Department of Computer Science and Engg, IIT Bombay

CS 348: Computer Networks Endsem: 19th Nov 2012, 14:00 – 17:00

Handwritten notes permitted. No photocopies. Weightage: 50%, Max Marks – 80

Q1: [15 Marks]

a) When using CRC, how many bits are in the checksum when using the generator polynomial “x^4+x+1”?

b) A channel has a bit-rate of 4Kbps and a propogation delay of 20msec. For what range of frame sizes does stop-and-wait ARQ give an efficiency of 50%?

c) What is the network number, subnet number and host number for the address 135.104.192.100, mask 255.255.128.0?

d) Let N be the number of nodes, E be the number of edges. For Link state routing, how many message exchanges (roughly, expressed as a function of the above parameters) need to be exchanged to build the topology at each and every node in the network?

e) In public-key cryptography, suppose A is sending a message to B. How should the message be encrypted so that it is only understood by B, and B is sure that the message was indeed sent by A?

Q2: [20 Marks] Explain the difference between:

a) p-Persistent and non-Persistent CSMA.

b) Persist Timer and Retransmit Timer in TCP.

c) Recursive and Iterated Queries in DNS.

d) Idempotent and non-Idempotent operations in RPC.

Q3: [5 Marks]

On an 10Mbps Ethernet, there is a rogue station that detects transmissions and disrupts them by beginning a competing transmission as soon as it hears the beginning of the transmitted frame, thereby causing a collision. Suppose your machine, which is on this Ethernet, detects collision during the transmission of its 12th bit on the wire (including any preamble). Given that the speed of the signal in the wire is 2 x 10 ^8 meter/second, how far away (in meters) is the rogue station from you machine?

Q4: [10 Marks]

Consider an 802.11 WLAN operating at 54 Mbps, in DCF mode and having several stations (STA). Each STA runs a voice over IP (VoIP) application which generates a 240 byte VoIP packet, every 20 milliseconds. The VoIP packet is sent using UDP over IP to the destination. Compute the maximum number of VoIP calls that can be supported.

Assume (VoIP header + UDP header + IP header + Checksum) = 44 bytes; (MAC header + FCS) = 33 bytes; ACK size = 11 bytes; RTS Threshold = 800 bytes. PHY header = 20μs; SlotTime = 20μs; SIFSTime = 10μs;

(Hint: First compute the minimum overhead for one VoIP packet in DCF mode, including various headers, ACK and channel access times. Then compute how many such packets can be accomodated in one second. Finally compute the maximum number of calls, keeping in mind that each VoIP call is duplex.)

Q5: [10 Marks]

Consider a network with links having different *capacities*, i.e., one link could have 100 Kbps capacity, and another could have 1 Mbps. We want to modify the Distance Vector (DV) protocol to compute paths which have the *maximum capacity* (instead of minimum cost). The capacity of a path is the minimum of the capacities of its constituent links (since the minimum capacity link is the bottleneck). From among the many paths between a Source and Destination, we want to choose the path that has maximum bottleneck capacity.

How would you modify the DV protocol to implement this feature? Specify clearly (a) What will a node advertise? (b) What does a node do on recepit of an advertisement from a neighbor?

Q6: [5 Marks]

Three users X1, X2, X3 using three different computers within the IIT Bombay network serviced by a single mail server wish to send emails. X1 wishes to send email to Y1, X2 to Y2 and X3 to Y3, where Y1, Y2 and Y3 are three distinct users within IIT Kanpur network. What is the worst case and best case number of TCP connections that should be opened to enable this email exchange? Assume all the users use a non-HTTP email reader such as thunderbird. And the email should finally arrive in the inbox of the respective email readers. Specify all assumptions made clearly.

<u>Q7:</u> [5 Marks]
Consider a cell phone network. Assume that the geographical area covered by the network has been divided into a 2-dimensional array of square cells. When there is an incoming call for a given mobile, the network has to find the location of the mobile, i.e., it has to determine the cell in which the mobile is currently located. Consider the following location update strategy. A mobile updates its location after every k cell changes, for a given integer k. The network pages for the mobile in a group of cells near the mobile's last known location. For example: if k=1, then the mobile updates the location each time it changes a cell and no paging is required. If k is very large, then the network has to page all the cells. Let C(k) denote the number of cells the system must page for a given k. (i) What is the number of cells the system must page if k=3? (ii) What is the general expression for C(k)?

<u>Q8:</u> [10 Marks]
Consider the topology shown in figure 2, where A, B, C and D are wireless nodes. The solid lines represent the transmission range of nodes A and D (centered at the nodes) and the dotted lines represent the transmission range of nodes B and C (centered at the nodes). Such an asymmetry in range can result when some nodes (A and D) transmit at the higher power than others (B and C). Answer the questions below, with appropriate justification for the answers.

(a) Suppose node C starts transmission of a broadcast packet. Nodes A, B and D also have their own packets to transmit. If all nodes employ carrier sensing, at this point, which nodes will defer their transmissions and which nodes actually transmit?
(b) Referring to above, given that some other nodes may transmit packets apart from node C, which nodes (among A, B and D) successfully receive the broadcast packet from C?
(c) Suppose A wants to send large amount of data to B. At about the same time, C also wants to send large amount of data to D. Now, suppose the nodes are using ALOHA (do not implement carrier-sensing and transmit data as fast as they can, only limited by the physical capacity of the channel). What is the throughput achieved by the transfer from A toB and the transfer from C to D as a fraction of the wireless channel capacity? Assume that there are no wireless transmission errors.
(d) Referring to above, suppose all nodes employ CSMA (carrier sensing). Now calculate the throughput of A to B and C to D transfers as a fraction of the wireless channel capacity.
(e) Suppose all nodes employ RTS/CTS as well as a random backoff before transmission of any packet. Again calculate the throughput as a fraction of the wireless channel capacity.