Packet Switching

Outline
Store-and-Forward Switches
Bridges and Extended LANs
Cell Switching
Segmentation and Reassembly

Packet Switching

• Problem: “Not all networks are Directly Connected”
• Directly connected networks have two limitations:
  - number of hosts that can be accommodated
  - geographic limitation
• Goal – networks that are global in scale
• Like Telephone using (circuit) switches,
  we use packet switches (store-and-forward) that take
  packets that arrive on an input and forward (switch) them
  to the right output. Two ways to do it:
    - connection
    - connectionless
Packet Switching

- Key problems that a switch must deal with:
  - Contention – packet arrival exceeds packet dispatch (in this chapter)
  - Congestion – packets discards (due to running out of buffer space) too frequently (in future chapter)

- Key issues covered
  - forwarding
  - contention

- Two switching technologies
  - LAN switching – Popular in LAN, evolved from Ethernet bridging
  - Asynchronous Transfer Mode (ATM) – popular in WAN

Star Topology

- Large numbers of switches can be connected
- Connecting switches/hosts using Point-to-Point links
- Scaling doesn’t always mean performance ↓ (switches designed with enough aggregate capacity)
Scalable Networks

- **Switch**
  - forwards packets from input port to output port, this is referred to as either *switching* or *forwarding*. In terms of the OSI architecture, it is the main function of the network layer.
  - port selected based on address in packet header

![Switch Diagram]

- **Advantages**
  - cover large geographic area (tolerate latency)
  - support large numbers of hosts (scalable bandwidth)

Switches

Q. How does the switch determine output port?

A. By looking at an identifier in the packet header

Three approaches:

- Virtual Circuit (connection-oriented)
- Datagram (connectionless)
- Source Routing
Virtual Circuits

- PVC *Permanent Virtual Circuit*
  - Need network administrator to configure the state
- SVC "*Signalled*" *Virtual Circuit*
  - Send a message into the network (signalling)

- Two types:
  - PVC Permanent Virtual Circuit
  - SVC Signalled Virtual Circuit

- Analogy: phone call
- Each switch maintains a VC table

Explicit connection setup (and tear-down) phase
Subsequence packets follow same circuit
Sometimes called connection-oriented model

VCI *Virtual Circuit Identifier* (0, 1, 2, ...)
- combined with incoming/outgoing interface (e.g., 0, 1, 2, 3) can uniquely identify the virtual connection (VC)
- assigned whenever a new connection is created
- not a globally significant identifier for the VC; rather, only on a given link
### Virtual Circuit Model

- Typically wait full RTT for connection setup before sending first data packet.
- While the connection request contains the full address for destination, each data packet contains only a small identifier, making the per-packet header overhead small.
- If a switch or a link in a connection fails, the connection is broken and a new one needs to be established.
- Connection setup provides an opportunity to reserve resources (QoS reservations).
- ATM utilizes virtual circuits
Datagrams

- Idea – provide just enough information for the switch to forward the packet
  - No setup time
  - Independent forwarding packets
- Analogy – postal system
- Each switch maintains a forwarding (routing) table. More routing in the next chapter

Workstation Used As a Switch

Main problem: all packets must pass through a single point of contention. (I/O bus, read to/write from the main memory)
**Forwarding Table for Nodes**

- Give the datagram forwarding table for each node:

<table>
<thead>
<tr>
<th>Node A</th>
<th>Node B</th>
<th>Node C</th>
<th>Node D</th>
<th>Node E</th>
</tr>
</thead>
<tbody>
<tr>
<td>Destination</td>
<td>Next Hop</td>
<td>Destination</td>
<td>Next Hop</td>
<td>Destination</td>
</tr>
<tr>
<td>B</td>
<td>B</td>
<td>A</td>
<td>A</td>
<td>A</td>
</tr>
<tr>
<td>C</td>
<td>B</td>
<td>C</td>
<td>C</td>
<td>B</td>
</tr>
<tr>
<td>D</td>
<td>B</td>
<td>D</td>
<td>D</td>
<td>D</td>
</tr>
<tr>
<td>E</td>
<td>B</td>
<td>E</td>
<td>C</td>
<td>E</td>
</tr>
</tbody>
</table>

** Datagram Model**

- There is no round trip time delay for connection setup; a host can send data as soon as it is ready.
- Source host has no way of knowing if the network is capable of delivering a packet or if the destination host is even up.
- Since packets are treated independently, it is possible to route around link and node failures.
- Since every packet must carry the full address of the destination, the overhead per packet is higher than for the connection-oriented model.
Source Routing

- Source host contains all information
  - rotates data

- Does not need to use either VCs or Datagrams although can be used in combination with
  - IP for instance uses datagrams but has a source routing option
  - Can be used for VC setup