Implementing Cisco Quality of Service (QOS)

Course Summary

Description
Implementing Cisco Quality of Service (QOS) v2.5 provides learners with in-depth knowledge of QoS requirements, conceptual models such as best effort, IntServ, and DiffServ, and the implementation of QoS on Cisco platforms. The curriculum covers the theory of QoS, design issues, and configuration of various QoS mechanisms to facilitate the creation of effective administrative policies providing QoS.

Case studies and lab exercises included in the course help learners to apply the concepts from the individual modules to real-life scenarios. The course also gives learners design and usage rule for advanced QoS features. This gives the learners the opportunity to design and implement efficient, optimal, and trouble-free multiservice networks.

Objectives
After taking this course, students will be able to:
- Explain the need for QoS, describe the fundamentals of QoS policy, and identify and describe the different models that are used for ensuring QoS in a network
- Explain the use of MQC and AutoQoS to implement QoS on the network and describe some of the mechanisms used to monitor QoS implementations
- Given a converged network and a policy defining QoS requirements, classify and mark network traffic to implement the policy
- Use Cisco QoS queuing mechanisms to manage network congestion
- Use Cisco QoS congestion avoidance mechanisms to reduce the effects of congestion on the network
- Use Cisco QoS traffic policing and traffic shaping mechanisms to effectively limit the rate of network traffic
- Given a low speed WAN link, use Cisco link efficiency mechanisms to improve the bandwidth efficiency of the link
- Describe the recommended best practices and methods used for end-to-end QoS deployment in the enterprise

Topics
- Introduction to QoS
- Implement and Monitor QoS
- Classification and Marking
- Congestion Management
- Congestion Avoidance
- Traffic Policing and Shaping
- Link Efficiency Mechanisms
- Deploying End-to-End QoS

Audience
The primary target audiences for the course are pre- and post-sales technical engineers responsible for designing, implementing, or troubleshooting networks. This course is also designed for network architects responsible for designing multiservice networks to carry voice, video, and data traffic in enterprise or service provider environments. Others who will find this course beneficial include those working in Advanced Unified Communications Specialization, Master UC Specialization, and Master Telepresence ATP. Secondary target audiences are CCIE R&S candidates.

Prerequisites
Before taking this course, students should have taken the Interconnecting Cisco Networking Devices, Part 1 and 2 (ICND1 and ICND2) (PT6162 and PT6133) courses.

Duration
Five days
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Course Outline

I. Introduction to QoS
   A. Review Converged Networks
      1. Converged Networks
      2. Quality Issues in Converged Networks
      3. Available Bandwidth
      4. Components of Network Delay
      5. Calculating End-to-End Delay
      6. Jitter
      7. Packet Loss
   B. Understand QoS
      1. QoS Defined
      2. QoS Policy Defined
      3. Implement a QoS Policy
      4. Identify Network Traffic
      5. Voice Traffic Profile
      6. Videoconferencing Traffic Profile
      7. Cisco TelePresence Traffic Profile
      8. Data Traffic Profile
      9. Divide Network Traffic into Classes
      10. Define Policies for Traffic Classes
      11. QoS Mechanisms
      12. QoS Implementation Methods
      13. QoS Monitoring Methods
      14. Cisco Medianet QoS Design
   C. Describe Best-Effort and Integrated Services Models
      1. QoS Models
      2. Best-Effort QoS Model
      3. IntServ Model
      4. Resource Reservation Protocol
      5. RSVP Components
      6. RSVP Interface Bandwidth Queuing
   D. Describe the Differentiated Services Model
      1. DiffServ Model
      2. DiffServ Terminology
      3. DSCP Encoding
      4. Per-Hop Behaviors
      5. Expedited Forwarding
      6. Assured Forwarding
      7. AF Drop Probability
      8. Class Selector
      9. Integration of IntServ and DiffServ

II. Implement and Monitor QoS
   A. MQC Introduction
      1. Modular QoS CLI
      2. MQC Components
      3. Example: MQC Policy Configuration
      4. Class Maps Overview
      5. Match Operation in Class Maps
      6. Policy Maps Overview
      7. Service Policy Overview
      8. Hierarchical Policy
   B. Monitor QoS
      1. SNMP Management of QoS
      2. Describe Class-Based QoS MIB
      3. Cisco NBAR
      4. Cisco NBAR Protocol Discovery
      5. Cisco NBAR Protocol Discovery MIB
      6. NetFlow
      7. Cisco Flexible NetFlow
      8. Cisco Flexible NetFlow Integration with NBAR
      9. Class-Based Flexible NetFlow
      10. Cisco Performance Monitor
      11. Cisco Mediatrace
      12. Cisco IP SLA
      13. IP SLA: UDP Jitter
   C. Define Campus AutoQoS
      1. AutoQoS Macros
      2. Trust Boundaries
      3. Campus AutoQoS Trust
      4. Campus AutoQoS Conditional Trust
      5. Campus AutoQoS Video
      6. Campus AutoQoS VoIP
      7. Campus AutoQoS Classify
      8. Monitoring AutoQoS in the Campus
   D. Define WAN AutoQoS
      1. Cisco AutoQoS for Routers
      2. WAN AutoQoS VoIP
      3. AutoQoS for the Enterprise Overview
      4. Configuring AutoQoS for the Enterprise
      5. Monitoring AutoQoS in the WAN

III. Classification and Marking
   A. Classification and Marking Overview
      1. Classification
      2. Marking
      3. Classification and Marking at the Data Link Layer
      4. Classification and Marking at the Network Layer
      5. Mapping QoS Marking Between OSI Layers
      6. QoS Service Class Defined
      7. Service Class Templates
      8. RFC 4594 Marking Recommendations
   B. MQC for Classification and Marking
      1. MQC Classification Options
      2. Configuring Class Maps
      3. Monitoring Classification
      4. MQC Marking Options
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Course Outline (cont’d)

IV. Congestion Management
A. Queuing Introduction
1. Congestion and Queuing
2. Queuing Components
3. Hardware Queue Size
4. Congestion on Logical Interfaces
5. Queuing Algorithms
6. FIFO Queuing
7. Priority Queuing
8. Round-Robin Queuing
9. WRR Queuing
10. DRR Queuing
B. Configure WFQ
1. Weighted Fair Queuing
2. WFO Classification
3. WFO Scheduling
4. WFO Drop Operation
5. Benefits and Drawbacks of WFO
6. Configuring WFQ
7. Monitoring WFQ
C. Configure CBWFQ and LLQ
1. Class-Based Weighted Fair Queuing
2. CBWFQ Architecture
3. Benefits and Drawbacks of CBWFQ
4. Configuring CBWFQ
5. Low Latency Queuing
6. LLQ Architecture
7. Configuring LLQ
8. Monitoring LLQ-CBWFQ
D. Configure Campus Congestion Management
1. Campus Queuing
2. Catalyst Switch Hardware Queue Nomenclature
3. Queue Mapping
4. WRR on Campus Switches
5. WRR Bandwidth and Buffer Settings
6. SRR on Campus Switches
7. SRR Common and Reserved Buffers
8. Configuring Ingress Queuing on Cisco Catalyst 3750 Series Switches
9. Configuring Egress Queuing on Cisco Catalyst 3750 Series Switches
10. Monitoring Congestion Management On Cisco Catalyst 3750 Series Switches

V. Congestion Avoidance
A. Congestion Avoidance Introduction
1. TCP Behavior
2. Congestion and TCP
3. Example: TCP Congestion Control Algorithms
4. Managing Congestion with Tail Drop
5. Impact of Tail Drop
6. Random Early Detection
7. RED Profiles and Modes
8. TCP Behavior Before and After RED
B. Configure Class-Based WRED
1. Weighted Random Early Detection
2. Class-Based WRED
3. WRED Building Blocks
4. WRED Profiles
5. IP Precedence-Based WRED
6. DSCP-Based WRED
7. Configure CBWRED
8. Changing WRED Sensitivity to Bursts
9. Example: DSCP-Based WRED
10. Monitoring CBWRED
C. Configure ECN
1. Explicit Congestion Notification
2. ECN Field
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Course Outline (cont’d)

3. ECN and WRED
4. ECN Operation
5. Configuring ECN
6. Monitoring ECN
D. Describe Campus-Based Congestion Avoidance
   1. Congestion Avoidance in the Campus
   2. Weighted Tail Drop
   3. Configuring WTD Thresholds on the Cisco Catalyst 3750 Series Switch
   4. WRED on Campus Switches
   5. Dynamic Buffer Limiting

VI. Traffic Policing and Shaping
A. Traffic Policing and Shaping Overview
   1. Traffic Policing and Traffic Shaping
   2. Policing and Shaping Use Cases
   3. Policing vs. Shaping
   4. Single Token Bucket Model
   5. Single Token Bucket Class-Based Policing
   6. Dual Token Bucket Class-Based Policing
   7. Dual-Rate Token Bucket Class-Based Policing
   8. Class-Based Traffic Shaping
B. Configure Class-Based Policing
   1. Class-Based Policing
   2. Configuring Class-Based Policing
   3. Example: Single-Rate Single Token Policer
   4. Example: Single-Rate Dual Token Policer
   5. Example: Dual-Rate Policer
   6. Monitoring Class-Based Policing
C. Campus Policing
   1. Campus Policing Overview
   2. QoS Map Tables: Policing
   3. Applying Campus Switch Policing
   4. Campus Aggregate Policing
   5. Campus Microflow Policing
D. Configure Class-Based Shaping
   1. Class-Based Shaping
   2. Shaping Methods
   3. Configuring Class-Based Shaping
   4. Example: Shaping Configuration
   5. Example: Hierarchical Shaping
   6. Monitoring Class-Based Shaping
E. Configure Class-Based Shaping on Frame Relay Interfaces
   1. Frame Relay Refresher
   2. Frame Relay Congestion Control
   3. Frame Relay Congestion Adaptation
   4. FECN-to-BECN Propagation
   5. Configuring Adaptive Class-Based Shaping
   6. Monitoring FRTS
F. Configure Frame Relay Voice-Adaptive Traffic Shaping and Fragmentation
   1. Frame Relay Voice-Adaptive Traffic Shaping and Fragmentation
   3. Frame Relay Voice-Adaptive Traffic Shaping and Fragmentation Operation

VII. Link Efficiency Mechanisms
A. Link Efficiency Mechanisms Overview
   1. Link Efficiency Mechanisms
   2. Layer 2 Payload Compression
   3. Header Compression
   4. Large Packet "Freeze Out"
   5. Serialization Delay
   6. Link Fragmentation and Interleaving
   7. Fragment Size Recommendations for Voice
B. Configure Class-Based Header Compression
   1. Header Compression
   2. Class-Based TCP Header Compression
   3. Example: Class-Based TCP Header Compression Configuration
   4. Class-Based RTP Header Compression
   5. Example: Class-Based RTP Header Compression
   6. Configuring Class-Based Header Compression
   7. Monitoring Class-Based Header Compression
C. Configure LFI
   1. LFI Options
   2. Configuring MLP with Interleaving
   3. Monitoring MLP Interleaving
   4. FRF.12 Frame Relay Fragmentation

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Course Outline (cont’d)

5. Configuring FRF.12 Frame Relay Fragmentation
6. Monitoring FRF.12 Frame Relay Fragmentation

VIII. Deploying End-to-End QoS
A. Apply Best Practices for QoS Policy Design
   1. Optimally Deploying QoS Within the Enterprise
   2. Strategically Defining QoS Objectives
   3. Cisco Modified RFC 4594 Marking Recommendations and Class Expansion
   4. Understanding Application Service-Level Requirements
   5. QoS Requirements for Control Plane Traffic
   6. Control Plane Policing
   7. Data Plane Policing
   8. Classification and Marking Best Practices
   9. Policing and Markdown Best Practices
   10. Queuing and Dropping Best Practices
   11. Link Efficiency Mechanisms Best Practices
B. End-to-End QoS Deployments
   1. Deploying End-to-End QoS
   2. Enterprise Campus QoS Guidelines
   3. Campus QoS Deployment Steps and Options
   4. Branch Router QoS Guidelines
   5. WAN Edge QoS Design Considerations
   6. Enterprise Network with Layer 2 Service
   7. Enterprise Network with Layer 3 Service
   8. QoS Service Level Agreements
   9. QoS Implications of Layer 3 Service Offerings
   10. Enterprise-to-Service Provider QoS Class Mapping
   11. Re-Marking DSCP at SP MPLS Edge

IX. Labs
A. IP SLA Setup and QoS Baseline Measurement
B. Configuring QoS with Cisco AutoQoS
C. Classification and Marking Using MQC
D. Using NBAR for Classification
E. Configuring QoS Preclassify
F. Campus Classification and Marking Using MQC
G. Configuring Fair Queuing
H. Configuring LLQ-CBWFQ
I. Configuring Campus-Based Queuing Mechanisms
J. Configuring DSCP-Based WRED
K. Configuring WTD Thresholds
L. Configuring Class-Based Policing
M. Configuring Class-Based Shaping
N. Configuring Class-Based Header Compression
O. Configuring LFI
P. Mapping Enterprise QoS Policy to the Service Provider Policy