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| **El-Minia University**  **Electrical Engineering Department**  **شبكات الاتصالات الكهربية** |  | **Faculty of Engineering**  **2015**  **Electrical Communication Networks** |

**Question 1: (10 Marks)**

1. Consider an application that transmits data at a steady rate (for example, the sender generates an *N*-bit unit of data every *k* time units, where *k* is small and fixed). Also, when such an application starts, it will continue running for a relatively long period of time. Answer the following questions, briefly justifying your answer:
2. Would a packet-switched network or a circuit-switched network be more appropriate for this application? Why?
3. Suppose that a packet-switched network is used and the only traffic in this network comes from such applications as described above. Furthermore, assume that the sum of the application data rates is less than the capacities of each and every link. Is some form of congestion control needed? Why?
4. This elementary problem begins to explore propagation delay and transmission delay, two central concepts in data networking. Consider two hosts, A and B, connected by a single link of rate *R* bps. Suppose that the two hosts are separated by *m* meters, and suppose the propagation speed along the link is *S* meters/sec. Host A is to send a packet of size *L* bits to Host B.
5. Express the propagation delay, *d*prop, in terms of *m* and *s*.
6. Determine the transmission time of the packet, *d*trans, in terms of *L* and *R*.
7. Ignoring processing and queuing delays, obtain an expression for the end-to-end delay.
8. Suppose Host A begins to transmit the packet at time *t* = 0. At time *t* = *d*trans, where is the last bit of the packet?
9. Suppose *d*prop is greater than *d*trans. At time *t* = *d*trans, where is the first bit of the packet?
10. Suppose *d*prop is less than *d*trans. At time *t* = *d*trans, where is the first bit of the packet?
11. Suppose, *L* = 120 bits, and *R* = 56 kbps. Find the distance m *so* that *d*prop equals *d*trans.

**Question 2: (15 Marks)**

1. How does SMTP mark the end of a message body? How about HTTP? Can HTTP use the same method as SMTP to mark the end of a message body? Explain.
2. Suppose you can access the caches in the local DNS servers of your department. Can you propose a way to roughly determine the Web servers (outside your department) that are most popular among the users in your department? Explain.
3. Suppose that your department has a local DNS server for all computers in the department. You are an ordinary user (i.e., not a network/system administrator). Can you determine if an external Web site was likely accessed from a computer in your department a couple of seconds ago? Explain.
4. Consider distributing a file of *F* bits to *N* peers using client-server architecture. Assume a fluid model where the server can simultaneously transmit to multiple peers, transmitting to each peer at different rates, as long as the combined rate does not exceed *us*.
5. Suppose that *us/N* ≤ *d*min. Specify a distribution scheme that has a distribution time of *NF/us*.
6. Suppose that *us/N* ≥ *d*min. Specify a distribution scheme that has a distribution time of *F*/ *d*min.
7. Conclude that the minimum distribution time is in general given by max{*NF/us*, *F*/ *d*min}.

**Question 3: (15 Marks)**

1. Consider distributing a file of *F* bits to *N* peers using a P2P architecture. Assume a fluid model. For simplicity assume that *d*min is very large, so that peer download bandwidth is never a bottleneck.
2. Suppose that *us* ≤ (*us* + *u*1 + ... + *uN*)/*N*. Specify a distribution scheme that has a distribution time of *F/us*.
3. Suppose that *us* ≥ (*us* + *u*1 + ... + *uN*)/*N*. Specify a distribution scheme that has a distribution time of *NF*/(*us* + *u*1 + ... + *uN*).
4. Conclude that the minimum distribution time is in general given by max {*F/us*, *NF*/(*us* + *u*1 + ... + *uN*)}.
5. Suppose that the UDP receiver computes the Internet checksum for the received UDP segment and finds that it matches the value carried in the checksum field. Can the receiver be absolutely certain that no bit errors have occurred? Explain.
6. Host A and B are directly connected with a 100 Mbps link. There is one TCP connection between the two hosts, and Host A is sending to Host B an enormous file over this connection. Host A can send its application data into its TCP socket at a rate as high as 120 Mbps but Host B can read out of its TCP receive buffer at a maximum rate of 50 Mbps. Describe the effect of TCP flow control.
7. Consider the GBN protocol with a sender window size of 4 and a sequence number range of 1,024. Suppose that at time *t*, the next in-order packet that the receiver is expecting has a sequence number of *K*. Assume that the medium does not reorder messages. Answer the following questions:
8. What are the possible sets of sequence numbers inside the sender’s window at time *t*? Justify your answer.
9. What are all possible values of the ACK field in all possible messages currently propagating back to the sender at time *t*? Justify your answer.

**Question 4: (15 Marks)**

1. Consider a router that interconnects three subnets: Subnet 1, Subnet 2, and Subnet 3. Suppose all of the interfaces in each of these three subnets are required to have the prefix 223.1.17/24. Also suppose that Subnet 1 is required to support at least 60 interfaces, Subnet 2 is to support at least 90 interfaces, and Subnet 3 is to support at least 12 interfaces. Provide three network addresses (of the form a.b.c.d/x) that satisfy these constraints.
2. Consider a subnet with prefix 128.119.40.128/26. Give an example of one IP address (of form xxx.xxx.xxx.xxx) that can be assigned to this network. Suppose an ISP owns the block of addresses of the form 128.119.40.64/26. Suppose it wants to create four subnets from this block, with each block having the same number of IP addresses. What are the prefixes (of form a.b.c.d/x) for the four subnets?
3. Consider the following network. With the indicated link costs, use Dijkstra’s shortest-path algorithm to compute the shortest path from *x* to all network nodes.



1. Suppose two packets arrive to two different input ports of a router at exactly the same time. Also suppose there are no other packets anywhere in the router.
2. Suppose the two packets are to be forwarded to two *different* output ports. Is it possible to forward the two packets through the switch fabric at the same time when the fabric uses a *shared bus*?
3. Suppose the two packets are to be forwarded to two *different* output ports. Is it possible to forward the two packets through the switch fabric at the same time when the fabric uses a *crossbar*?
4. Suppose the two packets are to be forwarded to the *same* output port. Is it possible to forward the two packets through the switch fabric at the same time when the fabric uses a *crossbar*?

**Question 5: (15 Marks)**

1. If all the links in the Internet were to provide reliable delivery service, would the TCP reliable delivery service be redundant? Why or why not?
2. Suppose two nodes start to transmit at the same time a packet of length *L* over a broadcast channel of rate *R*. Denote the propagation delay between thetwo nodes as *d*prop. Will there be a collision if *d*prop *< L*/*R*? Why or why not?
3. Why would the token-ring protocol be inefficient if a LAN had a very large perimeter?
4. How big is the MAC address space? The IPv4 address space? The IPv6 address space?
5. What are the two most important network-layer functions in a datagram network? What are the three most important network-layer functions in a virtual circuit network?