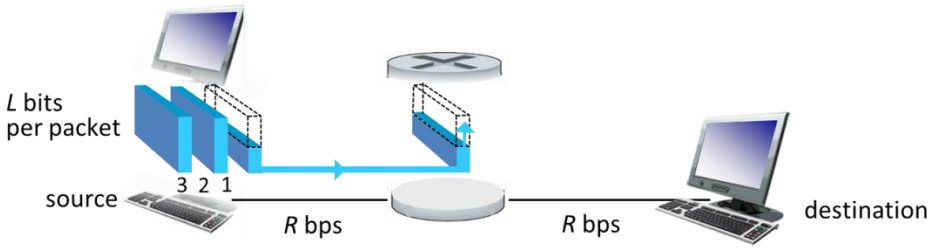
1. As we introduced in the lecture, the packet switching uses **store-and-forward transmission** at the inputs to the links. That means the entire packet must arrive at router before it can be transmitted onto the next link. (Ignore queuing, propagation delay, and processing delay)



An illustrative example of Packet-switching: store-and-forward

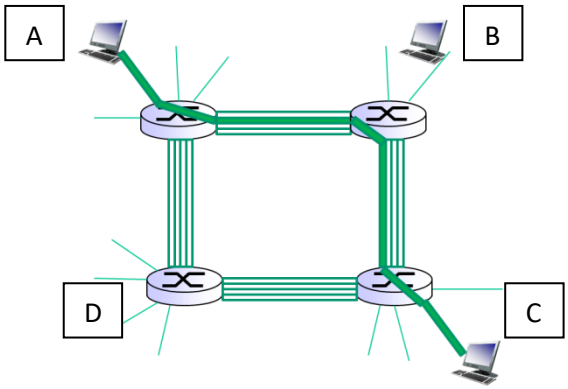
a. Suppose there is exactly one packet switch between a sending host and a receiving host. The transmission rates between the sending host and the switch and between the switch and the receiving host are R_1 and R_2, respectively. With store-and-forward switching, what is the total end-to-end delay to send a packet of length L?

A) L / R_1
B) L / R_2
C) $L / R_1 + L / R_2$
D) $2L / R_1 + 2L / R_2$

b. Assuming the transmission rate to be constant at R, what will be the end-to-end delay for sending P=3 packets each of length L across N=2 links (i.e., the packets need to pass two links to reach the destination as shown in the figure above)?

A) L / R
B) 2L / R
C) 3L / R
D) 4L / R

2. Consider the circuit switch network in Figure below. Suppose that there are 4 circuits on each link. Label the four switches A, B, C and D, going in the clockwise direction.



a. What is the maximum number of simultaneous connections that can be in progress at any one time in this network?

A) 4 B) 8 C) 16 D) 32

b. Suppose that all connections are between switches A and C. What is the maximum number of simultaneous connections that can be in progress?

A) 4 B) 8 C) 16 D) 32

c. Suppose we want to make four connections between switches A and C, and another four connections between switches B and D. Can we route these calls through the four links to accommodate all eight connections?

A) No B) Yes

3. Suppose we want to send a file of 160,000 bits from Host A to Host B over a circuit-switched network. Suppose that all links in the network use FDM with 12 frequency bands of the same bandwidth. Assume that the 12 frequency bands together can support a total bit rate of 1.536 Mbps. Also suppose that it takes 600 msec to establish an end-to-end circuit before Host A can

begin to transmit the file. How long does it take to send the file?

A) 1.85 sec B) 1.95 sec C) 2.05 sec D) 2.15 sec

4. Suppose users share a 3 Mbps link. Also suppose each user requires 150 kbps when transmitting, but each user transmits only 10 percent of the time.
    a. When circuit switching is used, how many users can be supported?

A) 10 B) 20 C) 30 D) 40

    b. For the remainder of this problem, suppose packet switching is used. Find the probability that a given user is transmitting.

A) 0.1 B) 0.2 C) 0.3 D) 0.4

    c. Suppose there are 120 users. Find the probability that at any given time, exactly n users are transmitting simultaneously.

A) $\binom{120}{n}(0.1)^{120-n}(0.9)^n$ B) $\binom{120}{n}(0.9)^{120-n}(0.1)^n$ C) $(0.9)^n$ D) $(0.1)^n$