CSEE W4119 Computer Networks

Homework 4

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1. We studied a number of multiple access protocols in this course, including (1) TDMA, (2) CSMA, (3) Slotted Aloha and (4) Token passing. Suppose there are N stations on a LAN that has capacity (transmission rate) C. All packets have a fixed length L and the end-to-end propagation delay of the channel is P. For each of the protocols above, answer the following questions:

   (a) Suppose only one station ever has a message to send (i.e., the other N-1 stations generate no traffic). What is the maximum possible throughput of the protocols above?

   (b) Suppose now that all stations have the same average traffic arrival rate. We are now interested in the aggregate throughput of the LAN. For each of the above protocols, is it possible to achieve a throughput of 1 (i.e., have the channel always be fully utilized)? If not, indicate how/why the protocol limits the maximum throughput to less than 1.

   (c) In a heavily loaded network, what is the worst case amount of time a node has to wait under each of the protocols, before it can send a message?

Answer:

(1)TDMA:

(a) The possible maximum throughput is C / N.

(b) Yes. Every station has its slot, so it's possible that the stations send message in their slot and the channel always be fully utilized.

(c) The wait time is 1 frame time.

(2)CSMA:

(a) The possible maximum throughput is C.

(b) Because there is propagation delay, collisions always occur, so CSMA cannot achieve a throughput of 1. However, theoretically, if the propagation delay becomes 0, CSMA might achieve a throughput of 1. (only theoretically)

(c) In the worst case, a node may wait forever. So the worst case amount of time is infinite.

(3)Slotted Aloha:

(a) The possible maximum throughput is C.

(b) No, because there are always collisions, the channel cannot be fully utilized.

(c) In the worst case, maybe there are always collisions for a node, so this node may wait forever, and the worst case amount of time is infinite.

(4)Token passing:

The time which token circulates around all nodes is equal to the end-to-end propagation delay P, and all packets have a fixed length L, so for one node, it should spend time L transmitting a message.

(a) The possible maximum throughput is (L / (P + L)) * C

(b) If the time of passing token (T1) is small enough and we can ignore it, the channel utilization can approach 1.

And if we cannot ignore the time of passing token,

the utilization = (N*L) / (P + N*L) (less than 1)

(c) If the worst case means one of the nodes fails to pass its token to the next node, other nodes may wait forever, the amount of time is infinite

And if the network works well, all nodes can pass their token, the wait time = (N-1) * (P/N + L)

2. Consider the simple network shown below:

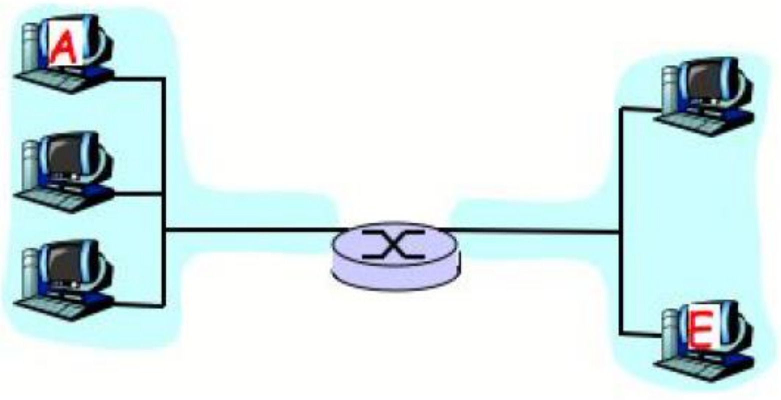

Figure 1: an example LAN

(a) Write down an IP address for all interfaces at all hosts and routers in the network. The IP addresses for A and E are 111.111.111.111 and 222.222.222.222 respectively. You should assign IP addresses so that interfaces on the same network have the same network-part of their IP address. Indicate the number of bits in the network-part of this address.

(b) Choose physical addresses (LAN addresses) for only those interfaces on the path from A to E. Can these addresses be the same as in part a)? Why?

(c) Now focus on the actions taken at both the network and data link layers at sender A, the intervening router, and destination E in moving an IP datagram from A to E:

- How do A, E and the router determine the IP addresses needed for the IP datagram?
- What, specifically, are the addresses in the IP datagram that flows from A to the router. What, specifically, are the addresses in the IP datagram that flows from the router to E.

- How do A, E and the router determine the physical (LAN) addresses needed for the data link layer frame?

(d) Suppose that a bridge replaces the router in the figure.

- How would the IP addresses change in this case?
- How would the physical (LAN) addresses change in this case?
- How would does a learning bridge learn the physical addresses of the attached hosts

Answer:

(a) The IP addresses for the hosts and routers depend on the number of bits in the network-part of this address, assume the number is N. For interfaces in left network part, the first N bits of IP address are as same as 111.111.111.111, and the rest bits can be any number. For interfaces in right network part, the first N bits of IP address are as same as 222.222.222.222, and the rest bits can be any number.

For example, if the network part of address is 24 bits, then the left network part IP address will be 111.111.111.x, and the right network part IP address will be 222.222.222.x.

(b) No. The physical address (LAN address is unique for every interface), and the physic address is 48-bits long, so it cannot be the same as in part (a).

(c)

1. A, E and the router can find the IP addresses from their router table.

2. In the IP datagram that flows from A to the router, the source is A's IP address 111.111.111.111, and the destination is E's IP address 222.222.222.222

And in the IP datagram that flows from router to E, source is also 111.111.111.111 and destination is also 222.222.222.222

3. The method is using ARP.

(d)

1. If a bridge replaces the router, the IP address of A and E must change, because 111.111.111.111 and 222.222.222.222 are not in the same network part, but the IP addresses of A and E must be in the same network part.

2. The physic address will not change, because physic address is unique to every interface.

3. When a host sends a frame through the bride, the bridge will know the physic address of the host from the frame.

3. Why do Wireless MAC protocols use CSMA/CA and not CSMA/CD? Explain why Wireless link layer protocols use acknowledgments whereas Wired ones typically do not.

Answer:

The main reason is that Wireless MAC protocols cannot detect collisions when it sends packages, so it can only use acks to avoid collisions, and for wireless link, the bits error rate is higher than wired link, thus using acks is a good choice. Therefore, Wireless MAC protocols use CSMA/CA rather than CSMA/CD. And for Wired MAC protocols, it's easy to detect collisions, so using CSMA/CD is a better choice, there is no need to use acks.

4. Consider the following four CDMA code sequences, labeled A,B,C,D:

A	1	1	1	1	1	1	1	1
B	1	1	-1	-1	1	1	-1	-1
C	1	-1	1	-1	1	-1	1	-1
D	1	-1	1	1	-1	-1	1	-1

(a) Prove that these four codes cannot be used simultaneously by four devices to communicate upon the same frequencies?

(b) Suppose all four codes are in fact used simultaneously by four different devices A,B,C,D (where device x uses code x). Indicate whether any device's transmissions will arrive uncorrupted by the other transmissions.

Answer:

(a) $A \bullet B = 1+1-1-1+1+1-1-1 = 0$

$A \bullet C = 1-1+1-1+1-1+1-1 = 0$

$A \bullet D = 1-1+1+1-1-1+1-1 = 0$

$B \bullet C = 1-1-1+1+1-1-1+1 = 0$

$B \bullet D = 1-1-1-1-1-1-1+1 = -4 \neq 0$

$C \bullet D = 1+1+1-1-1+1+1+1 = 4 \neq 0$

So these four codes cannot be used simultaneously by four devices to communicate upon the same frequencies, B, C and D will be corrupted.

(b) From my calculation in (a), it's easy to see that A and B, C, D are uncorrupted, but B, C and D cannot transmit uncorrupted.