SPECIAL REPORT

BTR
BROADBAND TECHNOLOGY REPORT®

SPONSORED BY

Anritsu
envision : ensure

GREENLEE.
COMMUNICATIONS

VeEX

What's New in Optical Test?

PennWell®

Network Testing Simplified

All-in-one Transport Tester Expands Capability

The next generation Network Master™ Pro MT1000A all-in-one portable tester is revolutionizing the industry with its scalable platform for CPRI, Ethernet and OTDR modules that can operate standalone or simultaneously installed with available multi-rate transport module now supporting new 25 GbE, 100 GbE, and OTU4 to create a rugged, handheld solution that field technicians can use to ensure proper installation and optimum performance of all network types – mobile fronthaul and backhaul, DAS, metro, data center, access or long haul.

Learn More and Watch our video:
[Anritsu MT1000A Network Master Pro All-in-One Field Portable Tester]

Network Master Pro

Anritsu
envision : ensure

Trends in optical testing

By Stephen Hardy, Editorial Director & Associate Publisher

As cable operators deploy fiber deeper into their networks and use it to serve a growing number of applications, fiber-optic testing obviously becomes more important. Unfortunately, it also becomes more complex. Fiber types might change, connectors might change and the nature of the optical transmission might change (both in the type of transmission as well as in the number and location of wavelengths). Meanwhile, the crews assigned to install and troubleshoot new fiber-optic connections might not change – they may be the same technicians who have been working with coax for most of their careers.

Therefore, cable deployment crews need test equipment that is easy to operate even if the user has had little exposure to optical networking. These test sets also should be useful in a wide variety of scenarios. Optical test instruments have evolved rapidly over the past few years in response to these requirements. Which is a good thing, as future optical networks promise even thornier test problems.

Keeping pace with changing circumstances

Automation has proved the main weapon for test instrument vendors in the battle against growing optical evaluation complexity. From ribbon fiber inspection to PON operation certification, such automation enables technicians to set up and execute tests rapidly and accurately, even with what might be regarded as a minimum of training. That automation can extend to documentation of the procedures and results as well.

Meanwhile, to make their instruments applicable to a wider variety of applications, test equipment vendors have embraced modular designs that support a wider range of interfaces. The necessary software to perform the tests assigned for the day can be downloaded into such instruments as needed, often from a remote source in a cloud-based manner. Again, the technician can send the results of the tests back to a central facility for later evaluation or trend analysis via the cloud as well. Portability goes hand-in-hand with such modularity.

Meanwhile, optical communications equipment vendors are helping to make things easier for cable operators by building in lower-level test capabilities into their systems. PON optical line terminals and other optical transport hardware may have optical time-domain reflectometer (OTDR) capabilities built in that can provide hints about fault locations to technicians before they enter their trucks for further investigation.

Things to come

The evolution toward more automated, cloud-friendly, multi-use instruments comes just in time for significant changes in the optical communications technology cable operators will

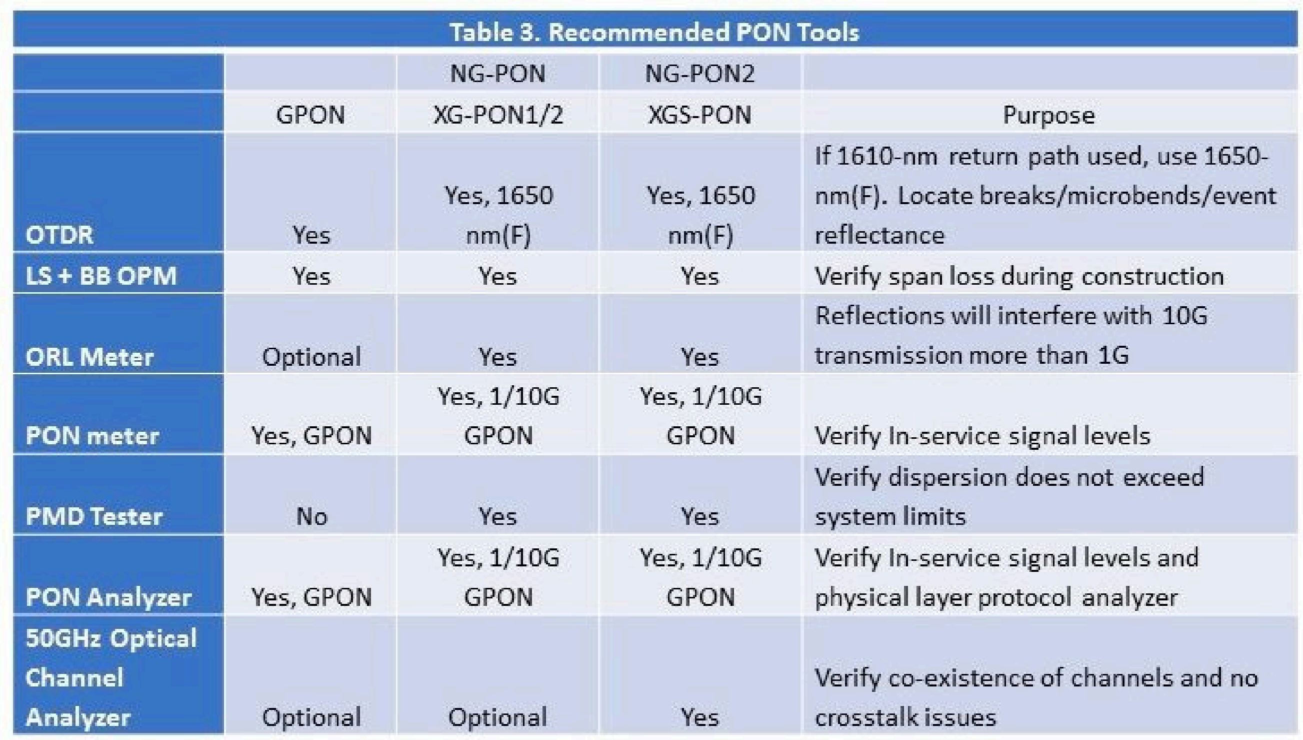


Table 3. Recommended PON Tools

		NG-PON	NG-PON2	
	GPON	XG-PON1/2	XGS-PON	Purpose
OTDR	Yes	Yes, 1650 nm(F)	Yes, 1650 nm(F)	If 1610-nm return path used, use 1650-nm(F). Locate breaks/microbends/event reflectance
LS + BB OPM	Yes	Yes	Yes	Verify span loss during construction
ORL Meter	Optional	Yes	Yes	Reflections will interfere with 10G transmission more than 1G
PON meter	Yes, GPON	Yes, 1/10G GPON	Yes, 1/10G GPON	Verify In-service signal levels
PMD Tester	No	Yes	Yes	Verify dispersion does not exceed system limits
PON Analyzer	Yes, GPON	Yes, 1/10G GPON	Yes, 1/10G GPON	Verify In-service signal levels and physical layer protocol analyzer
50GHz Optical Channel Analyzer	Optional	Optional	Yes	Verify co-existence of channels and no crosstalk issues

(Source: VeEX Inc. via LIGHTWAVE.)

have at their disposal. While certain test will remain essential – including fiber/connector inspection, transceiver certification, insertion loss and optical return loss evaluation, and OTDR measurements – how these tests are conducted and what they're seeking to measure likely will change.

Next-generation PON technology is a good place to start. Whether an operator has deployed EPON or GPON, new technology that will support at least 10 Gbps per wavelength (and certainly more in upcoming next-generation EPON standards) and potentially over multiple wavelengths is on its way. As an example of the effects on test procedures, the table below lists the test capabilities one test instrument vendor suggests operators have in stock as they roll out XGS-PON or NG-PON2, particularly if they plan to offer services via these technologies alongside existing GPON-based services.

And that doesn't take into account any testing that might be required on the tunable optical network terminal (ONT) transceivers NG-PON2 will demand. Next-gen EPON, thankfully, won't require such tunability. But we're likely looking at higher transmission rates than the 10 Gbps of NG-PON2 wavelengths.

Meanwhile, as network managers consider a move toward Distributed Access Architectures, optical test requirements will evolve as well. In an SCTE LiveLearning Webinars™ for Professionals webcast on April 26, Stephen Colangelo of VIAVI Solutions noted that test requirements likely will include Ethernet testing on top of such traditional measurements as insertion loss, return loss, and connector inspection. Dispersion testing also may be required.

But the big unknown as far as optical testing is concerned is where operators will use coherent detection. The technology has become essential for long-haul and metro networks as transmission rates move to 100 Gbps and greater. The question is how much of a role coherent transmission will play in other parts of the network. CableLabs is evaluating coherent for use in the access network as a means to enable older fibers designed for support of no more than a few gigabits per second (if that) to be used to support Distributed Access Architectures and Full Duplex DOCSIS, where transmission rates can reach 10 Gbps (or perhaps more if the link needs to support multiple service types; see "A Light Lunch: CableLabs Eyes Coherent Optics" and "Full duplex coming soon to a fiber near you").

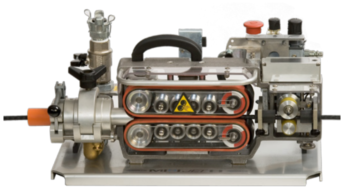
One of the fiber effects relevant to coherent detection is polarization mode dispersion (PMD), something operators didn't have to worry about much with standard non-return-to-zero, on/off keying modulation (coherent encodes signal information into phase as well as amplitude, so polarization gets involved). A significant amount of digital signal processing (DSP) is applied to coherent transmissions to mitigate the effects of PMD. Systems vendors will tell you that such DSP does such a good job that PMD and chromatic dispersion, and therefore PMD and chromatic dispersion testing, is irrelevant; test instrument vendors disagree. The test equipment suppliers' case is particularly strong where conventional transmissions will share the same fiber as coherent transmissions. One would think as well that the older the fiber in question, the more necessary both PMD and chromatic dispersion measurements would be when looking at transmitting multiple gigabits per second.

The rapidly evolving optical network environment has put significant pressure on deployment and troubleshooting technicians. Test instrument vendors have attempted to ease the technician's burden – but there's likely more work to be done as new optical technologies reach the field.

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

Learn more about optical testing

You can now view on-demand the April 2018 SCTE·ISBE LiveLearning Webinars™ for Professionals webcast, produced by BTR, "Testing and Measuring Optics." The growing interest in fiber deep deployments has put new emphasis on the ability of technicians to quickly and accurately measure fiber-optic networks. This webinar highlights what technicians need to know as well as how to ensure accurate, efficient optical network measurements. Register for the webinar and view it now!



SPECIAL REPORT

Testing and troubleshooting fiber-optic connectors

By Keith Foord, Greenlee Communications

As fiber reaches deeper into telecommunication networks, the need for maintaining the integrity of these networks becomes increasingly important. It is imperative that best practices are employed and that high-quality components are used throughout the installation and verification process of fiber networks. No matter how technologically sophisticated the network, basic components of the system can severely impair connectivity or create a system failure. One of the most basic components of fiber-optic networks is the lowly connector. The connector is typically given the least amount of thought, except to seek out cost "savings"; however, this humble component can have a large impact on the reliability of the network.

There are four different methods to facilitate network connections, each with their own advantages and disadvantages: Pre-terminated cables, mechanical connectors, cutting a patch cord in half and splicing each half jumper, and splice-on connectors. But the key to success with any connection method is properly cleaning and inspecting the ferrule end face to minimize loss and reflectivity.

Know Your Options

Splice-on connectors provide a low insertion loss, low return loss approach and do not require a splice tray, as the splice protector is housed in the strain relief of the connector. Since the connection point in a splice-on connector is a fusion splice there is no mechanical integrity issue and the long-term performance is not a factor. The insertion loss of a fusion splice is typically <0.02 dB, which is much less than

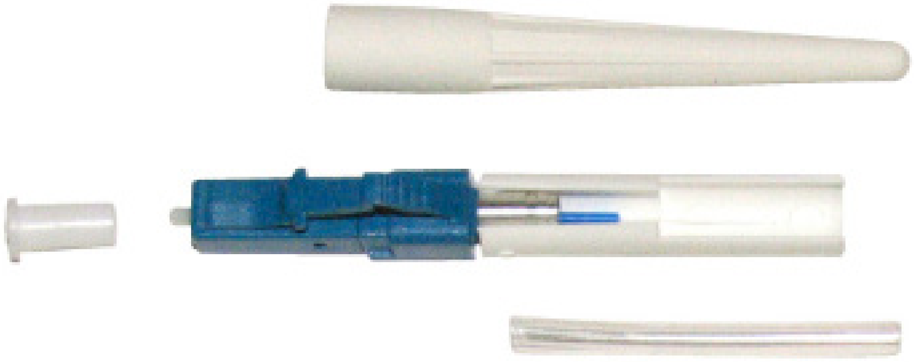
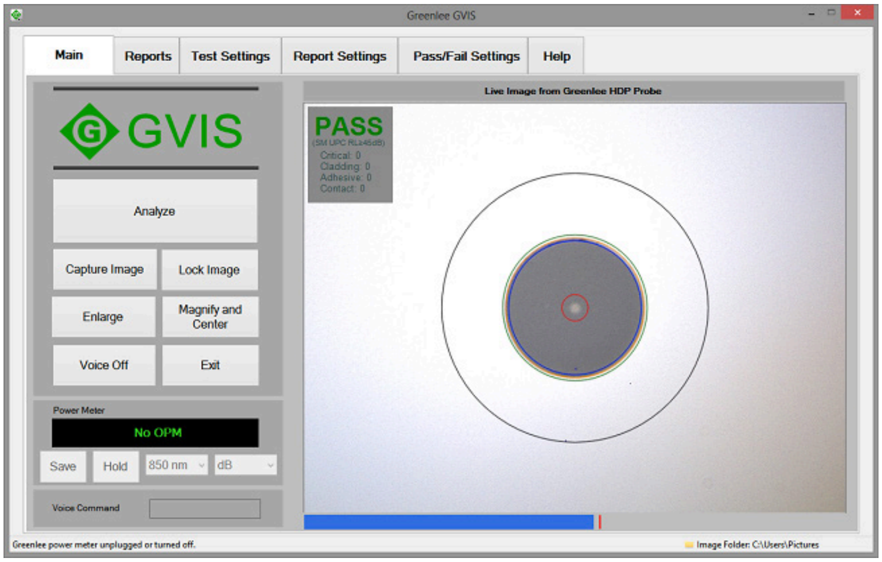


Figure 1. Image of a typical LC splice-on connector.

the specification for a typical connector at 0.3 dB. If a mated connector is clean and in good condition the insertion loss should be <0.1 dB.



PASS
(SM UPC RL≥45dB)
Critical: 0
Cladding: 0
Adhesive: 0
Contact: 0

No OPM

Greenlee power meter unplugged or turned off.

Image Folder: C:\Users\Pictures

Figure 2. Example test result of connector ferrule that passes IEC specifications.

Mechanical connectors can have a maximum insertion loss of 0.75 dB (including the loss from the ferrule connection) but the main concern with mechanical connectors remains the potential for a high return loss. Mechanical connectors have a possible failure point where the field fiber is connected to the ferrule fiber within the connector, which can also cause high insertion and return losses. Mechanical connectors should only be used in emergency restoration situations and be subsequently replaced at a later date.

Mated Angle Polished Connectors (APCs) will have a typical return loss (reflectivity) of approximately -70 dB. If the field fiber separates from the fiber stub inside of a mechanical connector, the return loss could increase significantly. An open glass to air interface is commonly referred to as a 4% reflection and is quantified as -14.4 dB. This would cause a very high reflective event and a high insertion loss. If a large reflection such as this is present in the network, the ability of the fiber link to reliably transport data can be severely impaired.

Trouble tips

Over 80% of network failures are attributed to improper cleaning of connector end faces (or to not cleaning them at all). A fiber link that is not clean will not transmit data efficiently or will have a total failure due to high insertion loss and/or a high return loss. Return loss is the measure of the reflectivity of the connector. Reflections are the enemy of fiber-optic networks and need to be minimized at any and every opportunity. Today's high-bandwidth applications such as 4K TV require fiber links that have low reflectivity to reliably transport the content to the consumer. To insure contaminated or damaged connectors are not installed in the network, the technician needs to inspect before every connection is made, clean if necessary, inspect again and then if the connector is deemed to be clean and in good condition, make the connection.

If a connector is not cleanable or is damaged it should be replaced to avoid compromising data transference. This must also be repeated for the bulkhead connector. Failing to perform the cleaning and inspecting process with both the connector ferrule and the bulkhead ferrule is only doing half of the job and most certainly will cause a failure.

If the above preventative guidelines have been followed, the connections should be successful. But, "things happen," at which time the technician needs to be able to diagnose the failure that is caused by a connector. One troubleshooting method is to use a visual fault locator (VFL). When a ferrule of a connector is inserted into the VFL, the red laser light emitted should be efficiently coupled into the fiber. If the light "explodes" at the connector, this indicates that the connector is contaminated or damaged. This is a highly subjective analysis on the part of the technician and is not the recommended method to troubleshoot. If connection to the VFL is good, the red laser light will be able to propagate down the fiber and the technician will be able to also identify kinks in the fiber and or discontinuities.

The most powerful tool in the technician's toolbox is the optical time-domain reflectometer (OTDR). Today's OTDRs can pinpoint the location, loss and reflectivity of each event and the optical return loss (ORL) of the entire fiber link.

When testing, the first step is to make sure that the bulkhead and launch cable connections are clean and not damaged. This insures that the probe pulse emitted from the OTDR is effectively coupled to the fiber link under test. Once the field fiber is connected, the technician must set the range of the OTDR to capture the entire length of the fiber. The optimum setting would be 75% fiber link and 25% noise after the end of the fiber. The pulse width is usually automatically set to accommodate the range selected, so the technician can now initiate a measurement.

Figure 3. An OTDR measures the length to a fault or the length of singlemode and multimode fiber-optic cables.

Once the measurement is complete, the various events are annotated. Sometimes the technician will need to adjust the pulse width and averaging times to obtain a better idea of what each fault is. Increasing the averaging time will smooth the OTDR trace and allow for a clearer representation of very small events. Increasing the pulse width will couple more energy into the fiber under test but will result in poorer resolution. Decreasing the pulse width will improve the resolution but also reduce the maximum distance that the OTDR can probe. A wider pulse width will also increase the

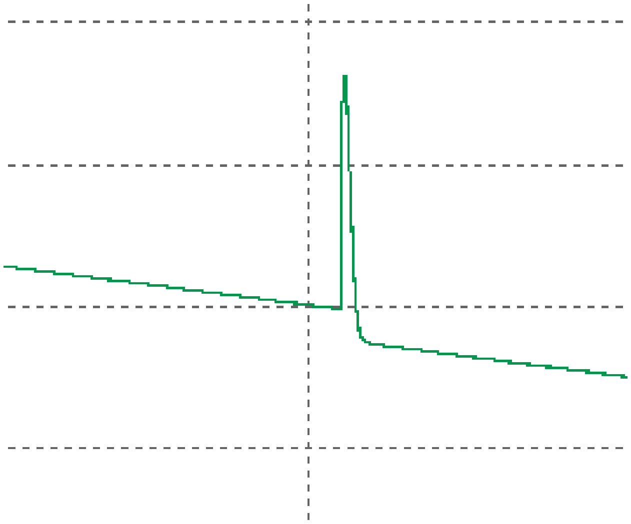


Figure 4. Example OTDR image of a lossy connector (IL = 1.09 dB; RL = -35.7 dB).Figure 4. Example OTDR image of a lossy connector (IL = 1.09 dB; RL = -35.7 dB).

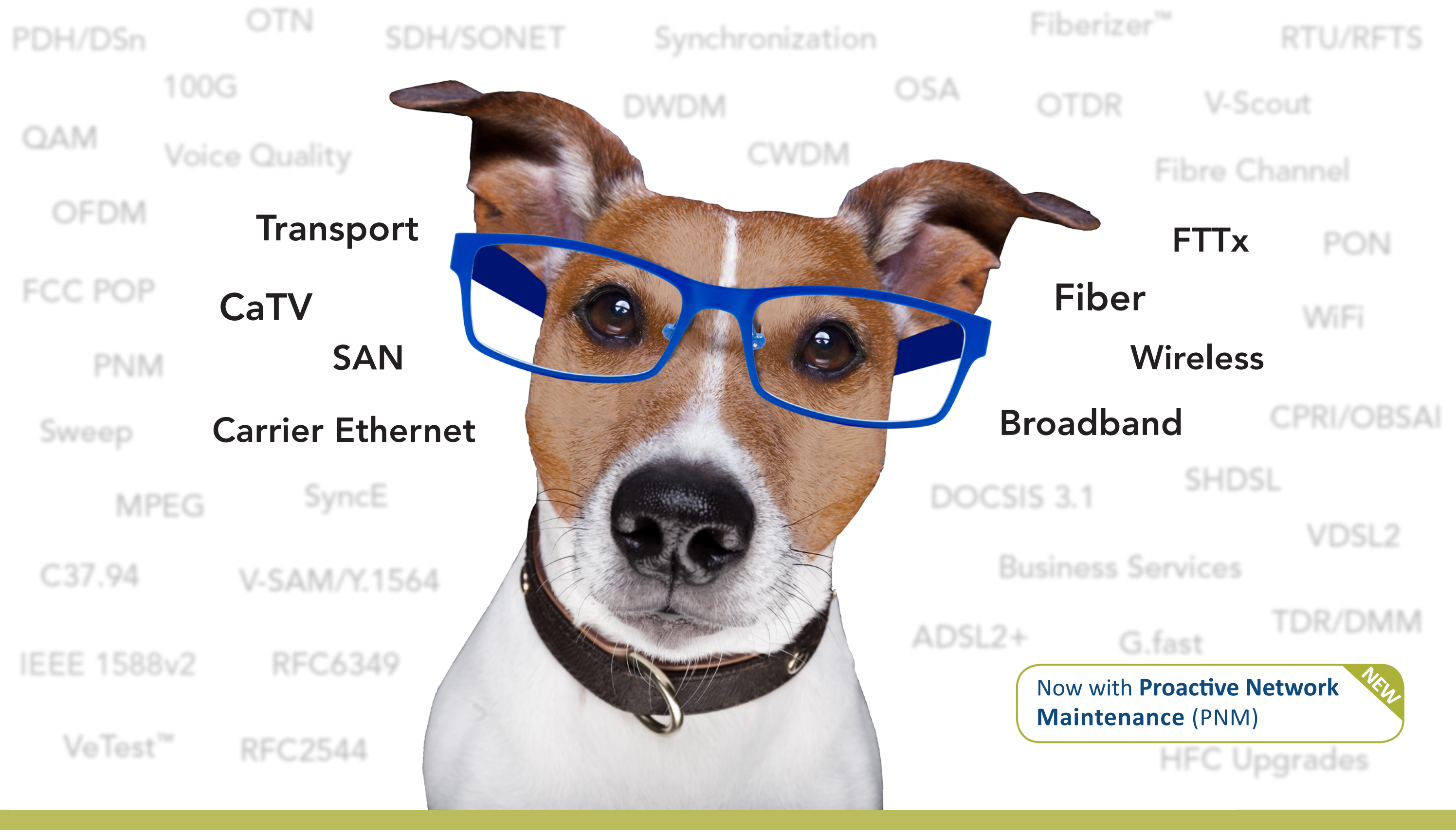
dead zone of the OTDR. The event dead zone of the OTDR is the ability of the OTDR to resolve between two reflective (Fresnel) events. The attenuation dead zone is the ability of the OTDR to measure a non-reflective event (Raleigh) after a reflective (Fresnel) event.

In the case of a faulty connector, the event will likely show a reflective component (Fresnel) and loss component (Raleigh).

This requires the technician to be able to carefully setup the OTDR to minimize the dead zone to enable effective measurement and diagnosis of the performance of a faulty connector. If the pulse width is set too wide, the faulty connector may never be "seen" because that connector was too close to another event and will be hidden by the dead zone of the OTDR.

As fiber networks are tasked with transmitting more data, it is imperative that the technician cleans and inspects every connector before they are connected to the network. This is necessary to ensure that all future high-bandwidth applications operate reliably. The ability of the technician to effectively measure the performance of an optical connector using an OTDR is necessary to enable quick identification and repair of the fiber link back to operational status.

Keith Foord is product manager, fiber optics at Greenlee Communications.


PDH/DSn
OTN
SDH/SONET
Synchronization
Fiberizer™
RTU/RFTS
100G
DWDM
OSA
OTDR
V-Scout
QAM
Voice Quality
CWDM
Fibre Channel
OFDM
Transport
FTTx
PON
FCC POP
CaTV
Fiber
WiFi
PNM
SAN
Wireless
Sweep
Carrier Ethernet
Broadband
CPRI/OBSAI
MPEG
SyncE
DOCSIS 3.1
SHDSL
C37.94
V-SAM/Y.1564
Business Services
VDSL2
ADSL2+
G.fast
TDR/DMM
IEEE 1588v2
RFC6349
Now with Proactive Network Maintenance (PNM)
NEW
VeTest™
RFC2544
HFC Upgrades

SPECIAL REPORT

Test challenges for the new cable network paradigm

By Keith Cole, VeEX

There was a time operating a cable network was straightforward: Maintain the local network, feed outside programming into the headend and leave data transmission to the telcos. Today's cable MSOs are not just serving multiple systems, they are serving up multiple services: premium Internet, vast libraries of on-demand content and direct links to over-the-top (OTT) streaming video services. The installed coax plant is not going away anytime soon, but the cable network model is changing. In a move to achieve higher data rates, increase port counts and lower cost per bit, the cable network is modernizing its fiber footprint, with MSOs pushing fiber out toward the end user. At the other end, cable operators are increasingly adopting the data center model, either explicitly or following the trend of headends re-architected as data centers (HERDs).

Of course, all this is easier said than done. In the drive to meet bandwidth demand, the fiber space is in an era of unprecedented technological change. MSOs need to understand the shifts underway and the tools they can use to design, install and maintain fiber networks and data centers. These tools include test. Let's take a closer look at the challenges of test, techniques for success and how to choose equipment that will help organizations to meet the challenges of the future.

Faster, cheaper, more reliable

Bandwidth demand has pushed Ethernet development into a hockey stick curve. The IEEE took 35 years to develop and ratify six Ethernet standards (10 Mbps through 100

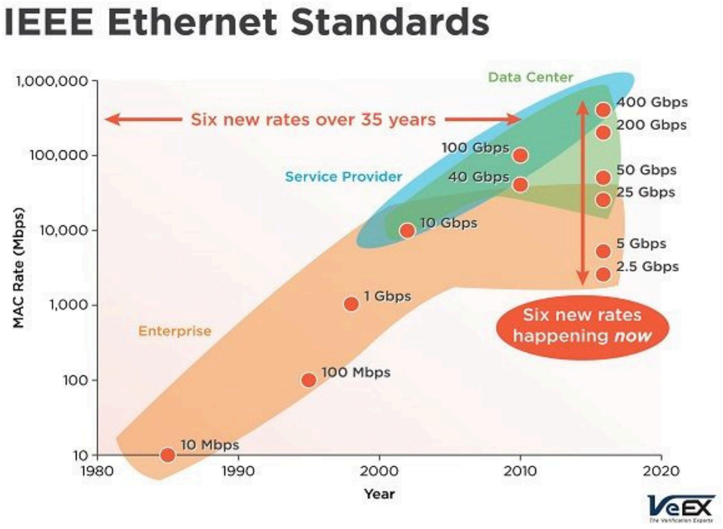
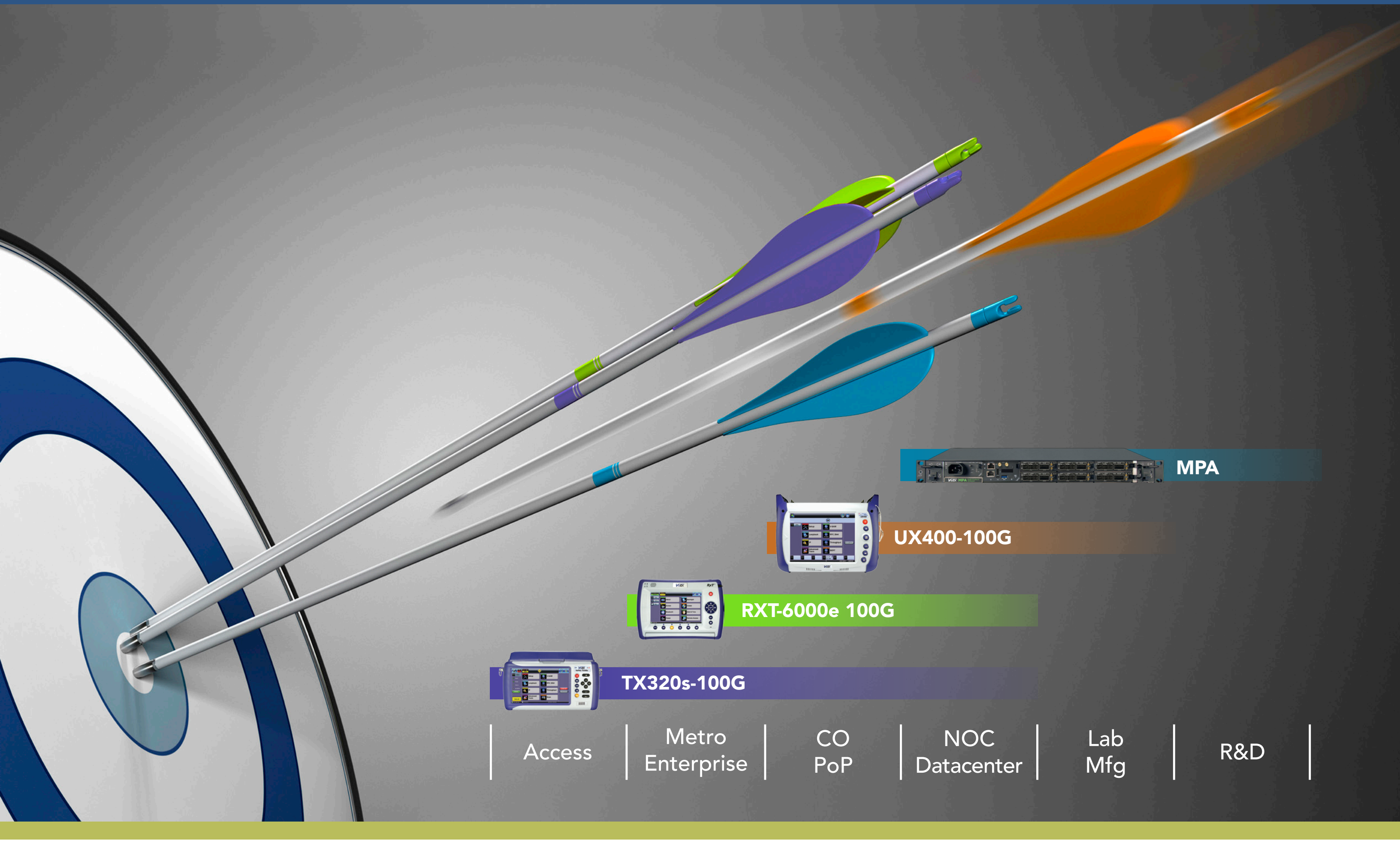


Figure 1. The IEEE spent 35 years developing the first six Ethernet standards; the next six recently completed development or soon will.

Target Your 400G/100G Testing



VeEX Solutions Keep You On Point

Not all 400G and 100G test and measurement applications are the same. From Field, CO, Datacenter, Manufacturing, to R&D environments, VeEX has the right tools to pinpoint your specific testing requirements and environmental needs. Whether it is a portable do-it-all handheld for the field, or a high port density rack-mount, VeEX solutions share a common user interface and feature set allowing seamless interaction between field and core network teams.

Your 100G network deserves a bull's-eye test solution. Visit us at www.veexinc.com to learn more!

- 400G, OTUCn, FlexE, 100GE, 100GE RS-FEC, 50GE, 40GE, 25GE, OTU4, OTU3, STL256.4
- Available in CFP8, CFP4, CFP2, CFP, QSFP28, QSFP+ Interfaces
- With or without lower Ethernet, OTN and legacy SDH/SONET PDH/DSn interfaces

The Verification Experts

Website: www.veexinc.com
Email: info@veexinc.com
Tel: +1.510.651.0500
Fax: +1.510.651.0505

***400G/100G** testing*

Gbps). Currently, an additional six Ethernet standards have either recently completed development or are in their final stages (see Figure 1). Although some time is likely to pass before these standards see broad deployment, cable MSOs need to prepare now to keep up with bandwidth demand and provide modern services that will enable them to remain competitive.

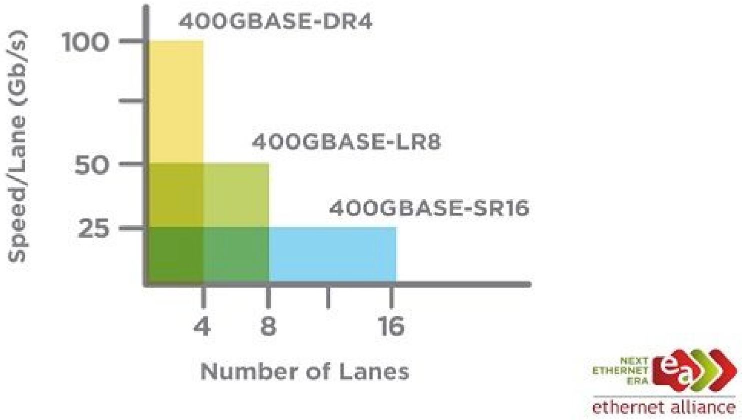


Figure 3. Higher data rates can be achieved using semiconductor materials with slower clock rates by running multiple data streams in parallel.

The challenges don't stop with communications protocols. The physics of semiconductor materials limits the achievable clock rates. To build equipment capable of realizing the new communication standards, transceiver manufacturers apply a variety of techniques, including multiple modulation formats.

For many years, the primary modulation format was on-off keying, or non-return-to-zero (NRZ) modulation. In an attempt to increase bit rates without resorting to the complexities of coherent modulation, the industry has moved toward four-level pulse-amplitude modulation (PAM-4) keying (see Figure 2). The approach delivers double the bit rate compared to NRZ modulation. On the downside, doubling the number of amplitude levels decreases signal-to-noise ratio, making accurate detection and demodulation more difficult. This factor increases the importance of compensation techniques like forward-error correction, which¾again¾add cost and complexity to the network.

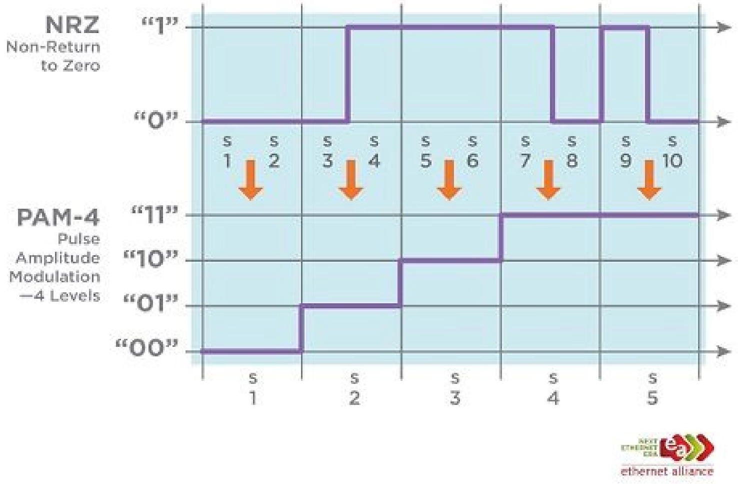


Figure 2. PAM-4 doubles bit rate compared to binary NRZ modulation.

Just doubling the data rate through modulation is not enough to realize the new Ethernet rates, however. Transceiver manufacturers have followed the computer industry in achieving better performance through modular reuse of existing technology. A 400-Gbps module, for example, can be realized using 16 lanes at 25 Gbps or eight lanes at 50 Gbps (see Figure 3).

The size of optical modules adds another practical concern. Particularly in the data center, maximizing faceplate density is essential. This has led to the development of a number of new form factors for optical transceiver modules (see Figure 4). Although the classic small form-factor pluggable (SFP) and the quad small form-factor pluggable (QSFP) packages remain

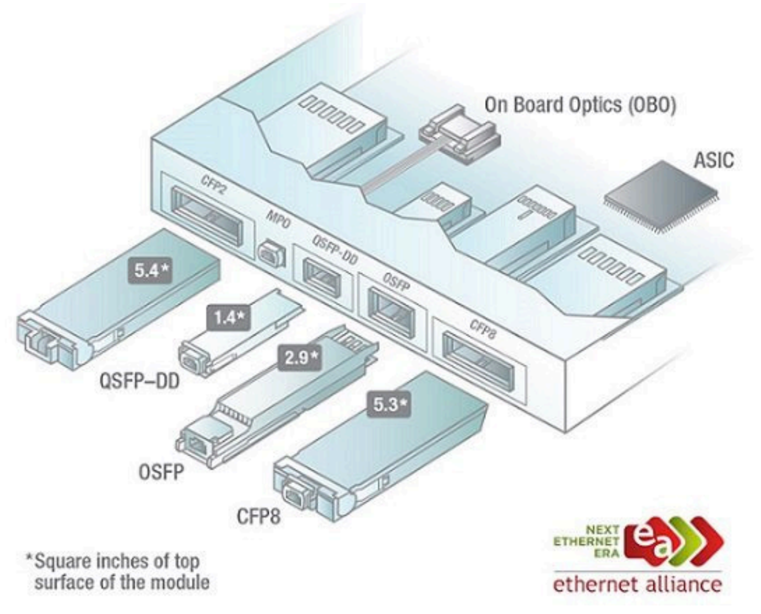


Figure 4. Emerging specifications for optical transceiver modules include QSFP-DD, which can support eight lanes at 50 Gbps, and CFP8, which supports 16 lanes at 25 Gbps.

the workhorses of the industry, new form factors have been designed specifically to support the new high-speed protocols. Emerging form factors include a new compact form factor (CFP8) that supports 16 lanes of 25 Gbps transmission each (for a 400 Gbps port rate) and a double-density version of the QSFP (QSFP-DD), that delivers eight lanes at 50 Gbps (400 Gbps). The latter module has dimensions similar to those of a 100G QSFP28 and is backward compatible with QSFP28 ports.

Amid this ever-evolving technology landscape, cable MSOs still have to design and build networks and keep them running. That requires equipment that will support functional testing and monitoring, even as protocols, modules and form factors change.

Testing tasks

Testing for cable operators falls into three basic categories: system verification at the testbed level, system installation and integration, and system monitoring. Building a new network starts with designing and validating the system. Testbeds need to be evaluated in an environment that simulates real-world conditions to demonstrate performance and interoperability. During deployment, teams need to perform acceptance testing on equipment and then verify network /data center performance using simulated traffic. Finally, the functioning network needs to be monitored on an ongoing basis to ensure quality of service. Let’s take a closer look at the key test operations involved.

Transceiver Module Verification. Pluggable transceivers need to be evaluated prior to deployment to ensure that they meet specifications. Key characteristics include bit error rate (BER) performance and optical power level, both in terms of output and received power. The programming and read-write operation of the MDIO and I2C registers should to be verified. It is also important to check input power tolerance and the overall power consumption of the module. Finally, the clock generation and offsets of the high-speed lanes need to be evaluated.

Ethernet/IP Traffic Verification. We can split Ethernet/IP traffic verification into two parts: validating the physical coding sublayer (PCS) and evaluating data exchange in the Ethernet/IP layer.

The PCS is the top level of the PHY layer. It repackages the raw data of the PHY layer to interface with the media-independent interface. Verifying the PCS includes checking lane skew/ latency, lane misalignment and lane swapping.

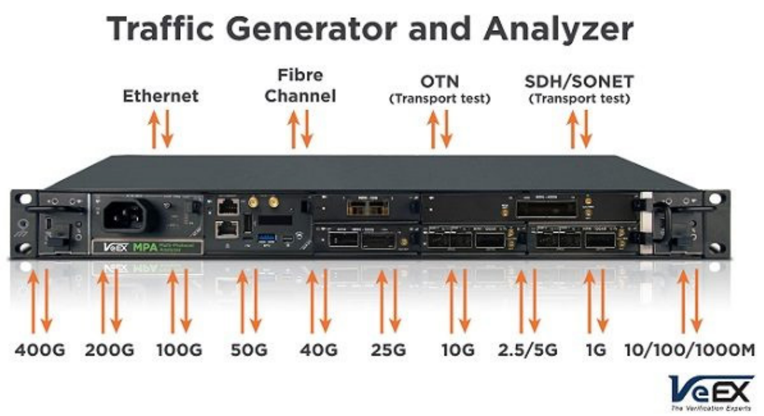


Figure 5. Cable MSOs need to be able to test heterogeneous networks and data rates simultaneously.

The process of validating the Ethernet/IP layer includes checking key performance indicators like throughput, frame loss, latency and jitter, as well as frame-size (MTU) performance. The RFC 2544 and Y.1564 industry standards specify the parameters subject to test and the protocols for evaluating them.

In addition to the layer-specific tests, error/alarm response should be evaluated for both PCS and Ethernet/IP.

The biggest challenge in this testing is effective traffic simulation and measurement. Recall, the IEEE already has six Ethernet standards in place. The 400G Ethernet standard, one of the six new standards, was ratified in December 2017; in fact, only IEEE P802.3cd (for 50 Gigabit Ethernet, multimode 200 Gigabit Ethernet, and a new “cost effective” version of 100 Gigabit Ethernet) remains to be completed of the new six. Effective testing of connections based on new and “original six” Ethernet requires accurate and consistent traffic simulation at the data rate of interest and accurate, high-resolution measurement of the results. This is particularly important given that most networks use a mixture of transport technologies and data rates, depending on the specific data transport task underway (see Figure 5).

Service disruption time (SDT). The days of customers being limited to either their cable channels or the neighborhood video store are long gone. If service cuts out during an episode of Westworld, today’s viewer can easily switch off the TV and stream directly into their tablet¾and potentially never turn the TV back on. To retain customers, cable MSOs absolutely have to be able to assure network availability.

The test process starts with characterizing the service restoration time for the equipment in the aftermath of a failure event. This involves verifying reset times of components, transceivers and systems. It includes details like microcontroller firmware reboot to clock data recovery. Perhaps more relevant in this context is the summation of the total restoration process. This information needs to be established for all port rates and protocols in use.

Test requirements

The new network paradigm, coupled with rapidly changing hardware and protocols, puts special demands on network operators and the test equipment they use. Engineering and operating the systems is difficult enough¾test equipment should be able to meet the technical challenges and simplify the process.

For starters, equipment must be capable of testing components and systems at the new port rates and protocols. Optical networking is not a one-speed-fits-all proposition. The optimal data rate differs depending on the function, budget and even age of the network. It’s financially impractical to buy separate test gear for each speed. Equipment must be multifunction so that it can be applied throughout the network as required.

Similarly, the equipment needs to be able to accommodate multiple pluggable form factors. The ideal platform is built around pluggable modules that enable new features and ports to be added when required. This "pay-as-you-go" approach enables test equipment to adapt to the evolving technology.

Traffic generators and analyzers should be designed to provide flexible, high-density traffic generation. It is also useful to have equipment capable of multi-port traffic generation and analysis for high density and aggregation applications.

Finally, ease-of-use should not be underestimated. Easy configuration speeds set up. Automated test increases repeatability and reliability of results. Installing and maintaining the network may be challenging but the test aspect of it does not have to be.

Conclusion

From software to hardware, protocols to optical modules, the data communications industry is in a radical state of flux. New business models are forcing cable MSOs to become data-center operators. The new hardware and software trends demand the availability of flexible instrumentation to support new product development and network operation. Existing test equipment toolboxes need to be refreshed to be able to support the new technologies that are being deployed. Although the new high-speed network protocols may not see broad adoption immediately, cable MSOs need to prepare for the future. The right test equipment will help them do just that.

Keith Cole *is vice president of product marketing at* *VeEX* *(Fremont, CA).*

Packet Optical Transport Network Benchmark Testing, Methodology and Case Study

Case Study

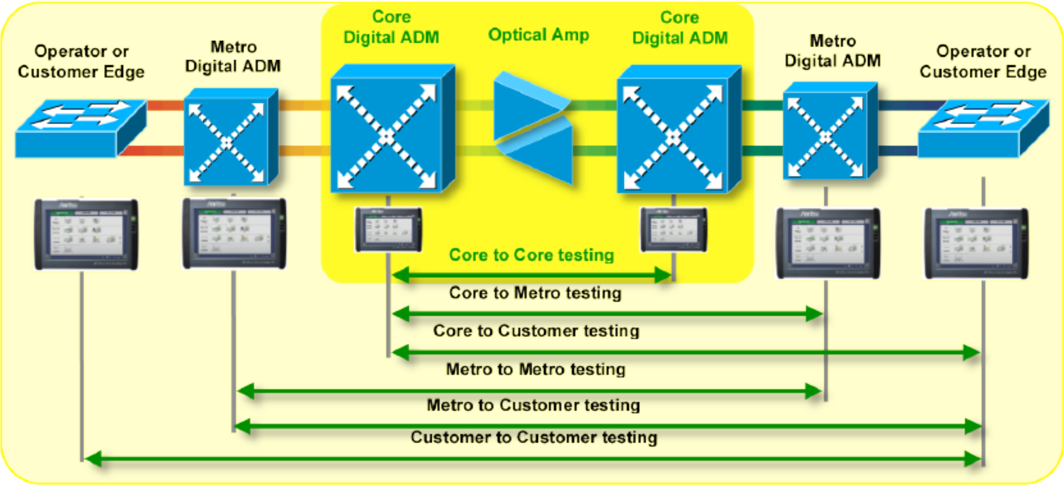
What is Packet Optical Transport Systems (P-OTS)?

Packet Optical Transport Systems (P-OTS) is a network consisting of multiple client payloads transported over flexible optical transport protocols, most common being **Multi-Protocol Label Switching–Transport Profile (MPLS-TP)**, **Provider Backbone Bridges–Traffic Engineering (PBB-TE)** and **Optical Transport Network (G.709 or OTN)**. P-OTS networks can transport a mixture of packet and circuit based clients, including **SDH/SONET, Ethernet/IP** and **Fibre Channel** payloads over a single, managed, resilient fiber optic meshed or ring network.

P-OTS networks are growing significantly in the Access and Metro network segments due to the ability to support multiple client mappings and payloads into a manageable, reliable network while reducing CAPEX and time to market. The reason why P-OTS networks are desirable is because the latest generation of P-OTS equipment levies the existing circuit- and packet-based transport technologies already existing in most optical networks with new enhancements introduced in P-OTS technology, such as MPLS-TP, PBB-TE and OTN.

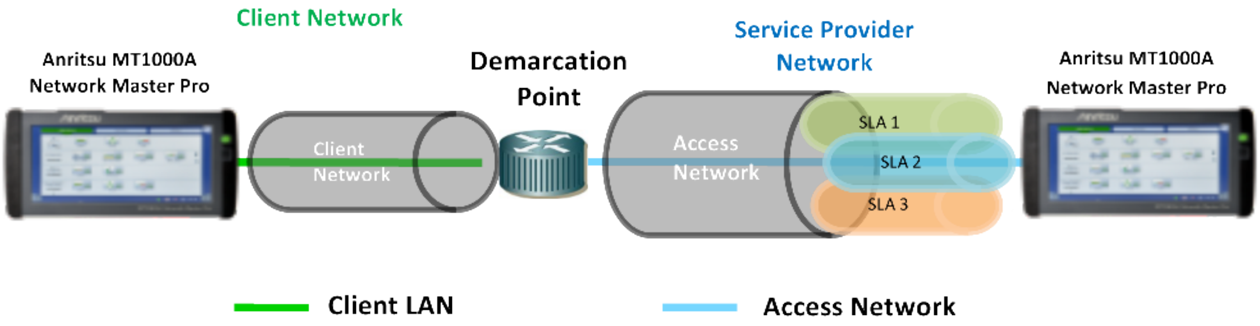
Role of P-OTS Test Equipment

To ensure existing and new clients' payload and traffic attain the same **Quality of Service (QoS)** agreed upon by the business client and service provider, test equipment is required to measure the performance of the client traffic through a network segment. The client traffic is emulated by the test equipment and generated from the point of origin where the client traffic enters a particular network segment. In most cases, this point of origin is called the **Demarcation Point**. The test equipment must then **terminate** (receive) the emulated client traffic at the destination and measure performance criteria to determine if the QoS was met. The terminate point can be another demarcation point, which is referred to as **End-to-End testing**, or the same demarcation point, which is referred to as **Reflected** or **Single-ended testing**.



Where to Use P-OTS Test Equipment

The demarcation point varies depending on the segment of the network. For example, the demarcation point can be at the customer premise, where the client traffic first enters the service provider network. The client's traffic must now follow the rules and policies agreed upon between the service provider and the client. The service provider network segment connected closest to the client premise is called the **Access Network**. The structured agreement between the service provider and client to determine the QoS the client traffic will receive is called the **Service Level Agreement (SLA)**.



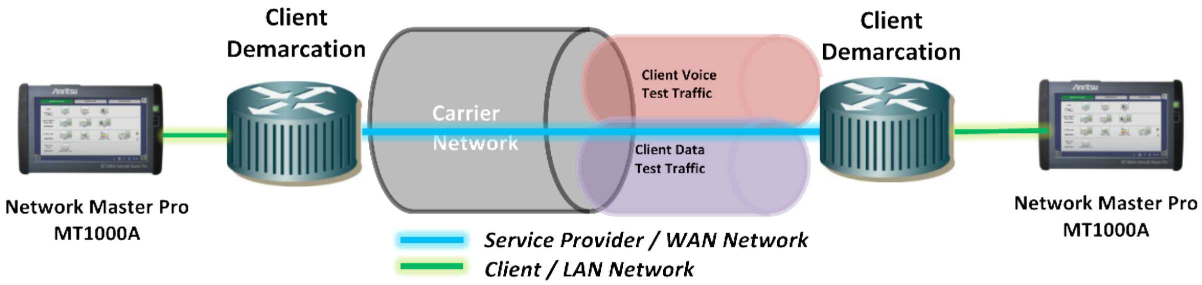
Service providers, Network Equipment Manufacturers (NEM) and clients want to perform P-OTS network testing in the Access Network. For service providers and clients, they must verify the SLA is structured correctly and the performance meets expectations. Service providers must ensure they are not providing more than what the client is paying for, which could result in loss in profit and network inefficiency. Clients (commercial, medical, government, education) must ensure they are receiving the QoS they are paying for as well as adjust for new services when encountering growth or change in needs.

P-OTS Test Case Example – Mobile Backhaul Client Service Verification

Anritsu demonstrated the mobile backhaul test capabilities of the Anritsu Network Master Pro MT1000A by performing a test evaluation on a packet-based mobile backhaul network connected over a service provider fiber-optic managed network. The test evaluation identified several unknown network issues residing on the mobile backhaul and offered several possible solutions to improve network performance.

Mobile Backhaul Network Overview

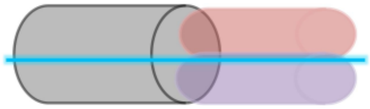
Two Anritsu Network Master Pro MT1000A test instruments were used in performing end-to-end testing between two client demarcation points–the wireless provider base station and the central office. Each unit performed traffic generation and monitoring to verify measurement results in bi-directional monitoring. The diagram below describes the network test configuration. Two different client test traffic flows were generated and monitored–one to simulate voice traffic, the other to simulate data traffic.



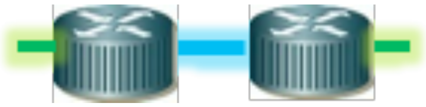
Service Provider and Client Quality of Service Measurements

Selection of the proper benchmark verification **test** and **location** will determine packet-based QoS through client and service provider networks. Each benchmark test addresses a specific P-OTS network, demarcation point or equipment to determine if the Service Level Agreement has been met.

a. **RFC 2544–IETF** standards body test typically used for packet-based **Network Equipment** or new lines. This traditional benchmark test is used to test the layer 2 "pipe" throughput, latency and frame loss measurements after the physical layer 1 fiber has been tested using an OTDR. This test was originally designed to benchmark layer 2 network equipment and not networks, but has been adopted by most operators as there was no other standard completed at the time of use.



b. **Y.1564–ITU** standards body test relatively new to the industry, often used to replace RFC 2544 in the operator end-to-end testing scenario but not for individual Packet Optical Transport equipment. Y.1564 is a benchmark test used to emulate the "services" purchased by a client to verify the Service Acceptance Criteria (SAC) agreed upon between client and service provider. Unique from RFC2544, this test is capable of testing transport and networking layers. Similar to RFC2544 benchmark testing, but designed to test end-to-end networks specifically, RFC 6349 allows more dynamic test and better simulates real-world use of the Packet Optical Transport service.

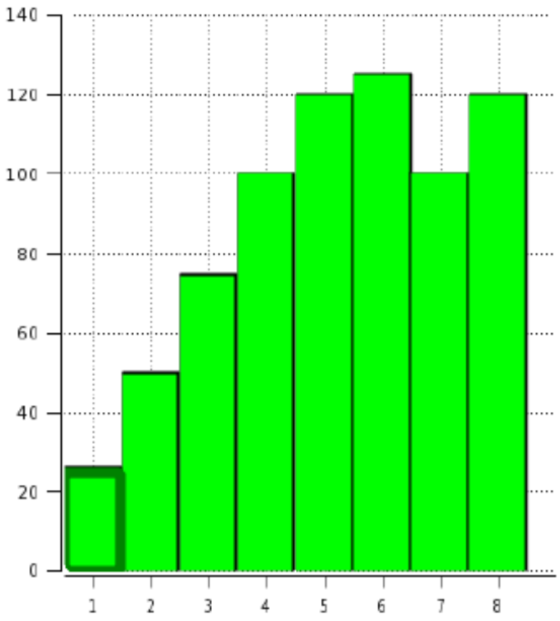


c. **RFC 6349–IETF** standard body test, recently developed. This benchmark test tests the layer 4 TCP communication within the packet-based transport. This test is focused on the client-to-client communication once physical, transport and network layers are tested. Although not required by most NEM, service providers and clients, this benchmark test enables deeper testing into the packet and designed to test end-to-end throughput through a client demarcation point or firewall. This test is increasing in popularity.

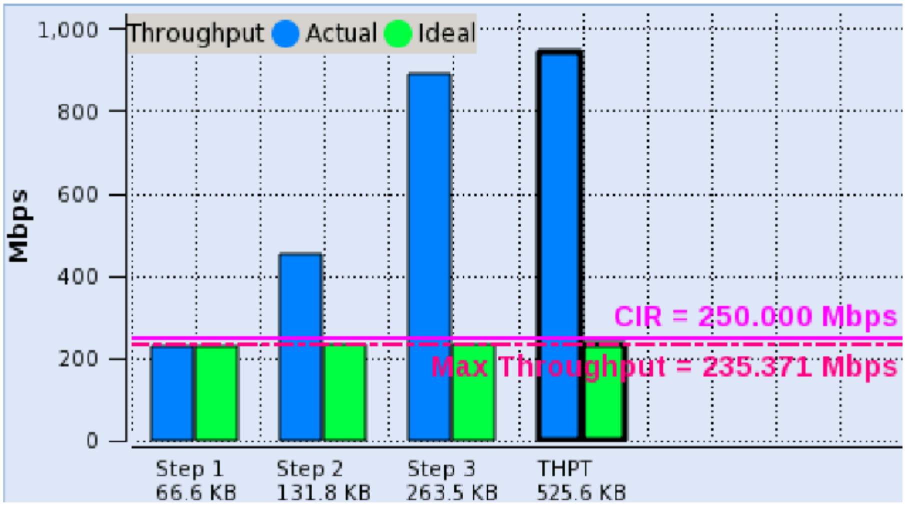
Mobile Backhaul Network Verification Summary

Anritsu Optical Transport Network testers have the ability to test and create detailed reports to measure SAC and TCP throughput for wireless mobile backhaul applications. The Anritsu MT1000A Network Master Pro was used to identifying uni-directional packet service performance through both the client and service provider network. The Anritsu Network Master MT1000A can encapsulate TCP traffic into the ITU-T **Y.1564** service activation test and IETF **RFC 6349**.

The graphs below are sample results of the Y.1564 and RFC 6349 tests:



Y.1564 Service Configuration Test Results Graph



RFC6349 TCP Throughput Window Scan Results Graph

Data provided by the Anritsu MT1000A Network Master Pro can assist wireless mobile backhaul service providers by offering the following information.

1. The Y.1564 service activation test was able to determine if due to lack of network policing, the SLA between the wireless provider (client) and fiber optic service provider met/exceeded expected guaranteed level of performance. This information is critical for the service provider to ensure client related service is provided.

2. The IETF RFC 6349 TCP throughput test was able to determine the client service is provisioned correctly from the client demarcation point. Due to lack of network policing, the client service TCP throughput exceeded expectations. This information is critical for the client to ensure their service is provisioned to maximize the SLA purchased through the service provider.

Anritsu Network Master Family

All-in-one transport network testers support testing from 1.5 Mbps to 100 Gbps - the MT1100A Network Master Flex and MT1000A Network Master Pro redefine the direction of future test platforms by bringing all your network test requirements to a portable device. These instruments support **OTN**, **MPLS-TP, Ethernet** and **Fibre Channel**, as well as legacy networks, including **PDH/DSn** and **SDH/SONET**. Additional transport testing capabilities include **CPRI/OBSAI** and **RFC 6349** TCP throughput testing, OTN multi-stage mapping for OTU3/4, MDIO analysis and support of a Video Inspection Probe (VIP).

Anritsu
envision : ensure

Specifications are subject to change without notice.

United States
Anritsu Company
1155 East Collins Blvd, Suite 100
Richardson, TX 75081, U.S.A.
Toll Free: 1-800-267-4878
Phone: +1-972-644-1777
Fax: +1-972-671-1877

Canada
Anritsu Electronics Ltd.
700 Silver Seven Road, Suite 120
Kanata, Ontario K2V 1C3, Canada
Phone: +1-613-591-2003
Fax: +1-613-591-1006

Brazil
Anritsu Electrônica Ltda.
Praça Amadeu Amaral, 27 - 1 Andar
01327-010 Bela Vista, São Paulo, Brazil
Phone: +55-11-3283-2511
Fax: +55-11-3288-6940

Mexico
Anritsu Company, S.A. de C.V.
Av. Ejército Nacional No. 579 Piso 9, Col. Granada
11520 México, D.F., México
Phone: +52-55-1101-2370
Fax: +52-55-5254-3147

United Kingdom
Anritsu EMEA Ltd.
200 Capability Green
Luton, Bedfordshire LU1 3LU
United Kingdom
Phone: +44-1582-433280
Fax: +44-1582-731303

France
Anritsu S.A.
12 Avenue du Québec
Bâtiment Iris 1-Silic 612
91140 Villebon-sur-Yvette, France
Phone: +33-1-60-92-15-50
Fax: +33-1-64-46-10-65

Germany
Anritsu GmbH
Nemetschek Haus, Konrad-Zuse-Platz 1
81829 München, Germany
Phone: +49-89-442308-0
Fax: +49-89-442308-55

Italy
Anritsu S.r.l.
Via Elio Vittorini 129
00144 Roma, Italy
Phone: +39-06-509-9711
Fax: +39-06-502-2425

Sweden
Anritsu AB
Kistagången 20B
164 40 KISTA, Sweden
Phone: +46-8-534-707-00
Fax: +46-8-534-707-30

Finland
Anritsu AB
Teknobulevardi 3-5
FI-01530 Vantaa, Finland
Phone: +358-20-741-8100
Fax: +358-20-741-8111

Denmark
Anritsu A/S
Kay Fiskers Plads 9
2300 Copenhagen S, Denmark
Phone: +45-7211-2200
Fax: +45-7211-2210

Russia
Anritsu EMEA Ltd.
Representation Office in Russia
Tverskaya str. 16/2, bld. 1, 7th floor
Russia, 125009, Moscow
Phone: +7-495-363-1694
Fax: +7-495-935-8962

United Arab Emirates
Anritsu EMEA Ltd.
Dubai Liaison Office
P O Box 500413 - Dubai Internet City
Al Thuraya Building, Tower 1, Suite 701, 7th Floor
Dubai, United Arab Emirates
Phone: +971-4-3670352
Fax: +971-4-3688460

Singapore
Anritsu Pte. Ltd.
11 Chang Charn Road, #04-01, Shriro House
Singapore 159640
Phone: +65-6282-2400
Fax: +65-6282-2533

India
Anritsu India Private Limited
2nd & 3rd Floor, #837/1, Binnamangla 1st Stage
Indiranagar, 100ft Road, Bangalore - 560038, India
Phone: +91-80-4058-1300
Fax: +91-80-4058-1301

P.R. China (Shanghai)
Anritsu (China) Co., Ltd.
27th Floor, Tower A
New Caohejing International Business Center
No. 391 Gui Ping Road Shanghai, Xu Hui Di
District
Shanghai 200233, P.R. China
Phone: +86-21-6237-0898
Fax: +86-21-6237-0899

P.R. China (Hong Kong)
Anritsu Company Ltd.
Unit 1006-7, 10/F., Greenfield Tower
Concordia Plaza
No. 1 Science Museum Road, Tsim Sha Tsui East
Kowloon, Hong Kong, P. R. China
Phone: +852-2301-4980
Fax: +852-2301-3545

Japan
Anritsu Corporation
8-5, Tamura-cho, Atsugi-shi
Kanagawa, 243-0016 Japan
Phone: +81-46-296-1221
Fax: +81-46-296-1238

Korea
Anritsu Corporation, Ltd.
5FL, 235 Pangyoyeok-ro, Bundang-gu
Seongnam-si
Gyeonggi-do, 463-400 Korea
Phone: +82-31-696-7750
Fax: +82-31-696-7751

Australia
Anritsu Pty Ltd.
Unit 21/270 Ferntree Gully Road
Notting Hill, Victoria, 3168, Australia
Phone: +61-3-9558-8177
Fax: +61-3-9558-8255

Taiwan
Anritsu Company Inc.
7F, No. 316, Sec. 1, Neihu Rd, Taipei 114, Taiwan
Phone: +886-2-8751-1816
Fax: +886-2-8751-1817

Document Number: Anritsu Case Study_v1

Printed OCT 15

Anritsu
envision : ensure

Description

Anritsu Company is the United States subsidiary of Anritsu Corporation, a global provider of innovative communications test and measurement solutions for 120 years. Anritsu's "2020 VISION" philosophy engages customers as true partners to help develop wireless, optical, microwave/RF, and digital instruments, as well as operation support systems for R&D, manufacturing, installation, and maintenance applications. Anritsu also provides precision microwave/RF components, optical devices, and high-speed electrical devices for communication products and systems. The company develops advanced solutions for 5G, M2M, IoT, as well as other emerging and legacy wireline and wireless communication markets. With offices throughout the world, Anritsu has approximately 4,000 employees in over 90 countries.

To learn more visit www.anritsu.com and follow Anritsu on Facebook, Google+, LinkedIn, Twitter, and YouTube.

LINKS:

- Industry's Smallest-in-class 100G Tester
- Network Master™ Pro Product Page
- Anritsu Fiber Optic & OTDR Certification

VIDEOS:

- Anritsu Network Master Family of Optical Transport Testers Introduction
- Anritsu MT1000A Network Master Pro All-in-One Field Portable Tester

GREENLEE COMMUNICATIONS

Description

GREENLEE COMMUNICATIONS offers industry-leading, innovative and rugged Test Tools for the communication service provider industry used in Ethernet, Datacom, Telecom, Fiber-Optic and CATV applications. Choose from a large line-up of premium installation test tools such as E1/E3 (BRI/PRI), GigE & 10GBitE, xDSL, Wi-Fi, CATV, OTDR's, Fusion Splicers, OLS, OPM, LFI, VFF, Tone & Probe Kits, Test Telephones and more - all field tested to perform.

The Greenlee Communications brand within Greenlee was part of that initiative and through our strategic acquisitions in Fiber & Ethernet segments; Greenlee has emerged as the leading provider of next generation test & measurement solutions in the global communications industry. We serve customers across the globe from the Americas, Canada, Europe, Africa and Asia. Our success is built on a long track record of delivering high quality innovative solutions enabling technicians to achieve their goals faster and with confidence.

Description

VeEX Inc. develops innovative test solutions for next generation communication networks and services. With a blend of advanced technologies and vast technical expertise, VeEX's products address all stages of network deployment, maintenance, field service turn-up, and service verification features across DSL, Fiber Optics, CATV/DOCSIS, Mobile, next-generation Transport Network, Fibre Channel, Broadband/IPTV, WiFi, Synchronous and Carrier Ethernet technologies. For more information visit www.veexinc.com.

LINKS:

- Main website
- Fiber Optics
- Multi-Protocol Analyzer (MPA) Series
- RXT-6000e
- RXT-6200