

Scott Sumner, Partnership Program Manager, EXFO Protocol

As Ethernet services grow in popularity with enterprises, the rapid deployment of Voice-over-Internet Protocol (VoIP) has become a top priority for many service providers. When customers switch from private voice lines to VoIP, they have extremely high expectations: they expect only top-quality voice and data services to run over their Ethernet access lines. That is why service-level agreements (SLAs) are becoming increasingly stringent.

SLAs can be committed to with confidence if the services are thoroughly tested when commissioned. A simple test plan that only validates the basic functionality of an Ethernet link leaves an operator exposed to poor network performance once live customer traffic begins. To avoid such issues, some service providers over-commission bandwidth to ensure SLAs will be met. However, this practice is quite expensive. So how do you comply with all your SLAs without breaking the bank?...by diligently confirming a link's performance before activating a service.

To completely test an Ethernet access line requires understanding the type of applications running over the link. For basic Ethernet services such as Internet access, virtual private LANs, and storage area network applications, the Internet Engineering Task Force (IETF) standard for benchmarking network interconnect devices, RFC-2544, is an excellent testing baseline. RFC-2544 outlines specific tests to validate throughput, latency, frame loss and back-to-back (burst) performance.

Delay-sensitive applications such as VoIP and IPTV are sensitive to additional performance parameters, such as inter-packet delay (packet jitter) and packet sequencing. Because VoIP coexists with other types of data traffic, bandwidth-demanding applications such as remote backup or FTP can quickly degrade the quality of VoIP services. This type of problem can be avoided by simulating real traffic patterns during commissioning and adjusting network parameters to give priority to time-sensitive VoIP packets.

Five Critical VoIP Pre-Deployment Tests

Before turning up a VoIP service, the Ethernet access line should be tested for performance with a focus on five key parameters: packet jitter, frame loss, throughput, latency and out-of-order packets rate. The table below lists the main problems caused by each of these parameters if recommended values are not maintained.

VoIP Parameter	Effect	Unclear speech	Dropouts	Pops/clicks	Delays/gaps
Packet jitter		X		X	
Frame loss		X	X	X	
Throughput		X	X		X
Latency					X
Out-of-order packets			X	X	X

Table 1. Typical parameter and their effects on VoIP transmission

These parameters are equally valuable for troubleshooting VoIP services during or after deployment. As shown in the table above, most of these parameters indicate more than one problem, which can also occur simultaneously. Their duration/frequency and various combinations of occurrence point towards different network problems. With comprehensive test results, an experienced deployment team will be able to quickly optimize a customer link. The most common sources of poor VoIP performance are:

- **Route flapping**—when a network frequently changes the path used by the packets to get to their final destination. This can be caused by congested networks or poor traffic engineering. Route flapping causes several call quality issues and is often related to packet jitter, latency, out-of-order packets and packet loss statistics.
- **Access link congestion**—when VoIP packets are not given dedicated bandwidth or sufficient priority over the access link, other bursty or sustained bandwidth-consuming applications can rapidly degrade voice quality or the ability to sustain a call. Common examples of these interfering applications include large file downloads, off-site remote backup, or video-conferencing services. Poor throughput and packet loss are both indicators of access link congestion.
- **Backhaul congestion**—when bandwidth is limited during the aggregation of access lines; this is often indicated by high latency and low throughput.

By analyzing the types of errors measured and comparing them to their frequency and duration (intermittent, periodic, continuous), service providers can properly assess the adjustments required to commission a link, satisfying SLA-defined quality levels.

Simulating Real Traffic Patterns

To realistically simulate and analyze the interaction of multiple services being transported over a single link, multistream traffic generation is fundamental. When stressing a network with multiple streams, it is important that measurements be performed on one stream, while controlling the priority, bandwidth, and characteristics of the others. This technique replicates actual network traffic over a wide variety of typical boundary conditions. Advanced Ethernet testers (such as EXFO's FTB-8510 Packet Blazer—Ethernet Test Module) are capable of providing all of these features. Having access to sophisticated tools greatly simplifies the critical task of commissioning multiple services running over a single link.

Mean Opinion Scores (MOS)

Other VoIP analysis tools focus on perceptual voice quality measurements (e.g., MOS, R-factor, and other PESQ algorithms). These metrics are computed from the five key parameters outlined above and attempt to provide a single, aggregate score that typifies the quality of voice conversations that will be experienced by end users. These consolidated figures of merit are useful in confirming that links have been properly commissioned once stress-testing and network analysis is complete, but they do not offer the granularity required to help deployment teams troubleshoot or fine-tune an access link's network parameters.

Conclusion

There are several penalties associated with sub-standard service: poor customer satisfaction, increased spending on maintenance and, often, direct financial penalties detailed in SLAs. Following the main points outlined above will consistently ensure that Ethernet links are ready for the high-quality services customers are demanding, turning SLAs into sales tools that help service providers attract and retain customers.

Corporate Headquarters > 400 Godin Avenue, Vanier (Quebec) G1M 2K2 CANADA | Tel.: 1 418 683-0211 | Fax: 1 418 683-2170 | info@exfo.com
Toll-free: 1 800 663-3936 (USA and Canada) | www.exfo.com

EXFO America	4275 Kellway Circle, Suite 122	Addison, TX 75001 USA	Tel.: 1 800 663-3936	Fax: 1 972 836-0164
EXFO Europe	Le Dynasteur, 10/12 rue Andras Beck	92366 Meudon la Forêt Cedex FRANCE	Tel.: +33.1.40.83.85.85	Fax: +33.1.40.83.04.42
EXFO Asia-Pacific	151 Chin Swee Road, #03-29 Manhattan House	SINGAPORE 169876	Tel.: +65 6333 8241	Fax: +65 6333 8242
EXFO China	Beijing New Century Hotel Office Tower Room 1754-1755 No. 6 Southem Capital Gym Road	Beijing 100044 P. R. CHINA	Tel.: +86 (10) 6849 2738	Fax: +86 (10) 6849 2662