Multimedia and Networks
a summary

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Basic Networking

• Networks are organized in Layers
  - Lower Layers (Physical, DataLink/MAC)
  - Middle Layers (Network, Transport)
  - Upper Layers (Applications)

• The Internet is the standard, hence the IP protocol is the standard.
What IP provides

- Standard network protocol
- Datagram service (not Virtual Circuit)
- Best effort, no guarantees.
- Decentralized control
How does the Internet provide services?

- Protocols build on the IP infrastructure.
- If you require a protocol that is reliable, it needs to provide the reliability since IP doesn't.
- If you require a protocol that has a certain QoS (delay, bandwidth) you need to provide it since IP doesn't*

*Not always possible without the help of IP or the infrastructure
TCP

- End-to-End
- Reliable
- Ordered delivery
- Byte stream
- Flow control / Congestion control
UDP

- Plain Datagram IP
- No delivery guarantee
- No ordered guarantee
- Minimal overhead
- No official packet flow
- No delivery confirmation
- No congestion control / flow control
Distributing streamed content

- Audio / Video: single user
  - tcp download
  - udp stream
- Audio / Video: multi-user
  - multiple downloads / streams
  - multicast
Multicast

• One distribution tree for all the receivers

• Routers are in charge of duplicating packets for receivers on different paths

• Some of the challenges:
  - Where do we meet?
  - How fast do we send?
  - How does it scale?
  - How do we charge?
QoS: Quality of Service

- Things to consider: reliability, delay, bandwidth, jitter.
- Examples: email, files, surfing the web, IM, ssh.
- Multimedia: audio on demand, video on demand, VoIP, Videoconferencing
- How does the network provide these requirements?
Providing QoS

- Have lots of resources
- Reserve resources (specify requirements)
- Traffic Shaping
  - Leaky bucket
  - Token bucket
- Buffer
Packet Scheduling

- Fair queuing
- Weighted fair queuing
- Integrated Services (flow based)
- Differentiated Services (class based)
RSVP

- Resource reSerVation Protocol
- Nodes send RSVP packet upstream to source
- Routers check if they can reserve the requested resources and forward the message upstream
- If a router can't it returns an error
- If it reaches the source, the requirements have been met.
RTP

- Real-time Transport Protocol
- Works over UDP
- Multiplexes streams into UDP packets
- Allows multiple samples per packet
- Time stamps packets (relative to start of transmission)
- RTCP - control protocol for RTP. Allows receiver to send parameters back or request changes.
RTSP

- Real-Time Streaming Protocol
- The remote control to streaming servers.
- Commands: describe, setup, play, record, pause, teardown.

- Buffer management with RTSP

![Buffer Diagram]

- Low watermark
- High watermark

Buffer
Packet Loss

- FEC (Forward Error Correction)
- PET (Priority fields)
- Layering
- Interleaving