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H.323
Packet Based Multimedia Communications Systems

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What is H.323?

- H.323 is suite of ITU standards that has evolved from the H.320 suite (for ISDN)
  - **based on the H.32x series of audio/video/data conferencing over POTS (H.324), ISDN (H.320) and LANs (H.323 itself)**
- H.323 is an umbrella recommendation for a number of co-operating protocols
- H.323 Recommendation specifies terminals, GWs, gatekeepers and other equipment for multimedia communications between two and more parties on packet based networks which may not provide a guaranteed Quality of Service (e.g. IP networks)
  - **Multimedia is defined as combinations of real-time voice, data and video, including videotelephony**
  - **Voice communication is mandatory**
- Specifies how to interwork with existing telephone networks and MM equipment

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What is H.323? (cont.)

- Was picked up by vendors as a basis for Service Provider "telephony over IP"
  - **for this role MEGACO and SIP now seen as the way to go**
- A lot of H.323 products are now available and used
  - **mainly for corporate IP telephony**


Related standards

- H.320 - The original ISDN videoconferencing standard

- H.324 - An extension of H.320 for videoconferencing over PSTN lines
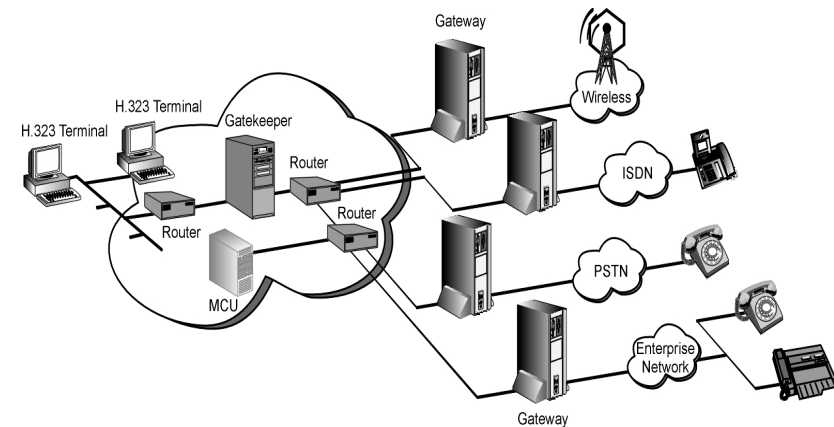
- T.120 - Real time data conferencing protocol

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The H.323 umbrella

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Scope of H.323

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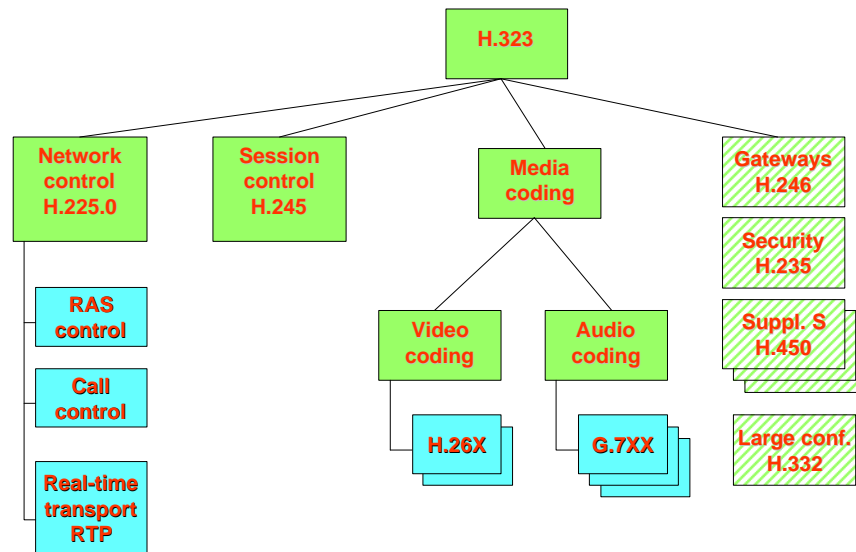
H.323 components (1)

- **Terminal**, the "phone" for real-time two-ways communications from/to an other terminal, or gateway or a MCU (Multipoint Control Unit), supporting voice (mandatory) plus optional video and data.
- **Gateway**, connect a H.323 based network to other networks such as ISDN, B-ISDN and PSTN. Both network and application level interworking.
- **Gatekeeper**, a "network control point" for a part of a H.323 network - zone. It acts as Registration, Admission and Call Control server, Address Translator and Gateway Localization.

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H.323 components (2)

- **Zone,** set of Terminals, Gateways and MCUs managed by a single gatekeeper
- **MCU**, Multipoint Conference Unit - "Conferencing is more than two"; MCU is an endpoint that allows three or more terminals and/or gateways to participate at a conference; it is composed by
  - ➤ **MC, Multipoint Controller (mandatory)**
 - ➤ **MP, Multipoint Processor (optional)**

H.323 topology
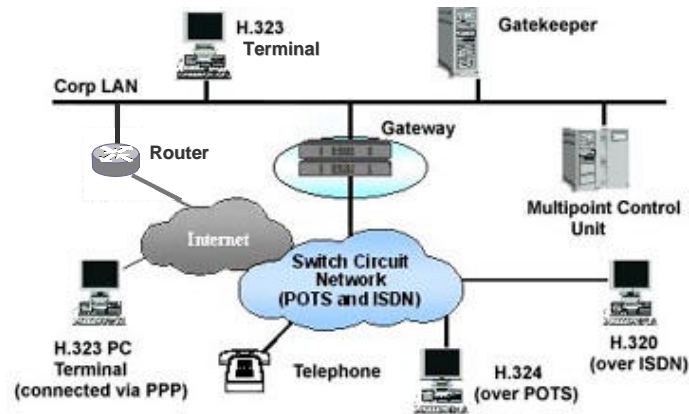
H.323 Terminal

- Used for real-time bidirectional multimedia communications

- Can either be a personal computer (PC) or a stand-alone device, running an H.323 stack and multimedia application.

- It supports audio communications and can optionally support video and/or data communications

- The primary goal is to interwork with other multimedia terminals

- H.323 terminals may also be used in multipoint conferences

- Mandatory:
  - **audio codec (at least G.711)**
  - **signaling/control protocols: H.245, Q.931, RAS**
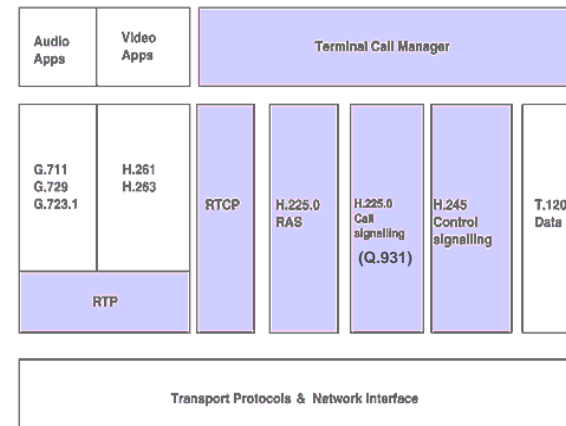
- Optional:
  - **Video**
  - **Dati**
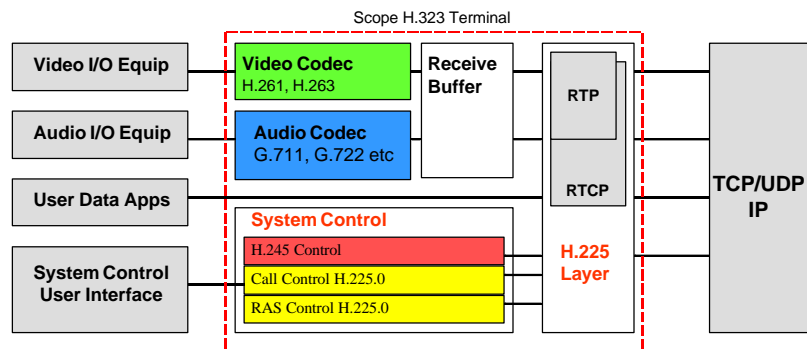
H.323 Terminal

• All terminals must be capable of encoding and decoding speech according to G.711. Terminals shall be capable of transmitting and receiving A-law and u-law encoded voice. The rest is optional as well as video and data.

H.323 Terminal architecture

- audio CODECs
- video CODECs
- H.225 registration, admission, and status (RAS)
- H.225 call signaling
- H.245 control signaling
- real-time transfer protocol (RTP)
- real-time control protocol (RTCP)

Audio CODEC

- Audio capabilities are mandatory

- Media Encoding:
  - **G.711 audio at 64/56 kbit/s, A/m - law (PCM)**
  - **G.722 audio at 48/56/64 kbit/s**
  - **G.723.1 audio at 5.3/6.3 kbit/s**
  - **G.728 audio at 16 kbit/s**
  - **G.729A audio at 8 kbit/s**
  - **GSM Full rate, Half rate, Enhanced Full rate**

- Audio algorithm is derived during H.245 Capability Exchange

- Terminals should be capable of asymmetric operation

Video CODEC

- Video capabilities are optional

- Media Encoding:
  - **H.263 low bit rate coding**
  - **H.261, the "old" H-320 codec**

- More than one video channel may be transmitted and/or received, as negotiated during H.245 Capability Exchange

- Terminals can operate in asymmetric video bit rates, frames rates and picture resolutions

Real-time voice and video streams

- Both Audio and Video streams are formatted as described in recommendation H.225.0

- Transported in unidirectional flows

- One or more RTP flows per session
  - **i.e. one RTP flow per each direction and media**

- Every RTP connection is accompanied by a RTCP control flow

H.323 Gateway

- An H.323 Gateway is a smart device connecting two dissimilar networks
  - **an H.323 network and a non–H.323 network**
  - **for example, a GW can connect and provide communication between an H.323 terminal and SCN networks**
  - **SCN networks include all switched circuit networks, e.g. PSTN**

- This connectivity of dissimilar networks is achieved by translating protocols for call setup and release, converting media formats between different networks, and transferring information between the networks connected by the gateway

- A gateway is not necessarily required for communication between two terminals on an H.323 network

H.323 Gateway architecture
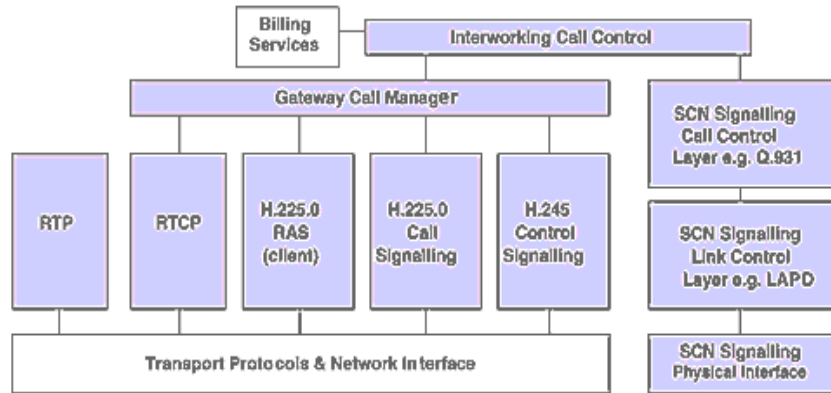
H.323 Gateway

- Call Control and Session Control interworking
  - **H.225 RAS and Call control ↔ Q.931/Q.2931 on ISDN**
  - **H.245 ↔ H.242 on ISDN**
  - **MF tones for speech only terminals on SCN side**
- Voice and/or video transcoding
  - **H.263 ↔ H.261**
  - **G.723.1 ↔ G.711 (PCM)**
- Performs call setup and clearing on both H.323 side and SCN side
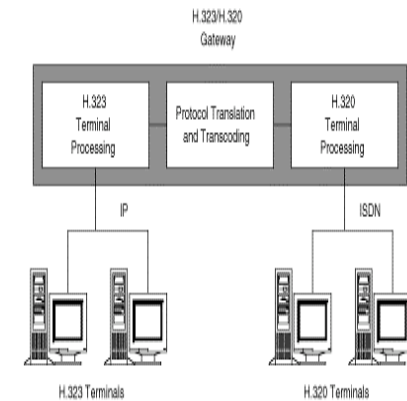
Gateway decomposition

- Logically split into:
  - **Signaling Gateway and Media Gateway Controller**
    - handle H.225.0 RAS messaging with an external gatekeeper
    - optionally handle the SS7 signalling interface
    - optionally handle the H.323 signalling interface
  - **Media Gateway**
    - terminates IP network interface
    - terminates bearer channels on SCN network interface
- A Media Gateway Controller (MGC) controls one or more Media Gateways (MGs)
- H.248 (Megaco) standard has been developed for the interface between MGC and MG

H.323 Gatekeeper

- A gatekeeper can be considered the "brain" of the H.323 network. It is the focal point for all calls within the H.323 network.
- It is not necessary (optional) for small networks with a small number of gateways statically configured
- Each Gatekeeper control a "Zone", that is a portion of the network composed of terminals and GWs (one GK per zone)
- Gatekeepers may provide important services such as:
  - **address translator (alias)**
  - **authorization and authentication of terminals and GWs**
  - **bandwidth management**
  - **accounting**
  - **billing; and charging**
- Gatekeepers may also provide call-routing services
  - **signaling relay node**

H.323 Gatekeeper

| Mandatory Functionality	Optional Functionality
☑ **Address Translation** Alias address (E.164) to Transport Network address (IP + port)	☑ **Call Authorization & Control**
☑ **Admissions Control** Grants/rejects the right to use the real time communication service on a per session basis	☑ **Bandwidth Management** Simultaneous permitted access to the network
☑ **Bandwidth Control**	☑ **Call Management** Gk maintain a list of ongoing H.323 calls
☑ **Zone Management**	☑ **Dialed Digit Translation** Translate dialed digits into E.164 number or Private Network number
	☑ **Supplementary Services**

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H.323 Gatekeeper architecture
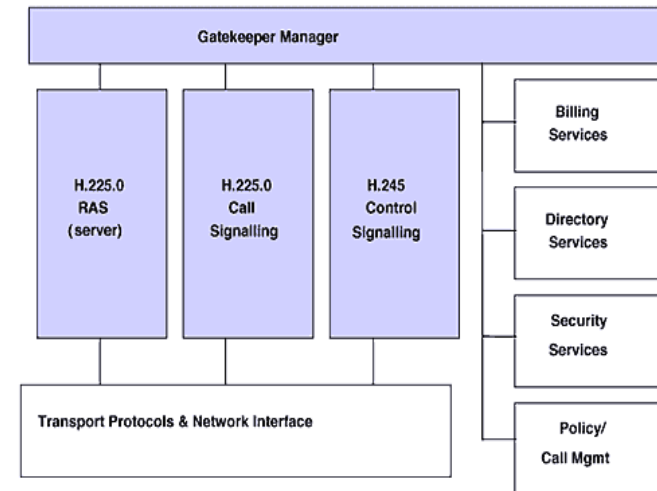
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H.323 Network Architecture
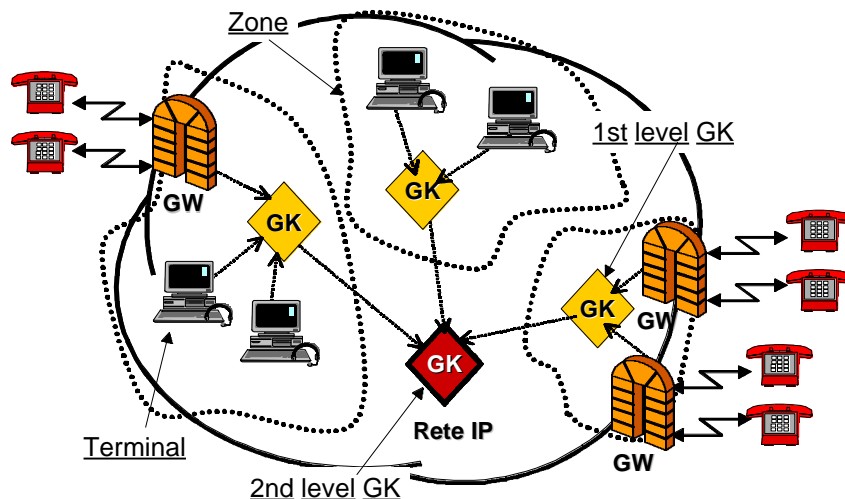
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Multipoint Control Unit (MCU)

- MCUs provide support for conferences of three or more H.323 terminals
  - **used when more than 2 parties wish to communicate**
- All terminals participating in the conference establish a connection with the MCU
- The MCU
  - **manages conference resources,**
  - **negotiates between terminals for the purpose of determining the audio or video coder/decoder (CODEC) to use, and**
  - **may handle the media stream**
- The gatekeepers, gateways, and MCUs are logically separate components of the H.323 standard but can be implemented as a single physical device

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# Multipoint Control Unit (MCU)

- Consists of two logical entities:
  - **Multipoint Controller (MC) which controls the conference resources and H.245 negotiation between terminals**
  - **Multipoint Processor (MP) which mixes, switches and process the information streams upon request from the MC**
- MC and MP (optional) can be co-located or separated
- Defines uses in the following situations:
  - **Centralized Conferencing**
 - **Decentralized Conferencing**
  - **Hybrid Conferencing**

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Multipoint Conferences

- Centralised Conferencing : all audio/video/data and control streams goes via MC, MP can do conversions on data streams.

- Decentralised Conferencing : MC does control, data streams go from terminal to terminal.

- Hybrid Conferencing : One component may be centralised (e.g. audio) while the other can be decentralised (e.g. video)
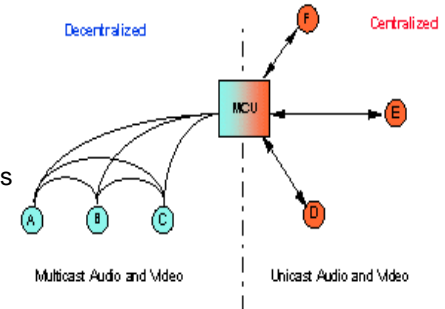
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H.323 Protocol Stack
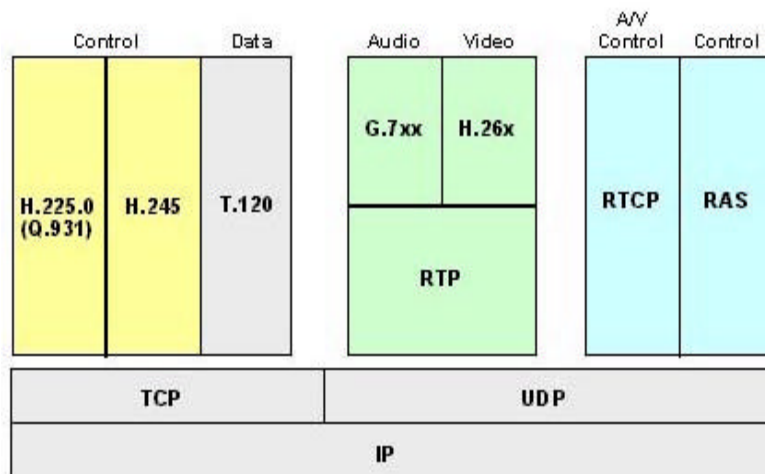
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Call establishment - H.323 Signaling

- H.323 uses three control channels/protocols:
  - **H.225.0/RAS Registration, Admission, and Status**
    - between client and gatekeeper (registration, admission, bandwidth requests and status)
    - uses UDP
  - **H.225.0/Q.931 call signaling**
    - between client and gatekeeper/peer client to establish connection between two client
    - uses TCP
  - **H.245 control signaling**
    - capability exchange
    - between client and gatekeeper/peer client
    - uses TCP
- H.323 messages in ASN.1 format
  - **"compact" message format**
  - **not human readable**

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H.225.0/RAS signalling protocol

- Registration, admission, and status (RAS)
- Used between Endpoints (Terminals and GWs) and Gatekeepers
- A RAS channel is used to exchange RAS messages
  - **This signaling channel is opened between an endpoint and a gatekeeper prior to the establishment of any other channels**
- The RAS is used to perform
  - **Gatekeeper discovery: EP determines the GK to register with**
    - GRQ/GCF/GRJ discovery messages
    - Endpoint multicast GRQ to the UDP well-known port 1719
  - **Endpoint registration: EP joins a Zone and informs GK of its Transport Address and Alias**
    - RRQ/RCF/RRJ registration messages
    - URQ/UCF/URJ de-registration (cancellation) messages
    - Endpoint send RRQ to the UDP well-known port 1718 (RAS Channel TSAP)
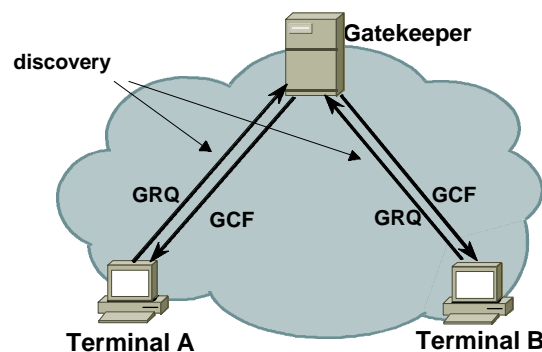
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H.225.0/RAS signalling protocol (Cont.)

- **Endpoint location - between GKs**
  - LRQ/LCF/LRJ location messages
- **Admission - communication request**
  - ARQ/ACF/ARJ admission messages
  - ARQ specifies also the requested Call Bandwidth
- **Bandwidth changes - for bandwidth modification during a call**
  - BRQ/BCF/BRJ messages
- **Status and others..**
  - IRQ - Information Request
  - DRQ - Disengage of the communication
  - RAI - GW resource availability - from GW to GK

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RAS: Gatekeeper dicovery

- Gatekeeper discovery:
  - **manual configuration**
  - **Gatekeeper Request messages (GRQ) sent to the gatekeeper UDP discovery multicast address (224.0.1.41)**
  - **DNS**

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RAS: Endpoint registration
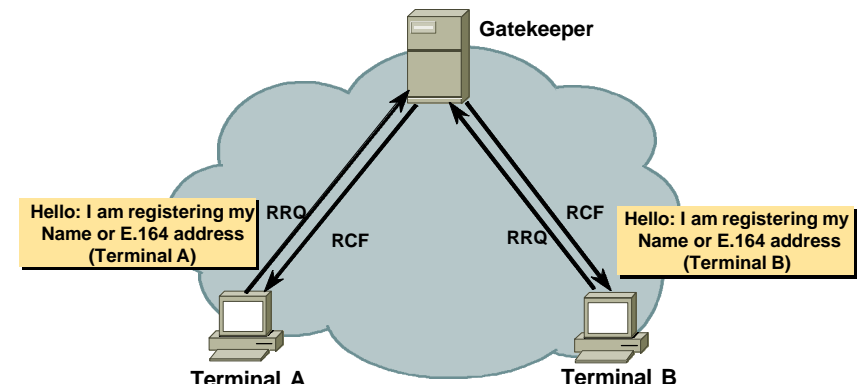
RAS - Registration Admission and Status

UDP Transport Port 1719
RRQ - Registration Request
RRJ - Registration Reject
RCF - Registration Confirm

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Intra-zone call

GatekeeperA (Zona A)

1
ARQ (Admission Request):
I would like to call
Terminal B

ARQ

ACF

3
H.323 Call Setup

Terminal A

Terminal B

2
ACF (Admission Confirm):
Yes you can, here it's IP
Address X.X.X.X

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H.225/Q.931 call signalling protocol

- To establish a connection between two H.323 Endpoints.
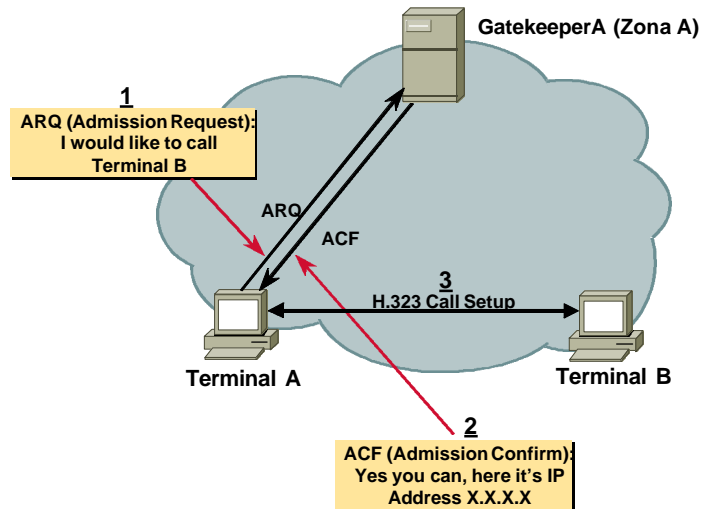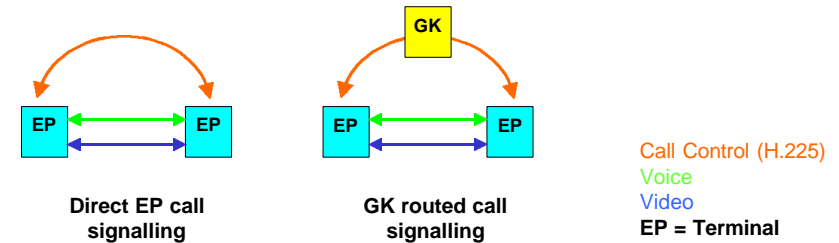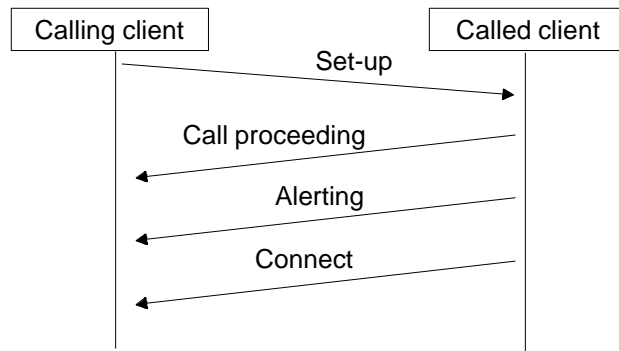 - **Used between Endpoints and GK or between Endpoints directly**
- This is achieved by exchanging H.225 protocol messages on the call-signaling channel
  - **The call-signaling channel is opened between two H.323 endpoints or between an endpoint and the gatekeeper**
  - **Endpoint TCP Port = 1720**
- Based on Q.931 (the same used by ISDN, ATM, etc.)

GK

EP — EP

EP — EP

Direct EP call signalling

GK routed call signalling

Call Control (H.225)
Voice
Video
EP = Terminal

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Q.931 signalling (Set-up)

Calling client

Called client

Set-up

Call proceeding

Alerting

Connect

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H.245 session control protocol

- To exchange end-to-end control messages governing the operation of the H.323 endpoint
  - **Capability exchange/negotiation**
    - each terminal specifies the supported media/codecs
  - **Open and close Logical Channels for media transport (audio, video, ecc)**
  - **Flow-control messages & general commands and indications**
- One Control Channel for each call
- H.245 uses a TCP connection
  - **a dedicated TCP connection opened after the Q.931 setup (the TCP port is specified during the Q.931 message flow), or**
  - **the same TCP connection used for Q.931 signaling ("Fast setup" option)**

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H.225/H.245 session models

Session Control (H.245)
Call Control (H.225)
Voice
Video

EP = Term, GW, MCU

Direct signalling

GK

GK routed call signalling

GK

GK routed H.245
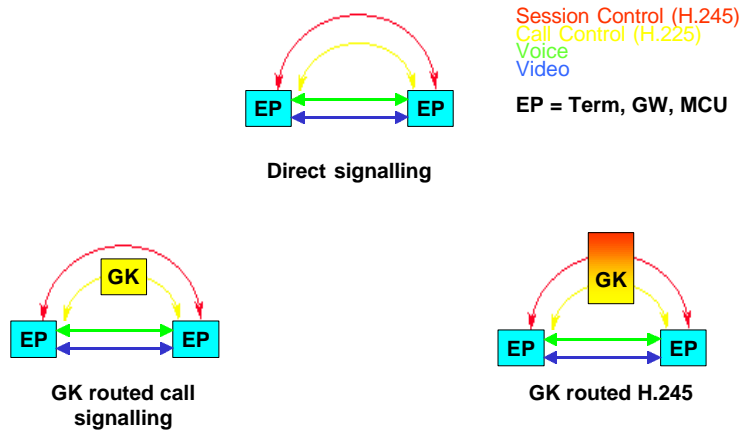
H.245 signalling (after connect)

Calling client

Called client

TerminalCapabilitySet

TerminalCapabilitySetAck

TerminalCapabilitySet

TerminalCapabilitySetAck

MSdetermination

MSdeterminationAck

MSdeterminationAck

OpenLogicalChannel

OpenLogicalChannelAck

OpenLogicalChannel

OpenLogicalChannelAck

RTP/RTCP flows

Closing connection

Calling client

Called client

CloseLogicalChannel

CloseLogicalChannelAck

EndSessionCommand

H.245

(Both uplink and downlink)

Release Complete

Q.931

Signaling overview

H.225.0

Gatekeeper

Gatekeeper

H.225.0

H.225.0

RAS

H.225.0

RAS

H.225.0

Calling Client

H.245

Called Client

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Call Setup flow overview (with gatekeeper)

H.323 Terminal #2   H.323 Gatekeeper   H.323 Terminal #1

- H.225: Admission Request (ARQ)
- H.225: Admission Confirm (ACF)
- Open TCP Channel For Q.931
- Q.931 Setup
- Q.931 CallProceeding
- H.225: Admission Request (ARQ)
- H.225: Admission Confirm (ACF)
- Q.931 Alerting
- Q.931 Connect
- Open TCP Channel For H.245
- H.245 Term Cap
- H.245 Term Cap Ack
- H.245 Term Cap
- H.245 Term Cap Ack
- H.245 open audio logical channel
- H.245 open audio logical channel Ack
- H.245 open audio logical channel
- H.245 open audio logical channel Ack

Full Duplex Audio Sent In Both Directions With Transcoding In The Gateway

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Addresses

- Network Address, the address of an H.323 entity in the packet network (IP address)

- TSAP identifier, TCP/UDP port
  - **Endpoint CallSignalling TSAP identifier=TCP well-known Port (1720)**

- Transport Address = Network address + TSAP identifier = Transport service access points (IP + UDP or TCP port)
  - **Call Signalling Transport Address (IP + CS port) shall be used to establish a call to an H.323 entity**

- Alias Address, one or more addresses associated to a terminal, GW or MCU.

- Alias addresses are unique within a zone
  - **E.164 numbers**
  - **H.323 IDs including e-mail like names**
  - **Alias address is translated into call signaling TSAP by GK**

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