APPLICATION NOTE 173

ETHERNET TEST SCENARIOS: ENSURING OPTIMAL EFFICIENCY

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Ethernet continues to proliferate throughout all network topologies and can be found in access, metro and transport networks. However, this popularity poses unique field-testing challenges for carriers and service providers as they strive to benchmark their networks in order to comply with customer service-level agreements.

This article briefly discusses Ethernet testing requirements, providing insight into available test modes and their corresponding methodologies. It also examines how each application can be tailored to address individual requirements, so as to help service providers select the best approach for them,

Ethernet Testing in the Field—Key Requirements

Although the market offers carriers and service providers a wide range of Ethernet field testing solutions, access and metro markets have unique characteristics requiring different test applications. From the feature set perspective, the testing instrument must be able to cover an extensive range of Ethernet field tests, including bit-error-rate testing (BERT), service turn-up verification, network performance assessment and IP connectivity testing. To avoid the additional cost and logistical complexity that arise from extra manpower, the field instrument must also support single-technician testing of local and remote access points, and provide flexible on/off-screen reporting so technicians can save results to a flash key or display results on-screen for immediate review.

Because many field technicians who were previously dedicated to testing circuit-based switching elements are now required to install and turn-up Ethernet services, from a usability perspective, the testing instrument must offer intuitive, streamlined navigation and require minimal training to reduce the learning curve for novice and expert technicians alike. Simple pass/fail displays and one-touch function buttons are essential to address the real-life challenges experienced by field technicians when turning up or maintaining Ethernet and IP services.

Ethernet Bit-Error-Rate Test

This test scenario is used to verify link integrity during the installation and service turn-up phase of an Ethernet link. It is based on sending a test pattern across an Ethernet-based circuit and measuring the ratio of errored bits compared to the number of sent bits.

An important configuration point for bit-error-rate (BER) testing is the framing layer (FL). Different levels are available, ranging from Frame Layer 0 to Frame Layer 4, and each level identifies the encapsulation around the test pattern. The most commonly used framing layers are FL1, FL2, FL3 and FL4, as these cover the last four layers of the OSI stack. Each of these layers is unique in their process:

FL1: Data is sent in chunks with IFG between test packets to ensure resynchronization with the receiving end. FL1 refers to the framing at the lowest layer and is therefore indirectly tested by any higher framing layer.

FL2: Data is encapsulated in an Ethernet frame. This is essential to ensure that the test packets can be carried through networks containing switches and routers.

FL3: Data is encapsulated in an IP header and then encapsulated in an Ethernet frame. This is essential to ensure that the test packets can be carried through networks containing routers.

FL4: Data is encapsulated in a UDP header, and then encapsulated in IP and Ethernet headers. This encapsulation ensures that the test pattern is carried through a transport service which is closer to the reality of Internet and allows testing through firewalls.

Framing Representation	Framing Layer	OSI Equivalent
IFG | MAC Header | IP Header | UDP Header | Test Pattern | CRC	FL4	Transport
IFG | MAC Header | IP Header | Test Pattern | CRC	FL3	Network
IFG | MAC Header | Test Pattern | CRC	FL2	Data Link
IFG | Test Pattern	FL1	Physical

The flexibility provided by the different layers allows for BER testing in:

- Transparent networks, where Ethernet frames are carried without any processing in the layers.
- Switched networks, where Ethernet frames are forwarded according to the destination MAC addresses
- Routed networks, where Ethernet frames are routed according to the destination IP addresses
- Between networks, where test frames can be sent to outside networks through the use of default gateways

Ethernet Performance Assessment: RFC 2544 Test Scenario

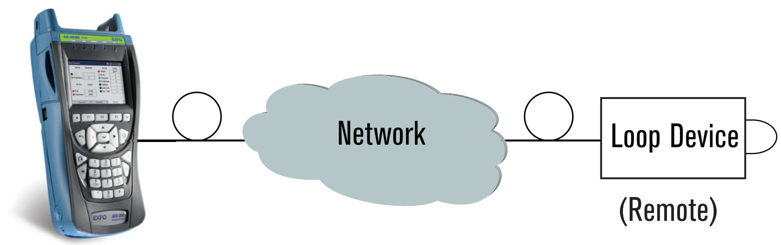
The RFC 2544 series of tests was introduced as a method to benchmark interconnected network devices. Because of its ability to measure throughput, burstability, frame loss and latency, this methodology is also used to test Ethernet-based networks and is now the de facto standard when benchmarking an Ethernet network. The test methodology defines the different frame sizes to be tested (64, 128, 256, 512, 1024, 1280 and 1518 bytes), the test time for each test iteration (should be set to at least 60 or 120 seconds (latency)), the frame format (IP/UDP), etc.

- The *throughput* test allows the technician to obtain the maximum rate at which none of the offered frames are dropped by the device/system under test (DUT/SUT). This measurement translates the obtained rate into the available bandwidth of the Ethernet virtual connection.
- The *burstability* or back-to-back test refers to the fixed length of frames that are presented at a rate such that there is the minimum legal separation for a given medium between frames (maximum rate) over a short to medium period of time, starting from an idle state. The test result provides the number of frames in the longest burst that the device or network under test will handle without the loss of any frames.
- The *frame* loss test calculates the percentage of frames that should have been forwarded by a network device under steady state (constant) loads that were not forwarded due to lack of resources. This measurement can be used for reporting the performance of a network device in an overloaded state, as it can be a useful indication of how a device would perform under pathological network conditions such as broadcast storms.
- The latency test (for store-and-forward devices) refers to the time interval that begins when the last bit of the input frame reaches the input port and ends when the first bit of the output frame is seen on the output port. It is the time taken by a bit to go through the network and back. Latency variability can be a problem. With protocols like VoIP, a variable or long latency can cause degradation in voice quality.

The RFC 2544 methodology was created to assess different parameters found in service-level agreements. By providing performance availability, transmission delay, link burstability and service integrity measurements, a carrier can certify that the working parameters of the delivered Ethernet circuit comply with the contract.

Loopback Testing

A typical Ethernet test requires a testing instrument at the transmission point to insert traffic into the network, and a testing instrument at the receiving points to receive this traffic and measure statistics. This approach demands two technicians; i.e., one at each end. An easier, less expensive solution is to use a single testing instrument at the local end (for generation and analysis) that supports a logical loopback function to perform receiving end functions and transmit traffic back to the tester for analysis, thus eliminating the need for, and associated costs of, a second technician at the receiving end.



Traditional Loopback Methods

A physical loopback device offers an inexpensive and easy solution but has constraints and limitations that do not permit its use in switched and routed networks; mainly because Ethernet MAC addresses are unique to each device, so there cannot be two devices with the same MAC address. With physical loopback devices, when Layer 2 devices are switching traffic, the same MAC address is detected as the source on two distinct ports. Also, the physical method cannot be used with certain rates and media such as 1000 Base-T, as this media greatly limits the application of the loopback feature.

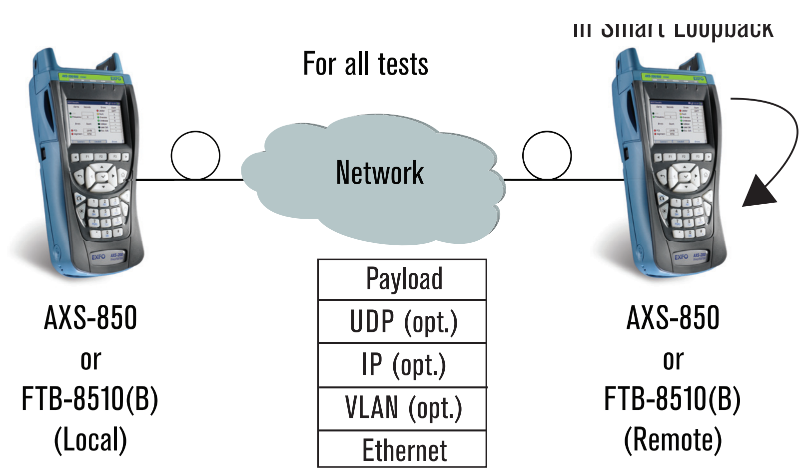
The loopback function can also be performed with a remote device that terminates the link and recreates the Ethernet frame just like a physical loopback device. The main advantage of this method is that it can be used with any type or rate, as the Ethernet layer is recreated. Another advantage is that the function can be enabled or disabled remotely. The main disadvantage of this method, however, is that these devices sometimes perform Layer 2 functions and will discard frames with errors, limiting their use in testing environments. Also, this method does not swap traffic at Layer 3, where routers can also discard frames whose IP addresses are not swapped. Because of this, these devices cannot be used in routed networks.

Smart Loopback: Swappability

A swapping loopback feature offers the best solution, as it loops traffic back to the tester while swapping MAC and IP addresses in order to comply with Ethernet address rules. Only traffic addressed to the device is retransmitted with MAC and IP addresses swapped, and this can be done at wirespeed (100% throughput), regardless of VLAN settings and without any loss.

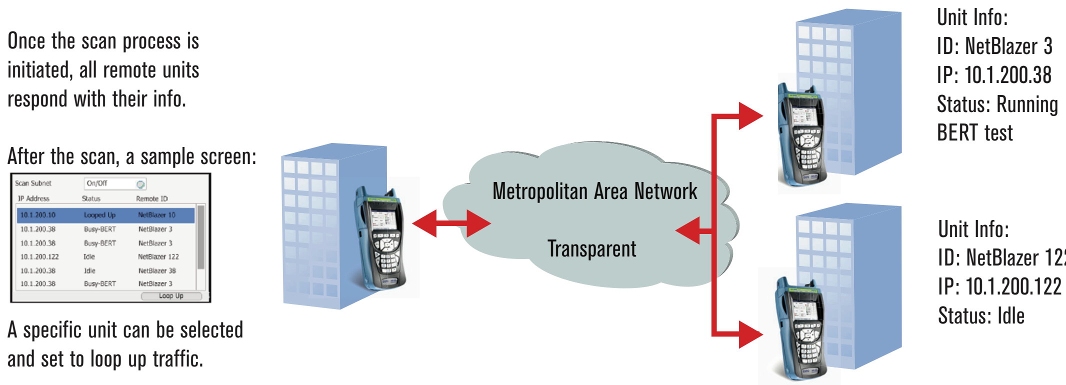
Smart Loopback with Remote Discovery

An additional valuable feature is the remote discovery function. Without it, a user must absolutely know the MAC and IP address of a remote device in order to send frames to it. This would usually require the intervention of a second user at the far end to communicate the information, defeating the purpose of having less personnel assigned to the testing process.



The remote discovery feature eliminates the need for extra hands by enabling one tester to detect all connected units within a subnetwork. Detailed information includes their IP address, MAC address, remote ID and status information. The remote identification consists of a user-configured tag that helps identify the remote unit during discovery while the status information indicates the state of the remote modules (what test is in progress, is it idle or not?). The IP and MAC addresses are the parameters of the test port connected to the network under test, and the IP can also be obtained through DHCP address lease.

Once a scan is complete, the user has the ability to select a specific unit and remotely enable or disable the loopback feature. All destination parameters (MAC and IP addresses) are automatically applied to test streams, reducing the number of configuration steps. From that point, the user can start any test with that remote device set in loopback, and all traffic sent will be retransmitted by the far end and analyzed locally. With this tool, a single user becomes a one-man team, allowing him to control both the remote end and the local end.



IP Connectivity Tools

IP connectivity tests allow technicians to verify if remote IP addresses are reachable through the user of the Ping and Traceroute tools.

The Ping tool is used to verify that we can reach a specific address within or outside of a subnetwork. The Traceroute tool is a modified version of the Ping tool and is used to determine the route or the number of hops that are required to reach a destination host.

These basic tools are essential when testing through routed networks, as they enable the user to ensure that hosts can be reached; or, if there is a delay when trying to communicate with a remote host, the tools can help determine whether or not the cause of the delay is due to the route used to reach the destination. Overall, the results of these tests can pinpoint critical configuration issues within the network.

Ethernet Field Testing in One Compact Tester: The AXS-200/850

EXFO's AXS-200/850 Ethernet Tester (part of our SharpTESTER Access Line) provides all the functionality described above in one handheld, user-friendly and rugged unit with an easy-to-understand interface. Offering industry-recognized tests such as BERT, RFC 2544 and Ping/Traceroute, combined with exclusive time- and money-saving features such as Smart Loopback and Remote Discovery, the AXS-200/850 is specifically designed to facilitate the tasks of technicians performing field tests in access and metro Ethernet networks.

The AXS-200/850 Ethernet Tester is also compatible with EXFO's existing Ethernet product line, including the FTB-8510B Packet Blazer test modules.

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