

QoS Design, Implementation, and Troubleshooting

**Presented by:
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About the Speaker

- **Dr. Pete Welcher**
 - Cisco CCIE #1773, CCSI #94014, CCIP
 - Network design & management consulting
 - Stock quotation firm, 3000 routers, TCP/IP
 - Second stock quotation firm, 2000 routers, UDP broadcasts
 - Hotel chain, 1000 routers, SNA
 - Government agency, 1500 routers
 - Teach many of the Cisco courses
- **Enterprise Networking Magazine articles**
 - <http://www.netcraftsmen.net/welcher/papers>



Objectives

Upon completion of this seminar, you will be able to:

- Describe how Content Delivery Networking interacts with providing QoS
- Explain the potential issues with SAN and Network Backup in a QoS network
- Describe the major QoS design considerations
- Explain the stages of implementing QoS
- Troubleshoot QoS issues in a network

Topics

- **QoS and Other Network Applications**
- **Design Considerations**
- **Implementing QoS**
- **Troubleshooting**

Content Networking

- **Content networking devices can help with bandwidth and QoS:**
 - Web caching and local delivery of content reduce bandwidth demands and deliver large files faster
- **Better user experience via:**
 - Speed- or geography-aware delivery of content
 - Load balancing and content switching
 - SSL and other offload



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Cisco Content Networking Devices

- **Devices:**
 - Content Services Switch
 - Secure Content Accelerator
 - Content Transformation Engine
 - Video Server
 - Content Engine
 - Storage Array
 - Content Distribution Manager
 - Content Routing
 - Distributed Director
 - Local Director
 - Global Site Selector (GSS)



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Cisco ACNS Software

- **Application and Content Networking System (ACNS) Software**
 - Self-Organizing Distributed Architecture (SODA)
 - Reliable multicast used for content distribution
- **Used with:**
 - Content Engine
 - Storage Array
 - Content Distribution Manager



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Cisco CDN and QoS

- **Cisco CDN devices (except the Content Router) can be configured, if desired, to send media files to clients using one of:**
 - RSVP
 - A specified DSCP value



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Storage Area Networking

- **Considerations:**

- Centralized storage creates large data flows to all sites
 - Trade-off: management costs, ease of backup, and convenience versus bandwidth
- Server to storage flows can be crucial to application performance
 - Effectively replaces computer bus with network
 - May need to use QoS techniques to give such traffic priority

Network Backups

- **Can be extremely large volume (“bandwidth hog”)**
- **Can also be considered critical**
- **Need to determine what parts of the network they potentially impact**
 - During what time periods
- **With SAN, consider out-of-band or low priority for backup traffic**
 - Usually you want application / client traffic to get priority
 - Unless backups aren’t completing in timely fashion

Topics

- Other Network Applications
- Design Considerations
- Implementing QoS
- Troubleshooting

The Major Things QoS Can Do

Classify and mark	Use DSCP bits to indicate the packet class and importance
LLQ (“priority”)	Prioritize VoIP and critical traffic
“bandwidth”	Provide minimum bandwidth to important traffic
Police or shape	Limit bandwidth used by a potential bandwidth hog
WRED	Intelligent congestion avoidance for marked traffic

An Overall QoS Architecture

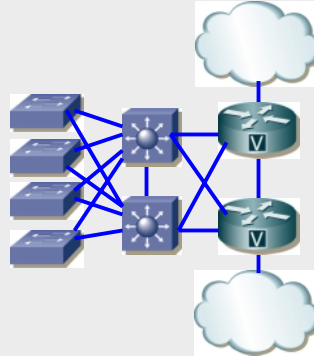
Class of Traffic	IP Precedence or CoS	DSCP Value
Voice (Bearer)	5	EF (46)
Video Conferencing	4	AF41 (34)
Voice Control	3	AF31 (26)
Critical Data	2	AF21 (18)
Streaming Video	1	AF13 (14)
Medium Data	1	AF11 (10)
Best Effort Data	0	BE (0)

Hierarchical Design

- **QoS is best applied to an already solid network design**
- **Hierarchical WAN and Campus design is best**
 - High availability, redundancy techniques
 - Scalable addressing and routing
 - Low hop count between edge devices
 - Manageable

High Availability

- **QoS is best deployed on a network with solid if not high availability**
- **Redundancy techniques and failover designed in and tested**
- **Minimal use of L2 STP**
- **Summarized routing, fast convergence**



Management Practices

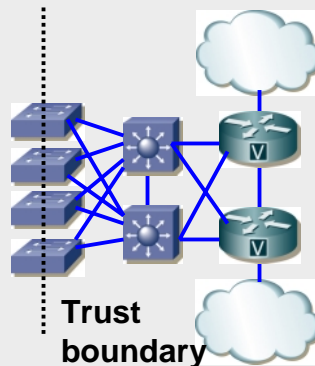
- **Procedures ensuring Operations staff does no harm**
- **Usable performance reporting**
 - Visibility into what the worst problem areas are
 - Measure incremental improvement
 - Understand what deployed QoS policy is doing
 - Understand applications and flows on each interface
- **CiscoWorks for device management**
- **QPM for QoS Policy management**

Addressing

- **Classification is a lot easier if you can key off an address or range of addresses**
- **Examples:**
 - Application servers (one app, one server?)
 - IP/TV, WMS, or other media server addresses
 - IP telephony to desktop (aux VLAN)
 - IP voice trunking (use part of VoIP space)
 - IPVC (via proxy gateway)
 - Streaming video (dedicated multicast range)

Other Issues

- **Trust boundary**
 - Device capabilities versus cost
- **Classification**
 - Do it carefully now or redo sloppy ACL's periodically
- **Upstream switches**
 - Trust COS for inbound congestion avoidance?
- **IPVC policy**
 - Decide on AF41 versus LLQ

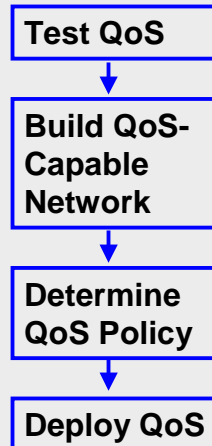


Topics

- Other Network Applications
- Design Considerations
- **Implementing QoS**
- Troubleshooting

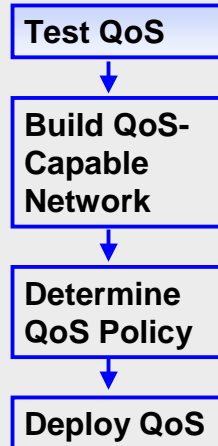
Main Stages in Implementing QoS

- QoS Testing and Proof-of-Principle
- Build a QoS-capable network
- Determine QoS policy
- Deploy QoS



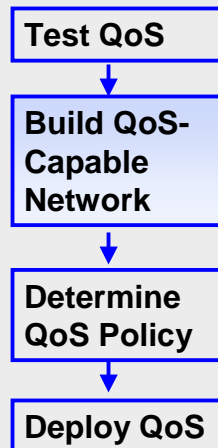
Testing QoS

- **Generally sites will wish to conduct some initial lab or field testing of QoS and QoS tools before deployment**
- **This can be good for**
 - Tuning QoS configuration templates
 - Building staff QoS understanding and skills



Build a QoS-Capable Network – 1

- **Baseline network**
 - Devices on network
 - Cisco IOS, CatOS versions
 - IP addressing scheme
- **Capacity planning**
 - Utilization
 - Current application mix
 - Projected new applications, especially network backup and high bandwidth applications



Build a QoS-Capable Network – 2

- **Network re-design**

- Deploy QoS-capable devices as needed
- Resolve bandwidth (capacity) problems, usually in the WAN
- Build hierarchical redundant WAN and campus networks
- Design, implement, and test use of appropriate protocols to achieve quick failover

- **Baseline new network**

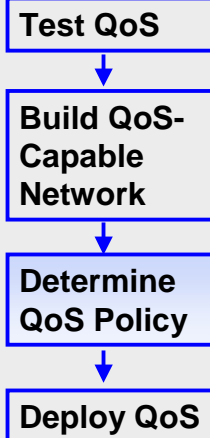
- Make sure it works as needed
- Avoid finding problems later



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Determine QoS policy

- **This can be concurrent with the previous task**
- **Need to take the current and projected application mix and traffic volumes and come up with a QoS policy**
- **Focus on the more critical issues first, can later re-visit for fine-tuning**
 - Priority for VoIP or IPVC
 - Protect from excess video, audio, file transfer, backup, or other large flows
 - Provide protected bandwidth for critical data applications



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Deploy QoS

- **Usually QoS is more critical in the WAN**
- **Possible issue with WAN-first deployment: who does the classification and marking?**
 - Do the routers re-mark all traffic?
 - Or just classify once at the trust boundary and assume traffic is already marked when it reaches the WAN routers?
- **Consider using QPM**

Test QoS



Build QoS-Capable Network



Determine QoS Policy



Deploy QoS

Topics

- **Other Network Applications**
- **Design Considerations**
- **Implementing QoS**
- **Troubleshooting**

Troubleshooting – 1

- **Summary, based on ideas from Networkers 2002, VVT-330**
 - Ethernet port settings on switches
 - Lack of QoS
 - End-to-end latency
 - Video codec capabilities

Troubleshooting – Ethernet Port

- **Check for speed and duplex mismatches**
- **Symptom:**
 - Incrementing errors (other than single collision) for half-duplex
 - Any errors on full duplex
- **You really ought to be regularly tracking and reporting switch ports with high error rates**
 - Only scalable way to get and keep this fixed across an enterprise

Troubleshooting – Lack of QoS

- **Overall QoS**

- Is it getting classified and marked correctly?
- Is the QoS policy in place end-to-end?
- Video will cause jitter and poor voice unless voice is protected from video

- **Drops**

- Are there WAN drops or errors?
- Do not use LFI with video
- Is per-interface shaping or policing configured?
- Check CBWFQ drop counter for video, should be zero



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Troubleshooting – Lack of QoS 2

- **RSVP**

- Is H.323 RSVP sync enabled?
- Did an RSVP reservation get made?
- Is the RSVP reservation bandwidth being exceeded?
- Does RSVP show a “resource provider”?

- **Queuing**

- Is WFQ or CBWFQ in place on all outbound interfaces for queuing?



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Troubleshooting – Lack of QoS 3

- **Frame Relay**

- Sum of all the CIR's should be less than or equal to the port speed
- If doing adaptive shaping, sum of MINCIR should be less than or equal to the port speed
- CIR on a PVC must be smaller than or equal to the remote port speed
- If doing non-adaptive shaping, MINCIR = CIR

Troubleshooting – Latency

- **Voice should be ≤ 150 msec one way for “high quality” voice**

- Video codecs: 100-300 msec
- MCU / gateway: 100-500 msec
- Satellite links: 500-1000 msec
- Serialization and queuing delay is high when utilization is over 90%

Troubleshooting – Video Codec

- **Hardware based codec recommended**
 - NetMeeting may be in the 15 FPS range
 - Polycom ViaVideo etc. depend on the PC's CPU power

Summary

Having completed this chapter, you should be able to:

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Questions

Any Questions?



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A Word From Us ...



- **We can provide**
 - Network design review: how to make what you have work better
 - Periodic strategic advice: what's the next step for your network or staff
 - Network management tools & procedures advice: what's right for you
 - Implementation guidance (your staff does the details) or full implementation
- **We do**
 - Small- and Large-Scale Routing and Switching (design, health check, etc.)
 - IPsec VPN and V3PN (design and implementation)
 - QoS (strategy, design and implementation)
 - IP Telephony (preparedness survey, design, and implementation)
 - Call Manager deployment
 - Security
 - Network Management (design, installation, tuning, tech transfer, etc.)



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Cisco Certifications

Chesapeake Netcraftsmen
is certified by Cisco in:



- IP Telephony
- Network Management
- Wireless
- Security
- (Routing and Switching)



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