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H.323
Packet Based Multimedia Communications Systems

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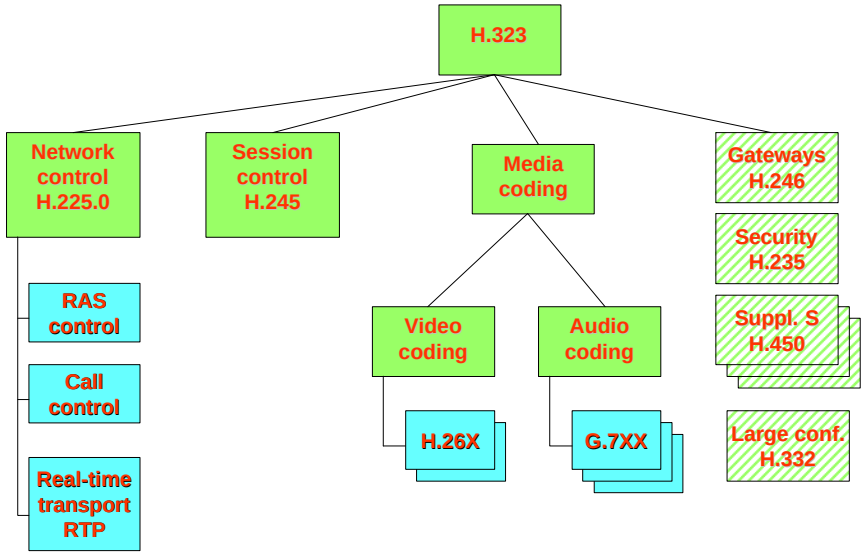
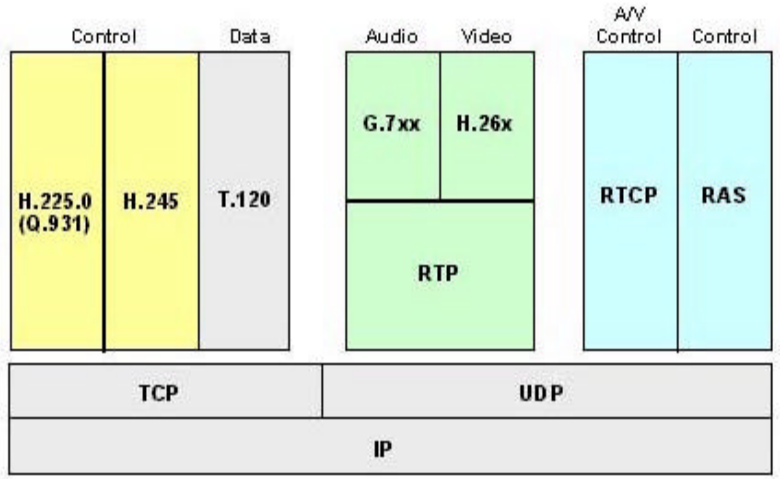
What is H.323?

- H.323 Recommendation specifies terminals, GWs, gatekeepers and other equipment for multimedia communications between two and more parties on packet based networks (e.g. IP nets)
  - **Multimedia is defined as combinations of real-time voice, data and video, including videotelephony**
  - **Voice communication is mandatory**
  - **Specifies also how to interwork with existing telephone networks**
- H.323 is suite of ITU standards that has evolved from the H.320 suite (for ISDN)
  - **umbrella recommendation for a number of co-operating protocols**
  - **based on the H.32x series of audio/video/data conferencing over POTS (H.324), ISDN (H.320) and LANs (H.323 itself)**
- The first VoIP standard
  - **In the last years a lot of H.323 products were available**
  - **Now replaced by SIP**

The H.323 umbrella

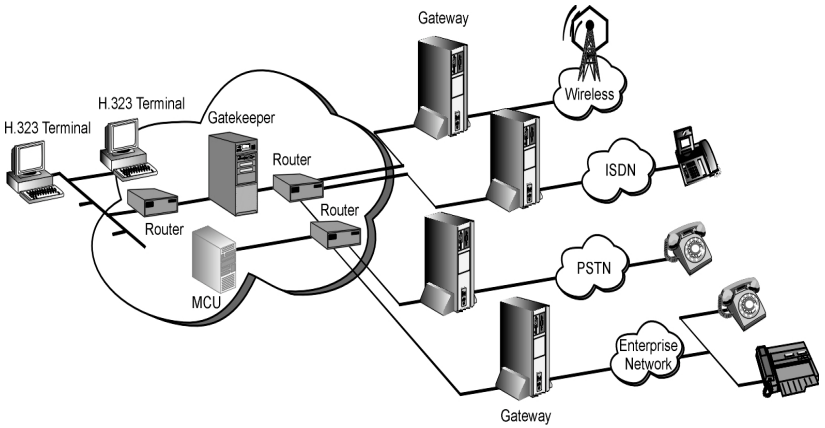


H.323 Protocol Stack



Scope of H.323

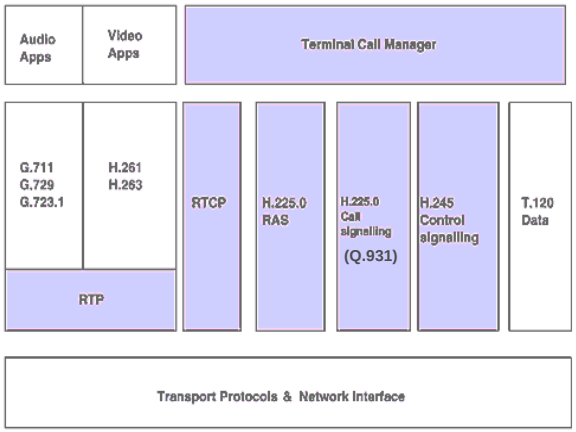
- H.323 Zone is a set of Terminals, Gateways and MCUs managed by a single gatekeeper



H.323 components - Terminal

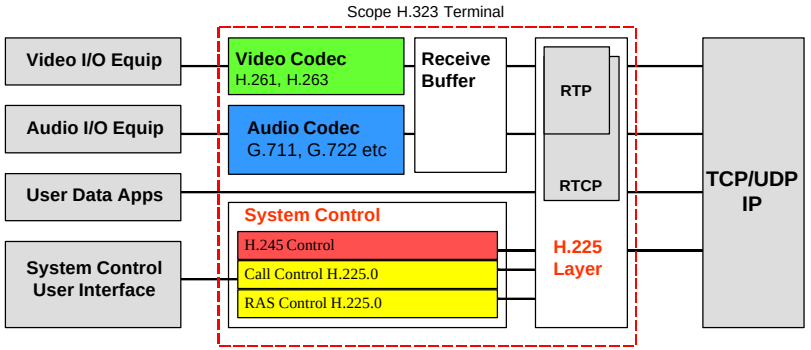
- The “phone” for real-time two-ways communications from/to an other terminal, or gateway or a MCU (Multipoint Control Unit)
- Can either be a PC or a stand-alone device
- May be used in multipoint conferences
- Mandatory
  - **media: audio (at least G.711 codec)**
  - **signaling/control protocols: H.245, Q.931, RAS**
- Optional
  - **Media: video, data**
- Media transported in unidirectional flows
- Every RTP connection is accompanied by a RTCP control flow

H.323 Terminal Protocol Stack



- 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)

Example of H.323 Terminal Architecture

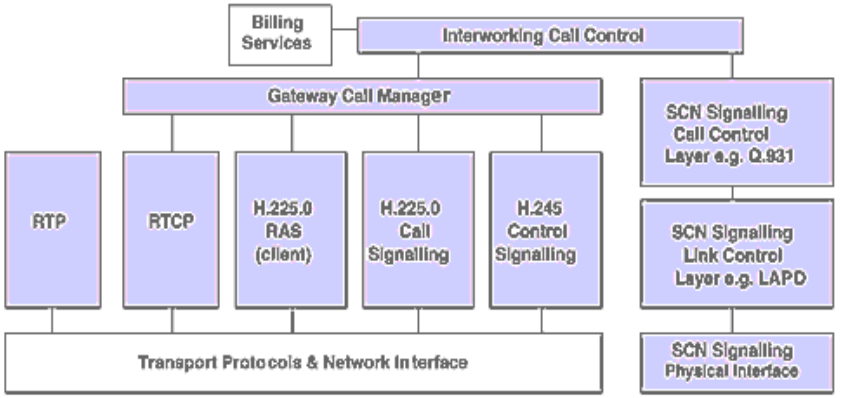


• All terminals must be capable of encoding and decoding speech according to G.711. Terminals shall be capable of transmitting and receiving A-law and u-law encoded voice. The rest is optional as well as video and data.

H.323 components - Gateway

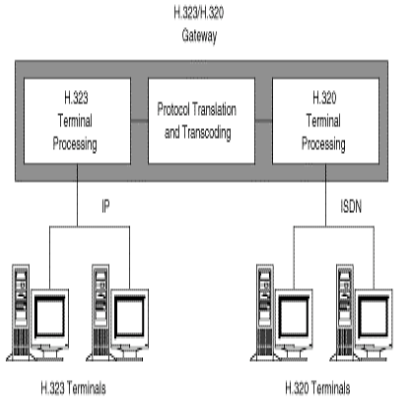
- Connect a H.323 based network to other networks such as ISDN, B-ISDN and PSTN
  - **not required for communication within a H.323 network**
- Provides both network and application level interworking
  - **translates protocols for call setup and release**
  - **converts media formats between different networks**
- Logically split into:
  - **Signaling Gateway and Media Gateway Controller (MGC)**
    - handle H.225.0 RAS messaging with an external gatekeeper
    - optionally handle the SS7 and/or H.323 signalling interfaces
  - **Media Gateway (MG)**
    - terminates IP and PSTN network interfaces
- A MGC controls one or more MGs
  - **H.248/Megaco/MGC protocol has been developed for the interface between MGC and MG**

H.323 Gateway Protocol Stack



Example of H.323 Gateway

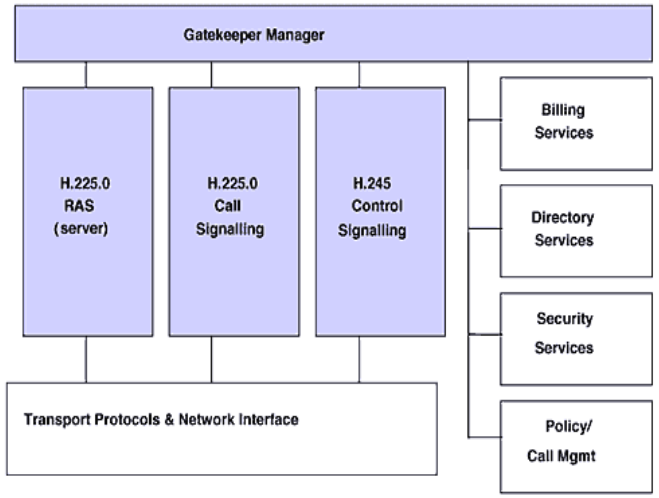
- Call Control and Session Control interworking
  - **H.225 RAS and Call control ↔ Q.931/Q.2931 on ISDN**
  - **H.245 ↔ H.242 on ISDN**
  - **MF tones for speech only terminals on SCN side**
- Voice and/or video transcoding
  - **H.263 ↔ H.261**
  - **G.723.1 ↔ G.711 (PCM)**
- Performs call setup and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



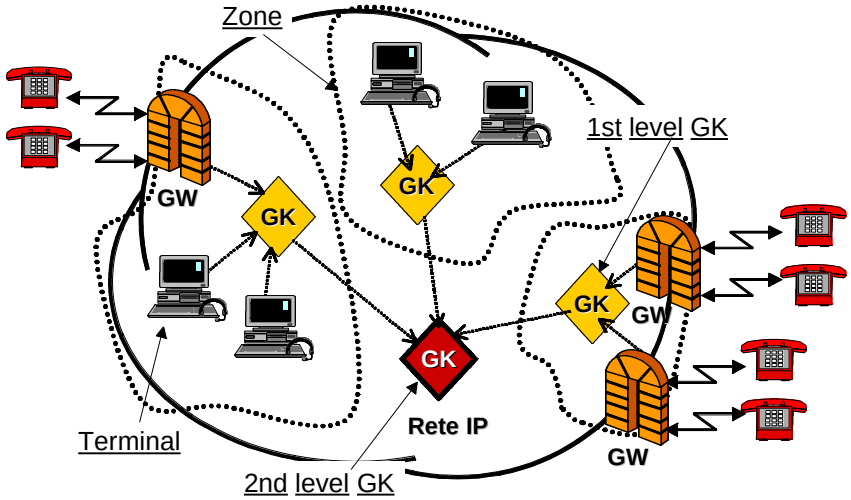
H.323 components - Gatekeeper

- The network control point for a part of a H.323 network
  - **Acts as Registration, Admission and Call Control server, Address Translator and Gateway Localization**
  - **Optional for small networks**
  - **Each GK control a "Zone"**
- Mandatory services:
  - **Address Translation (E.164 to Transport Network address)**
  - **Admissions Control**
  - **Bandwidth Control**
  - **Zone Management**
- Optional services:
  - **Call Management and Signaling relay**
  - **Authorization and Authentication of terminals and GWs**
  - **Accounting and Billing**
  - **Supplementary services**

H.323 Gatekeeper Protocol Stack



H.323 Network Architecture

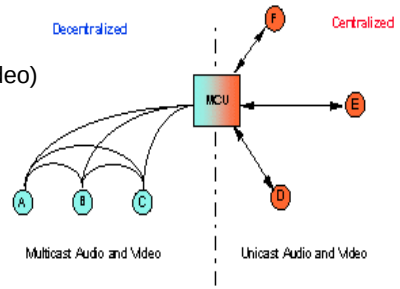


H.323 components - MCU

- Multipoint Conference Unit (MCU) - Endpoint that allows three or more terminals and/or gateways to participate at a conference
  - **All terminals participating in the conference establish a connection with the MCU**
  - **Manages conference resources**
  - **Negotiates between terminals for the purpose of determining the audio or video coder/decoder (CODEC) to use**
  - **May handle the media stream**
- Consists of two logical entities:
  - **Multipoint Controller (MC)**
    - controls the conference resources and H.245 negotiation between terminals
  - **Multipoint Processor (MP)**
    - mixes, switches and processes the information streams upon request from the MC

Multipoint Conferences

- Three type of conference configurations:
  - **Centralized Conferencing**
    - all audio/video/data and control streams goes via MC, MP can do conversions on data streams
  - **Decentralized Conferencing**
    - MC does control, data streams go from terminal to terminal
  - **Hybrid Conferencing**
    - One component may be centralized (e.g. audio) while the other can be decentralized (e.g. video)



H.323 components

- MC and MP (optional) can be co-located or separated
- The gatekeepers, gateways, and MCUs are logically separate components of the H.323 standard but can be implemented as a single physical device

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**

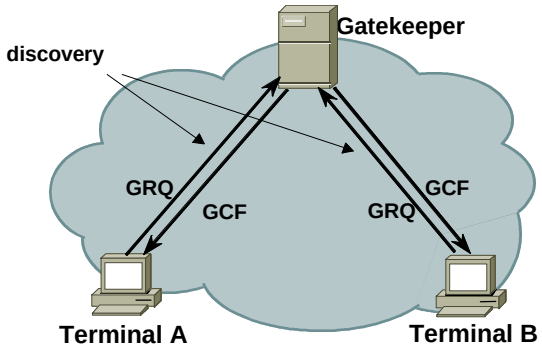
H.225.0/RAS signalling protocol

- 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)

H.225.0/RAS signalling protocol (Cont.)

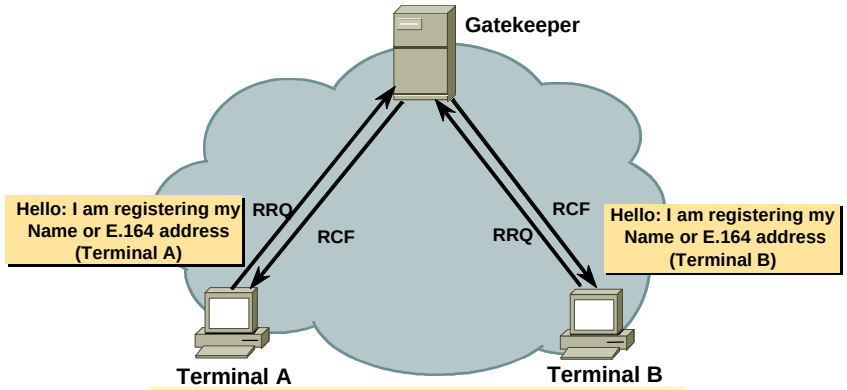
- **Endpoint location - between GKs**
  - LRQ/LCF/LRJ location messages
- **Admission - communication request**
  - ARQ/ACF/ARJ admission messages
  - ARQ specifies also the requested Call Bandwidth
- **Bandwidth changes - for bandwidth modification during a call**
  - BRQ/BCF/BRJ messages
- **Status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

RAS: Gatekeeper dicovery



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

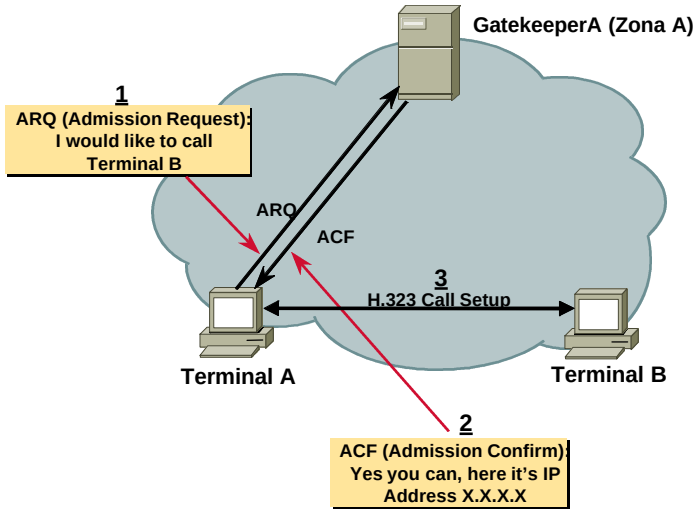
RAS: Endpoint registration



RAS - Registration Admission and Status

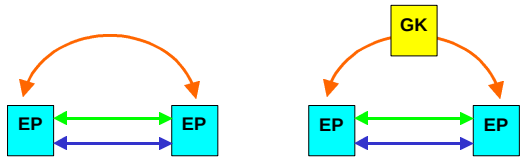
UDP Transport Port 1719
RRQ - Registration Request
RRJ - Registration Reject
RCF - Registration Confirm

Intra-zone call



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.)

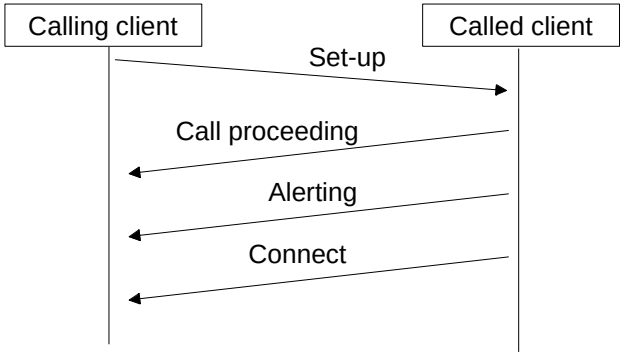


Direct EP call signalling

GK routed call signalling

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

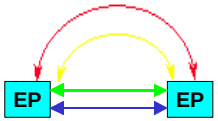
Q.931 signalling (Set-up)



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)**

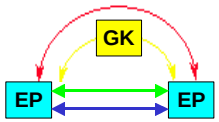
H.225/H.245 session models



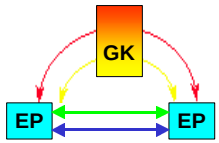
Session Control (H.245)
Call Control (H.225)
Voice
Video

EP = Term, GW, MCU

Direct signalling

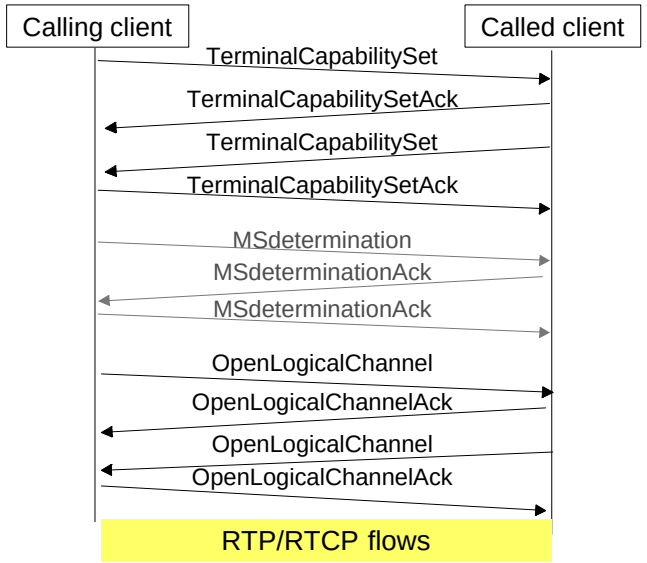


GK routed call signalling

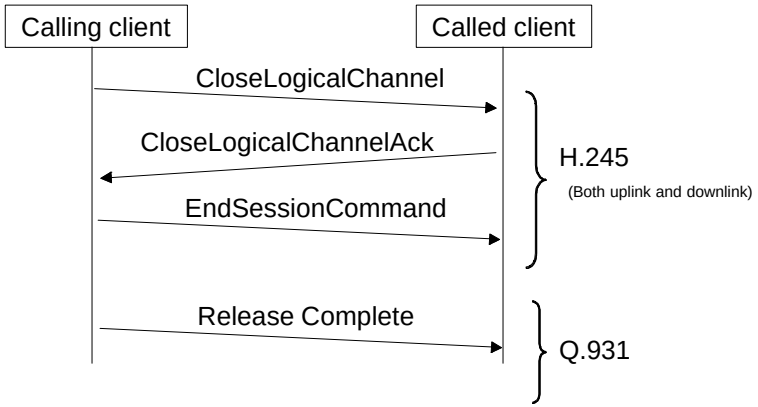


GK routed H.245

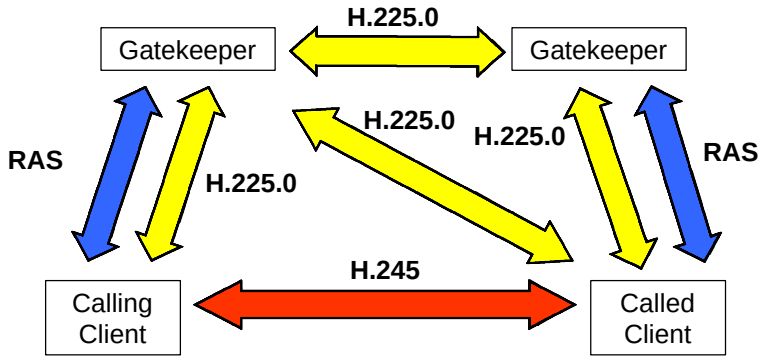
H.245 signalling (after connect)



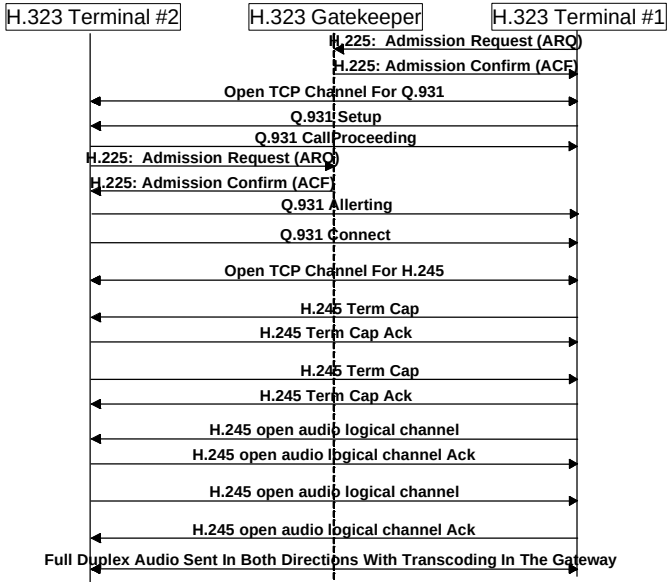
Closing connection



Signaling overview



Call Setup flow overview (with gatekeeper)



Addresses

- Call Signalling Transport address = IP address + TCP/UDP port
  - **TCP well-known port is 1720**
- Alias address, one or more addresses associated to a terminal, GW or MCU
  - **unique within a zone**
  - **E.164 numbers**
  - **H.323 IDs including e-mail like names**
  - **translated into call signaling TSAP address by GK**