Packet Transmission

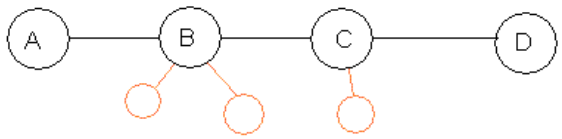
COMP476 Networked Computer Systems

Switching methods

- **Circuit switching** — a switch electronically connects the wires of the two computers together.
- **Message switching** — An intermediate sends the message after it is completely received.
- **Packet switching** —information transferred in small packets.

Example Problem

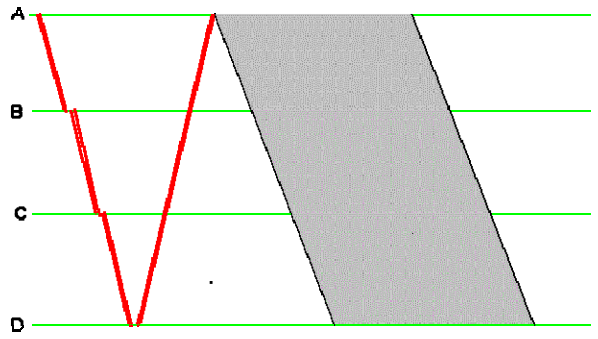
- Consider an arbitrary network that has at least K nodes
- Assume we want to send X bits from node A to node D



Circuit Switching

- An electrical connection is made between the source and the destination.
- The telephone system uses circuit switching when connecting local calls.
- Circuit switching generally requires some initial setup time. This is analogous to dialing the phone.
- After the connection is made, the data can be sent with no delay.

Circuit Switching



Circuit Switching Time

- **K** = number of hops
- **D** = average propagation delay per hop
- **R** = Circuit request size
- **S** = Circuit switch setting time

$$circuit = K * \left(\frac{R}{B} + D + S \right) + \frac{R}{B} + K * D + \frac{X}{B} + D * K$$

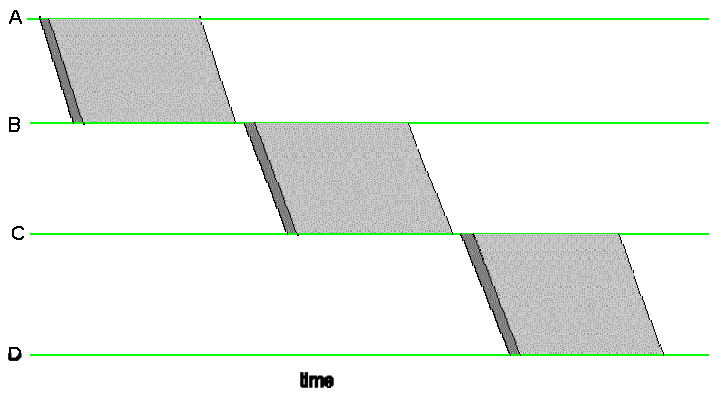
Message Switching

- Message switching - All of the digital data is sent from the source to the destination as a unit.
- When there are intermediate nodes between the source and destination, each intermediate node must receive the entire message before sending it on to the next intermediate or final destination

Message Switching

- Called "store and forward" transmission.
- The intermediate nodes may have to make a decision as to which route the message will be sent.
- A header is attached to the beginning of the message to identify the destination.

Message Switching



Message Switching Time

- **H** = size of the header in bits

$$msg = K \cdot \left(\frac{X + H}{B} + S + D \right)$$

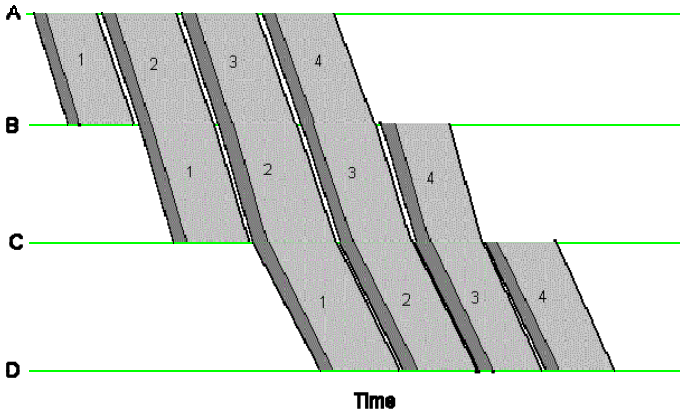
Packet Switching

- Similar to message switching except the data is divided into packets.
- Intermediate nodes must receive an entire packet before sending on towards the destination, but they do not have to receive the entire message.
- Each packet needs a header to identify its destination.

Packet Switching

- The packets can be variable sized or (more often) fixed sized.
- The size of a packet is usually much smaller than the total data size.
- Packet sizes range from 48 bytes for ATM to 1500 bytes for Ethernet to 8K bytes for frame relay.

Packet Switching



Packet Switching Time

- **P** = number of bits in a packet

$$packet = \frac{X}{P} * \left(\frac{P+H}{B} + S \right) + D + (K-1) * \left(\frac{P+H}{B} + S + D \right)$$

Comparison of Methods

- Circuit switching works well if the time to transfer the data is long compared to the circuit setup time.
- Packet switching easily allows multiple independent data streams to be combined one a channel.
- The Internet uses packet switching.

Standard Packet

- Header contains destination address, maybe source address and other parameters.
- Data bytes are sent without start, stop or parity bits. Only the data is sent.
- Trailer contains error checking values.

Ethernet frame format

Preamble	Destination	Source	type	data	CRC
8	6	6	2	46 - 1500	4

Transmission Time

- When calculating the transmission time of data sent over a packet switched system, you have to account for the header and trailer overhead.
- Each packet has a header and can only hold some maximum amount of data.

$$time = \left\lceil \frac{dataBits}{PktSize} \right\rceil * \frac{PktSize + headerSize}{transmissionRate}$$

Error Detection Codes

- Parity bits are not used on each byte of a packet transmission.
- The Trailer contains information to detect transmission errors.
- The amount of overhead to detect errors is reduced for large packets.

Error Detection Concept

- When the packet is sent, the sender computes a function of the data bits and sends the result after the data.
- The receiver computes the same function on the data bits and compares the result to the received value.
- Different error check values indicate a transmission error.

Error Detection Functions

- Sum the data bytes.
- XOR the data bytes
- Cyclic Redundancy Check (CRC) is the result of polynomial division. These are the most commonly used error detection functions.

Error Correction

- Error correcting codes (also called Forward Error Correction or Hamming codes) can reconstruct a few incorrect bits.
- Most systems use retransmission of the packet.