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PURPOSE: Discussion

INTERNATIONAL TELECOMMUNICATION UNION

ITU-T DRAFT H.323

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STANDARDIZATION SECTOR
OF ITU

LINE TRANSMISSION OF NON-TELEPHONE SIGNALS

VISUAL TELEPHONE SYSTEMS AND EQUIPMENT FOR LOCAL AREA NETWORKS WHICH PROVIDE A NON-GUARANTEED QUALITY OF SERVICE

DRAFT ITU-T Recommendation H.323

FOREWORD

The ITU Telecommunication Standardization Sector (ITU-T) is a permanent organ of the International Telecommunication Union. The ITU-T is responsible for studying technical, operating and tariff questions and issuing Recommendations on them with a view to standardizing telecommunications on a worldwide basis.

The World Telecommunication Standardization Conference (WTSC), which meets every four years, established the topics for study by the ITU-T Study Groups which, in their turn, produce Recommendations on these topics.

ITU-T Recommendation H.323 was prepared by the ITU-T Study Group 15 (199x-199x) and was approved by the WTSC (Place, Month xx-xx, 199x).

SUMMARY

Recommendation H.323 describes terminals, equipment, and services for multimedia communication over Local Area Networks which do not provide a guaranteed Quality of Service. This LAN may be a single segment or ring, or it logically could be the entire Internet. It should be emphasized that operation of H.323 terminals over the entire Internet, or even several connected LANs may result in poor performance. The possible means by which quality of service might be assured on this LAN, or on the Internet in general is beyond the scope of this recommendation. H.323 terminals and equipment may carry real-time voice, data, and video, or any combination, including videotelephony.

H.323 terminals may be integrated into personal computers or implemented in stand-alone devices such as videotelephones. Support for each media type (voice, data, video) is optional, but if supported, the ability to use a specified common mode of operation is required, so that all terminals supporting that media type can interwork. H.323 allows more than one channel of each type to be in use. Other Recommendations in the H.323 series include the H.22Z multiplex, H.245 control, H.261 and H.263 video codecs, and G.711, G.722, G.728, and G.723 audio codecs.

H.323 makes use of the logical channel signaling procedures of Recommendation H.245, in which the content of each logical channel is described when the channel is opened. Procedures are provided for expression of receiver and transmitter capabilities, so transmissions are limited to what receivers can decode, and so that receivers may request a particular desired mode from transmitters. Since the procedures of H.245 are also planned for use by Recommendation H.310 for ATM networks, and Recommendation H.324 for GSTN, interworking with these systems should be straightforward.

H.323 terminals may be used in multipoint configurations, and may interwork with H.310 terminals on B-ISDN, H.320 terminals on N-ISDN, H.321 terminals on B-ISDN, H.322 terminals on Guaranteed Quality of Service LANs, and H.324 terminals on GSTN and wireless networks.

CONTENTS

{Need to simplify the text by using terminal when referring to terminals and gateways; and being explicit when referring to terminals only or gateways only.}

1 Scope

This Recommendation, H.323, covers the technical requirements for narrow-band visual telephone services defined in H.200/AV.120-Series Recommendations, in those situations where the transmission path includes one or more Local Area Networks (LAN), which may not provide a guaranteed Quality of Service (QoS) equivalent to that of N-ISDN. Examples of this type of LAN are:

-Ethernet (IEEE 802.3)

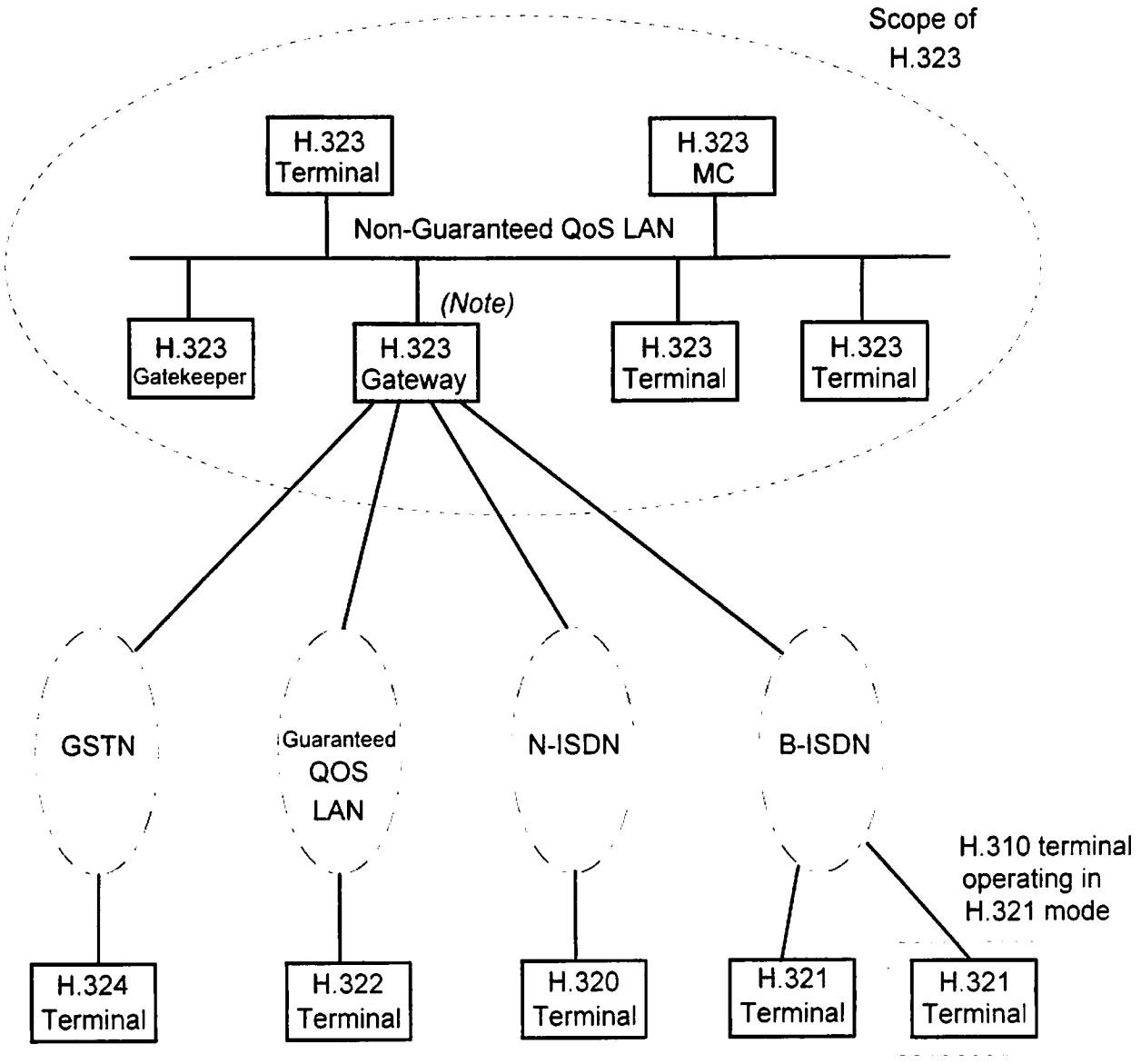
-Fast Ethernet (IEEE 802.10)

-FDDI (non-guaranteed quality of service mode)

-Token Ring (IEEE 802.5)

Recommendation H.322 covers the case of visual telephone services in those situations where the transmission path includes one or more Local Area Networks (LAN), which are configured and managed to provide a guaranteed Quality of Service (QoS) equivalent to that of N-ISDN such that no additional protection or recovery mechanisms beyond those mandated by Rec. H.320 need be provided in the terminals. Pertinent parameters are the data error and loss properties and variation of transit delay. An example of a suitable LAN is: Integrated Services (IS) LAN: IEEE 802.9 Isochronous services with Carrier Sense Multiple Access with Collision Detection (CSMA/CD) Media access control (MAC) service.

H.323 terminals may be used in multipoint configurations, and may interwork with H.310 terminals on B-ISDN, H.320 terminals on N-ISDN, H.321 terminals on B-ISDN, H.322 terminals on Guaranteed Quality of Service LANs, and H.324 terminals on GSTN and wireless networks. See Figure 1/H.323.



ote. A gateway may support only the GSTN, GQOS-LAN, N-ISDN or B-ISDN connection.

Figure 1/H.323

Interoperability of H.323 Terminals

1.1 H.323 Components

This Recommendation describes the components of an H.323 system. This includes terminals Gateway Units, Gatekeepers, and Multipoint Controllers. Control messages and procedures within this Recommendation define how these components communicate. Detailed descriptions of these components are contained in Section 5

1.1.1 Terminals

An H.323 Terminal is an endpoint on the local area network which provides for real-time, two-way communications with another H.323 terminal, Gateway Unit, or Multipoint Control Unit. This communications consists of control, indications, audio, moving color video pictures, and/or data between the two terminals.

1.1.2 Gateway Unit

An H.323 Gateway Unit (GW) is an endpoint on the local area network which provides for real-time, two-way communications between H.323 Terminals on the LAN and other ITU Terminals on a wide area network. Other ITU Terminals include those complying with Recommendations H.310 (ATM), H.320 (ISDN), H.321 (ATM), H.322 (GQOS-LAN), H.324 (GSTN), and H.324M (Mobile). The Gateway Unit has the characteristics of an H.323 Terminal on the LAN, and of the ITU terminal on the WAN. The Gateway Unit provides the necessary conversion between the different terminal types.

1.1.3 Multipoint Controller

The Multipoint Controller (MC) is an endpoint on the local area network which provides for the control of three or more terminals participating in a multipoint conference. The MC provides for capability negotiation with all terminals to achieve common levels of communications. It also may control conference resources such as who is multicasting video. The MC does not necessarily provide for mixing or switching of audio, video and data.

1.1.4 Gatekeeper

The Gatekeeper (GK) is a centralized conference manager that controls access to the local area network for H.323 terminals, Gateway Units, and Multipoint Controllers. The gatekeeper may also provides services to the terminals, gateway units, and multipoint controllers for providing address translation, and for locating gateway units and multipoint controllers.

1.2 Topology

The following logical topology elements are defined in order to explain the scope and intercommunications of H.323 components.

1.2.1 Sub-Domain

A Sub-Domain is the collection of all terminals, Gateway Units, and Multipoint Controllers managed by a single Gatekeeper. A Sub-Domain may or may not include a Gateway Unit. A Sub-Domain has one and only one Gatekeeper. Multiple LAN segments may be connected using routers or other devices. See figure 2/H.323.

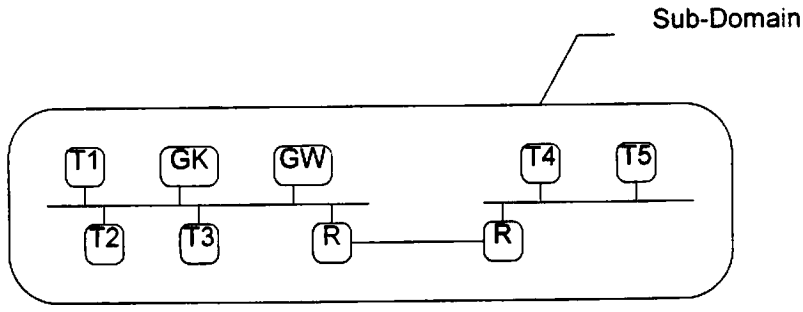


Figure 2/H.323 Sub-Domain

1.2.2 Domain

A Domain is the collection of all Sub-Domains having access to a Gateway Unit. A Domain may contain several Gatekeepers. These Gatekeepers cooperate to control access to the LAN and the Gateway. Sub-Domains within a Domain may be interconnected by Routers or other devices. A Domain having only one gatekeeper is also a Sub-domain. See Figure 3/H.323.

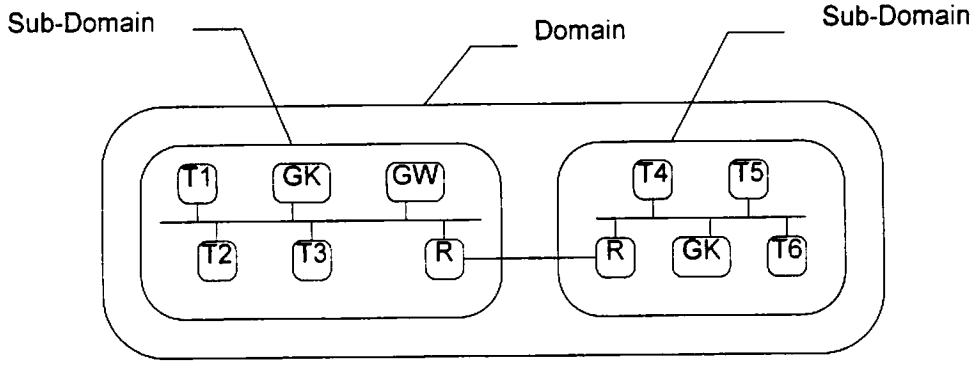


Figure 3/H.323 Domain

1.2.3 Super-Domain

A Super-Domain is the collection of all Domains and Sub-Domains across which a call can be made without using a Gateway Unit. Multiple Domains may exist within a Super-Domain. A Super-Domain having only one Gateway Unit is also a Domain.

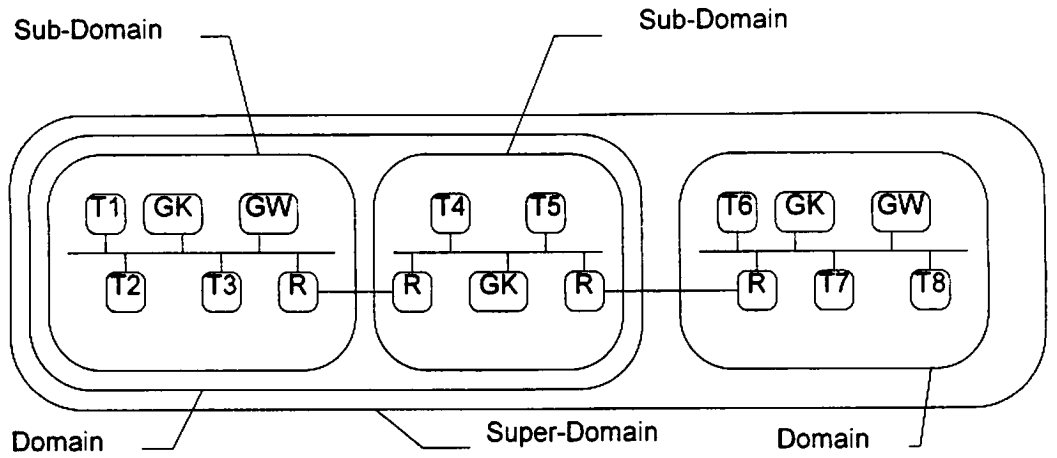


Figure 4/H.323 Super-Domain

2 Normative references

The following ITU-T Recommendations and other references contain provisions which, through reference in this text, constitute provisions of this Recommendation. At the time of publication, the editions indicated were valid. All Recommendations and other references are subject to revision; all users of this Recommendation are therefore encouraged to investigate the possibility of applying the most recent edition of the Recommendations and other references listed below. A list of the currently valid ITU-T Recommendations is regularly published.

[[need to review this list, update reference numbers]]

[1] ITU-T Recommendation H.22Z (199X): "Multiplexing protocol Visual Telephone Systems and Terminal Equipment on Non-Guaranteed Bandwidth LANs".

[2] ITU-T Recommendation H.245 (199X): "Control of communications between Visual Telephone Systems and Terminal Equipment on Non-Guaranteed Bandwidth LANs ".

[3] ITU-T Recommendation G.711 (1988): "Pulse Code Modulation (PCM) of Voice Frequencies".

[4] ITU-T Recommendation G.722 (1988): "7 kHz Audio-coding within 64 kbit/s".

[5] ITU-T Recommendation G.723 (1995): "Dual Rate Speech coder for multimedia telecommunications transmitting at 6.4 and 5.3 kbit/s".

[6] ITU-T Recommendation G.728 (1992): "Speech Coding at 16 kbit/s".

[7] ITU-T Recommendation G.xxx (1995): [[reserved for low complexity algorithm]] "Speech coder for multimedia telecommunications transmitting at *** kbit/s".

[8] ITU-T Recommendation H.261 (1993): "Video CODEC for audiovisual services at p X 64 kbit/s"

[9] ITU-T Recommendation H.263 (1993): "Video CODEC for narrow telecommunications channels at < 64 kbit/s"

[10] ITU-T Recommendation T.120 (1994): "Transmission protocols for multimedia data"

[11] ITU-T Recommendation H.320 (1993): "Narrow-band ISDN visual telephone systems and terminal equipment".

[12] Draft ITU-T T.84 | ISO/IEC 10918-3 (1996): "Digital Compression and Coding of Continuous Tone Still Images - Extensions"

[13] ITU-T Recommendation T.434 (1992): "Binary File Transfer Format for the Telematic Services"

3 Definitions

For the purposes of this Recommendation the definitions given in Clause 3 of both H.22Z [1] and H.245 [2] apply along with the following.

[[need to review this list]]

Audio mute: muting the loudspeaker of a terminal.

Basic Videophone: A videophone containing mandatory features and conforming to performance parameters contained in the Recommendation.

Channel: a unidirectional link between two users.

Connection: a bi-directional link between two users.

Control and Indication (C&I): end-to-end signaling between terminals, consisting of Control, which causes a state change in the receiver, and Indication which provides for information as to the state or functioning of the system (see also H.245 [2] for additional information and abbreviations).

Data: refer to information signals other than audio/speech and video, carried in the logical data channel (see H.22Z [1]).

Enhanced Videophone: A videophone containing enhanced operational features and conforming with performance parameters defined as "optional" in the Recommendation.

Fall-back: A procedure initiated by either the videophone or the network that reduces the bitrate of the voice band connection.

In-band Signaling: Signaling between videophone units that supports user control functions, monitoring functions, user alerts or advisory information about the status of the videophone units or the network connection.

In-band signaling: signaling via Control Channel (see H.245 [2]).

Lip synchronization: operation to provide the feeling that speaking motion of the displayed person is synchronized with his speech.

Man-machine interface: interface between human user and terminal/system, consisting of a physical section (electro-acoustic, electro-optic transducer, keys, etc.) and a logical section dealing with functional operation states.

Out-of-band Signaling: Signaling between the videophone and the network supporting call setup and cleardown.

Videophone System: Two or more videophone units capable of interoperating with the LAN, and each other.

Videophone Unit: A unit of terminal equipment capable of sending and receiving speech and moving picture information simultaneously. Alternatively, a videophone equivalent may be implemented on a general purpose micro-computer equipped with application specific hardware and software capable of performing the functions of a videophone.

4 Symbols and abbreviations

For the purposes of this Recommendation ~~Recommendation~~ ~~Recommendation~~ ~~Recommendation~~ ~~Recommendation~~ ~~Recommendation~~ ~~Recommendation~~, the following symbols and abbreviations apply.

[[need to review this list]]

ACE	Audio Command Equalize
AIA	Audio Indicate Active
AIM	Audio Indicate Mute
ANS	Answer Tone
B-ISDN	Broadband - Integrated Services Digital Network
CI	Call Indication Signal
C&I	Control and Indication
CIF	Common Intermediate Format
CR	Capabilities Request
DCE	Data Communication Equipment
DEMUX	Demultiplex
DTE	Data Terminal Equipment
GW	Gateway Unit
GK	Gatekeeper
GSTN	General Switched Telephone Network
ISDN	Integrated Services Digital Network
ITU-T	International Telecommunications - Telecommunications Standardization Sector
IWA	InterWorking Adaptor
LCA	Loopback Command Audio
LCD	Loopback Command Digital
LCO	Loopback Command OFF
LCV	Loopback Command Video
MCC	Multipoint Command Conference
MCU	Multipoint Control Unit
MIS	Multipoint Indicate Secondary-status
MIZ	Multipoint Indicate Zero-communication
MR	Mode Request
MSB	Most Significant Bit
N-ISDN	Narrow Band-Integrated Services Digital Network

RTP	Real Time Protocol
RTCP	Real Time Control Protocol
QCIF	Quarter CIF
SQCIF	Sub QCIF
*SPIFF	Still Picture Interchange File Format (ITU-T T.83)
TEA	Terminal Equipment Alarm
VCF	Video Command Freeze
VCU	Video Command Update
VIA	Video Indicate Active
VIR	Video Indicate Ready-to-activate
VIS	Video Indicate Suppressed

[[Delete items marked with *.]]

5 System description

This Recommendation describes the elements of the H.323 components. These are Terminals, Gateway Units, Gatekeepers, and Multipoint Controllers. These components communicate through the transmission of Information Streams. The characteristics of these components are described in this section.

5.1 Information Streams

Visual telephone components communicate through the transmission of Information Streams. These Information Streams are classified into video, audio, data, and control as follows:

Audio signals are isochronous~~ and may be delayed to maintain synchronization with the video signals~~. In order to reduce the average bitrate of audio signals, voice activation may be provided.

Video signals are also isochronous. {Comment Only: Bitrate will change depending on the congestion in the network}~~Video is transmitted at a fixed bitrate selected as a result of the capability exchange.~~

Data signals include still pictures, facsimile, documents, computer files, and other data streams.

Control signals pass control data between remote like functional elements.

The information streams described above are packetized and sent onto ~~formatted into PDUs and multiplexed into~~ the output data stream as described in H.22Z.

5.2 Terminal Characteristics

An example of an H.323 terminal is shown in Figure 5/H.323. The diagram shows the user equipment interfaces, video coder, audio coder, telematic equipment, packetizer/depacketizer~~mux/demux~~, system control functions, and the interface to the LAN. All H.323 terminals shall have a System Control Unit, Packetizer/Depacketizer Unit, and a Network Interface Unit.~~,~~ The~~and an~~ Audio Codec Unit~~. The~~ Video Codec Unit and User Data Applications are optional.

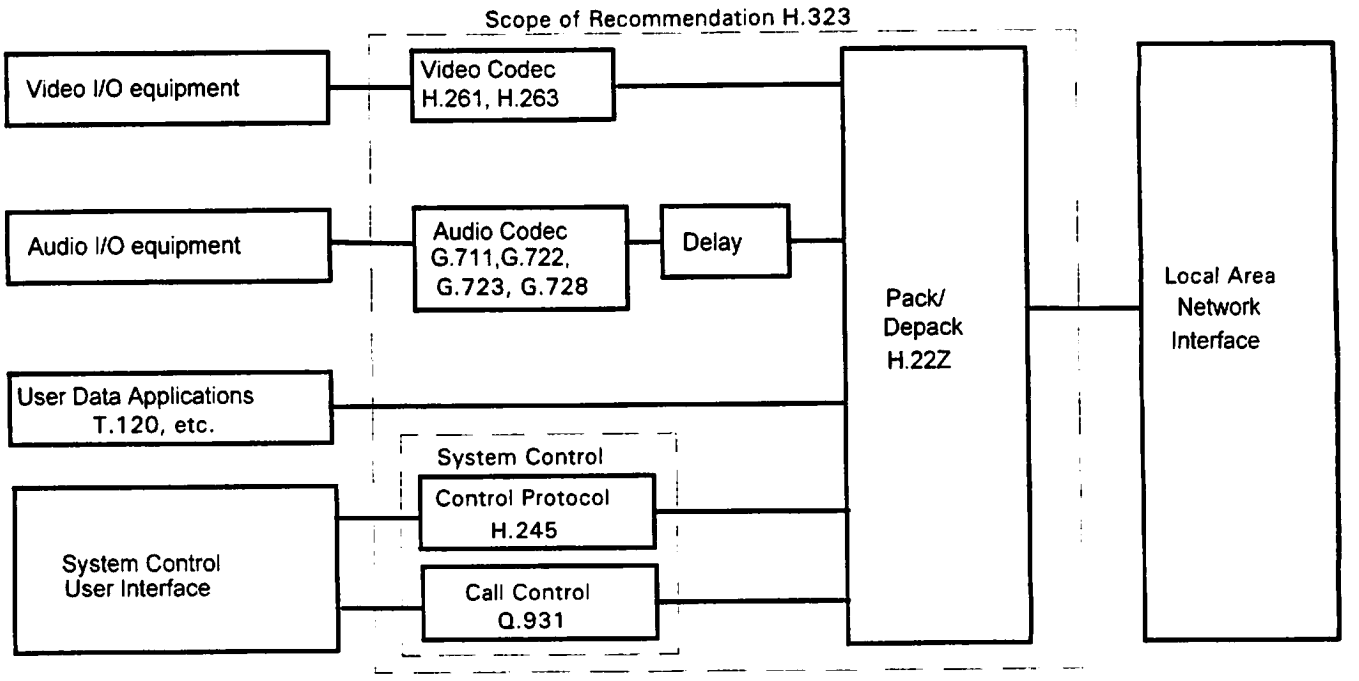


Figure 5/H.323
Rec. H.323 Terminal equipment

{Comments on Figure 5: The Delay Unit is not needed because the audio and video streams are packetized by the audio and the video applications respectively and put onto the network separately.

There should be more than one line between the Pack/Depack block and the Local Area Network Interface block to show that audio, video, data, and control packets are not being multiplexed.}

5.2.1 Terminal elements outside the scope of H.323

The following elements are not within the scope of H.323, and are therefore not defined within this Recommendation:

- Attached audio devices providing, voice activation sensing, microphone and loudspeaker, telephone instrument or equivalent, multiple microphones mixers, and acoustic echo cancellation.
- Attached video equipment providing cameras and monitors, and their control and selection, video processing to improve compression or provide split screen functions.
- Data applications and associated user interfaces which use T.120 or other data services over the data channel.
- Attached Network Interface, which provides the interface to the LAN, supporting appropriate signaling, and voltage levels, in accordance with national standards.
- Human user system control, user interface and operation.

5.2.2 Terminal elements within the scope of H.323

The following elements are within the scope of H.323, and are therefore subject to standardization and are defined within this Recommendation:

- The Video Codec (H.261, etc.) encodes the video from the video source (ie. camera) for transmission and decodes the received video code which is output to a video display. The received video samples are enqueued so that they are played back at the appropriate time in the sequence of audio samples. ~~The codec carries out redundancy reduction coding and decoding for video signals.~~

- The Speech Codec (G.711, etc.) encodes the speech signal from the microphone for transmission, and decodes the received speech code which is output to the loudspeaker. The audio is played back at its natural frequency and the video is synchronized with the audio. ~~Optional delay may compensate for the video delay, so as to maintain speech and video synchronization.~~

- The Data Channel supports telematic applications such as electronic whiteboards, still image transfer, file exchange, database access, audiographics conferencing, etc. Standardized data applications include T.120 for real-time audiographics conferencing, T.84 simple point-point still image file transfer, T.434 simple point-point file transfer, and transport of user data using buffered V.14 or LAPM/V.42. Other applications and protocols may also be used via H.245 negotiation.

- The System Control Unit (H.245, Q.931) provides signaling for proper operation of the H.323 terminal. It provides for call control, capability exchange, signaling of commands and indications, and messages to open and fully describe the content of logical channels.

- The Packetizer/Depacketizer (H.22Z) formats the transmitted video, audio, data and control streams into PDUs for output to the network interface, and retrieves the received video, audio, data, and control streams from PDUs which have been input from the network interface. In addition, it performs logical framing, sequence numbering, error detection, and error correction by means of retransmission, as appropriate to each media type.

5.2.3 Network Interface

The network interface is implementation specific and is out side the scope of this recommendation. However, the network interface shall provide the services described in Recommendation H.22Z. This includes the following: Duplex reliable end-to-end service is mandatory for the Control Channel and the Data Channel. Duplex, simplex, or multicast unreliable end-to end service may be used for the audio and video channels depending on the application.

5.2.4 Video Coding

The video coder is optional. All H.323 terminals providing video communications shall be capable of encoding and decoding video according to H.261 QCIF. Optionally, a terminal may also be capable of encoding and decoding video according H.261 CIF or H.263 SQCIF, QCIF, CIF, 4CIF, and 16CIF. The H.261 and H.263 codecs shall be used without BCH error correction and without error correction framing.

CIF and QCIF are defined in H.261. For the H.263 algorithm, SQCIF, 4CIF and 16CIF are defined in H.263. For the H.261 algorithm, SQCIF is any active picture size less than QCIF, filled out by a black border, and coded in the QCIF format. For all these formats, the pixel aspect ratio is the same as that of the CIF format. NOTE - The resulting picture aspect ratio for H.263 SQCIF is different from the other formats.

The video bitrate, picture format and algorithm options that can be accepted by the decoder are defined during the capability exchange using H.245. The encoder is free to transmit anything that is in line with the decoder capability. The decoder should have the possibility to generate requests for a

certain mode, but the encoder is allowed to simply ignore these requests if they are not required modes. Decoders which indicate capability for a particular algorithm option shall also be capable of accepting video bitstreams which do not make use of that option.

H.323 terminals shall be capable of operating in asymetric video bitrates, frame rates, and picture resolutions. This will allow for transmission of QCIF while receiving CIF pictures.

When each video logical channel is opened, the maximum operating mode to be used on that channel is signaled to the receiver. The picture header within the video bitstream indicates which mode is actually used for each picture, within the stated maximum. Receivers may signal, via H.245, a preference for a certain mode.

NOTE - The maximum mode signaled includes maximum picture format, algorithm options, etc. For example, a video logical channel opened for CIF format may transmit CIF, QCIF, or SQCIF pictures, but not 4CIF or 16CIF. A video logical channel opened with only the **unrestrictedVector** and **arithmeticCoding** options may use neither, either, or both options, but shall not use options which were not signaled.

Other video codecs, and other picture formats, may also be used via H.245 negotiation. More than one video channel may be transmitted, as negotiated via the H.245 control channel.

5.2.4.1 Continuous Presence

H.323 terminals may receive more than one video channel, particularly for multipoint conferencing. In these cases, the H.323 terminal may need to perform a video mixing or switching function in order to present the video signal to the user.

5.2.5 Audio Coding

~~All H.323 terminals shall have an audio coder.~~ All H.323 terminals shall be capable of encoding and decoding speech according to Recommendation G.711. Terminals intended for interregional operation should be capable of transmitting and receiving A-law and μ-law. A terminal may optionally be capable of encoding and decoding speech using Recommendations G.722, G.728, and G.723. When available, G.DSVD will be an option. The audio algorithm used by the encoder shall be defined during the capability exchange using H.245.

5.2.5.1 Delay compensation

The video codecs require some processing delay, while the speech codec involves much less delay. Lip synchronization shall not be mandatory, but if it is to be maintained, the received video samples are enqueued so that they are played back at the appropriate time in the sequence of audio samples.~~additional delay must be added in the speech path to compensate.~~

An H.323 terminal shall not add delay for this purpose in its transmitting speech path. Instead, since video and speech coder delays may vary according to implementation, H.323 terminals shall signal, via indications in the H.245 control channel, the average skew by which their transmitted video signal trails the speech signal.

Intermediate processing points such as MCUs or Gateway Units may alter the video/speech skew, and shall transmit appropriately modified video/speech skew indications, reflecting their transmitted signals. ~~Video signals shall not precede speech signals; if necessary, video path delay shall be added to prevent this.~~

Receiving terminals may optionally use this information to add appropriate delay in the speech path to achieve lip synchronization.

5.2.5.2 Audio Mixing

H.323 terminals may receive more than one audio channel, particularly for multipoint conferencing. In these cases, the H.323 terminal may need to perform an audio mixing function in order to present a composite audio signal to the user.

5.2.6 Data Channel

The data channel is optional. If available, the data channel shall be capable of supporting standardized data applications such as Multipoint Audiographic Teleconferencing, as defined in the T.120 series of Recommendations. Other data channel services may also be used.

5.2.7 Control channel

The control channel carries end-to-end control messages governing operation of the H.323 system, including capabilities exchange, opening and closing of logical channels, mode preference requests, ~~multiplex table entry transmission,~~ flow control messages, and general commands and indications.

In point-to-point conferences, the control channel and H.245 signalling is established between the terminals or between the terminal and Gateway Unit. In multipoint conferences, the control channel and H.245 signalling is established between the terminal or Gateway Unit and the MC.

There shall be exactly one control channel in each direction within H.323, which shall use the messages and procedures of Recommendation H.245. The control channel shall be carried on logical channel 0. The control channel shall be considered to be permanently open from the establishment of digital communication until the termination of digital communication; the normal procedures for opening and closing logical channels shall not apply to the control channel.

General commands and indications shall be chosen from the message set contained in H.245. In addition other command and indication signals may be sent which have been specifically defined to be transferred in-band within video, audio or data streams (see the appropriate Recommendation to determine if such signals have been defined).

H.245 messages fall into four categories: Request, Response, Command, and Indication. Request messages require a specific action by the receiver, including an immediate response. Response messages respond to a corresponding request. Command messages require a specific action, but do not require a response. Indication messages are informative only, and do not require any action or response. H.323 terminals shall respond to all H.245 commands and requests as specified in H.245 ~~except for the ones mentioned here, and shall transmit accurate indications reflecting the state of the terminal~~. The request PDUs that will not be implemented include masterSlaveDetermination, openBiDirectionalChannelRequest, openBiDirectionalChannelRelease, multiplexEntrySend, multiplexEntrySendRelease, requestMultiplexEntry. The response PDUs that will not be implemented include masterSlaveDeterminationAck, masterSlaveDeterminationReject, openBiDirectionalChannelAck, openBiDirectionalChannelReject, multiplexEntrySendAck, multiplexEntrySendReject, requestMultiplexEntryResponse. The indication PDU that will not be implemented include jitterIndication because it is provided by RTCP.

NOTE - All control channel messages are sent over a link layer protocol which acknowledges correct receipt. This acknowledgment is distinct from the response messages, which convey content beyond that of correct receipt of the message.

H.323 terminals shall be capable of parsing all H.245 **MultimediaSystemControlPDU** messages, and shall send and receive all messages needed to implement required functions and those optional functions which are supported by the terminal. All messages and procedures of Recommendation H.245 are required, except for those explicitly described in this document and those defined as optional in H.245, or which are related to defined optional capabilities the terminal does not support. H.323 terminals shall send the **FunctionNotSupported** message in response to unrecognized request, response, or command messages

A control channel indication, **UserInputIndication**, is available for transport of user input alphanumeric characters from a keypad or keyboard, equivalent to the DTMF signals used in analog telephony. This may be used to manually operate remote equipment such as voice mail or video mail systems, menu-driven information services, etc. H.323 terminals shall support the transmission of user input characters 0-9, '*', and '#'. Transmission of other characters is optional.

NOTE - If the encryption procedures of this Recommendation are in use, the control channel will not be encrypted. Users are therefore cautioned regarding the carriage of user data in the control channel, the use of non-standard messages, and the confidentiality risk from traffic analysis of the control channel.

5.2.7.1 Capabilities exchange

Capabilities exchange shall follow the procedures of H.245, which provides for separate receive and transmit capabilities, as well as a system by which the terminal may describe its ability to operate in various combinations of modes simultaneously.

Receive capabilities describe the terminal's ability to receive and process incoming information streams. Transmitters shall limit the content of their transmitted information to that which the receiver has indicated it is capable of receiving. The absence of a receive capability indicates that the terminal cannot receive (is a transmitter only).

Transmit capabilities describe the terminal's ability to transmit information streams. Transmit capabilities serve to offer receivers a choice of possible modes of operation, so that the receiver may request the mode which it prefers to receive. The absence of a transmit capability indicates that the terminal is not offering a choice of preferred modes to the receiver (but it may still transmit anything within the capability of the receiver).

The transmitting terminal assigns each individual mode the terminal is capable of operating in a number in a **capabilityTable**. For example, G.723 audio, G.728 audio, and CIF H.263 video would each be assigned separate numbers.

These capability numbers are grouped into **AlternativeCapabilitySet** structures. Each **AlternativeCapabilitySet** indicates that the terminal is capable of operating in exactly one mode listed in the set. For example, an **AlternativeCapabilitySet** listing {G.711, G.723, G.728} means that the terminal can operate in any one of those audio modes, but not more than one.

These **AlternativeCapabilitySet** structures are grouped into **simultaneousCapabilities** structures. Each **simultaneousCapabilities** structure indicates a set of modes the terminal is capable of using simultaneously. For example, a **simultaneousCapabilities** structure containing the two **AlternativeCapabilitySet** structures {H.261, H.263} and {G.711, G.723, G.728} means that the terminal can operate either of the video codecs simultaneously with any one of the audio codecs. The **simultaneousCapabilities** set { {H.261}, {H.261, H.263}, {G.711, G.723, G.728} } means the terminal can operate two video channels and one audio channel simultaneously: One video channel per H.261,

another video channel per either H.261 or H.263, and one audio channel per either G.711, G.723, or G.728.

NOTE - The actual capabilities stored in the **capabilityTable** are often more complex than presented here. For example, each H.263 capability indicates details including ability to support various picture formats at given minimum picture intervals, and ability to use optional coding modes. For a complete description, see Recommendation H.245.

The terminal's total capabilities are described by a set of **CapabilityDescriptor** structures, each of which is a single **simultaneousCapabilities** structure and a **capabilityDescriptorNumber**. By sending more than one **CapabilityDescriptor**, the terminal may signal dependencies between operating modes by describing different sets of modes which it can simultaneously use. For example, a terminal issuing two **CapabilityDescriptor** structures, one ((H.261, H.263), (G.711, G.723, G.728)) as in the previous example, and the other ((H.262), (G.711)), means the terminal can also operate the H.262 video codec, but only with the low-complexity G.711 audio codec.

Terminals may dynamically add capabilities during a communication session by issuing additional **CapabilityDescriptor** structures, or remove capabilities by sending revised **CapabilityDescriptor** structures. {Comment only: A transmit-only terminal with an absence of capability will not be able to meet the restriction that it shall transmit at least one CapabilityDescriptor structure.}~~All H.323 terminals shall transmit at least one **CapabilityDescriptor** structure~~.

Non-standard capabilities and control messages may be issued using the **NonStandardParameter** structure defined in H.245. Note that while the meaning of non-standard messages is defined by individual organizations, equipment built by any manufacturer may signal any non-standard message, if the meaning is known.

Terminals may reissue capability sets at any time, according to the procedures of H.245.

5.2.7.2 Logical channel signaling

Each logical channel carries information from a transmitter to a receiver, and is identified by a logical channel number unique for each direction of transmission.

Logical channels are opened and closed using the **OpenLogicalChannel** and **CloseLogicalChannel** messages and procedures of H.245. When a logical channel is opened, the **OpenLogicalChannel** message fully describes the content of the logical channel, including media type, algorithm in use, H.22Z adaptation layer and any options, and all other information needed for the receiver to interpret the content of the logical channel. Logical channels may be closed when no longer needed. Open logical channels may be inactive, if the information source has nothing to send.

Logical channels in H.323 are unidirectional, so asymmetrical operation, in which the number and type of information streams is different in each direction of transmission, is allowed. However, if a receiver is capable only of certain symmetrical modes of operation, it may send a receive capability set that reflects its limitations. Terminals may also be capable of using a particular mode in only one direction of transmission.

{Comment only: All physical channels are inherently bidirectional}~~Certain media types, including data protocols such as T.120, inherently require a bi-directional channel for their operation. In such cases a pair of unidirectional logical channels, one in each direction, may be opened and associated together to form a bi-directional channel using the bi-directional channel opening procedures of the H.245 **OpenBiDirectionalChannelRequest** and **OpenLogicalChannel** messages. Such pairs of associated channels~~

need not share the same logical channel number, since logical channel numbers are independent in each direction of transmission.

5.2.7.3 Mode preferences

Receivers may request transmitters to send a particular mode using the H.245 **RequestMode** message, which describes the desired mode. Transmitters should comply if possible.

5.2.8 Packetizer/Depackerizer

Logical channels of video, audio, data or control information may be transmitted, established according to the procedures of Recommendation H.245. Logical channels are unidirectional, and are independent in each direction of transmission. Any number of logical channels of each media type may be transmitted, except for the H.245 control channel of which there shall be one. The PDUs used to transmit these logical channels shall conform to Recommendation H.22Z.

H.22Z specifies the format of the logical channel PDUs. Each information stream has a different PDU format which handles error control and sequence numbering, as appropriate to the information stream.

H.323 terminals shall signal their H.22Z capabilities via the H.245 **H22ZCapability** message.

5.2.8.1 Logical channel numbers

Each logical channel is identified by a logical channel number (LCN), in the range 0 to 65535, which serves only to associate logical channels with the transport connectioncorresponding entries in the H.22Z multiplex table. Logical channel numbers are selected arbitrarily by the transmitter, except that logical channel 0 shall be permanently assigned to the H.245 control channel.

5.2.8.3 Flow control

H.323 terminals shall respond to the **FlowControlCommand** message of H.245, which commands a limit to the overall bit rate of aone or more logical channels, or the entire multiplex.

When one or more logical channels are limited by the **FlowControlCommand**, other less restricted logical channels may increase their transmission rate. The limit applies to the content of the logical channel at the input to the H.22Z layer, before the PDU header is applied.

When all the logical channels arethe entire H.22Z multiplex is limited by the **FlowControlCommands**, or when the terminal has no information to send, the terminal shall send no information. Fill data is not to be sent. The limit applies on a per logical channel basisto the sum of the contents of all logical channels at the input to the H.22Z layer, before the PDU header isa applied.

{Comment only: H.22z will not receive data from the lower layers with errors}5.2.8.4 Error control {needs review}

Error control for each logical channel is handled separately by the H.22Z layer, which may use a variety of error control techniques, including but not limited to error detection and retransmission.

5.3 Gateway Unit Characteristics

The Gateway Unit provides the appropriate translation between multiplex formats (for example audio RTP and video RTP H.22Z to/from H.221) and between communications procedures (for example H.245 to/from H.242). The Gateway Unit must also perform call setup and clearing an both the LAN side and the WAN side. Translation between video, audio, and data formats may also be performed in

the Gateway Unit. An H.323 terminal communicates with another H.323 terminal on the same LAN directly and without involving the Gateway. The Gateway may be omitted if communication with external terminals (terminals not on the LAN) is not required.

An example of an H.323 Gateway Unit is shown in Figure 5.3/H.323. The diagram shows the H.323 terminal function, the WAN terminal function, and the conversion function. The H.323 terminal function has the characteristics described in 5.1. The Gateway Unit appears to the other H.323 teminals on the LAN as one or more H.323 terminals. It communicates with the other H.323 terminals using the procedures in this Recommendation. The WAN terminal function has the characteristics described in the appropriate Recommendation (H.310, H.320, H.321, H,322, H,324). The Gateway Unit appears to the terminals on the WAN as one or more of the same terminal types. It communicates to another terminal on the WAN using the procedures described in the appropriate Recommendation for that terminal. The conversion function provides the necessary conversion of ~~multiplex,~~ control, audio, video, and/or data streams between the different terminal recommendations.

At a minimum, the Gateway Unit shall provide a conversion function for the ~~multiplex (~~packets~~)~~, and the control signals and procedures.

This recommendation describes the connection of one H.323 terminal on the LAN to one WAN terminal on the WAN through the Gateway Unit. The actual number of H.323 terminals that can communicate through the Gateway Unit is a logical extension of this connection and is not subject to standardization. Similarly, the number of WAN connections, number of simultaneous independent conferences, audio/video/data conversion functions, and inclusion of multipoint functions is also outside the scope of this Recommendation.

The Gateway Unit may be connected via N-ISDN or B-ISDN to other Gateway Units to provide H.320 communication between H.323 terminals which are not on the same LAN.

Equipment which provides transparent interconnection between LANs without using H.320 (such as routers and remote dial in units) are not Gateway Units and are not within the scope of this Recommendation. These transparent LAN interconnection devices should allow H.323 to H.323 terminal communications, provided that they provide sufficient quality of service (ie. bandwidth, delay).

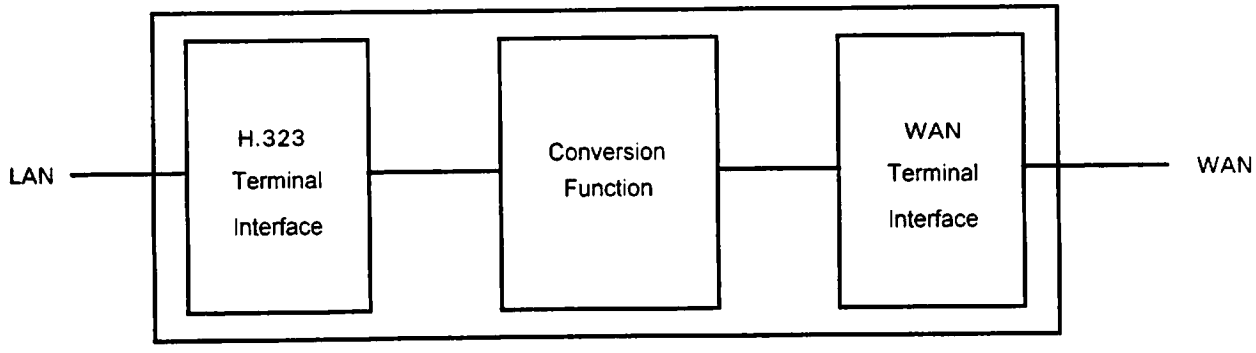


Figure 3/H.323
Rec. H.323 Gateway Unit

5.4 Gatekeeper Characteristics

The Gatekeeper, which is optional in an H.323 system, provides call control services to the H.323 terminals and Gateway Units. The Gatekeeper provides the following services:

- Call Authorization - Authorizing a terminals access to the LAN. Through the use of the H22z PDU ~~Q.931~~ signaling, the Gatekeeper may reject calls from a terminal due to authorization failure. The reasons for rejection may include, but are not limited to, restricted access to/from particular terminals or Gateway units, and restricted access during certain periods of time. The criteria for determining if authorization failed is outside the scope of this Recommendation.

- Bandwidth Management - Control of the number of H.323 terminals permitted simultaneous access to the LAN. Through the use of the H22z PDU ~~Q.931~~ signaling, the Gatekeeper may reject calls from a terminal due to bandwidth limitations. This may occur if the Gatekeeper determines that there is not sufficient bandwidth available on the network to support the call. The criteria for determining if bandwidth is available is outside the scope of this Recommendation.

- Connection Management - The Gatekeeper may need to maintain a list of active connections between terminals, Gateways, and Gatekeepers. This information may be necessary to indicate that a called user is busy. ~~*{Is this also necessary for allocating dynamic sockets?}*~~

- Conference Management - The Gatekeeper may need to maintain a list of ongoing conferences. This information may be necessary to allow access to ongoing conferences. ***{This may be handled by the Multipoint Controller function also.}***.

- Termination of ~~Q.931~~ signaling - The Gatekeeper may terminate~~s~~ the ~~Q.931~~ signaling from the terminals and Gateway units~~, acting as the *network* as defined in Q.931~~. The Gatekeeper is responsible for completing the call setup procedure between terminals or terminals and Gateway units if present on the network.

- LAN Address Translation - The Gatekeeper or the Gateway may performs E.164 to LAN address translation. ***{Static mandatory, dynamic optional.}***

- Network management information data structure.

- Multicast address allocation. This can be handled by the MC also.

The Gatekeeper is logically separate from the terminal and the Gateway, however, its physical implementation may coexist with a terminal, gateway, server, or other network entity. The Gatekeeper may be a single entity or may be multiple entities that cooperate to provide the gatekeeper services.

5.5 Multipoint Controller (MC) Characteristics

The MC provides control functions to support conferences between three or more terminals (multipoint conferences). The MC is functionally a separate entity, however, it may be combined with the functions of the Gateway Unit or the Gatekeeper.

An H.323 terminal wishing to participate in a multipoint conference, opens its Control Channel with the MC. Audio and video channels may be multicast if the terminals have decentralized multipoint capability, or they may be opened to the MC if the MC is providing centralized multipoint capability.

The MC shall comply with Recommendations H.231 and H.243 as tailored in this section. ***{Does H.245 contain the multipoint control and indication signals from 231 and 243?}*** ***{Comment only: It should contain the relevant control and indication signals from 231 and 243}***

The MC shall coordinate a common communications mode between the terminals in the multipoint conference.

5.5.1 Centralized Multipoint Capability

If the terminals and MC have centralized multipoint capability, the terminals communicate with the MC in a point-to-point manner on all information channels. The MC operates like the traditional H.231/243 MCU. In this mode, the MC performs:

- H.231/243 multipoint control functions ~~*{should we only use t.AVC for multipoint control?}*~~
- Video switching or mixing
- Audio mixing
- T.120 multipoint data distribution

The MC transmits the resulting video, audio, and data streams back to the terminals.

5.5.2 Decentralized Multipoint Capability

If the terminals and MC have decentralized multipoint capability, ***{how is this signalled?}*** the terminals communicate with the MC in a point-to-point mode on the control channel and data channels only. The MC may not receive the audio and video packets. If the MC receives the audio packets, it could ~~The MC~~ directs a selected terminal or terminals to multicast its(their) video channel to the other terminals in the conference. All terminals in the conference multicast their audio channels.

The terminals receive multicast video channels and select one or more of the available channels for display to the user. The terminals receive the multicast audio channels and perform an audio mixing function in order to present a composit audio signal to the user.

The MC shall provide conference control functions such as chair control, video broadcast and video selection. This is done by receiving H.231 or T.120 commands from a terminal and then sending the appropriate control to other terminals to enable or disable their video multicast.

The MC may optionally provide a mixed audio stream, particularly if there are a large number of terminals participating in a conference.

5.5.3 Operation

The MC gives the terminals the communication mode of the conference through the ConferenceModelCommand {this command in AVC-825 should be added to H.245}. Through ConferenceModelCommand, the MC distributes multicast address information to all the terminals involved. The terminal can request for the communication mode through the ~~request~~ConferenceModelRequest {this command should be added to H.245} and the MC responds with ~~request~~ConferenceModelResponse~~Aek~~ {this command AVC-825 should be added to H.245}.

In a predetermined centralized or decentralized conference, the MC can send the ConferenceModelCommand anytime to announce the communication mode of the conference. However, if the communication mode for the conference is unknown the terminals present this capability in the TerminalCapabilitySet {this request PDU should be extended as shown in AVC-825}. The MC then switches the communication mode of the conference based on the capabilities of the terminals involved.

A point-to-point conference can grow to multipoint by picking the MC. If more than one entity is capable of being an MC, the mcDetermination, mcDeterminationAck, mcDeterminationReject PDUs (these PDUs in AVC-825 should be added to H.245) are used to pick the MC.

6 Call Signaling

Call signaling between terminals, Gateways, and Gatekeepers takes place over a unreliable ***{unreliable ???Comments only: Establishing a reliable channel requires a long connection time. If it takes a few PDUs to setup a connection then it makes sense to do it on a unreliable channel and avoid the overhead of establishing a reliable channel. Also, reliable connections require more resources than unreliable connections}*** channel using the ~~procedures for circuit switched calls~~ described in section 7. ~~Q.931~~. The ~~Q.931~~ messages are transmitted in Control PDUs as defined in H.22Z.

In networks that do not contain a Gatekeeper, Call Signaling messages are passed directly between the calling and called terminals or Gateways. In these networks, it is assumed that the calling terminal knows the network address of the called terminal and thus can communicate directly.

In networks that do contain a Gatekeeper, Call Signaling messages are passed between the calling terminal and the Gatekeeper; and the Gatekeeper and the called terminal. ~~The terminals communicate with the Gatekeeper as if the Gatekeeper were the *network* as defined in Q.931~~. It is assumed that calling LAN terminals know the network address of the Gatekeeper ~~in its Sub-Domain and sends~~ a network address for the called LAN terminal or an E.164 address for the called WAN terminal in the Connect ~~Setup~~ message. The Gatekeeper may translates the E.164 address into a network address for communications with the called terminal.

The Gateway performs the appropriate inter-exchange signaling procedures between the H.22Z~~Q.931~~ Control PDUs and the WAN signaling system (Q.931~~, Q.2931, SS7?~~). ***{Where are these inter-exchange signaling procedures defined?}***

The Q.931 messages shall contain all of the mandatory information elements and may contain any of the optional information elements as defined in Q.931.

The Protocol Discriminator Information Element in the Q.931 message shall contain the Q.931 Recommendation user-network call control message identifier value of 08H.

The Call Reference Information Element in the Q.931 message shall be one octet long and contain the dummy call reference code of 00H.

6.1 Terminal Addresses

Each H.323 terminal shall have a network~~terminal~~ address. Additionally it may have ~~The H.323 terminal address (network access number, telephone number, etc.) shall be~~ a valid E.164 number consisting of the Subscriber Number (SN) field. The SN consists of n digits from the set of 0 to 9. The number of digits is left to the discression of the manufacturer.

In the Connect~~Setup~~ Message, The Destination Address Information Field may~~shall~~ contain the E.164 address of the called terminal. This will allow the Gatekeeper to identify the network address of the called terminal. The Originating Address Information Field may~~shall~~ contain the E.164 address of the calling terminal. This will allow the Gatekeeper to identify the network address of the calling terminal. ~~The Numbering Plan field of the address shall indicate E.164 address (01H). The Type of Address field shall indicate Network Specific Number (03H).~~

The Destination address may~~shall~~ consist of ~~an optional access code followed by~~ the E.164 address of the called terminal. ~~The access code consists of n digits from the set of 0 to 9. The number of digits is~~

~~left to the discression of the manufacturer. For called terminals within the same Super-Domain as the calling terminal, the access code is not needed. For called terminals accessed via a Gateway Unit, the access code (such as 9) shall indicate that the call is for an external terminal.. The access code may be used to discriminate between different Wide Area Networks (ie 9 for ISDN, 8 for PSTN).~~

~~*{The gatekeeper will know from the destination address access code that a call is destined for a Gateway}*~~

{During the Call Set-up procedure, the gateway must communicate the network addresses of the called and calling terminals to each other. This information will be carried in the CRQ PDU.~~~~This may be done with the User to User Information Element in the Q.931 message which can be 32 or 128 bytes (we may also be able to specify any length since this is internal to the LAN).}~~

7 Terminal procedures

The provision of the communication is made in the following steps:

- phase 0: Terminal Registration (subclause 7.1);
- phase A: Call set-up (subclause 7.2);
- phase B: Initial communication and capability exchange (subclause 7.3);
- phase C: Establishment of audio visual communication (subclause 7.4);
- phase D: Call termination (subclause 7.5)

7.1 Phase 0 - Terminal Registration

When a Gatekeeper is present, ~~it must be aware of the~~ terminals, MCs, and Gateways within its Sub-Domain must register/bind with it. In addition, Gatekeepers may need to communicate with other Gatekeepers within the same Domain and Super-Domain about the availability of terminals and Gateways in other Sub-Domains. The registration process may also associates a terminal's network address with its E.164 address and ~~an optional~~ terminal identifier. The initial binding ~~Registration~~ may be done statically or automatically~~dynamically~~. Static registration includes methods such as manual configuration of the Gatekeeper/terminal by an operator. Automatic/static ~~Dynamic~~ registration requires communications between the Terminal and the Gatekeeper as described below.

7.1.1 Binding~~Registration~~ of H.323 Terminals and Gateway units with a Gatekeeper

As part of their configuration, H.323 terminals and Gateway units, may send a Registration Request (RRQ) to the appropriate Gatekeeper for their site. The Gatekeeper must respond with either a Registration Confirmation (RCF) or a Registration Rejection (RRJ). The RRQ may be repeated periodically (ie, at terminal power up) so the Gatekeeper must be able to handle multiple requests from the same terminal. See Figure 2. There is no un-registration message, so the Gatekeeper should have a mechanism to periodically remove inactive terminals.

It is presumed that during install or at some other appropriate point, the user of a H.323 terminal or Gateway may~~will~~ be given the opportunity to enter an address of the appropriate Gatekeeper.

(Guardian is the term given to a Gatekeeper with which a terminal(s) has bound. ~~(~~A terminal will attempt connections to other terminals via contacting its *guardian* gatekeeper.)

If at any time a terminal determines it has an invalid binding with its guardian, it must rebind. The invalid binding may be detected by either an **RRJ** (with an **Not Bound** status) or a timeout on an **RRQ**. Before it re-binds, it should issue an **GRQ** to discover its 'owning' gatekeeper.

The terminal may issue the **RRQ** with the bind flag set to TRUE *only* if it receives a **GCF** or a timeout. (receiving only **GRJ**'s constitues denial of permission to conference).

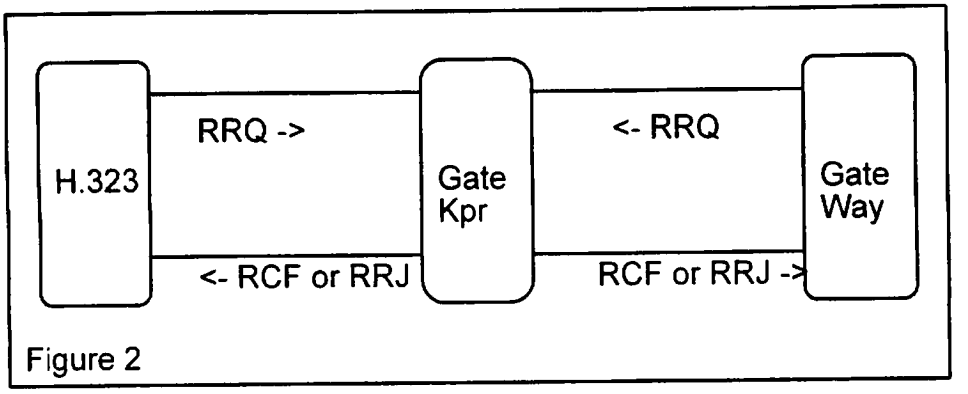


Figure 2

7.1.2 Gatekeeper to Gatekeeper Registration and Configuration

7.1.2.1 Registration

It is presumed that during install or at some other appropriate point, the user of the Gatekeeper may ~~will~~ be given the opportunity to enter the addresses of the other Gatekeepers on the network. No dynamic registration of Gatekeepers is provided. **{is a permanent reliable link established between all gatekeepers, of is it established as needed? A permanent reliable link is not required between gatekeepers.}**

7.1.2.2 Node~~Sub-Domain~~ List Request

~~Each Gatekeeper on the network should periodically poll all other Gatekeepers in the Super Domain for the terminals and Gateways in their Sub-Domain using the Sub-Domain list Request (SLR). { in five minute intervals, how about automatic updates when new terminals register}. Each Gatekeeper must respond with a Sub-Domain Registered List (SRL) of their H.323 registered terminals, Gateways, and all of the other Gatekeepers which it has knowledge of. The Gatekeeper inclusion in this report allows for the easy addition of new Gatekeepers to the network. This periodic polling will allow each Gatekeeper to keep track of all registered H.323 terminals. The information included in this response is at the discretion of the Gatekeeper. This flexibility will allow configurations where resources can be shared or protected and provide a way for terminals to automatically seek alternate Gatekeepers during a failure scenario. See Figure 5.~~

~~Note: As an optional feature, Gatekeepers can accept and respond to terminal list requests from terminals.~~

1. Any gatekeeper can issue the Node List Request (NLR) at any time. The NLR will specify whether gatekeeper, MC, or gateway information is requested. In the event of a gatekeeper list request, all gatekeepers receiving the request will respond with their gatekeeper address information and a list of all other known gatekeepers (NRL). In the event of a gateway list request, the gatekeepers

receiving the request may respond with their gateway address information and a list of all other known gateways.

Gatekeepers will age out cached remote gatekeeper information if somea configurable number of periods have passed without receiving a NRL.

When a gatekeeper is first activated, it sends an immediate NRL broadcast (or multicast) which contains just its own address. This is used as a notification that a new gatekeeper has joined the enterprise.

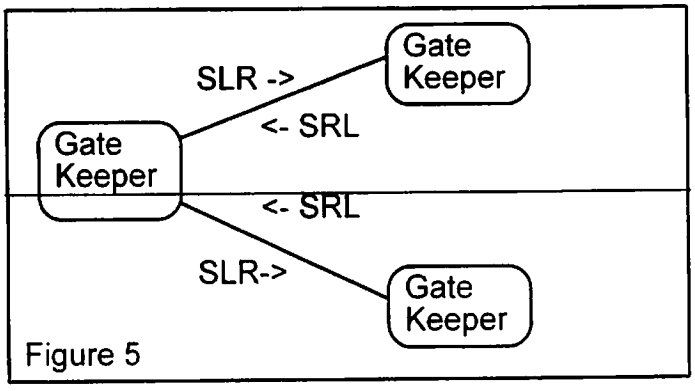


Figure 5

{The above figure should show NLR and NRL PDUs being passed between gatekeepers}

~~**7.1.2.3 Termination**~~

~~Prior to the removal of the Gatekeeper, the Gatekeeper shall notify each known Gatekeeper on the network of its exit from the network with a Gatekeeper Terminated Indication (GTI) and then close the reliable link it had open with each Gatekeeper.~~

7.2 Phase A - Call set-up

~~Call Set-up takes place according to the call control procedures for circuit switched calls defined in Q.931 as tailored (summarized) below.~~ Call set up takes place according to the call control procedures outlined below and utilizing the connection PDUs specified in H.22Z.

7.2.1 Call Set-up without a Gatekeeper

{is the reliable channel established first for call setup and then the unreliable channel is added after the call is accepted? or are both established first?}

When there is no Gatekeeper on the network, a call is established directly between the terminals or terminal and Gateway unit. This is done by the calling terminal sending a Connect Request ~~establishing a reliable connection~~ to the called terminal's well known network address. ***A successful connection setup will ultimately result in a reliable, bi-directional control connection established between the two terminals.*** ~~***{is this a bi-directional connection, or does the called terminal also have to establish a connection. If so, the called terminal must know, at this point, the calling terminals network address.}***~~

The call is initiated by the calling terminal by sending a CRQ PDUQ.931 Setup message (1) to the called terminal. A Destination Address Information Element is not needed in this message unless the called terminal is a Gateway unit. The called terminal mayshall respond with a CCF or a CRJ PDUAlerting, Call Proceeding, Release Complete, Disconnect, or Connect message. The called terminal may use the CIP PDUAlerting message (2) to indicate that it is waiting for the user to accept the call. If the called terminal is a Gateway, it may use the Call in ProgressProceeding message (3) while it performs the WAN call set-up procedures. The Connect Confirm Release Complete message (4) Connect RejectDisconnect message (5), or no response indicates that the called terminal is unable to accept the call. The Connect Confirm message (6) indicates that the call has been accepted by the called terminal. The calling terminal responds to the called terminal with a Connect Acknowledge message (7). The call is now established and phase B is entered. See Figure x.

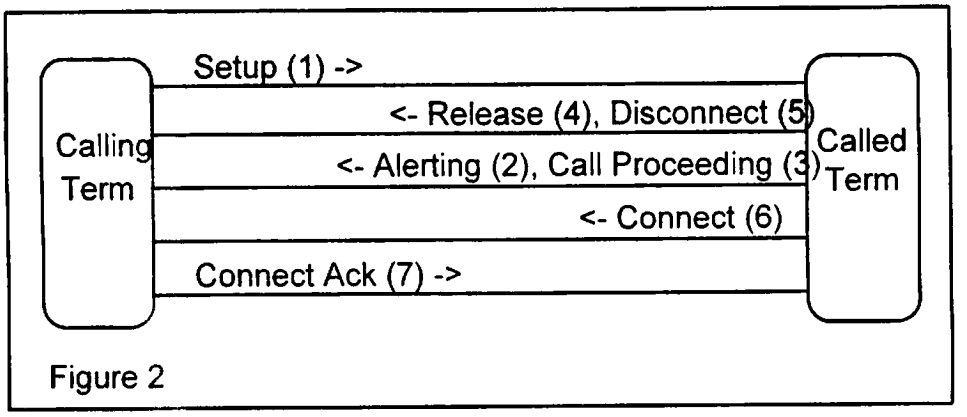


Figure 2

{Both of the figure '2' pictures need to be updated with the newer description showing CRQ,CRJ,CCF, and CIP PDUs}

7.2.2 Call Set-up with a single Gatekeeper

When there is a Gatekeeper on the network, call signaling takes place between the terminals or terminal and Gateway unit through the Gatekeeper. call signaling takes place between the terminals or terminal and Gateway unit through the Gatekeeper. This is done by the calling terminal issuing the Connect Request PDU establishing a reliable connection to the Gatekeeper's well known network address.

The call is initiated by the calling terminal by sending a Connect RequestQ.931 Setup message (1) to the Gatekeeper. The Destination Address Information Element may contains the called terminals E.164 address. The Gatekeeper shall respond with a Call in ProgressProceeding, Connect ConfirmRelease Complete, or Connect RejectDisconnect message. The Connect RejectRelease Complete message (2), or Disconnect message (3) response isare used if the Gatekeeper has not allowed the call to be placed. If the Gatekeeper determines that the call can be placed, it sends the Call Proceeding message (4). The If the call is permissible, the Gatekeeper may then translates the E.164 address to a network address, or utilize the supplied destination network address and established a reliable connection with the called terminals well known network address. It which then forwards the Connection RequestSetup message (5) to the called terminal.

The called terminal mayshall respond with a Alerting, Call in Progress,ProceedingConnecton Reject, Release Complete, Disconnect, or Connect Confirm message. The called terminal may use the Call in ProgressAlerting message (6) to indicate that it is waiting for the user to accept the call. If the called terminal is a Gateway, it may use the Call in ProgressProceeding message (7) while it performs the WAN call set-up procedures. Q.931 reason codes may be returned within the Connect Reject. The Connect RejectRelease Complete message (8), Disconnect message (9), or no response indicates that the called terminal is unable to accept the call, the Gatekeeper forwards this to the calling terminal.

The Connect Confirm message (10) indicates that the call has been accepted by the called terminal. The Gatekeeper forwards this to the calling terminal and responds to the called terminal with a Connect Acknowledge message (11). The call is now established and phase B is entered. See Figure x.

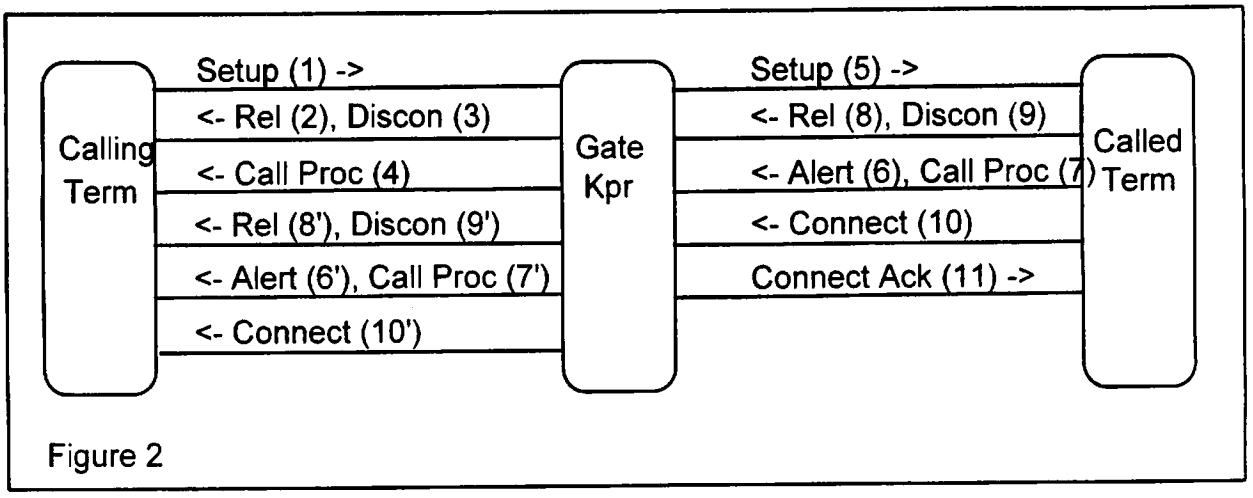


Figure 2

7.2.3 Call Set-up with Multiple Gatekeepers

When a call must traverse several Sub-Domains within a Super-Domain, multiple Gatekeepers will be involved in the call setup. Call signaling takes place between will be gated through the calling gatekeeper and the corresponding gatekeeper at the called end, the terminals or terminal and Gateway unit through these Gatekeepers. This is done by the calling terminal establishing a reliable connection to its Gatekeeper's well known network address.

The call is initiated by the calling terminal by sending a Connect RequestQ.931 Setup message to the Gatekeeper. The Destination Address Information Element may contains the called terminals E.164 address. The Gatekeeper shall respond with a Call in Progress Proceeding, Connect RejectRelease Complete, or Connect Confirm Disconnect message. The Connect RejectRelease Complete message is, or Disconnect message response are used if the Gatekeeper has not allowed the call to be placed. If the Gatekeeper determines that the call can be placed, it may sends the Call in ProgressProceeding message. The Gatekeeper will determine that the called terminal is not in its Sub-Domain and must check the Sub-Domain List received from the other Gatekeepers. The Gatekeeper then forwards the Connection RequestSetup message to the Gatekeeper associated with the called terminal.

The called terminal's Gatekeeper shall respond with a Call in ProgressProceeding, Connection ConfirmRelease Complete, or Connection RejectDisconnect message. Connection RejectRelease Complete, isor Disconnect response are used if the Gatekeeper has not allowed the call to be placed. If the Gatekeeper determines that the call can be placed, it may sends the Call in ProgressProceeding message to the calling terminal's Gatekeeper. The called terminal's Gatekeeper may then translates the E.164 address to a network address or utilize the supplied destination network address and established a reliable connection with the called terminal's well known network address. It then forwards the Connection RequestSetup message to the called terminal.

The called terminal shall respond with a Alerting, Call in ProgressProceeding, Connection RejectRelease Complete, Disconnect, or Connection Confirm message. The called terminal may use the Call in ProgressAlerting message to indicate that it is waiting for the user to accept the call. If the called terminal is a Gateway, it may use the Call in ProgressProceeding message while it performs the WAN call set-up procedures. Q.931 reason codes may be returned within the Connect Reject The Connection RejectRelease Complete message, Disconnect message, or no response indicates that the called terminal is unable to accept the call, the called terminal's Gatekeeper forwards this to the calling

terminal's Gatekeeper which in turn forwards it to the calling terminal. The Connect Confirm message indicates that the call has been accepted by the called terminal. The called terminal's Gatekeeper forwards this to the calling terminal's Gatekeeper, ~~and responds to the called terminal with a Connect Acknowledge message~~. The calling terminal's Gatekeeper forwards the Connect Confirm message to the calling terminal. The call is now established and phase B is entered.

{Is it necessary to have the Gatekeeper to Gatekeeper call signaling? This seem extra complex, however, each Gatekeeper controls access to the network for its Sub-Domain. Different Gatekeepers may have different authorization and bandwidth control procedures for its Sub-Domain. If not, the calling terminals Gatekeeper could complete the call setup procedure with the called terminal directly without communicating with the called terminals gatekeeper. The calling terminals Gatekeeper will know the network address of the other Gatekeepers terminals as a result of the Sub-Domain List message. The interaction is simply end-to-end pairs of terminals and gatekeepers. This allow the policy and control flexibility that is mentioned above.}

7.2.4 Call Set-up via Gateways

7.2.4.1 Gateway Inbound Call Set-up

Call set-up between a Gateway and a terminal proceeds the same as the terminal to terminal call setup. The Gateway exchanges Connection Request/Response~~Q.931~~ messages with the Gatekeeper which forwards them to the called terminal. The Gateway unit may need to issue Call Proceeding messages to the external terminal while establishing the call on the network. ***{There is still the question about how the external terminal communicated the address of the LAN terminal to the Gateway.}***

7.2.4.2 Gateway Outbound Call Set-up

Call set-up between a terminal and a Gateway unit proceeds the same as the terminal to terminal call setup. The Gateway unit will receive the destination E.164 address in the Connection Request~~Setup~~ message. It will then use this address to place the outbound call. The Gateway unit may issue Call Proceeding messages to the Gatekeeper while establishing the outgoing call.

7.3 Phase B - Initial communication and capability exchange

When the connection has been acknowledged, Phase B begins. The Control Channel is immediately opened between the two terminals. The procedures of H.245 are used over the Control Channel for the the capability exchange and to open the media channels. ~~The Audio Channel may optionally be opened prior to capability exchange, providing the capability to have speech communications at the earliest possible opportunity and before proceeding to visual telephony.~~

During Phase B the terminals may exchange operating mode capability information using the procedures defined in Recommendation H.245. Following this exchange of capabilities, the terminals may proceed directly to the desired operating mode i.e. Phase C.

7. 4 Phase C - Establishment of audiovisual communication

7.4.1 Procedure at answering terminal

The answering terminal may immediately activate the audio channel to facilitate voice communication. After the completion of the capability exchange, the answering terminal may activate the video and data channels within the capability of the calling terminal.

7.4.2 Procedure at calling terminal

After completion of the capability exchange, the calling terminal may activate the video and data channels within the capability of the calling terminal.

7.4.3 Mode changes

During a session the procedures for changing channel structure, capability, receive mode etc. shall be carried out as defined in Recommendations H.22Z and H.245.

7.4.4 Exchange of video by mutual agreement

The symbol VIR, "Video Indicate Ready-to-activate", is defined in H.245 [2]. Its use is optional, but when used the procedure shall be as follows.

Terminal X has been set so that video is not transmitted unless, and until, the remote terminal has also indicated readiness to transmit video. Terminal X shall send the indication VIR when the initial capability exchange has been completed, but shall not transmit a video signal until it has received either VIR or incoming video.

A terminal which has not been set in this optional way is not obliged to wait until receipt of VIR or video before initiating its video transmission.

7.5 Phase D: Call termination

Either terminal may terminate a call by the following procedure:

1) It shall transmit the C&I message VCF (see H.245 [2]) and then discontinue transmission of video packets at the end of a complete picture.

2) It shall discontinue transmission of data.

3) It shall discontinue transmission of speech

4) It shall transmit a final message "End_Session" (see H.245 [2]) in the control channel, and then discontinue all packet transmission within the protocol H.22Z [1].

~~5) It shall clear the call using the procedures defined in Q.931.~~

A terminal receiving "End_Session", without first having transmitted it, shall carry out 1) to 4) above. ***{Does this terminal also send the "End_Session" back to the other terminal?}***

7.5.1 Call Clearing without a Gatekeeper

In networks that do not contain a gatekeeper, after transmitting the "End_Session", the terminating terminal shall transmit a Disconnect Request~~Q.931 Disconnect~~ message to the other terminal. ~~A terminal receiving the Disconnect message shall respond with a Release message. A terminal receiving the Release message shall respond with a Release Acknowledge message. At this point the connection shall be terminated.~~

7.5.2 Call Clearing with a Gatekeeper

In networks that do contain a gatekeeper, after transmitting the "End_Session", the terminating terminal shall transmit a Disconnect Request to its gatekeeper. Any terminal that receives a Disconnect PDU will in turn, send a Disconnect Request PDU to its respective Gatekeeper.~~Q.931 Disconnect message to the Gatekeeper. The Gatekeeper shall forward this message to the other terminal if it is in~~

~~the same Sub-Domain, or the other terminals Gatekeeper if it is in a different Sub-Domain. A terminal receiving the Disconnect message shall respond with a Release message which is forwarded through the Gatekeepers to the terminating terminal. The terminating terminal receiving the Release message shall respond with a Release Acknowledge message which is forwarded through the Gatekeepers to the other terminal~~. At this point the connections between terminals and Gatekeepers shall be terminated.

8 Interoperation with other terminals

Interoperation with other terminals shall be accomplished through the Gateway Unit. See Section 5.3.

8.1 Speech only terminals

Interoperation with speech only terminals shall be supported. In the decentralized (multicast audio and video) case, different multicast addresses should be used for audio and video so that terminals can join only the multicast addresses that their capability allows.

8.2 Visual telephone terminals over the ISDN (H.320)

Interoperation with visual telephone terminals over the ISDN (H.320) can be provided by:

1) using a LAN-ISDN Gateway Unit.

The Gateway Unit must consider the following issues:

- Video format conversion. (if desired, H.261 is mandatory for both terminal types.)
- Audio code conversion. (if desired, G.711 is mandatory for both terminal types.)
- Bitstream conversion. (H.22Z to/from H.221)
- Control conversion. (H.245 to/from H.242)
- Call Control Signalling conversion.

8.3 Visual telephone terminals over GSTN (H.324)

Interoperation with visual telephone terminals over the GSTN (H.324) can be provided by two methods:

1) using a LAN-GSTN Gateway Unit.
2) using a LAN-ISDN Gateway Unit assuming that there exists an ISDN/GSTN Interworking Unit in the network.

The Gateway Unit must consider the following issues:

- Video format conversion. (if desired, H.261 is mandatory for both terminal types.)
- Audio code conversion. (G.711 is mandatory for H.323 terminal, G.723 is mandatory for H.324 terminal.)
- Bitstream conversion. (H.22Z to/from H.223)
- Call Control Signalling conversion.

8.4 Visual telephone terminals over Mobile Radio (H.324/M)

For further study

8.5 Visual telephone terminals over ATM (H.321)

Interoperation with visual telephone terminals over ATM networks (H.321) can be provided by two methods:

1) using a LAN-ATM Gateway Unit.
2) using a LAN-ISDN Gateway Unit assuming that there exists an I.580 ISDN/ATM Interworking Unit in the network.

The Gateway Unit must consider the following issues:

- Video format conversion. (if desired, H.261 is mandatory for both terminal types.)
- Audio code conversion. (if desired. G.711 is mandatory for both terminal types.)
- Bitstream conversion. (H.22Z to/from H.221)
- Control conversion. (H.245 to/from H.242)
- Call Control Signalling conversion.

8.6 Visual telephone terminals over Guaranteed Quality of Service LANs (H.322)

Interoperation with visual telephone terminals over Guaranteed Quality of Service LANs (H.322) can be provided by two methods:

1) using a NGQOSLAN-GQOSLAN Gateway Unit.
2) using a NGQOSLAN-ISDN Gateway Unit assuming that there exists a GQOSLAN-ISDN Gateway Unit in the network.

The Gateway Unit must consider the following issues:

- Video format conversion. (if desired, H.261 is mandatory for both terminal types.)
- Audio code conversion. (if desired, G.711 is mandatory for both terminal types)
- Bitstream conversion. (H.22Z to/from H.221)
- Control conversion. (H.245 to/from H.242)
- Call Control Signalling conversion.

9 Optional enhancements

9.1 Data facilities

A terminal may have physical I/O ports for external telematic and other equipment, or there may be data applications within the terminal itself. Data transmission may be activated and deactivated by local action.

9.2 Encryption {needs review}

Encryption may optionally be used by H.323 terminals. Encryption, including selection of algorithm and key exchange, shall be according to the procedures of Recommendations H.233 and H.234 with the following modifications to the procedures defined in H.233. The ability to support encryption shall be signaled by the presence of the **h233EncryptionTransmitCapability** and **h233EncryptionReceiveCapability** parameters of the **Capability** message of H.245.

In H.233, specific reference is made to H.221 in describing how encryption takes place. In applying H.233 to H.323 terminals, references to H.221, FAS, and BAS channels therein shall be ignored and appropriate substitute recommendations be taken from this section. Messages referred to as carried in

the H.221 ECS channel shall be re-interpreted as being carried within the **encryptionSE** parameter of the H.245 **EncryptionCommand** or encryption initialization vector (EIV) logical channel, as specified below.

9.2.1 EncryptionSE messages

H.233 session exchange (SE) messages shall be carried in the **encryptionSE** parameter of the H.245 **EncryptionCommand** message. Since the H.245 control channel is carried on a reliable data link layer using retransmission of errored frames, the error protection bits described in H.233 shall not be applied to SE messages.

If the 8th bit is set in the media identifier this indicates the following encodings. The normal tuple of 3 bytes containing the media identifier, algorithm identifier, and parameter identifier (each with one byte respectively) will be replaced by a tuple of 5 bytes containing media identifier, algorithm identifier, parameter identifier, and a 16 bit value, channel identifier.~~The H.233 header for SE messages shall have the value binary 00000000, indicating an SE message in a single block, not followed by related blocks.~~

~~The H.233 media identifier value shall be binary 00000000, which shall indicate encryption of all logical channels except for the EIV and H.245 control channels. The use of other values is for further study.~~

NOTE - Non-standard encryption algorithms may be referenced in SE messages after associating a non-standard algorithm with a H.233 Algorithm Identifier value using the **encryptionAlgorithmID** parameter of the **EncryptionCommand** message.

~~9.2.2 Encryption initialization vector (EIV) channel~~

~~The encryption initialization vector (EIV) logical channel is used for the transmission of H.233 initialization vector (IV) messages.~~

~~To ensure accurate synchronization of the IV messages with the H.22Z multiplex bitstream, the EIV channel is an independent logical channel which shall be non-segmentable and use a reliable transport mechanism. The entire IV message, exactly as defined in H.233, including error protection bits, shall be placed in a single H.22Z PDU.~~

~~Messages carried within the EIV channel shall retain the error protection mechanism of H.233.~~

9.2.3 Encryption procedure

The encryptor shall produce a pseudo-random bitstream (cipher stream) corresponding to all bits output by the H.22Z multiplex prior to insertion into the H.22Z PDU.

When encryption is activated according to H.233, the H.22Z bitstream shall, prior to insertion into the H.22Z PDU, be exclusive-ORed with the pseudo-random bitstream generated by the encryptor. However, the exclusive-OR procedure shall not be applied to the H.22Z header octet and all octets belonging to the H.245 control channel or EIV channel, which shall all be placed transparently into the H.22Z.

For each transmitted H.22Z header octet or octet belonging to the EIV or control channels, eight bits shall be discarded from the pseudo-random bitstream generated by the encryptor. The receiver shall apply the reverse procedure.

9.2.4 Encryption initialization vectors

Once an encrypted session is in progress the transmitter should periodically send new IV messages in order to limit the duration of repeated pseudo-random bitstream in the event of a collision with a previously used state of the pseudo-random bitstream generator. The frequency of these messages is left to the discretion of the implementor.

The new IV will be synchronized with the media packets utilizing RTP sequence numbers. This implies having the H.233 implementation extract this information from the RTP header in order to provide the encryption synchronization. ~~New initialization vectors (IVs) take effect at the start of the next H.22Z PDU following the PDU containing an IV message. In order for the receiver to have time to process the new IV before needing to use it, the transmitter shall wait a minimum time after sending the last octet of the IV message, as specified by the receiver's **h233IVResponseTime** capability, before starting transmission of the next PDU.~~

9.2.5 Error recovery

In the event that the receiver suspects that it has lost encryption synchronization it shall send an **encryptionIVrequest** command, ~~except that it should not re-send such commands at intervals less than the maximum expected round trip response time.~~

Upon receipt of an **encryptionIVrequest** command, the transmitter shall, at its earliest opportunity, send a new IV message, ~~except that it should ignore **encryptionIVrequest** commands received within the minimum expected round trip response time since sending the last IV message.~~

9.3 Multilink

Provision for multilink operation is for further study.

10 Multipoint considerations {needs review}

H.323 terminals may be used in multipoint configurations via interconnection through MCUs, as indicated in Figure 10/H.323.

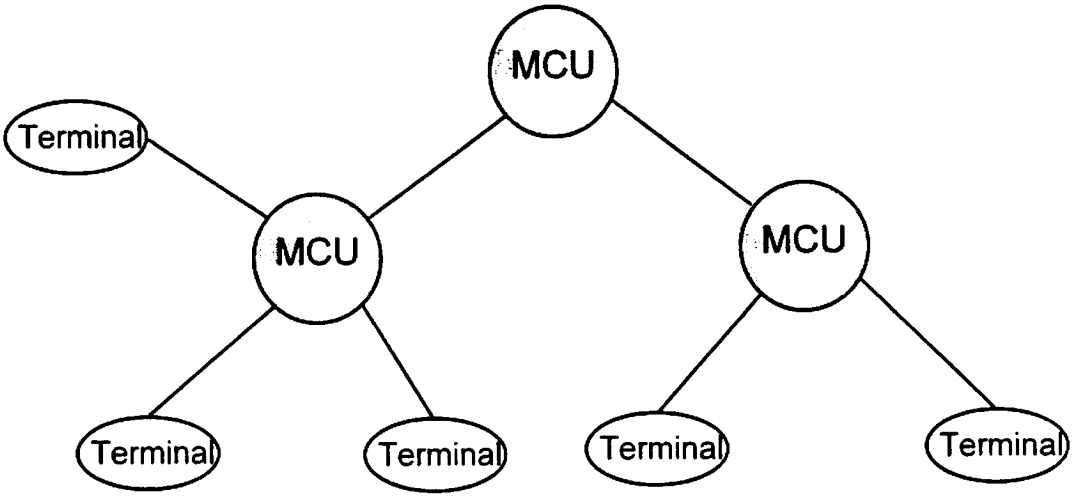


FIGURE 10/H.323

Multipoint configuration

10.1 Establishment of common mode

MCUs may force terminals into a particular common mode of transmission by sending to the terminal a receive capability set listing only the desired mode of transmission.

10.2 Multipoint rate matching

Since the terminals on each link in a multipoint configuration may be operating at different bit rates, MCUs may choose to send H.245 **FlowControlCommand** messages to limit the transmitted bit rates to those which can be sent to receivers.

10.3 Multipoint lip synchronization {need review, new H.245 message}

In a multipoint configuration, each terminal may be transmitting a different **H22ZSkewIndication** message for associated video and audio channels. To enable lip synchronization at receiving terminals, MCUs shall transmit accurate **H22ZSkewIndication** messages. MCUs may accomplish this by adding delay to equalize the audio/video skew for all transmitting terminals, or, when switching between broadcasting terminals, may transmit a new **H22ZSkewIndication** message reflecting the audio/video skew of the current broadcaster.

10.4 Multipoint encryption

In a multipoint configuration the MCU is considered to be a trusted entity. Each port of the MCU encrypts/decrypts the H.22Z bitstream from the H.323 terminal or MCU attached to that port as though it were an H.323 terminal in accordance with section 9.2.

11 Maintenance

11.1 Loopbacks for maintenance purposes

Some loopback functions are defined in H.245 to allow verification of some functional aspects of the terminal, to ensure correct operation of the system and satisfactory quality of the service to the remote party. The system loopback (**systemLoop**) request may also be used during actual conversations, for example to measure the network delay.

a) Normal mode: no loop. Indicated in (a) of Figure 11/H.323.

b) System loop at codec-network interface (toward network interface). Upon receiving the **systemLoop** request as defined in H.245, loopback toward the network side shall be made, as indicated in (b) of Figure 11/H.323. The bit rate should not be changed in response to this request. Support for this loopback is mandatory for all terminals, but users may optionally disable response to it

c) Media loop at analog I/O interface (optional): Upon receiving the **mediaLoop** request as defined in H.245, loopback of the content of the selected logical channel shall be activated as close as possible to the analog interface of the video/audio codec towards the video/audio codec, so that decoded and re-coded media content is looped, as indicated in (c) Figure 5/H.323. This loopback is optional, and should be used only on logical channels opened using the bi-directional channel procedures of H.245.

d) Logical channel loopback in H.22Z multiplex (toward network interface). Upon receiving the **logicalChannelLoop** request, each H.22Z MUX-SDU for the specified logical channel should be looped back on the corresponding reverse logical channel, as indicated in (d) Figure 11/H.323. This loopback is optional, and should be used only on logical channels opened using the bi-directional channel procedures of H.245.

The message loopback off (**MaintenanceLoopOffCommand**) requires that all loopbacks currently in effect be turned off.

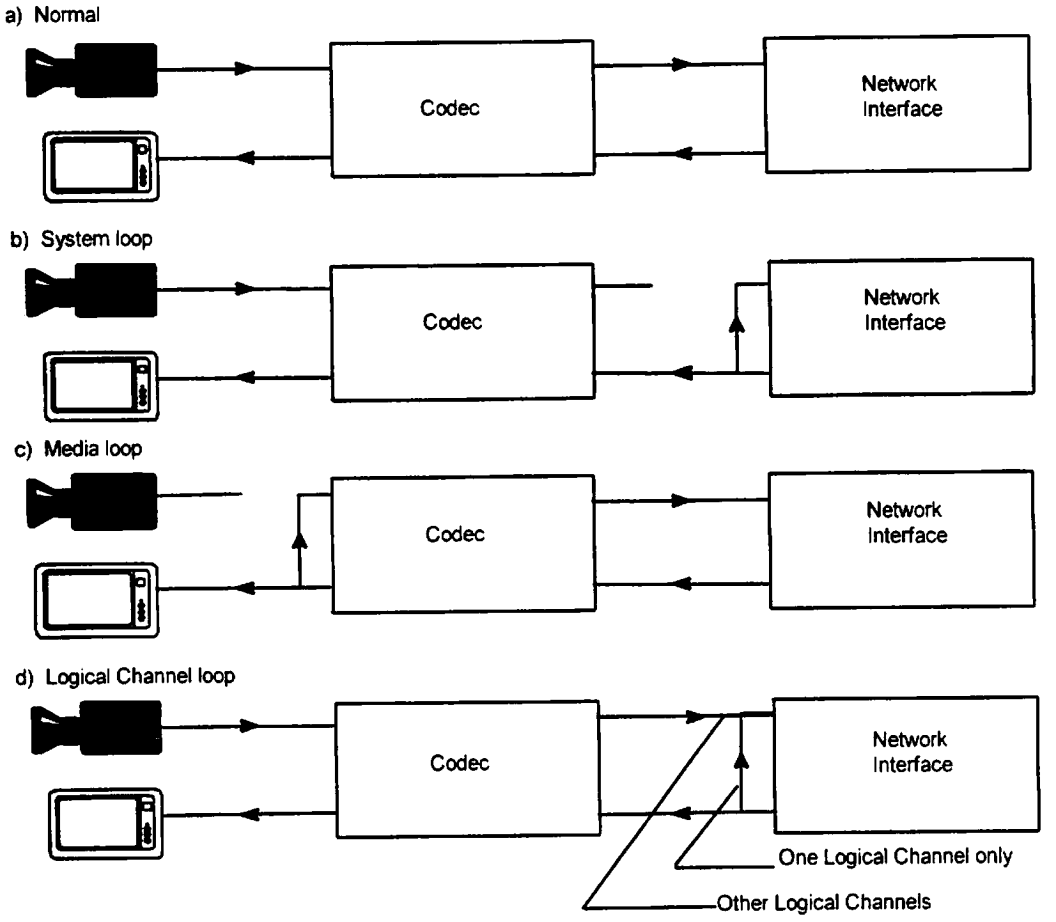


FIGURE 11/H.323

Loop back