Video
Communications:

Building Blocks for a Simpler Deployment
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Overview

The convergence of IP-based (H.323) and ISDN-based (H.320) standards in today’s video communication network requires in-depth knowledge to smoothly deploy IP video communication applications across a network. Deploying IP video communication extends beyond connecting video communication terminals to the LAN. The full implementation of video communication incorporates many components and architectural designs to facilitate the “ease of use” for end-users and IT professionals. To identify these components and obstacles in deploying IP video, the network administrator will need to understand video communication infrastructure and networking variables. These concepts can then be applied to deploy video networks for small work groups or service agencies within large multinational corporations. Polycom simplifies the process of selecting the right components for the required application, by providing a guideline for a complete solution of video communication by defining standards and highlighting building blocks for video communication.

Historical Background

Deployments

In the past, video communication systems were designed with components from a multitude of competing vendors. Integrating products from different vendors typically reduces the overall feature set, down to a subset of features that can be supported across all vendor products. For example, a user could select a particular manufacturer’s terminal based on a specific feature such as data collaboration. When this terminal is in use, this feature may not be preserved once the terminal interacts with other manufacturer’s terminals or H.323 endpoints such as a gateway or MCU as shown in Figure 1. The issue of lowest common denominator feature support is that there is no incentive or mechanism in place for manufacturers to ensure that features remain constant across multi-vendor solutions. Standards are in place for intercommunication, however advanced features are not all mandatory for implementation. As a result, features considered more valuable to the user are often left out of the design.
Polycom is the only manufacturer today that actually designs and manufactures all of the pieces required to bring the highest level of user-related features to video communication. Polycom is committed to raising the level of features supported across all components, from terminals through video specific networking infrastructure as shown in Figure 2.

**The Standards**

Video communication systems were originally based on the International Telecommunications Union (ITU), H.320 standard defining Integrated Switched Digital Network (ISDN) connection-based video communication. This technology leverages the existing Public Switched Telephone Network (PSTN). The cost of deployment and the inability to scale to large numbers of cost effective communication sessions led to the development of the ITU H.323 standard for packet-based multimedia communications over Transmission Control Protocol/Internet Protocol (TCP/IP). The H.323 standard is a logical extension of the H.320 standard to enable corporate intranets and packet-switched networks to transport multimedia and video communication traffic. The H.323 recommendations cover IP devices that participate and control H.323 sessions and video specific infrastructure that interact with the PSTN. In common with other ITU multimedia teleconferencing standards, H.323 implementation applies to either point-to-point or multipoint sessions. The ITU has ratified these core protocol components for audio, video and communication for H.323 sessions:

- **H.225**: Specifies messages for call control including signaling, registration and admissions, and packetization/synchronization of media streams
- **H.245**: Specifies messages for
opening and closing channels for media streams, and other commands, requests and indications

- H.263: A newer video codec that added additional picture formats over H.261 (4CIF and 16CIF)
- G.723: Audio Codec, for 5.3 and 6.3 Kbps modes

These ITU protocol components were previously defined in H.320, but also apply to H.323.

- H.261: Video codec for audiovisual services at p x 64 Kbps
- G.711: Audio codec, 3 KHz at 48, 56, and 64 Kbps (normal telephony)
- G.722: Audio Codec, 7 KHz at 48, 56, and 64 Kbps
- G.728: Audio Codec, 3 KHz at 16 Kbps

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**Video Communication is a Real-Time Application**

Video communication is a new application for most IP networks. Although real-time applications do exist today, video communication unlike e-mail or typical database applications, require limits on the total end-to-end delay (latency), and the variability of the delay (jitter). Figure 3 shows the latency and jitter result in packet loss, which is responsible for degrading audio and video quality and usability. It should be noted that the overall delay budget for a one-way video or voice conversation is approximately 125-150 milliseconds.

Facts about Packet loss:
(As quantified by Polycom Labs)

- Network jitter can result in packet loss
- A 1% packet loss may produce blocky video and/or audio loss
- A 2% packet loss may make video unusable, although audio may sound somewhat acceptable

While packet loss above 2% is unacceptable for H.323, 1-2% is considered “poor” and should be resolved.

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**IP Basics for Implementation**

When deploying an IP-based network for video communication, an understanding of how video communication differs from other IP-based applications is required. The three key differences are:

1. Video communication is a real-time application.
2. Video communication can use higher bandwidth.
3. Firewall traversal of the video traffic.
A new protocol for Real-Time Data Transport

TCP, the Layer 4 protocol, which serves as the data-transport mechanism for most packet-switched networks (including the Internet), was developed to guarantee the reliable delivery of information in the proper sequence from a sender to a receiver. However, TCP’s error and flow-control mechanisms may result in indeterminate delays and abrupt data delivery.

This approach does not fit the needs of real-time video, which requires a relatively tight delay characteristic. The Real-Time Protocol (RTP) with its adjunct Real-Time Control Protocol (RTCP) works alongside TCP to carry video data over the network. RTP uses packet headers that contain sequencing information, time stamps required to time the output (for example, display of frames) and synchronize different data streams (for example, audio and video) so that the remote end will receive the video data in the correct order.

Additionally, Polycom IPriority initiative consists of the following features:

- IP Precedence - for Quality of Service (QoS)
- Dynamic Bandwidth Allocation- for network congestion
- Packet and Jitter control - for network congestion
- Asymmetric Speed control - for dissimilar speeds of transmit and receive, i.e., ASDL (384 Kbps up and 128 Kbps down)
- Fixed port firewall capabilities - for simplifying deployments of video that traverses firewalls
- Network Address Translation (NAT) support - for security
- Onscreen diagnostics - for rapid problem resolution
- Intensive H.323 interoperability testing - for preservation of your investment in a standards based environment
**Video Communication Bandwidth Basics**

Video communication over IP can use more bandwidth than traditional applications. A typical business-quality call over IP requires the following bandwidth:

\[
\text{Audio (64 Kbps) + Video (320 Kbps) + IP overhead of Approximately 25\% = 480 Kbps}
\]

Figure 4 illustrates an IP video call made at “384 Kbps” needs 25% more bandwidth to produce the same quality result as an ISDN call made at 384 Kbps.

*Figure 4: 384 Kbps ISDN call quality over IP*

Prior to deployment, it is critical that a baseline of existing application bandwidth utilization be conducted, particularly over WAN links. Network bandwidth for mission critical applications need to be accounted for first, prior to making recommendations for the number of sessions that can be supported. Please see Figure 5 for a reference of video communication bandwidth utilization.

*Figure 5: 384 Kbps ISDN call quality actual bandwidth utilization over different protocols*

**Internet Conferencing**

The Internet does represent a quality concern to video based communications due to the lack of QoS. Some Internet service providers are currently offering Service Level Agreements (SLAs) that address the latency and jitter issues, however no one provider is able to guarantee the quality of every communication session from all ISP’s over today’s Internet (end-to-end). Internet conferencing does represent a way to connect with other IP domains, outside of an individual organization. Cost advantages over traditional point-to-point connections are also attractive to designers. However,
traversing through firewalls and Network Address Translation (NAT) poses obstacles in using the Internet as a medium for passing video traffic today.

**Firewalls**

**What is the firewall problem with H.323?**

One of the reasons why firewalls are problematic is the heavy use of dynamically allocated ports within H.323 making it impossible to pre-configure firewalls to allow H.323-signaled traffic without opening up large numbers of ports in the firewall. As an example, Microsoft recommends configuring firewalls for use with NetMeeting, which is an H.323-based conferencing application. Their recommendation for firewall configuration is as follows:

“To establish outbound NetMeeting connections through a firewall, the firewall must be configured to do the following:

Pass through primary TCP connections on ports 389, 522, 1503, 1720, and 1731.
Pass through secondary TCP and UDP connections on dynamically assigned ports (1024-65535).”

From Microsoft’s website:
http://support.microsoft.com/support/kb/articles/Q158/6/23.asp

This represents a somewhat more lax firewall policy than would be acceptable at many sites, and it still does not address the problem of receiving incoming calls.

The other workaround with firewalling H.323 is in using an H.323 application proxy, which is a software component of a UNIX or NT-based firewall that actually takes part in the protocol. In the H.323 context, a proxy would take part in the H.323 conversations, terminating the call on the firewall and creating a second call to the final destination, and finally plug-boarding the two calls together. These steps may cause a delay in voice and video transmission that could disrupt the communication session.

The enterprise firewall must additionally handle all H.323 call setup/teardown work, as well as moving all the video traffic for all the endpoints attempting to communicate across the firewall. This presents significant security and performance/scalability challenges for both H.323 as well as all data traffic traversing the enterprise firewall. H.323 support within the firewall, which is in addition to the traditional role of firewalls in securing common protocols such as HTTP and FTP, makes firewall design complex and (by definition) more vulnerable to attack. H.323 support has the potential of degrading overall firewall performance and scalability.

**What is the NAT problem with H.323?**

Network Address Translation (NAT) is a method by which IP addresses
are mapped from one IP domain to another, in an attempt to provide transparent routing to hosts, specifically from private non-routable addresses to publicly routable addresses. Traditionally, NAT devices are used to connect an isolated IP domain with private unregistered addresses to an external IP domain with globally unique registered addresses. NAT is generally used for two purposes: 1) as a mechanism to work around the problem of IPv4 (Internet Protocol version four) address space depletion, and 2) for security purposes (to hide hosts at an unroutable address). NAT works by having a NAT device, often implemented as part of a firewall application, rewrite IP headers as packets pass through the NAT. The NAT maintains a table of mappings between IP addresses and port numbers.

The problem with NAT from an H.323 perspective is that H.225 and H.245 make heavy use of embedded IP addresses. If NAT is being used, addresses in the protocol stream will be the addresses in the private address space (behind the NAT), rather than the address at which the host has a public, routable interface. For example, a host may have its address in a private address space, 172.18.0.51, which when traversing a NAT is translated to 207.126.235.233. When that host attempts to place a call, the “calling party” information element in the H.225 signaling stream will contain the private, non-routable address (172.18.0.51), and attempts to make an H.225 connection back to that address will fail.

What is the “external (or incoming) call resolution problem” with H.323? Some vendors have begun to create firewalls with H.323-aware NAT, which allow outgoing calls (as described above) to function correctly. These firewalls translate the IP address in the H.323 signaling protocol stream as well as the IP address in the data packets themselves. However, NAT cannot allow an incoming call from an external H.323 endpoint to an endpoint behind a NAT. If an external endpoint tries to call an internal endpoint using an internal endpoints’ private IP address, the incoming call will contain an unroutable address in two places and the call’s packet is discarded by the first router it reaches. If the external user tries to use the public IP address of the NAT device, the NAT device has no way of knowing who the intended recipient is for the call.

**IP Deployment Recommendations**

A network that is optimized for voice and video over IP will ensure proper transfer of data quickly and smoothly. Before deploying video communication, upgrading your organization’s network to meet the minimum IP-video requirements is strongly recommended. Listed below are basic networking issues
and components that will help define the essential infrastructure requirements.

**10/100 Ethernet Switches**

High back plane density Fast Ethernet switches are recommended (3.2 Gbps to 100 Gbps) versus shared hubs. The zero collision domains of a switch and its higher back-plane density allow for proper operation of video communication over IP networks.

**Wide Area Networking**

Wide Area Networking (WAN) links require policies to limit bandwidth utilization so as to not saturate the use of common WAN links for mission critical applications. An H.323 gatekeeper can be used to set policy on bandwidth, by user/groups of users. Please see “Quality of Service” below for more relevant information on shaping traffic with IP Precedence.

**Quality of Service**

Quality of Service (QoS) is also an important area of consideration. Polycom video communication terminals allow for the setting of the IP precedence bit in the Type of Service (ToS) field of their IP headers as shown in Figure 6. IP precedence tells downstream networking equipment (routers & switches) to give priority to audio and video packets, marks each audio and video packet with a user-defined precedence (default is 5). Users may specify the level of precedence from 0 to 7, with 0 indicating no priority and 7 indicating the highest priority, 5 is recommended by networking vendors for multimedia data.

**Figure 6: Screenshot of ViewStation QoS Configuration Page**

<table>
<thead>
<tr>
<th>Quality of Service and Firewalls</th>
</tr>
</thead>
<tbody>
<tr>
<td>Use Fixed Ports: TCP Ports: 2222</td>
</tr>
<tr>
<td>UDP Ports: 32130</td>
</tr>
<tr>
<td>IP Precedence: 5</td>
</tr>
<tr>
<td>Dynamic Bandwidth:</td>
</tr>
<tr>
<td>System is behind a NAT:</td>
</tr>
<tr>
<td>NAT outside (WAN) address:</td>
</tr>
</tbody>
</table>

**Note:** Routers and switches must be able to support IP Precedence; by default this is turned off on most and is not enabled on the Internet.

**Firewalls and NAT**

Polycom terminals allow for the setting of a small range of UDP ports to use, as well as the mapping of Public IP addresses to Polycom ViewStation group conferencing systems. For a solution to the issues of scaling corporate firewalls to support H.323, please refer to the description below for functionality supported by a protocol gateway. This paper will not address the technical problems of deploying
dynamic host configuration protocol (DHCP) of private IP addresses. Please refer to the “Accord Networks Technical White Paper Addressing Issues with H.323, Security and Firewalls.”


**Gatekeepers**

Gatekeepers are designed to allow for the setting of policies as it relates to:

- Users/group of users’ ability to conference, and at what bandwidths.
- Those resources that are available to the user/group of users on the network, i.e., MCUs, Gateways, other Terminals.
- Name resolution from an H.323 alias (alpha name) to an IP address.
- Name resolution from an E.164 alias (number) to an IP address.

**Directory Services**

Directory services are becoming one of the most important components of any deployment of video communication. Directories enable users to select from a list of potential users for communication. Users then simply click on the user from the list and the system automatically dials. Polycom Global Management System™ provides a central Directory for all Polycom endpoints using an intelligent dialing system that even determines if the area code and country code are needed to place the call.

**Network Management Software**

Network management is one of the newest and most critical adjuncts being applied to video communication systems today. Administrators need the tools to make the application work and keep it working. Network monitoring, help desk, software updates, and inventory control are just a few of the uses of network management software. The full solution of video communication can be extremely complex in nature and without tools such as network management software your internal customers will be dissatisfied with your offering. Polycom Global Management System provides network management of Polycom terminals. The Polycom Accord® MGC Manager™ provides management and configuration of the Polycom Accord infrastructure products.
**Defining the Application**

Prior to the design of a video communication solution, one must first address all the variables of how users will actually utilize the technologies implemented. Understanding how users interact, and the video specific infrastructure and services they require, is paramount to a successful deployment. The highest level of effort should be focused on keeping the users’ responsibilities to a minimum. Presenting users with a common user interface across all technologies and simple to use controls are mandatory. Far too often designers and users get caught up on a particular feature that they “must have”, only to find out that the actual implementation is far too complex for all users to actually benefit from it.

Polycom users benefit from simple point and click access to all features. Intense development of web-based technologies also leverages a users’ understanding of browsing for control of their video communication environment. The following section will introduce the interaction of users and the video specific infrastructure required for a full deployment of video communication technologies.

**Interaction**

Video interaction of terminals can be separated into three categories:

- **Point-to-point using a single protocol** - A single terminal calling another terminal using the same network and communications protocol, i.e., all H.320 (ISDN) or all H.323 (IP).

- **Point-to-multipoint using a single protocol** - Either point-to-point or point-to-multipoint; a group of terminals conferencing together all using an MCU i.e., all H.320 (ISDN) or all H.323 (IP).

- **Point-to-multipoint using multiple protocols** - Either point-to-point or point-to-multipoint; a group of terminals conferencing together all using an MCU. A Protocol Gateway is required to support multiple protocol intercommunications.

*Note:* This third category is the most common implementation today.

**Terminals**

Video communication terminals can be categorized as follows:

- **Small room systems** - Designed for use by 1-3 people. The Polycom ViewStation™ model SP128 and SP384 are in this category.
Medium or large room systems - Designed for use by 3-10 people. The Polycom ViewStation™ models 128, H.323, MP, and FX are in this category.

Integrated room systems - Designed for use by 10-30+ people. The Polycom VS4000 is in this category.

Desktop systems - Designed for use by one person. The Polycom ViaVideo™ is a USB based business quality video communication terminal that does not require placement of a PC card inside the PC. This represents one of the most significant advances in desktop video communication to date.

Video Specific Infrastructure and Services

Multipoint Control Units (MCU) MCUs are network devices that process all of the associated signaling and media involved in a multipoint conference. Multipoint conferences can consist of three or more participants. Polycom offers solutions to meet your multipoint needs should they be small group systems or large highly redundant enterprise and/or service provider systems.

Note: MCU’s are often referred to as Bridges.

MCUs come in three different categories:

ISDN-only MCU Type one: Dedicated network resource shared by all. This would be considered a legacy device by today’s standards.

Type two: Terminal embedded four-port MCU. Polycom offers this feature on our ViewStation 512, ViewStation MP and FX, and VS4000 products.

IP-Only MCU Type one: Low cost, small port count, limited feature starter/workgroup MCU.

Type two: Higher cost, large port count, limited feature scalable enterprise MCU.

Type three: Higher cost, larger port count, maximal feature set, enterprise or Service provider MCU.

Hybrid MCU/Protocol gateway This represents the state-of-the-art in ease of use and experience of video communication today. Polycom offers the:

- Accord MGC-50™ Workgroup to Enterprise Solution
- Accord MGC-100™ Enterprise or Service Provider Solutions
Protocol Gateways

Protocol gateways provide for the protocol and media conversion from one H.32X protocol to another. For instance, H.323-based terminals within a LAN, can only communicate with H.323 terminals unless a protocol gateway is used to call legacy systems off the LAN. Protocol gateways can also be used to securely connect independent IP domains (H.323 to H.323). Additionally, gateways offer video specific quality enhancements because of its optimization for the processing of H.323 and H.320 video and audio protocols.

Is scheduling a requirement for your organization?

Web-based and Outlook-based scheduling is available with Polycom’s Accord products. The Web Commander™ is a simple to use, web-based reservation system designed with the user in mind. Web Commander™ provides both scheduling and conference control. Outlook Commander™ provides scheduling of MCU resources and meeting scheduling via Microsoft’s Outlook client.

Gateways come in four different categories:

Basic Rate ISDN (BRI) Gateways (No Video Transcoding)

- BRI gateways can support up to 512Kbps of conferencing sessions between IP and PSTN networks. BRI gateways can be stacked to increase overall throughput. BRI gateways are not recommended when scalability is a major requirement.
- Video speed matching is not supported. For instance, if a terminal wanted to conference over the LAN using the H.323 (IP) Protocol at 384 Kbps and connects with a legacy H.320 (ISDN) via a gateway at 128 Kbps. Non-speed matching gateways will reduce the call to the lowest common denominator, all sites are forced to the speed to 128 Kbps for all users. This is not acceptable in many instances and requires a video transcoding gateway to solve the deficiency in speed matching.

- Most gateways support limited audio transcoding, i.e., G.728 to G.711
- Reliability from a high mean time between failure (MTBF)
- Redundancy via Gatekeeper logic (if more than one gateway on the network)

Video Communication: Building Blocks for a Simpler Deployment
**Single-Primary Rate ISDN (PRI) gateways (No Video Transcoding)**
- In the US, PRI (T1) gateways can support up to 1.5 Mbps of conferencing sessions between IP and PSTN networks. In Europe, PRI (E1) gateways can support up to 2 Mbps of conferencing sessions between IP and PSTN networks.
- PRI gateways can be stacked to increase scalability.
- Video speed matching is not supported. For instance, if a terminal wanted to conference over the LAN using the H.323 (IP) Protocol at 384 Kbps and connects with a legacy H.320 (ISDN) via a gateway at 128 Kbps. Non-speed matching gateways will reduce the call to the lowest common denominator, all sites are forced to the speed to 128 Kpbs for all users. This is not acceptable in many instances and requires a video transcoding gateway to solve the deficiency in speed matching.
- Reliability from a high mean time between failure (MTBF)
- Redundancy via Gatekeeper logic (if more than one gateway on the network)

**Multiple-Primary Rate ISDN (PRI) gateways (With Video Transcoding)**
- In the US, PRI (T1) gateways can support up to 1.5 Mbps of conferencing sessions between IP and PSTN networks. In Europe, PRI (E1) gateways can support up to 2 Mbps of conferencing sessions between IP and PSTN networks. PRI cards can be added to the chassis to support upwards of 48 PRI connections or OC-3 ATM in the future.
- Highly available and hot swappable.
- Enterprise or Service Provider solution.

**H.323 (IP) to H.323 (IP) Protocol Gateways (with or without video transcoding)**
Also referred to as Firewall Gateways.
- Provide secure conferencing connections from two different IP domains
- Off-load video intense traffic from corporate firewalls
- Optimize video and audio to compensate for delay and protocol mismatches.
- Offer a solution to the inbound dialing issues as they relate to private IP addressing schemes, as discussed previously in this document.

**Gatekeepers**
Gatekeepers are available in two formats:

**Embedded in Infrastructure**
Gatekeepers embedded in infrastructure are limited in the number of registered terminals that can be supported, as well as the number of simultaneous communication sessions that can be managed. Typically, an embedded gatekeeper may limit registrations to 100 terminals and only
allow for the processing of 30 sessions.

**Note:** If you believe your deployment will scale to more than 30 sessions, decide now to implement a larger gatekeeper. Please also note that Gatekeeper processing may compete with the infrastructure’s primary responsibility.

**Server-Based Gatekeepers**

Server-Based gatekeepers typically run on Microsoft Windows NT operating systems and Intel platforms. Server-based gatekeepers scale to a much larger number of registered terminals and simultaneous sessions supported. For example, a typical server-based gatekeeper may be able to support several hundred registered terminals and process hundreds of simultaneous sessions.

Although video communication specific infrastructure products may or may not be required for your initial deployment of video communication, decisions made now will need to consider future requirements. If users will be conducting multipoint meetings over the network, conferencing between two protocols (ISDN and IP), or conferencing over the Internet via a firewall, considerations should be made now for the type of MCU and or Gateway to use. It is important to understand the overall costs associated with a deployment as it scales. Often decisions are made in the short term to save up front costs, that over time result in higher costs per communication session.

**Directory Services and Management**

As noted previously, directory services are becoming a vital component of any video communication deployment.

**Global Management System™**

Enables for both management and directory services for all IP connected terminals. This product is a requirement when reliability and control important to the video solution. Global Management System™ provides for the following:

- Proactive network monitoring of all Polycom terminals (IP or ISDN). Remote Alert Notification enables administrators to be paged about critical events.
- Help desk features to allow for direct support of end-users providing a level of support equal to being in the room with the user.
- Software Update Service can be done in a “start now” mode or scheduled to occur after hours in every time zone that terminals are deployed.
- Call Detail Record for analysis of network utilization of video communication terminals. This is great for bill-back and/or cost analysis.
**Figure 7:** Global Management System

**Figure 8:** ViewStation Global Directory

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**Global Directory Server™**

Provides for:

- **Zero Administration directory services.** All terminals can be dynamically added to the directory as they are deployed on the network. Global Dial is a comprehensive routing mechanism designed to ensure that calls connect simply every time, without the use of service codes or prefixes required by competing vendors.

- **LDAP compliance.** Microsoft’s ILS support for access to ViaVideo™ and NetMeeting terminals.
Summary

As more organizations move towards IP-based platforms for video communications, hybrid networks will be the norm of the foreseeable future. The rate of deployment of H.320 technology is predicted to slow when juxtaposed against the scale of IP video communication deployments over the next 3 to 5 years. Upgrading the IP infrastructure is vital to the deployment of video communication. In deploying IP video communication, one must consider the full solution. Consider Figure 9 a checklist to your design process.

Even if you are only looking to start a pilot, all the variables of the actual deployment must be considered to ensure the ultimate solution is cost effective and meets the needs of both users and administrators over time. An example of the complete Polycom solution is shown in Figure 10.
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