CSE and EE 461
Lecture 21

Summer Quarter 1998

Congestion Control

- Open loop control - preventative - useful for virtual circuit subnets

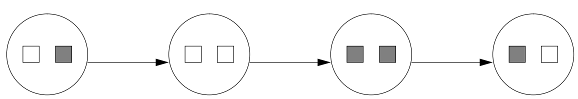
  - preallocation of buffers to virtual circuit - no buffer overflow.
  - flow control into the network - Less flow requires fewer buffers.
  - traffic shaping - smoother flows have smaller queues at switches
  - refuse connections in a virtual circuit

- Closed loop control - reactive - useful in datagram subnets

  - recompute routing tables
  - good buffer management
  - throttle sources using choke packets
  - load shedding

Preallocation of Buffers

- Virtual circuit network layer - prealloaction of buffer space and bandwidth to circuits can be used effectively. Switch to switch window control will never allow queues to build up nodes.



- Each node including the host has k buffers allocated to a virtual circuit.

  - A node sends a packet to the next node only if it knows there is a free buffer available at the next node. When a buffer becomes free a "request" is sent to the previous node.

  - There may be a waste of buffers if a virtual circuit underutilizes its buffers.

Buffer Pool Management

- Pure buffer pool

  There are M buffers total. They are allocated on a first come first serve basis to the various virtual circuits. If no buffer is available then the packet is tossed.

- Restricted buffer pool

  There are M buffers total and n virtual circuits. Virtual circuit i is limited to having at most m(i) buffers allocated to it. The value of m(i) is determined at set-up time. Typically m(i) << M, but m(1)+m(2)+ ... + m(n) > M.

  There is some chance that a virtual circuit will not have a buffer available if the other virtual circuits are using M buffers total.

- Restricting outgoing queues

  There are M buffers total. Each output queue may have no more than m buffers allocated to it. A virtual circuit may not get its fair share.

Flow Control and Traffic Shaping

- Leaky Bucket:

  At the entrance to the network is a "bucket" which passes packets to the network at a steady rate regardless of the rate exhibited by the source.

  Packets that overflow the bucket are thrown away. Alternatively, the tap at the source can be turned off.

  Guaranteed smooth flow.
- Token Bucket:

  Tokens are added to a bucket at a steady rate up to the capacity of the bucket. When the capacity is exceeded tokens are thrown away.

  Packets which have a token can be transmitted immediately.

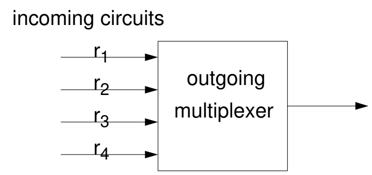
  Flow may be bursty, but never exceeds on average the rate of token arrivals.

Dealing with Fairness

- This can be done in a virtual circuit network more easily.
- Fair queuing

  - each virtual circuit c has an assigned packet rate r(c). At a specific switch packets for c may arrive at a rate different from r(c).

  - Suppose the outgoing line has total assigned rate R from all virtual circuits then c gets a r(c)/R percent share of the outgoing packets when the outgoing line is heavily loaded.

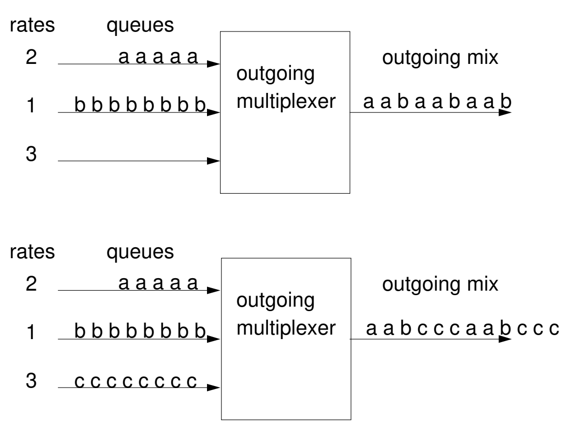


$R = r_1 + r_2 + r_3 + r_4$

Queues build up for each incoming circuit.

The server samples r_i for service r_i/R percent of the samples.

Fair Queuing Example



RSVP

- RSVP = Resource Reservation Protocol
- Used for congestion control in a multicast environment
- Routers can reserve bandwidth for sources to a set of destinations to ensure higher quality of service.