Applying QoS in an Enterprise Network

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Overview

- VoIP issues
- QoS mechanisms
- Filtering & ACLs
- 3 Deployment Models
- Operational Considerations
- Summary

Potential VoIP Issues

- Packet loss can harm voice quality
- Jitter can harm voice quality
- Delay can harm voice quality
- Degree to which these are issues relates directly to which voice encoder (vocoder) algorithm is being used
- Adaptive vocoders are better for packet networks

Voice Encoder Issues

- Many voice encoder (vocoder) algorithms have been standardised
  - Examples: ITU-T G.711, ITU-T G.729, CELP
- Different algorithms have different properties
  - G.729 requires about half the bandwidth of G.711 for nearly the same voice quality
  - Some algorithms less tolerant of jitter, delay or loss.
- Proper selection of vocoder algorithm is crucial

Other QoS Issues

- Not all data applications are equally important to the enterprise
  - Example: Database access is usually much more important than instant messaging inside the enterprise network
- Important to ensure that mission-critical applications receive the best quality of network service.

Enterprise QoS Mechanisms

- Over-provisioning Capacity
- Ethernet Precedence
  - Originally specified in IEEE 802.1p
  - Later merged into IEEE 802.1d
- IP Type-of-Service/Precedence/DiffServ
  - 3 names for essentially the same mechanism
  - Latest name is “Differentiated Services”

Over-Provisioning Capacity

- Simplest QoS is to over-provision the network so congestion never occurs
- If over-provisioned, no congestion, so no packet loss or other issues to address
- Usually has higher capital cost
  - Requires higher speed equipment
- Usually has lowest operational costs
  - No special configuration to deploy, maintain, etc

Ethernet Precedence

- IEEE 802.1q VLAN tags contain 3-bit Ethernet precedence field
  - Support precedence 0 (lowest) to 7 (highest)
  - Not all equipment supports 8 queues/port !
- Queuing algorithms and other details left mostly to the implementer
  - These implementation details DO matter !
- Maps 1:1 to IP Precedence bits

IP Precedence

- Now often referred to as “DiffServ”
- IP has 8-bit Type-of-Service field
  - 3 bits of this are used for IP Precedence
- Not all equipment supports IP-layer QoS
  - Not all equipment supports 8 queues/port
  - Queuing algorithms vary
  - Implementation details do matter

IP Queuing

- DiffServ defines only 2 per-hop behaviours
  - “Assured Forwarding” or AF
  - “Expedited Forwarding” or EF
- Myth:
  - There are only 2 configurations on a given queue
  - One can choose either AF or EF
- Reality:
  - Good implementations have many configuration options, so AF and EF terminology is too restrictive

IP Queuing: VoIP

- Myth:
  - VoIP requires EF
- Reality:
  - VoIP requires thoughtful queuing
  - Either AF or EF can work well or work badly
  - Other deployment details are critical

QoS Filtering

- QoS/Precedence labels are not cryptographically authenticated
- Instead, the deployment strategy is to (re-)mark traffic at the edge using ACLs
- Edge switches set QoS label based on traffic characteristics and port configuration
  - Example: Ethernet ports connected only to VoIP phones might mark all packets as "voice"

QoS Models

- Many different QoS models could be created
- Here we discuss 3 example QoS models
  - Simple QoS Model
    - Requires 4 queues/port
  - Fine-Grained QoS Model
    - Requires 8 queues/port
  - Strict-Precedence QoS Model

Common QoS Model Features

- Highest priority group is “network control”
  - Includes Spanning Tree, IP Routing, SNMP, etc
- Next-highest priority group is “voice-related”
  - Includes SIP, MGCP, RTP, etc.
- Next priority group is “critical applications”
- Lowest priority is “all other traffic”
- Usually allocate some reserved bandwidth to most groups
  - Avoids starvation of low precedence traffic
  - Unused capacity might be used by other queues

Simple QoS Model

- Requires 4 queues/port in all equipment
- Highest is inter-domain control traffic
  - Examples: BGP, PIM, SNMP
- Next-highest is intra-domain control traffic
  - Examples: STP, OSPF, RIP, IPv6 MLD, IGMP
- Then voice traffic
  - Examples: SIP, MGCP, RTP, etc
- Finally, other traffic is in lowest priority queue
- Reserve some capacity for each queue
  - Example for the above: 10%, 10%, 20%, 5%

Fine-Grained QoS Model

- Requires 8 queues/port
- Split “voice” into 2 queues
  - (Highest) Voice Signalling: SIP, MGCP
  - Voice Traffic: RTP
- Add “important applications”
  - File Access: SMB, RPC, NFS, etc
  - Database: SQL, etc
- Add “interactive” above “everything else”
  - HTTP, IM, X11, etc
- Reserve some capacity for most queues:
  - Example: 10%, 10%, then 5% each for remainder

Strict Precedence

- Key difference:
  - lower precedence traffic might be starved by higher precedence traffic
- Requires 8 queues/port
- Queue mappings as for Fine-Grained QoS Model
- Has been used in some governmental/military networks

Operational Considerations

- Isolate VoIP traffic onto separate VLANs from other data traffic
- Lock-down MAC address of each Ethernet port to prevent accidental misuse
- Mark traffic at all edge switches
- Apply QoS in all switches and routers
- Monitor traffic patterns and utilisation

Equipment Considerations

- Want full 8 queues/port, not 4 or 2 queues
- Want flexible QoS mechanisms
  - Min and max bandwidth provisioning choices
  - Several queuing algorithms (WRED, WFQ, etc)
- Want hardware-based (ASIC-based) ACLs for applying QoS and filtering packets
- Want hardware-based (ASIC-based) QoS implementation
- CPU-based implementations can't scale, so deploying QoS can result in lower quality service

Conclusions

- QoS can be an important part of one's enterprise network architecture
- Several QoS mechanisms exist
  - Over-provisioning
  - Ethernet Precedence and IP Precedence
- Careful equipment selection is important
  - Test before you buy !
- Converged networks are practical today

Thank You