Maintaining Wireline-Grade VoIP QoE in Cable Networks

Introduction

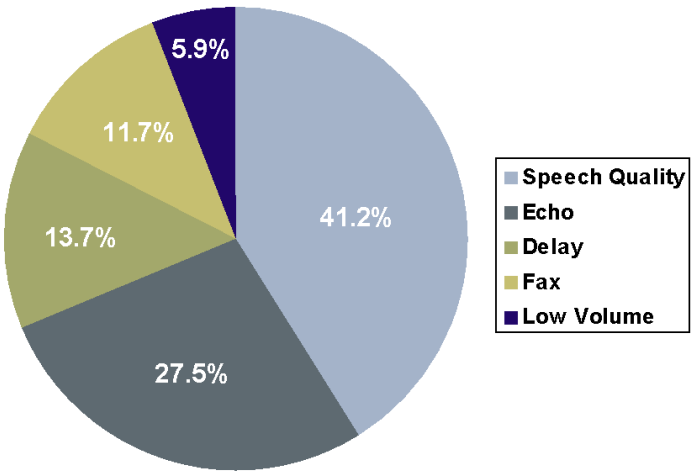
Monitoring and maintaining excellent VoIP service quality poses a number of challenges. VoIP traffic must share broadband networks with TV, Internet, Video-on-Demand (VoD) and HDTV services, all of which are consuming increasing amounts of bandwidth as their popularity grows. Voice packets must be properly prioritized within this shared network, in both upstream and downstream directions. Calls need to be setup quickly, and emergency services, alarm systems, and voice features such as caller ID, voicemail, conference calling and online banking have to work flawlessly. Despite the challenges, Cable MSOs are successfully making the grade using VoIP service quality test strategies that assure their success.

Common Sources of VoIP Quality Issues

VoIP problems in cable networks generally originate in one of five key areas: (1) at the subscriber premises, (2) in the Hybrid Fiber Coax (HFC) / RF access network, (3) in the IP/Fiber backhaul network, (4) in the Voice Operations center where call features such as switching, voicemail, and caller ID are hosted, or (5) at the Media Gateway to the PSTN, where the majority of calls are relayed off-net. The figure on page 2 demonstrates the typical cable VoIP network architecture.

In addition to problems within the operator's network, customers also experience quality issues originating off-net as calls get routed through VoIP peering and partner carrier networks to far-end destinations. Cable MSOs must be able to determine if customer-reported problems originate from within or outside their networks to properly enforce Service Level Agreements (SLAs) with partner-carriers.

The figure below shows the top customer-identified VoIP quality issues. Speech quality and echo are the most critical issues related to customer perception and service retention.



Common Post-Install VoIP Service Quality Issues

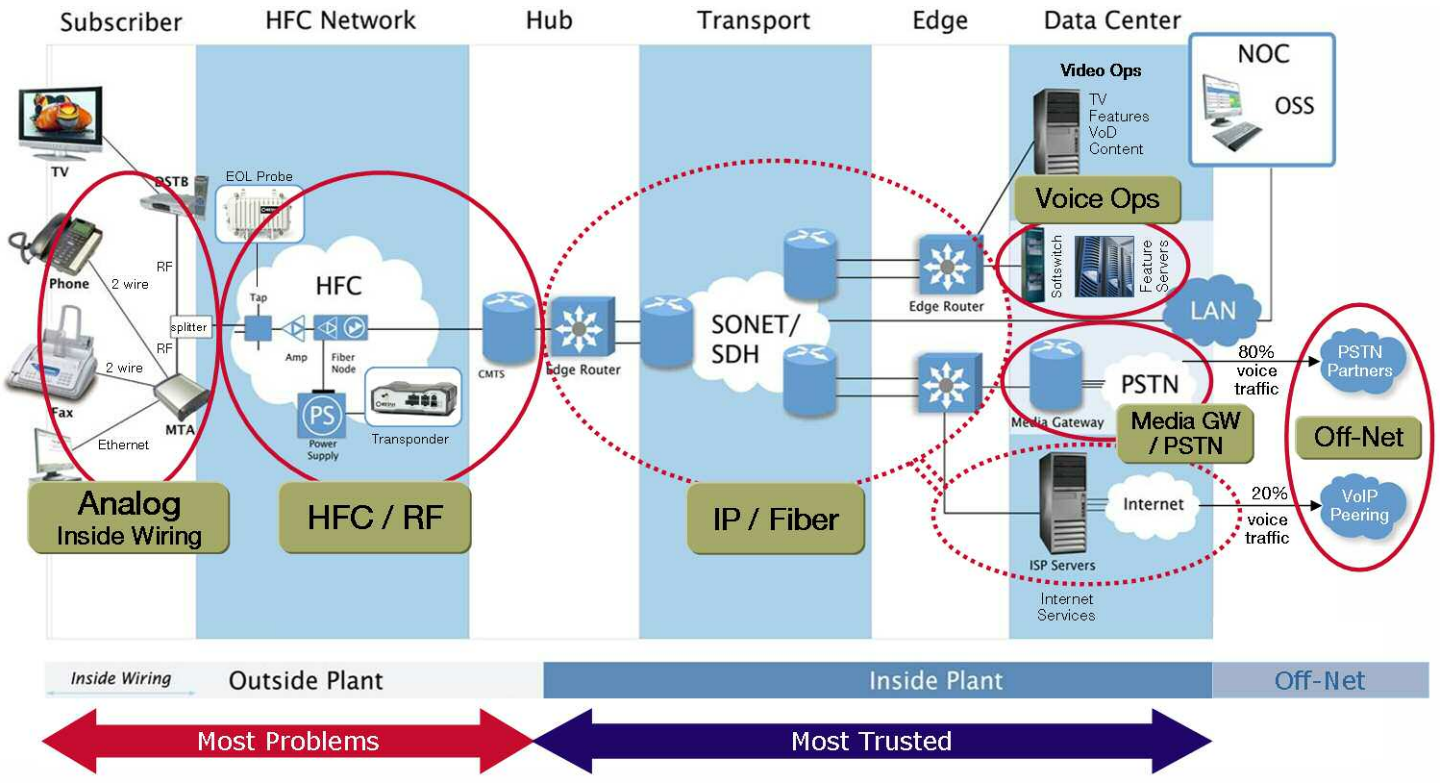
Tektronix® Communications

VoIP Troubleshooting & Monitoring

Thorough Day-of-Install testing is the best way to ensure that VoIP meets customer expectations when deployed. A complete end-to-end service quality assessment that reflects the real-user experience helps to identify and resolve issues before subscribers begin using the service. These provisioning practices help to assure customer satisfaction and service retention during the critical first-weeks after deployment when most service quality issues are discovered.

However, there are no guarantees that services will remain trouble-free for prolonged periods. Service quality can degrade for a variety of reasons, including access network congestion caused by increasing voice, HDTV, internet and VoD traffic, network upgrades, DoS/Security/Spam attacks, network reliability issues, and exceptional events that stress networks (e.g. the Superbowl in HDTV, major news, Mother's day / Christmas phone calls, or natural disasters).

Response time is a critical factor influencing customer perception and service retention. Efficient response also helps operators maintain low operating costs, leading to a faster return on VoIP infrastructure investments. These issues can be addressed without dispatching a technician by using remote service quality testing methods.



Common VoIP Problem Locations in Cable Networks

MTA Loop-back Testing to Subscribers

The logical first step to take when a customer reports a service-quality issue is to fully assess and confirm the problem with an end-to-end test that replicates the customer perception. This is performed using remote loop-back testing to the subscriber's residence. DOCSIS 2.0 (and later) compliant MTAs provide both analog and IP / RTP loop-back functionality that allow test systems to measure over 50 different IP and analog-based speech / service quality measurements directly from the NOC. Some test systems can initiate loop-back tests from the PSTN-side of the media gateway, usually from a T1 interface, to include all the end-to-end elements phone calls normally encounter.

If no problem is detected, it may be that the problem resides within the subscriber's residence –support can transfer the subscriber to the self-service test system to collect results that can be compared with MTA loop-back results to detect issues located past the MTA in the subscriber's home. Issues caused by poor quality handsets, interference from wireless networks, poorly connected phones, or faulty wiring are easy for customers to detect and resolve with proper guidance from support personnel.

Loop-back Testing to Cable Transponders

If the MTA loop-back test displays a service quality issue, the next step is to pinpoint the network location where the problem originates. Once the network is segmented and the problem is isolated, traditional domain-specific tools are used to complete problem diagnosis and service restoration - including data from return-path monitoring systems, CDRs from softswitches, and results from handheld test tools used by dispatched technicians.

Just as test systems can perform loop-back testing to MTAs, they can also perform IP-layer Real-time Transport Protocol (RTP) loop-back tests to cable transponders located throughout the HFC. Loop-back testing is supported by transponders compliant with DOCSIS 2.0 MTA loop-back specifications or the SMRP remote testing protocol. RTP loop-back tests can assess speech quality (MOS, R-factor, packet loss, jitter, etc.), DTMF transparency, delay, and network media streaming performance. RTP loop-back tests can also be used to assess the network's ability to deliver digital video including HDTV and VoD streams.

By integrating a service level test automation platform with the transponder EMS / topology database, the test system can perform loop-back tests from the Cable Modem Termination System (CMTS) or the Network Operations Center (NOC) to all transponders serving a subscriber in the HFC. This powerful technique can determine if a problem originates from the HFC, and its exact location.

Probe-to-Probe Testing to CMTS / Edge Routers

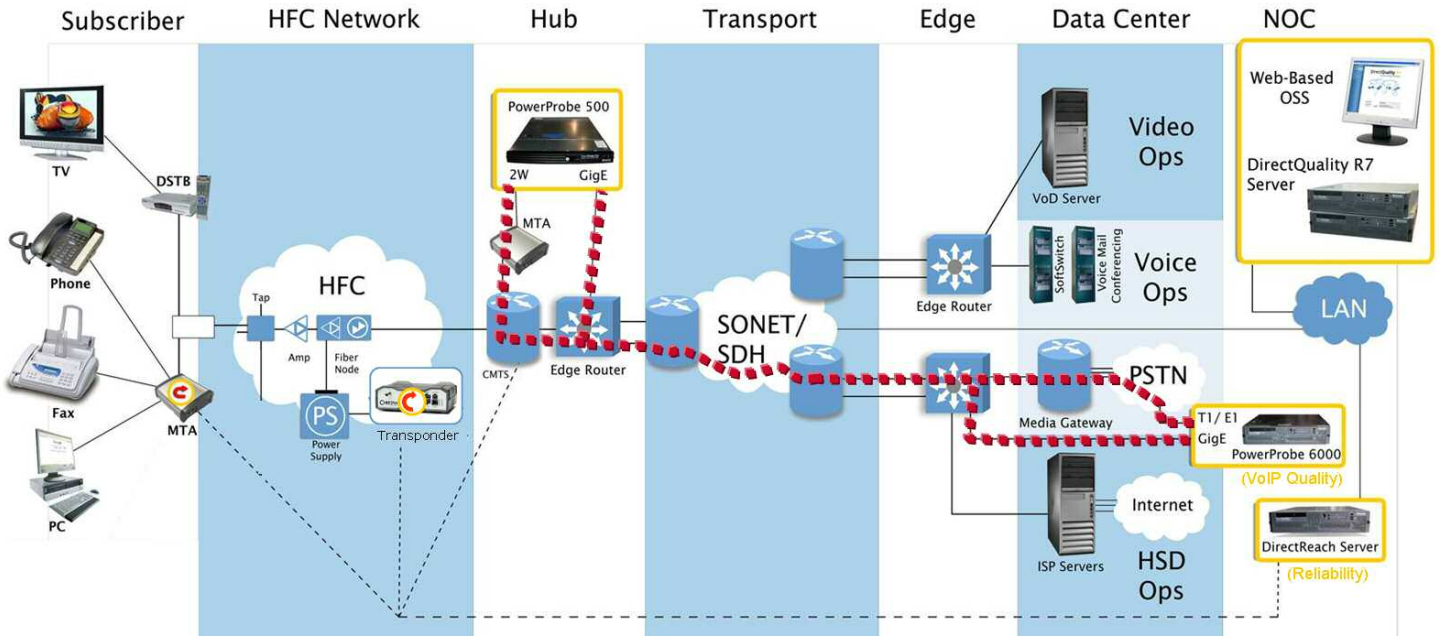
Providers can evaluate the Fiber/IP network by performing VoIP service quality tests from the NOC to CMTS hubs using probe-to-probe testing, where test calls are placed from one probe to another, providing complete control over test stream content and quality measurements in both directions. Probe-to-probe testing offers a wider range of measurements than loop-back testing, including upstream/downstream evaluation of VoIP, PSTN, video, Internet, and fax/modem service quality. Cable MSOs typically place probes in each CMTS hub for complete backhaul-network monitoring and fault-management.

In addition to monitoring access/backhaul networks, probe-to-probe testing allows operations to isolate problems with edge routers and Media Gateways, as tests can be initiated from the PSTN side of the Gateway from a T1/E1 port, or into the IP network directly through an IP connection; test calls can be routed through the hub's CMTS or edge router by selecting a two-wire or IP destination test port.

Return Path Monitoring

HFC networks are subject to RF performance issues caused by faulty transponder performance, aging wiring or damaged fibers, failing amplifiers / optical nodes, corroded cable connections and poor optical splices. When RF signal levels shift, a number of subscribers often experience service quality issues or disruptions, some of which may only affect services in the upstream, the return-path direction from subscriber to CMTS. A stable RF return-path is increasingly important with the increase in two-way, packet-based Internet and VoIP services.

The RF return-path is best monitored with a specialized, central monitoring system employing probes located at strategic locations in the HFC network (hubs, headend). These systems are also normally compatible with field-based RF testsets.



Probe-to-Probe Test ArchitectureTests can be initiated / terminated from each interface shown

Testing Off-Net

Sometimes customers report service-quality issues that an end-to-end test cannot confirm. This frequently happens when a subscriber is placing a call beyond the cable VoIP network, i.e. off-net (for example, a long-distance call overseas). To ensure that PSTN partner-carriers and VoIP-peering networks are providing service levels defined by service level agreements (SLAs), cable operators can use single-ended (ping-style) testing methods that can test off-net, partner-network VoIP performance to off-net destinations worldwide.

Single-ended testing measures voice, signaling, fax, Internet and modem service quality without far-end test equipment. To do this, a test probe in the NOC places test-calls off-net to public interactive voice response (IVR) systems, fax machines, modems, video conferencing terminals or IP servers stored in a global test destination database.

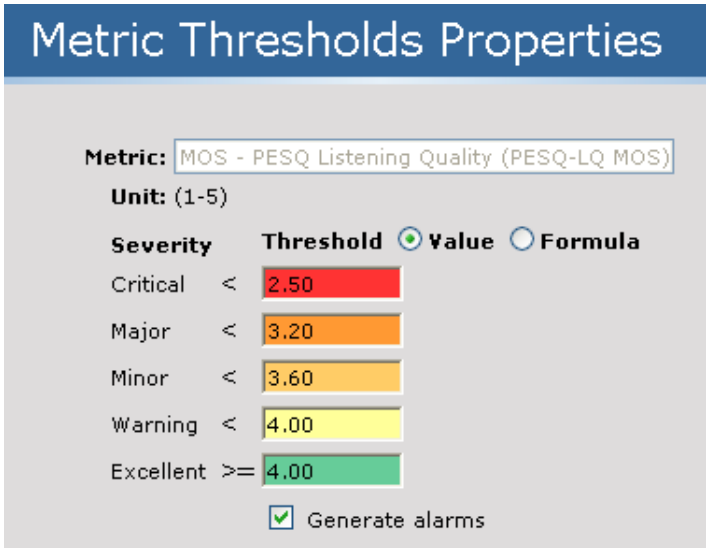
The test calls include pre-recorded samples of actual speech in a number of specifications related to perceptual speech quality measurement. The calls are recorded and analyzed against the original reference file by the test probe using a series of algorithms that provide speech quality (MOS) scores, connectivity stats, fax transmission rates, IP server availability and performance, and a wide range of other quality metrics. Test tones are sent periodically during the test call to permit echo testing, a common problem with long-distance connections. By testing to different area codes, cities, and countries, partner networks can be tested against SLA parameters. This method is also used by operators to help them select and validate partner carriers before putting them into service.

Test Automation & Management

Remote testing techniques have been discussed in the context of VoIP service quality troubleshooting and problem resolution. The same techniques are commonly used to proactively monitor VoIP services by controlling tests from a service-level test automation platform. Real-time service quality monitoring lets operators trend quality metrics to detect service degradation, usually before subscribers can perceive them. This level of information is used to schedule preventive maintenance, network management and upgrades to ensure VoIP maintains PSTN-quality despite substantial subscriber and service-usage growth often experienced during large-scale VoIP deployment.

Proactive Monitoring

Service quality monitoring is performed by scheduling automated VoIP service quality tests to critical locations in the Cable VoIP network using a test-automation operational support system (OSS). By regularly testing the HFC, IP/Fiber, Media Gateway, and Voice Operations network domains, operators can determine how service quality varies by location, network segment, and time of day (low/peak-usage hours). By setting service quality thresholds for key VoIP quality metrics such as MOS, echo, latency, jitter, post-dial delay (PDD), and call completion ratio (CCR), reports can indicate which aspects of VoIP service are degrading, and how quickly. Aggregated reports created from the data help network engineering, marketing, and billing departments make business-level decisions using objective, quantitative data.



Example of Service Level Class Thresholds

Conclusions

Cable operators face many challenges when deploying PSTN-quality VoIP. MSOs can maintain high-quality phone service by using a test approach that can reduce return visits and ensure customers will be satisfied with their new phone service.

Operators extend the value of their test system by using a centralized test management platform that automates remote testing for continuous service quality monitoring. By integrating VoIP test results into existing OSS and fault-management systems, operators can use service quality measurements to drive network planning, preventative maintenance, marketing and business-level decisions, helping them to efficiently provide PSTN-quality VoIP over large-scale cable networks.

About Tektronix:

Tektronix has more than 60 years of experience in providing network operators and equipment manufacturers a comprehensive and unparalleled suite of network diagnostics and management solutions for fixed, mobile, IP and converged multi-service networks.

These solutions support such architectures and applications as fixed mobile convergence, IMS, broadband wireless access, WiMAX, VoIP and triple play, including IPTV.

For Further Information:

Tektronix maintains a comprehensive, constantly expanding collection of application notes, technical briefs and other resources to help engineers working on the cutting edge of technology.

Please visit www.tektronix.com/communications

Contact Tektronix:

Please visit www.tektronix.com/communications

Phone:
1-800-833-9200 option 1
+1-469-330-4000

Locate your nearest Tektronix representative at:
www.tektronix.com/contactus

01/08 | CAW-21026-1

Tektronix® Communications