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Chapter 6

P18. Suppose nodes A and B are on the same 10 Mbps broadcast channel, and the propagation delay between the two nodes is 325 bit times. Suppose CSMA/CD and Ethernet packets are used for this broadcast channel. Suppose node A begins transmitting a frame and, before it finishes, node B begins transmitting a frame. Can A finish transmitting before it detects that B has transmitted? Why or why not? If the answer is yes, then A incorrectly believes that its frame was successfully transmitted without a collision. Hint: Suppose at time t = 0 bits, A begins transmitting a frame. In the worst case, A transmits a minimum-sized frame of 512 + 64 bit times. So A would finish transmitting the frame at t = 512 + 64 bit times. Thus, the answer is no, if B's signal reaches A before bit time t = 512 + 64 bits. In the worst case, when does B's signal reach A?

- A would finish transmitting the frame at $t = 576$. And the worst case would be that B started transmission just before the first bit reaching to it from A at $t = 324$. B would then detect the collision and send a jam signal. The first bit of frame sent from B would reach to A at $t = 324 + 325 = 649$, which is larger than 576 So A can finish transmitting before it detects that B has also transmitted, and A would incorrectly believe that its frame was successfully transmitted without a collision.

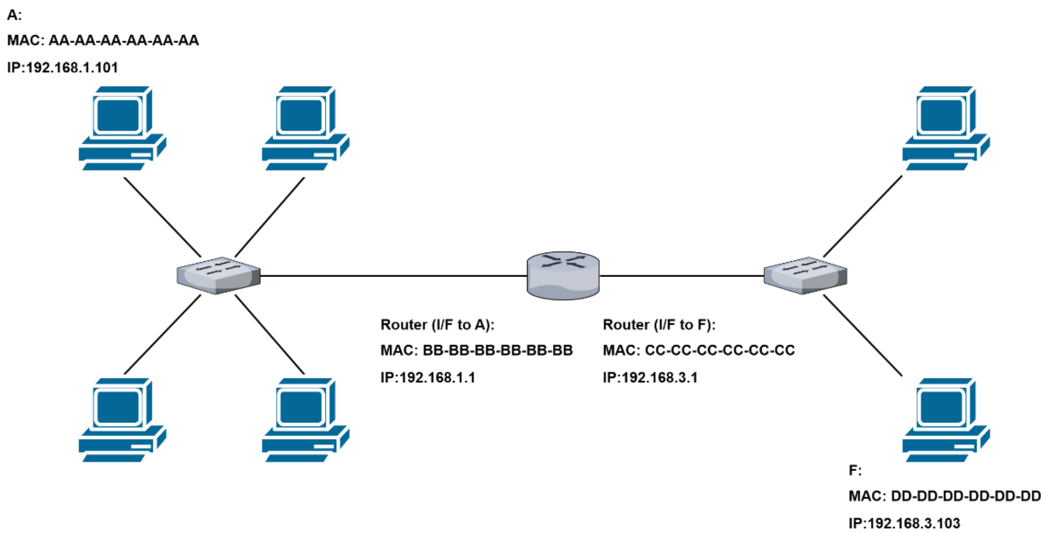
P19. Suppose nodes A and B are on the same 10 Mbps broadcast channel, and the propagation delay between the two nodes is 245 bit times. Suppose A and B send Ethernet frames at the same time, the frames collide, and then A and B choose different values of K in the CSMA/CD algorithm. Assuming no other nodes are active, can the retransmissions from A and B collide? For our purposes, it suffices to work out the following example. Suppose A and B begin transmission at t = 0 bit times. They both detect collisions at t = 245 t bit times. Suppose KA = 0 and KB = 1. At what time does B schedule its retransmission? At what time does A begin transmission? (Note: The nodes must wait for an idle channel after returning to Step 2—see protocol.) At what time does A's signal reach B? Does B refrain from transmitting at its scheduled time?

- At $t = 245$, both A and B detected collision, and then started sending a jam signal. It takes 48 bit times to transmit the signal, hence, at time $t = 245 + 48 + 245 = 538$, A and B would receive the signal. Then A detected the channel is idle, and begins to wait for a IFS time (=96 bit times). After that, at $t = 538 + 96 + 245 = 879$, A's second transmission reaches B. While on the B's side, at $t = 245 + 48 = 293$, B finishes sending the jam signal, and then needs to wait a backoff time, which is $Kb * 512 = 512$, and a IFS time before resend. Thus, at time $t = 293 + 512 + 96 = 901$, B would schedule the retransmission.

Since $879 < 901$, B refrains from transmitting at its scheduled time. The retransmission from A and B will not collide.

P22. Suppose now that the leftmost router in Figure 6.33 is replaced by a switch. Hosts A, B, C, and D and the right router are all star-connected into this switch. Give the source and destination MAC addresses in the frame encapsulating this IP datagram as the frame is transmitted (i) from A to the switch, (ii) from the switch to the right router, (iii) from the right router to F. Also give the source and destination IP addresses in the IP datagram encapsulated within the frame at each of these points in time.

- The network will be like this after replacing:



(i) from A to the switch:

Source MAC: AA-AA-AA-AA-AA-AA

Destination MAC: BB-BB-BB-BB-BB-BB

Source IP: 192.168.1.101

Destination IP: 192.168.3.103

(ii) from the switch to the right router:

Source MAC: AA-AA-AA-AA-AA-AA

Destination MAC: BB-BB-BB-BB-BB-BB

Source IP: 192.168.1.101

Destination IP: 192.168.3.103

(iii) from A to the switch:

Source MAC: CC-CC-CC-CC-CC-CC

Destination MAC: DD-DD-DD-DD-DD-DD

Source IP: 192.168.1.101

Destination IP: 192.168.3.103

P23. Consider Figure 6.15. Suppose that all links are 1 Gbps. What is the maximum total aggregate throughput that can be achieved among the 9 hosts and 2 servers in this network? You can assume that any host or server can send to any other host or server. Why?

- The maximum total aggregate throughput can be calculated as:

  $$(2+9) * 1 \text{ Gbps} = \mathbf{11\ Gbps}$$

  as all nodes send out data at the maximum possible rate with a connection to switch.

P24. Suppose the three departmental switches in Figure 6.15 are replaced by hubs. All links are 1 Gbps. Now answer the questions posed in problem P23

- If three departmental switches are replaced by hubs, the maximum throughput for each of these departments would be 1 Gbps since each hub allows one collision domain.
  Thus, the maximum total aggregate throughput can be calculated as:

  $$3 * 1 \text{ Gbps} + 2 * 1 \text{ Gbps} = \mathbf{5\ Gbps}$$

P25. Suppose that all the switches in Figure 6.15 are replaced by hubs. All links are 1 Gbps. Now answer the questions posed in problem P23.

- If all the switches are replaced by hubs, there would only be one collision domain. So, the maximum total aggregate throughput would be **1 Gbps.**

P26. Let's consider the operation of a learning switch in the context of a network in which 6 nodes labeled A through F are star connected into an Ethernet switch. Suppose that (i) B sends a frame to E, (ii) E replies with a frame to B, (iii) A sends a frame to B, (iv) B replies with a frame to A. The switch table is initially empty. Show the state of the switch table before and after each of these events. For each of these events, identify the link(s) on which the transmitted frame will be forwarded, and briefly justify your answers.

Event	*Switch table*	*Links*
	Empty	
B sends to E (i)		ACDEF (Flooding)
	B's MAC addr	
E replies to B (ii)	B's MAC addr	B (Forward)
	B's MAC addr E's MAC addr	
A sends to B (iii)	B's MAC addr E's MAC addr	B (Forward)
	B's MAC addr E's MAC addr A's MAC addr	
B replies to A (iv)	B's MAC addr E's MAC addr A's MAC addr	A (Forward)
	B's MAC addr E's MAC addr A's MAC addr	

(i) Switch would flood the frame to all the links since the Switch table is empty at initial. And would learn B's MAC address.

(ii) Switch would forward the frame to B, as there is a mapping record to B in the table. And would learn E's MAC address.

(iii) Switch would forward the frame to B, as there is a mapping record to B in the table. And would learn A's MAC address.

(iv) Switch would forward the frame to A, as there is a mapping record to A in the table.