FIELD TESTING FOR ACTIVE ETHERNET NETWORKS

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As demand for higher-bandwidth residential services continues its steady growth, a number of service providers are looking to leverage their existing network infrastructures to provide differentiated triple-play services to their customers. These triple-play services consist of high-speed Internet or data services, telephony (VoIP) and both broadcast TV and video-on-demand.

Traditional networks use a combination of fiber optics and electrical links to deliver Ethernet services to customers. The fiber-optic links are mainly reserved for long-haul and metro applications, as they require high data rates. Due to the high cost of installing, implementing and maintaining a fiber network its use in customer-premises applications is limited. It is therefore the electrical links that are usually used for access and residential links as their easy installation and low cost are ideal for massive deployments. As we know, however, electrical links are limited in bandwidth and in deployment lengths.

As the cost and complexity of fiber-optic deployment decreases, fiber is becoming an increasingly viable medium for delivering high-bandwidth services to both business and residential customers. Two types of architectures propose fiber media from the headend/central office (CO) to the customer premises, Passive optical networks (PONs) and Active Ethernet networks. The following article proposes a solution for Active Ethernet testing from the installation and service turn-up phase to service-level agreement verification for Active Ethernet deployments.

Active Ethernet vs. PON

The PON architecture is a point-to-point technology that proposes delivery of data over fiber from the headend/CO to the customer's premises. It relies on passive optical components, such as optical splitters, to provide optical service at multiple customer sites. This approach does not allow for quality of service (QoS) assurance and introduces limitations in power budget, distance and number of splits.

The Active Ethernet architecture, on the other hand, delivers the same service as PON technologies, but without using passive optical components like splitters. Instead, the traffic consists of standard Ethernet frames (hence does not represent a technology leap), and removes interoperability complexities that arise with PON architectures. Instead of using optical splitters, Active Ethernet makes use of Layer 2 switches enabling QoS verification and symmetrical upload and download speeds. Also, this architecture provides simplicity when upgrading bandwidth, as higher rates can be enabled on the path using the same fiber. Active Ethernet is also a standardized architecture through the IEEE802.3ah Ethernet in the First Mile standard.

Active Ethernet Testing

There are two distinct testing phases that can be identified in Active Ethernet architectures. The first phase is the installation and service turn-up phase (during which the line is qualified for errors), and the second phase is the performance-benchmarking phase.

Active Ethernet Installation and Service Turn-Up Test

The installation and turn-up test phase is used to measure the integrity of the new optical line. This test is necessary when activating new lines, as errors inserted during the transmission affect the integrity of the data, which can lead to frame loss. In Ethernet frames, the frame check sequence (FCS) section is used to protect the payload and Ethernet header section. This checksum is calculated over the protected sections and analyzed by a receiving Ethernet-aware device. A mismatch between the calculated FCS and the received FCS will automatically result in the frame being discarded, causing a frame-loss error. This same condition can be attained when a low-integrity line inserts errors in the frame while it is being carried to the destination. These frame losses have a significant effect on each of the services provided to the client. For data transmission, frame loss will result in retransmission, which affects the efficiency of the link. For voice and video services, frame loss will result in diminished quality of experience.

The bit-error-rate test (BERT) is the ideal test scenario to verify link integrity during the installation and service turn-up of an Ethernet link. It is based on sending a known test pattern across an Ethernet-based circuit and analyzing the Ethernet and payload area for errors, thus effectively qualifying the integrity of the link. This test must be conducted without using Ethernet-aware devices within the tested link since errors during the transmission will cause the frames to be dropped by these network devices.

Active Ethernet SLAs and Network-Performance Benchmarking

Service-level agreements (SLAs) are legal contracts between operators and customers that require specific levels of service to be assured. To do so, operators must perform network-performance benchmarking tests once the link has been qualified for errors.

The Internet Engineering Task Force (IETF) has put together a test methodology to address the issues of performance verification at the Layer 2 and 3 levels. RFC 2544, Benchmarking Methodology for Network-Interconnect Devices, specifies the requirements and procedures for testing different performance parameters. These are segmented in subtests:

- Throughput subtest – a measurement of the maximum bandwidth an Ethernet link can sustain without any errors
- Latency subtest – a measurement of the time taken by a test packet to travel through the network and back to the tester.
- Back-to-back subtest (sometimes referred to as burstability) – a measurement of the ability of a network to cope with bursts of traffic; i.e., how many frames in burst can a network support before frame loss occurs
- Frame loss subtest – a measurement that provides a distribution of the frame loss rate per transmission throughput.

When these measurements are performed, they provide a baseline for operators to define SLAs with their customers. They enable operators to validate the quality of the service delivered and can provide them with a tool to create value-added services that can be measured and demonstrated to customers. The SLA criteria defined in RFC 2544 can be precisely measured using specialized test instruments. The performance verification is usually done once the installation is complete. The measurements are taken when the network is out of service to make sure that all parameters are controlled.

IP Connectivity Test

To ensure that optimum Internet service is provided to customers, network elements such as edge routers and switches must be properly configured; this enables the traffic to be sent and received from the outside network to the customer and vice-versa.

Simple tools to verify connectivity are the ping and trace route commands. The Ping command uses an echo packet to reach remote computers. The pinged computer or device that receives the echo packet replies to it with an echo-reply packet. From this reply, statistics such as loss rate and delay are gathered. Replies from the remote host indicate that the network is properly configured and that remote devices can be reached.

The trace route tool is a modification of the ping command; when using trace route, routers reply to expired echo commands. As each reply is from a router, the user is provided with the route taken by the packets when they are being transmitted to a host. This test determines how many hops are taken by packets when being transmitted to remote points, which provides an indication of whether or not network devices are properly configured.

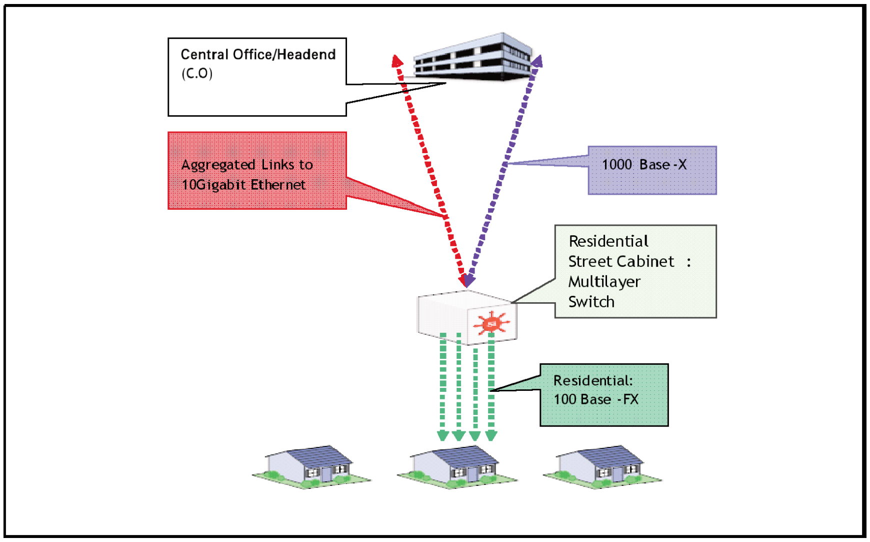
Active Ethernet: A Typical Scenario

As a simulation, consider an Active Ethernet deployment where residential customers are provided with 100 Mbit/s transmission through 100 Base-FX optical links. The residential street cabinet aggregates the data into either Gigabit Ethernet or 10 Gigabit Ethernet links to the headend/CO. A new residential customer is being added to the service and a single field technician is sent to ensure that the line can carry traffic and record performance measurements for the SLA.

The testing procedure would consist mainly of two tests:

- The BER test, to ensure the integrity of the line being activated.
- The RFC-2544 test, to benchmark the performance of the line as well as to ensure compliance with the SLA.

Optionally, an IP connectivity test can be performed as the last test to ensure that the network is properly configured and that the new client can communicate with any IP address.



Active Ethernet Testing with the AXS-200/850 Ethernet Test Set

The AXS-200/850 provides technicians in the field with the ability to conduct both BER tests and RFC 2544 performance tests at the customers premises.

In addition, each of these tests can be performed using a combination of the AXS-200/850 (in the field) and a FTB-8510B Packet Blazer module (at the headend/CO or street cabinet), as these units are fully compatible. When used together, the headend/CO technician uses the Packet Blazer's Smart Loopback application to reloop traffic back to a source (in this case, the AXS-200/850) and swap MAC and IP addresses, fully complying with Ethernet address rules. The Smart Loopback feature enables the field tester to perform unilateral tests; i.e., without requiring another tester at the far end.

In order to use this feature, the field technician only needs to configure the destination IP and MAC address of the test streams to that of the unit in Smart Loopback mode. This information can be made available to all field technicians as the Smart Loopback-enabled unit may be configured with a specific static IP address for future tests.

BER testing

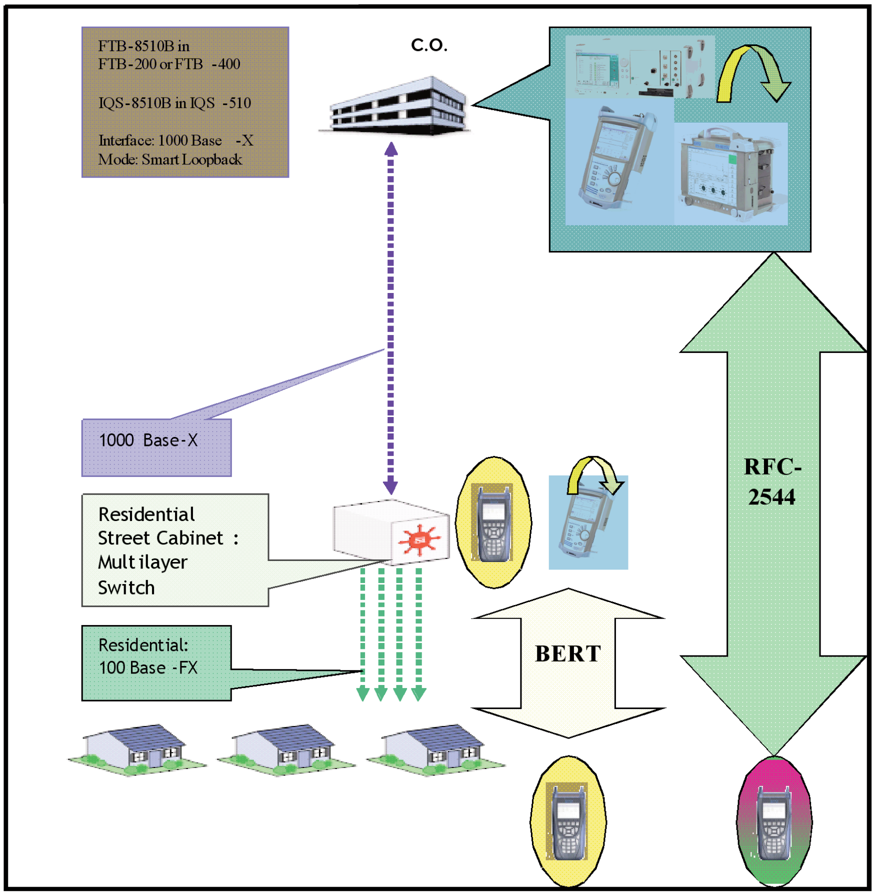
The BER test should be performed between the line terminations with the field technician manning an AXS-200/850 at the residential site, and with either another AXS-200/850 or a Packet Blazer set in Smart Loopback mode at the street cabinet. Test frames sent from the AXS-200/850 will be relooped by the Packet Blazer and analyzed by the AXS-200/850 for errors at the Ethernet and payload layers. Since the units are at the line termination, inherent errors during transmission will be detected and declared as errors instead of discarded frames by Ethernet-aware devices.

RFC 2544 testing

The RFC 2544 test should be performed between the residential site and the headend/CO At the headend/CO, a Packet Blazer set in Smart Loopback mode will be used to reloop test packet back to the RFC generator.

The typical tests performed are the throughput and latency tests. The throughput test will determine the maximum transmission rate at which no errors occur. Since the traffic is relooped at the headend/CO, this measurement will qualify both directions of the line; i.e., from the headend/CO to the residential site and vice versa. This critical measurement is used to determine the maximum rate that can be sent and received through this line without errors–an important part of the SLA.

The latency test will measure the round-trip latency time, or the total time required for a test frame to travel from the residential site to the headend/CO and back to the residential site. This measurement is critical for voice and video applications, as latency can greatly affect the quality of experience.



Conclusion

Through the use of network devices, the simplified approach of Active Ethernet architectures provide subscribers with the high bandwidth they crave and operator with the easy network installation and management they seek.

To ensure optimal results, Active Ethernet architectures are qualified in two phases. First, during the installation and service turn-up phase and, second, during the SLA assessment phase. Verifications such as BER tests and RFC 2544 performance benchmarking tests enable service providers to ensure that their networks meet their customers' needs.

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