Cisco IOS Quality of Service

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The Challenge

A communications network forms the backbone of any successful organization. These networks serve as a transport for a multitude of applications, including delay sensitive voice, and bandwidth intensive video. These business applications stretch network capabilities and resources, but also complement, add value, and enhance every business process. Networks must therefore provide secure, predictable, measurable, and sometimes guaranteed services to these applications. Achieving the required Quality of Service (QoS)—by managing the delay, delay variation (jitter), bandwidth, and packet loss parameters on a network, while maintaining simplicity, scalability, and manageability—is critical to running an infrastructure that truly serves the entire business.

The Solution

Cisco IOS® Software provides QoS features and solutions for addressing the diverse needs of voice, video, and data applications. Cisco IOS QoS allows complex networks control and predictable service for a variety of networked applications and traffic types. Small to medium businesses, enterprises, and service providers all benefit from deploying Cisco QoS on their networks. Bandwidth, delay, jitter, and packet loss can be effectively controlled. By ensuring the desired results, QoS enables efficient, predictable services for business-critical applications.

Using the rich QoS feature set in Cisco IOS Software, businesses can build networks that conform to either the Internet Engineering Task Force (IETF) Integrated Services (IntServ) model or the Differentiated Services (DiffServ) model. Cisco IOS QoS features also provide value-added functionality, such as Network Based Application Recognition (NBAR), for classifying traffic on an application basis, Cisco IOS IP Service Level Agreements (SLAs) for end-to-end QoS measurements, and Resource Reservation Protocol (RSVP) signaling for admission control and reservation of resources.

Applications

Small and medium businesses (SMBs) often cannot justify the resources required to continually upgrade the link speeds in their networks. Cisco IOS QoS provides an alternative solution for taking charge of the available bandwidth and managing it efficiently to meet application demands. Mechanisms such as Link Fragmentation and Interleaving (LFI), Compressed Real Time Protocol (CRTP), Class Based Weighted Fair Queuing (CBWFQ), and Low Latency Queuing (LLQ) allow the most efficient distribution of the available bandwidth among the applications.

With Cisco AutoQoS provisioning, enterprises can deploy Cisco IOS QoS features quickly and easily across an entire network. End-to-end QoS solutions enable business-critical and multimedia applications to be prioritized, so the required network bandwidth and delay bounds are allocated. Expensive WAN connections can also be used efficiently, ensuring low delay, jitter, and assured bandwidth for Voice over IP (VoIP), with the new QoS bandwidth estimation. RSVP, CBWFQ, Committed Access Rate (CAR), Generic Traffic Shaping (GTS), and Weighted Random Early Detection (WRED) are some of the core Cisco QoS tools for enterprises. A service provider can

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offer QoS enabled VPNs and non-VPN services to gain the competitive edge. The tightly integrated Cisco DiffServ and Multiprotocol Label Switching (MPLS) features enable further differentiation with end-to-end IP services. Service providers catering to traditional Asynchronous Transfer Mode (ATM) and Frame Relay customers can also benefit from Cisco IP QoS-to-ATM Class of Service (CoS) features, Frame Relay Traffic Shaping (FRTS), Frame Relay Fragmentation (FRF).12, and other solutions.

Finally, mapping RSVP reservations to ATM Permanent Virtual Circuit (PVC) and Switched Virtual Circuit (SVC) QoS is also a differentiating tool for service providers providing end-to-end QoS services.

Cisco IOS QoS Technology

Classification and Marking

Packet classification features allow traffic to be partitioned into multiple priority levels, or classes of service. Packets can be classified in a variety of different ways—ranging from input interface, to NBAR for difficult to classify applications, to arbitrary access control lists. Classification is the first component of Modular QoS CLI (MQC), the simple, scalable, and powerful Cisco IOS QoS framework. MQC allows for clear separation of classification, from the policy applied on the classes, to the application of a QoS policy on an interface or sub-interface. Packets can also be marked in a variety of ways (ie: Layer2—802.1p/Q/ISL, ATM CLP bit, Frame-Relay DE-bit, MPLS EXP bits, etc., Layer3—IP Precedence, Differentiated Services Code Point (DSCP)) using the policy framework component of the MQC.

Congestion Avoidance

The WRED algorithm provides for congestion avoidance on network interfaces by providing buffer management, and allowing Transmission Control Protocol (TCP) traffic to throttle back before buffers are exhausted. This helps avoid tail drops, and global synchronization issues, thereby maximizing network utilization and TCP-based application performance. The policy framework component of MQC accommodates WRED.

Congestion Management

Often a network interface is congested (even at high speeds, transient congestion is observed), and queuing techniques are necessary to ensure that the critical applications get the forwarding treatment necessary. For example, real time applications such as VoIP, stock-trading, etc. may need to be forwarded with the least latency and jitter (up to a provisioned limit). Cisco Low Latency Queuing (LLQ) provides this type of solution. For other non-delay sensitive traffic (such as File Transfer Program (FTP), HyperText Transfer Protocol (HTTP), etc.), other queuing techniques such as CBWFQ, and Modified Deficit Round Robin (MDRR) may be used. The queuing techniques can also be instantiated using the policy framework of the MQC.

Traffic Conditioning

Traffic entering a network can be conditioned by using a policer or shaper. A policer enforces a rate-limit, while a shaper limits the traffic flow to a specified rate using buffers. Mechanisms such as CAR, GTS, and FRTS can be configured without/within the MQC framework.

Signaling

In addition to supporting provisioned QoS (including the IETF DiffServ model with techniques such as CAR, GTS, L3 packet marking), Cisco IOS Software also provides for the IETF IntServ model.

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RSVP is the primary mechanism to perform admission control for flows in a network. An example can be found in VoIP. A call is completed only if the resources are available for it, ensuring that a call coming into a network does not bump or affect the quality of existing calls. Another technique called QoS Policy Propagation via BGP (QPPB) allows for indirectly signaling (using the community list attribute in BGP) the forwarding priority for packets destined toward an autonomous system, AS-path, or IP-prefix. This is a very useful feature for service providers and large enterprises.

Link Efficiency Mechanisms

Streaming video and voice traffic uses the Real Time Protocol (RTP). IP, UDP, and RTP packet headers can be compressed from approximately 40 down to 5-8 bytes. This saves a tremendous amount of bandwidth in the case of low speed links, and when a large number of media streams are being supported. In addition, FRF.12 specification for frame fragmentation and Cisco Link Fragmentation and Interleaving (LFI) allow for fragmenting large data packets, interleaving them with RTP packets, and maintaining low delay and jitter for media streams.

Hardware Support

- Cisco 800, 1700, 1800, 2600, 2800, 3600, 3700, 3800, 7200, 7300, 7500, 7600, 10000, and 12000 Series Routers
- Cisco Catalyst® 3500, 3700, 4000, and 6000 Series Switches

Table 1. Key Cisco IOS QoS Technology Areas and Features

Technology Area	Associated QoS Features
Classification	NBAR, IP Precedence, DSCP, Protocol, ACLs
Congestion Management	Queuing techniques: WFQ, CBWFQ, LLQ, MDRR
Congestion Avoidance	WRED, DSCP-Compliant WRED
Traffic Shaping and Policing	GTS, FRTS, CAR, MQC-based TS
Signaling	RSVP, QPPB
Link Efficiency Mechanisms	LFI, cRTP

Additional Information

http://www.cisco.com/go/qos/

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