CS 422 (Park) **Midterm** **Oct. 19 (Fri.), 2007**

Remarks: 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 no good either. Time is not meant to be plentiful. Make sure not to get bogged down on a single problem.

PROBLEM 1 (48 pts)

(a) Does a single bit travel faster on a modern high-speed network compared to a network from 10 years back? In what sense is "high-speed" a misnomer? What is a technically more accurate term? Provide an analogy with road systems. In what sense could one say that modern networks are "high-speed"?

(b) What are the main differences between contention-free (e.g., TDM, FDM) vs. contention-based (e.g., CSMA/CD, CSMA/CA) MAC protocols? Describe their pros/cons. Why are contention-based protocols construed to be suited for wireless LAN environments? Why are they considered not to be suited for satellite-based networks?

(c) What are the main differences between circuit-switched and packet-switched routing? If most applications have only a few packets to transmit, which is more appropriate and why? Which method yields smaller routing tables, a key bottleneck in network provider routers? Which method is employed in today's IP Internet? Are both source and destination addresses consulted during route table look-up?

(d) What is frequency reuse? Why is the 4-coloring theorem, a famous result in mathematics, relevant to wireless network design and engineering? In the U.S., IEEE 802.11 wireless LANs are endowed with 11 channels (i.e., carrier frequencies). Does that mean all 11 channels are available for frequency reuse?

PROBLEM 2 (32 pts)

(a) What is the starvation problem in WLANs? Explain how it comes about. How is it related to the hidden station problem? Does the CA (congestion avoidance) part of CSMA/CA employing RTS/CTS handshake solve the hidden station problem? Explain your reasoning.

(b) Suppose you are setting up a start-up company that purchases the right to use carrier frequency 50 GHz with approval from the FCC. If you decide to use TDM using AM (amplitude modulation) with 4 amplitude levels to encode bits, what is the resultant speed (bps) of your wireless network? What is the speed if 8 levels are employed? Would it make sense, from a technical perspective, for your company to compete in the wireless LAN sector with an advertising campaign that states that replacing IEEE 802.11 WLANs with your TDM-based system would yield super-high throughput? (*Hint: Consider qualitative differences between carrier frequencies in the 2–5 GHz range for WLANs vs. carrier frequencies in the 50 GHz range.*) In what type of network environment might your system be useful (and hence able to compete)?

PROBLEM 3 (20 pts)

What are the fundamental differences between classical bus-based Ethernets and today's switch-based Ethernets? Why is CSMA/CD not suited for the latter? Why is it, nonetheless, still used? In what situation is CSMA/CD not used (i.e., turned off)? What is the meaning of collision in a switched Ethernet? When switched Ethernets are connected together to form larger Ethernets, how is routing of packets handled across switches so that an Ethernet frame is correctly delivered to its destination? Given that all Ethernet network cards have unique 48-bit addresses, is there a need for additional 32-bit IP addresses—a purely logical/virtual construct—when connecting Ethernet switches to cover a campus-scale organization? Explain your reasoning.

BONUS PROBLEM (10 pts)

In modern networks, the distinction between data and telephone networks has blurred (some may say vanished) as, for example, evidenced by handheld devices such as iPhone that run a UNIX based operating system with both WLAN (i.e., CSMA/CA) and GSM (i.e., TDMA) network interfaces over which phone calls and data transmission are carried. Why is it perfectly natural to carry IP packets, say, generated by a web brower, over TDMA networks that were originally designed to carry telephone calls?