Selecting the Optimal Test Methodology for Ethernet Service Turn-Up

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Today's networks are becoming all Ethernet/IP based with various Ethernet services deployed over different topologies, distances and with supporting protocols such as multiprotocol label switching (MPLS). The reason networks are designed using this common infrastructure is simply due to the scalability and cost-effectiveness of Ethernet. Combined with new, emerging standards such as ITU Y.1731, MEF and IEEE 802.1ag, Ethernet has become a carrier class service with operations, administration and maintenance (OAM) functionality. These services, whether they be offered by an Internet service provider (ISP), mobile network operator (MNO) or even transported via a carrier's own network, have strict service level agreements (SLA's) to abide by.

An SLA is an agreement between a service provider (e.g. an ISP) and their end customer. It states that the turn up or validation (also referred to as "burned in") of an Ethernet service must be measured and must meet the specifications defined within that SLA. These performance measurements commonly include throughput, latency, jitter, frame delay variation (FDV), frame loss and out of sequence (OOS). Of course there are different network services offered such as online gaming, voice, video, video on demand (VOD) etc., and each service will be configured differently from network-to-network. To ensure Ethernet quality of service (QoS), network design configurations should be driven with the goal in mind of meeting SLA targets. These SLA's must be verified through structured testing. Failure to meet these criteria will result in an unsatisfactory experience on the part of the end customer and potential fines for the ISP for failing to meet pre-established SLA targets.

Therefore, testing Ethernet services and ensuring that those measurements are within the defined specifications of the SLA is critical.

Regardless of the test equipment vendor, there are four main Ethernet test methodologies which are used today.

So which Ethernet test methodology should be used?

- EtherBERT (bit-error-rate test)
- Traffic generation and monitoring/frame analyzer
- RFC 2544
- ITU-T Y.1564

The reality is that for Ethernet service turn-up and troubleshooting, RFC 2544 has been the methodology of choice. However, RFC 2544 was not created for testing new Ethernet services, or for testing live networks for that matter.

RFC 2544 METHODOLOGY: LIMITATIONS AND EXAMPLES

RFC 2544 Limitations

The testing methodology outlined in RFC 2544 has been used, deployed and written into countless test specifications, and methods and procedures since its creation in 1999. Obviously, the networks of 1999 were completely different from the networks of today. For example, large scale deployment of Ethernet was only beginning, and the speed rates offered to end customers (financial institutions, businesses etc.) were low. Naturally, networks have evolved incredibly since then, and today, customers expect much faster rates with tighter criteria.

Even though it was widely adopted, there are many reasons why RFC 2544 should not be the methodology of choice when testing and/or troubleshooting Ethernet services today. These include:

- **RFC 2544 methodology only tests throughput, frame loss, latency and burstability (also known as back-to-back)**. Today's Ethernet services, specifically video, are susceptible to jitter/FDV and this methodology does not comply with FDV testing standards.
- **Unrealistic methodology for testing services**. RFC 2544 methodology recommends testing one measurement (throughput, frame loss, latency or burstability) per each defined frame size. RFC recommends testing seven pre-defined frame sizes: 64, 128, 256, 512, 1024, 1280 and 1518 bytes. Therefore each test conducted should include one measurement per one frame size, one at a time. When you consider that services need to be turned-up rapidly, total test-time becomes too long. Consequently, service providers may drop individual tests to lower the overall test time to simply obtain a quick result. This may be of benefit to the engineer conducting the testing, but the result is that Ethernet service has not been tested long enough and as such the report is not trustworthy.
- **RFC 2544 was created for lab testing only**. As previously mentioned, RFC 2544 was developed in 1999 for testing in a controlled and isolated environment through a layer 2 switch. This methodology was not created for testing live networks, especially not for testing Ethernet services.

› **Hazardous throughput algorithm**. The reason why RFC 2544 can be hazardous to live networks is due to the binary division mechanism this methodology uses to discover the throughput result. Put simply, it uses a 50/50 split which can absorb bandwidth away from live, revenue generating traffic. This is the reason why RFC 2544 was created for laboratory testing only, and not for live networks, an issue discussed in the IETF documents quoted below.

5. Advisory on RFC 2544 Methods in Production Networks

The tests in [RFC2544] were designed to measure the performance of network devices, not of networks, and certainly not production networks carrying user traffic on shared resources. There will be unanticipated difficulties when applying these methods outside the lab environment.

Operating test equipment on production networks according to the methods described in [RFC2544], where overload is a possible outcome, would no doubt be harmful to user traffic performance. These tests MUST NOT be used on production networks and as discussed above, the tests will never produce a reliable or accurate benchmarking result on a production network.

Source: IETF Network Working Group, RFC 2544 Applicability Statement: Use on Production Networks Considered Harmful. June 12, 2012, https://tools.ietf.org/html/draft-ietf-bmwg-2544-as-04

4.2. Containing Damage

[RFC2544] methods, specifically to determine Throughput as defined in [RFC1242] and other benchmarks, may overload the resources of the device under test, and they may cause failure modes in the device under test. Since failures can become the root cause of more widespread failure, it is clearly desirable to contain all test traffic within the ITE.

In addition, such testing can have a negative effect on any traffic that shares resources with the test stream(s) since, in most cases, the traffic load will be close to the capacity of the network links.

Source: IETF RFC 6815, Applicability Statement for RFC 2544: Use on Production Networks Considered Harmful. November 2012 , https://tools.ietf.org/html/rfc6815

Additional limitations of RFC 2544 for testing Ethernet services include, but are not limited to:

› **Single stream test**. If the test engineer wishes to test multiple services, they are required to setup and run the same test several times, resulting in a longer testing time. Additionally, it's important to remember that there are many services deployed over any given network. As such, it's important to test loading on the network to ensure the Ethernet service is not impacted when transmitted with other test services; especially if that service has a high priority configured within a VLAN tag and/or MPLS label.

› **Excess and overshoot tests**. In addition to extra measurements required for today's Ethernet services, tests are required to measure excess bandwidth (EIR) and network equipment overshoot/policing which "throttles" service bandwidth to an agreed value, as stated in the SLA. The RFC 2544 methodology does not comply with EIR and overshoot/policing testing standards.

› **RFC 2544 is only a recommended testing methodology**. It is not a standardized methodology for testing Ethernet.

RFC 2544 Test Example

Below is an example of an RFC 2544 test. It was configured to test all measurements (throughput, frame loss, latency and burstability) for all RFC 2544 defined frame sizes (see figure 1). The interface is 1GE, and since Ethernet has no specification which defines how long to test for, an acceptable but minimal test time for 1GE is, for example, one minute for throughput testing (see figure 2). However, as rates increase, the test time should also increase.

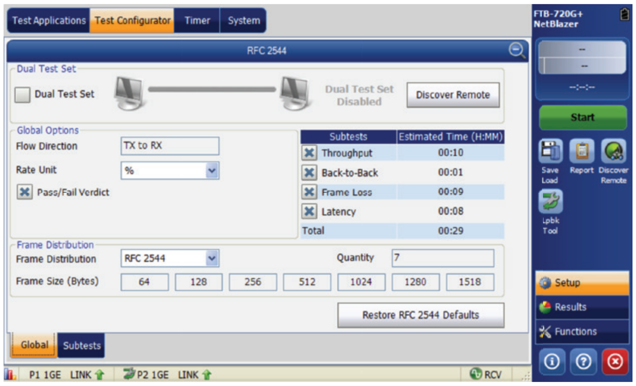

Figure 1: Global view of RFC 2544 test with RFC recommended frame sizes

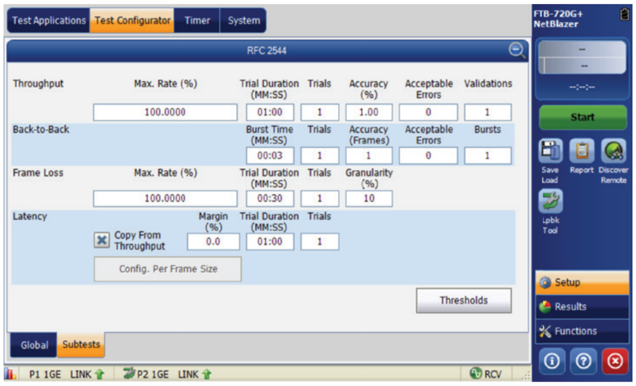

Figure 2: Detailed configuration of each subtest duration and other parameters

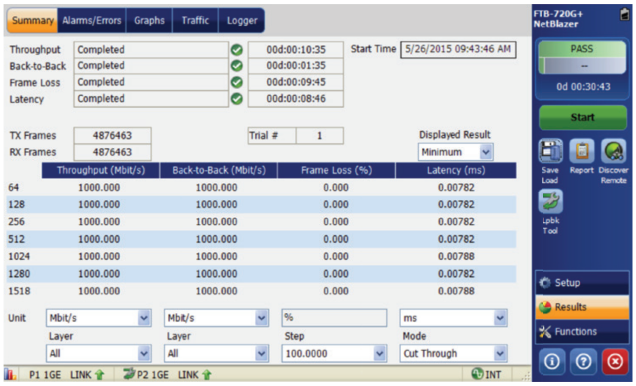

Figure 3: Results of RFC 2544 testing

As per the above example, this basic RFC 2544 test had a test duration of 30 minutes and 43 seconds (see figure 3); hence the reason why engineers will always lower test setup time, which in turn makes the results untrustworthy. It's important to remember however, that we have not defined the type of service (voice, video, data), and not tested multiple streams. Additionally, the test has used a known hazardous throughput binary division mechanism which can give misleading results and impact live services.

WHICH TEST METHODOLOGY SHOULD BE USED?

To resolve issues with existing methodologies, EXFO worked closely with the ITU-T standard body and was at the forefront of the introduction a new test standard: ITU-T Y.1564, which aligned closely with the requirements of today's Ethernet services. EXFO's EtherSAM, based on Y.1564, enables complete validation of all SLA parameters within a single test to ensure optimized quality of service (QoS) and, contrary to RFC 2544, supports multi-stream functionality.

EtherSAM also validates the QoS mechanisms provisioned in the network to prioritize the different service types, resulting in more accurate validation, and much faster deployment and troubleshooting.

ITU-T Y.1564 EtherSAM is based on the principle that the majority of service issues are found in two distinct categories:

› In the configuration of the network elements that carry the service

› In the performance of the network during high load conditions when multiple services cause congestion

Therefore this standardized methodology includes two Ethernet service tests:

1. Service Configuration Test

Network components (switches, routers, bridges etc.) must be properly configured to ensure traffic is adequately forwarded in accordance with SLA parameters. If a service is not configured on a single device end-to-end, network performance can be affected leading to service outages and network wide issues, such as link failures.

Therefore, the service configuration test will make sure the network equipment is configured properly thus certifying the CIR (committed information rate), EIR (excess information rate), CBS (committed burst size), EBS (excess burst size) and service policing are configured correctly for each service sequentially.

2. Service Performance Test

This refers to the ability of the network to carry multiple services at maximum CIR levels without any performance issues, such as loss. As network devices become loaded with more traffic, decisions regarding quality are required. One traffic flow is prioritized over another in order to meet key performance indicators (KPI's) such as latency, throughput, etc. per each traffic class. The service performance test will test all services simultaneously to ensure that KPI's can be met as per the SLA.

Using the same setup as the RFC 2544 test (outlined in figures 1-3 earlier in the document), a Y.1564 EtherSAM test has been configured to test a 1GE interface (see figure 4). However, within this methodology it is possible to state multiple services with extra measurements (EIR, CBS, EBS, EMIX) and with the two phases of Y.1564, which RFC 2544 does not support.

Therefore, three services (data, video, voice) have been defined (see figures 5,6,7) for a test duration of one minute each within the service performance phase and for thirty seconds each within the service configuration test (see "Subtests" in figure 4). In addition, burst testing (CBS, EBS) will be measured for all 3 services.

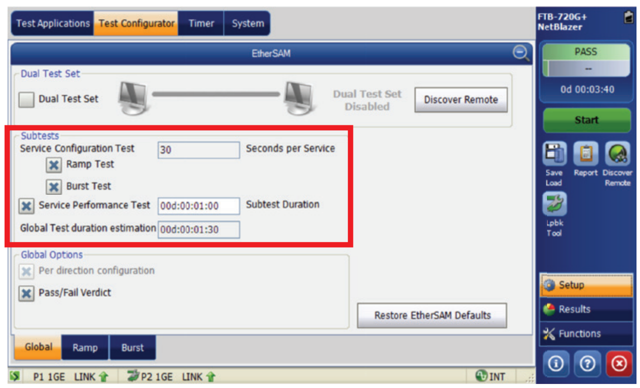

Figure 4: Global view of ITU-T Y.1564 EtherSAM test

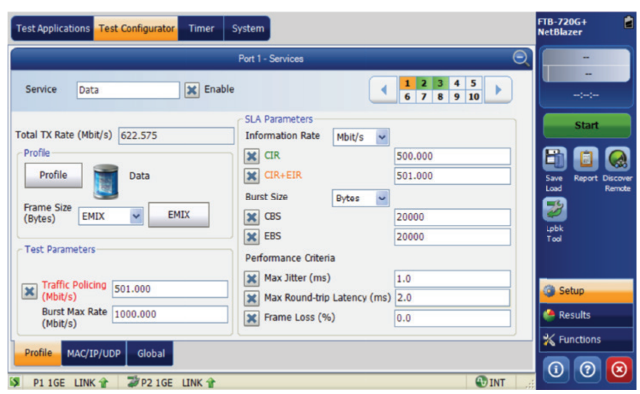

Figure 5: Service 1 (data) configuration with EMIX (Ethernet MIX) frame size

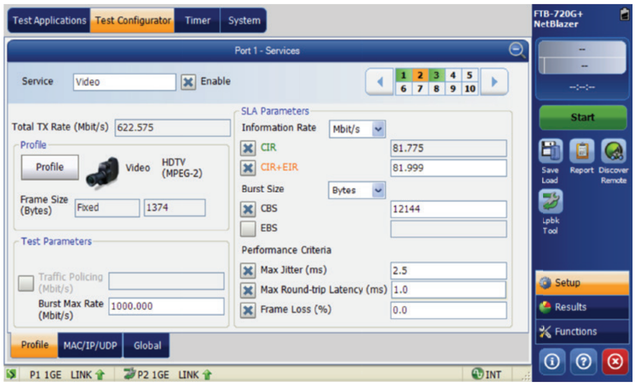

Figure 6: Service 2 (video) configuration

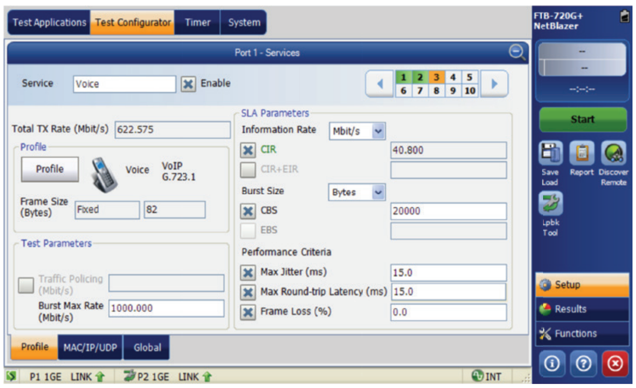

Figure 7: Service 3 (voice) configuration

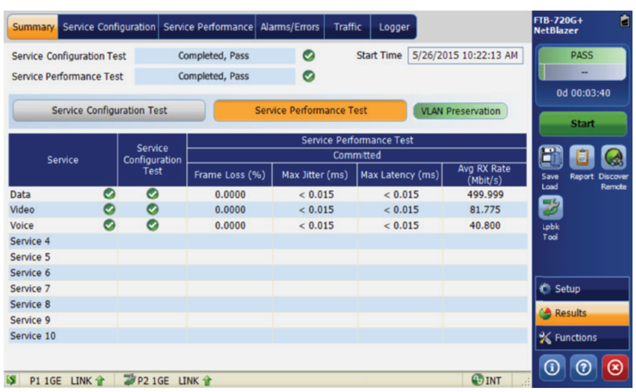

Figure 8: Results of ITU-T Y.1564 EtherSAM test

TRANSITIONING FROM RFC 2544 TO Y.1564 TESTING

Any service provider who has been using RFC 2544, especially those who have used it since its inception, will be very familiar with its testing methods, procedures, test vendor setup, etc. For example, a service provider's customer may suggest RFC 2544 for testing, simply because it's been around for so long.

Furthermore, engineers may be reluctant to adopt Y.1564 for testing as it's a new methodology and perhaps unfamiliar to them. It contains more testing measurements than the RFC 2544 and without the appropriate training/education, it could be daunting for a field technician to adopt. The end result is that field technicians may opt to stay with RFC 2544 to test Ethernet services, instead of testing with the correct and up-to-date methodology-Y.1564

Therefore, a testing methodology based on Y.1564 is required that is simple, quick and compliant to the ITU standard, while still providing the field technician with the information they need to validate and/or troubleshoot the service. Over the years, many test vendors have implemented their own flavor of the Y.1564 testing methodology, nonetheless resulting in the same challenges. Now, EXFO brings to market an evolution to Y.1564—iSAM (intelligent Service Activation Methodology). EXFO's iSAM was designed to simplify field technicians' daily tasks by focusing on the most common Ethernet service turn-up configurations used in the industry today. It is a simplified and automated version of the Y.1564 test methodology, allowing service providers who have not yet adopted Y.1564 to meet the challenge of easily transitioning from RFC 2544 to Y.1564, and be better aligned with the requirements of today's Ethernet services.

As seen below in figure 9, iSAM offers a one page setup: the field technician defines the test port and addressing, the service type, CIR, the option to use any one of the pre-defined MEF-23.1 standard performance metric profiles, and finally the option to test to a network interface device (NID), remote loopback or dual test set (DTS).

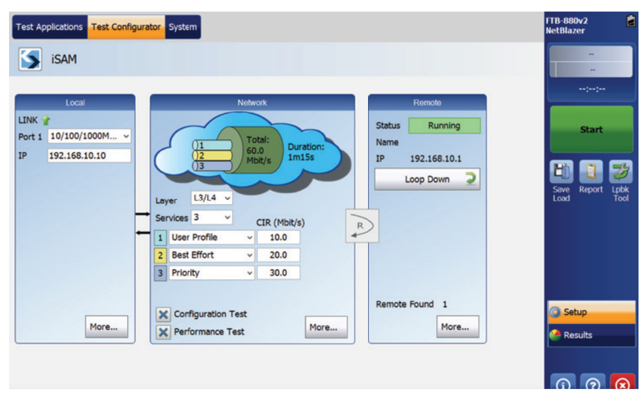

Figure 9: iSAM test configuration

Regardless of the field technician's level of training, knowledge or experience with Y.1564 testing, users of any skill level can use iSAM quickly and efficiently to test cutting-edge Ethernet services with the appropriate and standardized methodology, which is ITU-TY.1564.

CONCLUSION

It is clear to see there are many disadvantages to using RFC 2544 within a live network and for either service activation, troubleshooting or monitoring. It is also evident that the ITU-T Y.1564 testing methodology has been specifically created for testing cutting-edge Ethernet services and ensuring QoS and KPI's are in accordance with agreed upon SLAs.

For example, the RFC 2544 test shown earlier took 30 minutes and 34 seconds to test one stream of an Ethernet service with missing measurements (figure 3). In comparison, the Y.1564 EtherSAM test methodology took less time to perform—3 minutes and 40 seconds in total. Consequently, this new testing methodology results in both a huge savings in time and more accurate and reliable information—thereby making EtherSAM or iSAM a win-win scenario.

In conclusion, there are many Ethernet test methodologies which could be utilized. It is ultimately the decision of the service provider to determine which is the most appropriate given their requirements. However, careful thought and consideration should be taken prior to any testing to ensure that the best Ethernet test methodology is being used to achieve the task at hand and that the test setup is configured correctly to generate realistic and trustworthy results.

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