Designing and Deploying IP Videoconferencing
Session VVT-230
Enterprise Solutions Engineering
Session Objectives

• Give attendees the tools needed to implement H.323 videoconferencing on an Enterprise network; key components being covered are:
  - Network Quality of Service (QoS)
  - Video infrastructure
  - Call routing
  - Dial plans
• Related sessions: Introduction to H.323 Video VVT-2, H.323 Troubleshooting VVT-330, Deploying QoS for Voice and Video in IP Networks VVT-213
• Presentation follows the IP Videoconferencing QoS Design Guide: www.cisco.com/go/ese

Agenda

• H.323 Videoconferencing
• Network Design
• Video Infrastructure
• Dial Plans and Call Routing
• Case Study
Cisco AVVID—An End-to-End Architecture

H.320 vs H.323

H.320

- Dedicated ISDN lines to every system
- System cost is much higher than H.323
- Multiple networks

H.323

- Ethernet attached systems
- Lower system cost
- Shared resources
- Utilizes current network infrastructure
Large Oil Company in Houston

Why Move to H.323?

- Improvement of up-time and “soft” cost savings
- Lower usage costs associated with ISDN
- A 384k H.320 call lasting one hour ranges from $200–$500
- Deployable on the desktop

Building Blocks for a Successful H.323 Videoconferencing Network

- Dial Plan
- Call Routing
- Video Infrastructure
- Network Infrastructure
H.323 Considerations?

What Needs to Be Provided for Success?

- Network Quality of Service (QoS)
- Call Admission Control (CAC)
- Management of shared resources
- Flexible dial plans and call routing

H.323 Zones

What Are Zones?

- A logical grouping of H.323 devices managed by a single gatekeeper
- Each zone will identified by a unique prefix used to route calls between zones
- Zone prefixes are similar to an area code in the telephony world
- A zone is similar to a broadcast domain in an IP network
H.323 Video Network

Agenda

- Moving to H.323
- Network Design
- Video Infrastructure
- Dial Plans and Call Routing
- Case Study
Why QoS?

- Interactive videoconferencing requires low latency and minimal packet loss
  - Latency < 200ms
  - Packet loss < 1%
- H.323 video quality must be at least as good as H.320 video

Network

- Quality of Service (QoS)
  - Traffic classification
  - Queuing
- Call Admission Control (CAC)
  - Bandwidth controls
- WAN provisioning
  - Queue access
**Traffic Classification**

**Proxy Classification**
- **Proxy:**
  - IP Precedence 4 or Resource Reservation Protocol (RSVP)

**Endpoint Classification**
- **Endpoint:**
  - Polycom, PictureTel, and VCON
  - IP Precedence 4

**Switch Classification**
- **Switch:**
  - Access Layer Port on Layer 3 Switch
  - IP Precedence 4
  - DSCP AF41

**Router Classification**
- **Router:**
  - Access Control List (ACL) Entry
  - IP Precedence 4
  - DSCP AF41

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**Video Terminal Classification**

**Room Units vs Desktop Units**
- **Trust or Not to Trust?**

**Applications:**
- Videoconferencing
- Email
- Web Surfing

**Gatekeeper/Proxy**
- Classify or Reclassify all Video Streams
- Accessing the WAN

**In some cases PC's can be trusted by:**
- Limiting the UDP Port range used by the VC application
- Configuring the switch to trust only traffic that falls into the configured UDP Port range
End-to-End QoS

Central Campus

Remote Branch

QoS—Campus Access
Classification on Endpoint or Proxy
Trust Boundaries on Access Layer Switch and Router

QoS—Campus Dist.
Layer 3 Policing
Multiple Queues on All Ports; Priority Queuing for Video
WRED within Data Queue for Congestion Management

QoS—WAN
Low-Latency Queuing
Bandwidth Provisioning
Admission Control

QoS—Branch
Classification on Endpoints or Proxy and Trust Boundaries, Access Layer Switch and Router
Multiple Queues Access Ports

Low-Latency Queuing Logic Tree

Queuing

Voice 1 1
Video 2 2
SNA 5 5
Data 4 4

Router

Layer 3 Queuing Subsystem
Low Latency Queuing
PQ Voice
PQ Voice
Class = X
Class = Y
Default

Layer 2 Queuing Subsystem
Interleave
TX Ring
Fragment

Packets In

Packets Out

VVT-230
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Call Admission Control (CAC)
Bandwidth Management

Cisco IOS Bandwidth Commands

1. Interzone—Bandwidth from a local or default zone to all other local zones
2. Remote—Bandwidth to and from all local zones to all remote zones
3. Total—Total bandwidth in a zone

1.2.3. Session—Bandwidth per session in a zone

Call Admission Control
Bandwidth Management

What Can I Build Today?

Hub and Spoke
No Problem

Data Rate of this Call Is Not Deducted from this Links Bandwidth Limit

RSVP Support Will Fix this Issue
WAN Requirements

Minimum WAN Bandwidth Requirements

<table>
<thead>
<tr>
<th>Traffic Type</th>
<th>Leased Lines</th>
<th>Frame Relay</th>
<th>ATM</th>
<th>ATM/Frame Relay</th>
</tr>
</thead>
<tbody>
<tr>
<td>Video + Data Max. Video Data Rates Up to 384kbps</td>
<td>768 kbps or Greater</td>
<td>768 kbps or Greater</td>
<td>768 kbps or Greater</td>
<td>768 kbps or Greater</td>
</tr>
<tr>
<td>Video + Data Max. Video Data Rates &gt;384kbps</td>
<td>1.544 Mbps or Greater</td>
<td>1.544 Mbps or Greater</td>
<td>1.544 Mbps or Greater</td>
<td>1.544 Mbps or Greater</td>
</tr>
</tbody>
</table>

Video Conferencing Traffic Packet Size Breakdown (CIF)

- 37% 1025–1518 Bytes
- 34% 129–256 Bytes
- 20% 513–1024 Bytes
- 8% 257–512 Bytes
- 1% 65–128 Bytes
Video Characteristics
384kbps Video Call

- Packets per Second
  - No Motion Smaller Packets
  - High Motion Larger Packets

Provisioning

Video Data Rate + 20% = Bandwidth Required

- < 33% of Link Capacity
- < 75% of Link Capacity
- Link Capacity

Video Data Rate
- BW Required
- 128kbps = 153kbps
- 384kbps = 460kbps
- 512kbps = 614kbps
- 768kbps = 921kbps
- 1.5Mbps = 1.8Mbps
Priority Queue (PQ) Access

Option 1
Recommended Method!!!!!

Gatekeeper/Proxy IP Address 10.1.1.20
ACL Configured on WAN Router that only Allows Traffic from 10.1.1.20 to Access the PQ

Option 2

IP Prec 4 Is Marked at Video Terminal
Gatekeeper IP Address 10.1.1.20
ACL Configured on WAN Router that only Allows Traffic Marked with IP Prec 4 to Access the PQ

Option 3

IP Address 10.1.1.100
Gatekeeper IP Address 10.1.1.20
ACL Configured on WAN Router that only Allows Traffic from 10.1.1.100 to Access the PQ

Deploying QoS for Voice and Video in IP Networks
Session VVT-213
Agenda

- H.323 Videoconferencing
- Network Design
- Video Infrastructure
- Dial Plans and Call Routing
- Case Study

Video Infrastructure

- Gatekeeper
- Proxy
- Gateway
- Multipoint Conference Unit (MCU)
Gatekeeper (MCM)
Multimedia Conference Manager

Gatekeeper:

- H.323 component registration and call routing
- Bandwidth management (CAC)
- Directory gatekeeper functionality
- AAA (authentication, authorization and accounting) support (RADIUS and TACACS)
- Redundancy Hot Standby Routing Protocol (HSRP)

Call Admission Control (CAC)
Bandwidth Management

Cisco IOS Bandwidth Commands

1. Interzone—Bandwidth from a local or default zone to all other local zones
2. Remote—Bandwidth to and from all local zones to all remote zones
3. Total—Total bandwidth in a zone

1.2.3. Session—Bandwidth per session in a zone
Directory Gatekeeper

Hierarchical Gatekeeper Design

- G Has Routes for G, E, F, A, B, C and D
- F Has Routes for F, C and D
- E Has Routes for E, A and B
- Site G
- Site E
- Site F
- Site A
- Site B
- Site C
- Site D
- A Has Routes for A Only
- B Has Routes for B Only
- C Has Routes for C Only
- D Has Routes for D Only

Proxy (MCM)
Multimedia Conference Manager

Proxy:

- Classification of video and audio streams with IP precedence or RSVP for QoS
- Application Specific Routing (ASR)
- Access to NAT and firewall environments
Proxy QoS

Leg 1 – Terminated call from Video Terminal 1 to Proxy

Leg 2 – QoS-Enabled Call from Proxy to Proxy with IP Precedence 4 or RSVP

Leg 3 – Terminated from Proxy to Video Terminal 2

Application-Specific Routing

QoS-Enabled IP WAN

= Video Traffic

= Data Traffic
Video Gateways

WAN Options

- Primary Rate Interface (PRI)
- Basic Rate Interface (BRI)
- V.35 (Used with an external IMUX)

LAN to WAN Line Hunting

Line Hunting?
- All gateways register with the same service prefix(es)
- Gateways configured with RAI/RAC to notify the gatekeeper when ISDN resources are low
- Gatekeeper routes calls to an available Gateway based on RAI information

RAI = Resource Availability Indicator
RAC = Resource Availability Confirm
WAN to LAN Line Hunting

Issue
• All B channels must be busy for a call to roll to a secondary link and video calls can be made at different data rates

Resolution
• Standardize on a single video data rate and busy out odd channels

MCU Deployment

Multipoint Conference Unit

• Stacked
• Distributed MCUs
Stacking MCUs

Configured Services:
- 40881 = 128k 6 Users
- 40883 = 384k 4 Users
- 40885 = 512k 5 Users

MC = Multipoint Control Unit
MP = Multipoint Processor Unit

Calls Cannot Be Cascaded between Multipoint Processors. Stacking Allows More Conferences, not Larger Conferences.

Centralized MCUs

- Dedicated circuit to each video terminal and MCU
- MCU capacity based on WAN interface capacity

- Low speed WAN links
- Remote sites are limited to the amount of bandwidth provisioned for videoconferencing

No Problem

Bandwidth Issues
Distributed MCUs with Cascaded Conferences

Conserve WAN Bandwidth and Build Larger Conferences!

- Distribute MCUs to large sites
- Video terminals use their local MCU
- Single site Multipoint calls stay Local!
- WAN bandwidth is limited to one Call at the conference bandwidth

Agenda

- H.323 Videoconferencing
- Network Design
- Video Infrastructure
- Call Routing and Dial Plans
- Case Study
Call Routing and Dial Plans

Where Do I Start?

- Start with incoming PSTN call routing method
- Keep it simple and intuitive
- Mimic telephony dial strings

Call Routing

**H.320 Dialing**

San Jose 4083241250

Dials: 12122458907

New York 2122458907

**H.323 Direct Inward Dial (DID)**

San Jose 4083241250

Dials: 12122458050

DID Range 2122458000 2122458100

New York 2122458050

GW 2122458050?

10.1.1.125

ISDN
Direct Inward Dial DID

- **Pros:**
  - Easy to use
  - User E.164 addresses are already defined
  - H.320 users are used to this format

- **Cons:**
  - Gateway’s must reside in every area code
  - DID numbers cost money
  - Not flexible enough for ad hoc MCU conference IDs
Internal Voice Response IVR

• **Pros:**
  - Very flexible
  - Easy to centralize gateways
  - Users phone numbers can be used for video numbers

• **Cons**
  - Extensions must be dialed
  - Private numbering plan must be designed
  - Doesn’t support H.320 to H.323 MCU calls

DID or IVR

**How Do I Decide?**

• Will you have gateways in every area code with a zone?

• Is it important that the video number be the same as a users telephone number?

• Is using the IVR going to confuse users?

• In reality both routing methods will be implemented in a single network
DID and IVR

- IVR Used for MCU calls
- DID Used for Calls Directly to Video Terminals
- Dial String
  - 4085291000
  - 4085291090
- Conference ID
  - 408821234
- Dial String
  - 4085291090
- DID Range
  - 4085291000
  - 4085291100
- Used for IVR
- E.164 Address
  - 4085291090

Dial Plan Components

- Zone Prefixes: Numeric identifier for each zone “area code”
- Service Prefixes: Prefix used to define an available service on a gateway or multipoint conference unit (MCU) “technology prefix”
- E.164 Addresses: Numeric identifier defined on each video terminal “video number”
- H323-ID: Alphanumeric identifier defined on each video terminal “alias”
Zone Prefix

Think Geography!!!!

- Zone prefix?
- Use local area code
- Already unique and defined
- Users associate the area code with the location

San Jose Campus
Zone Prefix 408

QoS-Enabled
IP WAN

Denver Office
Zone Prefix 720

New York Office
Zone Prefix 212

Creating Multiple Zones in a Single Area Code

San Jose Campus
Zone 1
Zone Prefix 408*

San Jose Campus
Zone 2
Zone Prefix 4085*

QoS-Enabled
IP LAN

San Jose Campus
Zone 3
4086*

Single site with multiple zones
- Expand zone prefix (ZP) to include first digit of E.164 addresses
Service Prefix

- Reserve blocks of numbers for service prefix 8* for MCUs and 9* for gateways
- “As a rule,” local gateway is used for PSTN access when available
- If a zone does not contain a gateway PSTN calls are routed to a designated zone for PSTN access
- MCU service prefix includes zone prefix for zone association and dial-string consistency

San Jose Campus
Zone Prefix 408

E.164 and H323-ID

Think Telephony

E.164:
- Based on incoming PSTN routing method: DID, IVR, or TCS4
- Ensure that addresses are intuitive

H323-ID:
- Email addresses for desktop systems
- Room name for conference room systems

E.164 4085221000
H323-ID Wrigley

E.164 4085221001
H323-ID Jsmith
Dial Plan

San Jose Site

Zone Prefix 408
Gateway SP= 9#
MCU SP = 40883

E.164 Addresses
4085221000-4085221001

H323-IDs
Wrigley, Jsmith

Agenda

• Moving to H.323
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• Video Infrastructure
• Case Study
Health Provider X H.320 to H.323

Why Make the Move?

- ISDN costs are too high
- Looking to up usage without raising usage cost
- Looking to move to a converged network

Health Provider X

What Do We Have to Work ith?

- Five sites around the US
- 42 video units with 384k capability (126 ISDN lines)
- Single MCU in the central site (3 PRI lines)
- T1 WAN links
Health Care Provider X

Current Data Network

- Columbus OH: 24 H.320 videoconferencing units directly connected to the ISDN network with 3 BRI lines each. One H.320 MCU directly connected to the ISDN network with 3 PRI lines.
- Sacramento CA: 2 Buildings
- Los Angeles CA: Single Building
- Dallas TX: 3 Buildings
- Chicago IL: 1 Building

Current ISDN Network

- Sacramento CA: 6 H.320 videoconferencing units directly connected to the ISDN network with 3 BRI lines each.
- Los Angeles CA: 4 H.320 videoconferencing units directly connected to the ISDN network with 3 BRI lines each.
- Dallas TX: 10 H.320 videoconferencing units directly connected to the ISDN network with 3 BRI lines each.
- Chicago IL: 3 H.320 videoconferencing units directly connected to the ISDN network with 3 BRI lines each.
### Multimedia Conference Manager MCM

<table>
<thead>
<tr>
<th>Chassis</th>
<th>IP Routing</th>
<th>H.323 Endpoint Registration</th>
<th>Simultaneous Video Calls</th>
<th>Video Proxy Sessions</th>
</tr>
</thead>
<tbody>
<tr>
<td>72XX</td>
<td>50-100K pps</td>
<td>3000</td>
<td>500</td>
<td>5 @ 768kbps</td>
</tr>
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<td>75 @ 384kbps</td>
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<td></td>
<td></td>
<td>100 @ 128kbps</td>
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<td>25-100K pps</td>
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<td>25 @ 768kbps</td>
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<td>10-40K pps</td>
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<td>900</td>
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<td>3810</td>
<td>2-5K pps</td>
<td>900</td>
<td>60</td>
<td>6 @ 128kbps</td>
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<tr>
<td>25XX</td>
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<td>600</td>
<td>30</td>
<td>2 @ 768kbps</td>
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<td></td>
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<td>4 @ 384kbps</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>10 @ 128kbps</td>
</tr>
</tbody>
</table>

### Health Care Provider X Network Configuration

1. IP Precedence Set to 4
2. IP Prec. Set to 4 and Trust Boundary Configured
3. Trust Boundaries Configured
4. 2-3640 Routers Performing Gatekeeper and Proxy Functionality and Configured with HSRP; Proxy Setting IP Precedence to 4
5. Bandwidth Controls Set for Inter and Intra Zone Calls
6. Priority Queue (PQ) Configured for 920k
7. ACL Added to Set PQ Entrance Criterion; Only Packets from Configured Proxies (all Sites) Will Have Access to the PQ
Health Care Provider X
Network Configuration

Dallas and Sacramento

1. IP Precedence Set to 4

2. IP Precedence Set to 4 and Trust Boundary Configured

3. Trust Boundaries Configured

4. Gatekeeper and Proxy Functionality Configured on WAN Router; CAC Configured on Gatekeeper and IP Precedence Set to 4 on the Proxy

5. Priority Queue (PQ) Configured and Provisioned for 920k

6. ACL Added to Set PQ Entrance Criterion; Only Packets from the Proxy Will Have Access to the PQ

WAN Router

Video Terminal

MCU or Gateway

Health Care Provider X
Network Configuration

Los Angeles and Chicago

1. IP Precedence Set to 4

2. Gatekeeper and Proxy Functionality Configured on WAN Router; CAC Configured on Gatekeeper and IP Precedence Set to 4 on the Proxy

3. Priority Queue (PQ) Configured and Provisioned for 920k

4. ACL Added to Set PQ Entrance Criterion; Only Packets from the Proxy Will Have Access to the PQ

WAN Router

Video Terminal

Video Gateway
Health Care Provider X
Video Infrastructure

MCUs

- Columbus 1 MCU 50 users at 384k
- Dallas and Sacramento 1 MCU at each site 9 users at 348k

Gateways

- Columbus, Sacramento, and Dallas 1 PRI gateway each
- Los Angeles 1 BRI gateway with 4-BRI lines
- Chicago 1 BRI gateway with 3-BRI lines
Health Care Provider X
Video Infrastructure

Call Routing

- DID will be used for E.164 addresses (gateways reside in each zone)
- IVR will be used for MCU calls from the PSTN (users are used to using an IVR for voice bridge calls)
Health Care Provider X Zone Prefixes

- Columbus 614
- Sacramento 916
- Dallas 972
- Chicago 847
- Los Angeles 213

Health Care Provider X Service Prefixes

- Columbus Gateway 9# MCU 61463
- Sacramento Gateway 9# MCU 91683
- Dallas Gateway 9# MCU 97263
- Chicago Gateway 9# MCU 84783
- Los Angeles Gateway 9# MCU 21383
Health Care Provider X
E.164 and H323-ID

Columbus
6142451230
6142451260
Room Names

Sacramento
9164255670
9164255680
Room Names

Dallas
9726723420
9726723440
Room Names

Chicago
8475272620
8475272622
Room Names

Los Angeles
2133268920
2133268923
Room Names

Health Provider X
Columbus Dial Plan

Columbus
Zone Prefix 408
Gateway SP=9#
MCU SP=40883

E.164 Address
6142451230-6142451260

H323-ID
Room Names
Expansion Issues

- WAN bandwidth will need to be added
- How do you guarantee that WAN bandwidth is available for scheduled calls?
- What will be used for directory services (How do you make the system easier to use?)

Summary

- Network QoS
  End-to-End QoS guarantees video traffic and minimizes latency and packet loss
- CAC/bandwidth management
  Protects critical WAN bandwidth and provisioned PQs
- Management of shared resources
  Gateway and network resources are shared and must be managed properly
Summary

- Flexible dial plans and call routing
  Dial plans must be intuitive and scaleable
  Mimic telephony dial plans

Keep It Simple!!!!
Please Complete Your Evaluation Form
Session VVT-230