

Video Conferencing Standards

TANDBERG

Application Notes

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ITU Defined Standards

The International Telecommunications Union -- Telecommunications Standardization Sector (ITU-T) is responsible for generating worldwide "recommendations" (non-binding standards) for telecommunications. The ITU-T is divided into fourteen Study Groups. Each Study Group studies "questions" (i.e., topics for study); the results of their study define these recommendations. Study Group XVI is responsible for generating recommendations for data collaboration and videoconferencing. The following summarizes salient recommendations for multimedia communications produced by Study Group XVI.

Videoconferencing (H.3xx)

H.3xx are "umbrella" recommendations for videoconferencing. These recommendations reference other recommendations that include the protocols for coding video/audio, multiplexing, signalling, and control. The core H.3xx recommendations are:

- H.320 Narrow-band videoconferencing over circuit-switched networks (N-ISDN, SW56, dedicated networks)
- H.321 Narrow-band videoconferencing over ATM and B-ISDN
- H.323 Narrow-band videoconferencing over non-guaranteed quality-of-service packet networks (LAN, Internet, etc.)
- H.324 Very narrow-band videoconferencing over the general (dial-up) telephone network
- H.310 Wide-band (MPEG-2) videoconferencing over ATM and B-ISDN

For the H.3xx recommendations, referencing the T.120 recommendation for data collaboration is optional.

Introduction to H.323

H.323 is an International Telecommunications Union (ITU) standard that describes the protocols, services and equipment necessary for multimedia communications including audio, video and data on networks without guaranteed Quality of Service (QoS). These networks technologies may include Ethernet, Fast Ethernet, and Token Ring and protocols like Internet Protocol (IP) or Integrated Packet Exchange (IPX). Due to the need to communicate between smaller networks connected to the Internet, H.323 will be more popular on IP networks.

Today, the dominant method of Internet communications is email. However, there is a growing need to increase communications to include audio, video and data. The explosion of the Internet in the early 1990's has paved the way to higher bandwidth connections to corporate offices, universities and even to the home. Now that the bandwidth is available, the demand for multimedia communications over the Internet is growing.

Components

H.323 specifies several new standards to allow for communications between terminals on IP networks. These standards dictate how different mandatory and optional components of the H.323 standard interoperate with each other.

The major network components of H.323 include the mandatory terminal, and the optional gatekeeper, gateway and multipoint control unit (MCU).

Terminals

The terminal or endpoint must support a minimum of G.711 audio, H.225, H.245, Q.931 and RTP. If the terminal supports video, it must support a minimum of H.261 QCIF. The terminal may support T.120 data sharing although this support is optional. The TANDBERG 500, 800, 1000, 2500, 6000 and 7000 video conferencing systems all fit the definition of a H.323 terminal.



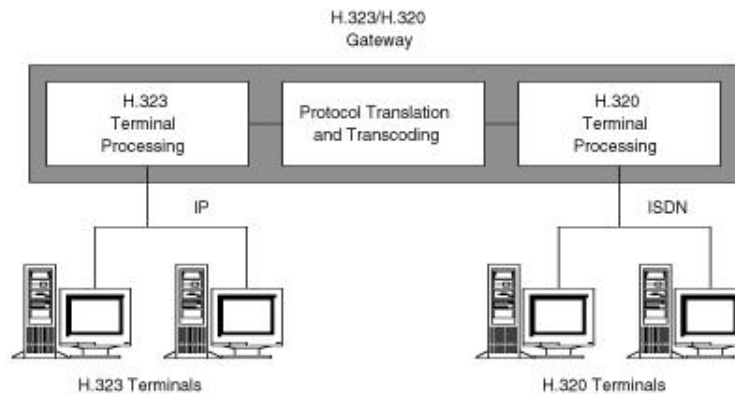
Gatekeepers

The gatekeeper is an optional component of H.323 that is responsible for managing other components of a H.323 network. It is a very important component to the managed network. The gatekeeper has several responsibilities which include: translation of E.164 aliases to IP or IPX addresses, bandwidth management of incoming or outgoing calls, call admission to accept or deny calls, and zone management. Gatekeepers can also support an optional feature that allows a call to be rerouted if there is no answer from the intended terminal. Gatekeepers also help manage different H.323 zones and help manage H.323 MCU sessions. It is important to remember that while gatekeepers are optional, the H.323 terminal must make use of the gatekeeper's services if the gatekeeper is present in the network.

Gatekeepers are typically software products that reside on a server. Although many H.323 MCUs and gateways have embedded gatekeepers, they usually offer less features than stand alone gatekeepers.

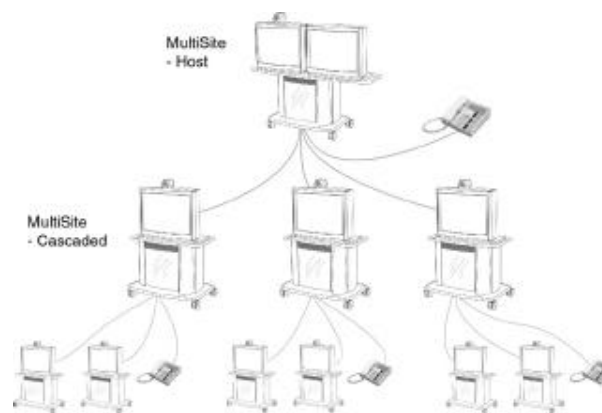
Gateways

If there is a need for a H.323 terminal to communicate with another terminal on a H.320, H.324 or analogue PSTN networks, a H.323 gateway is required to perform the translation. This optional components typically have ISDN and IP network connections and support the translation between these two networks. The number of simultaneous connections allowed through a gateway is not specified in any standard, so there are different options available from different manufacturers. Gateways typically have built in gatekeepers with minimal features.



Multipoint Control Units

The last of the major components is the MCU which controls conferences between 3 or more terminals. The H.323 MCU may be a separate component or may be incorporated into a terminal. The TANDBERG 800, 2500, 6000 and 7000 have optional software packages that enable internal H.323 MCU capabilities. The TANDBERG built-in multipoint conference unit (MCU), Multisite^{TF}, has the capability to establish meetings with up to 4 video sites (5 if at least one site is a telephone call, ISDN/analogue/mobile). A conference can consist of any combination of ISDN/LAN sites. Up to 4 TANDBERG Multisite^{TF} systems can be cascaded in one meeting. The maximum numbers of participants is 10 video system and 4 telephones, see fig below.



Introduction to H.320

In 1991 the European Videophony Experiment (EVE) saw various manufacturers trailing equipment using the CCITT standard H.320.

Simultaneously in Japan the HATS trial was initiated, also H.320 based and this included some ISDN trial work.

Today the H.320 standard forms an umbrella for a whole host of standards adopted by the main manufacturers of video conferencing equipment and ensures a fair degree of interconnectivity. A group is currently being formed to help ensure interoperability and promote the use of the H.320 set of standards.

H.320 is an overall standard and requires, as a minimum for VideoConferencing intercommunication, that the following standards are used:

1. G.711 Audio 3KHz bandwidth.
2. H.261 Video Quarter Common Intermediate Format.
3. H.221 Packaging.
4. H.242 Handshaking.
5. H.230 Frame-synchronous Control

Standards

The Audio Standards:

The governing standard for the transmission of audio is G725. This standard encompasses:

- G.711** G.711 is the oldest compression algorithm. It is mandated by all H.3xx recommendations (except H.324). G.711 codes toll-quality (3KHz analog bandwidth) audio into 48, 56, or 64 Kbps.
- G.722** Optional recommendation. G.722 codes enhanced quality (7 KHz analog bandwidth) audio into 48, 56, or 64 Kbps.
- G.722.1** Codes enhanced quality (7 KHz analog bandwidth) audio into 24 or 32 Kbps. G.722.1 was approved in September 1999.
- G.723** Speech coder at 6.3 and 5.3 Kbps data rate. Medium complexity. Required for H.324; Optional for H.323.
- G.728** Optional recommendation. G728 codes toll-quality (3KHz analog bandwidth) audio into 16 Kbps
- G.729** G729 codes toll-quality (3KHz analog bandwidth) audio into 8 Kbps.
- G.703** Is a standard associated with the PCM standard, requires a bandwidth of 64 kbps. G.703 is the electrical and functional description.

Digitisation of the audio signal is achieved through using Pulse Code Modulation (PCM). Within Europe the A-law conversion is used, whilst for the US and Japan the μ -law conversion is used. Essentially PCM takes an 8 bit sample of an audio waveform at a sampling rate of 8KHz. The sample is actual 7 bits with the most significant bit (*msb*) being used as a sign bit.

The G711 protocol strips off the least significant bit (*lsb*) from each sample to reduce the 64Kbit/s sample down to 56Kbit/s. This is essential to ensure that the 1st channel of 64Kbit/s has the capacity to carry signalling information in addition to audio.

When using SDS56 where there is only a 56Kbit/s channel available, G711 strips off a further bit to reduce the audio signal to 48Kbit/s.

The upshot of this bit stripping is the introduction of more noise to the audio component. To the human ear the difference is virtually imperceptible.

G722 which would normally require a channel capacity of 56Kbit/s is also able to reduce to 48Kbit/s however, this is achieved both at code level by altering the compression algorithms as well as at the bit level by simple *lsb* stripping.

The Video Standards

H.261

The governing standard for the transmission of video is H261 although this also acts as an umbrella for G725. H261 determines whether communication will exist at the Common Intermediate Format(CIF) level or the Quarter Common Intermediate Format(QCIF) and thereby provides a uniform process for a receiving Codec to interpret a compressed video signal. H.261 is based on Discrete Cosine Transform, DPCM and motion compensation techniques. In simple terms H.261 enables, for any rate up to 2Mbps connection:

- CIF - n frames/s @ a screen res. of 352x288 pixels.
- QCIF - n+ frames/s @ a screen res. of 176x144 pixels.

n is directly proportional to the degree of movement present in the image being transmitted and will be limited by processor speed and available bandwidth.

Beneath the H261 umbrella sit the following standards:

- H.221 - Frame structure, protocol and video/audio synchronisation
- H.230 - As above but for MCU communications
- H.242 - Inter -device communication i.e. in-band information exchange

Once an ISDN connection has been established the synchronisation of communicating devices is handled by H221. The H221 continues to handle all synchronisation issues throughout a conversation. H242 caters for inter-device communication.

H.261 Annex D

Protocol for transferring high quality still images 4CIF

H.263

H.263 is a newer compression algorithm and is optimized for the lower data rates. H.263 originally was developed under the H.324 umbrella for coding video at very low data rates (15K to 20K bps). H.263's performance is superior to H.261, specially at data rates below 128 Kbps.

H.263 has five resolution modes:

- SQCIF (128 pixels per line by 96 lines)
- QCIF (176 pixels per line by 144 lines)
- CIF (352 pixels per line by 288 lines)
- 4CIF (704 pixels per line by 576 lines)
- 16CIF (1408 pixels per line by 1152 lines)

H.263 is mandatory for H.324 and optional for all other H.3xx recommendations. H.263-enabled systems are required to decode both the sub-QCIF (SQCIF) and QCIF resolution modes and encode either the SQCIF or QCIF modes. All other resolution modes are optional.

The Communications Standards

- H.221** Frame Structure 64-1920 Kbps.
- H.223** Multiplexing protocol for low-bit rate multimedia communication.
- H.224** Protocol for simplex use of datachannel in H.221
- H.225** Media Stream Packetization and synchronization on non-guaranteed quality-of H.230: Frame synchronous control and indication signals for audio visual systems.
- H.230** Control and indication for frame sync (MCU/graphics)
- H.231** MCU (Multipoint Control Unit) for digital network up to 2 Mbit/s
- H.233** The ITU-T's data-encryption standard for real-time multimedia, H.233 is supported across a wide range of standard services, including H.320, H.323, and H.324. A related standard is H.234, which specifies how encryption keys are handled. See H.320, H.323, H.324.
- H.234** Encryption key management and authentication system for audiovisual services. Three methods of encryption key management are ISO 8732, Diffie-Hellman, RSA. They are applicable to the encryption of audiovisual signals transmitted digitally using the H.221 frame structure. The management messages defined are transmitted within the encryption control signal (ECS) channel of H.221, whose structure and use is defined in H.233.
- H.242** Protocols for call set up and disconnect for digital network up to 2 Mbit/s. In-band information exchange . Used with H.320 not H.323.
- H.243** MCU call set up (3 or more users) for digital network up to 2 Mbit/s
- H.244** H.221 + Bonding
- H.245** Control of communications between visual telephone systems and terminal equipment on non-guaranteed bandwidth LANs (H323).
- H.281** Far end Camera Control
- H.331** Broadcast mode VideoConferencing. No use of H.242. Receiver must know what Video and Audio algorithm are being used in order for successful connection to be made service LANs.
- BONDING** Frame structure for multiplexing 1 to 30 channels of 56 or 64 kbit/s. Alternative to H.221 (not part of the H.320 standards but the most

commonly used industry standard for multiplexing channels)

Data Collaboration T.120

T.120 is a family of recommendations that define the protocols for data collaboration. The T.120 recommendations are arranged in a layered hierarchy such that each layer leverages the layers above it to define the protocols and services. The following is a list of core recommendations that fall under the T.120 umbrella:

T.121 General template that provides guidance for developing T.120 application protocols

T.122/125 Multipoint Communication Service protocols

T.123 Transport protocol stack

T.124 Generic Conference Control (GCC); the application protocol supporting reservations and basic conference control services for Multipoint teleconferences

T.125 Multi Communication Services (MCS); protocol specification

T.126 Still image and annotation protocol

T.127 Binary file transfer protocol

T.128 Application sharing protocol

T.122 through T.125 define services for any application that uses these protocols; they can be thought of as the "plumbing" that links the user to the data management infrastructure. The important application (peer-to-peer) protocols are T.126, T.127, and T.128. T.126 defines the protocol for sharing images and text, and for whiteboard annotations; T.127 defines the protocol for transferring binary files; and T.128 defines the protocols for sharing applications.

It should be noted that T.120 is "network independent." In other words, T.120 works over IP, ISDN, ATM, or even the analog telephone network. This is in contrast to the videoconferencing recommendations discussed below, which are keyed to a particular network transport.

Standards overview

H.320 and H.323 have their own collection of standards that are defined in the chart below. We have included the other popular communications standards as a comparison.

	H.320	H.321	H.322	H.323 V1/V2	H.324
Approval Date	1990	1995	1995	1996/1998	1996
Network	Narrowband switched digital ISDN	Broadband ISDN ATM LAN	Guaranteed bandwidth packet switched networks	Non-guaranteed bandwidth packet switched networks, (Ethernet)	PSTN or POTS, the analog phone system
Video	H.261 H.263	H.261 H.263	H.261 H.263	H.261 H.263	H.261 H.263
Audio	G.711 G.722 G.722.1 G.728	G.711 G.722 G.728	G.711 G.722 G.728	G.711 G.722 G.728 G.723 G.729	G.723
Multiplexing	H.221	H.221	H.221	H.225.0	H.223
Control	H.230 H.242	H.242	H.242 H.230	H.245	H.245
Multipoint	H.231 H.243	H.231 H.243	H.231 H.243	H.323	
Data	T.120	T.120	T.120	T.120	T.120
Comm. Interface	I.400	AAL I.363 AJMI.361 PHY I.400	I.400 & TCP/IP	TCP/IP	V.34 Modem

Inter-Device Communication

Initially, upon establishing an ISDN (H.320) connection, both communicating devices start to transmit their capability using H242 'sets' whilst at the same time attempting to read and gain sync. with the other device. Until a device has gained sync. it will set its A bit (part of H221) high. The A bit is visible to the other device and when it sees the other device's A bit go low it knows that the other device has achieved sync. with its transmission. Once sync. is achieved both devices start to communicate over H221 using BAS commands.

At the point where synchronised communication is achieved both devices attempt to exchange capability sets using H242. After some arbitration both devices settle on the highest common format taking pre-selected menu options into account.

For H323 calls the H245 Control of communications is used.

NB

TANDBERG equipment has adopted the concept of A and B devices, where the A device is the calling device and the B device is the device being called. In establishing a common capability, as a B device, a TANDBERG device will remain passive awaiting a request from the A device for the common capability to be set. Only if after several seconds, no request is received from the A device, will a TANDBERG device request a common capability setting. Once a common set has been established the second channel (where this is the case) will be connected. The H221 communication remains the same but as capabilities etc. have already been established there is no H242 interaction.

If for some reason sync. is lost in the second channel then both devices will set their A bits high again and attempt to re-establish sync. If after a few seconds sync cannot be achieved the second channel is dropped and re-connection must be requested manually.

During a conversation changes in the communication set-up e.g. changing from CIF to QCIF or G711 to G728 are communicated using H242 and can be driven by either device (return to 2 channels from 1 channel can only be made by the A device). When a request is made on a TANDBERG device to change one or more settings that device changes immediately, requests the other device do the same (H242) and waits for 2 seconds for the other device to comply. If no compliance occurs within 2 seconds the TANDBERG device will revert to its original setting.