Communications TECHNOLOGY

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TRILITHIC
INNOVATIVE ENGINEERING

The Guardian II family
from Trilithic

VoIP Test and Measurement

...the Key to IP Telephony

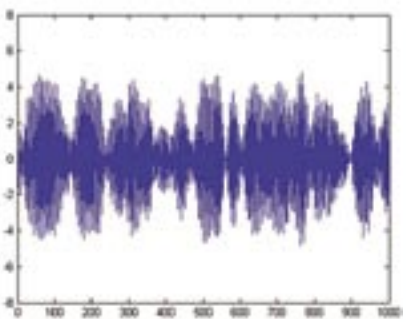
Success

Trilithic Offers Three Keys for Engineering VoIP

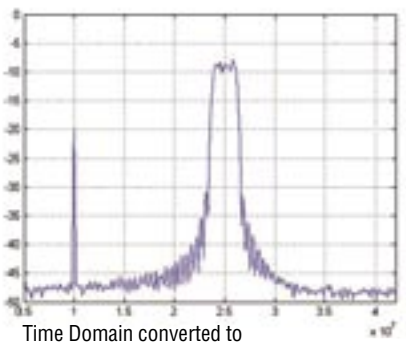
HFC network engineers with IP telephony service experience know that high-quality services are founded on a clear plan for system oversight that includes monitoring, aligning, maintaining, troubleshooting and proper installation. If any of these factors are neglected, subscribers are likely to have a negative experience and quickly head for another telephony provider.

Because high-speed data (HSD) and IP telephony are both packetized data services, it would be easy to conclude that a network that provides acceptable HSD performance will provide acceptable performance with VoIP. The reality is that high-speed data services are more robust because they don't require real-time connectivity. To some extent, transient interference, jitter and other impairments can be shrugged off because errors can either be corrected by FEC (Forward Error Correction) or lost packets can be resent, with the delay virtually imperceptible to the customer.

Figure 1: Time doman vs. frequency domain



Time domain snapshot



Time Domain converted to Frequency Domain using FFT.

Voice is more finicky. Because telephone is a real-time service, interference and interruptions are harder to repair or hide, and even moderate levels of interference can cause calls to break up or be dropped. Aggressive FEC correction or resending lost packets are not options for masking interference problems because of the transmission delays they incur. Clearly, VoIP quality maintenance requires a more effective strategy.

Trilithic, a leading cable TV instrumentation provider for over 30 years, through recent engineering investment has developed products using DSP technology to meet the changing needs of HFC networks. These products enable systems to achieve and maintain the network health required to reliably carry VoIP services, by providing an optimal means for vigilantly monitoring the return band, properly aligning and maintaining the plant, and quickly but comprehensively testing installations.

Monitoring: Why Speed Is King

It is essential to monitor the return band in order to catch problems early and maintain the high reliability needed for VoIP services. When it comes to monitoring the return band, speed is essential. "It is especially important to have a fast monitoring system because fast transients and 'bursty' impulse noise have a more adverse affect on VoIP services than they do on high speed data services," Trilithic's Product Manager Steve Windle explains.

That's why the industry-leading speed of Trilithic's Guardian II system is especially popular with cable engineers who are rolling out IP telephony services.

The return path should be monitored continuously for both consistent and transient interference. Even though transient bursts are a major contributor to poor audio quality, detecting them is a difficult problem for traditional monitoring systems that use frequency scanning analysis technology. Transients can go unnoticed because the scanning analyzer must share its time between many nodes and wide spans of bandwidth. Noise can occur while the device is watching another node or scanning a different frequency.

The use of DSP technology enables Trilithic's Guardian II System to address

How to Install and Troubleshoot VoIP Without Headaches

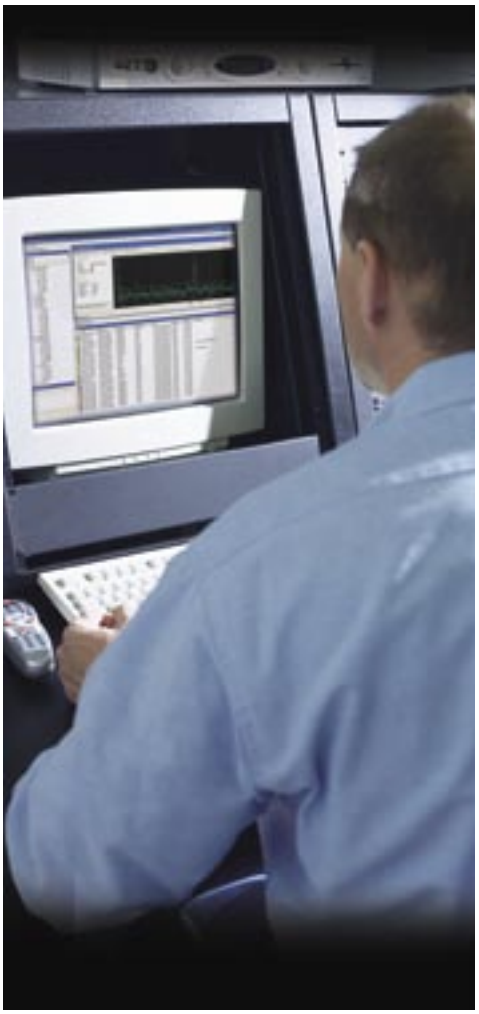
For VoIP, Trilithic's 860 DSPi offers useful installation and troubleshooting tests. At installation, for example, they provide a baseline for future comparison, which technicians will be able to use to determine if there is any degradation in service quality.

One test uses Internet control message protocol (ICMP), and the other uses real-time protocol (RTP). Both look for packet loss, latency and jitter on the upstream and downstream, all of which can degrade voice traffic. It takes latency of just over 300 msec, jitter above 50 msec and 1 percent packet loss to adversely affect a conversation.

The ICMP test uses any network device, while the RTP test communicates with a server-side application. The RTP test also calculates a mean opinion score (MOS). The MOS is a score based on the voice quality perceived by a random group of people. The highest rating is 5.0, but it is unachievable since the codec always degrades quality by some amount. To achieve toll quality, an MOS of 4.0 is needed, and a rating of less than 3.6 is considered unsatisfactory.

The success of a VoIP endeavor depends on detecting interference before it becomes problematic. A cable operator must meet these challenges by employing a complete maintenance program that includes monitoring, alignment and testing, and proper installation. All are offered as part of Trilithic's complete, integrated solution, Guardian II system. ■

GUARDIAN™ SYSTEM II
Return Path Maintenance Technology



The Guardian II system is an integrated system of hardware and software elements that perform all the return path maintenance applications needed to verify VoIP service viability.

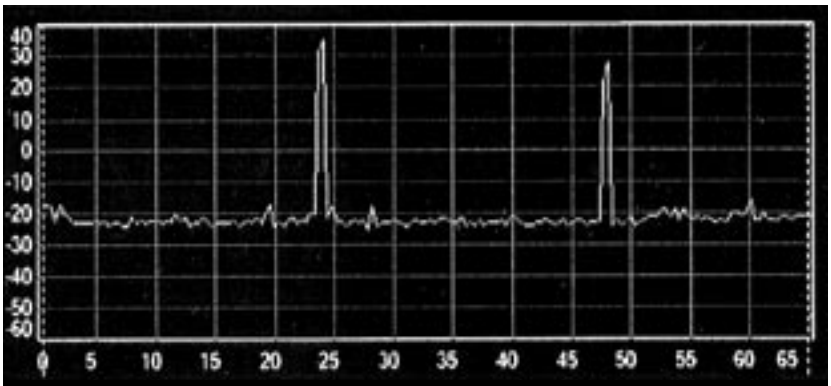


Figure 2: In a third-party test, the Guardian II system detected and accurately plotted every 15 msec impulse, every time. Note that the display shows both the impulse at 24 MHz and its harmonic at 48 MHz.

both consistent and transient problems. The hub of this system, the 9581 SST R4, captures the entire spectrum at once in the time domain, and using FFT (Fast Fourier Transform) converts the received information to a frequency domain (spectrum) display. (Figure 1 illustrates a time domain snapshot and the resulting spectrum based on the FFT conversion.)

The speed of this process enables this system to capture VoIP service degrading impulse noise or ingress that traditional scanning analyzer-based systems don't see. Independent field tests have proven that the DSP-based Guardian II is over 10 times more likely to detect interference bursts than any competing system. (See Figure 2.)

In addition, transients can be "masked" by legitimate signals. To detect interference hidden within the return traffic itself, the 9581 SST R4 offers TraffiControl mode, which processes the captured data, eliminates legitimate signals from the displayed spectrum, and shows only intermodulation products, ingress and noise bursts. The result is that operators can see transients that burst in at the same frequencies as legitimate signals.

Distribution alignment and ingress control

While important, network monitoring is only part of ensuring quality VoIP service. The HFC distribution system must be carefully aligned and maintained, or some VoIP paths will suffer from a poor C/I ratio; others may cause laser clipping.

Trilithic's Guardian II system is an end-to-end solution, improving technician productivity through communication. Test signals and return band measurement information are exchanged between the 9581 SST R4 in the headend and a field analyzer, the 860 DSPi. The two devices work in tandem to display return band balance and gain for testing and aligning the return distribution plant. The instruments work together, so the technician can work alone—no need for a call to the NOC to find out what's happening there.

Trilithic's 860 DSPi offers superior alignment and troubleshooting features including return alignment, sweep response and spectrum analysis features. Using its return sweep mode, the 860 DSPi helps your techs achieve proper levels at the headend by optimizing reverse

By periodically accessing Trilithic's free upgrade Web site, the operator can keep his 860 DSPi ready for new challenges, and always up to the standard of currently shipping anaylzers. The VoIP Test function is an example. www.860DSP.com

amplifier alignment and assists the technician in finding and fixing frequency response issues.

The unique I-Stop probe is particularly useful for ingress troubleshooting, and helps technicians isolate the source of ingress. Working with the 9581 SST in the headend, and using an I-Stop Reverse Test Probe with the 860 DSPi spectrum analyzer feature, a technician can track reverse ingress sources to the nearest tap. Using this simple test, you can locate ingress sources down to the tap without removing reverse modules or diplexers and without disrupting forward or reverse service.

The 860 DSPi also has a comparison screen allowing the tech to compare spectra downloaded from the 9581 SST with the ingress present at the point to which the 860 DSPi is currently connected. This comparison of local vs. headend spectrum aids technicians who are troubleshooting for ingress problems.

Installation

To ensure reliability, a thorough test must be done at installation. This ensures headroom on critical parameters and that the service is not on the edge of failing. Technicians are more likely to perform a quick, simple test under time pressure, so the process should be automated as much as possible and provide a pass/fail result. The 860 DSPi can perform automated tests, and in addition to storing the data for baseline records, provides a pass/fail result, and in the event of failure, provides information about what parameter(s) are out of line as an aid in troubleshooting.

The automated process or macro should be configured to perform a battery of tests to prove the quality of the install.

1. It is important to verify that downstream analog and digital signal levels are within design limits.
2. Downstream carrier-to-noise, MER, and BER should be tested to verify proper ratios with margin to ensure reliability.
3. Upstream levels and carrier-to-noise/ingress ratios should be tested to verify proper receive levels and headroom. For trouble-free installations, the 860 DSPi offers an enhanced form of Trilithic's RSVP^2 Installer's Reverse Tester. This feature determines the

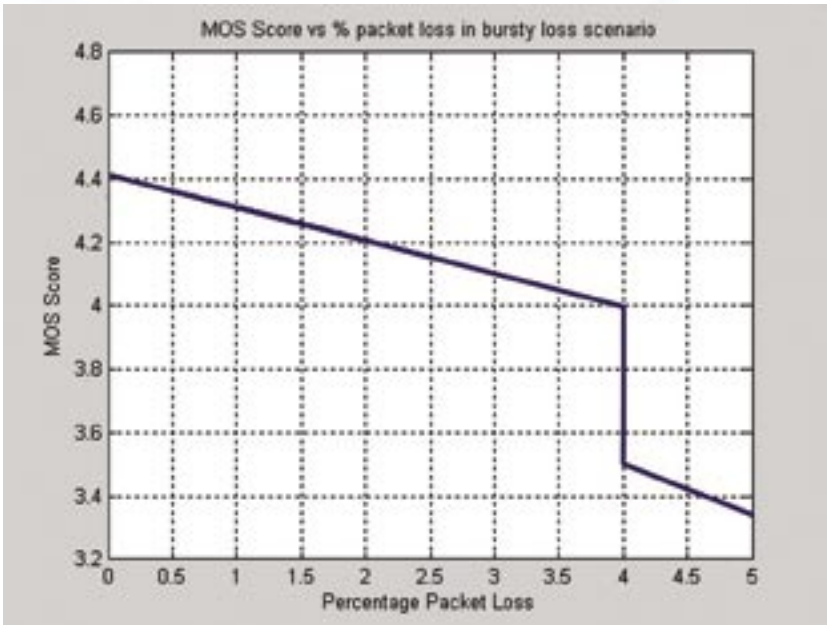


Figure 3: Packet Loss vs. MOS

Source: *VOICE OVER IP PERFORMANCE MONITORING COLE, R. G. AND ROSENBLUTH, J.H. AT&T LABORATORIES MIDDLETOWN, NJ*

required upstream transmit power from the customer premises and verifies alignment and proper installation at eight user-settable frequencies, from the subscriber to the headend. The 860 DSPi checks levels and carrier-to-ingress/noise at the eight frequencies in seconds and provides a pass/fail indication for each.

4. Two-way data communication should be verified by performing modem tests including ping and throughput.
5. VoIP tests should be performed to ensure that the network is viable for the service and has operating margin to ensure reliability.

In addition to the typical HSD installation tests, specific VoIP tests ensure IP telephony success. This is where the 860 DSPi VoIP test shines.

That's because it allows you to prequalify your HFC network for VoIP without requiring you to have VoIP equipment installed in the headend. Additionally, it tests the entire HFC network from the subscriber to the PSTN handoff point and provides a simple expedient test that quickly verifies operational headroom for optimal technician productivity.

Cable engineers are using the Trilithic VoIP test to prequalify their networks in large part because it doesn't require them to have VoIP service equipment in the headend. The communication takes place with a VoIP test server, either on the cable system network or at Trilithic headquarters. The test can be confined to the cable network and includes the entire affected network by installing the Trilithic VoIP test server in the NOC near the PSTN handoff point.

The Trilithic VoIP test sets up a call using proprietary signaling with the test server. The communication for the test takes place using the RTP protocol common to all PacketCable VoIP services. This means that the quality of the part of the system over which the technician has control is verified for service readiness.

But if VoIP services are already in place, why can't the installer simply connect the EMTA and make a phone call to verify the installation? While this would tell the installer that the phone works now, it wouldn't ensure that the connection is reliable. To ensure continued serviceability the installer must verify that there is headroom on critical parameters. These parameters are tested in the MOS (RTP) test.

Trilithic recommends performing this test first to verify the viability of the network for the subscriber's VoIP service. The test verifies packet loss, latency and jitter and provides a score based on these parameters that relates to the quality of the call—MOS (mean opinion score). In addition, it provides detailed information on each of the parameters to enable further troubleshooting to determine the root cause in the event of failure. (Figure 3 shows how changes in packet loss affect MOS.)

By performing this test, you remove

The Versatile 860 DSPi provides a full complement of test features for field maintenance and HSD and VoIP service installation.

the network infrastructure as the potential problem, leaving only the server system or the EMTA. If there is a server system failure, it is very likely that it will be uncovered first by someone in the NOC.

This leaves the EMTA as the source of the failure. A small percentage of EMTAs are DOA failures, but having proved that the network is viable by performing the VoIP analysis, and knowing that NOC personnel vigilantly monitor the servers, the installer can fairly confidently point to the EMTA as the source of failure if a call cannot be made. You can easily correct this problem by replacing the EMTA. Alternatively, a typo made when provisioning the EMTA could even be the cause.

With that point in mind, when VoIP serviceability is being added, Trilithic recommends a simple, two-step VoIP installation process:

1. Connect the VoIP analyzer to the cable outlet in the home. Access a VoIP test server in the NOC, as close as possible in the network topology to the PSTN handoff point. This configuration confines the test to the cable network and makes it as comprehensive as possible. Acceptable measurement parameters will have been programmed in the test setup. The test results will show either a "pass" or 'fail" for both upstream and downstream communication.
2. Connect the EMTA and make a phone call, within the network and outside the network. A successful call verifies that the entire system is working properly and reassures the subscriber that the service is up.

A subscriber phone goes through an MTA registration process, so using an MTA built into an analyzer doesn't provide much information. The problems indicated are either a bad phone, a cable modem registration problem (which would be uncovered with the Trilithic VoIP or other installation tests) or a problem with the VoIP equipment in the NOC that would be common to all subscribers. Testing the ability to make a phone call with a specialized test analyzer doesn't prove that a call can be made with the subscriber's phone.

Conclusion: Fast, Visible and Versatile

Service quality is critical to IP telephony success, and proper testing and alignment are essential for optimal VoIP service quality. Trilithic's Guardian II system monitors the return band with DSP technology, which enables capture of fast transient impulse noise and ingress, as well as visibility of interfering signals beneath service carriers using a unique TraffiControl feature. Comprehensive field testing, including interaction with the headend monitoring instrumentation, ensures proper alignment and helps to quickly troubleshoot ingress problems. Finally, a simple, quick and comprehensive test during installation verifies reliable service. ■

For more information

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