Multimedia Networking

Network

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Pr...es

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Overview

❑ Media Synchronization

❑ Multimedia over ATM

❑ Multimedia over IP: MBONE, RSVP,...

❑ Interesting applications on Internet

Local Multimedia
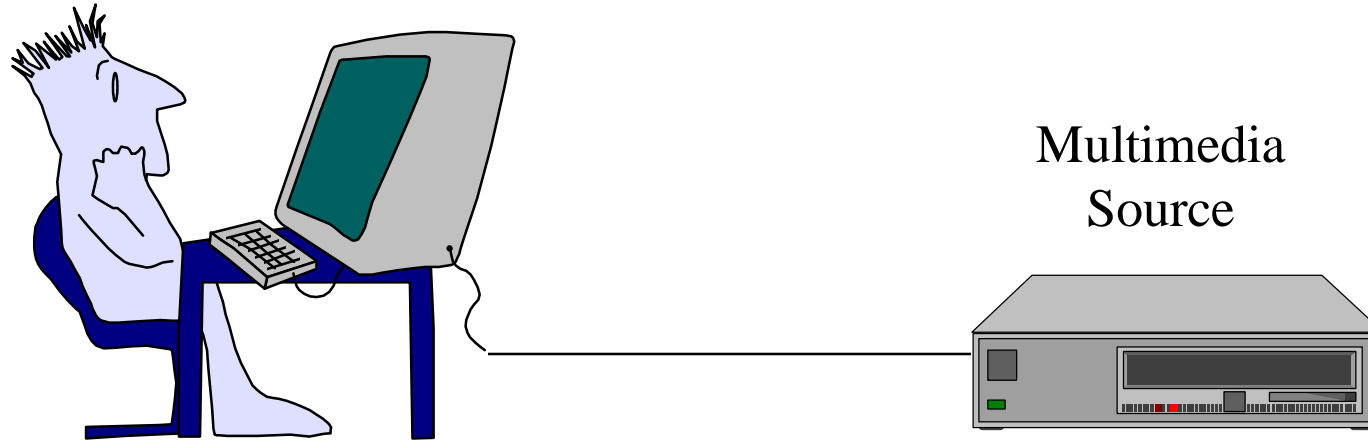
Multimedia
Source

- ❑ No bandwidth sharing ⇒ Constant bit rate
- ❑ Circuit switching   ⇒   No buffering
  No delay variation
  No (negligible) loss

Multimedia Synchronization

Multimedia
Source
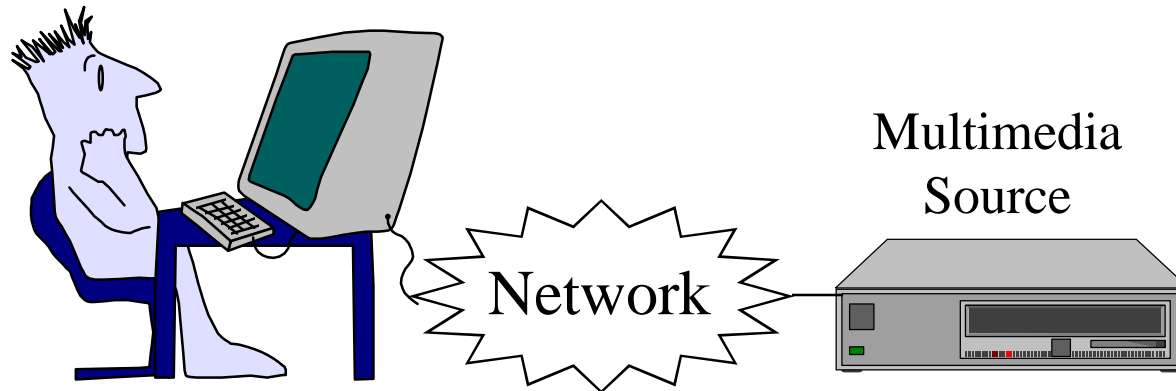
Network

- **Playout Synchronization**: Play signal generated at t at t+Δ inspite of variable network delay
- **Inter-Media Synchronization**: Between audio and video (Lip sync)
- **Intra-Media Synchronization**: All receivers play at the same time (simulations and wargaming)
- Playout is required for all continuous media. Intra- and Inter- may or may not be required.

Timestamps
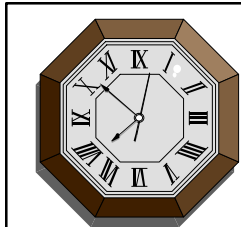
	Open at 10:30:3.123
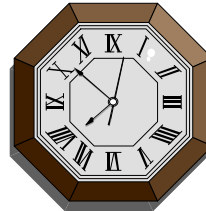
	Open at 10:30:3.223

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- **Unit**: frame (not good for variable frame rate), ms, μs, s
- **Bits**: 10, 32, 33, 64
  Wrap around may cause confusion
- MPEG uses 33-bit clock with a resolution of 90 kHz
  Divisible by 24 Hz, 25 Hz, 29.97 HZ, and 30 Hz
  However, 33-bits are one too many
- Network video protocol (NVP) uses 10-bit timestamps.
  For 20-ms audio packets, it wraps around in 20.5 s.

Error Control

❑ Options:
   ❑ None
   ❑ Error detection with no indication to application
   ❑ Error detection with indication to application
   ❑ Error detection with retransmission
   ❑ Error Correction: Forward error correction
   ❑ Error Concealment: Freeze frame

❑ Header errors: May cause mis-synchronization, wrong coding identification

❑ Data errors: Easier to tolerate

❑ Packet loss: Good to have sequence numbers

❑ Packet reordering: Need sequence numbers

Multimedia over ATM

❑ Service Aspects and Applications (SAA) Group

    ❑ MPEG2 over ATM

❑ Key Issues:

    ❑ What Applications?

    ❑ Transport stream or program stream?

    ❑ Which ATM Adaptation Layer (AAL)?

    ❑ What signalling parameters and values?

What Applications?

❑ MPEG1 for VHS-quality video/audio

❑ MPEG2 for theater-quality video/audio

❑ Video on Demand $\Rightarrow$ High-quality $\Rightarrow$ MPEG2

❑ CBR encoded MPEG2 transport streams are most common $\Rightarrow$ Do we need CBR transmission?

CBR vs VBR

Compression
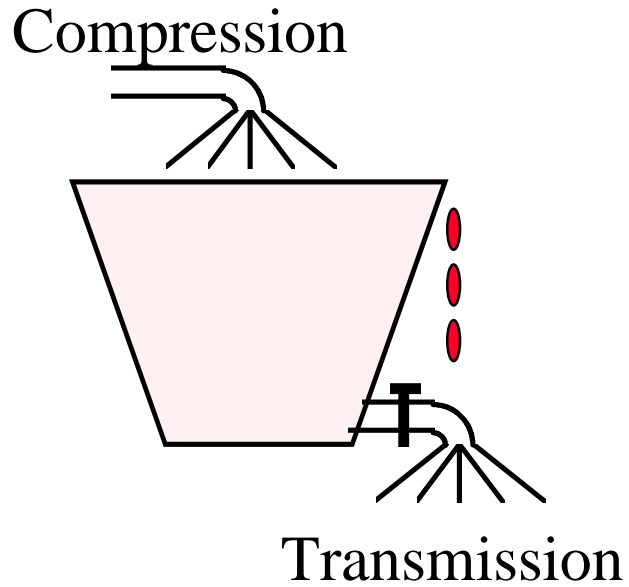
Transmission

		Compression	
		CBR	VBR
Transmission	CBR	No Buffering	Wasted Bandwidth
	VBR	Buffering	Buffering

Which AAL?

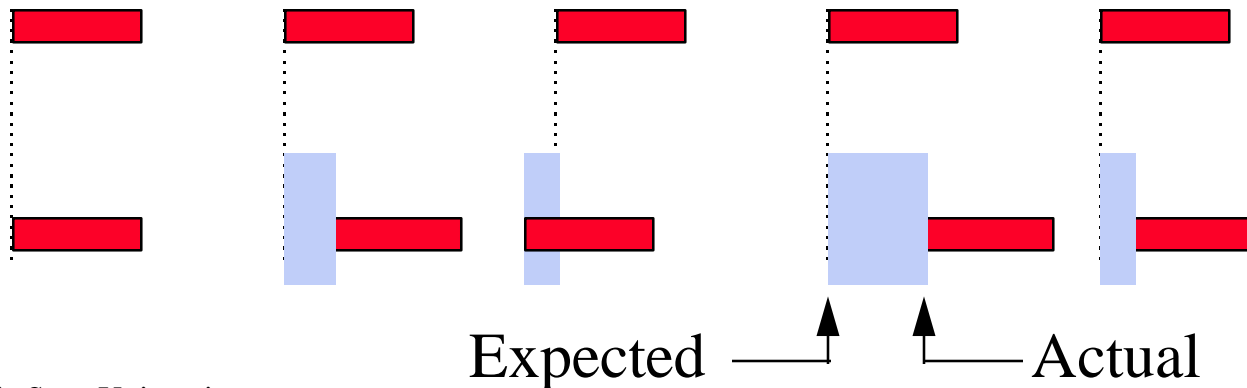| ATM Application |
| --- |
| ATM Adaptation Layer |
| ATM |
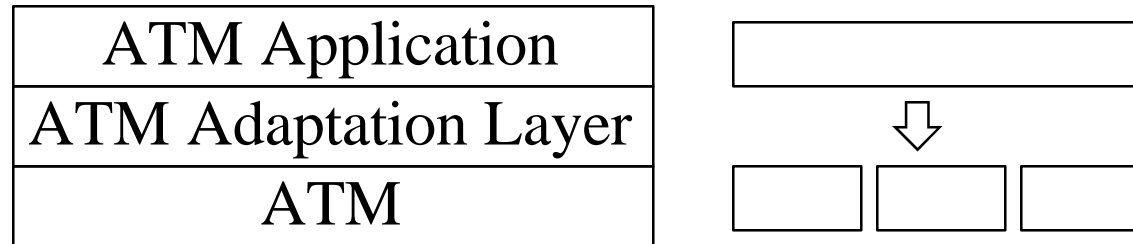
- ❑ AAL1: Designed for CBR,
    - ❑ Provides forward error correction option
    - ❑ Contains time-stamp
    - ❑ Less overhead than AAL5
    - ❑ Ideal fit: 188 byte MPEG2 transport packet = 4 cells
- ❑ AAL5: Implemented universally $\Rightarrow$ Low cost
    - ❑ Used for signaling and LAN emulation

Cell Delay Variation

❑ Instantaneous Cell-Delay Variation (I-CDV)
   Actual-Expected arrival time

❑ Expected = Emission + Nominal delay

❑ Cell Delay Variation Window (CDV-W)
   CDV-W = |I-CDV(Max)| + |I-CDV(Min)|

❑ Cells arriving outside window are considered lost

❑ Large CDV $\Rightarrow$ Large buffers $\Rightarrow$ Higher cost

Expected ——— Actual

Status and Plans

- ❑ Send to Forum membership for approval in September 1995
- ❑ Future:
    - ❑ Select QoS parameters
    - ❑ VBR MPEG2
    - ❑ Other compression standards
    - ❑ Other applications

Multimedia over IP

❑ Multicast Backbone: MBone

❑ Protocols:

  ❑ RSVP

  ❑ RTP

  ❑ ST2

❑ Applications:

  ❑ CU-SeeMe

  ❑ Internet Talk Radio

  ❑ INETphone servers

❑ Other Audio-Visual Tools: vat, nv, ivs, ...

MBone

❑ Internet Multicast backbone

❑ A set of routers that implement IP multicasting

❑ IP multicast address: start with 1110... (binary), 224.0.0.0 to 239.255.255.255 (decimal)

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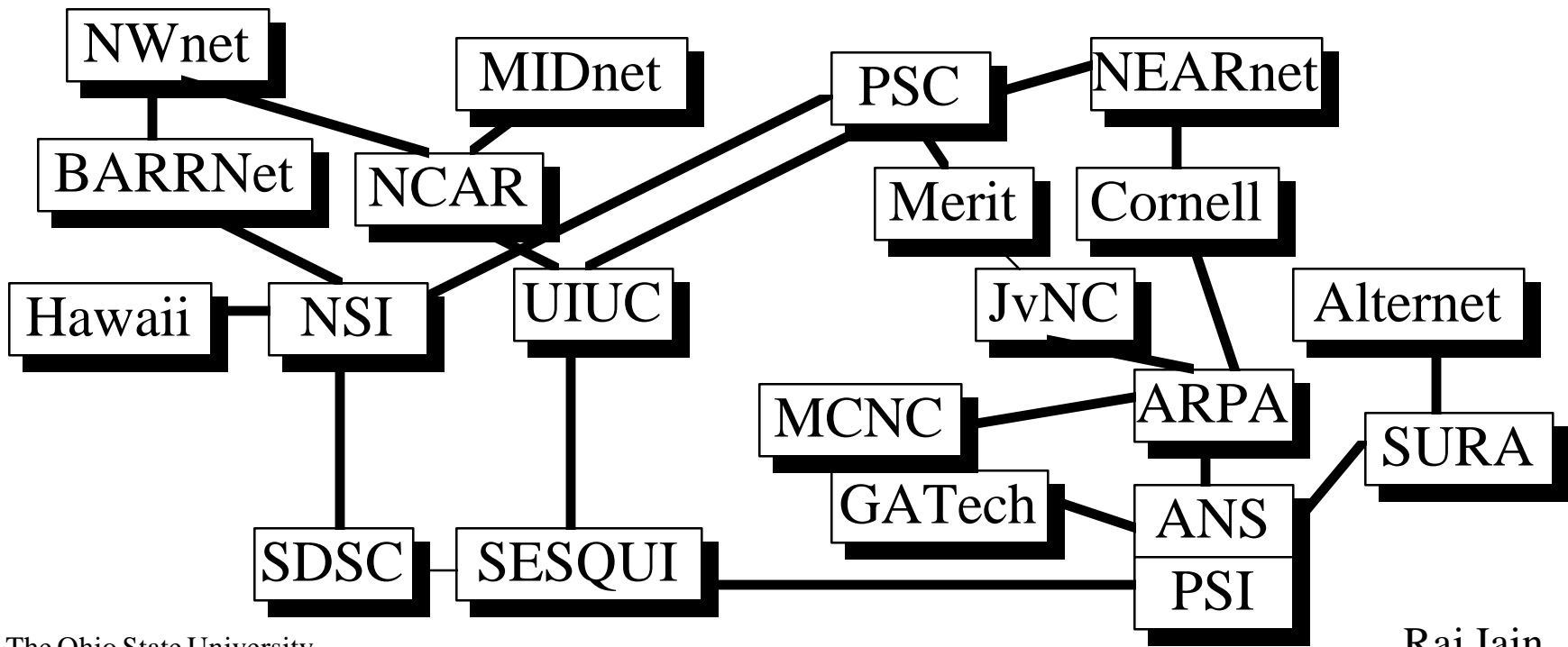
MBone (Cont)

❑ Uses radio/tv station paradigm: Sender is allocated a multicast address and it starts transmitting on that address

❑ Anyone can listen by tuning into the multicast address by sending an Internet Group Management Protocol (IGMP) request to router to join the multicast

❑ The router provides a connection to the nearest point

❑ Sender has no idea of who is listening
Sender controlled multicasts does not scale well.

❑ First audiocast in March 1992: IETF meeting to 20 sites

❑ Now over 600 hosts in over 15 countries

❑ Programs include space shuttle, conferences, IETF,...

❑ President Clinton and VP Gore have appeared

❑ Is a source of heavy traffic, congestion, and complaints

Mrouted

❏ The routing protocol that allows IP multicast

❏ Software available on the Internet.
Join the MBone mailing list.

❏ Many vendors implement it already in their routers

❏ To connect find the nearest Mrouted.
Maps available on the net.

❏ Mrouteds setup tunnels between them.
Tunnel = direct connection

❏ Routers on the path of the tunnel donot need to know
multicasting.
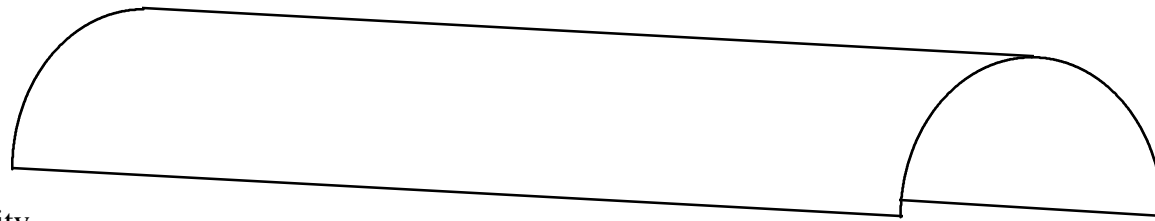
Tunnels
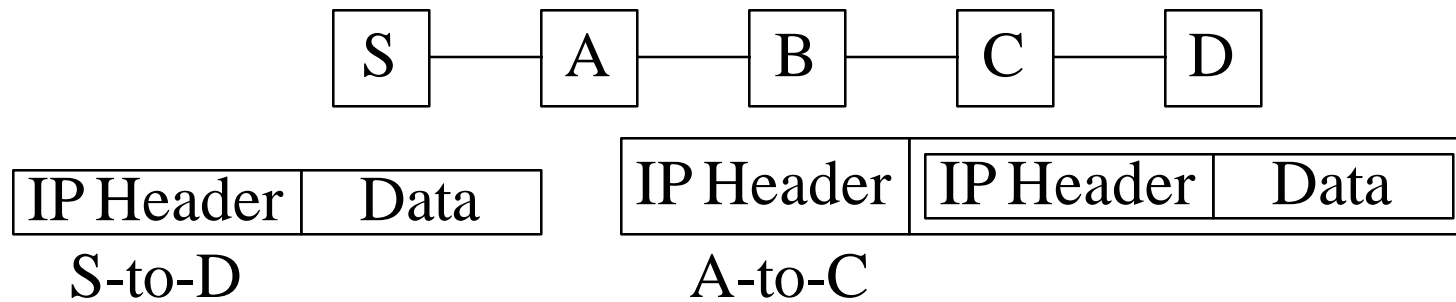
❏ Implemented by encaptulating the entire packet in another IP header.

❏ Each tunnel has a cost. Least cost path is found by exchanging distance-vectors with neighbors.
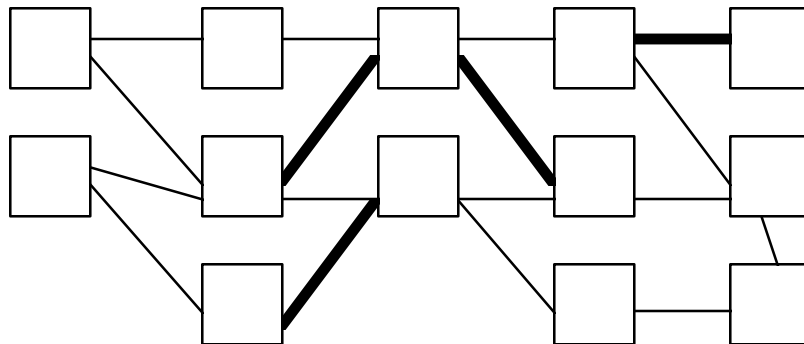
Tunnels Are Expensive

❑ Each tunnel requires 100 to 300 kbps.
  Use 500 kbps for design.
  A few tunnels can saturate the host.
  Four on SPARC 1, six on SPARC 10.
  Fifteen tunnels can saturate an Ethernet.
  Maximum two tunnels over T1.

❑ Each packet has a time to live (TTL).
  TTL is decremented at each router.
  The packet is forwarded iff its TTL is over a threshold.

❑ Periodically, leaf mrouteds poll to see if there are any listers.

❑ Pruning: If a mrouted gets a packet for which it has no listeners,
  it sends a message to the upstream mrouted to stop sending.

MBONE: References

- ❏ H. Eriksson, "MBone: The Multicast Backbone," CACM, August 1994, pp. 54-60.

- ❏ RFC 1112, "Host extensions for IP Multicasting"

- ❏ S. Casner, et al, "Frequently Asked Questions (FAQ) on the Multicast Backbone (MBone)," http://www.research.att.com/mbone-faq.html
  See also http:://www.cs.ucl.ac.uk/mice/faq.html

- ❏ M. Macedonia and D. Brutzman, "Mbone Provides Audio and Video Across the Internet," Computer, April 1994, pp. 30-36.

- ❏ MBONE: List of available s/w and FTP sites
  http:://www.cs.ucl.ac.uk/mice/mbone-soft.html

- ❏ MBONE Routers and Links
  http:://info.arl.army.mil/ACIS/ACD/MBONE/mbone-routers.html

- ❏ MBone interest group mailing list: mbone-request@isi.edu

- ❏ Conference announcements mailing list:
 rem-conf-request@es.net

IP Multimedia Tools

❏ vat - Visual audio tool (conferencing)
by Steve McCane and Van Jacobsen of LBL

❏ nevot - Network voice terminal (conferencing)
by Henning Schulzrine of AT&T

❏ ivs - INRIA video conferencing system by Thierry Thurle

❏ nv or NetVideo - network video by Ron Frederick of Xerox

❏ vic - Video conferecing tool

❏ wb - White board (shared drawing space)
by McCane and Jacobsen

❏ imm - Image (JPEG) multicast client
by Winston Dang of U. Hawaii

❏ sd - Session directory tool for MBone programs

IP Multimedia Tools (Cont)

❑ mmcc - Multimedia conference control by Eve Schooler of USC/ISI

❑ mmphone

❑ media on demand server by Anders Kelmets of RIT Stockholm (Allows unicast replays of past Mbone sessions)

❑ CuSeeMe - Desktop video conferencing

❑ Multicast reflectors

❑ maven - Audioconferencing tool

Ref: http://www.lbl.gov/ctl/vconf-faq.html
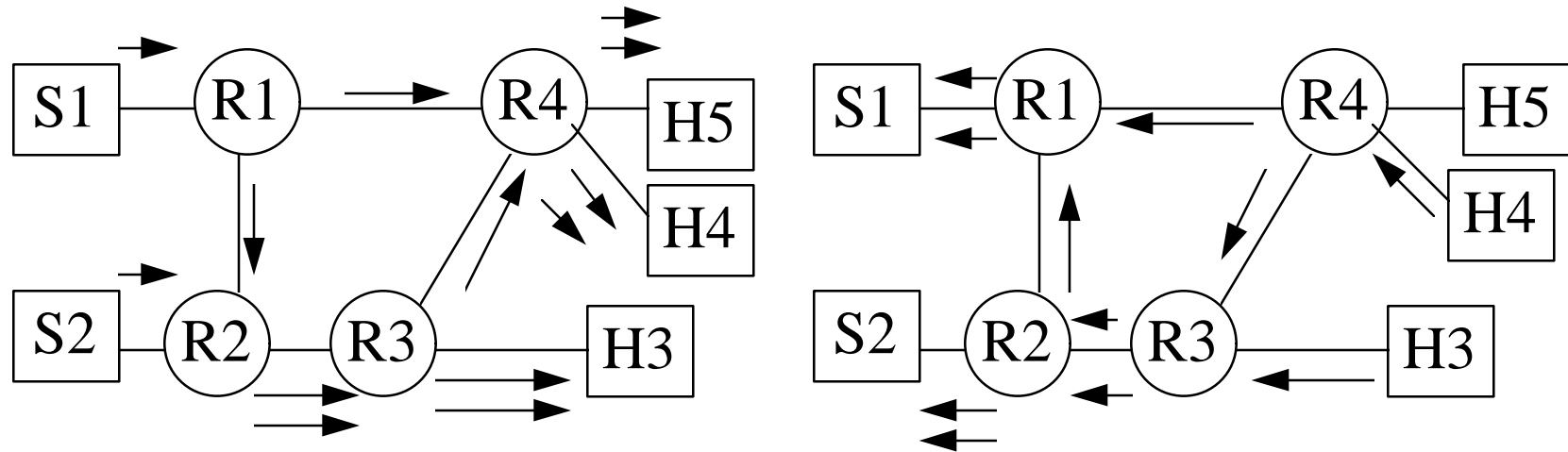
RSVP

- ❏ ReSource Reservation Protocol
- ❏ Simplex streams between sources and receivers
- ❏ Receiver initiated ⇒ Scalable
- ❏ Receiver requests are propagated upstream towards the senders
- ❏ Routers may merge requests from many receivers

RSVP (Cont)

- ❑ Routers maintain a soft state. The receivers have to refresh periodically.

- ❑ Routers have a packet classifier and a scheduler

- ❑ Provides many different reservation styles

  - ❑ Any source but a given multicast destination

  - ❑ List of sources (fixed or dynamic)
    Allows receivers to switch channels

- ❑ Routing trees from sources

- ❑ Sink trees from receivers

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RSVP: References

❑ L. Zhang, et al, "RSVP: A New Resource ReServation Protocol," IEEE Network 1993.

❑ R. Braden, et al, "Resource ReServation Protocol (RSVP) -- Version 1 Functional Specification," Internet draft, March 24, 1995, ftp://ietf.cnri.reston.va.us/internet-drafts/draft-ietf-rsvp-spec-05.txt

❑ D. Mitzel, et al, "An Architectural Comparison of ST-II and RSVP," Infocomm'94. ftp://catarina.usc.edu/pub/mitzel/Infocom94/infocom94.ps

❑ RSVP, http://www.isi.edu/div7/rsvp/

❑ Mailing list: rsvp-request@isi.edu

CuSeeMe

❑ Video conferencing software

❑ Works on any system connected to Internet: PC, MACs, workstations

❑ Developed at Cornell University. Sponsored by NSF.

❑ Software available free on the net

❑ Provides one-to-one connection

❑ One-to-many connection feasible using a reflector

❑ Reflector software for Sun workstations is available

❑ Many public reflector sites

CuSeeMe (Cont)

❑ Receivers need only normal video cards

❑ Senders need a video capture card and a video camera

❑ Captures 8-bit 160X120 video images. Displays 4-bit grayscale video at a low frame rate.

❑ Audio sounds are occasionally broken.

**Ref**: http://magneto.csc.ncsu.edu/Multimedia/Classes/Spring94/projects/proj6/cu-seeme.html

Internet Talk Radio

- Like National Public Radio on the Internet
- Supported by Sun Microsystems and O'Reilly & Associates Run by Carl Malamud
- Covers networking topics
- Does not use MBone. Audio files are distributed.
- Geek of the Week program features key Internet personalities
- The Incidental Tourist features restaurant reviews
- Key sessions of the many conferences are rebroadcast
- For further info info@radio.com

Ref: http://www.cmf.nrl.navy.mil/radio/ITRintro.readme.html

INETPhone:
Internet Phone Servers

❑ Being designed by Multiparty MUltimedia SessIon Control (MMUSIC) working group of IETF

❑ Open ownership of phone service (similar to internet)

❑ Telephone servers (similar to routers)

❑ Incoming and outgoing local phone lines on one side
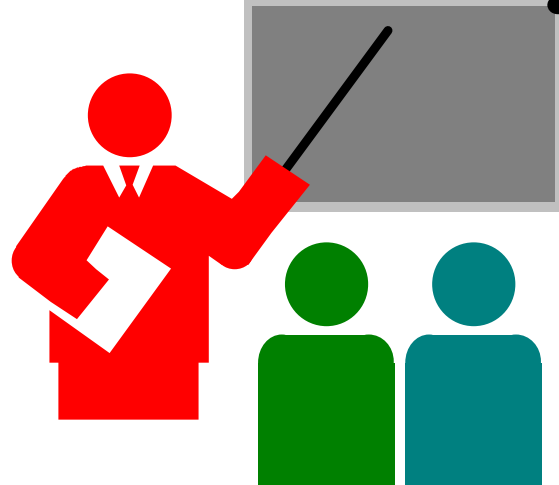
❑ Internet connections on the other side
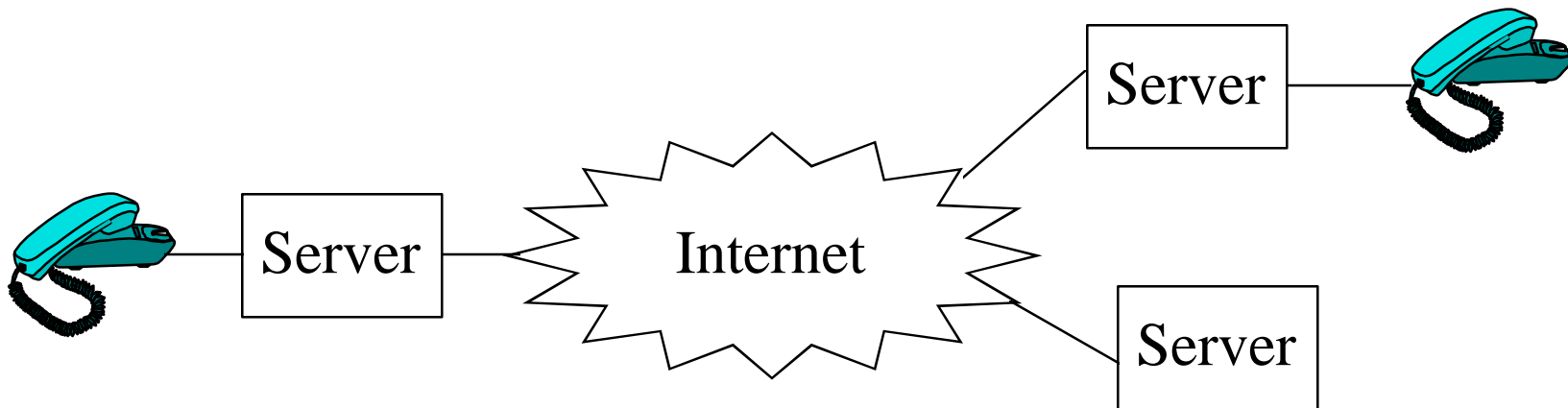
INETPhone (Cont)

❑ Receive local calls, determine the internet route and forward

❑ Accept remote calling requests

❑ Local call, Internet, local call

❑ Directory servers map INETPhone servers IP addresses to phone numbers

Ref: RFC 1789, "INETPhone: Telephone Services and Servers on Internet," April 1995.

Summary

- Constant bit rate MPEG2 video on demand

- Uses VBR AAL5 for CBR video

- TCP/IP protocols suite is being extended to allow multimedia on Internet.

- Multicast backbone (Mbone), Resource reservation (RSVP)

- Internet talk radio and Internet phone

Acronyms

AAL: ATM Adaptation Layer

ADSL: Asymmetric Digital Subscriber Line

AMS: Audiovisual Multimedia Services

ATM: Asynchronous Transfer Mode

AVIS: Audiovisual Interactive Services

BRI: Basic Rate Interface

CATV: Cable Television

CBR: Constant Bit Rate

CBT: Core-Based Trees

CDV-W: Cell Delay Variation Window

CDV: Cell Delay Variation

CELP: Code-excited liner prediction

CMMC: Conference Management and Multiplexing Center

CRC: Cyclic Redundancy Check

- CSMA/CD: Carrier Sense Multiple Access with Collision Detection
- FEC: Forward Error Correction
- FTTC: Fiber to the Curb
- GSM: Groupe Special Mobile (cellular phone standard)
- HDSL: High-Speed Digital Subscriber Line
- I-CDV: Instantaneous Cell Delay Variation
- IDMR: Inter-Domain Multicast Routing
- IGMP: Internet Group Management Protocol
- JPEG: Joint Picture Experts Group
- LEC: Local Exchange Carrier
- MBone: Multicast Backbone
- MIME: Multipurpose Internet Mail Extensions
- MMUSIC: Multiparty MUltimedia SessIon Control
- MOSPF: Multicast Extensions to OSPF
- MOSPF: Multicast Open Shortest Path First
- MPEG: Motion Picture Expert Group
- NVoD: Near Video on Demand
- PCR: Program Clock Reference

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- ❏ PCR: Program Clock Reference
- ❏ PDU: Protocol Data Unit
- ❏ PIM: Protocol Independent Multicast
- ❏ PIM: Protocol Independent Multicast
- ❏ PRI: Primary Rate Interface
- ❏ PS: Program Stream
- ❏ PTS: Presentation Time Stamp
- ❏ QoS: Quality of Service
- ❏ RBB: Residential Broadband
- ❏ RSVP: Resource ReServation Protocol
- ❏ RTP: Real-time Transport Protocol
- ❏ SAA: Service Aspects and Applications Group
- ❏ SCMP: Stream Control Message Protocol
- ❏ SDP: Session Description Protocol
- ❏ SRTS: Synchronous Residual Time Stamp
- ❏ ST2: Internet Stream Protocol Version 2
- ❏ STC: System Time Clock

- TS: Transport Stream
- TTL: Time to live
- VBR: Variable bit rate
- VCO: Voltage Controlled Oscillator
- VoD: Video on Demand

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