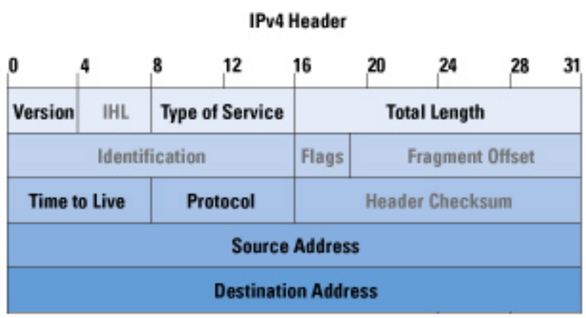
Name:____________________________ Student ID:____________________________

CSE123 Spring 2015 Homework #2
Instructor: Stefan Savage

Due Wednesday 4/29 **at the beginning of class**
(Please TYPE your answers… this will allow our TAs to be much more efficient)

1. IP Checksum

Below is a diagram of the IPv4 packet header format. The header is protected using a separate checkum (the "Header Checksum" field below) using the IP Checksum algorithm we described in class.



Consider a packet with the following content (in hex):

4500 0028 3e8a 4000 8006 9bd2 c0a8 0265 c73b 9b2a

a) What is the value of checksum carried in this packet?

9bd2

b) Is it correct? (show your work to calculate the IP checksum for this data; note that the checksum field itself is set to zero when calculating the checksum)

As in class

c) The "Time to Live" field in this packet is set to 128. However, each time the packet is forward by a router this field will be decremented by one (i.e., it will next be set to 127). How will the checksum need to change in response?

d) Is it possible to update the checksum in this case (as per part [d]) without recomputing the checksum over the entire packet header? If not, why not? If so, how?

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Since the checksum is computed on 16-bit fields, if a single such field changes from its old value (of) to its new value (nf), the old checksum (OC) can be transformed into the new checksum (NC) incrementally in 1s complement arithmetic as follows:

NC = OC + (of – nf)

[Technically it should be NC = ~(~OC + ~of + nf) to deal with the fact that one's compliment is not distributive when the result is 0, but this is not necessary for a correct answer]

2. Reliable Transmission

Consider a system that uses ARQ as described in class, using timeouts to detect loss. Assume the sender has an infinite number of packets to send, but every third packet that is transmitted by the sender is lost en route (assume all ACKs are delivered correctly). The length of the timeout is t and the round-trip time is m (m << 4*t... i.e.). Consider how the long it will take to successfully send the first eight packets. For each of the following cases,

i) provide a comma separated list showing the order of packets sent by the sender, by sequence number (include packets lost in transit and any retransmissions) and

ii) describe how much time it will take to deliver all 8 packets (in terms of t and m)

a) Using the alternating bit protocol (i.e., a send window of 1).

i) 1, 2, 3, 3, 4, 5, 5, 6, 7, 7, 8
ii) 3 * (2m + t) + 2m
You'll get two packets each RTT, but the third will be lost and you'll wait a timeout. You'll need to repeat this three times to get 6 packets and the last two packets will each take one RTT to transmit (2m all told)

b) Describe how much time it will take with a send window of 4 packets, but using the GoBackN retransmission strategy (i.e., a receive window of 1). Assume that serialization delay is 0 (i.e., you can send multiple back-to-back packets with no additional delay)

i) 1, 2, 3, 4, 5, 6, 3, 4, 5, 6, 7, 8, 5, 6, 7, 8, 9, 10, 7, 8
ii) 3t + m

You'll send 4 packets at once, and packets 1, 2 and 4 will get through, but packet 3 will be lost. The acks for packets 1 and 2 will allow packets 5 and 6 to be sent. Packet 6 will also be lost (since it is also a third packet sent), but this is irrelevant since packet 3 will timeout at time t and we'll retransmit packets 3, 4, 5 and 6. So we successfully

sent two packets in time t and we're now starting from a first packet again (restarting the cycle). So its going to take 3t (3 times through this cycle to send 6 packets) + m (the last two packets will get sent and then acknowledged in one RTT)

c) Describe how much time it will take with a send window of 4 packets, a receive window or 4 and the selective retransmission strategy described in class (retransmit the first missing packet).

i) 1, 2, 3, 4, 5, 6, 3, 6, 7, 8, 9, 10, 7
ii) 2t+2m

You'll send 4 packets at once, and packets 1, 2 and 4 will get through, but packet 3 will be lost. The ACKs for packets 1 and 2 will allow packets 5 and 6 to be sent. Packet 6 will also be lost (since it is also a third packet sent). At time t, a timeout happens and the sender retransmits packet 3. After one round-trip time (at time t+m), the sender receives an ACK for packet 5 and will now transmit packets 6, 7, 8 and 9 (since it has a window size of 4). Of these, packet 7 is lost since it is a third packet. However, we do receive an ACK for packet six and thus are allowed to send one additional packet: packet 10. It will be lost, since it is a third packet, but we don't care about it. At time 2t+m, the sender will time on packet 7 and retransmit it. One round-trip time later, at time 2t+2m, it will receive an ACK for packet 9 and we will know that all 8 packets have been successfully delivered.

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3. Media access

Consider a slotted Aloha system with four nodes in which the probability that each node has data to send in a given slot time is *p*.

a) What is the likelihood that none of the nodes send any data in a given slot time?
(1-p)^4

b) What is the likelihood that any node successfully sends data in a given slot time?
4p(1-p)^3

This is from class. For each node there is the probability that it sends (p) while the other three nodes don't (1-p)^3. These are independent probabilities so for four nodes, 4p(1-p)^3 represents the likelihood of any one being successful.

c) What is the likelihood that there is a collision in a given slot time?
This one is a bit tricky. To do this constructively, you would need to consider the 9 combinations that have collisions vs the ones that do not. However, you can more easily do it by noticing that the solution to a and b define all the options where there is no collision. Thus, you can determine the answer is:

1 - (1-p)^4 - 4p(1-p)^3

d) Suppose the length of the slot time is doubled. Assume that each node always has data to send and modulation is unchanged (i.e., the same number of bits per second can be sent). Do you expect total "goodput" (successful transmission of data over time, measured in bits per second) to go up, down or stay the same? Explain?

The amount of data transmitted in a slot will go up by two since the slots are longer. However, the amount of time wasted will also go up by two. The proportion between the two (the ratio between b and a+c) is unchanged so the total goodput will be unchanged.

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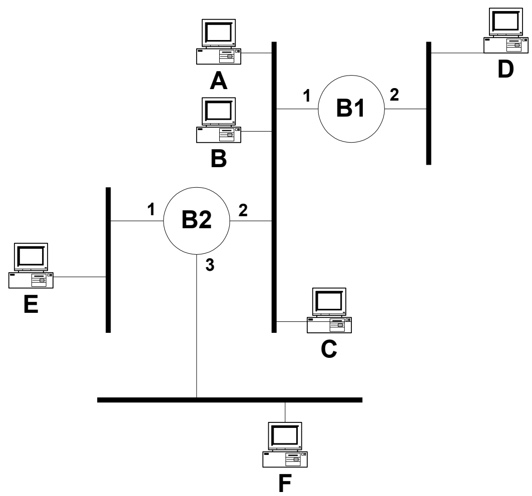
4. Bridging

Consider the network connected by learning bridges B1 and B2 shown below. Each LAN is connected to the bridge with a listed port number and each host is indicated with a letter.



Assuming that the initial forwarding tables are empty, show the forwarding table in each of the bridges after the following sequence of transmissions:

a) A sends to C

Bridge B1	
Destination	Port number
A	1

Bridge B2	
Destination	Porter number
A	2

b) D sends to A

Bridge B1	
Destination	Port number
A	1
D	2

Bridge B2	
Destination	Porter number
A	2
D	2

c) E sends to F

Bridge B1	
Destination	Port number
A	1
D	2
E	1

Bridge B2	
Destination	Porter number
A	2
D	2
E	1

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