CE3005/SC2008/CS3006 Computer Networks

Tutorial 4

Question 1: Connection-oriented vs Connectionless

What is the principal difference between connectionless communication and connection-oriented communication?

Q1 Answer

- Connection-oriented communication has three phases. In the establishment phase a request is made to set up a connection. Only after this phase has been successfully completed can the data transfer phase be started and data transported. Then comes the release phase.
- Connectionless communication does not have these phases. It just sends the data.

Question 2: Virtual Circuit vs Packet Switching

Packet switched networks route each packet as a separate unit, independent of all others. Virtual-circuit networks do not have to do this, since each data packet follows a predetermined route. Does this observation mean that virtual-circuit networks do not need the capability to route isolated packets from an arbitrary source to an arbitrary destination? Explain your answer.

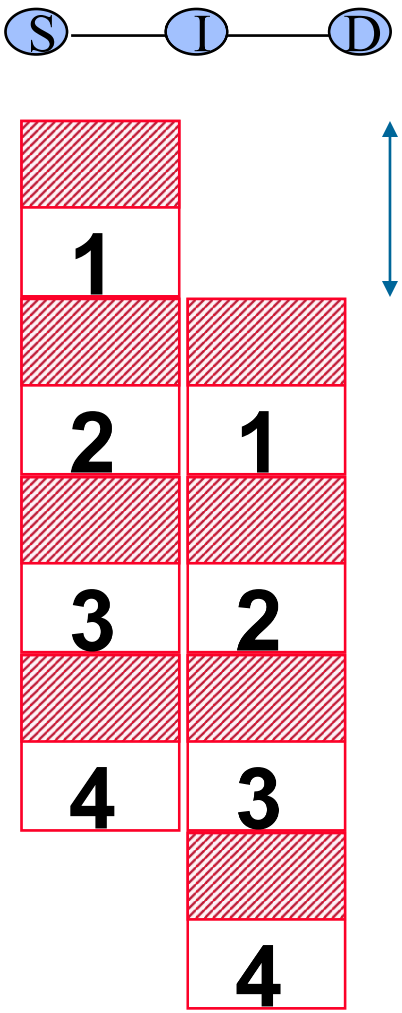
Q2 Answer

Virtual circuit networks most certainly need this capability in order to route connection setup packets from an arbitrary source to an arbitrary destination.

Question 3

Consider a packet switched network. Two nodes, node S and node D, are connected through an intermediate node I. A message of size 1000 bytes is transmitted from node S to node D. The message is fragmented into four packets each with a 50-byte header. All links run the same data rate. If propagation delay is negligible, determine the minimum data rate of the links to achieve 100ms of total transmission delay. (Hint: *pipeline effect*)

Q3 Answer



Transmission time, T_f
(frame size = 250 + 50 bytes)

Let:

- ***d*: the link data rate (to determine)**
- **T_f: transmission time of a packet**
- ***T*: The total transmission time**

According the question, we know that T<100ms
From the diagram, we know that $T = 5T_f$
so, $5T_f < 100$ms - - - (1)

Since T_f = (250 bytes + 50 bytes) * 8 / d - - - (2)

By (1) & (2), d > 120 kbps

Question 4

A factor in the delay of a store-and-forward packet switched network is how long it takes to store and forward a packet through a switch. If switching time is 10 μsec, is this likely to be a major factor in the response of a client-server system where the client is in New York and the server is in California? Assume the propagation speed in copper and fiber to be 2/3 the speed of light in vacuum. (Propagation rate is 200 m per usec., Distance between NY and California is 5000 km.)

Q4 Answer

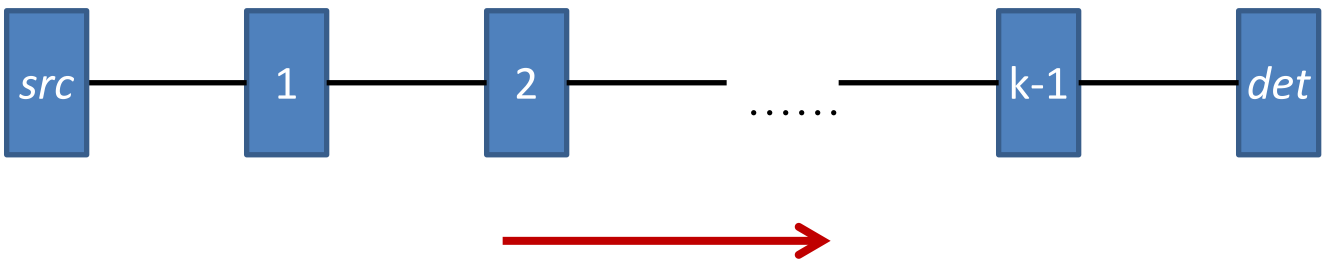
- The speed of propagation is 200,000 km/sec, i.e., 200 meters/μsec. In 10 μsec the signal travels 2 km.
- 1-way propagation delay is (5000km /0.2 km) μsec =25 msec
- Each switch adds 10 usec. the equivalent of 2 km of extra cable.
- If the client and server are separated by 5000 km, traversing even 50 switches adds only 100 km to the total path, which is only 2%. Thus, switching delay is not a major factor under these circumstances.

Question 5

Compare the delay in sending an x-bit message over a k-hop path in a circuit switched network and in a (lightly loaded) packet switched network. The circuit setup time is s seconds, the propagation delay is d seconds per hop, the packet size is p bits, and the data rate is b bps. Under what conditions does the packet switched network have a lower delay?

Q5 Answer

- Circuit switching

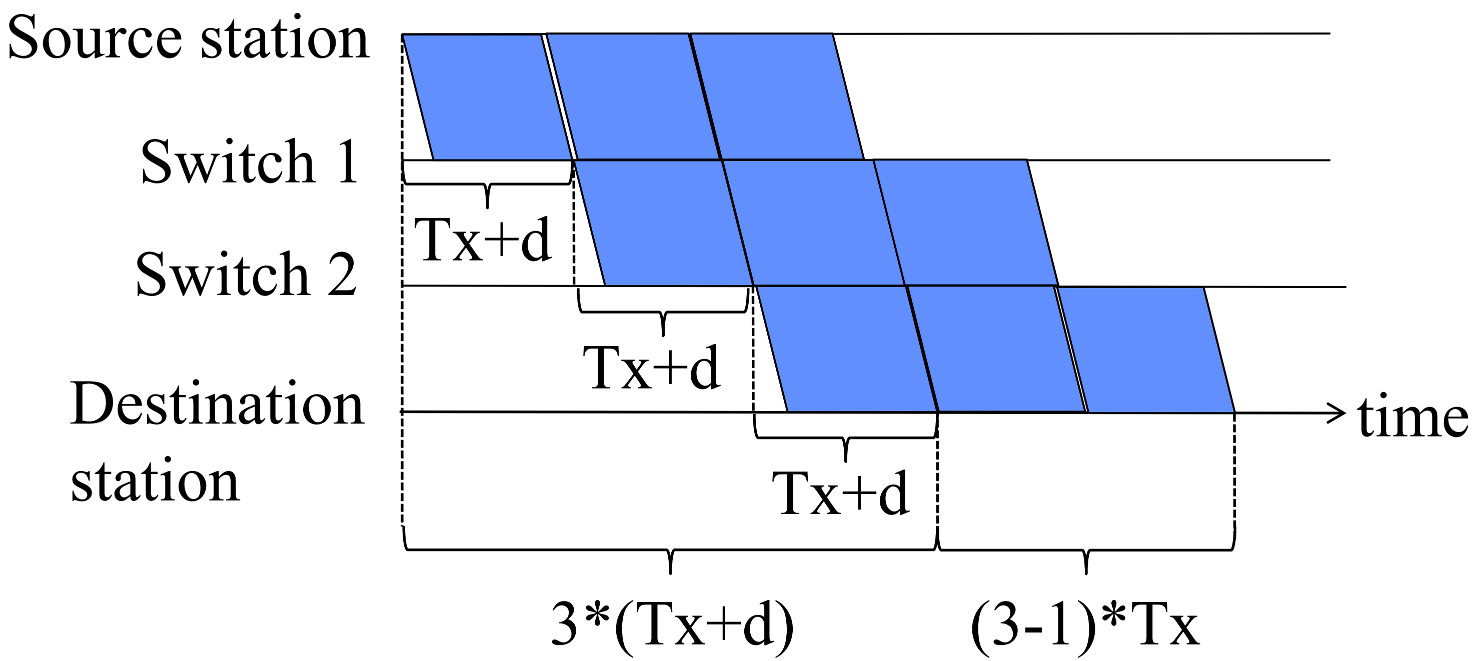


With circuit switching,
at $t = s$ the circuit is set up;
at $t = s + x/b$ the last bit is sent;
at $t = s + x/b + kd$ the message arrives.

Tx delay   Propagation delay

Q5 Answer (cont'd)

- Packet switching (pipeline, propagation delay)
  - An example of 3 packets and 3 hops
    - Tx: packet transmission delay at a station
    - d: propagation delay



Q5 Answer (cont'd)

- Packet switching (pipeline, propagation delay)

In general:

Total delay = # of hops * (Tx + d) + (# of packets – 1) * Tx

$$\text{Tx} = \frac{p}{b}$$

$$\#\text{ of packets} = \frac{x}{p}$$

Tx delay
(time to tx data)

Propagation delay

$$\text{Total delay} = k \cdot \left(\frac{p}{b} + d\right) + \left(\frac{x}{p} - 1\right) \cdot \frac{p}{b} = \frac{x}{b} + (k-1) \cdot \frac{p}{b} + k \cdot d$$

Intermediate node
delay

Q5 Answer (cont'd)

- When packet-switched network has lower delay?

$$\frac{x}{b} + (k-1) \cdot \frac{p}{b} + k \cdot d < s + \frac{x}{b} + k \cdot d$$

$$\boxed{(k-1) \cdot \frac{p}{b} < s}$$