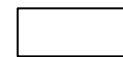


## **Agenda**

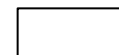
# **H.323 Tutorial**

- † **Brief description of Voice over Data, VoIP market drivers and applications**
- † **H.323 entities**
- † **Protocols in H.323**
- † **H.323 signalling models**
- † **Typical call setup and tear down**
- † **H.323 version 2 and beyond**



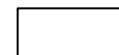
# **What is Voice Over Data?**

- † Voice over Data (VoD) transmits traditional voice services over data networks**
- † Such data networks can be Frame Relay (VoFR), ATM (VoATM) or IP (VoIP)**
- † Voice is usually compressed to save bandwidth**



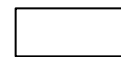
# **The Drive Towards Voice Over IP**

- † **“Internet phone” can provide very low-cost, long-distance and international phone calls**
- † **Internet traffic quickly surpasses voice traffic in volume; therefore, why transfer data over voice networks (e.g. today’s modems) when you can optimize for data and transfer voice over data?**
- † **New carriers can build a single, integrated data network to support both voice and data services**
  - **Delta-3, IDT and others already implement VoD phone calls**



# **VoD Enables New Applications**

- † “Click to talk” web sites for e-commerce**
- † Digital white-board conferences**
- † Broadcast audio and video over the Internet or a corporate Intranet**
- † Integrated messaging: check (or leave) voice mail over the Internet**
- † Fax over IP**



# ITU-T H.323 Standard

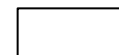
† **Umbrella standard covering multimedia communications over LANs that do not provide a guaranteed Quality of Service**

† **Entities**

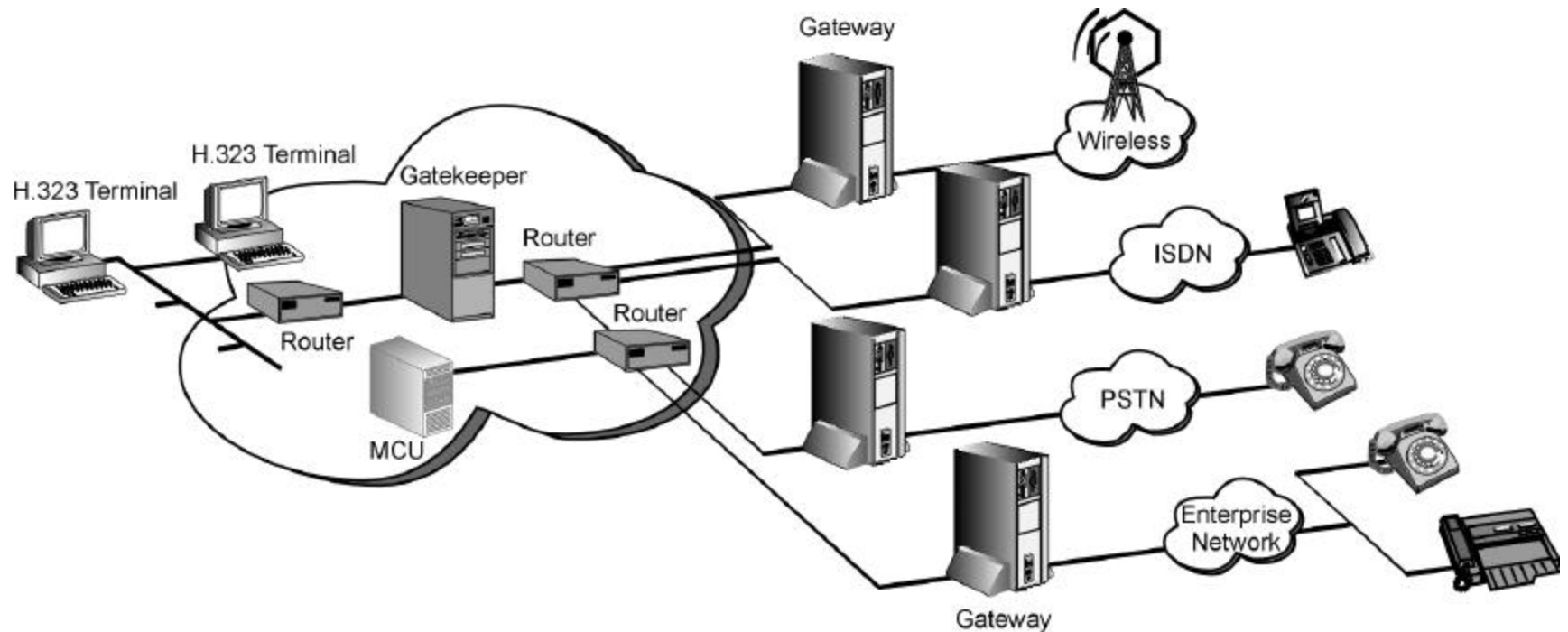
- Terminals
- Gateways
- Gatekeepers
- MCUs

† **Protocols**

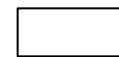
- Parts of H.225.0 - RAS, Q.931
- H.245
- RTP/RTCP
- Audio/video codecs



# H.323 Architecture

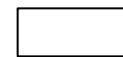


H.323 Network Architecture and Components



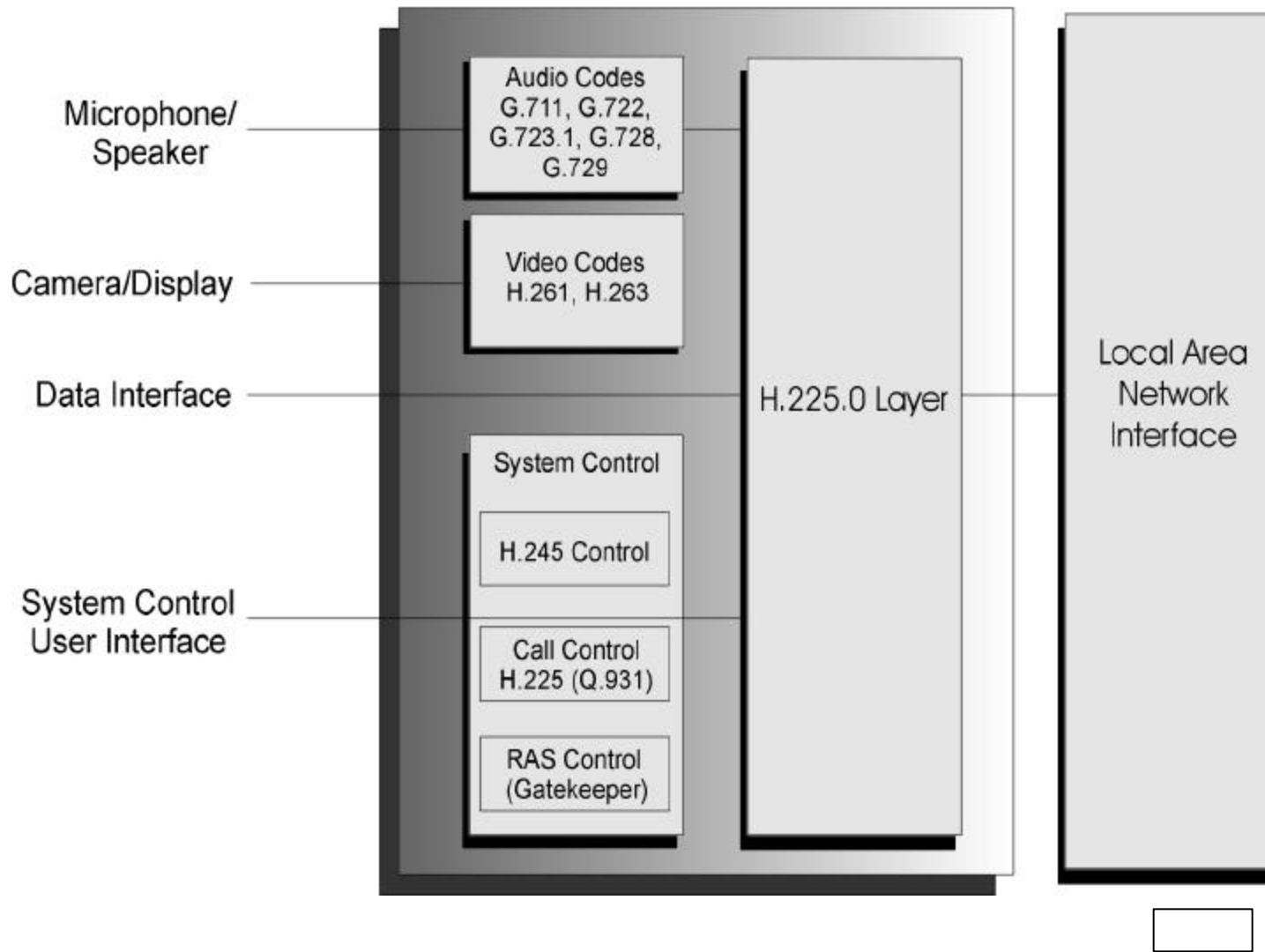
# H.323 Entities: Terminals

- † **Endpoint on a LAN**
- † **Supports real-time, 2-way communications with another H.323 entity**
- † **Must support:**
  - **Voice - audio codecs**
  - **Signalling and setup - Q.931, H.245, RAS**
- † **Optional support:**
  - **Video**
  - **Data**



# H.323 Entities: Terminals (cont.)

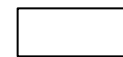
## H.323 Terminal





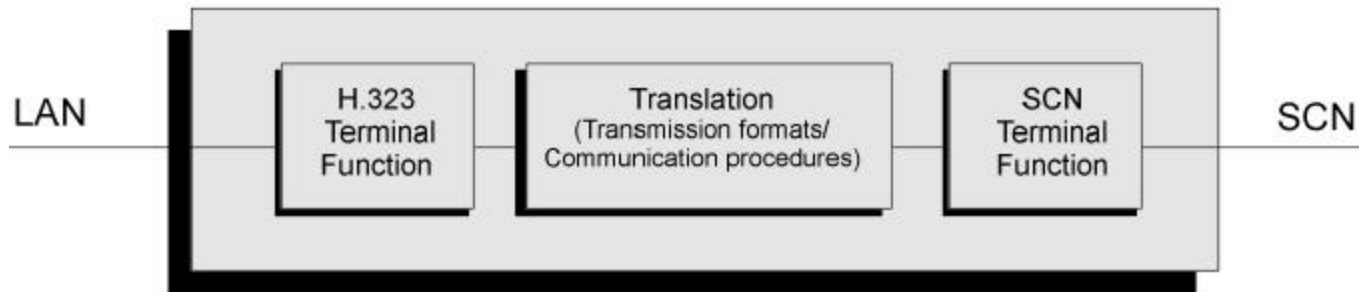
## **H.323 Entities: Gateways**

- † Interface between the LAN and the switched circuit network**
- † Translates communication procedures and formats between networks**
- † Call setup and clearing**
- † Compression and packetization of voice**
- † Example: IP/PSTN gateway**

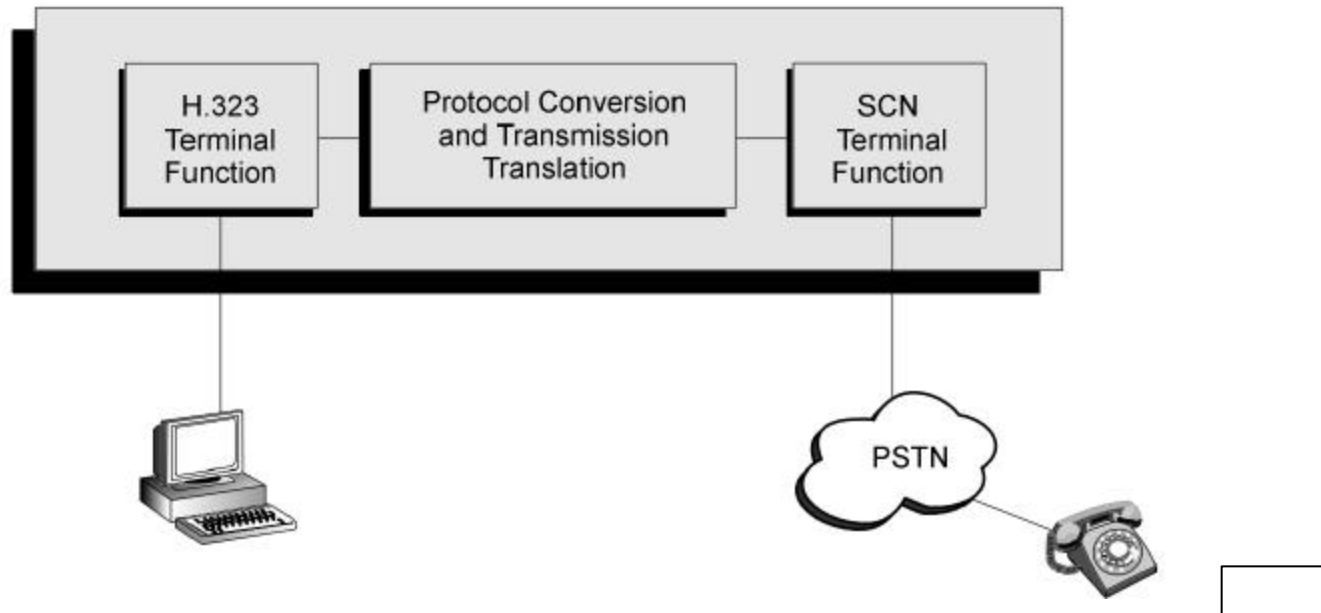


# H.323 Entities: Gateways (cont.)

## Gateway Function

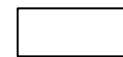


## IP/PSTN Gateway



## **H.323 Entities: Gatekeepers**

- † Optional (e.g., Netmeeting does not use gatekeepers), but must perform certain functions if present**
- † Manage a zone (a collection of H.323 devices)**
- † Usually one gatekeeper per zone; alternate gatekeeper might exist for backup and load balancing**
- † Typically a software application, implemented on a PC, but can be integrated in a gateway or terminal**



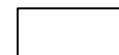
# H.323 Entities: Gatekeepers (cont.)

## Mandatory functions:

- Address translation (routing)
- Admission control
- Minimal bandwidth control - request processing
- Zone management

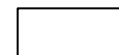
## Optional functions:

- Call control signalling - direct handling of Q.931 signalling between endpoints
- Call authorization, bandwidth management, and call management using some policy
- Gatekeeper management information (MIB)
- Directory services



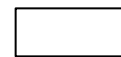
## **H.323 Entities: MCUs**

- † MCU - Multipoint Control Unit**
- † Endpoint that supports conferences between 3 or more endpoints**
- † Can be stand-alone device (e.g., PC) or integrated into a gateway, gatekeeper or terminal**
- † Typically consists of multi-point controller (MC) and multi-point processor (MP)**
  - MC - handles control and signalling for conference support**
  - MP - receives streams from endpoints, processes them, and returns them to the endpoints in the conference**



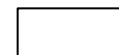
# **Centralized vs. Decentralized Conferences**

- † **Centralized - MCU handles both signalling (MC) and stream processing (MP)**
- † **Decentralized - MCU handles only signalling, streams go directly between endpoints**
  - **In this case MCU functions without MP**

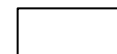
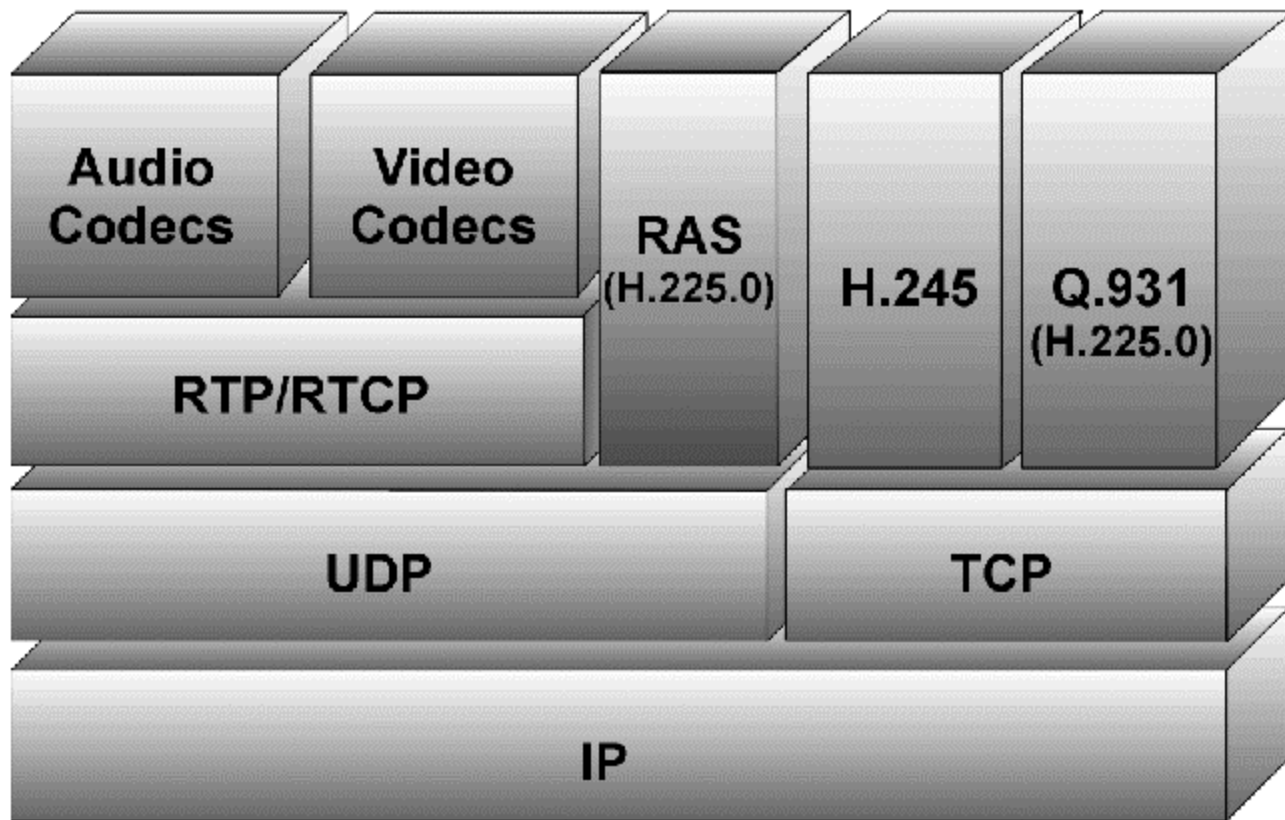


# H.323 Protocol Stack

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



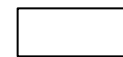
# H.323 Protocol Stack



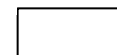
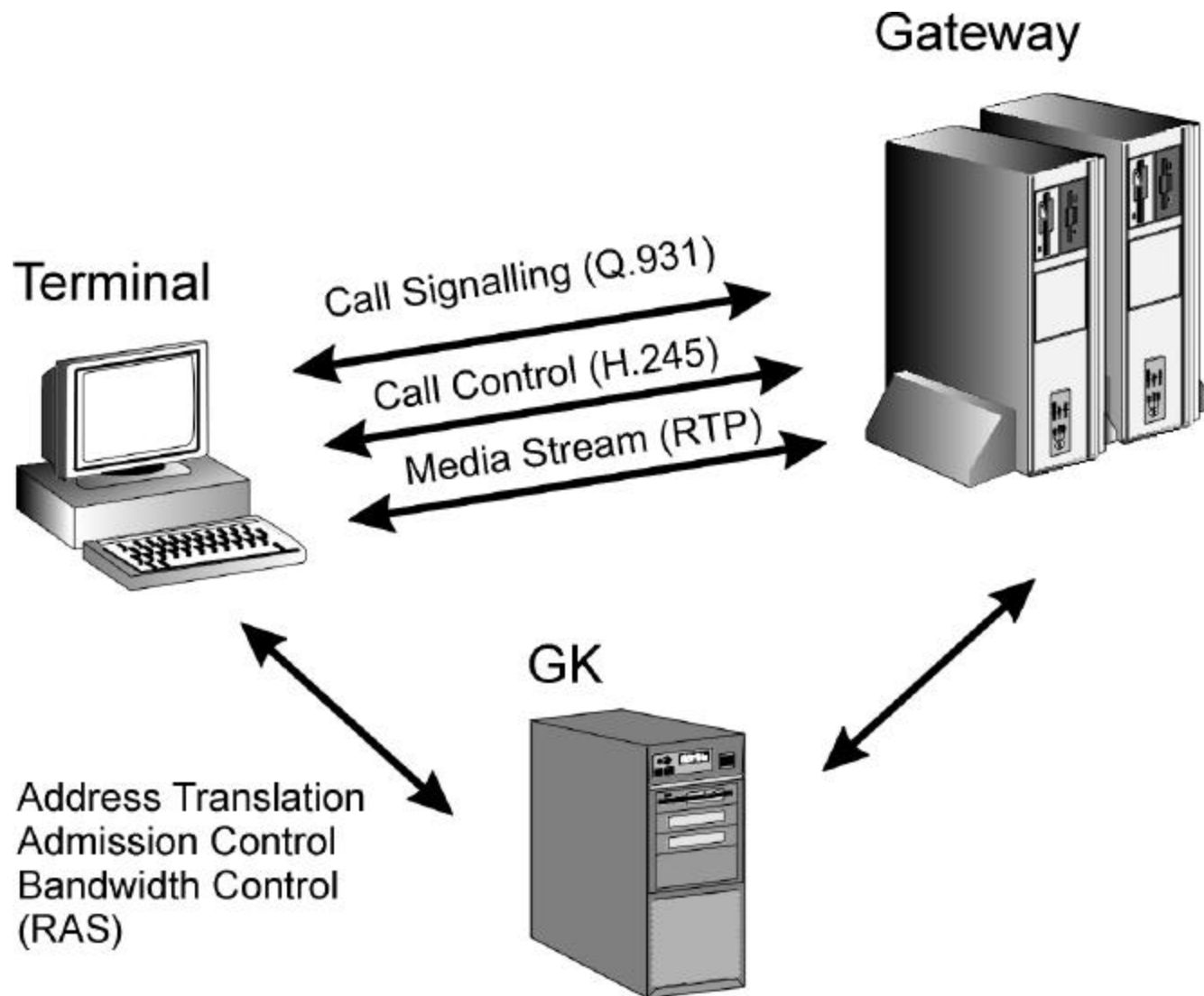


# Signalling Models

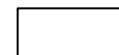
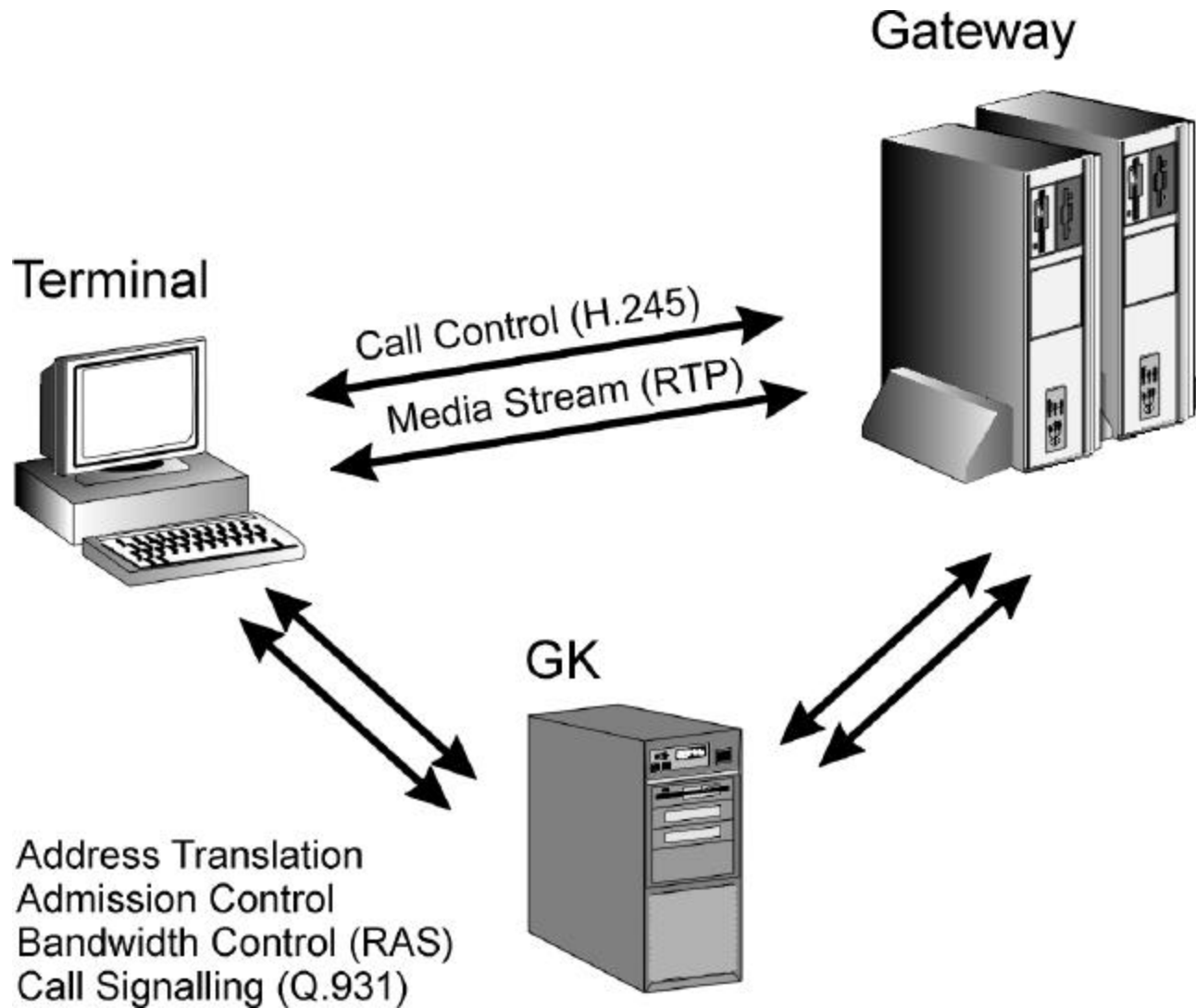
- † **Determines which protocol messages pass through the gatekeeper, and which pass directly between the two endpoints**
- † **The more messages that are routed between the gatekeeper, the more the load and responsibility (more information and more control)**
- † **The gatekeeper ultimately decides on the signalling model**
- † **Media never passes through the gatekeeper function**



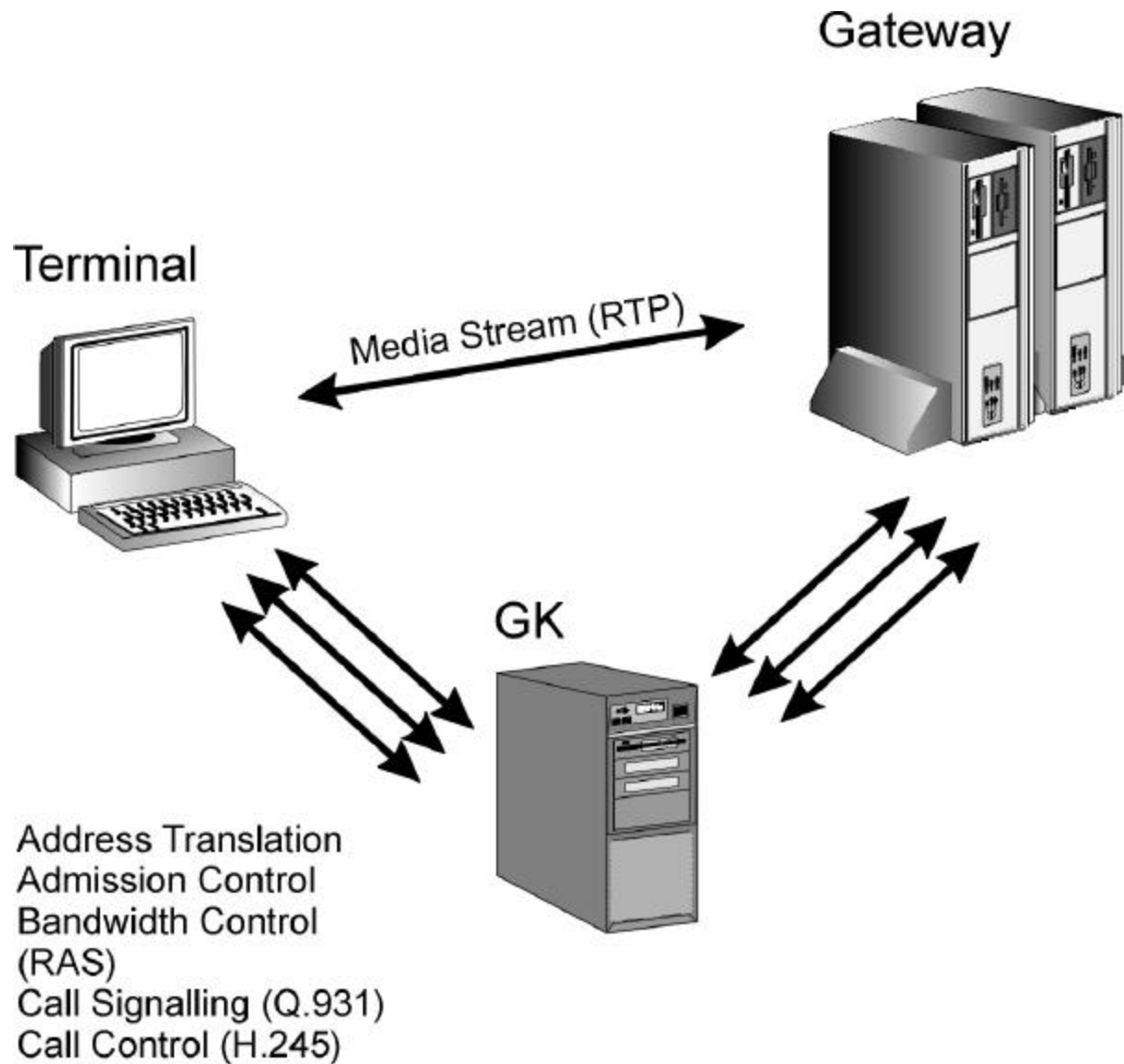
# Direct Endpoint Call Signalling



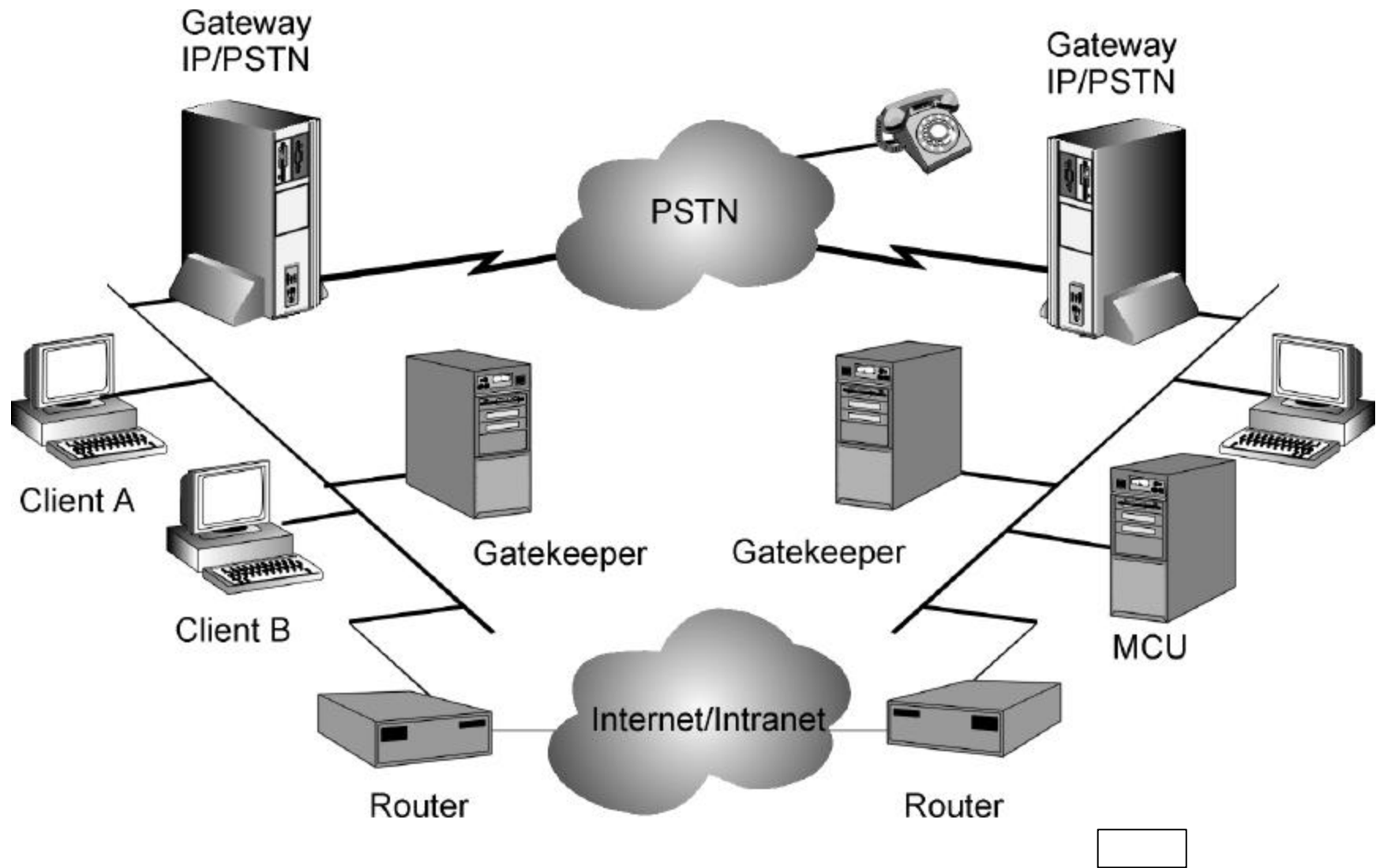
# Gatekeeper Routed Call Signalling (Q.931)



# Gatekeeper Routed Call Signalling (Q.931/H.245)



# Typical H.323 Network Deployment

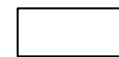


# Example

## Gatekeeper Routed Call Signalling (Q.931/H.245) between client A and client B

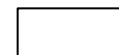
### † Establishing a call between client A and client B:

- Discover and register with the gatekeeper - RAS channel
- Routed call setup between the endpoints through the gatekeeper - Q.931 call signalling
- Initial communications and capability exchange - H.245 call control
- Establish multimedia communication/call services - H.245 call control
- Call termination - H.245 call control & Q.931 call signalling



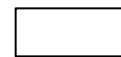
## **Discover Gatekeeper (RAS)**

- † **Client transmits a Multicast Gatekeeper Request packet (who is my gatekeeper?)**
- † **Gatekeeper responds with a Gatekeeper Confirmation packet or Gatekeeper Reject packet**



## **Register with Gatekeeper (RAS)**

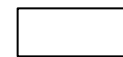
- † **Client notifies gatekeeper of its address and aliases**
- † **Client transmits Gatekeeper Registration Request**
- † **Gatekeeper responds with either Registration Confirmation or Registration Rejection**
- † **In network deployment in diagram, both client A and client B register with gatekeeper A**





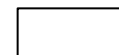
# **Call Admission (RAS)**

- † **Client A initiates Admission Request (can I make this call?); the packet includes a maximum bandwidth requirement for the call**
- † **Gatekeeper responds with Admission Confirmation**
  - **Bandwidth for call is either confirmed or reduced**
  - **Call signalling channel address of gatekeeper is provided**



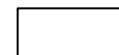
## **Call Setup Through Gatekeeper (Q.931)**

- † Client A sends call setup message to gatekeeper**
- † Gatekeeper routes message to client B**
- † If client B accepts, admission request with gatekeeper is initiated**
- † If call accepted by gatekeeper, client B sends a connect message to client A specifying the H.245 call control channel for capabilities exchange**



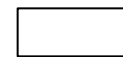
## **Capabilities Exchange (H.245)**

- † Clients exchange call capabilities with Terminal Capability Set message that describes each client's ability to transmit media streams, i.e. audio/video codec capabilities of each client**
- † If conferencing, determination of MCU is negotiated during this phase**
- † After capabilities exchange, clients have a compatible method for transmitting media streams; multimedia communication channels can be opened**



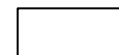
# **Establish Multimedia Communication**

- † To open a logical channel for transmitting media streams, the calling client transmits an Open Logical Channel message (H.245)**
- † Receiving client responds with Open Logical Channel Acknowledgement message (H.245)**
- † Media streams are transmitted over an unreliable channel; control messages are transmitted over a reliable channel**
- † Once channels established, either client or gatekeeper can request call services, i.e. client or gatekeeper can initiate increase or decrease of call bandwidth**



# Call Termination

- † **Either party can terminate the call**
- † **Assume client A terminates call**
- † **Client A completes transmission of media and closes logical channels used to transmit media**
  - **Client A transmits End Session Command (H.245)**
  - **Client B closes media logical channels and transmits End Session Command**
  - **Client A closes H.245 control channel**
  - **If call signalling channel is still open, a Release Complete message (Q.931) is sent between clients to close this channel**



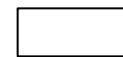
## **New Features in H.323 Version 2**

- † H.235 - security and authentication, i.e. passwords for registration with gatekeeper**
- † H.450.x - supplementary services such as call transfer and forwarding**
- † Fast call setup:**
  - Bypasses some setup messages**
  - Triggered by Q.931 Fast Start message that contains basic capabilities**



## **New Features in H.323 Version 2 (cont.)**

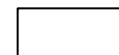
- † **Mechanism to specify alternative gatekeepers to endpoints**
- † **Gatekeeper can request forwarding of Q.931 information on direct routed calls; only RADCOM can play back H.323 streams off a network: a true differentiation**
- † **Smoother integration of T.120 (optional standard for data)**
  - **T.120 channel opened like any H.323 channel**



# **The Future of H.323**

## **Inter-Gatekeeper Communication:**

- † Current H.323 standards do not provide an inter-zone model that scales well for large networks**
- † Inter-gatekeeper protocols being discussed to enable gatekeepers to efficiently locate one another to route calls to non-local address**
- † Hierarchical arrangements with “clearing house” gatekeepers have been proposed**
- † This is critical for widespread interoperability between VoIP service providers**





# Internet Sites for Further Reading

† [www.imtc.org](http://www.imtc.org):

- Includes tutorial information and the Voice over IP Forum

† [www.pulver.com](http://www.pulver.com):

- Many useful VoIP links
- Free subscription to VoIP newsletter
- Links to CLECs using Voice over Data

† [www.data.com](http://www.data.com):

- Data communications provide many business-oriented articles about voice

