CS 372 – Intro to Networks – Benjamin Brewster, adapted from Kurose & Ross

Problems 5 – Chapter 5 (Book Required)

QUESTIONS

1. Re-read the analogy about transportation in section 5.1.1 of our book. If the passenger is analogous to a datagram, what might be analogous to a link layer frame?

   In this analogy the frame would be the vessel. An example of this would be if the datagram was the passenger at an airport then the link layer frame would be the air plane. This is because over a given link, a transmitting node encapsulates the datagram in a link layer frame and transmits the frame into the link.

2. Imagine that every single link in the Internet was able to provide completely reliable service between nodes. Would TCP's reliable data transmission guarantees still be useful? Would they be redundant? Why or why not?

   I believe it would be useful. It would not be redundant. This is because TCP is needed to identify the bite stream in the correct order. Also the other method doesn't guarantee that these would arrive in the correct order.

3. Review and list some the possible services that a link-layer protocol can offer to the network layer. These can be found in sections 5.1 and 5.2 of our book. Which of these link-layer services have similar services in IP? Which of these link-layer services have similar services in TCP?

   - Framing - packaging data into frames with header fields and content field, exists in both IP and TCP
   - Link access - MAC (medium access control) controls which nodes have access to a link for frame transmission at which times
   - Reliable Delivery - Also in transport layer such as TCP
   - Error detection and recovery - also in IP and TCP

4. Imagine a LAN with a very large token-ring deployment (i.e. the perimeter is very large). Would this be an inefficient method of managing the link layer? Contrast this with an Ethernet deployment in a star configuration, with the same number of nodes.

Since token ring and Ethernet are the two top performers with token ring in second. This would be efficient in terms of working right. However, it would also be very expensive as a token-ring deployment is an expensive set up. While when compare to Ethernet it would be considerably cheaper. This is due to token –ring using polling to take turns transmitting while Ethernet uses Collision Sense Multiple Access/Collision Detection (CSMA/CD) topology. Due to the large perimeter and costs for setting up a token-ring deployment I believe it would be an inefficient method in managing the link layer if given the option of Ethernet.

5.

A) How big is the IPv6 address space - i.e. how many addresses are there?

3.4×10^{38} addresses or 2^{128}

B) How big is the MAC address space?

2.8×10^{14} addresses or 2^{48}

C) How big is the IPv4 address space?

4.3×10^{9} addresses or 2^{32}

6. For what reason is an ARP request sent within a broadcast frame? How come an ARP response is sent back within a frame to a specific destination MAC address?

An ARP query is sent in a broadcast frame because the querying host does not know which adapter address corresponds to the IP address in question. For the response, the sending node knows the adapter address to which the response should be sent, so there is no need to send a broadcast frame.

7. A) Give an example of a two-dimensional parity check that can detect *and* correct a single bit error. Use figure 5.5 in the book for inspiration, but provide your own example.

No errors	Error
10010 | 0	10110 | 0
01101 | 1	01101 | 1
10101 | 1	10101 | 1
-------------	-------------
01010 | 0	01110 | 1

B) Give an example of a double-bit error that can be detected, but *not* corrected.

No errors	Error
10010 | 0	10100 | 0
01101 | 1	01101 | 1
10101 | 1	10101 | 1
-------------	-------------
01010 | 0	01110 | 1

Due to there being two bits that are change in the error example both in row 1 column 3 and 4. We cannot determine where the error is but it is correct just not correctable.

8. Calculate the value R that a sending link-layer device would use for a CRC EDC field. Use a generator (G) of 10011, and data (D) with a value of 1010101010.

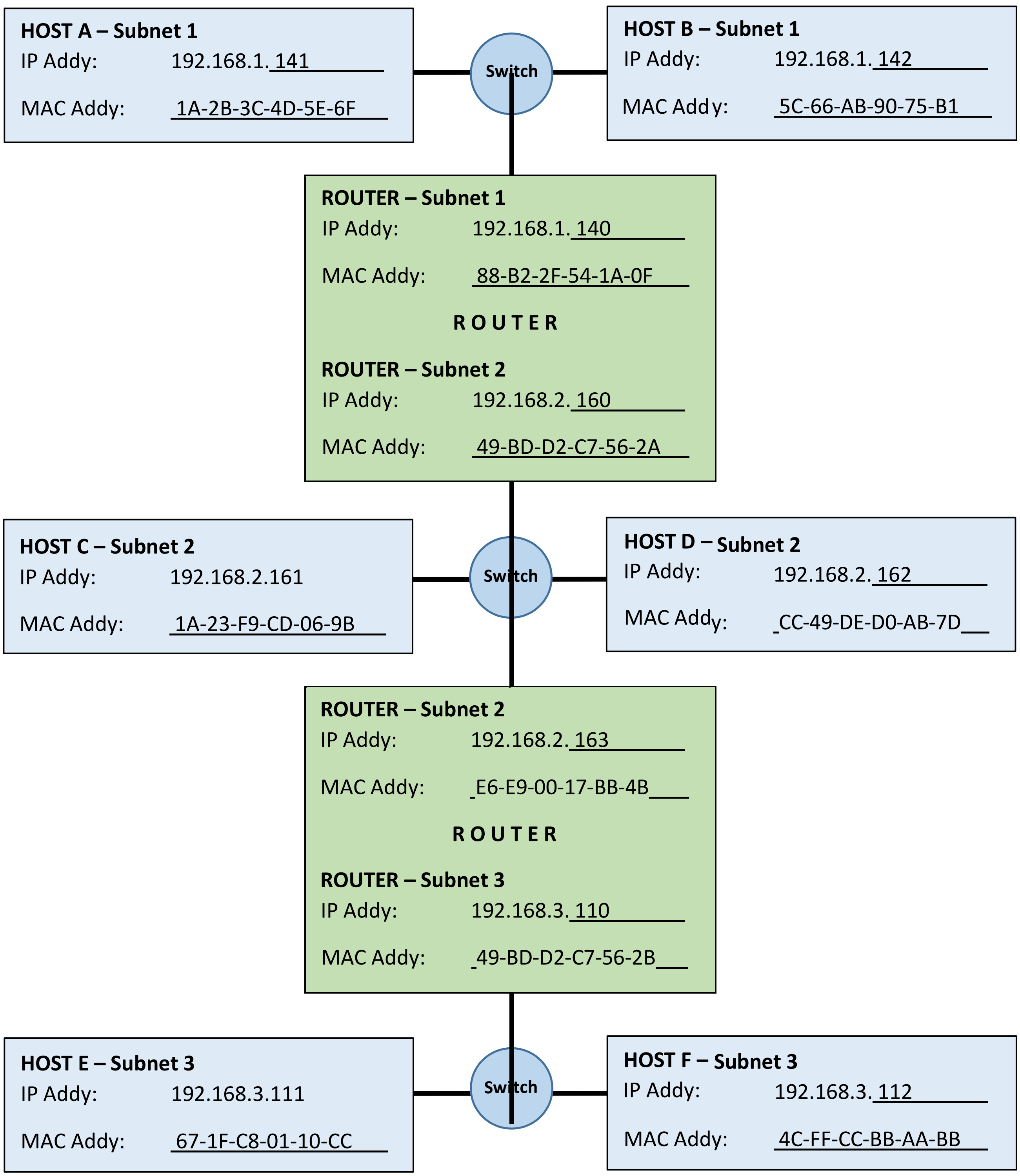
Append 4 zeros to the end

```
10011 |  10101010100000
          10011
          001100
            0000
            11001
            10011
            010100
             10011
             001111
               0000
               11110
               10011
               011010
                10011
                010010
                 10011
                 000010
                     00
                    0100
```

D is red and CRC is yellow

R: 10101010100100

9. A) Examine the following 3-LAN network. Fill in all blanks to assign IP and MAC addresses, as appropriate:



B) Let's say that all ARP tables are up to date. List all of the steps to send an IP datagram from Host E to Host B. Use the example in section 5.4.1 (page 469) as inspiration.

1. Forwarding table in Host E determines that the datagram should be routed to interface 192.168.3. 110
2. The adapter in Host E creates a frame with destination address 49-BD-D2-C7-56-2B.
3. Router 2 receives the packet and extracts the datagram. The forwarding table in this router indicates that the datagram is to be routed to 192.168.2. 160.
4. Router 2 then sends the frame with the destination address of 49-BD-D2-C7-56-2A and source address of E6-E9-00-17-BB-4B via its interface with IP address of 192.168.2. 163.
5. The process continues until the packet has reached Host B.

C) Now, let's say that all ARP tables are up to date *except* for the sender, Host E, whose ARP table is empty. List all of the steps to send an IP datagram from Host E to Host B.

ARP in Host E must now determine the MAC address of Host B. Host E sends out an ARP query packet within a broadcast Ethernet frame. Router 2 receives the query packet and sends to Host E an ARP response packet. This ARP response packet is carried by an Ethernet frame with Ethernet destination address. Now that Host E now has its ARP table updated the rest of this will be the same as part B.

10. Consider your graph above in problem 9. Let's say that Host A sends a datagram to Host F. Give the source and destination MAC and IP addresses in the frame surrounding this datagram as the frame gets transmitted:
    a. From Host A to the top-most router:

Source IP Address: 192.168.1. 141	Destination IP Address: 192.168.1. 140
Source MAC Address: 1A-2B-3C-4D-5E-6F	Destination MAC Address: 88-B2-2F-54-1A-0F

    b. From the top-most router to the bottom-most router:

Source IP Address: 192.168.2. 160	Destination IP Address: 192.168.2. 163
Source MAC Address: 49-BD-D2-C7-56-2A	Destination MAC Address: E6-E9-00-17-BB-4B

    c. From the bottom-most router to Host F:

Source IP Address: 192.168.3. 110
Destination IP Address: 192.168.3. 112
Source MAC Address: 49-BD-D2-C7-56-2A
Destination MAC Address: 4C-FF-CC-BB-AA-BB

11. A) Examine the switch in Figure 5.25 on page 483 of your book. Let's say that a router that understands VLANs is connected to port 1 on this switch.

Choose IP addresses for the 6 unassigned hosts and the router interface below:

Router IP Addresses (router interface connected to switch): 192.168.3. 110

Port 1 IP Address (switch interface connected to router): ASSIGNED BY ADMIN
Port 2 IP Address (switch interface for EE VLAN):
Port 3 IP Address (switch interface for EE VLAN): 192.168.3. 111

Port 4 IP Address (switch interface for EE VLAN):
Port 5 IP Address (switch interface for EE VLAN): 192.168.3. 112

Port 6 IP Address (switch interface for EE VLAN): 192.168.3. 113

Port 7 IP Address (switch interface for EE VLAN): 192.168.3. 114

Port 8 IP Address (switch interface for EE VLAN):

Port 9 IP Address (switch interface for CS VLAN):
Port 10 IP Address (switch interface for CS VLAN):
Port 11 IP Address (switch interface for CS VLAN): 192.168.4. 111

Port 12 IP Address (switch interface for CS VLAN): 192.168.4. 112

Port 13 IP Address (switch interface for CS VLAN): 192.168.4. 113

Port 14 IP Address (switch interface for CS VLAN): 192.168.4. 114

Port 15 IP Address (switch interface for CS VLAN):
Port 16 IP Address: 192.168.4. 115

B) Describe the steps for BOTH the network layer and link layer to transfer an IP datagram from a CS host to an EE host. Include in your comments a section on the VLAN tagging needed.

Suppose that host B in CS department with IP address 192.168.4. 111 would like to send an IP datagram to host A (192.168.3. 111) in EE department. Host B first encapsulates the IP datagram, destined to 192.168.3. 111, into a frame with a destination MAC address equal to the MAC address of the router's interface card that connects to port 11 of the switch. Once the router receives the frame, then it passes it up to IP layer, which decides that the IP datagram should be forwarded to subnet 192.168.4. 111/24 via sub-interface 192.168.4. 111. Then the router encapsulates the IP datagram into a frame and sends it to port 3. Note that this frame has an 802.1q tag VLAN ID 12. Once the switch receives the frame port 3, it knows that this frame is destined to VLAN with ID 12, so the switch will send the frame to Host A which is in EE department. Once Host A receives this frame, it will remove the 802.1q tag.

12. For this Problem, you'll be using much of what you have learned about networking protocols. You'll need to use DHCP, DNS, IP, ARP, TCP, HTTP, and MAC addresses as part of your answer.

    Describe the networking steps needed for a brand-new computer, with empty DNS, ARP, and web browser caches, to connect to an Ethernet for the first time and download a web page from the internet. Be very clear in how you get the IP and MAC addresses of the gateway router, and the IP address of your new computer. Note that this problem is worth 30 points, while the rest of the questions in this assignment are worth 10.

    Please type your answer, or write very clearly.

Your computer first uses DHCP to obtain an IP address. Then your computer creates a special IP datagram designated to 255.255.255.255 in the DHCP server discovery step, puts it in an Ethernet frame and broadcast it in the Ethernet.

Next the following the steps in the DHCP protocol, your computer is able to get an IP address with a given lease time. A DHCP server on the Ethernet also gives your computer a list of IP addresses of first-hop routers, the subnet mask of the subnet where your computer resides, and the addresses of local DNS servers (if they exist). Since your computer's ARP cache is initially empty, your computer will use ARP protocol to get the MAC addresses of the first-hop router and the local DNS server. Your computer will get the IP address of the Web page you would like to download. If the local DNS server does not have the IP address, then will use DNS protocol to find the IP address of the Web page.

Once your computer has the IP address of the Web page, then it will send out the HTTP request via the first-hop router if the Web page does not reside in a local Web server. The HTTP request message will be segmented and encapsulated into TCP packets, and then further encapsulated into IP packets, and finally encapsulated into Ethernet frames. Your computer sends the Ethernet frames destined to the first-hop router. Once the router receives the frames it passes them up into IP layer, checks its routing table, and then sends the packets to the right interface out of all of its interfaces.

Then the IP packets will be routed through the Internet until they reach the Web server. The server hosting the Web page will send back the Web page to your computer via HTTP response messages. Those messages will be encapsulated into TCP packets and then further into IP packets. These IP packets follow IP routes and finally reach your first-hop router, and then the router will forward those IP packets to your computer by encapsulating them into Ethernet frames.

INSTRUCTIONS

Write up your answers in any way you see fit, including appropriate equations and descriptions. Submit the resulting work as a document upload to Canvas, either scanning your paper work, or producing the work initially on a computer. If you have multiple files, please enclose them in a zip file.

I recommend you work in groups. If you choose to do so, you must still write and turn in your own work.

Please post your questions onto the relevant Canvas Discussion board.

GRADING

Problems 1 through 11 are worth 10 points if correctly answered, and worked out with appropriate equations and descriptions. If an answer to a problem is only partially correct, or is grossly missing supporting work, the grader may instead assign 5 points. Completely wrong or unanswered problems are worth 0 points.

Problem 12 is worth 30 points. If (major) steps are missed, partial credit will be given.

The total available is 140 points for this assignment.