Verifying Voice Quality

When VoIP calls are properly established, the next step is to verify that the voice quality is good. You should consider the following guidelines as you attempt to achieve good voice quality:

- Understand how much bandwidth a VoIP call consumes with each codec, including Layer 2 and IP/UDP/RTP headers. For more information about VoIP bandwidth consumption, refer to Voice Over IP - Per Call Bandwidth Consumption, document ID 7934.
- Understand the characteristics of the IP network over which the calls travel. For example, the bandwidth of a Frame Relay network at CIR is much different than that above-CIR (or burst), where packets could be dropped or queued in the Frame-Relay cloud. Ensure that delay and jitter are controlled and eliminated as much as possible. One-way transmit delay should not exceed 150 ms (per G.114 recommendation).
- Use a queuing technique that allows VoIP traffic to be identified and prioritized.
- When transmitting VoIP over low-speed links, consider using Layer 2 packet fragmentation techniques, such as Multilink Point-to-Point Protocol (MLPPP) with Link Fragmentation and Interleaving (LFI) on point-to-point links, or FRF.12 on Frame Relay links. Fragmentation of larger data packets allows less jitter and delay in transmitting VoIP traffic because the VoIP packets can be interleaved onto the link.
- Try the call with a different codec and with the voice activity detector (VAD) enabled and disabled to possibly narrow down the issue to the digital signal processor (DSP), as opposed to the IP network.

With VoIP, when you are troubleshooting QoS issues, look especially for dropped packets and network bottlenecks that can cause delay and jitter.

Specifically, look for the following:

- Interface drops
- Buffer drops
- Policy-map drops
- Interface congestion
- Link congestion

Each interface in the path of the VoIP call should be examined and drops and congestion should be eliminated. Also, round-trip delay should be reduced as much as possible. Pings between the VoIP end points give an indication of the round trip delay of a link. The round trip delay should not exceed 300 ms whenever possible. If the delay does have to exceed this value, efforts should also be taken to ensure this delay is constant, so that you do not introduce jitter or variable delay.

When low latency queueing (LLQ) is set up, you can check policy-map drops by looking for packets that match the priority class by entering the **show policy interface serial** command. This shows how much traffic

is matching the priority class and how much bandwidth is used.

Ensure that the Cisco IOS queuing mechanism is placing the VoIP packets within the proper queues. Cisco IOS commands, such as **show queue** and **show priority** can help you to verify queueing.

Measuring QoS

Cisco offers several options for monitoring QoS in networks using VoIP solutions. Cisco offers tools that provide information about the voice quality you are experiencing by measuring delay, jitter, and packet loss. Cisco solutions do not measure voice quality using Perceptual Speech Quality Measurement (PSQM) or some of the new proposed algorithms for voice quality measurement. Tools from outside vendors are available for this purpose.

When implementing service policies using the QoS command line interface (CLI), start with the Cisco Class-Based QoS Configuration and Statistics Management Information Base (MIB). This MIB provides read access to QoS configuration and statistics information for Cisco platforms that support the Modular QoS CLI. Statistics available through this MIB include summary counts and rates by traffic class before and after any configured QoS policies are enforced. In addition, detailed feature-specific statistics are available for select PolicyMap features. See Cisco MIBs for the object IDs.

In addition, Cisco offers the following software tools for monitoring QoS:

- **Network monitoring using Cisco Service Assurance Agent (Cisco SSA)**-The response time and availability monitoring capabilities of this tool include support for VoIP, QoS, and the World Wide Web. The Cisco SSA is an application-aware synthetic operation agent that monitors network performance by measuring key metrics such as response time, availability, jitter (interpacket delay variance), connect time, throughput, and packet loss. These metrics can be used for troubleshooting, for analysis before problems occur, and for designing future network topologies. This tool is designed more for trending, rather than real-time monitoring. Refer to Using Cisco Service Assurance Agent and Internetwork Performance Monitor to Manage Quality of Service in Voice over IP Networks for more information.
- **Cisco Gateway Management Agent (CGMA)**-The only real-time management Cisco IOS software agent and protocol for VoIP. The CGMA is a new gateway Cisco IOS agent that provides real-time call-state information for all VoIP calls. CGMA supports a push protocol, in which certain call-state changes result in a message being sent out of CGMA by the gateways. The interface from the CGMA is the Real Time Management Protocol (RTMP). RTMP is a lightweight XML-based protocol that uses TCP as the transport protocol. This solution allows Service Providers to monitor their calls (session initiation protocol (SIP) and H.323 networks), viewing call detail records (CDRs) and trunk utilization in real time. The validated gateways for the CGMA include the Cisco 2600 series, the Cisco 3600 series, and the Cisco 5000 series. The Cisco IOS that has been validated on all gateways is the 12.2(2)XB mainline release.
- **CiscoWorks QoS Policy Manager (QPM)**-QPM provides a scalable platform for defining, applying, and monitoring QoS policy on a system-wide basis for Cisco devices, including routers and switches.

  QPM enables you to baseline profile network traffic, create QoS policies at an abstract level, control the deployment of policies, and then monitor QoS to verify intended results. As a centralized tool QPM is used to monitor and provision QoS for groups of interfaces and devices.
  QPM provides a web-based intuitive user interface to define QoS policies, and translates those policies into the device's command line interface (CLI) commands.
  QPM runs on the CiscoWorks Common Services server, which can be installed as a standalone server, or as an add-on to CD One 5th Edition. CiscoWorks Common Services provides the infrastructure required by QPM to run from the CiscoWorks desktop environment, and also provides

management of user roles and privileges, allowing you to control who gets access to specific tasks in QPM.