Networks

B1. (25 pts) LANs

(a) (4 pts) Suppose that the (unslotted) ALOHA protocol is used to share a 72 Mbps satellite channel among 100 nodes. All ALOHA-PDUs are 1000 bits long. If all nodes transmit equal amounts of traffic, what is the maximum throughput in ALOHA-PDUs/second that a single node may expect to have?

(b) (4 pts) The round-trip propagation delay for the satellite channel in part (a) is 300 msec. (That is, 300msec. is the time for a signal to travel from a node on the ground to the satellite and back to another node on the ground). Assume that two hosts use this channel to send data to each other using the Go-Back-N protocol with piggybacked cumulative ACKs. Assume that each host wants to transmit at the maximum throughput per node that you computed in part (a). What should be the minimum sending window size for each direction of transmission so that this maximum throughput can be achieved in the absence of errors?

(c) (4 pts) What restriction does the Ethernet impose on the minimum Ethernet-PDU (a.k.a. frame) size? Why is this restriction necessary?

(d) (4 pts) A CSMA/CD network is being built to run at 1 Gbps over a 1 km long cable with no repeaters. If the signal propagation speed is 2x 10^8 m/sec, what should be the minimum Link-PDU size for this network? Express your answer in bytes.

(e) (5 pts) Describe the backoff strategy used in the Ethernet protocol for retransmitting an Ethernet-PDU after a collision.

(f) (4 pts) Suppose Ethernet-PDUs transmitted by two hosts on an Ethernet collide. What is the probability that "the hosts' first three retransmissions also collide, and then the hosts both successfully transmit on the fourth retransmission"? (Assume no other hosts need to transmit.)

Networks

B 2. (25 pts) Protocol Functionality and Performance

(a) (5 pts) Given the following specification of a communication protocol over a point-to-point link, *functionality*-wise, what problem may arise and how would you fix this protocol with the least overhead?

- o The link-PDU of the protocol has only three fields: sender address, receiver address, and data.
- o After transmitting one link-PDU, the sender waits for an ACK, sent by the receiver, before transmitting the next link-PDU.
- o If an ACK does not arrive within a certain period of time, the sender times-out and retransmits the original link-PDU.

(b) (5 pts) Given the protocol specified in (a), *performance*-wise, what is the protocol's major drawback and how would you improve it?

(c) (5 pts) Given the protocol specified in (a) and assume no transmission error, consideration transmission in one direction only. We define

L = length of link-PDU (in bits)
I = length of 'data' field (in bits)
A = length of ACK-PDU (in bits)
C = link capacity (in bits/sec)
D = one-way propagation delay & processing time (in sec)

Derive the maximum (Link) Utilization U, in terms of the parameters defined, as the fraction of time that useful data is successfully transmitted. (Derivation is needed for full credit.)

(d) (10 pts) Performance with link errors -- In addition to the definitions given in (c), and we also define

T = Timeout interval
P1 = probability a link-PDU is damaged/lost
P2 = probability an ACK-PDU is damaged/lost

Derive expected (Link) Utilization U, in terms of the parameters defined. (Derivation is needed for full credit.)

Networks

B 3. (25 pts) Fragmentation/Reassembly and Checksum-Computation/Checksum-Verification
Two important pairs of inverse functions in computer networks are "fragmentation/reassembly" and "checksum-computation/checksum-verification".
(a) (3 pts) Explain the primary motivation(s) for fragmentation/reassembly.
(b) (8 pts) Give pseudo-code explaining how an IPv4-router does fragmentation, and how an IPv4-receiver does reassembly.
(c) (4 pts) Name two protocols (at any layers) other than IPv4 that perform fragmentation/reassembly, and two protocols that do not.
(d) (6 pts) Give pseudo-code for both a TCP-sender and a TCP-receiver explaining how they use checksums.
(e) (4 pts) Compare the mathematical qualities of the TCP checksum vs. the Ethernet checksum.

Networks

B 4. (25 pts) Congestion Control and Flow Control

(a) (4 pts) Explain what flow control is, and why it is needed.

(b) (5 pts) Explain what congestion control is, and why it is needed

(c) (6 pts) Describe how TCP provides flow control.

(d) (10 pts) Describe how TCP provides congestion control. [There are subtle differences in how different TCP variations (i.e., Tahoe, Reno, NewReno) provide congestion control. In answering this question, consider Reno.]