



H.323

Chapter 4



Introduction

- We have learned
 - IP, UDP, RTP (RTCP)
- How does one party indicate to another a desire to set up a call?
- How does the second party indicate a willingness to accept the call?
- The set-up and tear-down of the sessions
 - Signaling
- In traditional telephony networks
 - ISUP, Integrated Services Digital Network User Part
 - A component of the Signaling System 7 (SS7)



H.323, ITU-T Recommendation

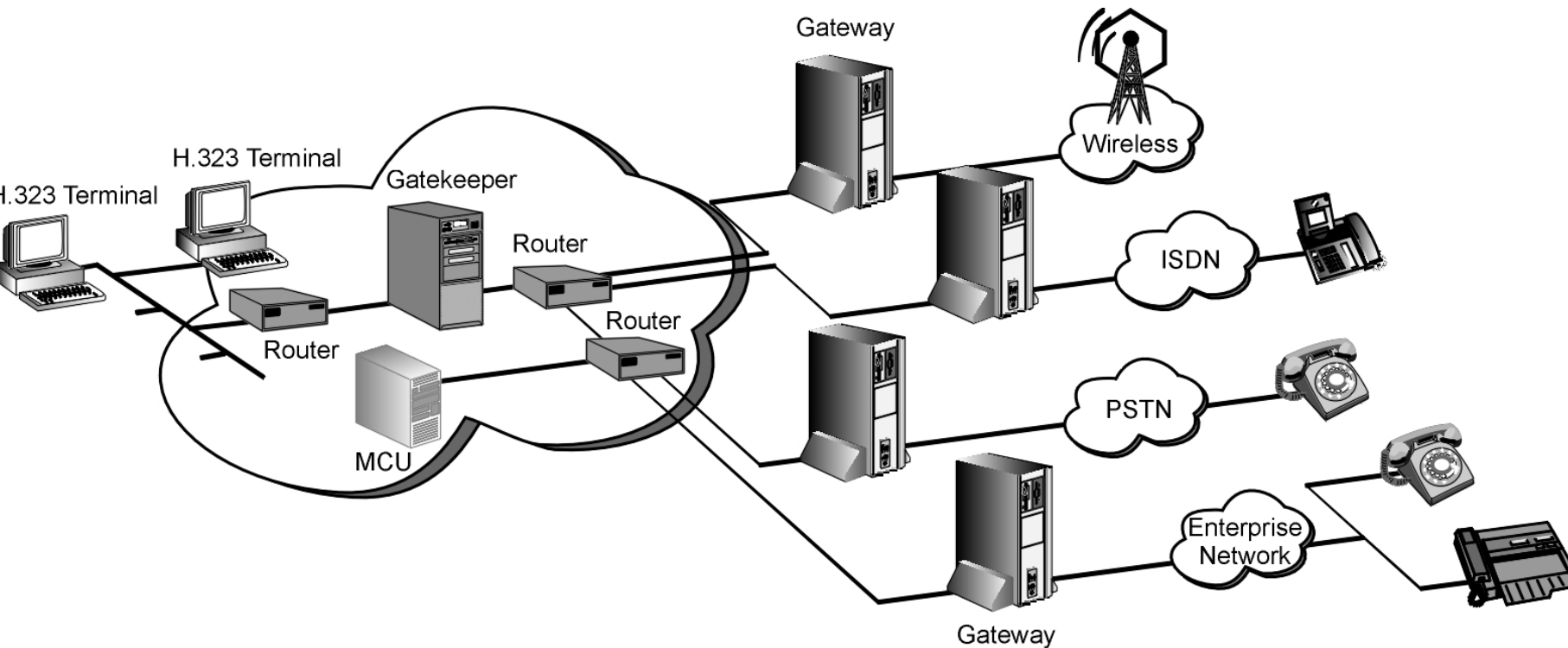
- The 1st version, 1996
 - Visual Telephone Systems and Equipment for Local Area Network which Provide a Non-Guaranteed Quality of Service
 - Its scope was multimedia communications over LAN.
- Version 2, 1998
 - Packet-based Multimedia Communications Systems
 - Widely implemented in VoIP solutions
- The most recent version is H.323 version 4.



The H.323 Architecture

- Entities
 - Terminals
 - Gateways
 - Gatekeepers
 - Multipoint Control Unit (MCU)
- Protocols
 - Registration, Admission and Status (RAS) Signaling
 - Call Signaling (Q.931)
 - H.245
 - RTP/RTCP
 - Audio/video codecs
- The objective of H.323 is to enable the exchange of media streams between H.323 endpoints (e.g., terminal, gateway, MCU)

H.323 Architecture

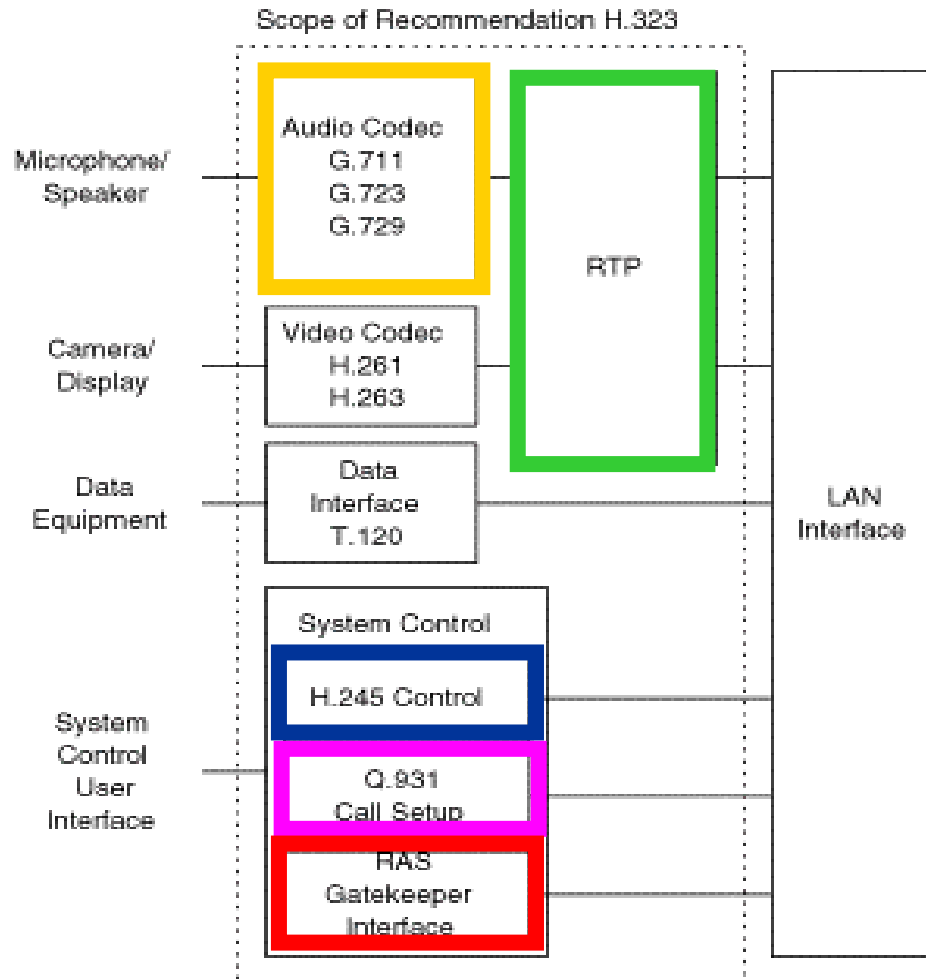




Terminals [1/2]

- Offering real-time, two-way communications with other H.323 endpoints
- Must support:
 - Voice - audio codecs
 - Signaling and setup - Q.931, H.245, RAS
- Optional support:
 - Video
 - Data

Terminals [2/2]



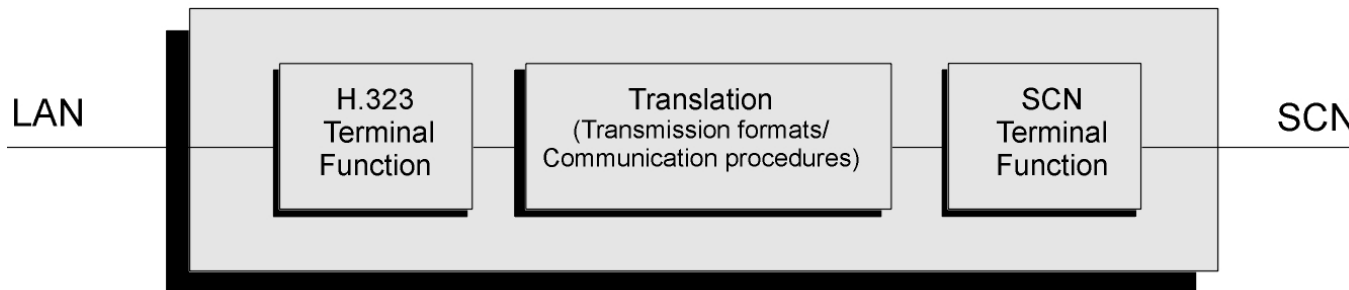


Gateways [1/2]

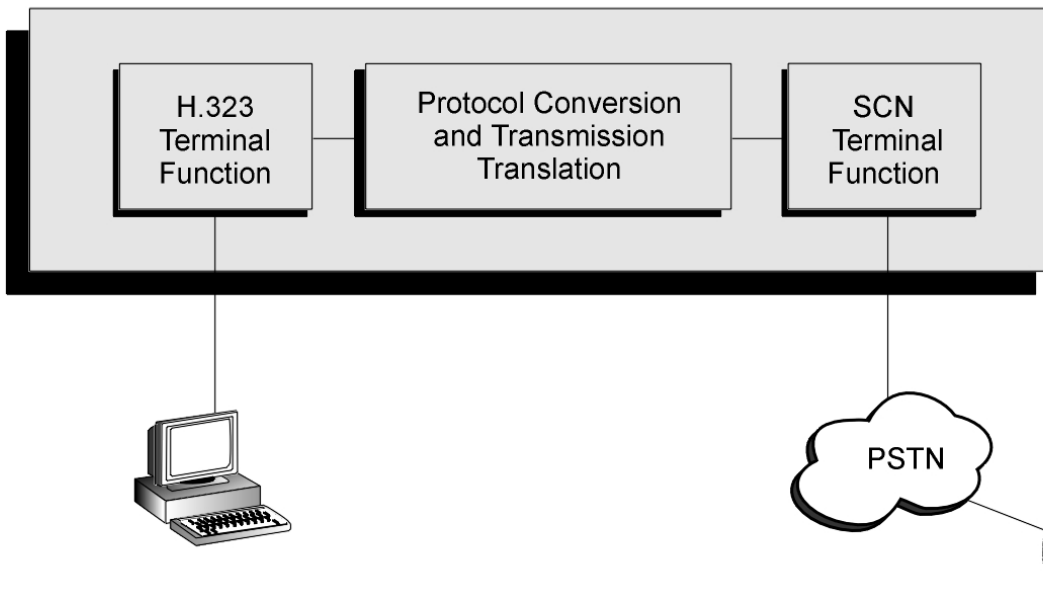
- Interface between the LAN and the switched circuit networks (e.g., ISDN, GSM, PSTN)
- Mandatory Functions
 - Transmission Format Translation
 - Communication Procedure Translation
 - Call Setup and Clearing On Both Sides
- Optional Function
 - Media Format Translation
- Example: IP/PSTN gateway

Gateways [2/2]

Gateway Function



IP/PSTN Gateway



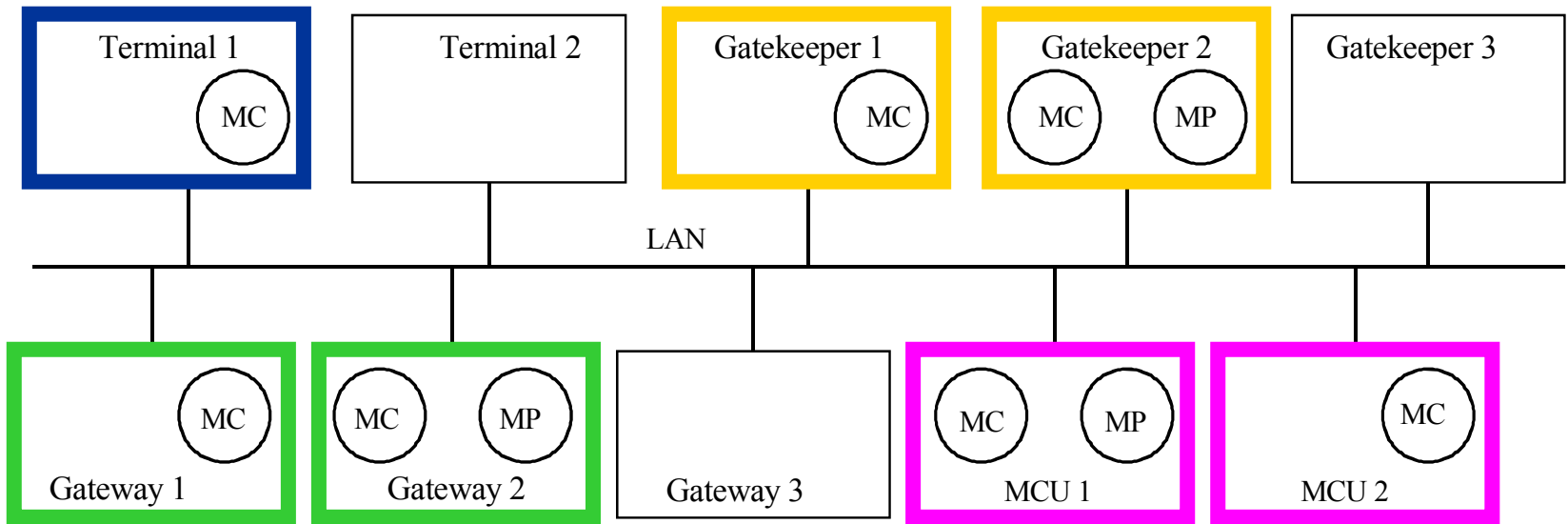


Multipoint Control Unit [1/2]

- MCU
 - Endpoint that supports conferences between 3 or more endpoints
 - Can be stand-alone device or integrated into a gateway, gatekeeper or terminal
- Typically consists of multi-point controller (MC) and multi-point processor (MP)
 - MC - handles control and signaling for conference support (controls multipoint conference)
 - MP - receives streams from endpoints, processes them, and returns them to the endpoints in the conference (provides media switching or mixing)

Multipoint Control Unit [2/2]

- MC and MP



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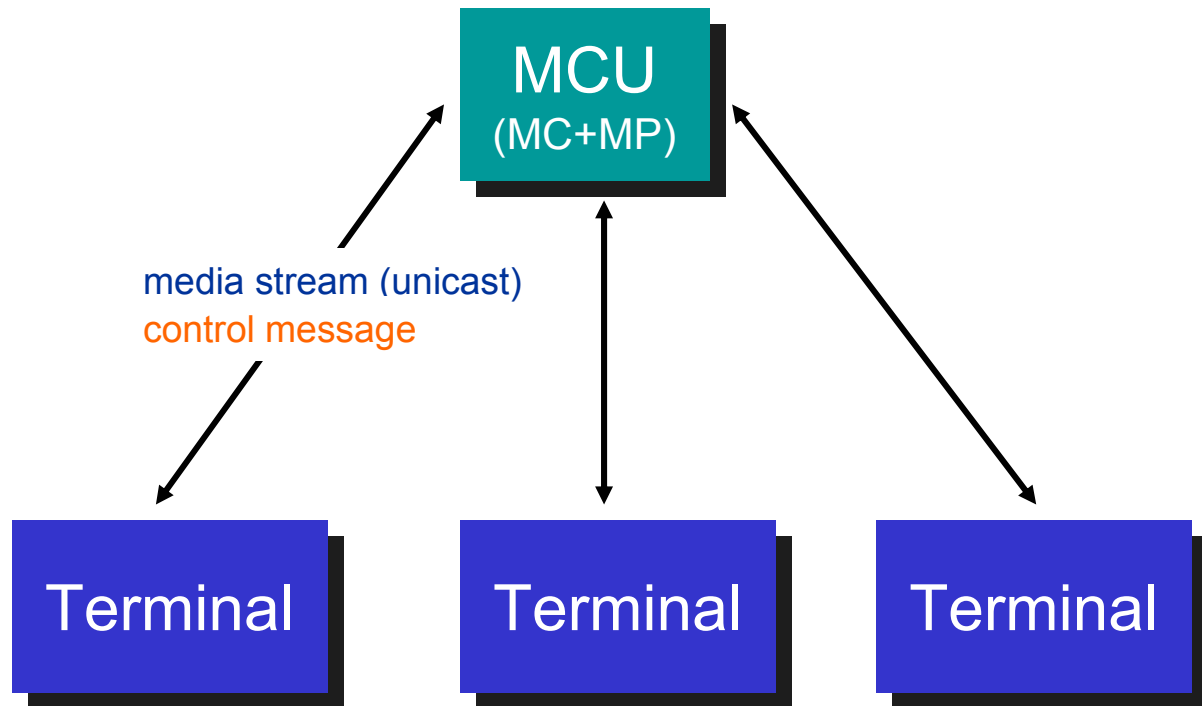


Multipoint Conference

- A Conference Between **Three or More** Endpoints
- Controlled by an **MC**
- Types
 - **Centralized**
 - **Decentralized**
 - **Mixed**

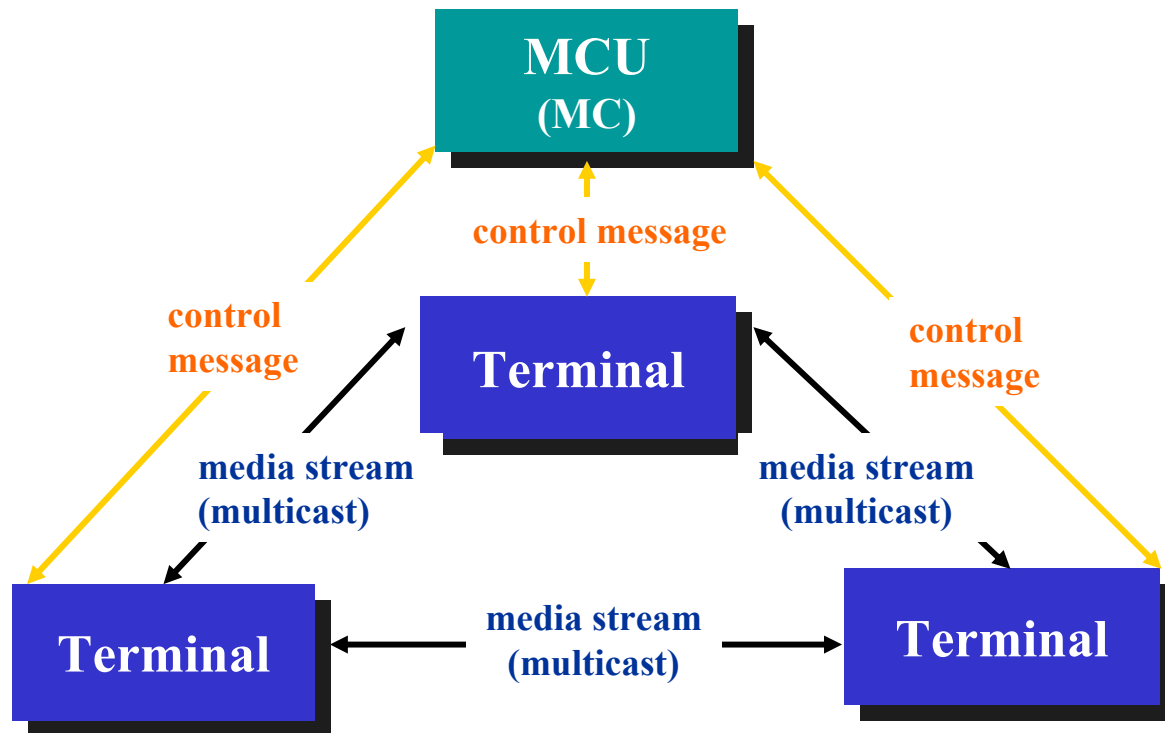
Centralized Conference

- MCU handles both signaling (MC) and stream processing (MP)

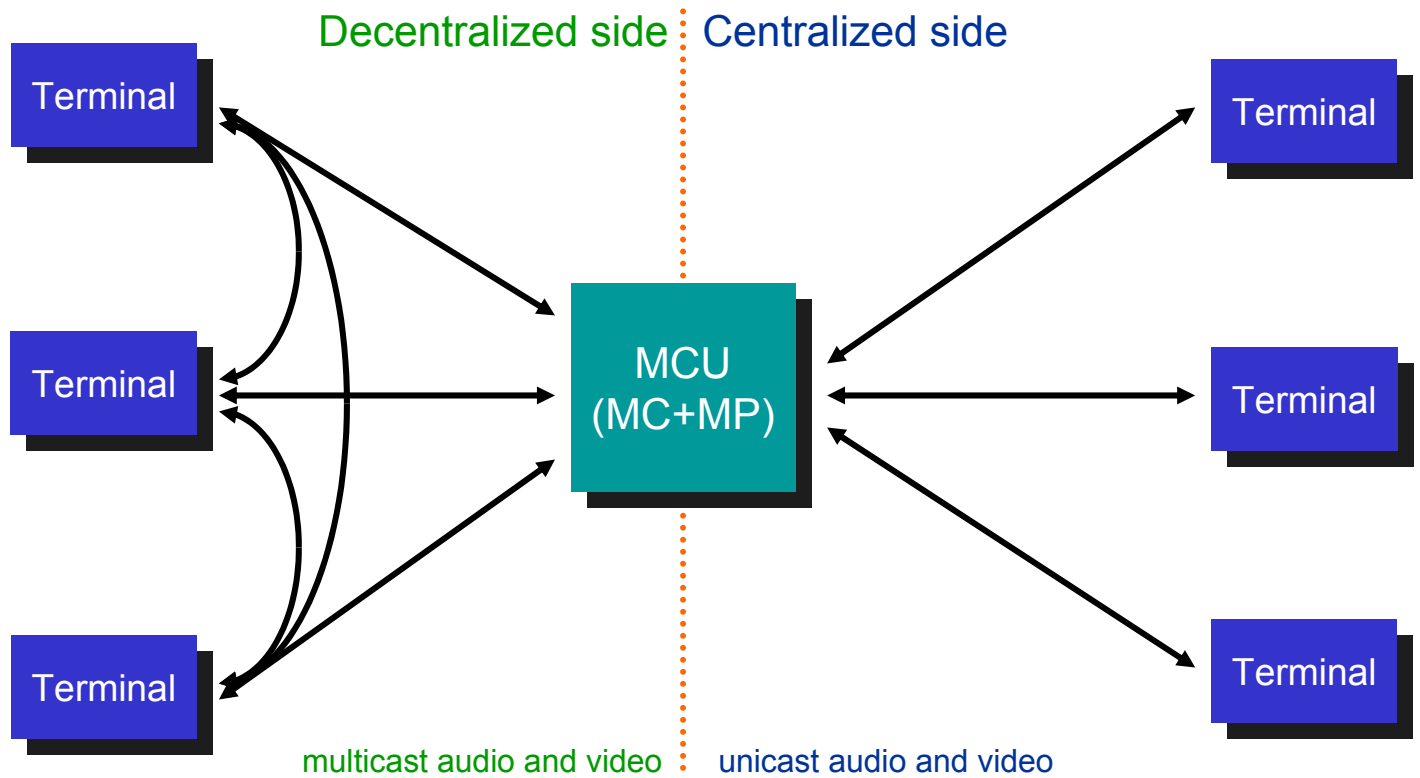


De-centralized Conference

- MCU handles only signaling
 - streams go directly between endpoints
 - In this case MCU functions without MP



Mixed Conference

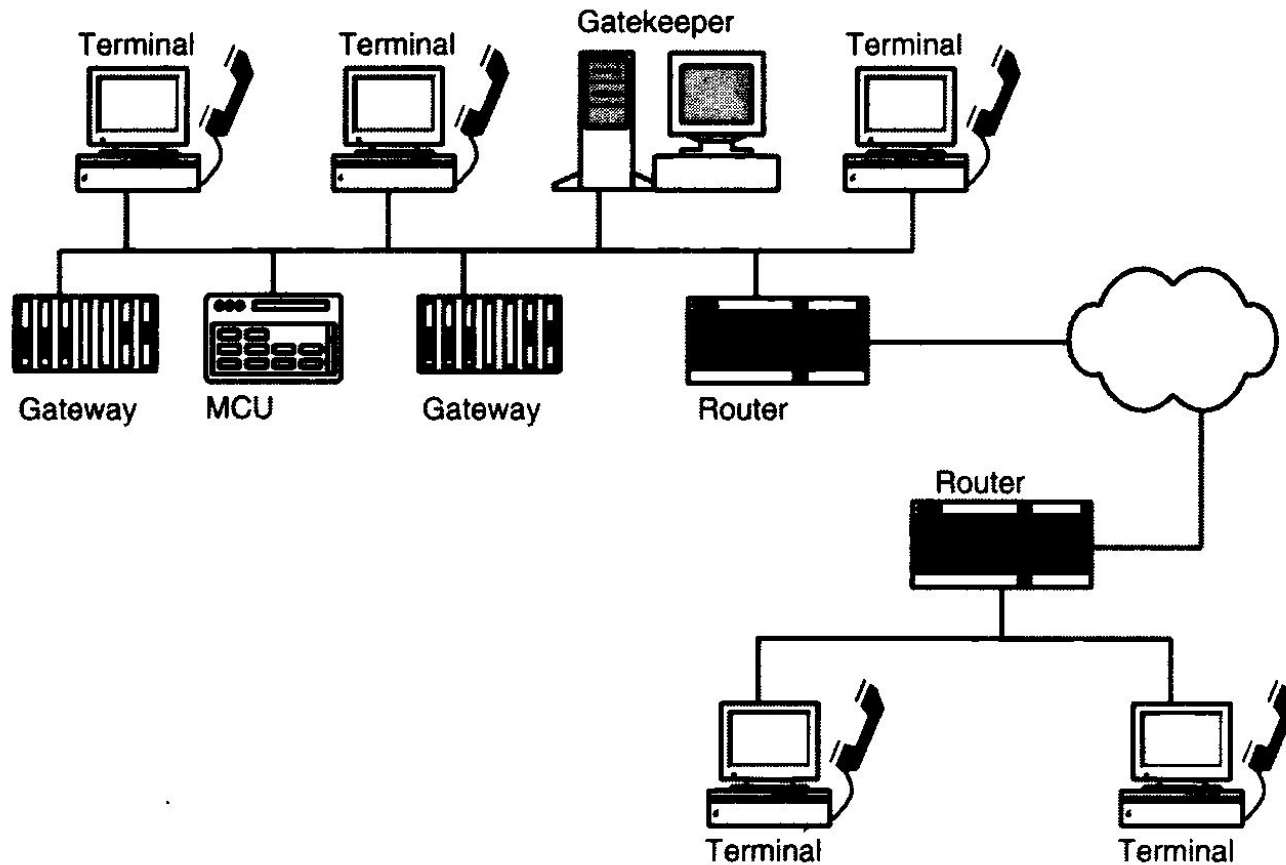




Gatekeepers

- Optional, but must perform certain functions if present
 - e.g., Netmeeting does not use gatekeepers?
- Authorize network access
 - Manage a zone (a collection of H.323 endpoints)
 - Terminals, gateways, multipoint controllers (MCs)
 - Ensure QoS if used in conjunction with bandwidth and/or resource management techniques
- Usually one gatekeeper per zone
 - Alternate gatekeeper might exist for backup and load balancing.
- Mandatory functions:
 - Address translation (routing)
 - Admission control
 - Bandwidth control
 - Zone management

H.323 Zone





Overview of H.323 Signaling [1/2]

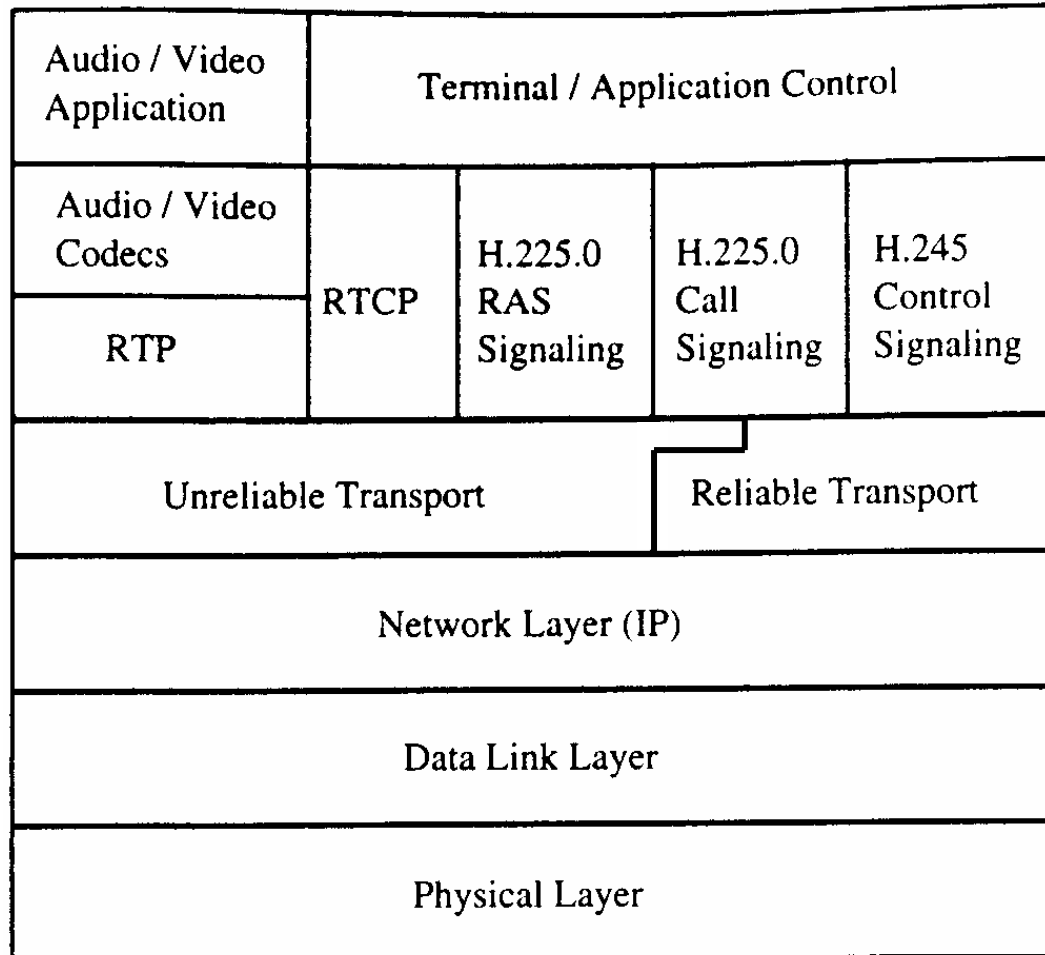
- Audio codecs (G.711, G.723.1, G.728, etc.) and video codecs (H.261, H.263)
- Media streams transported on RTP/RTCP
 - RTP carries actual media
 - RTCP carries status and control information
- RTP/RTCP carried unreliably on UDP
- Signaling
 - RAS - registration, admission, status (over UDP)
 - Q.931 - call setup and termination (over TCP or UDP)
 - H.245 - capabilities exchange (over TCP)



Q.931 Over TCP or UDP?

- The establishment of a TCP connection takes a little time, which can lead to a delay in call setup.
- Both TCP and UDP can be used in parallel.
 - The sending entity sends the first message using UDP and simultaneously establishes a TCP connection.
 - If no response has been received, the TCP connection is used.

H.323 Protocol Stack





Overview of H.323 Protocols [1/2]

- H.225.0, a two-part protocol
 - A variant of ITU-T recommendation Q.931, the ISDN layer 3 spec.
 - The set-up and tear-down of connections between H.323 endpoints
 - Call signaling or Q.931 signaling
 - RAS signaling
 - Registration, Admissions, and Status
 - Between endpoints and gatekeepers
 - Used by a gatekeeper to manage the endpoints within its zone



Overview of H.323 Protocols [2/2]

- H.245, control protocols
 - Used between two or more endpoints
 - Manage the media streams of a session
 - Capability exchange
- RAS, Q.931 and H.245
 - RAS to obtain permission from a gatekeeper
 - RAS channel
 - Q.931 to establish communication and set up the call
 - Call-signaling channel
 - H.245 to negotiate media parameters
 - H.245 control channel
 - Media streams over logical channels



H.323 Addressing

- An entity in the H.323 network has
 - A network address (e.g., an IP address)
 - URL, Uniform Resource Locator
 - E.g., ras://GK1@somedomain
- The TSAP, Transport Service Access Point
 - An id for a particular logical channel at a given entity
 - Socket address
 - GK UDP Discovery Port = 1718
 - GK UDP Reg. and Status Port = 1719
 - Call-signaling TCP or UDP Port = 1720
 - Registered with IANA



- Terminal and gateways

- Have one or more aliases

- Can take any number of forms

- Must be unique within a zone

- E.164 number

- It can correspond to the telephone numbers that are reachable at the PBX (private branch exchange).

- Codecs

- Video codec is optional

- G.711 (A-law and mu-law) is mandatory



RAS Signaling [1/2]

- Used between a GK and endpoints in its zone
- Functions
 - **GK Discovery** enables an endpoint to determine which gatekeeper is available to control it.
 - **Registration/Unregistration** enables an endpoint to register/unregister with a particular gatekeeper.
 - **Admission** is used by an endpoint to request access to the network for the purpose of participating in a session.
 - **Bandwidth Change**
 - Used by an endpoint to request the gatekeeper to allocate extra bandwidth to the endpoint
 - Used by a gatekeeper to instruct an endpoint to reduce the amount of bandwidth consumed.



RAS Signaling [2/2]

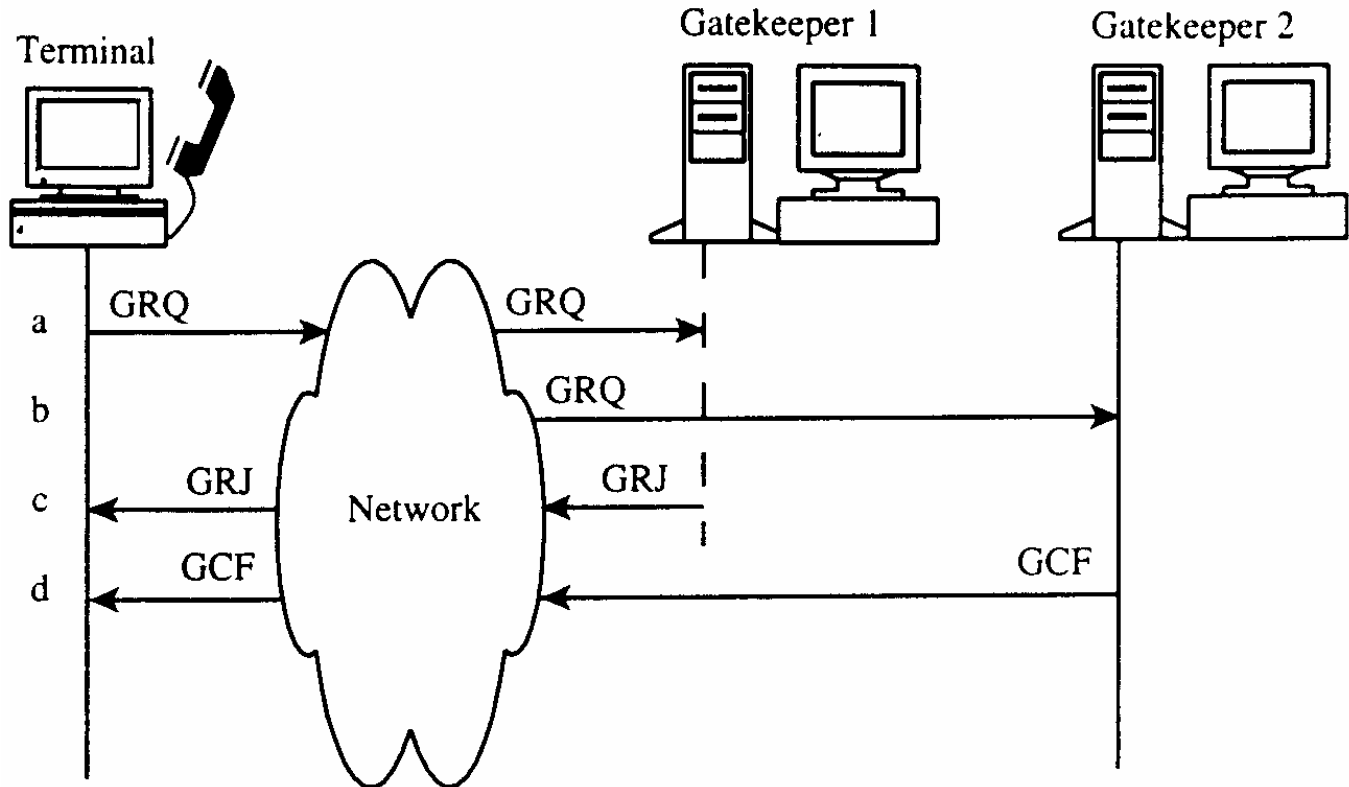
- **Endpoint Location**
 - The gatekeeper translates an alias to a network address.
- **Disengage** is used by an endpoint to inform a gatekeeper that it is disconnecting from a particular call.
- **Status** is used between the gatekeeper and endpoint to inform the gatekeeper
 - About the health of an endpoint
 - About certain call-related data, such as current bandwidth usage
- **Resource Availability (GW → GK)**
 - Used to inform the gatekeeper of an endpoint's currently available capacity
- **Non-standard**

Gatekeeper Discovery [1/2]

- Find a suitably accommodating GK
 - The static GK assignment is not suitable for the scenarios of load sharing or backup mode.
- GRQ – GK-request
 - Known addresses, multicast 224.0.1.41:1718
 - GK id: if empty, soliciting GKs
 - Will someone be my gatekeeper?
- GCF – GK-Confirm
 - Optionally, indicating one or more GKs to try. (With the parameter “AlternateGatekeeper”)
 - I cannot help you, but try the GK next door.
 - For load sharing or redundancy schemes
 - Only one GK can be chose.
- GRJ – GK-Reject
 - With a reason (e.g., a lack of resource)

Gatekeeper Discovery [2/2]

- GK Discovery





Endpoint Registration

- To become controlled by a GK
- RegistrationRequest (RRQ)
 - RAS signaling port is 1719
 - Includes
 - An address for RAS messages
 - An address for call-signaling messages
 - An alias
 - Optional TTL, keepAlive parameters
 - RegistrationReject (RRJ)
 - RegistrationConfirm (RCF)
 - May assign an alias
 - May lower TTL



Registration Cancellation

- UnregistrationRequest (URQ)
 - Cancel registration
 - By endpoints
 - By GKs
 - TTL has expired.
- UnregistrationConfirm (UCF)
- UnregistraionReject (URJ)
 - The endpoint is attempting to cancel a registration while still involved in a call.



Endpoint Location

- Request a real address of an alias
- LocationRequest (LRQ)
 - To a GK (unicast) or the GK discovery multicast address
 - A GK can also send an LRQ to another GK.
- LocationConfirm (LCF)
 - A call-signaling address
 - An RAS signaling address
- LocationReject (LRJ)
 - The endpoint is not registered



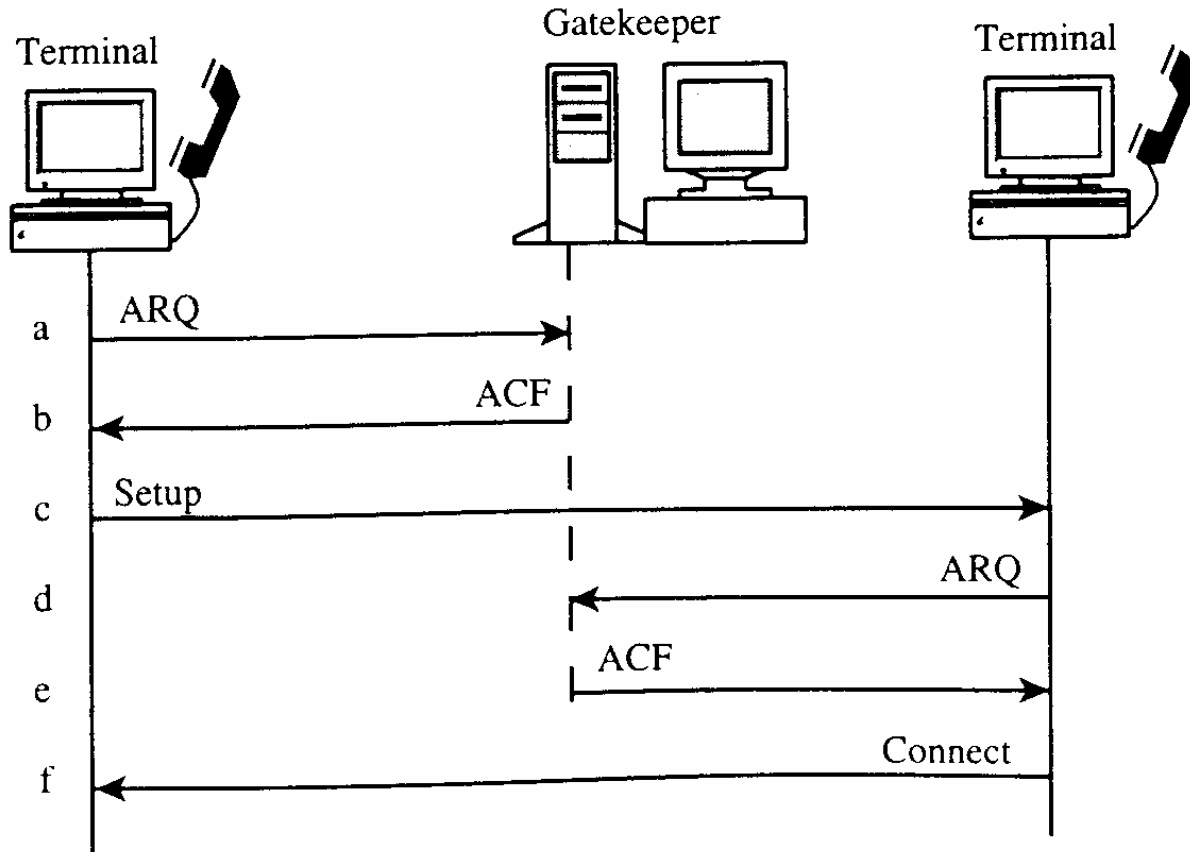
Admission [1/2]

- Request permission from a GK to participate in a call
- AdmissionRequest (ARQ)
 - The type of the call (e.g., two-party or multi-party)
 - The endpoint's own id
 - A call identifier (a unique string)
 - A call-reference value (an integer used in Q.931 messages for the same call)
 - Information of the other party
 - Aliases
 - Signaling address (optionally)
 - Bandwidth (mandatory)
 - TransportQOS: endpoint or GK to reserve the resource

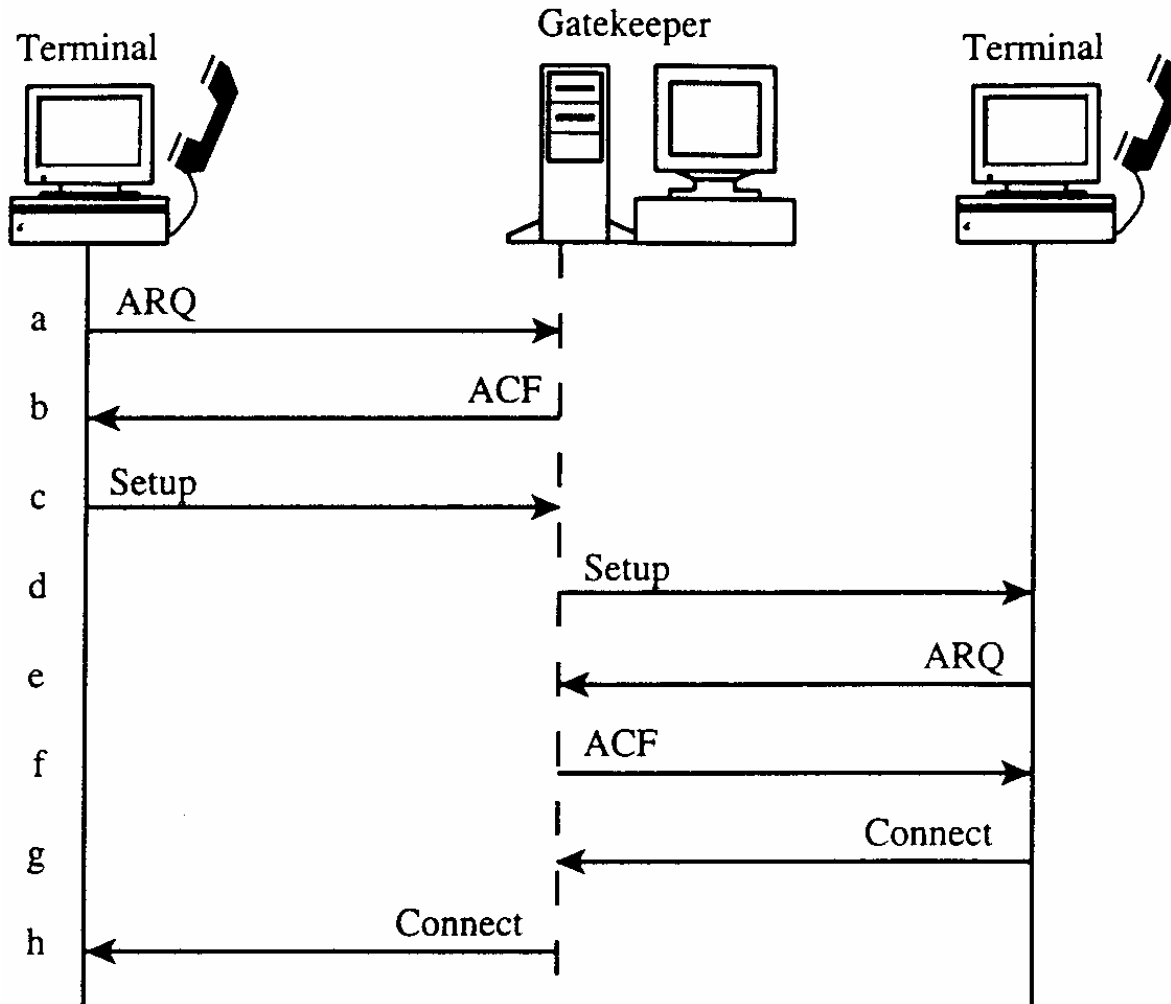
Admission [2/2]

- AdmissionConfirm (ACF)
 - Many of the same parameters as ARQ
 - A firm order from the GK
 - callModel
 - Optional in ARQ; mandatory in ACF
 - The endpoint sends call signaling directly or via the GK
- AdmissionReject (ARJ)
 - With a reason (lack of available bandwidth, incapability to translate a destination alias to a real address, and so on)
- Pre-granted admission
 - To minimize call setup delay, a gatekeeper can provide an endpoint with admission in advance (during registration).

Direct Call Signaling



GK-routed Call Signaling

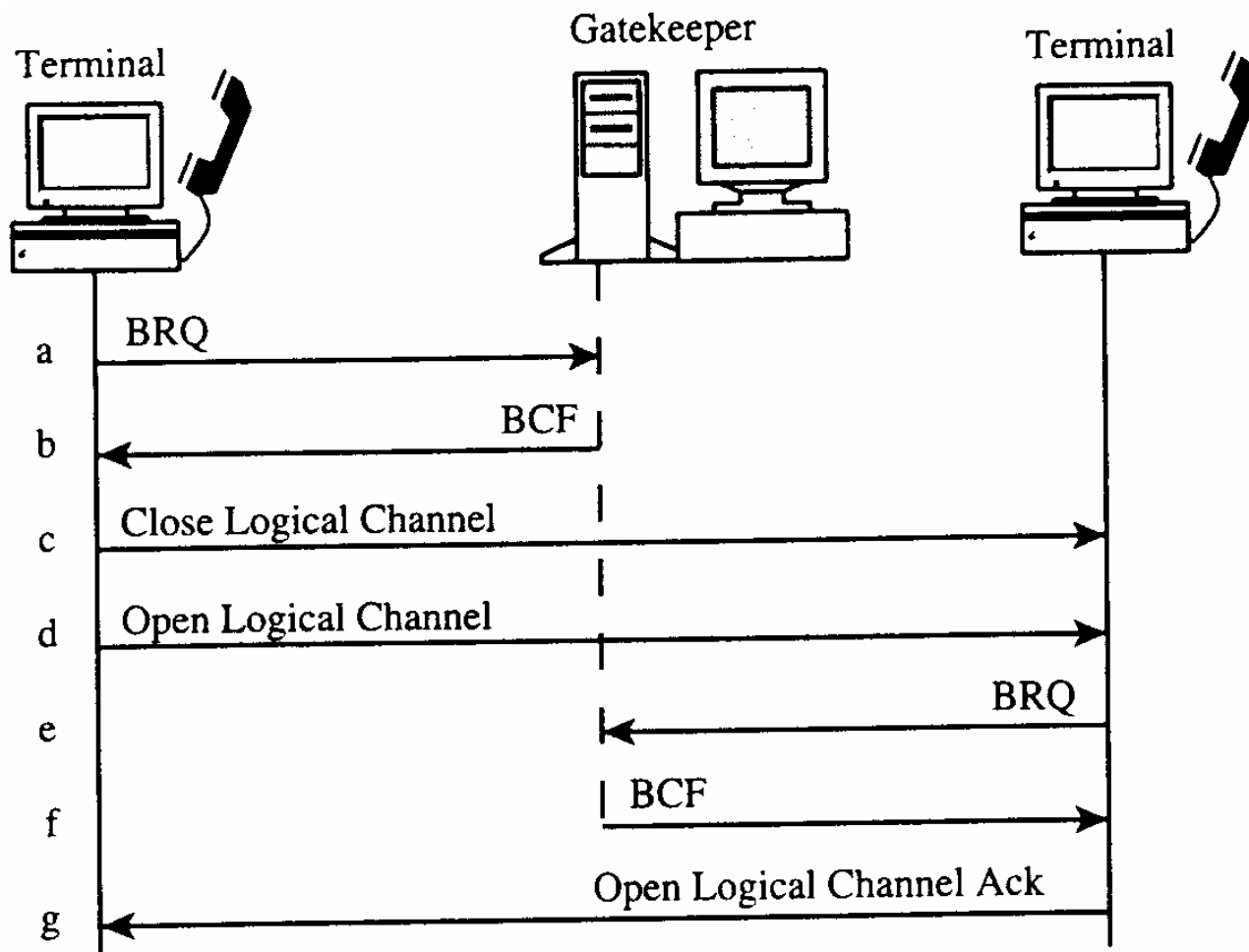




Bandwidth Change [1/2]

- Request an increase or decrease in allocated bandwidth
 - Can change without request if the changed bandwidth is within the limit in ACF
- BandwidthRequest (BRQ)
 - The new bandwidth requested
- BRJ
 - The endpoint must live with previous allocated bandwidth through the use of flow-control mechanisms.
- The GK can also request an endpoint to change the bandwidth
 - The endpoint must comply.
- Closely tied to H.245 signaling (for logical channels)
 - A reduction in bandwidth requires an existing logical channel to be closed and reopened with different parameters.

Bandwidth Change [2/2]





Status [1/2]

- A GK is informed of the status of an endpoint
- InformationRequestResponse (IRR)
 - Endpoint information
 - The active call information
 - Call id, call reference value, call type, the bandwidth
 - RTP session information (CNAME, RTP/RTCP address, etc.)
- The GK stimulate an endpoint to send an IRR in two ways.
 - IRQ
 - ACF (or RCF for pre-granted admission) with an irrFrequency parameter



Status [2/2]

- An IRR might or might not receive an acknowledgment.
 - The GK and endpoint jointly determine whether an acknowledgement is to be sent.
 - `willRespondToIRR` parameter in ACF, RCF messages
 - `needResponse` parameter in IRR message
- InfoRequestAck (IACK)
- InfoRequestNak (INACK)
 - An IRR message in error (e.g., from an unregistered endpoint)



Disengage

- The end of the call
- DisengageRequest (DRQ)
 - Call id, call reference value, a disengage reason (e.g., normalDrop)
- DCF & DRJ
- The GK might issue DRQ to an endpoint
 - The endpoint must
 - Close the session
 - Respond to the GK with a DCF message



- Resource Availability

- ResourceAvailableIndicate (RAI)

- A GW sends to a GK
- The available call capacity and bandwidth
- **almostOutOfResource** parameter

- ResourceAvailableConfirm (RAC)

- Service Control

- SCI (Service Control Indication) and SCR (Service Control Response)
- To enable advanced features



Request in Progress (RIP)

- A given request takes longer than expected.
- H.225.0 specifies recommended timeout periods for various messages.
- If an entity cannot respond to a request within the applicable timeout period, then it should send an RIP message indicating
 - The expected delay and the reason



Call Signaling

- For the establishment and tear-down of calls
- Q.931 modified by Rec. H.225.0
 - Reuse some messages with few modifications
 - A clever use of User-to-User information element
 - Convey all of the extra information needed in H.323
 - E.g., H.245 addresses to be used for logical channel



Setup

- The first call-signaling message
- Q.931 Protocol Discriminator
- A call reference
- Bearer Capability
 - Most of the fields are not used.
 - It may be used when the call has originated from outside the H.323 network and has been received at a gateway.
 - A gateway needs to perform the mapping
- User-to-User information element
 - Mandatory: call id, call type, the caller information
 - Optional: source alias, destination alias, H.245 address



- Call Proceeding

- Optional

- call-establishment procedures are underway

- Mandatory

- Protocol discriminator, call reference and message type

- User-to-user information element: destination information

- H.245 address of the called end (optional)

- Alerting

- The called user is being alerted

- Indicating specific alerting tone to the calling party (optional)

- The same parameters as Call Proceeding



- Progress

- Sent by a called gateway to indicate call progress in the case of interworking with a CS network
- Conveying in-band tones or announcements (optional)

- Connect

- The called party has accepted the call
- Must be sent if the call is to be completed
 - Call Proceeding and Alerting are optional
- User-to-User information
 - The same as Call Proceeding



- Release Complete

- Terminate a call

- No Release message

- In ISDN, Release and Release Complete

- Cause information element, optional

- Otherwise, a Release reason in User-to-User


- Facility (Q.932)

- A call should be redirected

- Also be used for supplementary services

- User-to-User contains reason parameter

- E.g., routeCallToGatekeeper

- 
- Interaction between Call Signaling and H.245 Control Signaling
 - Call signaling: call establishment and tear-down
 - H.245: the negotiation and establishment of media streams
 - The two signaling protocols are closely tied together.
 - When to begin the exchange of H.245 messages?
 - Between the Setup and Connect messages
 - Immediately after the Connect message
 - Equipment dependent

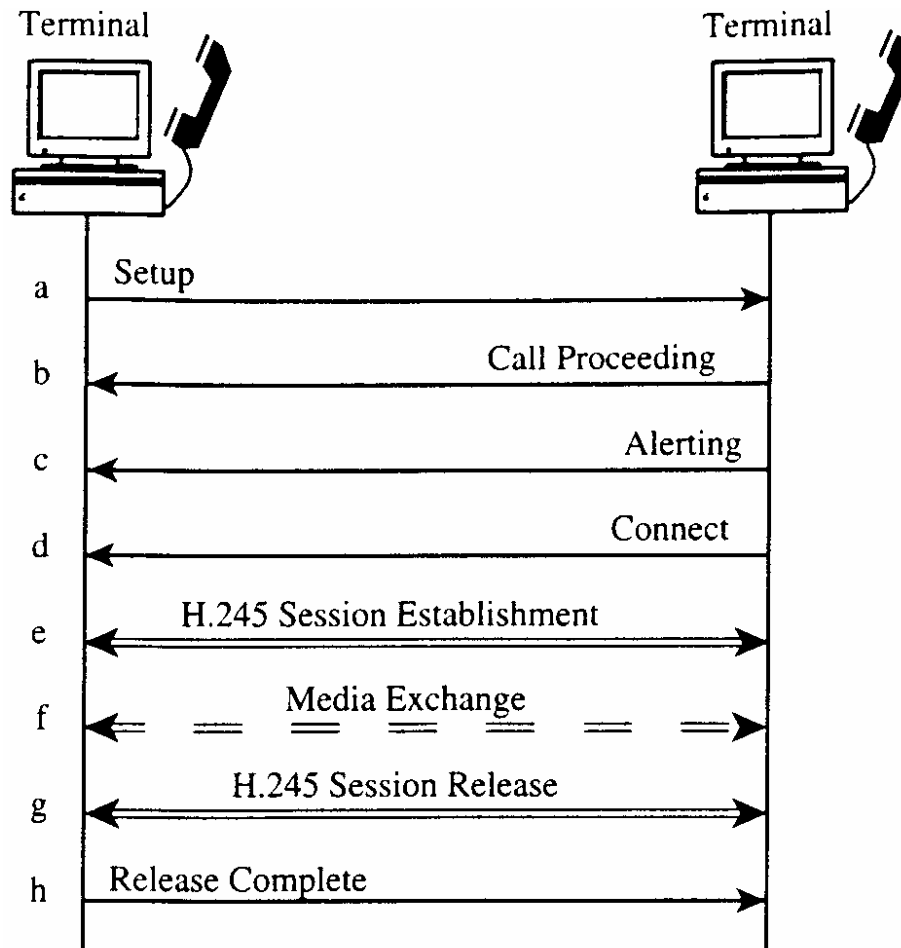


Life Cycle of a Call

- RAS Channel Setup (Optional)
- Call Signaling Channel Setup
- H.245 Control Channel Setup
- Logical Channel Setup
 - RTP/RTCP Channel (Audio & Video)
 - T.120 Data Channel (Data)

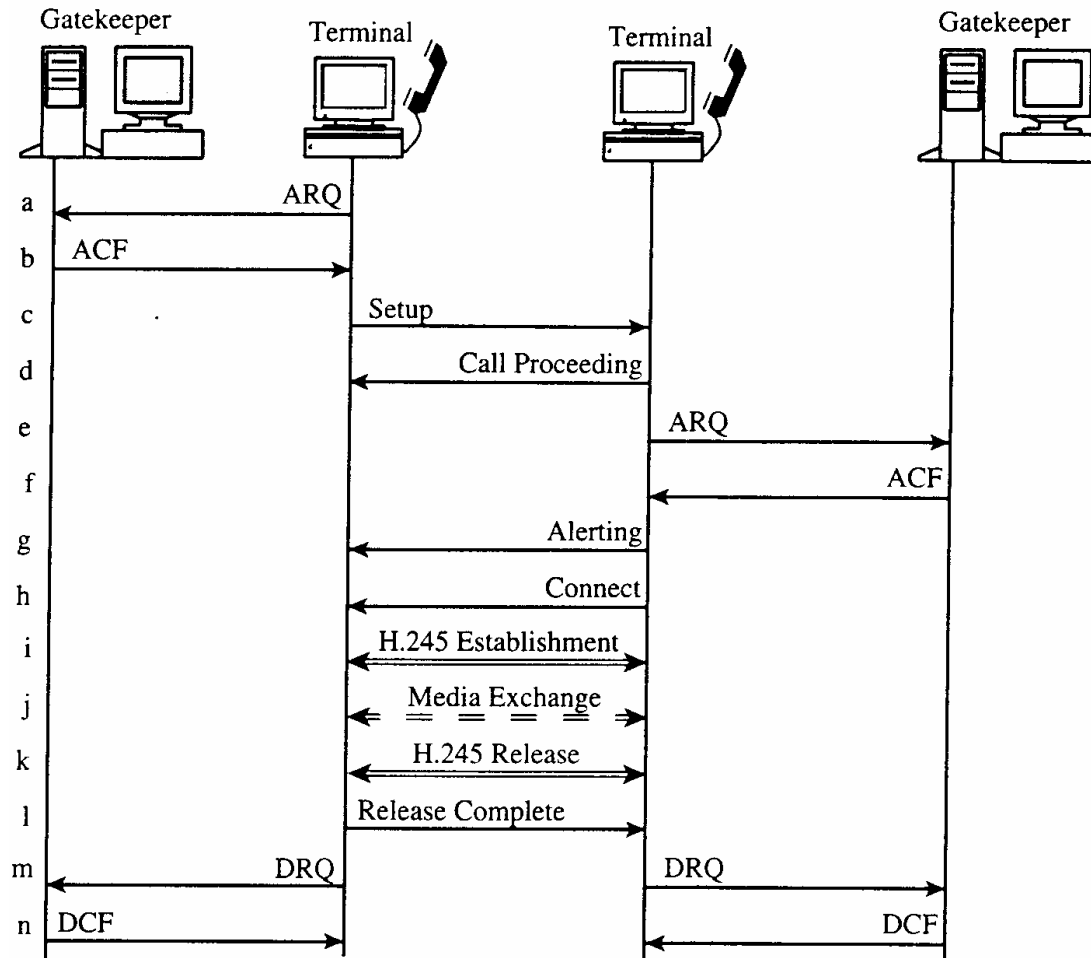
Call Scenarios [1/5]

- Basic Call without GKs

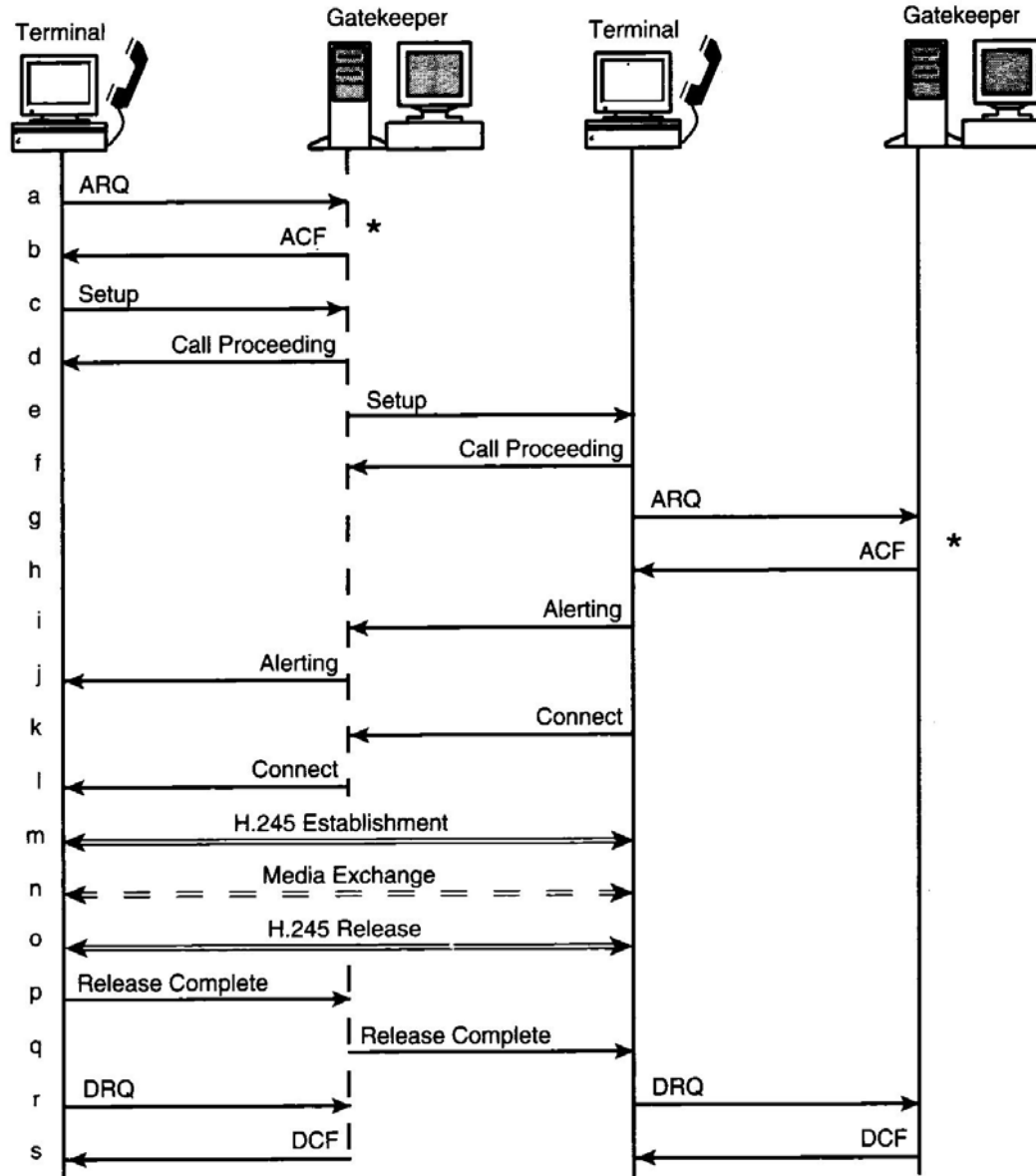


Call Scenarios [2/5]

- A Basic Call with GKs and Direct Endpoint Call Signaling

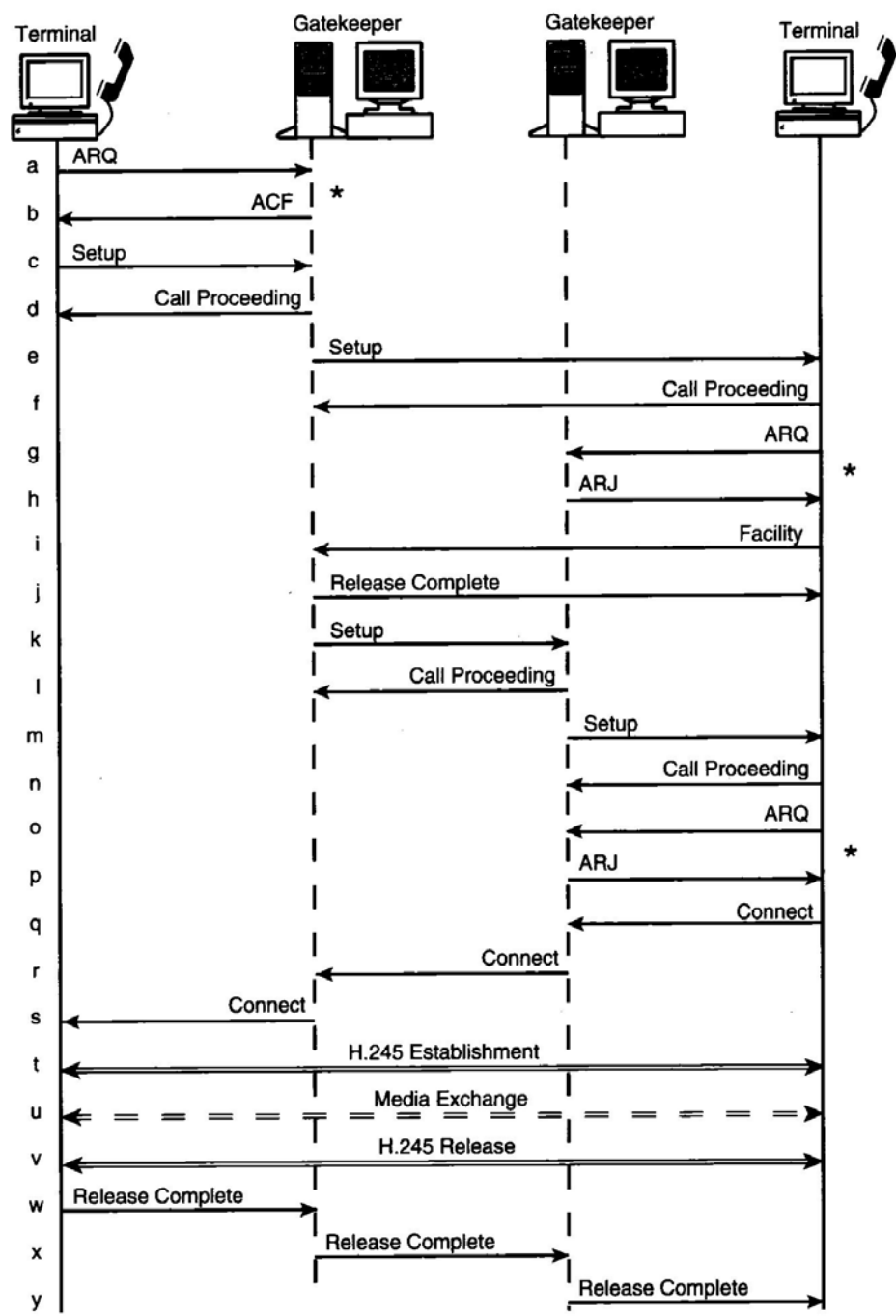


■ A Basic Call with GK/Direct Routed Call Signaling



A Basic Call with Gatekeeper-Routed Call Signaling

- ARJ with a cause code of routeCallToGatekeeper
- A Facility with a reason indicating the call be rerouted



Optional called-endpoint signaling

- LRQ, LCF

