Deploying Wireline-Quality VoIP

by Using Integrated Service Level Test Automation

Delivering Toll Quality VoIP During Rapid, Large Scale Deployment

Cable MSOs worldwide are deploying VoIP services to their subscribers, often facing strong demand that requires rapid, large-scale deployment. As cable operators begin to benefit from the effects triple-play service bundling has on customer retention and increased subscriber revenue, they must proactively ensure that the total customer experience meets expectations from VoIP day-of-install onward – a challenging feat considering the bandwidth delivered to each home is facing increased demand from multi-PC Internet usage, peer-to-peer file sharing, gaming, real-time messaging, HDTV, and video-on-demand.

When customers subscribe to Cable VoIP, they expect toll-quality voice service, with reliable, value added features such as caller ID, voicemail, three-way calling, and number portability. They also expect their alarm systems to work, 911 availability, and high-quality off-net, long-distance calls at rates below PSTN packages – while using inexpensive wireless phones subject to interference from WiFi networks and noise introduced by legacy copper wiring, fed by Hybrid Fiber-Coaxial (HFC) networks originally designed for unidirectional, analog video traffic.

With such a wide range of challenges, cable operators deploying VoIP need to ensure they have a focused service-quality testing strategy that covers all of these aspects, while also maintaining efficient operational budgets, and best-in-class customer response and mean-time-to-repair (MTTR). To meet these objectives, MSOs can use day-of-install and remote service quality testing to greatly reduce technician dispatches – including repeat visits after VoIP install, and truck rolls to troubleshoot service quality issues originating in the HFC. Effective testing can mean a big difference compared to ad-hoc practices: an internal study at one of America's largest Cable MSOs concluded that out of 1.5 million truck rolls, 240,000 were repeat visits to correct problems caused by poor installation, and 350,000 unnecessary visits could have been avoided - a total of 39% that could have been greatly reduced with simple VoIP testing techniques.

Common Sources of VoIP Problems

Location	Common Issues
Analog / Inside Wiring	Echo . Speech Quality (distortion, codecs, clipping) . Volume . Noise . DTMF transparency
RF/HFC	Transponders . Return path loss . QAM performance
IP/Fiber	Packet Loss . Jitter . Latency
Voice Operations	Caller ID . Conference Calling . Voice mail . CDR (billing)
Gateway / PSTN	Codec effects . Echo cancellers . Voice mail . CDR (billing)
Off-Net	Connection . Echo . Noise . Volume . Speech Quality Fax Services . Modem Connectivity and Transmission

Day-of-Install - one visit is all it takes!

The goal of full-service, technician-dispatched VoIP install should be to ensure the service is installed correctly, the first time. An effective test plan, covering RF to service quality ensures success. Best-in-class installation involves a series of quick tests, designed to cover all aspects of service quality and reliability. To perform the tests, a handheld cable and VoIP tester are required. Among the most cost-effective VoIP testing options available are line-powered test responders that connect to any two-wire standard phone jack to perform service quality testing. Responder-based tests can be controlled and reviewed on the cable tester, offering an integrated VoIP test solution that is far less expensive than replacing existing cable testsets with more complex, multifunction units.

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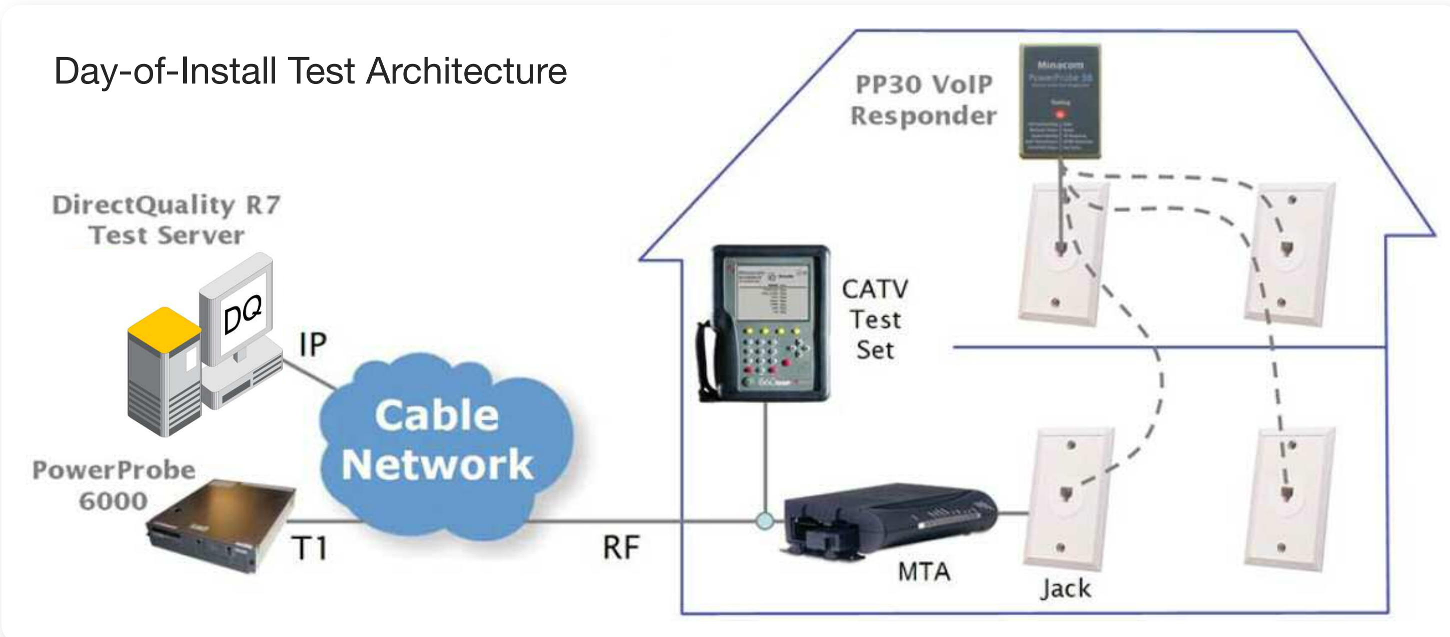

Figure 1: *Testing using Responders*

Responders work by receiving a test call from a probe connected to the operator's media gateway or the nearest CMTS, responding with a test stream that permits the probe to measure call connectivity (dial-tone delay, post-dial delay), user-percieved speech quality (MOS, R Factor), DTMF touch-tone transmission required for services such as voicemail and online banking, and analog measurements including line noise, distortion, echo, volume and clipping (Figure 1). Responders validate all aspects of a service that customers perceive, as well as analog and IP measurements that provide insight into the source of quality issues.

Responder test calls are typically completed in less than a minute, permitting technicians to thoroughly test a service without significantly increasing install time. If problems arise, the detailed test results help them to resolve the problem quickly by isolating the type of problem (wiring, network, or service issue), resulting in quicker than average installation performance .

Day-of-Install, Best Practice

Tier-1 MSOs have developed a best-practice, day-of-install test procedure that effectively reduces return visits:

1. Validate RF performance with a handheld testset, ensuring levels to the home are within the range the Multimedia Terminal Adapter (MTA) requires.
2. Install the MTA; validate throughput and service-flow configuration using built-in diagnostics.
3. Benchmark the existing PSTN service to baseline customer's expectations using a test responder – repeat for each jack in the home to locate wiring issues. Fix/replace wiring and jacks as required.
4. Transfer the phone number to the cable operator's call management server (CMS / softswitch).
5. Connect the responder to the MTA's 2-wire interface – validate speech quality (MOS), call connectivity, noise, volume, echo, and DTFM touch-tone transmission performance. If tests pass pre-defined criteria, connect the MTA to the inside house wiring.
6. Perform the same service quality tests from other jacks in the home, to confirm wiring connections.

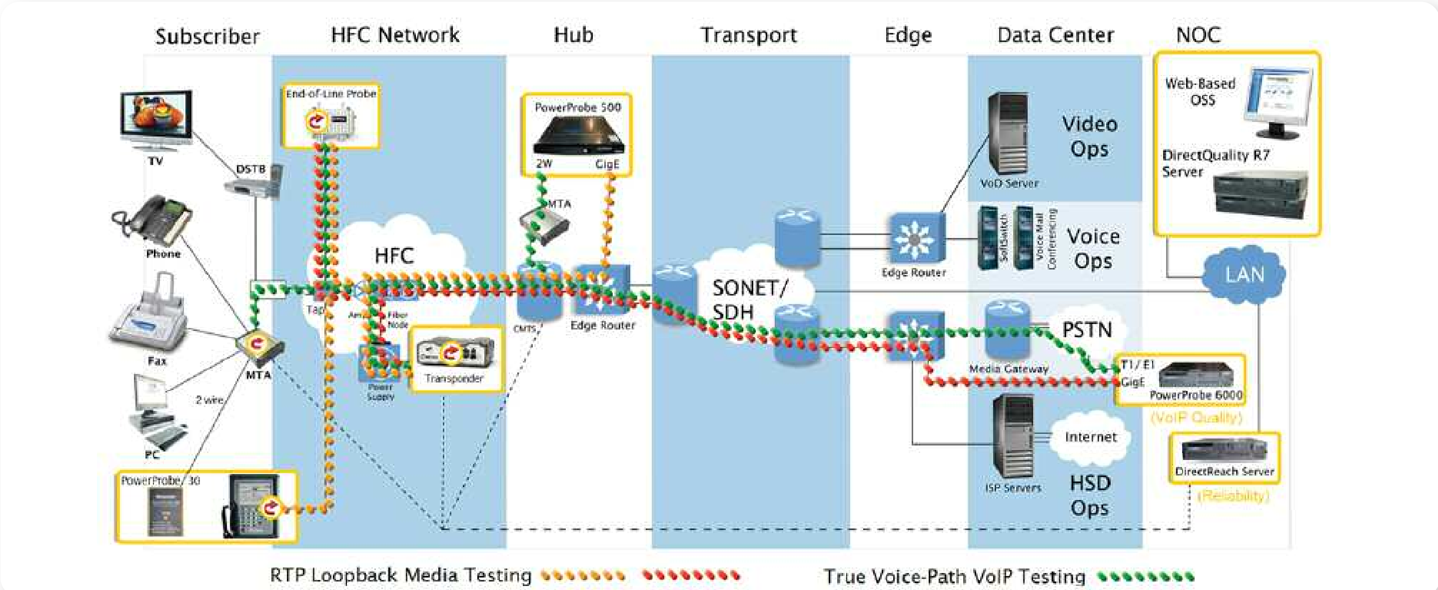

Figure 2: *Remote testing from the gateway to hubs, transponders, and MTAs*

Maintaining VoIP Service Quality - keep trucks in the garage

Successful installations are the best insurance MSOs have to add satisfied customers. However, even the best laid services can degrade, as external factors affect service quality, including access network congestion caused by increasing voice, HDTV, Internet and VoD traffic, network upgrades, new service introduction, environmental effects on passive fittings and components in the HFC and network reliability issues, DoS/Security/Spam attacks, and exceptional events that stress networks (e.g. the World Series in HDTV, major news, Mother's day / Christmas phone calls, or natural disasters).

When service quality issues arise, service providers' 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. Both of these needs can be addressed without technician dispatch using remote testing techniques to perform end-to-end service quality tests that confirm, quantify, and isolate the origin and cause of service issues. Remote testing is a key operational consideration supported by the data over cable service interface specification (DOCSIS, v2.x and 3.0).

Remote testing spans the full cable network from media gateway through the transport network to the HFC, and ultimately, to the subscriber (Figure 2).

The most recent methods include loopback testing to subscriber-MTAs and transponders located throughout the HFC. Both techniques leverage existing DOCSIS and PacketCable standards to permit user-perceived service quality testing over true voice-path, Dynamic Quality of Service (DQoS) service flows.

MTA Loopback Testing

To establish loopback testing, a test probe instructs the softswitch to active a loopback call to a subscriber's MTA. It is critical that the softswitch is aware of the loopback, as bypassing the switch leaves it out of sync with subscriber MTA status - a violation of PacketCable requirements that subscribers are never denied a dial tone, and that test calls are non-intrusive. All DOCSIS 2.0 or later MTAs provide two forms of loopback: IP/RTP (network loopback) and analog (network continuity). The IP/RTP (Real-time Transport Protocol) loopback directly reflects test packets back to the test probe, while the analog loopback first uses MTA's codec to decode the call to analog form, then re-encodes it before reflecting the call (see Figure 3). Analog loopback testing closely reflects what the subscriber hears, as the test reaches as far as the phone jack at the back of the MTA. Over 50 service quality parameters can be measured with loopback testing, including the majority of those measured by test responders (MOS, connectivity, DTMF, etc.).

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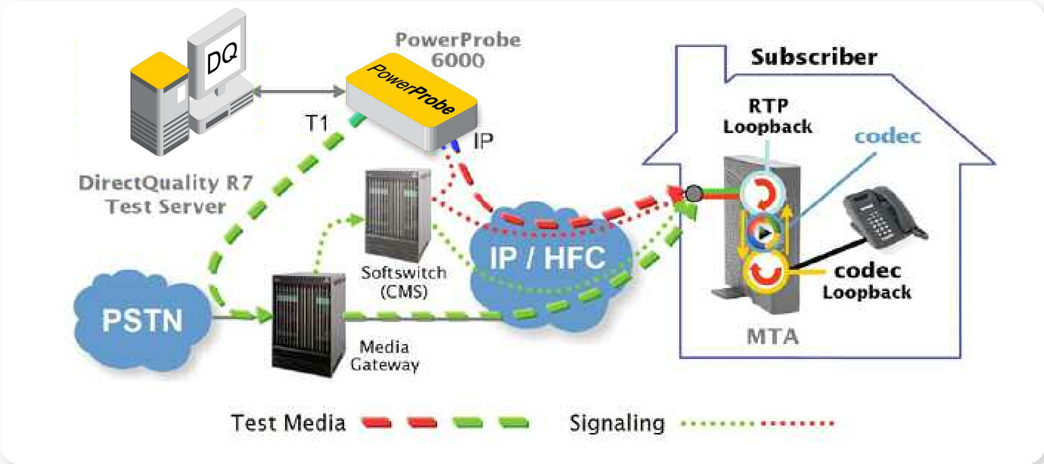

Figure 3: *MTA Loopback Testing*

Using Transponders as Test Reflectors

Most common status-monitoring transponders and end-of line probes support the same voice-path loopback testing as MTAs, as well as triple-play media delivery performance validation using RTP stream-testing. Transponders may also contain embedded VoIP responder technology which permits one-way, return-path testing.

Troubleshooting and Monitoring with Remote Testing

When a service quality issue is reported by a subscriber, MSOs can confirm and assess the problem by first performing an MTA loopback test to the home. If the results show no issues, the problem is likely located within the residence, either due to the handset quality, cascaded phone extensions, wireless phone battery drain, or any number of other causes that can usually be resolved using phone support. If the MTA loopback test confirms a problem, operations can perform tests to transponders located along the coax/fiber route serving the subscriber, to determine if the problem originates from within the HFC, and if it does, its location and characteristics. Probe-to-probe and off-net testing allow the problem to be quickly isolated if located outside the HFC.

Using test automation, subscriber MTAs, transponders, and test probes located in hubs can be used for ongoing, proactive monitoring, using service-level thresholding to detect degrading quality before it becomes subscriber-affecting. By integrating proactive monitoring with existing fault management systems, cable operators can monitor VoIP service reliability and quality alongside network and physical layer faults, providing integrated multi-layer visibility into the health of the network and services.

Rapid, large-scale VoIP deployment poses many challenges, the not the least of which is ensuring quality-conscious consumers' expectations are met starting from the first day of service. A service quality assurance strategy combining complete day-of-install practices, with remote VoIP testing help operators maintain the quality and reliability of their services most efficiently.

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.

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