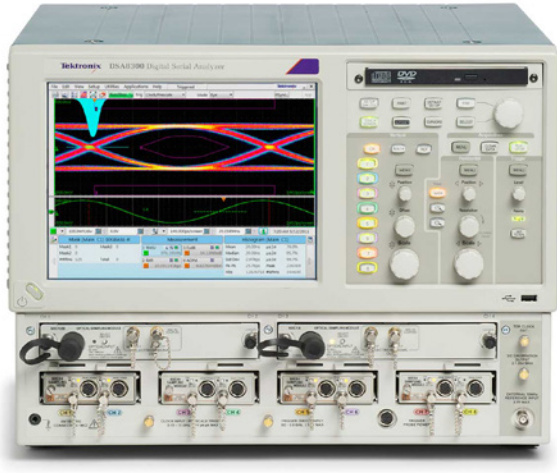
pattern generation for 400 GbE, inter symbol interference (ISI) stressed signal generation to simulate transmission path losses, and application software for capturing DUT error counts. The new options allow engineers to more accurately and efficiently evaluate the bit error rate (BER) of 400 GbE transceivers and devices, as well as DSP used by high-speed interfaces in data centers to reduce development time and speed time-to-market. With the options installed, the MP1900A PPG supports required 400 GbE transceiver PHY layer FEC tests, as well as QSFP-DD, and OSFP. It can conduct legacy jitter tolerance and input sensitivity measurements, as well as key tests on the impact of crosstalk due to use of multiple channels and error correction. To ensure interconnectivity between interfaces defined by the 400 GbE standards, the PAM4 PPG of the MP1900A has a built-in function for simulating signals after transmission through a PC board. This capability, which eliminates the need to prototype multiple PC boards to test transmission path losses, as well as the ISI function allow for more efficient testing. A built-in function for communicating with the DUT IC error-check function simplifies jitter tolerance measurements during early-stage development of high-speed devices."

Tritschler and Zivny, Tektronix: "Our optical portfolio now extends to real-time oscilloscopes, and we reach all the way to 59 GHz on our DPO7OE2 optical probes. With intrinsic jitter of less than 100 femtoseconds for extremely accurate device characterization, Tektronix' DSA8300 Series of digital serial analyzer sampling oscilloscopes provides comprehensive support for optical communications standards, time domain reflectometry, and S-parameters. The DSA8300 is a complete high-speed PHY layer testing platform for data communications from 155 Mb/sec to 400G PAM4."

Teledyne LeCroy: Our wideband multimode optical-to-electrical converters are designed for measuring optical communications signals. Their broad wavelength range and multimode input optics make these devices ideal for applications including Ethernet, fiber channel, and ITU telecom standards.

They connect to Teledyne LeCroy real-time oscilloscopes and provide capability for physical layer signal assessment using a variety of oscilloscope tools, such as SDAIII-CompleteLinQ Serial Data Eye, jitter, noise and crosstalk analysis, mask testing, serial triggering and decoding, and other compliance and debug tools. They are available to support optical data rates up to 11.3 Gb/s with reference receivers, or slightly higher without reference receivers."

Keysight: "Our M8290A Optical Modulation Analyzer and High-Speed Digitizer is a flexible solution platform for 400G coherent devices and transmitter test. It incorporates a 92 GSa/s modular optical modulation analyzer and a 92 GSa/s 4-channel electrical digitizer. Besides these modules, an additional arbitrary waveform generator module up to 92 GSa/s, such as the M8196A, can be added to the same AXIe chassis. This setup results in a compact and flexible coherent test solution that can be used together with additional specialized solution software for Integrated Coherent Receiver (ICR) and Coherent Optical Device module characterization."



◀ Tektronix' DSA8300 Digital Serial Analyzer sampling oscilloscope.

▲ OptoTest's OP415 Polarity Analyzer.

OptoTest: "In March of 2018, we announced our latest innovation in polarity testing solutions, the OP415 Polarity Analyzer. This polarity tester was designed to test 24-fiber MTP/MPO cable assemblies efficiently, but it can easily be configured for 8-fiber and 12-fiber testing. It comes preloaded with 12-fiber and 24-fiber polarity types A, B, and C plus the ability to create and store custom fiber mappings and channel configurations. Alternatively, the OP415 can learn polarity types from existing cables and store those for future use. Additionally, the OP415 has a manual mode that steps through a cable, channel-by-channel, which is useful for troubleshooting or routing fibers during ribbonizing. Bright red lasers on each channel allow for visual fault detection on ribbon cables."

Applications

What novel or unique applications have these vendors' regenerative optical communications test solutions been used for recently?

Goto, Anritsu: "The MP1900A has been used to generate a four-channel synchronized 100G PAM4 signal (53 GBd x 4 lanes) to support next-generation 50+ GBd applications, such as 400 GbE and CEI-112G."

Tritschler and Zivny, Tektronix: "We have always enjoyed working with researchers on very high-speed testing, and our 80C10C optical module has consistently been used as a reference for 53 GBd and faster. We are working on very early experiments in 112 GBd with a selected partner. We will show more at the ECOC show (Sept. 23-25 in Dublin, Ireland)." EE

REFERENCES

1. Keysight Technologies, "Coherent Optical Communications Test Challenges," August 2017.