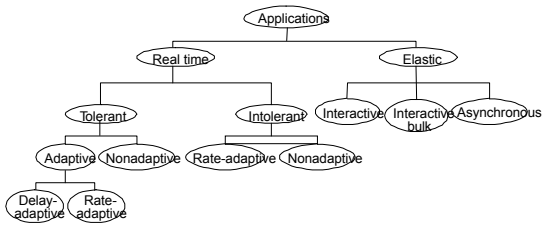
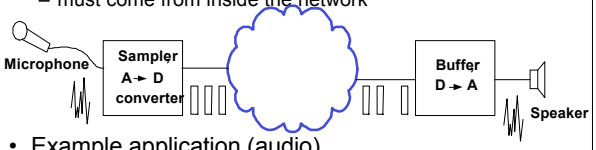
Taxonomy of network applications



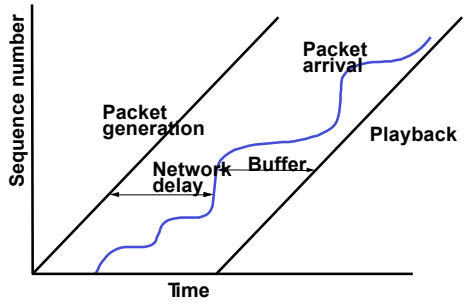
Realtime Applications

- Require “deliver on time” assurances
  - must come from inside the network



- Example application (audio)
  - sample voice once every 125 s
  - each sample has a playback time
  - packets experience variable delay in network
  - add constant factor to playback time: playback point

Playback Buffer



Quality of Service

- IP is a best effort protocol
- Certain applications require performance guarantees:
  - Video conferencing tools require lip-sync synchronization for audio and video streams
  - Multimedia audio or video streams need to reduce jitter and delays
  - Remote virtual reality operations require low latency command propagation
  - Users want performance guarantees
  - ISPs want to make money!!

QoS

- QoS is an end-to-end construct involving the OS, network, applications etc.

1. Applications need to specify their requirements
2. System “admits” applications only if it can support these requirements
3. System monitors to verify that the promises are being met
4. Applications are policed so that they adhere to their promises
5. Mechanisms to charge the user for the service
   - If “free”, everyone wants guaranteed service!!

Integrated Services (Intserv)

- Architecture for supporting QoS guarantees for IP networks
- Service Classes
  - Guaranteed: provides absolute guaranteed delay bound
  - controlled-load: provides several levels of application specified delay classes
  - Best effort: IP
- Mechanisms
  - signaling protocol
  - admission control
  - policing
  - packet scheduling

Flowspec

- Rspec: describes service requested from network
  - controlled-load: none
  - guaranteed: delay target
- Tspec: describes flow's traffic characteristics
  - average bandwidth + burstiness: token bucket filter
  - token rate r
  - bucket depth B
  - must have a token to send a byte
  - must have n tokens to send n bytes
  - start with no tokens
  - accumulate tokens at rate of r per second
  - can accumulate no more than B tokens

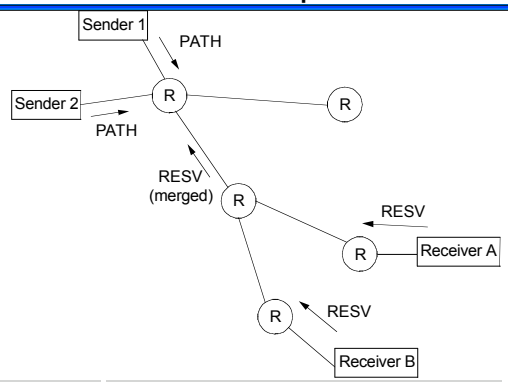
Per-Router Mechanisms

- Admission Control
  - decide if a new flow can be supported
  - answer depends on service class
  - not the same as policing
- Packet Processing
  - classification: associate each packet with the appropriate reservation
  - scheduling: manage queues so each packet receives the requested service

Reservation Protocol

- Called signaling in ATM
- Proposed Internet standard: RSVP
- Consistent with robustness of today's connectionless model
- Uses soft state (refresh periodically)
- Designed to support multicast
- Receiver-oriented
- Two messages: PATH and RESV
- Source transmits PATH messages every 30 seconds
- Destination responds with RESV message
- Merge requirements in case of multicast
- Can specify number of speakers

RSVP Example



RSVP versus ATM (Q.2931)

- RSVP
  - receiver generates reservation
  - soft state (refresh/timeout)
  - separate from route establishment
  - QoS can change dynamically
  - receiver heterogeneity
- ATM
  - sender generates connection request
  - hard state (explicit delete)
  - concurrent with route establishment
  - QoS is static for life of connection
  - uniform QoS to all receivers

Differentiated Services

- Problem with IntServ: scalability
  - Routers have to maintain state
  - RSVP processing overhead
- Idea: support two classes of packets
  - premium
  - best-effort
- Mechanisms
  - packets: 'in' and 'out' bit
  - edge routers:
    - Implement complex policies: tag packets with the required class
    - You pay for the service
  - core routers: RIO (RED with In and Out)
- No per flow guarantees, service per class

Quality of Service

- Aurrecoechea, C., Campbell, A.T. and L. Hauw, "A Survey of QoS Architectures", ACM/Springer Verlag Multimedia Systems Journal , Special Issue on QoS Architecture, Vol. 6 No. 3, pg. 138-151, May 1998