Preparing Your IP Network for Voice & Video Traffic

John Bartlett – Advanced Services
Agenda

• IP Network is Critical to Video Quality
• Designing for Video Bandwidth
• Designing Quality of Service
• Wireless Networks (WiFi)
• Internet Quality Management
• Monitoring Network Quality
Agenda

• *IP Network is Critical to Video Quality*

• Designing for Video Bandwidth

• Designing Quality of Service

• Wireless Networks (WiFi)

• Internet Quality Management

• Monitoring Network Quality
Video Depends on the Enterprise Network!

Is it Video-Ready?

Packet Loss  Internet Paths
Jitter
Latency  BW Constraints

Enterprise Network

Poor Network Transport Impacts Video Quality!
Data and Real-Time Interference

• Data traffic is very bursty – high peak to average ratio (red)
• Real-time traffic (voice & video) uses consistent BW (yellow)

Add QoS

• QoS gives priority to the real-time traffic
• QoS holds down peaks of data bursts, preventing packet loss and jitter in the real-time streams

How do we design for video in the enterprise?
How do we handle video outside the enterprise?
Agenda

• IP Network is Critical to Video Quality
• *Designing for Video Bandwidth*
• Designing Quality of Service
• Wireless Networks (WiFi)
• Internet Quality Management
• Monitoring Network Quality
Bandwidth, Resolution and FPS

• Typical relationship of bandwidth, resolution and fps shown in this table

• Higher compute power allows better resolution and fps for the same bandwidth

• Choose the right mix for your use cases

• Understand mix of endpoint types in use

<table>
<thead>
<tr>
<th>Polycom Video Bandwidth Requirements</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Transport BW</strong></td>
</tr>
<tr>
<td>128 Kbps</td>
</tr>
<tr>
<td>384 Kbps</td>
</tr>
<tr>
<td>512 Kbps</td>
</tr>
<tr>
<td>1 Mbps</td>
</tr>
<tr>
<td>2 Mbps</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Voice over IP (VoIP)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>BW</strong></td>
</tr>
<tr>
<td>G.729</td>
</tr>
<tr>
<td>G.711</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Lync Video Bandwidth Requirements</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Network BW</strong></td>
</tr>
<tr>
<td>600 Kbps</td>
</tr>
<tr>
<td>1 Mbps</td>
</tr>
</tbody>
</table>
Bandwidth

• It is critical for enterprise to understand the bandwidth impact of their video conferencing deployment
  - Primarily on WAN access links and aggregation links
  - Also in Wireless and wireless backhaul to controllers

• Bandwidth can add up quickly
• Users don’t understand the impact of their usage
• Enterprise must be building a bandwidth plan for video and managing it

<table>
<thead>
<tr>
<th>Site</th>
<th>Transport BW * Utilization</th>
<th>Network BW</th>
<th>Video Demand by Class</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>HD</td>
<td>Room</td>
<td>Exec</td>
</tr>
<tr>
<td>CHI</td>
<td>1.5E+6</td>
<td>768.0E+3</td>
<td>768.0E+3</td>
</tr>
<tr>
<td>ATL</td>
<td>1.5E+6</td>
<td>384.0E+3</td>
<td>1.2E+6</td>
</tr>
<tr>
<td>LAX</td>
<td>1.5E+6</td>
<td>1.2E+6</td>
<td>768.0E+3</td>
</tr>
<tr>
<td>BOS</td>
<td>1.2E+6</td>
<td>1.5E+6</td>
<td>768.0E+3</td>
</tr>
<tr>
<td>TOR</td>
<td>1.2E+6</td>
<td>1.9E+6</td>
<td>1.2E+6</td>
</tr>
<tr>
<td>HOU</td>
<td>2.3E+6</td>
<td>2.3E+6</td>
<td>1.5E+6</td>
</tr>
</tbody>
</table>
Multiple WAN Providers

- Global customers often choose this approach to reduce cost
- Adds complexity to QoS deployment
- Creates a bottleneck at network connection point (e.g. New York)
- Does not scale well with future video conferencing deployments

- This is often done because regional WAN providers have better coverage and costs in region
- Need to make customer aware of the tradeoffs
Bandwidth Calculation

• Determine Voice and Video traffic for each location
  - How many voice / video endpoints?
  - What is the call rate?
  - What is the concurrency?

• Size WAN access link
  - Voice & Video QoS Classes have sufficient BW for predicted demand

• Verify with testing tools
  - Validate WAN vendor provided correct provisioning
  - Monitor actual use to validate concurrency assumptions
Calculating Demand

By PBX Channels

<table>
<thead>
<tr>
<th>Site</th>
<th>SiteName</th>
<th>Channels</th>
<th>G711 or G729</th>
<th>Demand</th>
</tr>
</thead>
<tbody>
<tr>
<td>CHI</td>
<td>Chicago</td>
<td>12</td>
<td>G729</td>
<td>420.0E+3</td>
</tr>
<tr>
<td>ATL</td>
<td>Atlanta</td>
<td>8</td>
<td>G729</td>
<td>280.0E+3</td>
</tr>
<tr>
<td>LAX</td>
<td>Los Angeles</td>
<td>15</td>
<td>G729</td>
<td>525.0E+3</td>
</tr>
<tr>
<td>BOS</td>
<td>Boston</td>
<td>10</td>
<td>G729</td>
<td>350.0E+3</td>
</tr>
<tr>
<td>TOR</td>
<td>Toronto</td>
<td>12</td>
<td>G729</td>
<td>420.0E+3</td>
</tr>
<tr>
<td>HOU</td>
<td>Houston</td>
<td>25</td>
<td>G729</td>
<td>875.0E+3</td>
</tr>
</tbody>
</table>

Voice Demand by Class

<table>
<thead>
<tr>
<th>Site</th>
<th>SiteName</th>
<th>Channel</th>
<th>Voice BW</th>
</tr>
</thead>
<tbody>
<tr>
<td>CHI</td>
<td>Chicago</td>
<td>EF</td>
<td>420.0E+3</td>
</tr>
<tr>
<td>ATL</td>
<td>Atlanta</td>
<td>AF41</td>
<td>280.0E+3</td>
</tr>
<tr>
<td>LAX</td>
<td>Los Angeles</td>
<td>AF31</td>
<td>525.0E+3</td>
</tr>
<tr>
<td>BOS</td>
<td>Boston</td>
<td>AF21</td>
<td>350.0E+3</td>
</tr>
<tr>
<td>TOR</td>
<td>Toronto</td>
<td>BE</td>
<td>420.0E+3</td>
</tr>
<tr>
<td>HOU</td>
<td>Houston</td>
<td></td>
<td>875.0E+3</td>
</tr>
</tbody>
</table>

System Count

<table>
<thead>
<tr>
<th>Site</th>
<th>HD</th>
<th>Room</th>
<th>Exec</th>
<th>PCs</th>
</tr>
</thead>
<tbody>
<tr>
<td>CHI</td>
<td>4</td>
<td>2</td>
<td>2</td>
<td>19</td>
</tr>
<tr>
<td>ATL</td>
<td>4</td>
<td>1</td>
<td>4</td>
<td>14</td>
</tr>
<tr>
<td>LAX</td>
<td>3</td>
<td>4</td>
<td>2</td>
<td>32</td>
</tr>
<tr>
<td>BOS</td>
<td>3</td>
<td>5</td>
<td>3</td>
<td>21</td>
</tr>
<tr>
<td>TOR</td>
<td>6</td>
<td>6</td>
<td>5</td>
<td>17</td>
</tr>
<tr>
<td>HOU</td>
<td>6</td>
<td>6</td>
<td>5</td>
<td>17</td>
</tr>
</tbody>
</table>

Percent Concurrent Utilization

<table>
<thead>
<tr>
<th>Site</th>
<th>HD</th>
<th>Room</th>
<th>Exec</th>
<th>PCs</th>
<th>Utilization</th>
</tr>
</thead>
<tbody>
<tr>
<td>CHI</td>
<td>100%</td>
<td>100%</td>
<td>99%</td>
<td>22%</td>
<td></td>
</tr>
<tr>
<td>ATL</td>
<td>100%</td>
<td>100%</td>
<td>75%</td>
<td>27%</td>
<td></td>
</tr>
<tr>
<td>LAX</td>
<td>100%</td>
<td>100%</td>
<td>99%</td>
<td>21%</td>
<td></td>
</tr>
<tr>
<td>BOS</td>
<td>100%</td>
<td>100%</td>
<td>99%</td>
<td>16%</td>
<td></td>
</tr>
<tr>
<td>TOR</td>
<td>100%</td>
<td>100%</td>
<td>84%</td>
<td>21%</td>
<td></td>
</tr>
<tr>
<td>HOU</td>
<td>100%</td>
<td>100%</td>
<td>68%</td>
<td>24%</td>
<td></td>
</tr>
</tbody>
</table>

Units Concurrent Utilization

<table>
<thead>
<tr>
<th>Site</th>
<th>HD</th>
<th>Room</th>
<th>Exec</th>
<th>PCs</th>
</tr>
</thead>
<tbody>
<tr>
<td>CHI</td>
<td>4</td>
<td>2</td>
<td>2</td>
<td>5</td>
</tr>
<tr>
<td>ATL</td>
<td>4</td>
<td>1</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>LAX</td>
<td>4</td>
<td>3</td>
<td>2</td>
<td>5</td>
</tr>
<tr>
<td>BOS</td>
<td>3</td>
<td>4</td>
<td>2</td>
<td>6</td>
</tr>
<tr>
<td>TOR</td>
<td>3</td>
<td>5</td>
<td>3</td>
<td>5</td>
</tr>
<tr>
<td>HOU</td>
<td>6</td>
<td>6</td>
<td>4</td>
<td>5</td>
</tr>
</tbody>
</table>

Transport BW * Utilization

<table>
<thead>
<tr>
<th>Site</th>
<th>HD</th>
<th>Room</th>
<th>Exec</th>
<th>PCs</th>
<th>Utilization</th>
</tr>
</thead>
<tbody>
<tr>
<td>CHI</td>
<td>1.5E+6</td>
<td>768.0E+3</td>
<td>1.2E+6</td>
<td>1.9E+6</td>
<td></td>
</tr>
<tr>
<td>ATL</td>
<td>1.5E+6</td>
<td>384.0E+3</td>
<td>1.2E+6</td>
<td>1.5E+6</td>
<td></td>
</tr>
<tr>
<td>LAX</td>
<td>1.5E+6</td>
<td>1.2E+6</td>
<td>768.0E+3</td>
<td>1.9E+6</td>
<td></td>
</tr>
<tr>
<td>BOS</td>
<td>1.2E+6</td>
<td>1.5E+6</td>
<td>768.0E+3</td>
<td>2.3E+6</td>
<td></td>
</tr>
<tr>
<td>TOR</td>
<td>1.2E+6</td>
<td>1.9E+6</td>
<td>1.2E+6</td>
<td>1.9E+6</td>
<td></td>
</tr>
<tr>
<td>HOU</td>
<td>2.3E+6</td>
<td>2.3E+6</td>
<td>1.5E+6</td>
<td>1.9E+6</td>
<td></td>
</tr>
</tbody>
</table>

Network BW

<table>
<thead>
<tr>
<th>Site</th>
<th>HD</th>
<th>Room</th>
<th>Exec</th>
<th>PCs</th>
<th>Utilization</th>
</tr>
</thead>
<tbody>
<tr>
<td>CHI</td>
<td>1.3E+6</td>
<td>921.6E+3</td>
<td>1.4E+6</td>
<td>2.3E+6</td>
<td></td>
</tr>
<tr>
<td>ATL</td>
<td>1.3E+6</td>
<td>460.8E+3</td>
<td>1.4E+6</td>
<td>1.8E+6</td>
<td></td>
</tr>
<tr>
<td>LAX</td>
<td>1.3E+6</td>
<td>1.4E+6</td>
<td>921.6E+3</td>
<td>2.3E+6</td>
<td></td>
</tr>
<tr>
<td>BOS</td>
<td>1.4E+6</td>
<td>1.8E+6</td>
<td>921.6E+3</td>
<td>2.8E+6</td>
<td></td>
</tr>
<tr>
<td>TOR</td>
<td>1.4E+6</td>
<td>2.3E+6</td>
<td>1.4E+6</td>
<td>2.3E+6</td>
<td></td>
</tr>
<tr>
<td>HOU</td>
<td>2.8E+6</td>
<td>2.8E+6</td>
<td>1.8E+6</td>
<td>2.3E+6</td>
<td></td>
</tr>
</tbody>
</table>

Video Demand by Class

<table>
<thead>
<tr>
<th>Site</th>
<th>SiteName</th>
<th>Channel</th>
<th>Video BW</th>
</tr>
</thead>
<tbody>
<tr>
<td>CHI</td>
<td>Chicago</td>
<td>EF</td>
<td>6.0E+6</td>
</tr>
<tr>
<td>ATL</td>
<td>Atlanta</td>
<td>AF41</td>
<td>5.5E+6</td>
</tr>
<tr>
<td>LAX</td>
<td>Los Angeles</td>
<td>AF31</td>
<td>6.5E+6</td>
</tr>
<tr>
<td>BOS</td>
<td>Boston</td>
<td>AF21</td>
<td>6.9E+6</td>
</tr>
<tr>
<td>TOR</td>
<td>Toronto</td>
<td>BE</td>
<td>7.4E+6</td>
</tr>
<tr>
<td>HOU</td>
<td>Houston</td>
<td></td>
<td>9.7E+6</td>
</tr>
</tbody>
</table>
Make a Bandwidth Plan

- Bandwidth demand is a conversation between Application and Network teams
- Build a BW plan
- Design the network to support that plan
- Manage application BW to stay within the plan
- Monitor utilization to determine trends
- Renegotiate BW plan when needed

- Key design decision
  - Do we manage the application to the available BW? or
  - Do we manage the BW to stay ahead of demand?
Agenda

• IP Network is Critical to Video Quality
• Designing for Video Bandwidth
• Designing Quality of Service
• Wireless Networks (WiFi)
• Internet Quality Management
• Monitoring Network Quality
Five Components of QoS

- Classification
- WAN QoS
- LAN QoS
- Trust Boundaries
- WiFi QoS
Classification

- Identify the traffic that is to be given priority in the network
- Mark those packets appropriately
- Maintain DSCP markings end-to-end

- Video systems use three different types of traffic
  - Media (audio and video streams)
  - Signaling (registration, call setup, control, tear-down)
  - Management (telnet, web-page, SNMP, etc.)

- All three traffic types get a different classification
  - We cannot mark all traffic from a video IP as AF41

Typical:
Video – AF41 (34)
Signaling – AF31 (26)
Mgmt – Best Effort (0)

Reference: RFC-4594
Trust Boundary Definition

• Network has a trust boundary
  - Determines which traffic can be trusted to have the right mark
  - Or determines algorithmically how to mark traffic entering the net

• Standard voice approaches won’t work

• Marking all traffic from a video endpoint won’t work

• Preferred approach:
  - Mark traffic in the endpoint
  - Trust that traffic based on VLAN, or on port and protocol test

Get markings to be consistent across network

Implementing priority (PFB) is a separate step
WAN QoS

• Architecture
  − Prefer a single MPLS cloud WW for all offices
  − Prefer ISP with a 6-class model

• Multiple providers causes:
  − Possible incompatibles with DSCP markings
  − BW hotspots at data center connections
  − Does not scale as well, harder to manage

No Internet VPNs!!!!
LAN QoS

• Recommend LAN QoS
  − Bursty nature of data traffic causes momentary queue overflow
  − Impacts video traffic – can make a difference
    − LAN is lower priority than WAN, but still important

• Two key locations:
  − Downlink – Higher speed backbone connects to lower speed access links or access switches
  − Uplink – oversubscription means concurrent bursts momentarily overload uplink bandwidth
  − Be cautious with top-of-rack switches in data center and bridge – what bursty loads are on that switch?

• LAN QoS resolves these issues

Note: Marking consistency and LAN QoS can be addressed separately
Agenda

• IP Network is Critical to Video Quality
• Designing for Video Bandwidth
• Designing Quality of Service
• *Wireless Networks (WiFi)*
• Internet Quality Management
• Monitoring Network Quality
Five Components of WiFi for Voice/Video

- Signal Strength
- WAP Density
- Frequencies & BW
- QoS
- Backhaul
Signal Strength

• Bi-directional signal strength is critical to consistent quality

• Signal strength is compromised by:
  - WAP density
  - Blocking (cement, metal, mirrored glass)
  - Interference
    - Microwave oven,
    - DECT handsets or Bluetooth
    - WiFi from next floor or next building)

• Result
  - Dropped calls
  - One-way audio if asymmetric signal strength
Increase AP Density to Increase Total Capacity

- 802.11b/g at 2.4 GHz is limited to three non-overlapping channels, making it difficult to deploy high-density coverage
- 802.11a/n at 5 GHz has at least 12 non-overlapping channels, allowing smaller cell sizes for high-density coverage
- In 5Ghz band, 40Mhz channels are available
- Band steering takes advantage of 5Ghz capacity, less interference
  - AP doesn’t respond to 2.4Ghz authentication request, waits for 5Ghz request
802.11e/WMM QoS
Enhanced Distributed Coordination Access

- WiFi needs QoS just like the wired network
- WiFi map to standard priority shown at the right
- WiFi manages the shared channel wait time to prioritize voice and video
- Ensures voice and video packets are delivered with high reliability

<table>
<thead>
<tr>
<th>802.1p Priority</th>
<th>802.1p Traffic Type</th>
<th>802.11e Designation</th>
</tr>
</thead>
<tbody>
<tr>
<td>7 (High)</td>
<td>NC – Network Control</td>
<td>Voice</td>
</tr>
<tr>
<td>6</td>
<td>VO – Voice</td>
<td>Voice</td>
</tr>
<tr>
<td>5</td>
<td>VI – Video</td>
<td>Video</td>
</tr>
<tr>
<td>4</td>
<td>CL – Controlled Load</td>
<td>Video</td>
</tr>
<tr>
<td>3</td>
<td>EE – Excellent Effort</td>
<td>Best Effort</td>
</tr>
<tr>
<td>0 (Best Effort)</td>
<td>BE – Best Effort</td>
<td>Best Effort</td>
</tr>
<tr>
<td>2</td>
<td>(spare)</td>
<td>Background</td>
</tr>
<tr>
<td>1 (Low)</td>
<td>BK – Background</td>
<td>Background</td>
</tr>
</tbody>
</table>

Assumptions:
- WMM Default Parameters
- Backoff values shown are for initial CW equal to CWmin = 15

Minimum Wait (AIFS/NAV) vs. Random Backoff

© Polycom, Inc. All rights reserved.
Agenda

• IP Network is Critical to Video Quality
• Designing for Video Bandwidth
• Designing Quality of Service
• Wireless Networks (WiFi)
• Internet Quality Management
• Monitoring Network Quality
Vendors, Partners or Customers via Internet

- Internet users connecting into Enterprise voice or video infrastructure
  - Outward enabled SBC for firewall traversal
  - SBC is a media device – calculate BW

- Calculate BW impact on Internet path
  - Concurrent users on Internet link
  - Concurrent users on SBC

- Location of service important for global companies
  - Reduce latency by using in-theater resources
  - Manage where calls land on infrastructure
Internet-based Service

- Challenge to manage the network path quality
- Understand signaling and media flows
- Do the bandwidth calculations
- Test network paths for media quality
- Optimize Internet interface
  - Dedicated BW for media
  - Monitor Internet access quality
  - Match SP vendor to eliminate peering points
  - Consider WAN optimizers
  - Consider multiple-path WAN optimizers

Use Path-based monitoring to ensure Internet paths are as clean as possible
Agenda

- IP Network is Critical to Video Quality
- Designing for Video Bandwidth
- Designing Quality of Service
- Wireless Networks (WiFi)
- Internet Quality Management
- Monitoring Network Quality
Path-based Network Monitoring

• Path-based testing of network is critical to support of real-time traffic
  − Most data networking tools test devices (switches and routers)
  − Need to test along the path to have the same experience as the voice or video stream
    − Layer 1 issues (poor connection, duplex, long Ethernet, cat4, etc.)
    − Layer 2 issues (switching congestion, no priority, broadcast storms, insufficient bandwidth)
    − Layer 3 issues (router congestion, improper QoS marking or implementation)

• Continuous path-based testing provides:
  − Insight into the quality of network paths
  − History for forensic analysis (why was my call yesterday so bad?)
  − Triggers / alerts ahead of video conferencing usage
  − Common view of the network for the video team and the network team
Polycom Network Monitoring Tool (NMT)

• Polycom provides a service called Network Monitoring Tool
  – Cloud-based service
  – On-premise appliances (hard or soft)
  – Integration into Polycom devices (on roadmap)

• NMT monitors network paths 7x24 inside and outside the enterprise network
  – Constantly collects stats on bandwidth, utilization, video loss, video jitter, voice loss, voice jitter, latency, round-trip delay, QoS marking consistency and path
  – Available 7x24 to all stakeholders in all parts of the enterprise and their partners

• NMT finds the problem
  – Provides hop-by-hop (L3) isolation on the location of a fault when it occurs
    – Immediately identifies to whom the problem belongs (LAN, WAN, service provider, etc.)
Net Monitoring Tool

- Total Bandwidth
- Utilized Bandwidth
- Video (Data) loss
- Video (Data) jitter
- Latency
- RTT (ping)
- Voice Loss
- Voice Jitter (not shown)
- Over any timescale needed for analysis (1 hour to 1 year)
- Many paths evaluated concurrently – test to every video endpoint
Diagnostics for hop-by-hop isolation

- Each path has a service quality definition (SQD)
- When the SQD is violated, PathView runs a diagnostic
- Isolation information is then available for the point in time of the failure

Packet loss between hop 3 and 4

QoS mark cleared at first hop
Summary

1. The IP network is a critical component of the UC collaboration service delivery
2. Design the network for proper voice/video support (bandwidth & QoS design)
3. Monitor the network ongoing to ensure compliance with voice / video requirements
Thank You – Q&A

Additional Design Clinics

*Recorded – Success Factors for Designing Your Collaboration Environment*

June 11th – Video for Everyone: 7 Winning Workflow Strategies

June 16th – Understanding Utilization and Driving Adoption