

Assignment 6

ECE1150 - Introduction to Computer Networks University of Pittsburgh (100 points)

Instructions:

- Show all steps in answering the following questions.
- Make sure to put units of measurements (if applicable) in your answers.
- Include equations and explanations wherever applicable as points are allocated for all the above!
- Make sure to highlight your final answers.

1. (25 points) DATA LINK LAYER OF ETHERNET

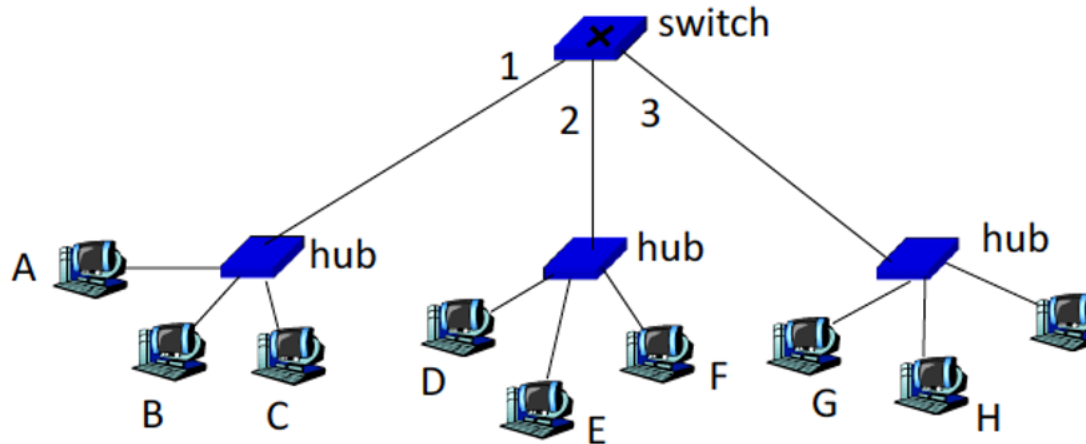
- (5 points) What are the main fields in an Ethernet frame (describe the frame structure pointing out the header and the trailer fields)?
- (5 points) MAC addresses are used for addressing in the data link layer. Describe how the MAC address is structured (how is it unique for each device?).
- (5 points) Explain the Exponential Backoff algorithm used in Ethernet. Why is it needed?
- (5 points) Using Exponential Backoff algorithm, what is the average number of backoff slots that a device will wait before attempting to re-transmit after detecting 5 collisions? [You can use any software for calculation]
- (5 points) Repeat (d) by computing the average number of back-off slots after 6 collisions?

2. (10 points) This question has two parts.

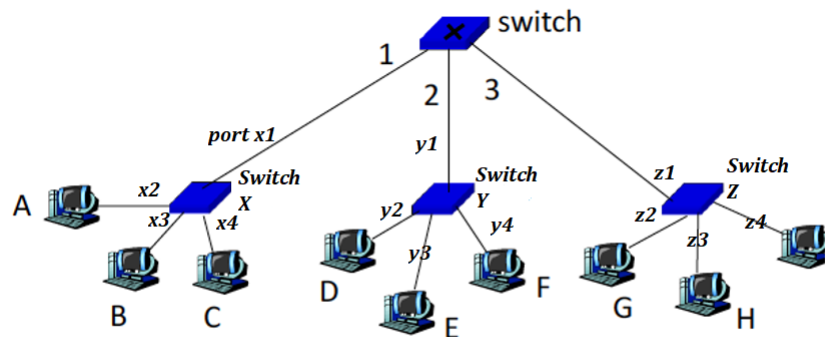
- A network is designed as illustrated in the figure below. Suppose that device A sends data to device G, and G responds back to A. Before these transmissions, the switch table was as follows:

MAC Address	Port
B	1
E	2
H	3

Show and explain how the transmission between A and G is handled by the network, and how the switch table is updated after A transmits to G and G responds to A .



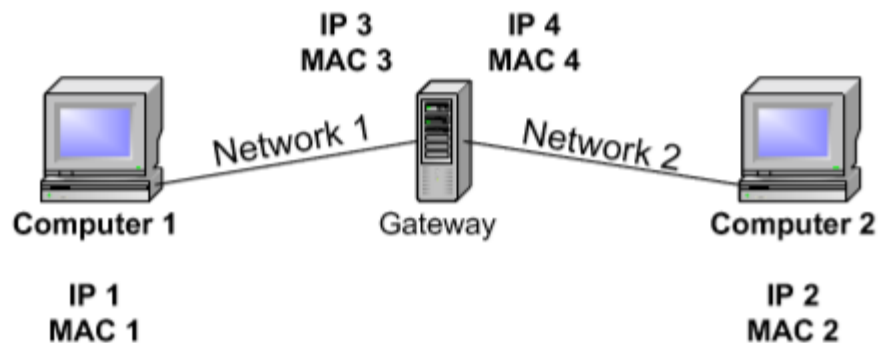
(b) Assume that the network administrator replaced the three hubs with three switches (X, Y, Z), with ports (x1, x2, x3, x4), (y1, y2, y3, y4), (z1, z2, z3, z4), respectively, as shown in the figure. Assume that change has been made after the transmissions of A and G in the previous part. Assume now, A wants to send another frame to G. Describe what how the transmission will be made using the new interconnecting devices. Show which device(s) will receive the frame and how the forwarding table be updated at X, Y, Z.



3. (15 points) CSMA/CA

- (5 points) Describe the DCF and PCF of CSMA/CA used in Wireless LANs.
- Follow the steps below to compare between two MAC protocols using Simulink.
 - Using Matlab add-on, please install Communications Toolbox in MATLAB (if not pre-installed)
 - Search "ALOHA and CSMA/CA Packetized Wireless Networks" using the search bar in MATLAB
 - Open the documentation and click on "Open Model" to run the model and visualize the performance. Read the documentation.
- (10 points) Compare Aloha and CSMA/CA using Simulink model. Specify the values obtained at each step and explain the following.

- (i) Check throughput reported for each of the three nodes when Aloha is used (read from throughput icon in the model). [Note the throughput is proportional to the probability of successfully received packets]
 - (ii) Check throughput of each of the three nodes when CSMA/CA is used. [You can double click on the switch in the model to change the MAC protocol]
 - (iii) By clicking on the Fading Network Channel, you can check the SNR of the AWGN channel for each node. What is the impact of lowering the SNR on the throughput? Give an example for each of the MAC protocols through running the demo and reporting the SNR and throughput results.
 - (iv) Comment (and justify) your results. Are the results expected?
4. (6 points) How is error correction done through retransmission? Explain the two mechanisms clearly. You can use an example if you want.
5. (8 points) If an organization need to support 100 hosts.
- (a) (5 points) What class of network should be used? Explain how.
 - (b) (3 points) If the organization uses a CIDR /N network, what should the number N be?
6. (12 points) **IP Addressing**
 From your understanding of the difference between the MAC address and IP address, answer the following.
 Let's assume that you have the following network architecture:



Computer 1 has IP address IP1 and MAC address MAC1. It sends a packet to computer 2 with IP2 and MAC2. Computer 2 is located in a different network, so the packet crosses a gateway router, which has two interfaces (interface 1 has addresses IP3 and MAC3, while interface 2 has addresses IP4, MAC4), as shown in figure.

Describe the addressing (IP and MAC addresses, source and destination addresses) in the packet/frame headers from computer 1 to gateway's interface 1 and from gateway's interface 2 to computer 2.

7. (18 points) **SUBNETTING**

- (a) (6 points) What is subnetting? Why and how is it used in networking? Give an example and explain how the IP addresses are allocated with subnetting.
 - (b) (3 points) **Answer the following questions (b to e) assuming your subnet mask is 255.255.254.0.**
How many bits are in host ID of this network?
 - (c) (3 points) If the network is /16 network, how many bits represents the subnet ID?
 - (d) (3 points) What is the maximum number of subnets?
 - (e) (3 points) If a device in the subnet has an IPv4 address 192.168.255.40, what is the subnet address?
8. (6 points) How are the shortages in IPv4 addresses handled? Also explain how is subnetting carried out in IPv6?