CS 536 (Park) **Midterm** **Oct. 13 (Wed.), 2021**

Remarks: Please keep the answers compact, yet precise and to-the-point. Long-winded answers that do not address the key points are of limited value. Binary answers that give little indication of understanding are not good either. Time is not meant to be plentiful. Make sure not to get bogged down on a single problem.

PROBLEM 1 (40 pts)

(a) Suppose you are asked to comment on the efficacy of deploying satellites in geostationary orbit (a little above 22K miles) that use Ethernet's CSMA/CD to provide Internet access service to customers living in metropolitan areas. Why would you advise against using CSMA/CD to mediate bandwidth sharing? What would be a better approach? It is clear why low-orbit satellites that are an order of magnitude closer to the earth surface are better suited for real-time apps such as Skype and Zoom due to lower latency. Why are they also better suited for improving throughput of file download?

(b) Suppose OFDMA is to be used to share wireless bandwidth in the 7–8 GHz range among multiple users. Assuming signal-to-noise ratio P_S/P_N is known, how would you go about estimating an upper bound on the maximum throughput (bps) achievable over the OFDMA system? In contrast to FDM which requires a guard band between neighboring carrier frequencies, OFDM achieves greater spectral efficiency by allowing the spectra of neighboring carriers to overlap. Why can't we use orthogonality to squeeze in ever more carrier frequencies in the 7–8 GHz range to transmit bits in parallel, thereby achieving ever greater throughput (bps)?

PROBLEM 2 (40 pts)

(a) Explain why classful IPv4 addresses are considered inefficient. Use class A and C addresses as an example. How does classless CIDR addressing help improve efficiency? Suppose a customer of an ISP is assigned a routable IPv4 address. The customer has multiple IP speaking devices that wish to interact with other devices on the global IP Internet. Using two devices at the customer side that must share the same routable IPv4 address, explain how NAPT works.

(b) Most 802.11 WLANs in use today utilize both OFDM and CSMA (i.e., DCF) when transmitting a frame from sender to receiver. Why does this seem, on the surface, illogical? What is the reason for employing both technologies? What are the main pros/cons of just using OFDMA—and dispensing with CSMA—to mediate bandwidth sharing in WLANs?

PROBLEM 3 (20 pts)

Suppose an Ethernet frame containing an IPv4 packet as its payload arrives at an Ethernet switch that does not speak IP. Based on our discussion of how frames are forwarded at the LAN layer, describe the possible actions undertaken by the Ethernet switch. In a second scenario, assume that the Ethernet switch speaks IP and acts as an IP router that implements subnetting. Describe the possible actions undertaken by the IP router to forward the IP payload contained in the Ethernet frame.

BONUS PROBLEM (10 pts)

Suppose three devices with 11-bit identifiers 11000000001, 10010101010, 10001111110 are connected to the same CAN bus. Describe which of the three devices wins the competition to send its data by NDA. From a scheduling perspective, what is a potential weakness of CAN? From a contention-based multiple access perspective, what is the main strength of CAN?