



H.323



Introduction

- We have learned
 - IP, UDP, RTP (RTCP)
 - How voice is carried in RTP packets between session participants
- 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

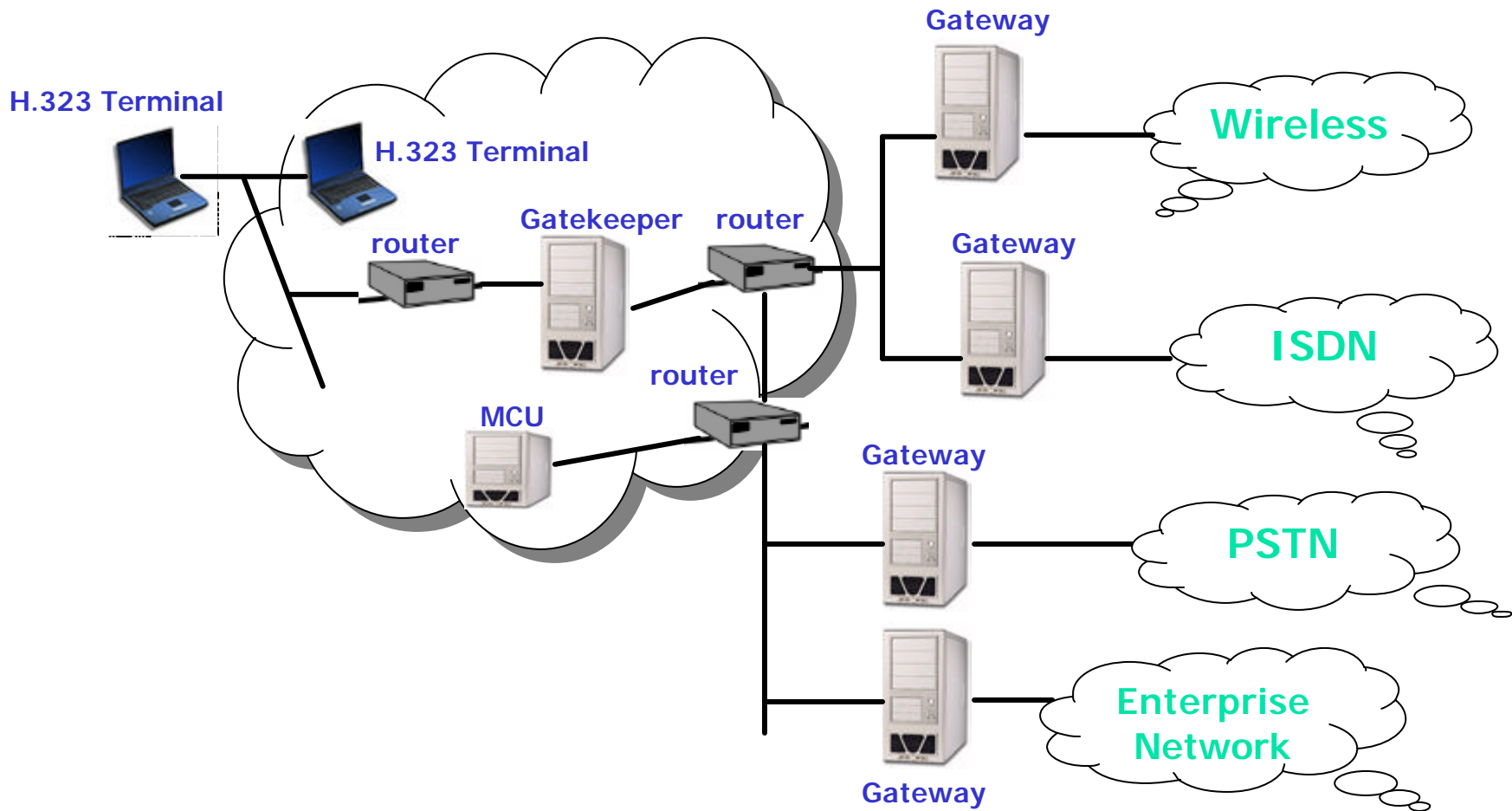
- The 1st version, 1996
 - Visual Telephone Systems and Equipment for Local Area Network which Provides a Non-Guaranteed Quality of Service
 - Its scope was multimedia communications over LAN.
- Version 2, 1998
 - Packet-based Multimedia Communications Systems
 - Widely implemented in VoIP solutions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

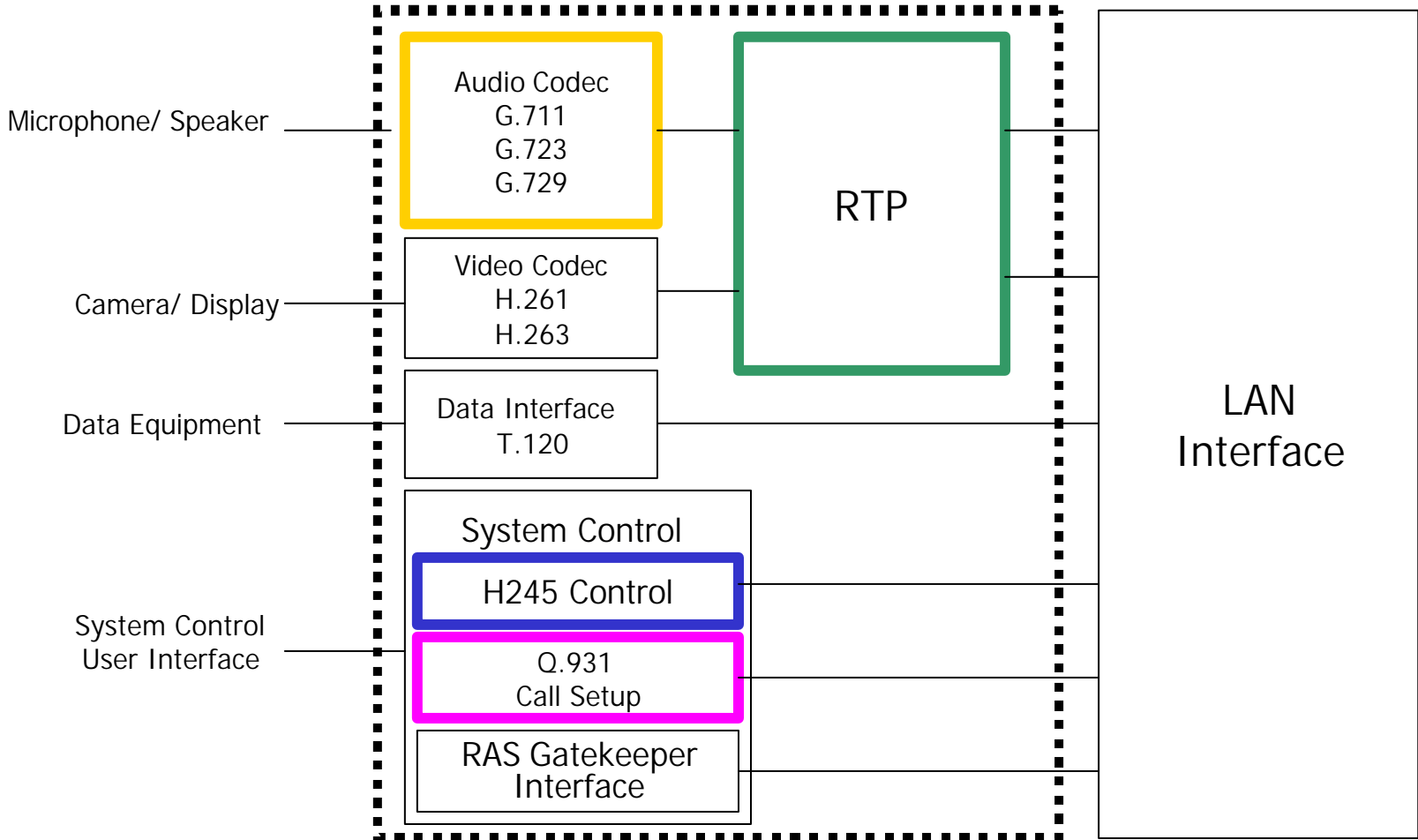




Terminals [1/2]

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

Terminals [2/2]



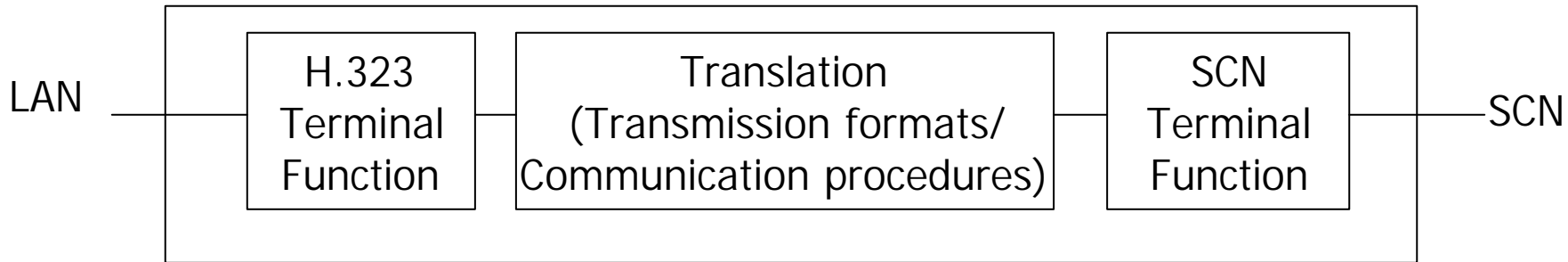


Gateways [1/2]

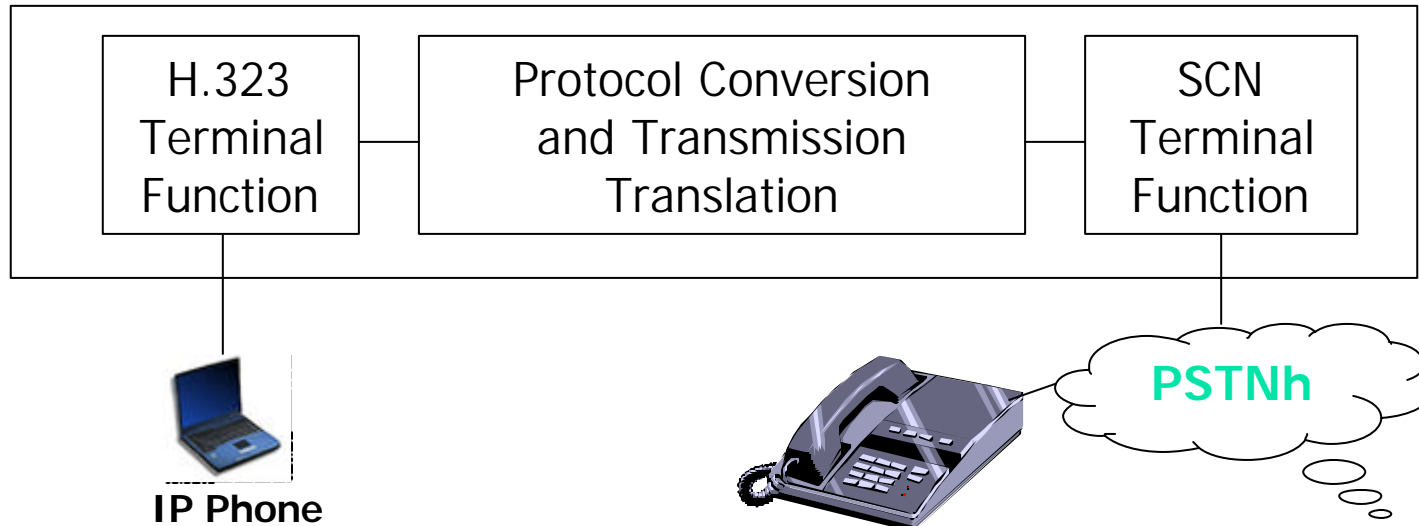
- Interface between the LAN and the switched circuit networks (SCNs, e.g., ISDN, GSM, PSTN)
- Mandatory Functions
 - Transmission Format Translation
 - Communication Procedure Translation
 - Call Setup and Clearing on Both Sides
- Optional Function
 - Media Format Translation
- Example: IP/PSTN gateway

Gateways [2/2]

Gateway function



IP/PSTN Gateway



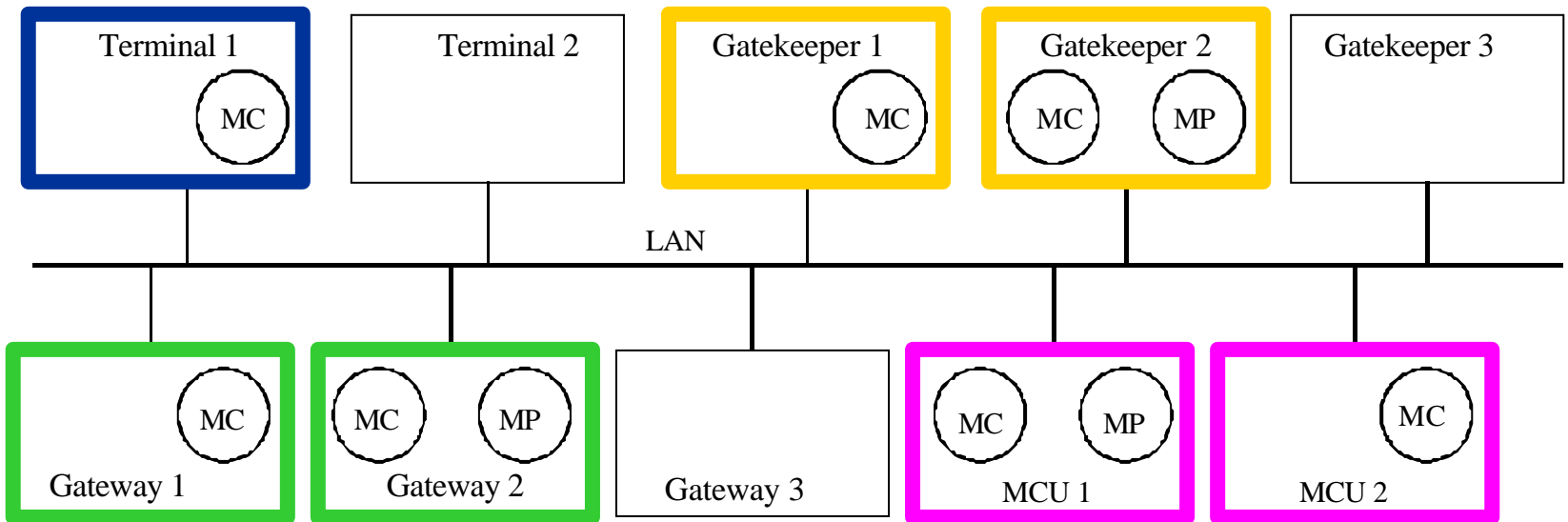


Multipoint Control Unit [1/2]

- 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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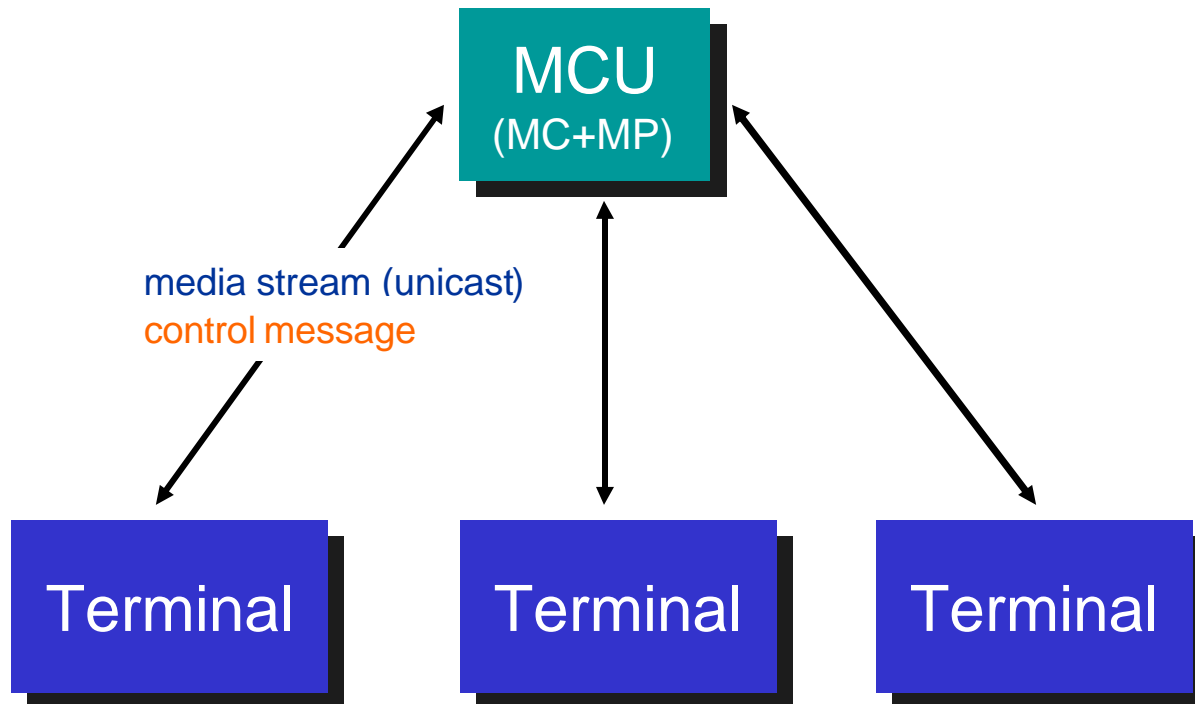


Multipoint Conference

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

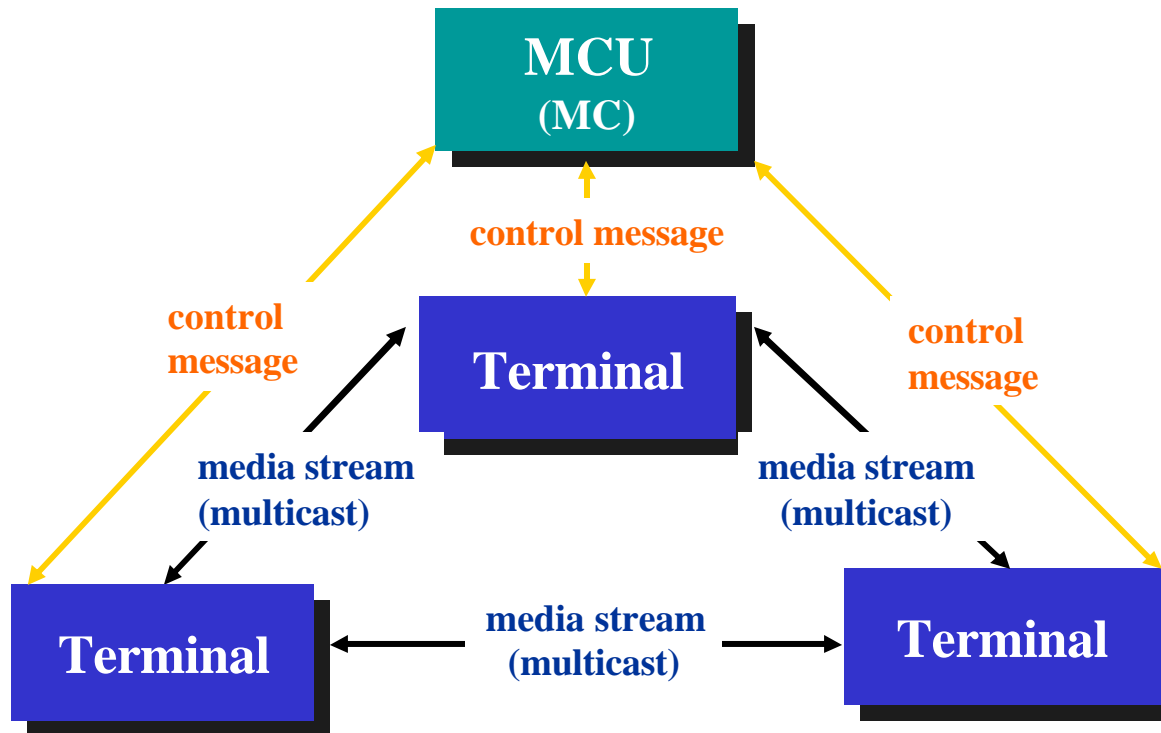
Centralized Conference

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

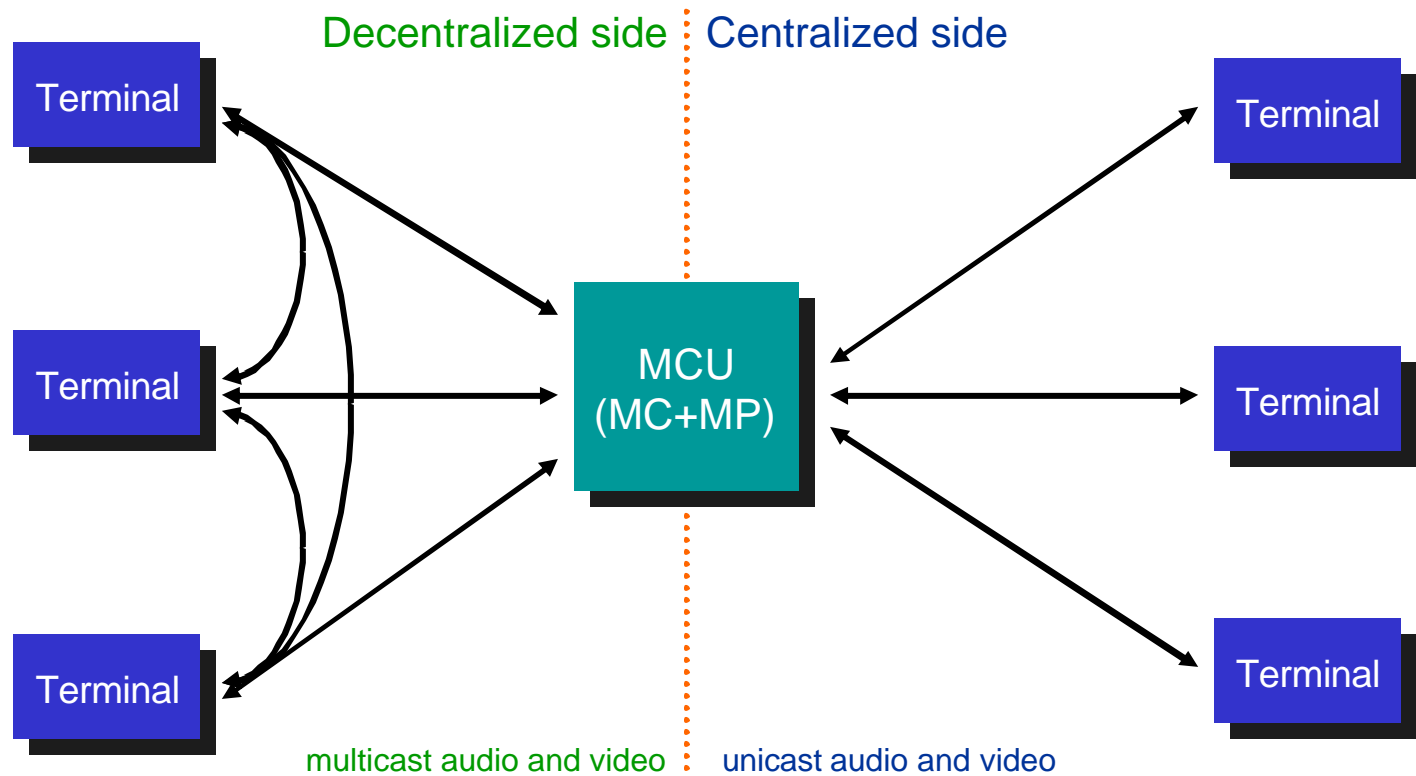


De-centralized Conference

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



Mixed Conference

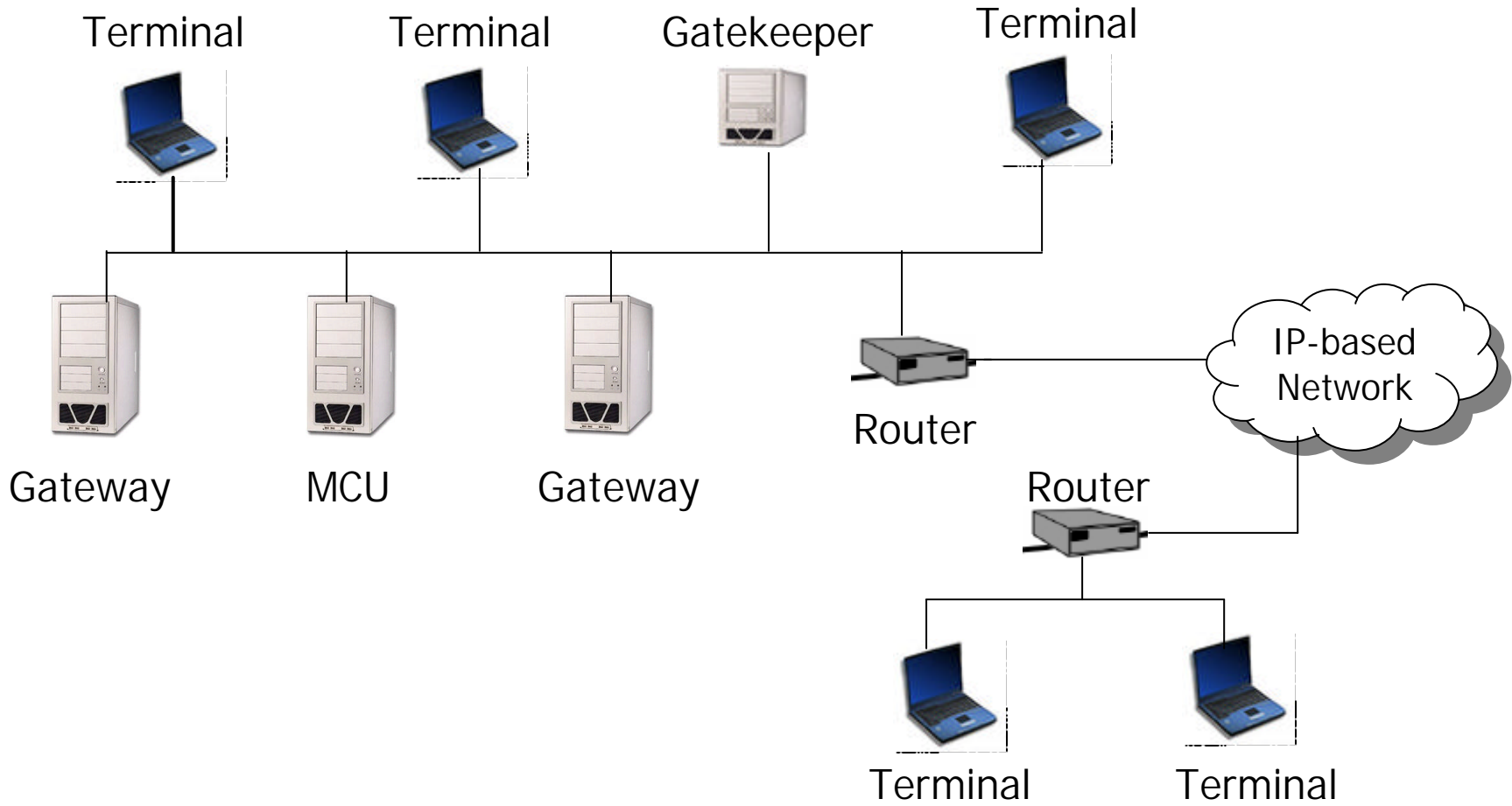




Gatekeepers

- 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

Audio/Video Application	Terminal/Application Control			
Audio/Video Codes	RTCP	H.225.0 RAS Signaling	H.255.0 Call Signaling	H.245 Control Signaling
RTP				
Unreliable Transport (UDP)			Reliable Transport (TCP)	
Network Layer (IP)				
Data Link Layer				
Physical Layer				

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 (if DNS is available)
 - E.g., ras://GK1@somedomain
- The TSAP, Transport Service Access Point
 - An id for a particular logical channel at a given entity
 - GK UDP Discovery Port = 1718
 - GK UDP Reg. and Status Port = 1719
 - Call-signaling TCP or UDP Port = 1720
 - Registered with IANA
- Terminals 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).



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.



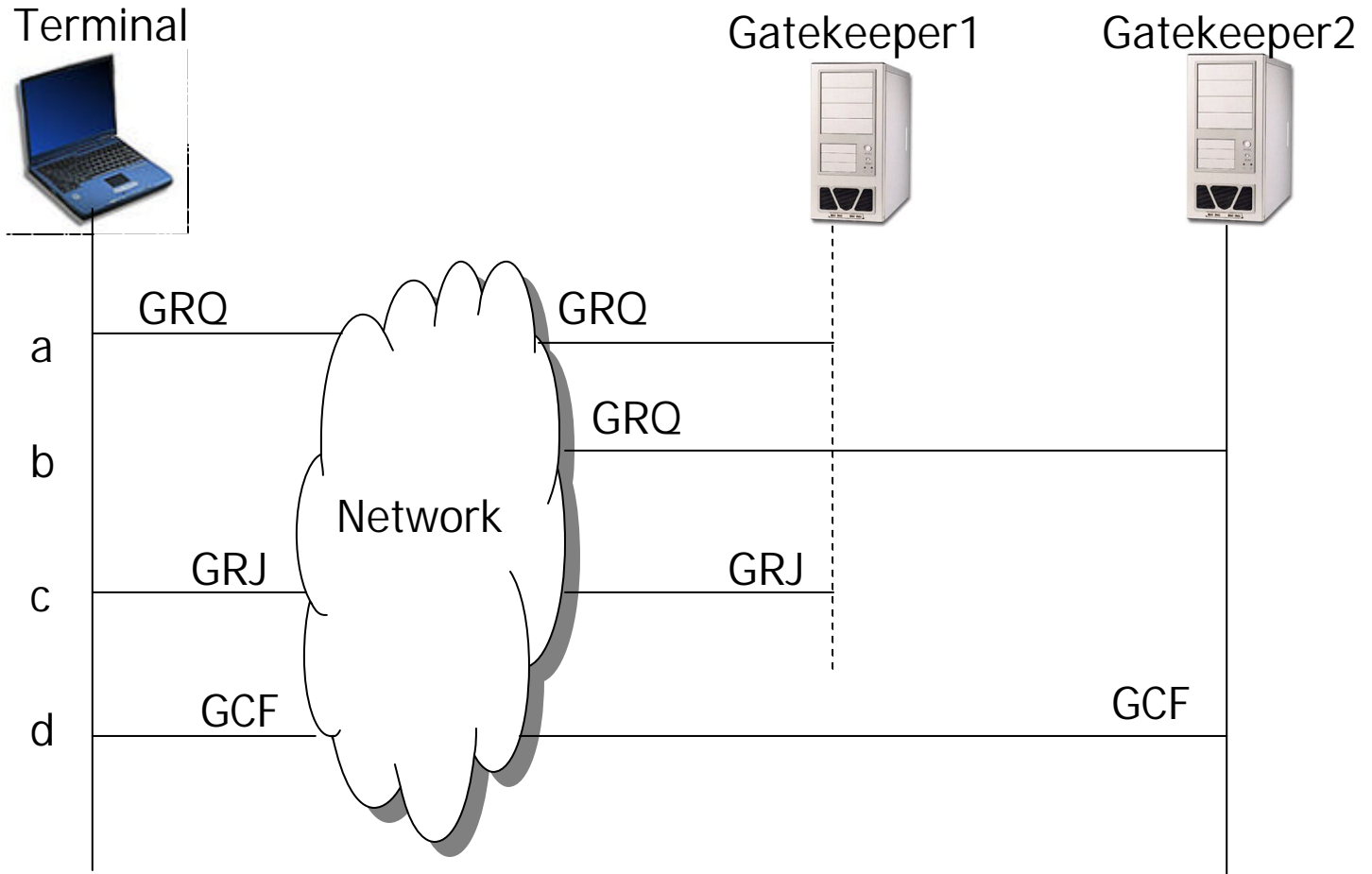
RAS Signaling [2/2]

- **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**
 - 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
 - Indicating that the gatekeeper is willing to control the endpoint
 - 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 chosen.
- GRJ – GK-Reject
 - With a reason (e.g., a lack of resource)

Gatekeeper Discovery [2/2]





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



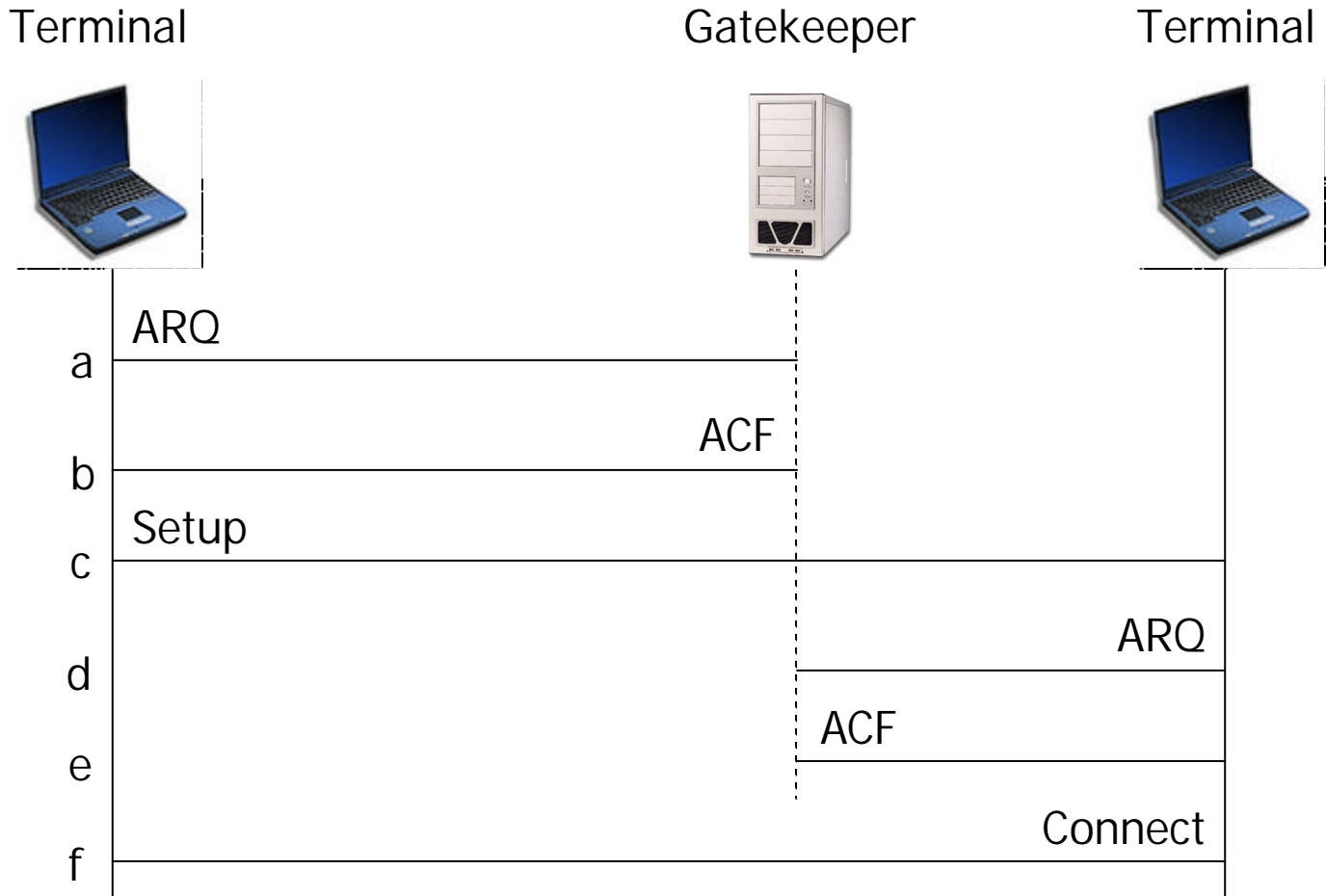
Admission [1/2]

- 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

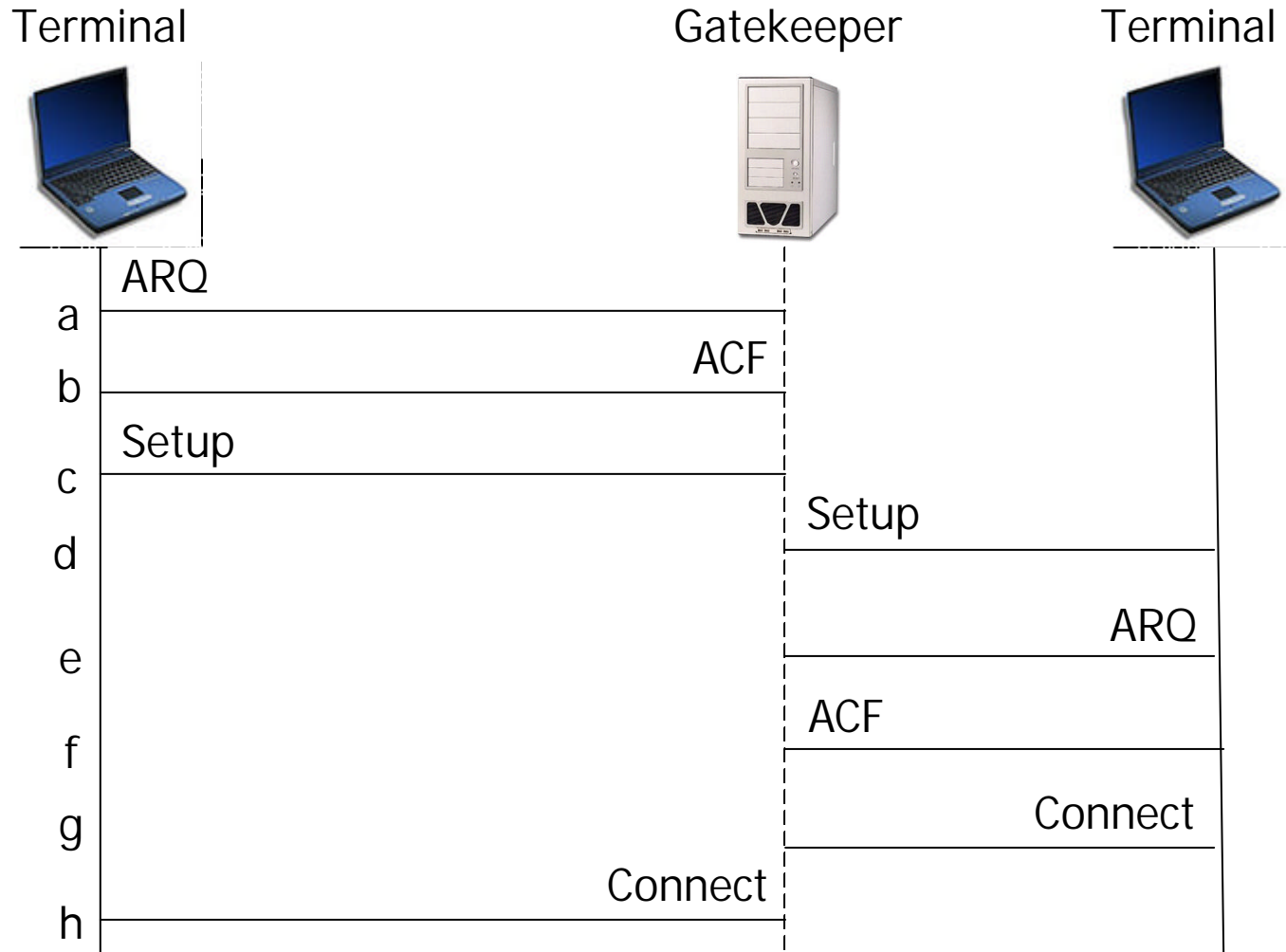
Admission [2/2]

- 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

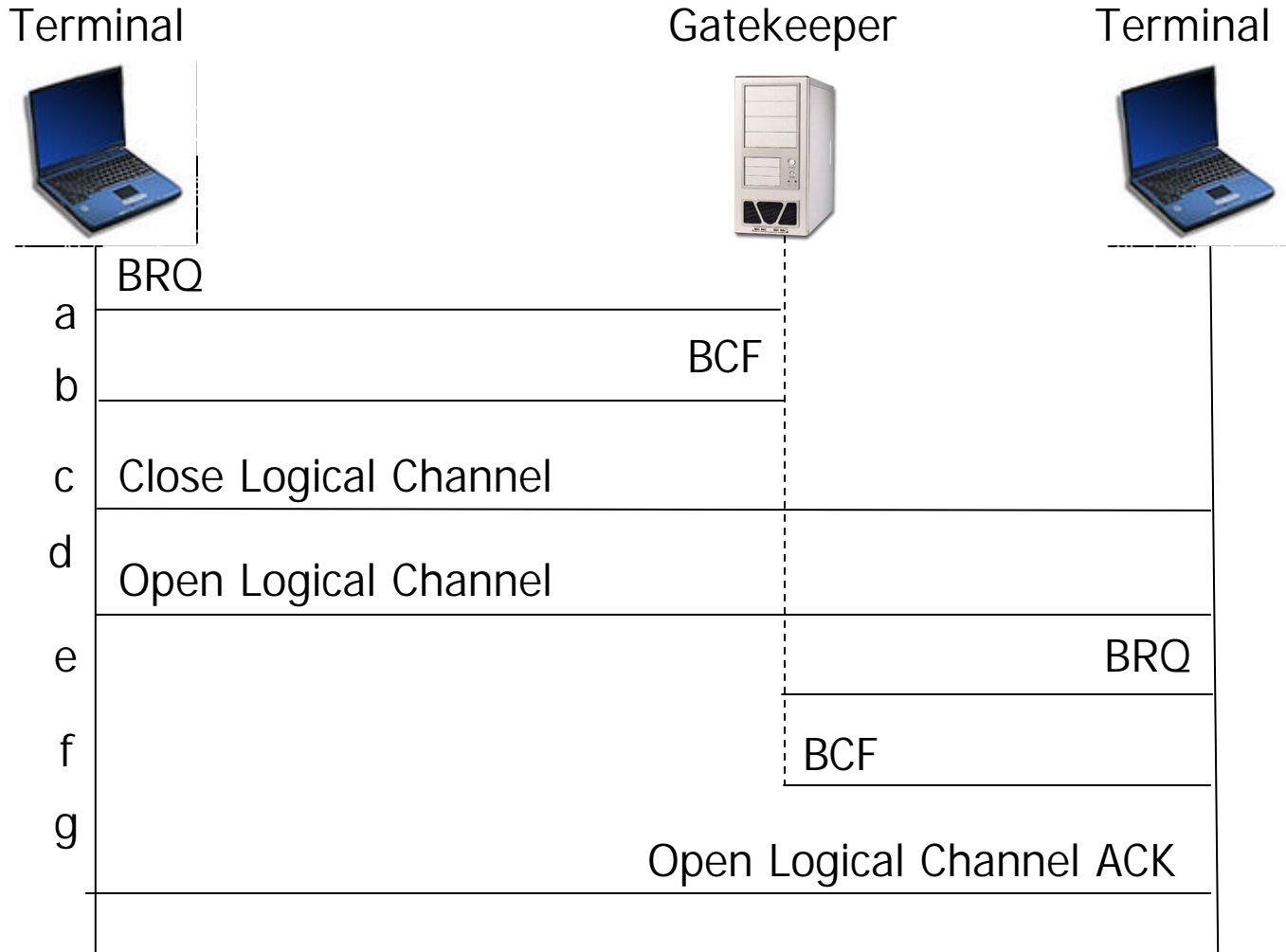




Bandwidth Change [1/2]

- 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, perhaps 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
 - GK polls the endpoint
 - ACF (or RCF for pre-granted admission) with an irrFrequency parameter
 - The endpoint periodically send the info.

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

- H.323 version 4
- SCI (Service Control Indication) and SCR (Service Control Response)
- To enable advanced features (vendor specific capability)



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