RFC 2544 Network Performance Testing with the Agilent FrameScope™

Product Note

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Introduction

This paper is intended for telecommunications engineers and technicians involved in the deployment and use of Ethernet services. It describes how the Agilent Technologies FrameScope™ 350 (10/100 Mbit/s) and FrameScope™ Pro (10/100/1000 Mbit/s) implement RFC 2544.

The Internet Engineering Task Force (IETF) is a large open international community of network designers, operators, vendors, and researchers concerned with the evolution of the Internet architecture and the smooth operation of the Internet. IETF publishes recommendations, Internet standards, or network protocols as "Request for Comments", commonly known as RFCs. RFC 2544 is an informational RFC, in other words it is *not a standard*.

RFC 2544 recommendations were originally designed for performance benchmarking of network devices like routers. These recommendations have become an increasingly popular and well-accepted method to determine the performance of network links; especially links with performance requirements bound by SLAs (Service Level Agreements), such as metro Ethernet links. RFC 2544 recommendations specify test criteria that characterize a network link for the performance on four of the most important parameters: Throughput, Latency, Frame Loss, and Back-to-back frames.

RFC 2544 requires specific frame sizes (64, 128, 256, 512, 1024, 1280 and 1518 byte) to be tested for a specific duration and for specified number of iterations.

Definitions

Throughput is the maximum rate in frames/sec at which data can be transported from source to destination with zero errors or lost frames.

Latency is the total time taken for a frame to travel from source to destination. This total time is the sum of both the processing delays in the network elements and the propagation delay along the transmission medium.

In order to measure latency a test frame containing a time stamp is transmitted through the network. The time stamp is then checked when the frame is received. Typical values of latency for an Ethernet link range from a few milliseconds to a few hundreds of milliseconds. Acceptable level of latency depends on application layer. Voice-over-IP, for example, will suffer from performance degradation if latency is above 100 msec, whereas for applications like email, latency hardly matters.

Frame Loss Rate is the percentage of frames that were transmitted successfully from the source but were never received at the destination. For example if 1000 frames were transmitted but only 900 were received the frame loss rate would be: (1000-900) / 1000 x 100% = 10%.

Frames can be lost, or dropped, for a number of reasons including errors, over-subscription and excessive delay. The impact of frame-loss rate on a network application's performance depends on the underlying transport protocol. Applications using TCP as the transport protocol can handle frame loss more efficiently because of built-in re-transmission schemes. It may therefore be desired to overload a link (have traffic beyond its throughput rate) even if a portion of the frames are lost.

On the other hand, streaming protocols (voice or video over IP for example) cannot support re-transmission because of the nature of the application. For such applications, it is essential to limit the traffic and ensure absolutely minimum frame loss.

Back-to-back Frames determines the maximum number of frames with minimum inter-frame gap (i.e. at full rate or in a burst) that can be sent across the link with no frame loss. Better capability of handling back-to-back frames improves performance of handling bursty traffic (e.g. resulting from file transfers or web page downloads).

How RFC 2544 is implemented in the FrameScope™

RFC 2544 tests may need a considerable amount of configuration based on network requirements. The test can be also be very time consuming and may require considerable amount of a user's time in setting up and conducting the tests.

Time spent on testing, technician's skill level requirement, and manual involvement during testing: all these are much bigger issues for IP link deployment testing than for lab testing. The Agilent FrameScope™ incorporates several efficiency improvement features to RFC 2544 testing.

Test Parameter Setup – the FrameScope™ allows a much greater flexibility in defining testing parameters than defined in RFC 2544 standards. Test parameters include network parameters and test setup centric parameters. The FrameScope™ supports RFC testing either at MAC layer or at IP layer. IP layer RFC tests expand the usefulness of the tests because the networked nodes within an enterprise network can also be tested for link performance.

MAC layer tests are applicable to raw links on which IP network has not been deployed, for example testing an Ethernet over Sonet/SDH link.

A unique feature of FrameScope™ is testing of symmetric and asymmetric links. One example of an asymmetric link is ADSL, which has different throughput rates in upstream direction and downstream direction.

The user can choose whether the testing will be done in only one direction (upstream only or downstream only) or both directions. This allows for effective testing of links where only upload performance or only download performance is important.

FrameScope™ RFC tests can be conducted with another FrameScope™ at the remote end, or alternatively using an IP or MAC layer loopback device at the remote end.

To save test time, the user can limit the RFC test to the maximum expected throughput of the link. It can also help prevent overloading the network to an extent where it could break down or cause undesired performance degradation on a live link.

FrameScope™ performance tests can be extended to frame sizes outside the range defined by RFC 2544: FrameScope™ Pro allows for RFC 2544 tests using Jumbo Ethernet frames, which is particularly useful for testing networks for applications like video streaming over IP.

Test Suites - Different end user networks call for different settings. All RFC testing parameters for an end user network requirement can be configured and saved into a test suite in advance. A supervisor or technician can customize testing parameters and store them in a test suite. A technician performing the test only has to select the appropriate test suite and all parameters get preset for the testing. FrameScope™ has built-in default values of test parameters as a starting point for creating customized test suites.

Automated Testing – FrameScope™ allows for fully automated testing. All four RFC 2544 tests or any combination of the tests can be performed. Once a test starts running, there is no need for further user interaction.

Reporting - One of the most powerful features of FrameScope's RFC 2544 tests is the web based reporting. FrameScope™ produces professional-quality graphical reports for the testing, making it an ideal document for SLA verification between a service provider and end users.

Compliance to RFC 2544

FrameScope™ RFC 2544 tests are compliant to RFC 2544 recommendations. It should be noted here that some testing parameter customization could drift the testing away from the definitions of RFC 2544. Examples include throughput testing with Jumbo frames, or constraining the through put test to the maximum throughput of the link under test.

FrameScope™ RFC 2544 tests are primarily intended for testing an Ethernet link. The test requirements for a metro Ethernet link or an IP link are different from those of a networking device like a router. One instance of such adaptation to link performance testing in FrameScope™ is the latency test method: RFC 2544 recommendations specify latency test to be conducted while the link is loaded with full capacity traffic (traffic at throughput rate). This is necessary for network devices like routers or switches, where one of the significant constituents of overall delay is buffering delay. Having high traffic would exhaust the packet buffers of the device and cause a higher delay in processing a packet.

In a metro Ethernet network, however, the link under test is typically rate limited to a fraction of the overall link capacity. The throughput is limited not by the pipe's physical capacity, but by the rate limiting mechanism. Similarly, the pipe's overall performance is determined by a large number of individual IP links. The link under test typically has little or no control over the overall traffic pattern in an Ethernet pipe.

Second, uni-directional links will not be able to perform latency test with fully loaded traffic.

Third, this requirement will make it impossible to conduct a latency test without first performing throughput test, impacting the flexibility of testing.

Considering these factors, Agilent Technologies decided to support both measurement modes in the FrameScope™: latency tests *with and without* producing traffic at throughput rate on the link under test. This makes FrameScope™ perfectly useful for network and link testing as well as for testing routers and switches.

In order to cover all potential test cases, FrameScope™ Pro allows to adjust arbitrary levels of upstream and downstream traffic loads (software version 2.2.2 or later required). Software version 3.2.8 and later enables the same functionality for FrameScope™ 350.

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January 27, 2006

5989-4270EN

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