

Welcome!

Designing and Configuring QoS in Voice and Video (AVVID) Networks

Presented by

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About the Speaker

- **Bruce Enders**
- **Has been delivering voice-over training and consulting services for over 4 years**
- **Began as a Telephone person, became a Networking person**
- **Has worked in many facets of the Telecomm/Datacomm Industry**
- **Experienced in all 4 Voice technologies**



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We will only scratch the surface of QoS!

- **We will be using specific examples within the AVVID infrastructure**
- **We will focus on variable delay**
 - Queuing Delays
 - Serialization Delays

What are You Fighting?

- **Packet Loss**
- **Fixed Delay**
- **“Variable Delay” aka “Jitter” – our “Worst Enemy”**
- **Voice and Video Quality depend on consistent “Real Time” Delivery!**

Packet Loss

- **Caused by Insufficient Bandwidth**
 - Sometimes more bandwidth is the right answer
- **Or, “Dirty” networks- bad Layer 1**
- **Or, caused by Queues filling**
- **Or, sometimes aggregation points simply get overcome by too many “bursts” all at once**

Fixed Delay

- **Propagation Delay - Not much you can do about the Laws of physics**
- **Processing Delay – Fix this by modernizing your infrastructure**
- **Managed Serialization Delay – Slow WAN links that HAVE LFI implemented**

Variable Delay

- **Queuing Delay** – Any R/S device where **Voice traffic MAY** have to wait for other traffic in a shared queue (No support for multiple queues?)
- **Un Managed Serialization Delay** – Slow Links < 768k that **DON'T** have LFI implemented

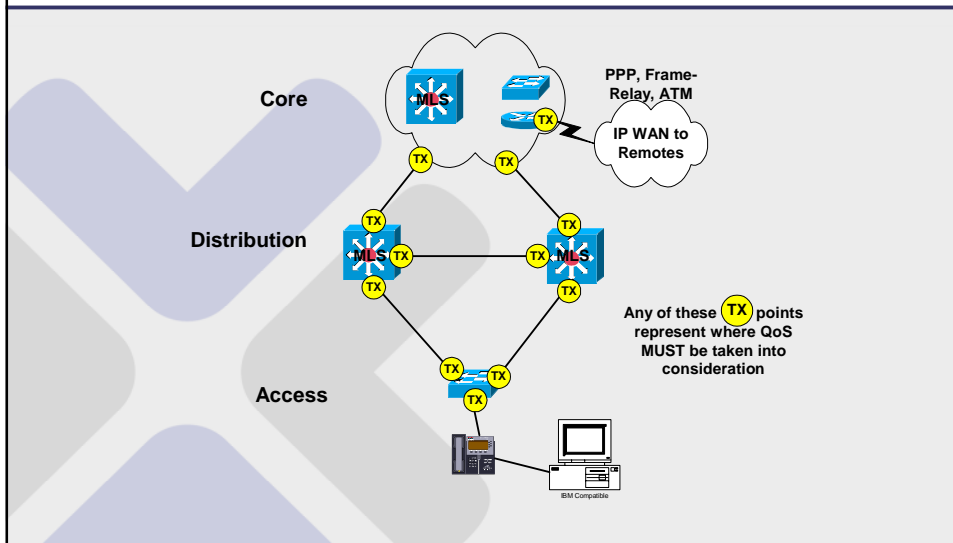
Where should I Implement QoS?

- **At all Transmission points**
 - At the WAN edge
 - Anywhere there is a speed mismatch
 - Slow WAN links
 - “Many-to-One” aggregation points
 - Anywhere voice traffic may have to “wait” for non Real-Time traffic to be sent

What are my Weapons?

- Low-Latency-Queuing (LLQ) Algorithms
- Link-Fragmentation and Interleaving (LFI)
- Traffic Shaping
- Call Admission Control (CAC)

Network Example



Extend the Trust Boundary

- **Extend the Trust boundary as close to the User as practical**
- **“Trust”, or Control the traffic that enters your network**
- **IP Telephones can help by default**

Trust Boundary at the Access Switch Port

```
cat-access> (enable) set port qos 5/1-48 trust
trust-cos
cat-access> (enable) set port qos 5/1-48 vlan-
based
cat-access> (enable) set port qos 5/1-48 trust-
ext untrusted
cat-access> (enable) set port qos 4/2 port-based
```

Set ACLs

```
cat-access> (enable) set qos enable
cat-access> (enable) set qos acl ip ACL_IP-PHONES
dscp 26 tcp any any range 2000 2002
cat-access> (enable) set qos acl ip ACL_IP-PHONES
trust-cos ip any any
cat-access> (enable) set qos acl ip
ACL_VOIP_CONTROL dscp 26 tcp any any range 2000
2002
cat-access> (enable) commit qos acl all
cat-access> (enable) set qos acl map ACL_IP-
PHONES 110
cat-access> (enable) set qos acl map
ACL_VOIP_CONTROL 4/2
```



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Set Transmit Queuing (LLQ)

```
cat-access> (enable) set qos map 2q2t tx 2 1 cos
3
```



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Show commands

```
cat-access>(enable) sh qos info run 5/1
Run time setting of QoS:
QoS is enabled
Policy Source of port 5/1: Local
Current 10/100 "1" linecards support 2q2t/1q4t
  only
Tx port type of port 5/1 : 2q2t
Rx port type of port 5/1 : 1q4t
Interface type: vlan-based
ACL is mapped to VLAN
ACL attached:
The qos trust type is set to trust-cos.
Warning: Runtime trust type set to untrusted.
Default CoS = 0
```



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Show Commands (cont.)

```
Queue and Threshold Mapping for 2q2t (tx):
Queue Threshold CoS
-----
1      1      0 1
1      2      2
2      1      3 4 5
2      2      6 7
Queue and Threshold Mapping for 1q4t (rx):
Queue Threshold CoS
-----
1      1      0 1
1      2      2
1      3      3 4 5
1      4      6 7
```



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Layer 2 to Layer 3

- **Retaining DSCP status**

```
cat-access> (enable) set port qos 1/1 trust trust-dscp
```

- **Transmit Queues – Uplink**

```
cat-access> (enable) set qos map 1p2q2t tx 2 1 cos 3
cat6k-access> (enable) set qos map 2q2t tx 2 1 cos 3
```

- **CoS/ToS – DSCP Mapping**

```
cat-distrib> (enable) set qos cos-dscp-map 0 8 16 26
32 46 48 56
cat-distrib> (enable) set qos ipprec-dscp-map 0 8 16
26 32 46 48 56
```



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Show Commands

```
cat-distrib> sh qos map run cos-dscp-map
CoS - DSCP map:
CoS DSCP
0 0
1 8
2 16
3 26 -> 26 = AF31
4 32
5 46 -> 46 = EF
6 48
7 56
```



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Show Commands (cont.)

```
sh qos map run ipprec-dscp-map
IP-Precedence - DSCP map:
IP-Prec DSCP
0 0
1 8
2 16
3 26 -> 26 = AF31
4 32
5 46 -> 46 = EF
6 48
7 56
```



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WAN links <768k

- **LFI – Link Fragmentation and Interleaving**
- **LLQ**
- **Traffic Shaping**
- **CAC – Call Admission Control**
- **Consider TCP and RTP header-compression to reduce voice bandwidth consumption**



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IOS Commands - Header Compression

```
ip tcp header-compression iphc-format
```

```
ip rtp header-compression iphc-format
```

- Point-to-point environment
- May not be process-switched (check release notes)



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ip rtp priority

```
ip rtp priority 16384 16383 100
```

- **Sets STRICT** exhaustive priority queue
- **Works along with CBWFQ & WFQ**
- **Cautions:**
 - Does no CAC
 - “STRICT” priority may choke other traffic



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QoS and VOIP over Multilink PPP (MLP)

Multilink PPP (MLP)

- **Protection against Serialization delay in WAN environments <768k other than Frame-Relay or ATM when separate PVCs for voice and data are not available**
- **MLP provides for LFI when the transport doesn't**

VOIP and MLP

```
interface Multilink1
ip address 10.1.61.1 255.255.255.0
service-policy output QoS-Policy-
  256k
ppp multilink
ppp multilink fragment-delay 10
ppp multilink interleave
multilink-group 1
```



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MLP (cont.)

```
interface Serial0
bandwidth 256
no ip address
encapsulation ppp
ppp multilink
multilink-group 1
```



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MLP (cont.)

```
policy-map QoS-Policy-256k
class VoIP-RTP
priority 100          (CAC)
class VoIP-Control
bandwidth 8
class class-default
fair-queue
```



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MLP (cont.)

```
class-map VoIP-RTP
match access-group 100
class-map VoIP-Control
match access-group 101
!
access-list 100 permit ip any any
precedence 5
access-list 100 permit ip any any dscp ef
access-list 101 permit ip any any
precedence 3
access-list 101 permit ip any any dscp 26
```



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QoS and VoIP over Frame-Relay (VoIPoFR)

(VoIPoFR)

```
interface Serial1
no ip address
encapsulation frame-relay
frame-relay traffic-shaping
!
interface Serial1.71 point-to-point
bandwidth 256
ip address 10.1.71.1 255.255.255.0
frame-relay interface-dlci 71
class VoIP-256kbs
```

VoIPoFR (cont.)

```
map-class frame-relay VoIP-256kbs
frame-relay cir 256000
frame-relay bc 1000
frame-relay be 0
frame-relay mincir 256000
no frame-relay adaptive-shaping
service-policy output QoS-Policy-
  256k
frame-relay fragment 320
```



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VoIPoFR (cont.)

```
policy-map QoS-Policy-256k
class VoIP-RTP
priority 100 (CAC)
class VoIP-Control
bandwidth 8
class class-default
fair-queue
!
class-map VoIP-RTP
match access-group 100
class-map VoIP-Control
match access-group 101
```



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VoIPoFR (cont.)

```
access-list 100 permit ip any any  
precedence 5  
access-list 100 permit ip any any dscp ef  
access-list 101 permit ip any any  
precedence 3  
access-list 101 permit ip any any dscp 26
```

QoS and VOIP over ATM (VoIPoATM)

(VoIPoATM)

```
interface ATM2/0
no ip address
atm pvc 1 0 16 ilmi
no atm ilmi-keepalive
-----
-----
interface ATM2/0.37 point-to-point
pvc cisco37 0/37          (shared pvc)
tx-ring-limit 7
abr 256 256
protocol ppp Virtual-Template2
```



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VoIPoATM (cont.)

```
interface Virtual-Template2
bandwidth 256
ip address 10.1.37.52 255.255.255.0
service-policy output QoS-Policy-256k
ppp authentication chap
ppp chap hostname HQ_7200
ppp chap password 7 05080F1C2243
ppp multilink
ppp multilink fragment-delay 10
ppp multilink interleave
```



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VoIPoATM (cont.)

```
class-map VoIP-RTP
match access-group 100
class-map VoIP-Control
match access-group 101
policy-map QoS-Policy-256k
-----
class VoIP-RTP
priority 100
class VoIP-Control
bandwidth 8
class class-default
fair-queue
```



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VoIPoATM (cont.)

```
access-list 100 permit ip any any
precedence 5
access-list 100 permit ip any any dscp ef
!
access-list 101 permit ip any any
precedence 3
access-list 101 permit ip any any dscp 26
```



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Summary

- **QoS consideration is required in all network environments that carry “Real-Time” traffic (live audio or video)**
- **Issues are delay, and loss caused by**
 - Queuing delays
 - Loss and Jitter
 - Serialization delay on slow WAN links
 - Jitter and Loss
- **Primary Tools are LLQ, LFI, FRTS, and CAC**

Where to get more information

- **Cisco IP Telephony QoS Design Guide**
- **EVVoD and DQoS Training classes**
- http://www.cisco.com/univercd/cc/td/doc/product/voice/ip_tele/solution/avvidbk.pdf
- <http://www.cisco.com/warp/public/732/Tech/qos/>
- **And lots more within Cisco Documentation on CCO**

Questions

Any Questions?

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