CprE 489
Lecture 18

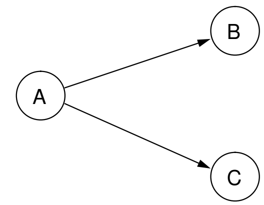
Fall Semester 1997

Structure of a Datagram Service

- Each switch has a routing table which allows the router to forward a packet to its eventual destination.
- Each packet has the final destination.

A's Routing Table

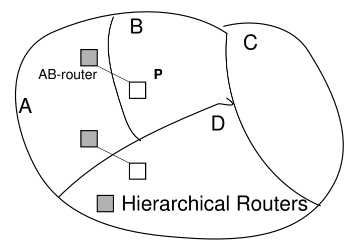
Destination	Next Hop
E	B
F	C
G	B
K	B
M	C



Main Issues in Maintaining Routing Tables

- Routing tables must be consistent - there can be no permanent cycles
- Routing tables should be dynamic - to route around congestion or failed switches.
- Routing tables should be small - hierarchical routing will be needed
- There are alternatives to using strict routing tables for accomplishing the task of packet delivery. Such alternatives are certainly needed to distribute data for maintaining routing tables. More later.

Hierarchical Routing



AB-router handles all traffic from subnet A to subnet B. Packets from A to B have an address of the form B.*. Within the subnet A they are always routed to AB-router.

Subnet A Routing Table

Destination	Next Hop
A.X	W
A.Y	U
A.Z	U
B.*	V
C.*	L
D.*	V

AB-router's Routing Table

Destination	Next Hop
A.X	T
A.Z	S
B.*	P
C.*	Q
D.*	Q

Alternative Routing Algorithms

- Multipath routing- routing tables contain alternative next hops to the same destination
- hot potato routing - route a packet on the shortest outgoing queue
- delta routing - route a packet on any outgoing link that is within a certain bound delta of the best outgoing link
- random routing - route a packet randomly
- flooding - route duplicates of a packet out all outgoing links

  - to avoid a massive number of duplicates, a copy can be kept so that if a duplicate arrives it is discarded. Must be careful not to discard the copy too soon.

  - flooding is used to send local information to all other nodes to construct routing tables.
- Optimal routing - given all the end-to-end demands compute the best possible routes to meet all the demands.

Who Does What

- Error Control

  - virtual circuit may or may not provide an errorless channel

  - datagram does not provide error free delivery nor FIFO delivery
- Flow Control

  - virtual circuit may demand flow control to avoid congestion

  - datagram - transport layer must provide its own flow control
- Connection Control

  - virtual circuit provides connection control

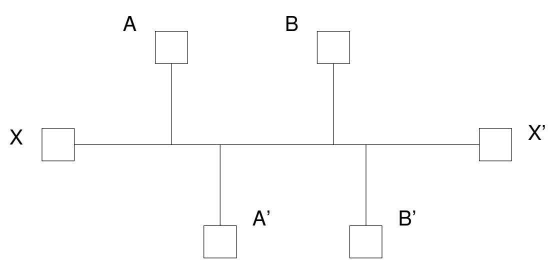
  - datagram - connection control must be done by the transport layer

Fairness vs. High Utilization

- Suppose ε ups need to flow from X to X' and 1 ups each from A to A' and B to B'. Suppose the capacity of the X to X' channel is 1 ups.

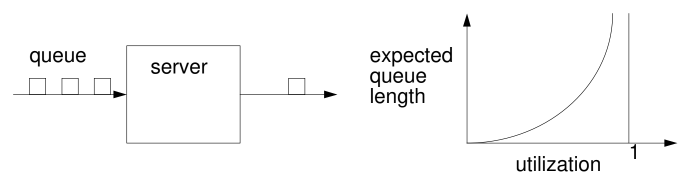
  By blocking X to X' traffic we get 2 ups through the system.

  Allowing X to transmit gives us 2 - ε ups through the system.



Delay vs. Utilization

- In almost any statistical queing situation, the higher the utilization the higher the delay.



- If server is 100% utilized then mean queue length is infinite.
- If Q_t is the queue length at time t and server is 100% utilized then:

$$\lim_{t \to \infty}\left(\sum_{i=1}^{t} Q_t\right)/t = \infty$$