CS 422 (Park)   Midterm   Mar. 11 (Fri.), 2011

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 (30 pts)

(a) Suppose a file of size S bytes is sent out on a NIC connected to a point-to-point link with bandwidth B bps. The latency of the link is D sec. Ignoring any software processing overhead, what is the completion time of the file transfer? Explain how it is arrived at.

(b) Stop-and-wait, a simple form of ARQ, still needs a bit in the packet header to act as a sequence number. Why is this the case? Explain using an example scenario.

(c) In FHSS (frequency hopping spread spectrum) CDMA, it is obvious why "spread spectrum" is a descriptive name for how bits are shipped over a frequency band. Why is calling the code vector (i.e., chipping or pseudo-random sequence) version—DSSS (direct sequence spread spectrum) CDMA—"spread spectrum" an accurate description? Can you think of a variant, call it DSNSS (direct sequence non-spread spectrum) CDMA, where "spread spectrum" would not be a correct characterization?

PROBLEM 2 (30 pts)

(a) What is an internetwork? Given that NICs have unique 48-bit physical addresses, why are IP addresses still used or needed? Are port numbers a necessity? Can you think of a network protocol that may not need to use port numbers?

(b) What is OFDMA? In what way is it superior to FDMA? For a given frequency band, say, 5 GHz–6 GHz, how many carrier frequencies—at least in principle—does OFDMA allow? In wireless networks that employ OFDMA, what is a practical contraint that limits how many carrier frequencies can be squeezed in a given frequency band?

(c) In real-world testing of a sliding window ARQ protocol, TCP, we have seen that throughput of nearly 90 Mbps is possible between Purdue and a university across the Pacific Ocean in East Asia. On the other hand, for a TCP throughput test between Purdue and a university in New Jersey, we observed throughput less than 8 Mbps. What are the protocol related features of sliding window ARQ that limit its maximum throughput? What are the non-protocol related system constraints that limit the practical throughput between sender and receiver?

PROBLEM 3 (40 pts)

(a) In the original CSMA/CD Ethernet, how is reliable communication achieved at the link layer? Is reliability guaranteed? Why is there a minimum frame size requirement? If link speed were increased, say, 10-fold, explain what would have to happen to either the frame size or wire length for CSMA/CD Ethernet to function correctly. What is the meaning of collision detection (CD) in today's switched Ethernet? Does carrier sense (CS) have any useful meaning? In wireless LANs that have inherited Ethernet's CSMA and exponential backoff, the collision detection (CD) capability has been dispensed with due to inherent difficulties. Using an example scenario, explain why CD is difficult to implement as a mechanism to achieve reliability in wireless networks.

(b) For a slowly moving mobile in an outdoor wireless network, what are the two factors that can make the received signal strength—and consequently throughput—fluctuate over time? Which of the two is more important? In an outdoor city environment, is it feasible to use carrier frequencies above 10 GHz for communication? Discuss your reasoning, pointing out the pros/cons and what factors you consider most relevant. How is wireless communication in indoor environments different from outdoors? Does being in direct line-of-sight of a base station (e.g., access point of a WLAN) in a room guarantee good throughput? When an indoor wireless client does not receive adequate throughput, what actions can be taken to improve throughput? In increasing power beneficial? Does it make sense to use carrier frequencies above 10 GHz indoors? Compare with your answer for the outdoor case.

BONUS PROBLEM (10 pts)

Suppose you work at a venture capital company and you are asked to evaluate a business plan that proposes to provide wireless Internet access for metropolitan areas using satellite networks that employ CSMA to achieve multi-user communication. What would be your assessment? Explain your reasoning. Would your assessment change if the business plan proposed using FDMA?