CIS-427 UM-Dearborn

HW4

With Dr. Zheng Song

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Question 1 (20 points)

A message 1110 0101 0001 1011 is transmitted using the Internet checksum (using 4 bit words). What is the resulting 20 bits message if the internet checksum is put to the end of the message.

Perform checksum operation using every 4 bits of the data:

1110 (1st 4-bits)

+

0101 (2nd 4-bits)

10011

+ (Perform sum of carry out of most significant bit to the sum:)

1

0100

+

0001 (3rd 4-bits)

0101

+

1011 (final 4-bits)

10000

+ (Perform sum of carry out of most significant bit to the sum)

1

0001 = (one's compliment) SUM → now flip all bits to get CHECKSUM = 1110.

Thus final message is original 16-bit message + computed 4-bit checksum for a total of 20 bits:

1110 0101 0001 1011 1110

*Bonus: then receiver will perform same exact checksum operation but will include the checksum sent with the data; in other words, it will perform the checksum using all 20 bits (adding them 4 bits at a time as shown in the sender process; so it will computer checksum for 5 4-bit sets). Checksum calculation of receiver should result in all 0s if no data loss occurred/detected.

Question 2 (30 points, 15 points each)

Suppose three active nodes—nodes A, B, and C—are competing for access to a channel using slotted ALOHA. Assume each node has an infinite number of packets to send. Each node attempts to transmit in each slot with probability p. The first slot is numbered slot 1, the second slot is numbered slot 2, and so on.

<u>Keeping these notes in mind:</u>

efficiency: long-run fraction of successful slots (many nodes, all with many frames to send)

- *suppose: N* nodes with many frames to send, each transmits in slot with probability *p*
    - prob that given node has success in a slot = $p(1-p)^{N-1}$

- prob that *any* node has a success = $Np(1-p)^{N-1}$
- max efficiency: find p^* that maximizes $Np(1-p)^{N-1}$
- for many nodes, take limit of $Np^*(1-p^*)^{N-1}$ as N goes to infinity, gives:

  max efficiency = 1/e = .37

- *at best:* channel used for useful transmissions 37% of time!

a)

What is the probability that node A succeeds for the first time in slot 5? Hint: Node A succeed for the first time in slot 5 means: (1) A doesn't succeed for the first 4 slots; and (2) A succeeds in slot 5.

- We need to know the P that node A fails for the first 4 slots, then succeeds on the last (fifth) time slot.
- P(node A fails first 4 slots) = [1 – p * (1-p)^(N-1)]^(4)
- P(node A succeed on 5th slot) = p * (1-p)^(N-1)
- Now we need to combine the probabilities to get our final answer:
  - **P(first success for node A at slot 5) = [1 – p * (1-p)^(N-1)]^(4) * p * (1-p)^(N-1)**
  - → a sequence of events where it fails the first 4 slots then succeeds on 5th slot.
- If we plug our values into the equation, where :
  - N = 3 (number of nodes), and
  - p = p_maximization of slotted ALOHA efficiency = 1/e = 0.37
- We get:
- **P(first success for node A at slot 5) =**
- **[1 - 0.37 * (1 - 0.37)^(3 - 1)]^(4) * 0.37 * (1 - 0.37)^(3 - 1) = 0.0778 = 7.78%**

b)

What is the probability that the first success occurs in slot 3? Hint: The first success occurs in slot 3 means no nodes succeed in the first two slots and one node succeeds in slot 3.

- We need P(all nodes failed first 2 slots) AND P(any one of the nodes succeeds in slot 3).
- P(all nodes failed first 2 slots) = [1 - (N * p * (1 - p)^(N - 1)]^(2)
- P(any one of the nodes succeeds in 3rd slot) = N * p * (1 - p)^(N - 1)
- Now we need to combine the sequences for the final probability:
  - **[1 - (N * p * (1 - p)^(N - 1)]^(2) * N * p * (1 - p)^(N - 1)**
  - → a sequence where all nodes fail first 2 slots, then one of the nodes has success at 3rd slot.
- If we plug our values into the equation, where :
  - N = 3 (number of nodes), and
  - p = p_maximization of slotted ALOHA efficiency = 1/e = 0.37
- We get:
- **P(first success occurs in slot 3) =**
  - **[1 - (3 * 0.37 * (1 - 0.37)^(3 - 1))]^(2) * 3 * 0.37 * (1 - 0.37)^(3 - 1) = 0.138 = 13.8%**

Question 3 (30 points)

Consider the arrangement of learning bridges shown in the following figure. Assuming all are initially empty, give the tables for each of the bridges B1-B3 after the following transmissions:

(1) A sends to B;

SWITCH	Forwarding table
B1	Port 1: A,B
B2	Port 1: A
B3	Port 2: A

(2) D sends to B;

SWITCH	Forwarding table
B1	Port 1: A,B; Port 2: D
B2	Port 1: A,B; Port 2: D
B3	Port 1: D; Port 2: A,B

(3) X sends to D;

SWITCH	Forwarding table
B1	Port 1: A,B; Port 2: D
B2	Port 1: A,B; Port 2: D; Port 3: X
B3	Port 1: D; Port 2: A,B,X

(4) Y sends to A;

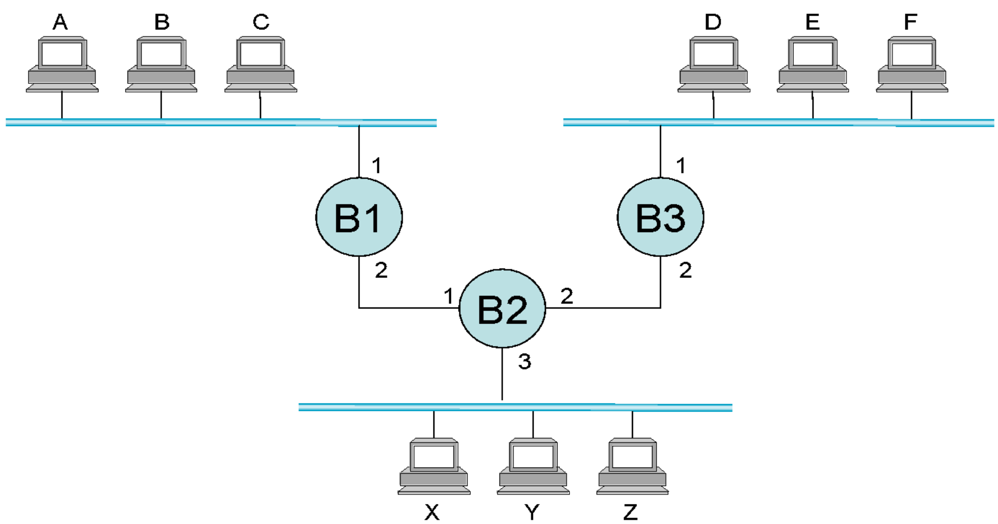
SWITCH	Forwarding table
B1	Port 1: A,B; Port 2: D,Y
B2	Port 1: A,B; Port 2: D; Port 3: X,Y
B3	Port 1: D; Port 2: A,B,X

(5) F sends to Y;

SWITCH	Forwarding table
B1	Port 1: A,B; Port 2: D,Y
B2	Port 1: A,B; Port 2: D,F; Port 3: X,Y
B3	Port 1: D,F; Port 2: A,B,X

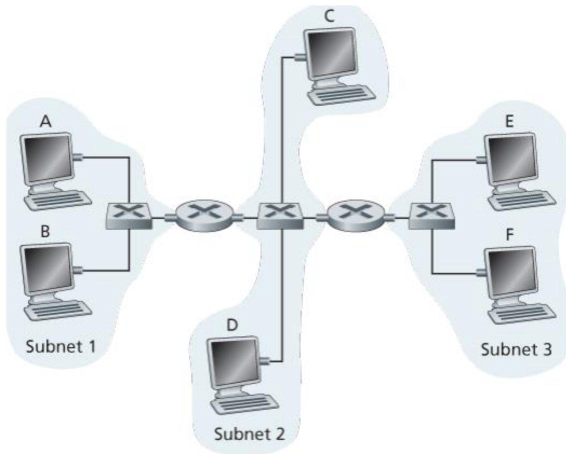
(6) E sends to X;

SWITCH	Forwarding table
B1	Port 1: A,B; Port 2: D,Y
B2	Port 1: A,B; Port 2: D,F; Port 3: X,Y
B3	Port 1: D,F,E; Port 2: A,B,X



Question 4 (20 points, 10 points each)

In the graph below, the circles with a cross denote a router and the squares with a cross denote a switch. From left to right we name them S1, R1, S2, R2, S3. The MAC addresses and IP addresses for the interfaces at Host A, both routers, and Host F are given as Mac(device), IP(device), where device can be A, R1, R2, and F.



a)

Suppose Host A sends a datagram to Host F. Give the source and destination MAC addresses in the frame encapsulating this IP datagram as the frame is transmitted

(i) from A to the left router,

source mac = MAC(A), destination mac = MAC(R1)

(ii) from the left router to the right router,

source mac = MAC(R1), destination mac = MAC(R2)

(iii) from the right router to F.

source mac = MAC(R2), destination mac = MAC(F)

(iiii) Also give the source and destination IP addresses in the IP datagram encapsulated within the frame at each of these points in time.

- SOURCE AND DESTINATION IP ADDRESS WILL BE THE SAME FOR ALL OF THESE POINTS IN TIME:
    - **SOURCE IP = IP(A), DESTINATION IP = IP(F).**
        - This is assuming we are not using NAT (network address translation) on the routers since this question does not specify port numbers (which is needed for port forwarding).
        - If we include using NAT and port forwarding, then:
            - A to left router → sourceIP = IP(A) and destIP = IP(on left port of R2, aka public address).
            - Left router to right router → sourceIP = (public IP of R1), destIP = (public IP of R2).
            - Right router to F → sourceIP = (public IP of R1), destIP = IP(F).

b)

Suppose that all the links between a computer and a switch are 100Mbps, the links between switches and routers are 500 Mbps.

How fast can data be transmitted from Subnet 3 to subnet 1 (i.e., any computer in Subnet 3 can be the sender and any computer in subnet 1 can be the receiver)?

Since the link speed between hosts and switches is 100Mbps, then the max speed that a given host can receive data at in subnet 1 is 100Mbps. Now, since the link speed between subnet 3 and subnet 1 is 500Mbps, then all nodes in subnet 3 can transmit at the same time (because they are connected to a switch, which has a separate collision domain for each connected host) and thus send 100Mbps each to the switch. Since there are 2 hosts in subnet 3, then the max data that they can transmit together is 200Mbps, which is underneath he 500Mbps bandwidth between subnet 3 and subnet 1. **So, based on this scenario, the fastest that data can be transmitted from subnet 3 to subnet 1 is 200Mbps.**

If we replace S1 with a hub, how fast can data be transmitted from Subnet 3 to subnet 1 now?

If we replace S1 with a hub, then the hub has only a single collision domain for all devices connected to it; thus, the limiting factor is the Hub since it can only transmit 100Mbps from a single host at a time. For example, if a host from subnet 3 transmits at 100Mbps, the hub will receive the transmission and flood the data out of all ports despite the data being only for one of the hosts connected to it on the local network in subnet 1. While a host in subnet 3 is transmitting data to a host in subnet 1, the hub can receive no other transmissions from any other hosts, otherwise the single collision domain will have collisions and data loss/drop. **So, based on this scenario, the fastest data transmission possible is 100 Mbps from subnet 3 to subnet 1.**