Ph.D. Qualifying Exam: Computer Networks
Department of Computer Science and Engineering
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1. Suppose that the cost of transmitting a multicast packet on link is completely independent of the cost of transmitting a unicast packet on a link. Will reverse path forwarding still work in this case? Just your answer. (15%)

2. Please describe the error control and flow control in data link layer, network layer, and transport layer. (10%)

3. Please describe the sorcerer's apprentice syndrome. Design a protocol to solve it. (10%)

4. Why cannot CSMA/CD be used in wireless local area networks? It is replaced by CSMA/CA. Please describe the CSMA/CA protocol, and explain why it is suitable in wireless local area networks. (10%)

5. Please calculate the bandwidth limit between a give source-destination pair which is running TCP if with the average round-trip time 50 ms. Consider the largest window scale option to be used. (5%)

6. Packet loss in a LFN (Long Fat Network, i.e., a network with large bandwidth-delay products, i.e., large capacity) can reduce throughput drastically. Could you explain the reason? (5%)

7. In the congestion avoidance mode of TCP, (1) estimate how many ACKs which can be received within a RTT, and (2) use the result of part (1) to show the small increment of *cwnd* to be $\frac{MSS^2}{cwnd}$ for each ACK arrival. (3) Continue part (2). Explain why computing this increment each time an ACK arrives may not result in the correct increment. Given a more precise definition for this increment. (10%)

8. What is *proxy ARP* and *gratuitous ARP*? What are MAC addresses of the hosts behind proxy ARP reported? Why do we need *gratuitous ARP*? (10%)

9. There is a network segment which is cut into two segments and connected by a bridge (link layer switch). The bridge has two Ethernet ports to connect to each segment. Please design a protocol for the bridge to switch Ethernet frames between two network segments. That is, any two hosts must be able to exchange data frames no matter whether both are at the same segment or different segments. Flooding must be avoided as possible as you can. (10%)

10. (1) What is Nagle algorithm? What network situation do we need it? (2) How fast inherent TCP can run is determined by two factors. Please show both factors. (3) Please explain why TCP needs the TIME_WAIT state (2MSL state). (9%)

11. (1) Please describe how congestion window size (*cwnd*) is incremented respectively in both cases of slow start and congestion avoidance. (2) There are two indications of packet loss: timeout and the receipt of duplicate ACKs. For both cases, the congestion window size (*cwnd*) increasing or decreasing? Please explain them. (6%)