

ECE/CSC570: Computer Networks

Spring 2020

Prof. Shih-Chun Lin

Homework 2

Due: 11:59 pm, Monday, February 17, 2020

1. Conceptual Question-I (10 points; 2 points each)

Each question is a judgment question. Write down your answer with **T** for True, **F** for False, and give the explanation if the answer is False.

- a. Consider a system of bandwidth 10Mbps, with multiple users, each is active (i.e., have data to transmit at rate 1Mbps) with a low probability, e.g. 0.1. From the capacity perspective, packet switching is better than circuit switching because the former can support more users.
- b. Denial of Service (DoS) attack can be generated by a large number of (legitimate) TCP connection requests to the same targeted server at the same time. These TCP requests can be originated from different hosts in a botnet, which is controlled by the attacker.
- c. In VSAT systems the micro-stations do not have sufficient power to communicate directly with one another; hence, they use a ground station called a hub with a high gain antenna to relay traffic.
- d. In the current Internet, communication across the Atlantic Ocean between the USA and Europe is mostly done by wireless communication using satellites.
- e. Coaxial cable provides larger bandwidth than the twisted pair cable, and fiber provides larger bandwidth than the coaxial cable.

2. Conceptual Question-II (12 points; 6 points each)

- a. Why CDMA can make users communicate at the same time using the same frequency band without interference? Explain the advantages and disadvantages of CDMA.
- b. Why ADSL can achieve the transmission rate of several Mbps using the bandwidth less than 1MHz?

3. Bandwidth and Data Rate (15 points)

Assume the channel bandwidth is 3100 Hz and the maximum data rate is 35 kb/s. To improve the maximum data rate by 60%, how many times should the signal-to-noise-rate (SNR) increase? Based on the improved maximum data rate and SNR, if the SNR further increases by 10 times, can the maximum data rate further increase by 20%?

4. Communication Satellites (15 points)

What is the latency of a call originating at the North Pole to reach the South Pole if the call is routed via Iridium satellites? Assume that the switching time at the satellites is 10 microseconds and Earth's radius is 6371km.

5. Modulation-I (15 points)

Dense constellation diagrams (i.e., more symbols) offer high bit rates. What could be a potential drawback with such dense constellation diagrams? Explain by drawing and comparing the constellation diagrams for 16-QAM and 64-QAM.

6. Modulation-II (15 points)

A constellation diagram has symbol points at $(1,0)$, $(0,1)$, $(-1,0)$, $(0,-1)$, $(1/\sqrt{2}, 1/\sqrt{2})$, $(-1/\sqrt{2}, 1/\sqrt{2})$, $(1/\sqrt{2}, -1/\sqrt{2})$ and $(-1/\sqrt{2}, -1/\sqrt{2})$. Draw the constellation diagram. What modulation is being used and what bit rate can a modem achieve at 2000baud?

7. Multiplexing (18 points; 6 points each)

Consider a CDMA system where transmitter A has the code 101010 and transmitter B has the code 111001. Assume that 1 is represented by +1V and 0 is represented by -1V.

- Show that the two CDMA codes (after mapping them to voltages) are orthogonal to each other.
- What is transmitted if A sends a bit of 0 and B sends a bit of 1?
- What did A and B most likely transmit if the received word is "-1 -1 -1 +1 +1 +1"?