Company Profile

MOTOROLA—Cisco IOS Software Delivers End-to-End Quality of Service and Classes of Service for Motorola's Global Enterprise Network

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> *~ Eric Milard, Network Architecture Manager at Motorola*

The old adage "time is money" might be amended to "real-time packet traffic is money" by the network architects at communications and electronics giant Motorola. In 1999, Motorola, a Cisco Powered Network program member and Cisco strategic alliance partner, took advantage of the quality-of-service (QoS) features available in Cisco IOS® Software to better guarantee and manage traffic across the company's global network, OneNET. QoS is a combination of techniques and protocols to manage the bandwidth, delay, jitter, and packet loss in network applications. The QoS features in Cisco IOS Software let Motorola control and predictably service OneNET's variety of networked applications and traffic types for more efficient and cost-effective operations.

Moving to End-to-End QoS

Motorola's OneNET is a typically busy multinational enterprise network, with business-critical enterprise resource planning (ERP) systems, e-mail, Web, voice, and video traffic all converging. Cisco 7500 Series routers form the OneNET core, and an array of other Cisco routing and switching platforms are in more than 400 Motorola offices worldwide.

"Our QoS effort was driven by the need to give our manufacturing, financial, and other business-critical applications consistent performance," says Eric Milard, Network Architecture Manager at Motorola. "We started testing QoS features when we moved our Latin American voice traffic to the IP network to reduce high long-distance toll charges there. Voice over IP (VoIP) over our WAN was calculated to greatly reduce our costs."

Motorola representatives attended an executive briefing at Cisco Systems headquarters in San Jose, California, and learned about the different QoS mechanisms that can be enabled with Differentiated Services (Diff-Serv), standards-based protocols available in Cisco IOS Software. Diff-Serv lets network administrators define different service characteristics for different kinds of traffic flows without the need for per-flow state and signaling at every hop.

Four classes of service were created for OneNET traffic. In order of highest to lowest priority, they include:

- Jitter-sensitive traffic—For VoIP, audio, and video streaming
- Time-sensitive traffic—For ERP applications involving user interaction such as database lookups, Citrix, or Telnet-based applications
- Normal traffic—For general data traffic, and the default class for all traffic
- Bandwidth-intensive traffic—For the ability to throttle down network-hungry applications like large file transfers or database replication

With Diff-Serv, each packet contains a particular QoS specification. This specification is implemented using the 3-bit IP Precedence setting in IP packet headers.

"Every packet entering OneNET is colorized, its IP Precedence value is defined-and this happens globally, depending on the class of service its application belongs to," explains Milard. Setting a QoS specification lets Motorola network administrators classify and mark traffic, and also performs intelligent queuing. Multilink Point-to-Point Protocol (MLPPP) is also used for splitting, recombining, and sequencing datagrams across multiple logical data links between sites. MLPPP is also used as an encapsulation mechanism on some links where VoIP is enabled in order to be able to use the RTP HC (Real Time Protocol Header Compression), and LFI (Link fragmentation, and interleaving mechanisms)

Motorola is running five separate Enhanced Interior Gateway Routing Protocol (EIGRP) regions interconnected with a Border Gateway Protocol (BGP) core. Enhanced IGRP provides superior convergence properties and operating efficiency, and combines the advantages of link state protocols with those of distance vector protocols.

Optimized Queuing

To provide consistent response times to heavy and light network users alike without adding excessive bandwidth, Motorola implemented Class-Based Weighted Fair Queuing (CBWFQ). One of the QoS features in Cisco IOS Software, CBWFQ is a flow-based queuing algorithm that schedules interactive traffic to the front of the queue to reduce response times, then fairly shares the remaining bandwidth among high-bandwidth flows. WFQ is also used where congestion is lighter and on circuits with fewer flows, and provides good results because it is IP Precedence-aware. Low Latency Queueing is another QoS feature Motorola is using, which allows highly delay-sensitive traffic, such as voice, to be dequeued and sent before other traffic.

EXECUTIVE SUMMARY

BACKGROUND

Headquartered in Schaumburg, Illinois, with its global WAN maintained in Phoenix, Arizona, Motorola provides integrated communications and embedded electronic solutions worldwide. Solution areas include: software-enhanced wireless telephone and messaging; two-way radio products; systems, networking, and Internet-access products; end-to-end systems for the delivery of interactive digital video, voice, and high-speed data solutions; embedded semiconductor solutions for wireless communications, networking, and transportation markets; and integrated electronic systems for automotive, telematics, industrial, telecommunications, computing, and portable energy systems markets.

CHALLENGE

A member of the Cisco Powered Network program, Motorola's OneNET serves more than 400 offices around the world. Motorola network executives searched for a method to prioritize and differentiate service across the network to support many different kinds of traffic. The goal was to optimize large, business-critical ERP systems.

CISCO SOLUTION

Motorola chose to implement the QoS features available in Cisco IOS Software. A variety of protocols and practices were tested, first for ERP and then for other applications. The Cisco IOS Software protocols used include Diff-Serv, to create four different classes of service; Enhanced IGRP, to define five separate regions interconnected with a Border Gateway Protocol (BGP) core for superior efficiency; Class-Based Weighted Fair Queuing (CBWFQ) for flow-based queuing with QoS features; WRED for congestion avoidance; and Cisco NetFlow for distributed packet accounting and troubleshooting. The enhanced QoS management information base gives Motorola much greater visibility into traffic in each class of service.

RESULTS

Motorola OneNET is a showcase of QoS features contained in Cisco IOS Software. The combination of protocols and practices applied to different types of network traffic in different parts of the world contributes to better network control and more intelligent utilization, absence of congestion, savings on voice toll charges, and the ability to guarantee the movement of diverse communications that represent the company's lifeline.

The Weighted Random Early Detection (WRED) feature in Cisco IOS Software is another set of congestion-avoidance algorithms used by OneNET. WRED is the Cisco implementation of standards-based Random Early Detection (RED) solutions. When RED is used and the source detects the dropped packet, it slows its transmission. It is primarily designed to work with TCP in IP internetwork environments.

Cisco Netflow Replaces IP Accounting

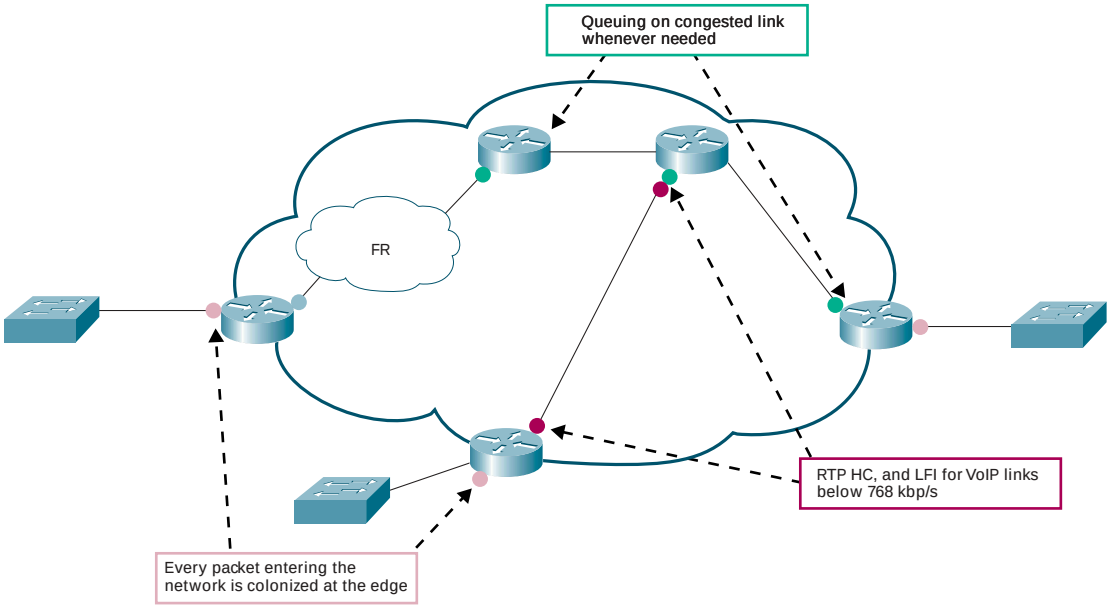
Another effort under way at Motorola is to replace IP Accounting for packet monitoring and troubleshooting with Cisco Netflow, also in Cisco IOS Software. As Motorola started pushing the QoS features into the network hardware, the use of Cisco Express Forwarding for faster switching of packets through the network ran into conflicts with IP Accounting, which is not designed to run in distributed mode.

"Enhancing the existing network management system was a highlight of the project," says Milard. "We use the Class-based QoS Management Information Base (MIB) to give us much greater visibility into traffic in each class of service. It reports back to us on utilization and drop, and acts as our eyes on the network. We can adjust the amount of bandwidth for a class of service based on utilization levels. Without the data coming from the Class-based QoS MIB, we'd be running blind."

Application Characterization

"We look at the characteristics of each application running across the network before we define its class of service. We need to understand the application to make sure we don't put a truck in the bike lane or a bike in the truck lane. If it's time sensitive and integral to the business, it is eligible to go into the time sensitive class of service of QoS," says Milard.

Figure 1. Motorola Network with QoS Implementation



The QoS information that comes into OneNET's management information base using Simple Network Management Protocol (SNMP) is a great help. "It enhanced our network management system with much greater granularity," says Milard. An even larger part of the rollout involved QoS for many of Motorola's key ERP systems.

"We have upgraded the OneNET core and the backbone so that every site can now use QoS," says Milard. "End users have been able to shut down redundant versions of databases on their LANs, consolidating them into a single instance, thanks to their confidence in response times due to our enhanced QoS features. Before, we would have had to throw up a lot of bandwidth across the Atlantic and the Pacific to support all users equally, with multiple copies of the same application running concurrently."

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Motorola sees QoS as a key resource for future technology integration products, including VoIP and data-center consolidation. "Voice over IP alone is now saving us up to US $50,000 a month in international calls in some locations," says Milard. "And application consolidation will save us millions. QoS has enabled us to smoothly transition from localized to remote applications, giving end users consistent performance across the WAN. Our architecture team has done a tremendous job of integrating these new technologies in OneNET and keeping them manageable, scalable, and controllable."

Milard is quick to add that QoS is no magic fix to remove congestion from the WAN. It does, however, give Motorola the management information, tools, and techniques to intelligently make decisions on traffic priorities and bandwidth allocation as volumes grow.

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