Communication Protocols and Internet Architectures
Harvard University, CSCI S-40, Summer 2018
Homework Assignment #2 due by 1 PM (Boston time) on July 9, 2018

Please submit your homework on the day it is due using the homework submission tool on the course website. You will need your HarvardKey to use this feature. Please do not email your homework to a TA or the instructor.

Your homework must use text format, PDF or MS Word. Do not use any fancy layout and do not use macros of any type. In other words, the simpler the format the better.

The file name for your homework must include your name and the specific hw# and the file name must not contain any spaces. In addition, you must always include your name and your email address as part of the document. We will not grade homework that does not follow these naming conventions.

There is a penalty for late homework and homework will not be accepted once the solutions are available. Graded homework will be posted on the course website or emailed back to you. Please note that the point assignment included next to each question might change as we refine the answer key for the assignment.

Your homework must be your own work, in your own words. The use of material from other sources, even when it is properly quoted and cited, should be limited. Please see*, Writing with Sources: A Guide for Harvard Students* if you have questions. We realize that some of the homework questions (or comparable questions) have been asked in previous terms but it is important that you learn the material covered by the question; it is never acceptable to copy an answer directly from another source. The teaching staff and the University take the issue of Academic Honestly very seriously.

Please note that the answer to a homework question is rarely longer than three or four paragraphs in length (plus any diagrams.) If your answer is more than a page long, it means that you are probably not answering the question we asked, or your answer is not as concise as it should be. In either case, you will not receive full credit for your answer. Finally, note that some of this homework requires that you do additional background reading and research.

HOMEWORK #2 QUESTIONS

Note: Your answer to a question should rarely be longer than three or four paragraphs. If your answer is more than a page long, it means that you are probably not answering the question we asked, or your answer is not as concise as it should be. In either case, you will not receive full credit for your answer.

1a.) Explain in detail what is meant by a collision domain and a broadcast domain in an 802.3 network. Explain how collision domains and broadcast domains are implemented by ethernet hubs, ethernet switches and routers. Note the differences and similarities between how each device implements them.
1b.) Your small business has 15 computers, 10 of which are used as desktop machines and the remaining 5 are file servers or mail servers. All of the computers have both wireless and wired Ethernet cards. Your local ISP has provided you with a wireless router (with a built-in Ethernet switch) that has 8 physical ports as well as a wireless antenna. Assuming no difficulties in wiring, how would you allocate the eight wired Ethernet ports to the fifteen computers in you office? Explain you rationale.
1c.) How do the network characteristics of a "server" differ from a “desktop” machine? Be specific, and provide some examples from the literature or your own experience. *(5 points total)*

2.) *(2 points total)* In a sentence or two, explain what the traceroute command does. Then, in a few paragraphs explain how the traceroute command works. Include details on the types of packets that are used, and the important protocol fields. (Please make sure that your answer is in your own words.)

3.) *(3 points total*) Every ethernet NIC that has been manufactured has a unique Ethernet address (also called a MAC or hardware address) and this means that each machine that has a NIC, has a unique address. Given this, why is it necessary for machines to also have an IP address? Explain in detail.

4) *(4 points total*) Consider a network consisting of four hosts: A, B, C and D. Each host is connected to a different port on a switch. Specifically, A is connected to Port 1, B to Port 2, C to Port 3, and D to Port 4. Assume that the switch forwarding table is completely empty when the following three events occur:

(1) Host A sends a frame to host C
(2) Host D sends out a broadcast frame
(3) Host C sends a frame back to host A.

Describe the operation of the switch as these events occur. Your answer should include details on how the frames are distributed by the switch, and describe the information that is contained in the switch forwarding table after each event.

5. *(3 points total)* We discussed the "star of stars" Ethernet switch layout in class. A savvy network administrator has pointed out that this type of network configuration has several "single points of failure." For example, the failure of a switch port that is used to connect to another switch could take down many machines in the office. The network admin proposes connecting the stars (i.e., the switches) together with additional ethernet cables. Without using technologies or protocols not discussed in class (such as the spanning-tree protocol), would this work? Why or why not? What would happen if these additional cables were installed between two switches?

6a.) *(4 points total)* A topology describes the structure, configuration and connectivity of a network. Identify and describe in detail the different topologies that can be used in LANs.
6b.) What does it mean that network topologies can be considered either logical or physical in nature? Give an example of how the same network can differ in this way.

7.) (3 points) The literature and the industry talk about different protocol reference models including the four-layer model, the five-layer model, and the seven-layer model. Compare and contrast these three different reference models. Next, choose one of them as the "best" model and explain your choice. Note that it is more important to us that you describe in a coherent and thoughtful way why you picked one model versus the others, than which particular model you chose.
Important note: we will use the five-layer protocol reference model as our reference model for this course.

8.) Submit your homework via the course website. Make sure that your name is on your homework assignment, and also confirm that your last name and the hw# are a part of the file name (as described above.) We know it seems foolish to mention that you have to write your name on your homework assignment but we always have a few students that forget to do this.

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