CSE 123: Computer Networks

Homework 2 Solutions

Out: 4/20, Due: 4/27

Total Points = 28

Problems

1. **High Frequency Trading [5 pts]**
   Companies like Goldman Sachs put a high value on using very low latency network switches to engage in high frequency trading because even an extra delay of a few milliseconds in their switches can lose them tons of money. Calculate the latency (from first bit sent to last bit received) for the following:
   a. 30-Mbps Ethernet with a single store-and-forward switch in the path and a packet size of 6,000 bits. Assume that each link introduces a propagation delay of 50 μs and that the switch begins retransmitting immediately after it has finished receiving the packet.
      i. Total time = (transmit time + propagation time) * number of links to destination = ((6*10^3 / 30*10^6) + 50us) * 2) = 250us * 2 = 500us
   b. Same as (a) but with three switches.
      i. Total time = time per link from (a) * number of links to destination = 250us * 4 = 1ms
   c. Same as (a), but assume the switch implements “cut-through” switching; it is able to begin retransmitting the packet after the first 300 bits have been received. What is the time savings of using “cut-through” switching?
      i. This effectively replaces the switch transmit delays to the delay to transmit those 300 bits for each switch. So Total time = switch queue time * number of switches + original transmit time + propagation time * number of links to destination = (300 / 30*10^6)*1 + (6*10^3 / 30*10^6) + (50us * 2) = 10us + 200us + 100us = 310us
      ii. 500us - 310us = 190us is the time savings

2 pts for a

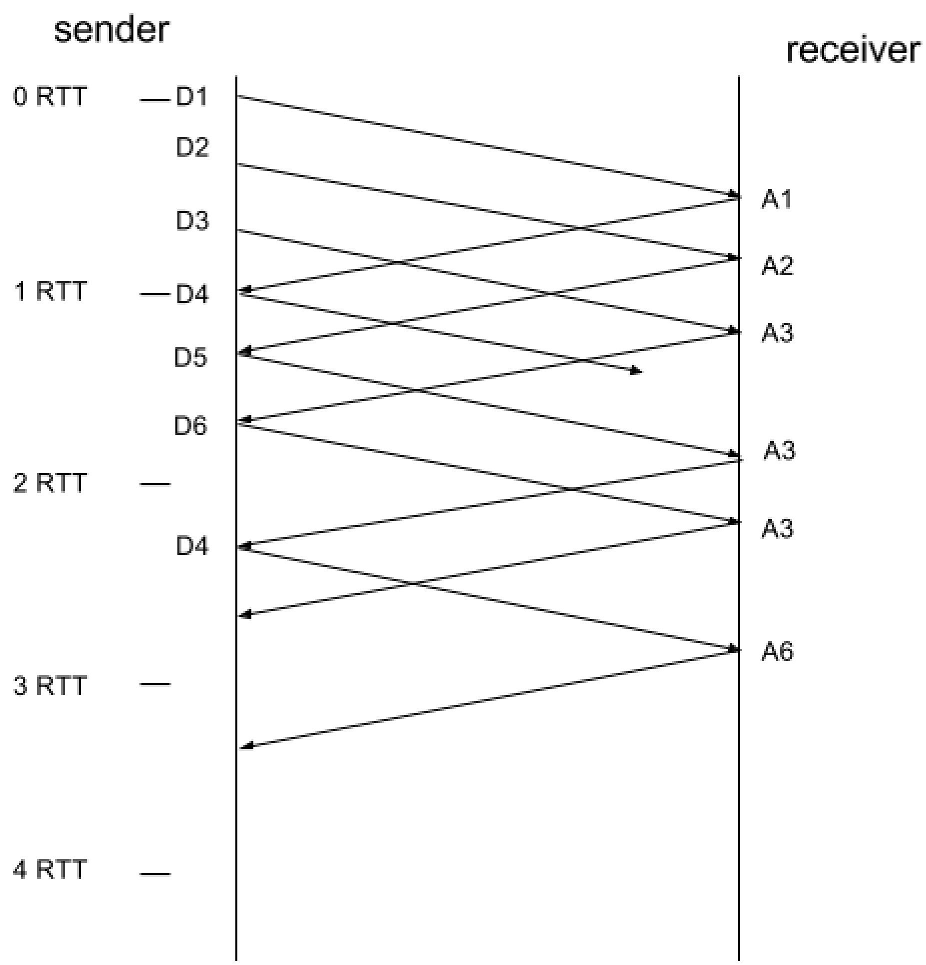
- 1 pt for correct setup/formula
- 1 pt for correct answer

1 pt for b for correct answer

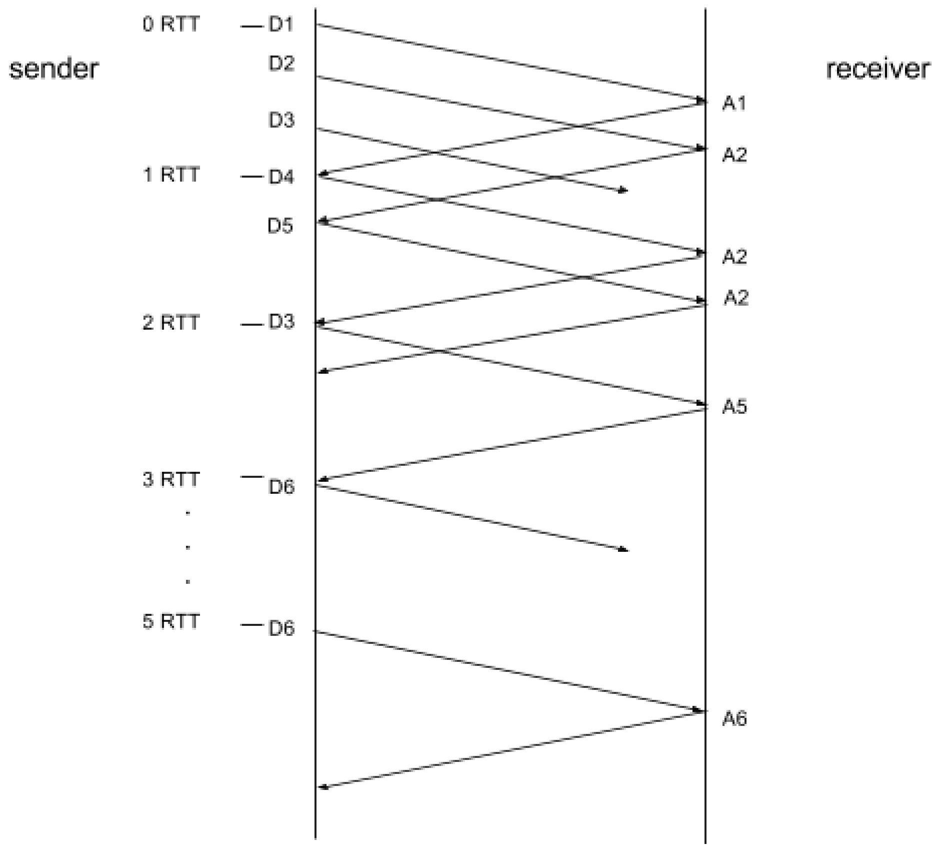
2 pts for c

- 0.5 pts for good setup with cut through switch
- 1 pt for correct time with a cut through switch
- 0.5 pts for correct time savings

2. **Sliding Window Protocol [5 pts]**
   Draw a timeline diagram for the sliding window algorithm with SWS = RWS = 3 frames, for the following two situations. Use a timeout interval of about 2 × RTT. Assume fast retransmission with selective retransmission is implemented and that packets with sequence numbers 1-6 will be sent. For fast retransmission, if more than 1 duplicate ACK is received, only retransmit on the first duplicate ACK.
   (a) Frame 4 is lost on the first transmission.



(b) Frames 3 and 6 are lost on their first transmissions.



2 pts for a

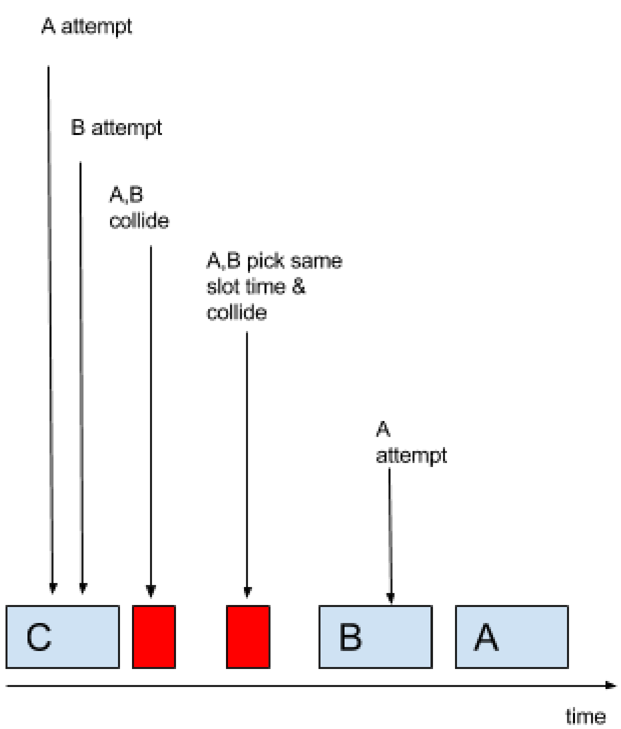
- 0.5 pts for showing dropped packet
- 0.5 pts for retransmitting at the first duplicate ACK
- 1 pt for the rest being correct

3 pts for b

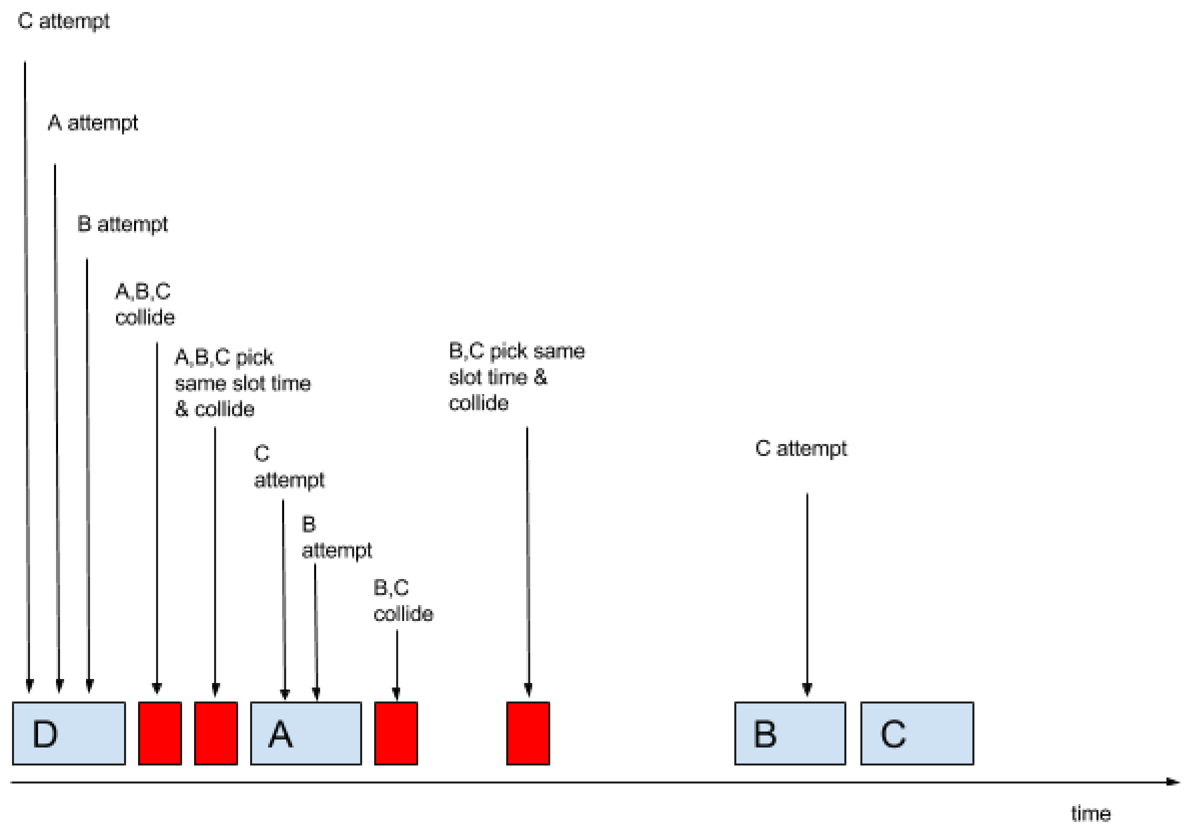
- 1 pts for dropped packets
  - 0.5 pts for 3
  - 0.5 pts for 6
- 1 pt for retransmissions
  - 0.5 pts for retransmitting 3 at first duplicate ACK
  - 0.5 pts for 6 being transmitted after timeout
- 1 pt for the rest being correct

** Note: The timeout being 2 RTT did leave some room for ambiguity on this problem because the packet with sequence number 5 on part a for example will be timing out right when it receives the cumulative ACK for 6. As such, credit will be given to those who decide to retransmit at that timeout.

3. **Sharing the Ethernet [4 pts]**
   Suppose A, B, and C all make their first carrier sense, as part of an attempt to transmit, while a fourth station D is transmitting. Draw a timeline showing one possible sequence of transmissions, attempts, collisions, and exponential backoff choices. A simpler example of the problem is given to you below. Your timeline should also meet the following criteria:
   (i) initial transmission attempts should be in the order C, A, B
   (ii) successful transmissions should be in the order A, B, C
   (iii) there should be at least four collisions.



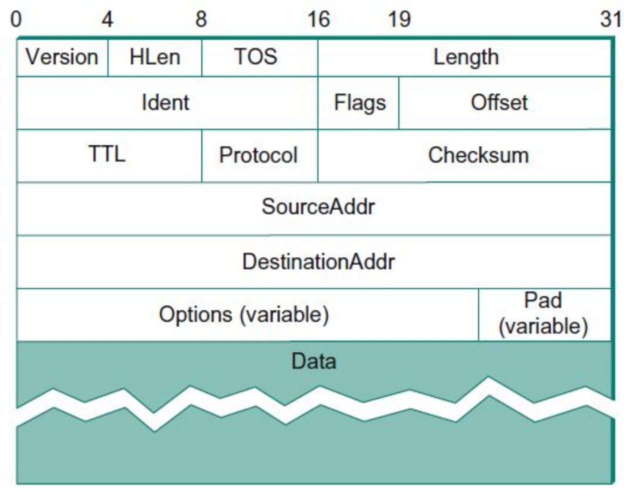
To the left, A and B make their first carrier sense while C is transmitting. The initial transmission attempts are in the order A,B. Successful transmissions in the order B,A. There are 2 total collisions that occur. The light blue boxes with a letter in them means that the transmitter with that letter is successfully transmitting on the channel. The red boxes indicate that a collision has occurred.



1 pt for initial transmissions in right order
2 pt for at least 4 collisions
1 pt for successful transmissions in right order
-0.5 pts for each type of minor error

4. **Ip Checksum and Endianness [5 pts]**
    a. The following IPv4 header, show in hex below, is received for an IP packet at its destination. Refer to the IPv4 header diagram below.

4500 05c8 1c46 25c8 4017 c311 aca8 0101 aca8 0102



Ipv4 Header

b. What is the header checksum? (You can find it by mapping the hex values to the IPv4 header diagram)
    i. c311

c. Using the Internet checksum algorithm, determine if there were any errors in the transmission (show work).
    i. Answer below

```
0100 0101 0000 0000 (4500)
0000 0101 1100 1000 (05c8)
-------------------
0100 1010 1100 1000 (4ac8)
0001 1100 0100 0110 (1c46)
-------------------
0110 0111 0000 1110 (670e)
0010 0101 1100 1000 (25c8)
-------------------
1000 1100 1101 0110 (8cd6)
0100 0000 0001 0111 (4017)
-------------------
```

```
1100 1100 1110 1101 (cced)
0000 0000 0000 0000 (0000)
-------------------
1100 1100 1110 1101 (cced)
1010 1100 1010 1000 (aca8)
-------------------
1 0111 1001 1001 0101 (17995)

0111 1001 1001 0110 (7996)
0000 0001 0000 0001 (0101)
-------------------
0111 1010 1001 0111 (7a97)
1010 1100 1010 1000 (aca8)
-------------------
1 0010 0111 0011 1111 (1273f)

0010 0111 0100 0000 (2740)
0000 0001 0000 0010 (0102)
-------------------
0010 1000 0100 0010(2842)

Do the complement
1101 0111 1011 1101 (d7bd)
```

There were errors because the computed checksum transmitted was c311, but it should have been d7bd. Alternatively, do sum the header with the provided checksum and compare to 0xFFFF.

d. What would this packet which is network byte order look like when stored in the memory of a big-endian system? (Assume that the packet is stored in an array of (32bit) integers in memory.)

   i.

#	Data
0	45 00 05 c8
4	1c 46 25 c8
8	40 17 c3 11
12	ac a8 01 01
16	ac a8 01 02

e. How about in the memory of a little-endian system? (Again assume that the packet is stored in an array of integers in memory)

   i.

#	Data
0	c8 05 00 45
4	c8 25 46 1c
8	11 c3 17 40
12	01 01 a8 ac
16	02 01 a8 ac

1 pt for b for correctness

2 pts for c

- 0.5 pts for stating there were errors
- 1.5 pts for computing the checksum
  - 1 pt for showing sensible work
  - 0.5 pts for the correct checksum

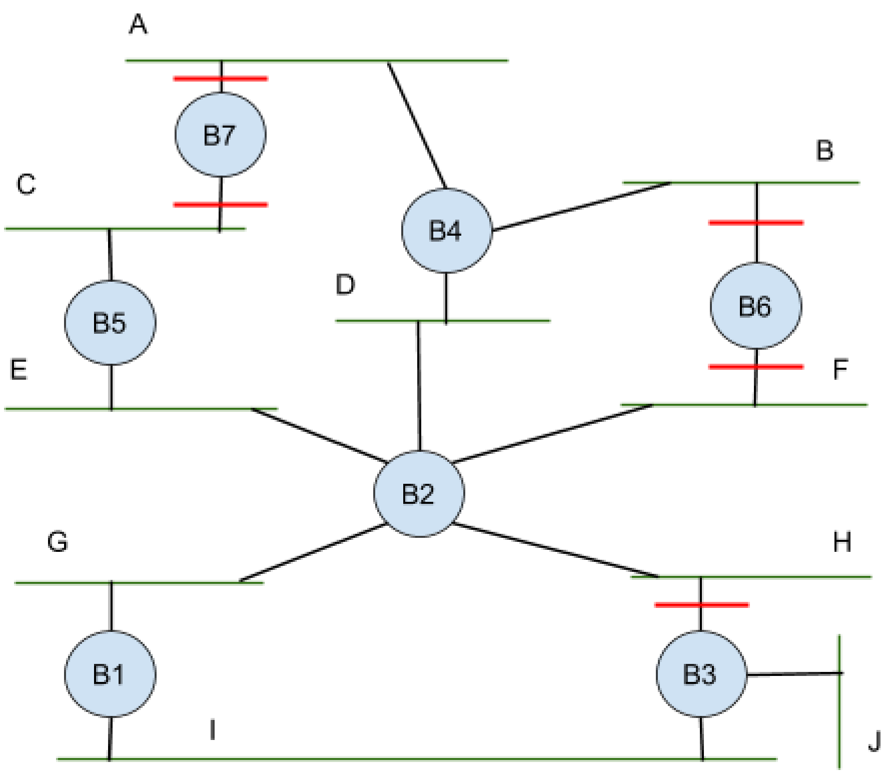
1 pt for d for correctness

- 0.5 pts for minor error

1 pt for e for correctness

- 0.5 pts for minor error

5. **Spanning Tree Question [3 pts]**
   Given the extended LAN shown below, indicate which ports are not selected by the spanning tree algorithm.

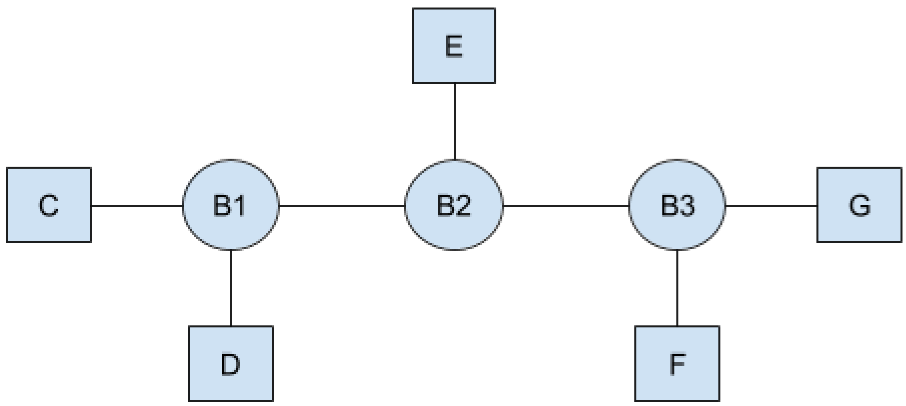


3 pts for spanning tree

- 1 pt for B7 cuts (split between both)
- 1 pt for B6 cuts (split between both)
- 1 pt for B3 cut
- -0.5 pts for each bad cut on any other bridges or between B3 and J

6. **Learning Bridges [6 pts]**

Use the diagram below to answer the following questions. Assume the circles are bridges and the rectangles are LANs with only one host defined by their letter. All bridges have empty tables at the beginning and the events below occur in the order presented.



a. E sends a packet to F, who receives the packet?
    i. C,D,F,G
b. C sends a packet to E, who receives the packet?
    i. E
c. D sends a packet to C, who receives the packet?
    i. C
d. E sends another packet to F, who receives the packet?
    i. C,D,F,G
e. G sends a packet to C, who receives the packet?
    i. C,F
f. F sends a packet to D, who receives the packet?
    i. D,E,G

6 pts

- 1 pt for each a-f for correctness (total of 6)