Multimedia im Netz

Wintersemester 2011/2012

Part IV

Conversational Multimedia Services

Outline

1.	Introduction and Motivation	
2.	Interactive Web Applications	Part I: Web Technologies for Interactive MM
3.	Web Programming with Java	
4.	Communities, the Web, and Multimedia	
5.	Digital Rights Management	Part II: Content-Oriented Base Technologies
6.	Cryptographic Techniques	
7.	Multimedia Content Description	
8.	Electronic Books and Magazines	Part III: Multimedia Distribution Services
9.	Multimedia Content Production and Management	
10.	Streaming Architectures	
11.	Web Radio, Web TV and IPTV	
12.	Multimedia Conferencing	Part IV: Conversational Multimedia Services
13.	Signaling Protocols for Multimedia Communication	
14.	Visions and Outlook	

12 Multimedia Conferencing

Literature:

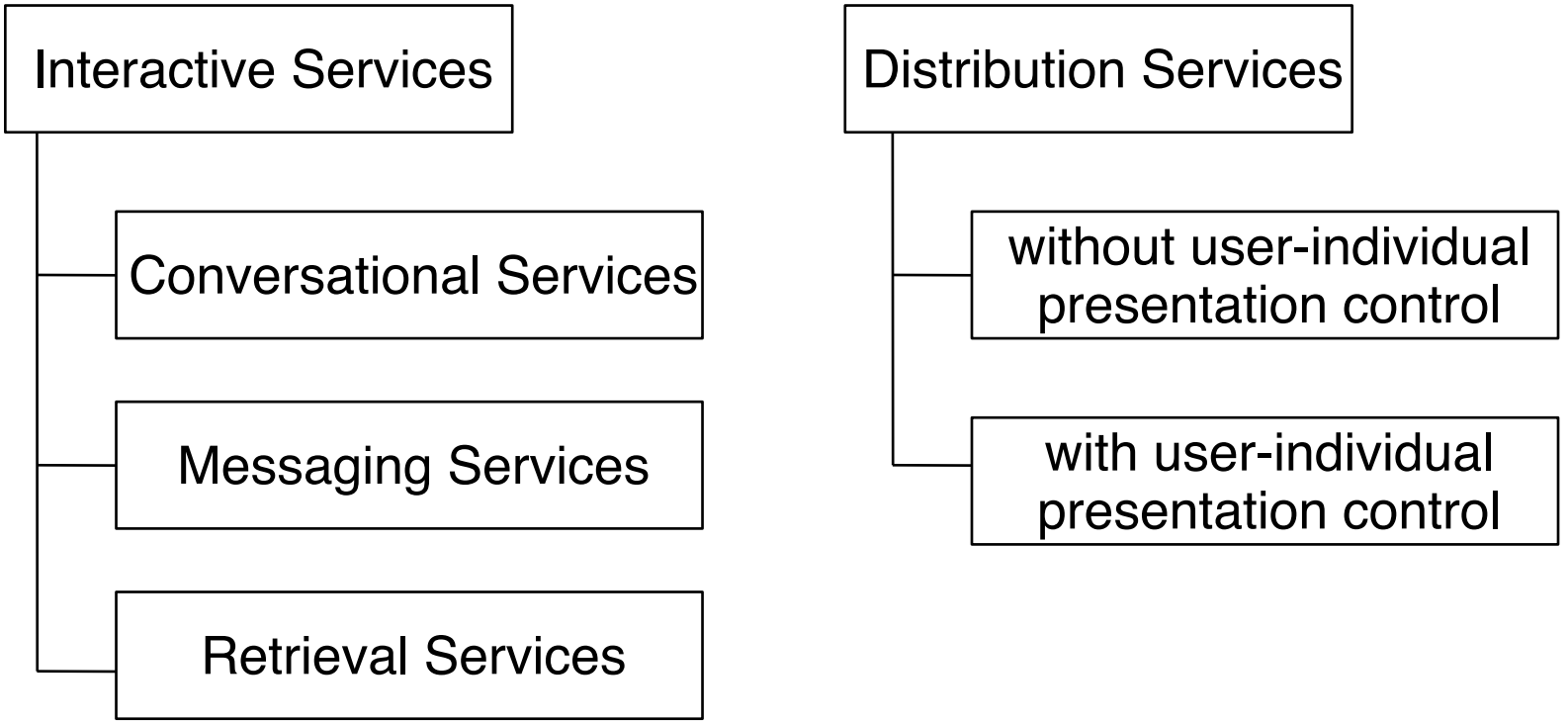
James R. Wilcox: Videoconferencing, the whole picture, 3rd ed,
CMP Media 2000

John Rhodes: Videoconferencing for the Real World,
Focal Press 2001

Scott Firestone et al.: Voice and Video Conferencing Fundamentals,
Cisco Press 2007

A Classification of Multimedia Services

- According to ITU-T recommendation I.211 “B-ISDN Service Aspects”



Videoconferencing: Definition

- Multimedia conferencing:
  - The *synchronous* exchange of digitized multimedia information (e.g. video, audio, images) between conference participants at two or more separate sites
  - Transferred images:
    - » Pictures of the participants
    - » Video clips, still pictures and other accompanying material in digitized form
    - » Screen or window content
  - Transferred sound:
    - » Discussions between meeting participants
    - » Sound from accompanying material (sound or video clips)
- Group-system videoconferencing: Joins two groups of people meeting in physically separate rooms
- Personal videoconferencing: Joins individual users (desktops, phones)
- Two sites *(point-to-point)* or more *(multi-point)*

An Old Dream: Video Conferencing in Movies

Metropolis, 1927

Star Trek, 1970s

2001: A Space Odyssey, 1968

Fritz Lang: Metropolis (1927)

Stanley Kubrick: 2001 – A Space Odyssey

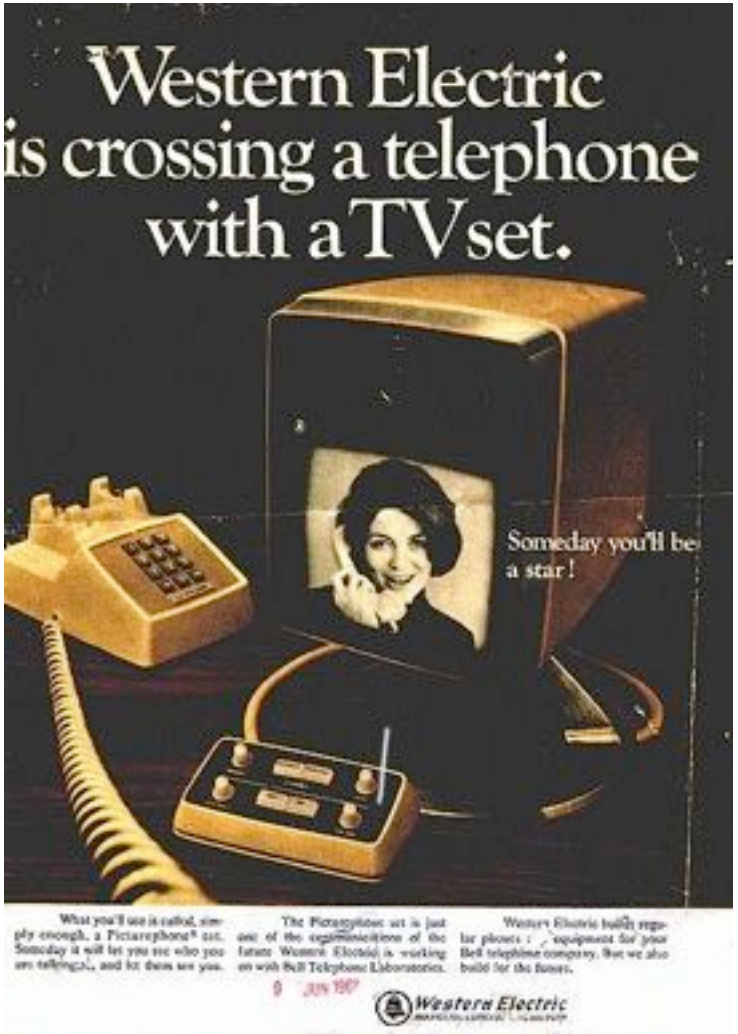
History of Videoconferencing

- Bell Labs, 1920s: First videoconference between Washington and New York
- Bell Labs, 1940s: Videoconference research resumed
- Bell Labs, 1964: Picturephone.
  - Other pioneers, 1970s: NEC, British Telecom (1979)
- 1983: Compression of video signal to phone line bandwidth: Widcom project (DARPA)
- 1984: PictureTel, first software-based videoconferencing system (224 Kbps)
- 1994: Intel ProShare system (two ISDN B-channels)
- 1996: Standards H.323 and H.324, including H.263 compression
- 1996 until today: Trend to use IP data network technology instead of ISDN

vintageadbrowser.com

Picturephone Mod 1

http://www.uni-due.de/kowi/gal_picturephone.shtml



System Type I: Picturephones

- Telephone sets enhanced by video display and small camera
- Available on the market already for significant time
  - E.g. for ISDN

Pictures: Aethra

System Type II: Desktop Systems

- Desktop videoconferencing systems
  - PC with small camera mounted above the monitor
  - “Picture phone” on PC basis
  - Optimal for *application sharing*
- Disadvantages:
  - Usable only by a person a time
  - Limited picture and sound quality
- Cost 2001: 500 – 2000 € plus PC
- Cost now: Very low (often built in)
- Pure software solutions:
  - Simple standard systems like Ekiga, Apple FaceTime, Microsoft Skype
  - Sophisticated specialized software with dedicated servers/online service (e.g. Microsoft Office LifeMeeting)

Pictures: VCON, Apple, LifeSize

System Type III: Set-Top Systems

- Small box containing camera, microphone, speakers, codec, network interface, …
  - To be put on top of TV set or monitor
- Simple, easy to use, targeted also to computer-illiterate users
- Disadvantage:
  - "Vendor lock-in":
    Upgrades are often difficult
- Cost: 3000 – 9000 €

Picture: LifeSize (Team 220)

System Type IV: Rollabout Systems

- Movable, medium-sized unit, often a rolling cabinet, containing
  - High-quality audio, video and telecommunication systems
  - One or two large monitors
  - Remotely controllable camera
- Optimal for small groups (three to six people)
- Cost: 10.000 – 20.000 €

Pictures: xtelesis, Tandberg

System Type V: Room Systems

- Room custom-equipped for conferencing requirements
- Possibly many cameras and monitors
- Furniture well integrated with conferencing equipment (cameras, monitors)
- High-quality sound system
- Cost: 30.000 – 1.000.000 €

HP Halo System
(www.telepresenceoptions.com)

Video Conference Room Design

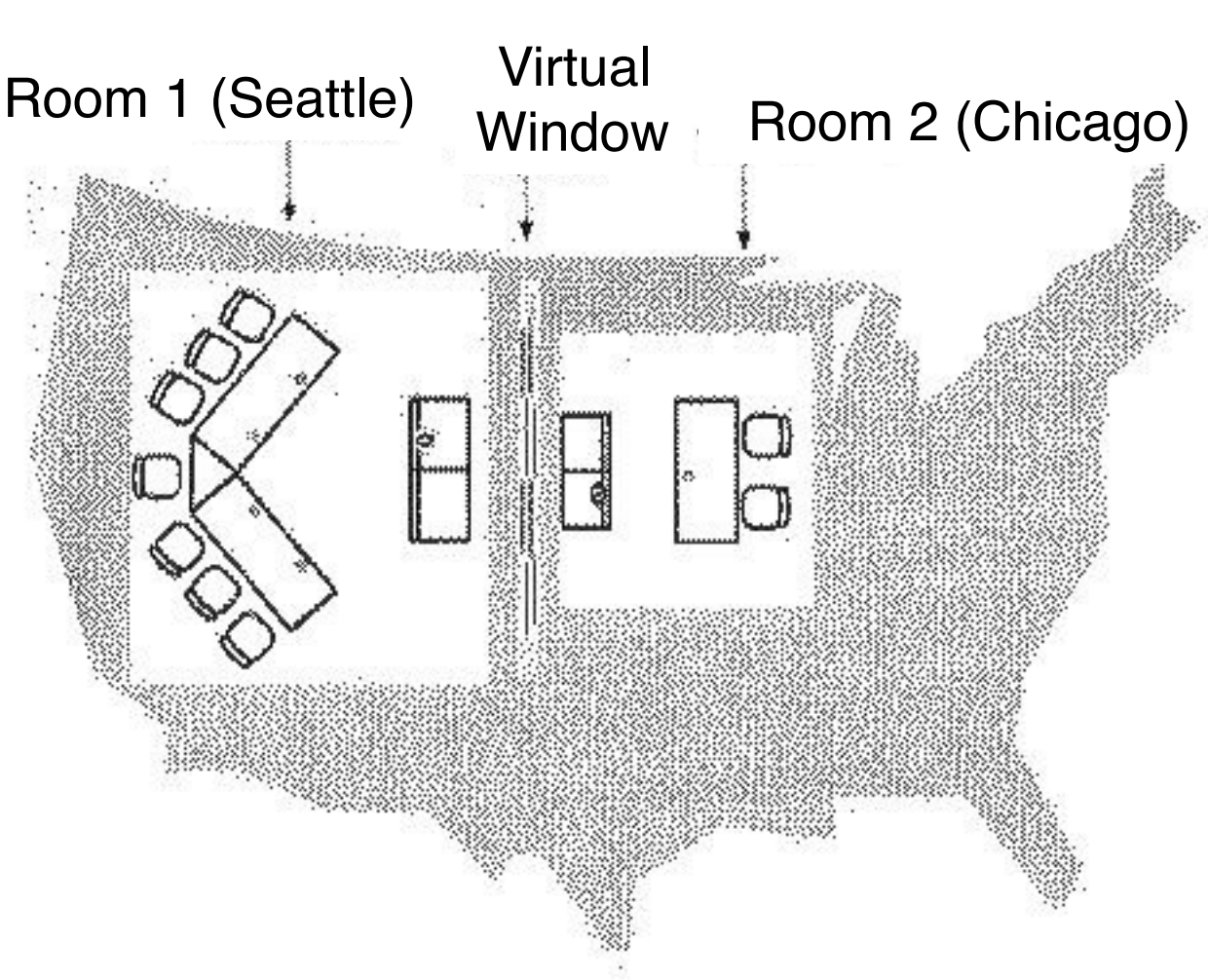


Figure 4-9 Two distant VTC rooms separated only by a virtual window.

Source:
Rhodes p. 79

System Type VI: Handheld Systems

- Videoconferencing clients running on mobile devices
  - Smartphones
  - Tablets
  - E.g. as apps for iOS or Android
- Examples: Apple FaceTime, LifeSize ClearSea client
- Cost: Very low cost + subscription (in some cases)

Pictures: Mirial/LifeSize

Camera Control

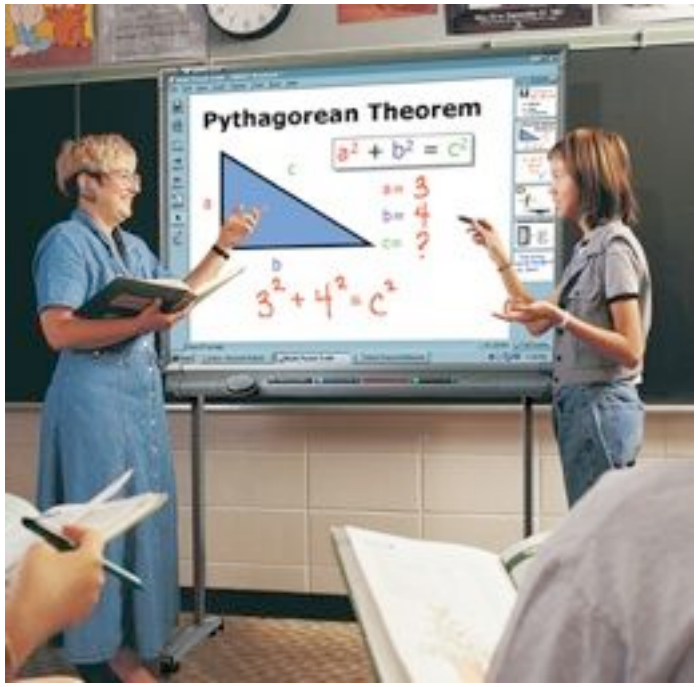
- Far-end camera control:
  - Participant or operator in room A allowed to control camera in room B
  - Useful when untrained people in room B
  - Mainly for point-to-point conferences
  - Standards exist (e.g. H.281/H.224 and H.323 V 5 Appendix Q, 2003)
- Camera presets:
  - Angles to view individual participants and other perspectives are pre-programmed before conference starts
  - Camera can be moved with a single key press, e.g. to show a specific participant
- Follow-me function:
  - Camera movement automatically synchronized with room or speaker microphones
  - Camera snaps into position for current speaker

Copy-Stand Camera

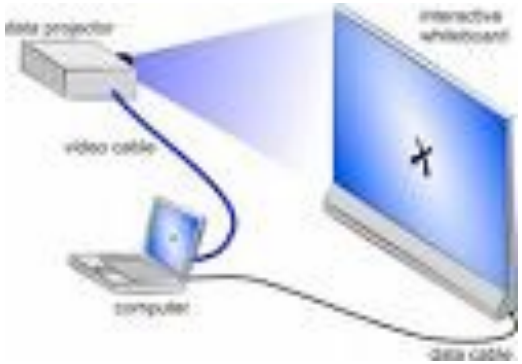
- Typical accessory of videoconference rooms

Electronic Whiteboard

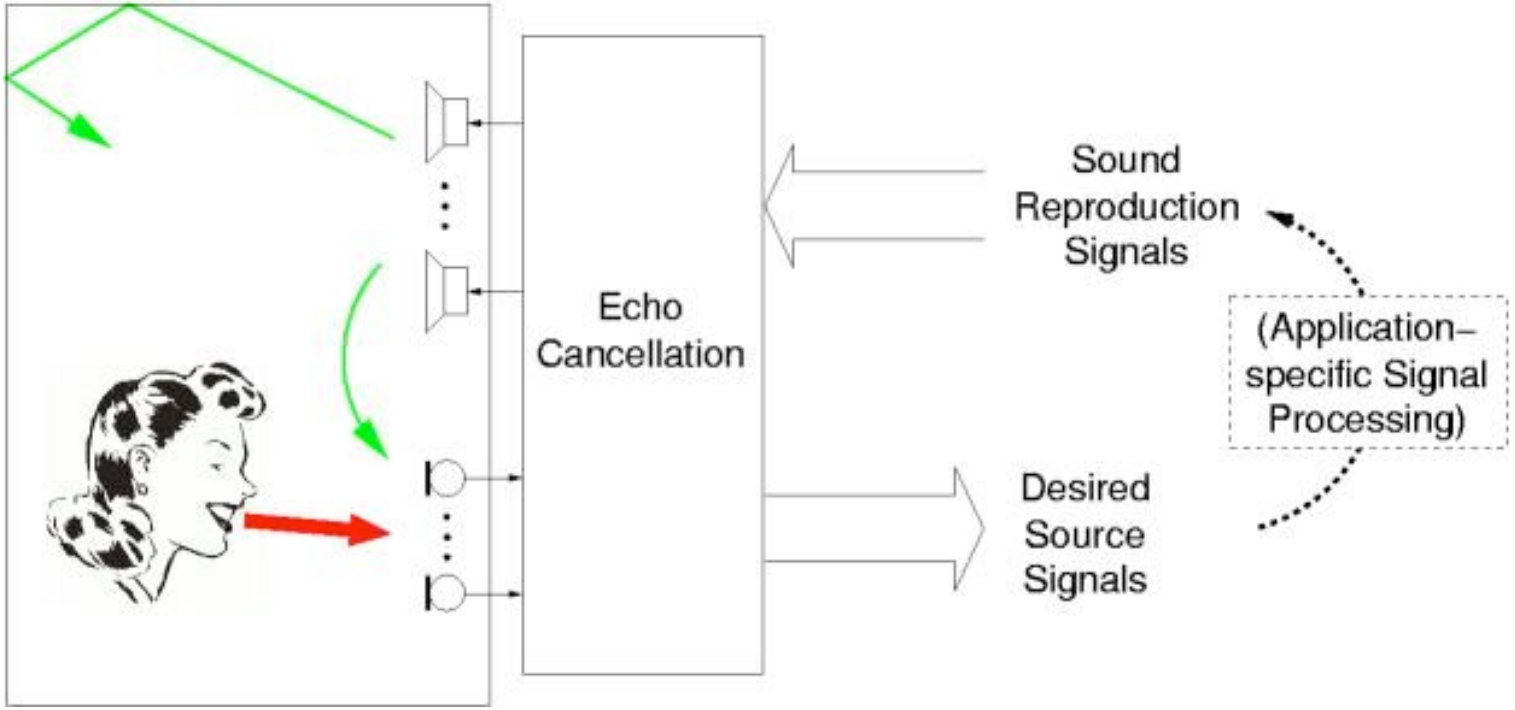
- Touch-sensitive whiteboard
  - To transmit life drawings over the network
- Technologies:
  - Front projection, rear projection, LCD display
  - Optical (infrared) tracking
- Collaborative software solutions with or without video conference



Picture: MGL World



Echo and Feedback



Picture:
Uni Erlangen

- Hands-free conference:
  - Feedback of own and foreign sound signals through loudspeaker into microphone
  - Various sources for delays
- Solutions: Cancellation in software, special microphones, headsets

Videoconferencing as Cloud Service

- Cloud resources:
  - Hardware (conference bridges)
  - Codecs (transcoding)
  - Directory services
- Simple clients
- No proprietary server needed
- Service paid per use
  - Subscription systems

ClearSea BETA in the Cloud

Images: 8x8, LiveSize

12 Multimedia Conferencing

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Application: PARC Media Spaces

- Xerox PARC System Concepts Laboratory, mid 1980-s
  - Geographical split between Palo Alto/California and Portland/Oregon
  - To maintain a single group and explore technologies for collaborative work
- Offices and meeting rooms connected by audio/video links
  - Local panels to configure connection configuration
- Positive effects:
  - *Awareness* of remote situation (e.g. presence of people at remote site)
  - Enabling informal encounters across sites
- Problems:
  - Boundaries of personal and private space
  - Integration into daily work life
    - » Placement of communication devices
    - » Integration into work flow and daily routine

Application: Preventing Nuclear Destruction

- Videoconference technology helped to protect the world during the year 2000 date rollover
  - To avoid control problems of nuclear power stations
  - Videoconference link between
    - » Emergency Center of the U.S. Department of Energy (Washington)
    - » Situation and Crisis Center of MinAtom (Moscow)
  - Expert exchange: Experts of the remote side present locally
- T1 line (24 phone lines bandwidth), off-the-shelf video codecs, LCD projectors etc.
- Newly developed (UNIX-based) video transmission software

Application: Distance Learning

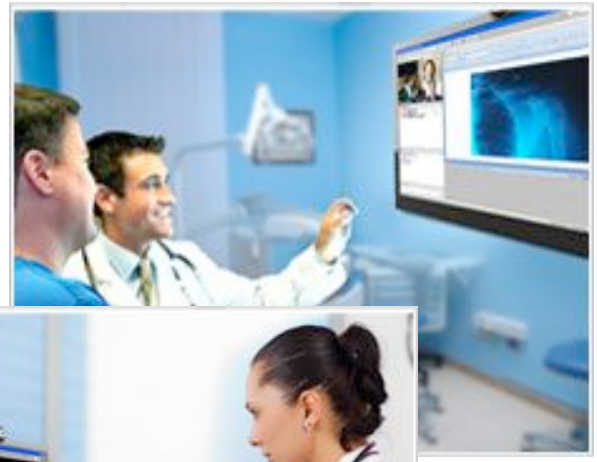
- Lectures transmitted to remote students
  - Training of staff in businesses
  - Home-learning
- Integration of remote guest speakers in meetings

www.sllboces.org

Application: Telemedicine

(According to Wilcox, p. 37)

- Remote consultation of medical specialists
  - Military health care for patients on remote bases
  - Health care services for prison inmates
  - Rapid emergency response
  - Specialist support during critical operations
- Visiting nurses video-consulting with patients
  - Allows reduction of physical visits
- Additional data:
  - Pictures:
    X-ray, tomography, …
  - Lab results
  - Current vital data



Pictures: Radvision

Application: Video Surveillance

- Remote surveillance is very similar to videoconferencing
  - Use of similar equipment and/or software
  - Video surveillance over IP
- Examples:
  - Security control of entrances, halls, …
  - Surveillance of public spaces (train stations etc)
  - Traffic control
  - Remote control of automatic bridges
- Bidirectional communication useful in some situations

www.vsoip.com

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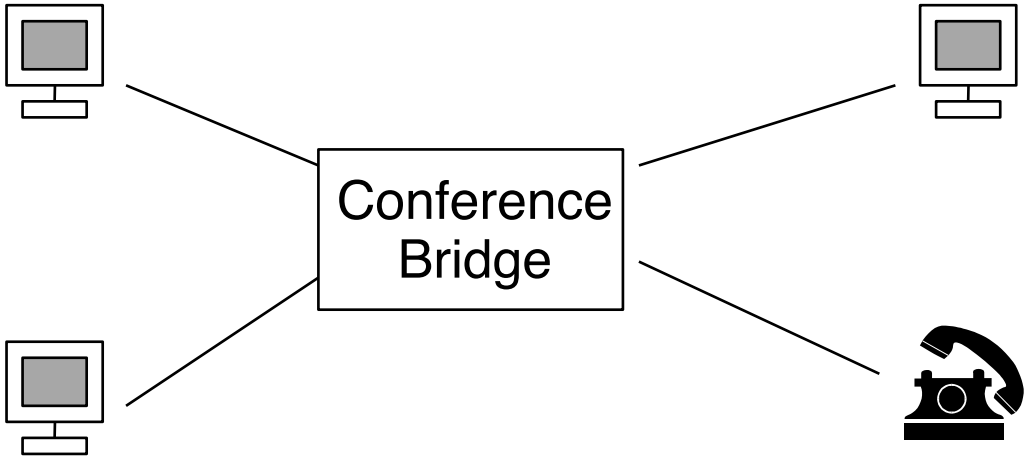
Types of Multi-Point Conferences

- Meet-Me Conference
- Ad-Hoc Conference
- Interactive-Broadcast Conference

Meet-Me Conference



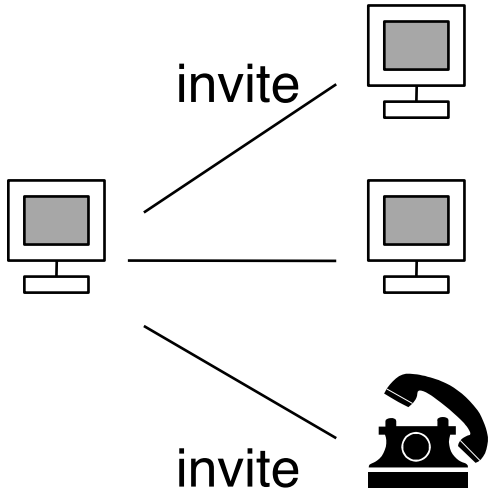
- Conference is pre-arranged
  - Time and address of bridge are known to participants
- Participants call the bridge to enter the conference
  - Bridge may also call out to participants
- Central conference bridge is a resource owned by a network or service provider
  - Mixes and distributes audio and video signals
- Examples: Telephone conference services, Skype conference call

Multi-Point Control Unit (MCU)

- Traditional name for conference bridges in telephone/ISDN networks
- Mixes the voice signals coming from participants
  - One consistent joint signal distributed to all partners
  - Partner may be silenced until sound level exceeds some threshold
- Determines the video signal to be sent to the participants (in case of audio/video conference)
  - Often, video source of participant with highest voice energy is chosen

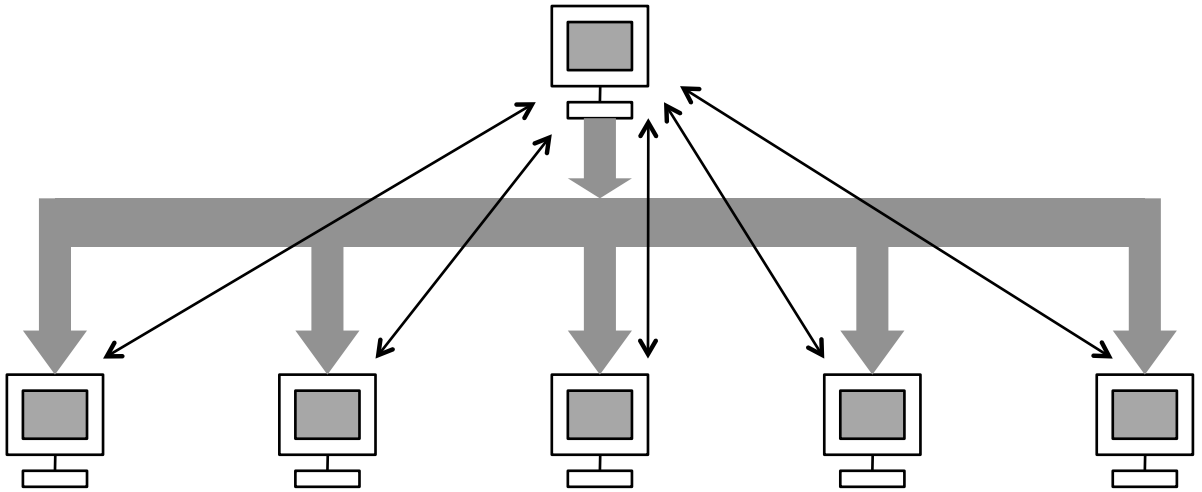
Ad-Hoc Conference

- Conference starts as a point-to-point conversation
- Grows to a multi-point conference when participants *invite* other people by calling their terminals
- Conference is usually not pre-arranged
- Example: Three-way call in ISDN/private telephone exchanges
  - A talks to B
  - A puts B *on hold*
  - A calls C
  - A joins B and C into a three-way call
- User originating the conference call must be able to provide the necessary bridge functionality
  - Bridge outside the public network, e.g. in a private network
  - Capacity limited (e.g. in number of participants)



Interactive-Broadcast Conference

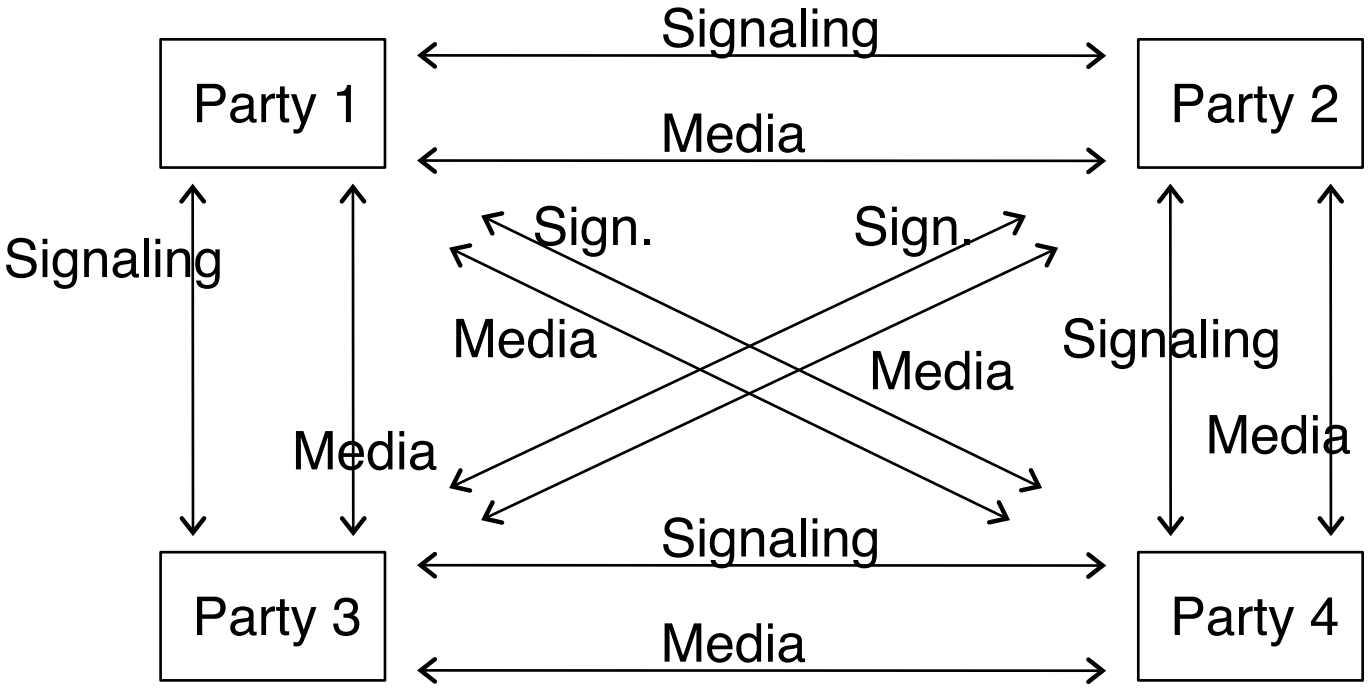
- Asymmetric conference
  - Master distributes media and signaling to many terminals
  - Terminals have a much simpler back channel to the master (e.g. just signaling or a plain text stream)
- Scales to thousands of terminals
- Typical applications: tele-teaching, business TV



Network Configurations for Multipoint Conferences

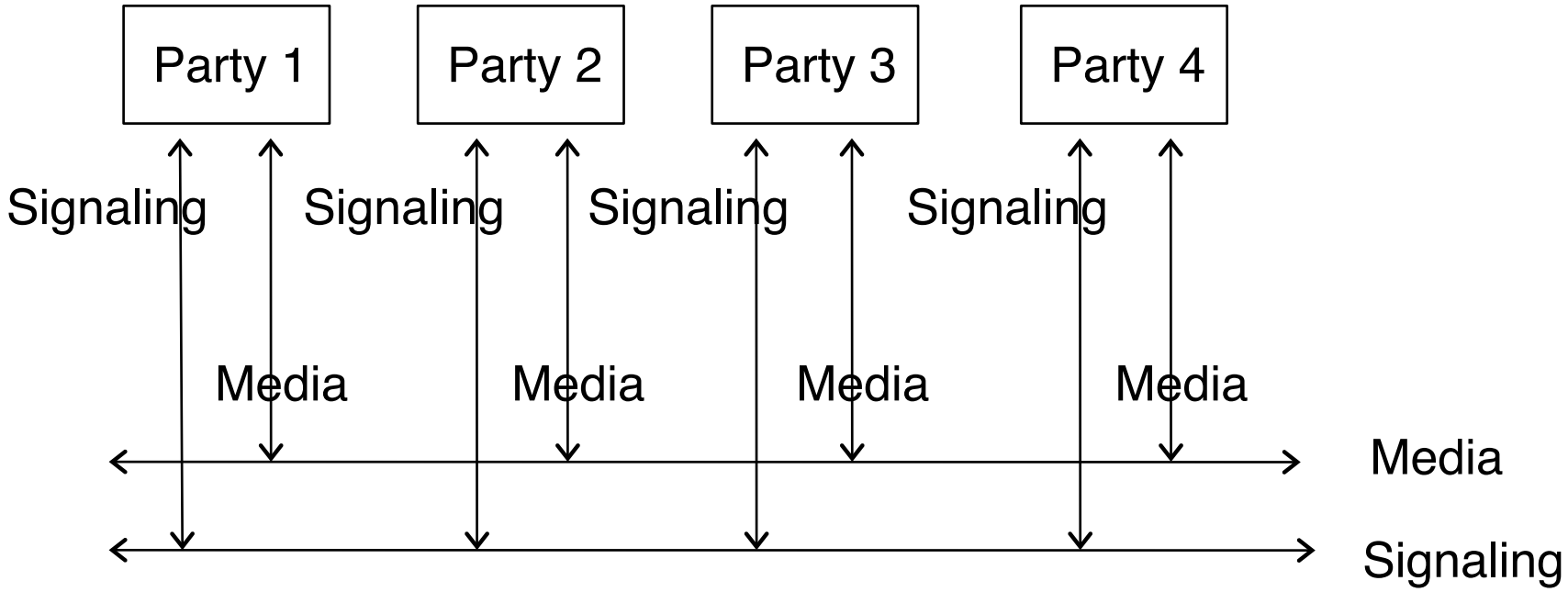
- Multi-Unicast
- Multicast
- Master-Slave

Multi-Unicast Network Configuration



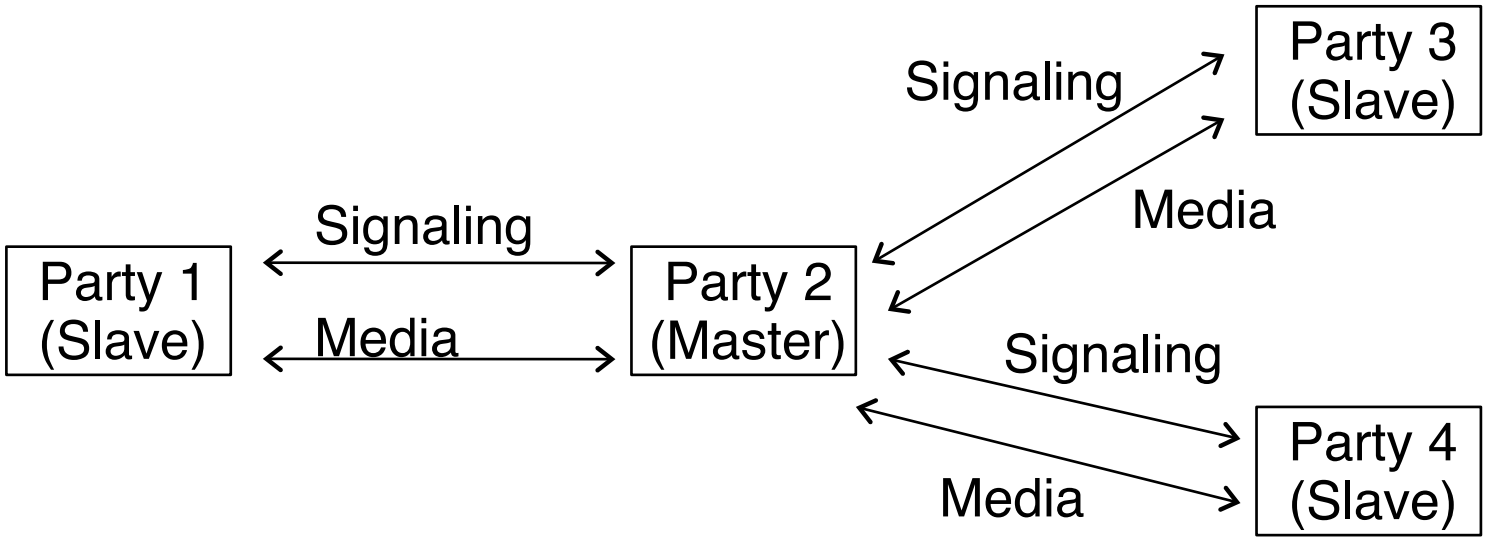
- Difficult to implement, no single point of failure, high bandwidth usage
- Suitable for ad-hoc conferences with low participant numbers

Multicast Network Configuration



- Uses multicast addresses
- Difficult to implement, no single point of failure, bandwidth-efficient
- Suitable for interactive broadcasts with high number of participants

Master-Slave Network Configuration



- Easy to implement, single point of failure, medium bandwidth-efficiency
- Suitable for meet-me and ad-hoc conferences of medium size
- *Note:* Hybrid forms may use different configurations for signaling and media!
  - H.323: Master-Slave signaling, master-slave or multicast media distribution

12 Multimedia Conferencing

12.1 Multimedia Conferencing:
Service Definition and Equipment

12.2 Application Examples

12.3 Typology of Multi-Point Conferences

12.4 Standards for Multimedia Conferencing

Literature:

James R. Wilcox: Videoconferencing, the whole picture, 3rd ed,
CMP Media 2000

H.32X Family

- H.323: ITU-T standard “Visual Telephone Terminals over Non-Guaranteed QoS Service LANs”
  - Compatible with ISDN and IP protocols
- Components:
  - Terminals: PCs, workstations, videophones (must support voice-data)
  - Gatekeeper: Access control, address administration
  - Gateway: E.g. interoperability between IP networks and ISDN
  - Multipoint controller: To support multi-point conferences

- H.324: ITU-T standard “Terminal for Low Bit-Rate Multimedia Communication”
  - Point-to-point audio and video over telephone lines
  - Comprises H.263 video compression
- More recent video standard:
  - H.264 video compression, identical to MPEG-4 AVC

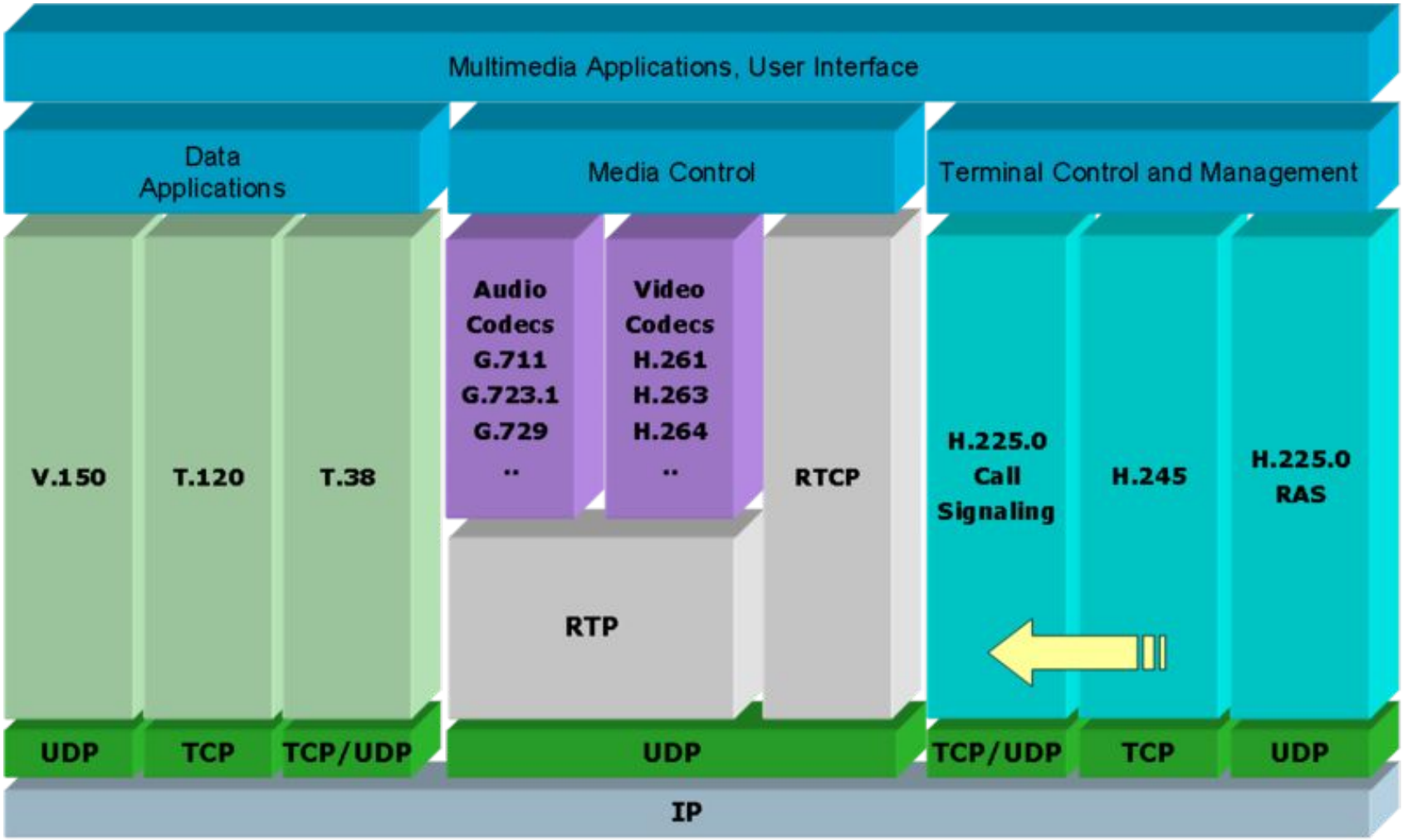
Call and Session Signaling in H.32X

- H.225
  - Call signaling and RAS (Registration, Admission, Status) over non-QoS networks
  - Additional protection and recovery mechanisms on top of H.320
- H.245
  - Control protocol for multimedia
  - Information exchange about terminal capabilities (e.g. codecs, ports)
  - Negotiation of logical channels between terminals
  - Can be “tunelled” through H.225 (firewalls)

Multimedia Data in H.32X Conferences

- Document or data conferencing: collaboration on documents
  - Audio/video conference plus additional information
- ITU-T standard T.120 (“Transmission Protocols for Multimedia Data”), 1996
  - Point-to-point and multi-point document conferencing
  - Main applications: shared whiteboard, multi-point file access
  - Start and management of applications
  - Reservation and transfer of tokens for access rights
  - Protocol designed for ISDN, PSTN, PSDN, not for Internet protocols
  - In practice carried over TCP
- ITU-T standard T.38 (Fax over IP)
  - Connecting G2/G3 fax devices over IP networks
- ITU-T standard V.150 (Modem over IP)
  - Transport of modem tones over IP networks

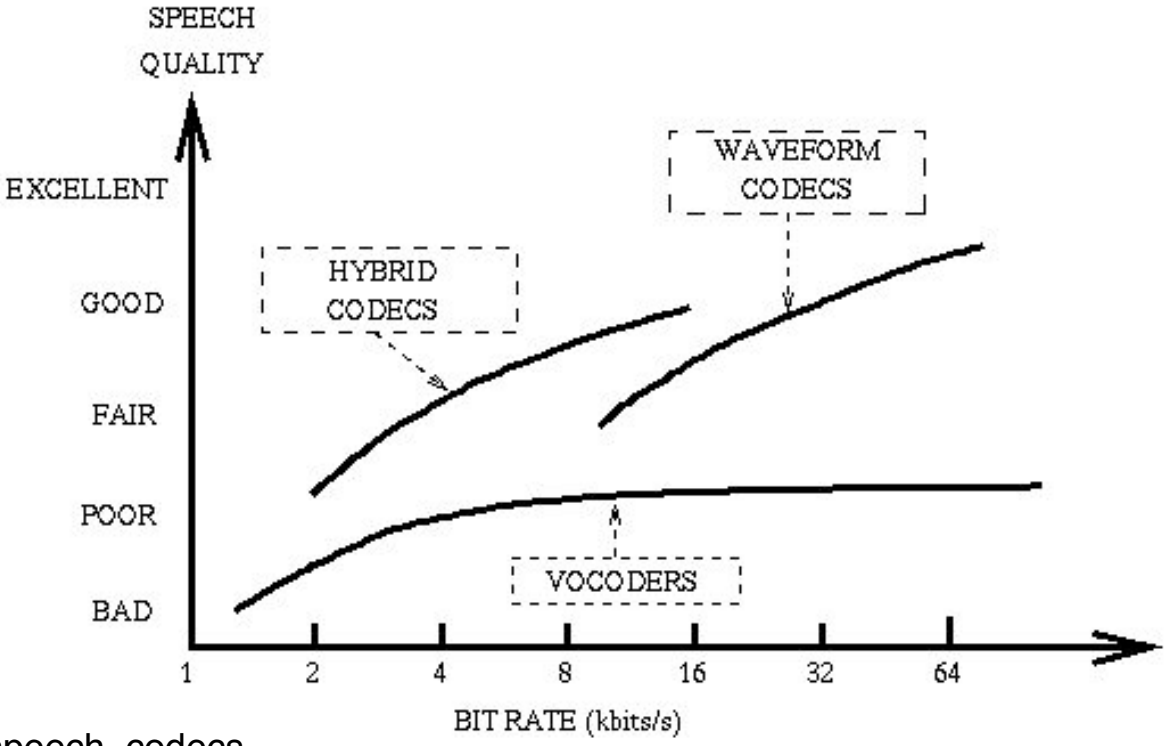
Typical Protocol Stack for H.323 over IP



Source: ITU

Speech Codec Technology

- General idea:
  - Speech has limited frequency bandwidth (< 4 kHz)
  - Speech has specific waveforms (due to human physiology)
    - » Relatively high degree of *predictability* of (parts of) signal
- Main types of codecs:
  - Waveform codec
  - Source codec (Vocoder, speech synthesis)
  - Hybrid codecs



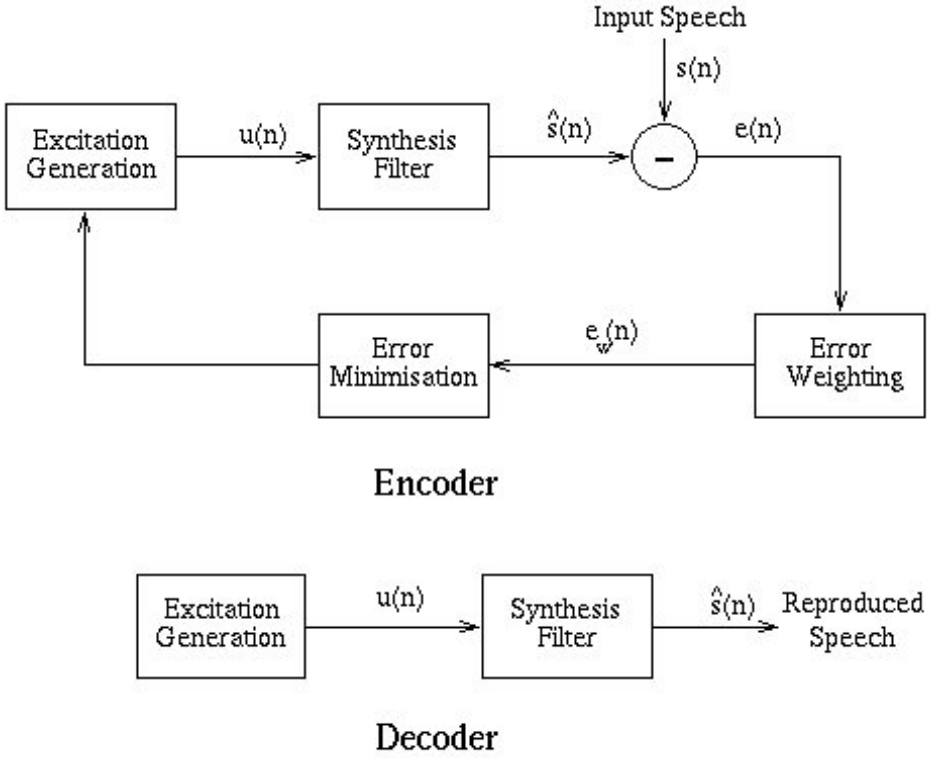
http://www-mobile.ecs.soton.ac.uk/speech_codecs

Waveform Speech Codecs

- Waveform codecs
  - Using pulse code modulation (PCM)
  - Differential encoding (prediction) of samples (DPCM)
  - Adaption to characteristics of actual speech being coded (ADPCM)
  - Sub-Band Coding (SBC): Different emphasis to separate sub-bands
  - Adaptive Transform Coding (ATC): Using transformation to frequency space
- μ-law and A-law:
  - Compander methods (dynamic compressor and expander)
  - Basic idea: loud signals are more strongly compressed than low signals
    - » Signal-noise ratio kept linear over the dynamic range

Hybrid Codecs

- Basic idea:
  - Based on speech synthesis using model of sound generation in vocal tract
  - Synthesize speech in parallel to analyzing the input
  - Adapt synthesis parameters to minimize difference between synthesized and original signal
- Main technologies:
  - CELP
  - RPE



"analysis-by-synthesis"

Standard Codecs

- G.711: 64 kbit PCM (e.g. ISDN)
- G.721, G.726, G.727: ADPCM with various bit rates
- G.728: Backward adaptive CELP (hybrid) codec, 2 ms delay, 16 kBit/s
- G.729: CELP codec with 8 kBit/s, optimized against packet loss
- GSM (mobile phones):
  - Simple hybrid codec (RPE)
- DoD Federal Standard 1016
  - 4,8 kBit/s CELP codec
- Codecs created by “Global IP Sound”
  - iLBC (standardized as RFC 3951, 3952): block independent linear predictive coding
  - iSAC: adaptive in packet size and bit rate
  - Resistance against packet loss

Conclusions…

- Advanced conferencing:
  - Virtual Collaborative Spaces
  - 2D or 3D, participants may be represented by *avatars*
    - » E.g. using *Second Life* for conference meetings
  - Embedded into physical environment (Augmented Reality, Instrumented Rooms)
- Innovation Processes:
  - Uptake of applications into social life takes much longer time than pure technological innovation
  - Innovators often fail when introducing new technology & applications
  - Many small steps, sometimes new combinations of technologies, finally introduce the new ideas
    - » Example video telephony --> Skype, Apple FaceTime
- "When we stop talking about the technology, that's when it will be here."
  Norman Gaut