UNIVERSITI SAINS MALAYSIA

Second Semester Examination
2013/2014 Academic Session

June 2014

EEE 521/4 – COMPUTER AND DATA COMMUNICATIONS NETWORK

Duration : 3 hours

Please check that this examination paper consists of **SIX (6)** pages printed material before you begin the examination.

Instructions: This question paper consists of **SIX (6)** questions. Answer **FIVE (5)** questions. All questions carry the same marks.

1. (a) A person in Penang wants to communicate with another person in Moscow using a digital circuit-switched network. The path in the circuit-switched network has a data rate of 12 Mbps. An exchange of 1200 bits is required for either request or acknowledgment during the setup and teardown phases. The distance between Penang and Moscow is approximately 8400 km. Let's assume the propagation speed of the signal to be 2×10^8 m/s. What is the total delay if :

   (i) 1000 bits of data are exchanged during the data transfer phase?
   (ii) 100,000 bits of data are exchanged during the data transfer phase?
   (iii) 1,000,000 bits of data are exchanged during the data transfer phase?
   (iv) Find the delay per 1000 bits of data for each of the above cases and compare them. What can you infer?

   (50 marks)

   (b) A system has an *n*-layer protocol hierarchy. Applications generate messages of length *M* Bytes. At each of the *n* layers (including the first and the last), an *h*-Byte header is added. What fraction of the network bandwidth is filled with headers?

   (20 marks)

   (c) What is the total delay (latency) for a frame of size 6 Mega bits that is being sent on a communication path with 7 routers each having a queuing time of 3 μs and a processing time of 2 μs? The total length of the communication path is 8000 km. The propagation speed of the signal is 2×10^8 m/s. Each link in the path has a bandwidth of 6 Mbps. Which component of the total delay is dominant? Which one is negligible?

   (30 marks)

2. (a) State and discuss FOUR important properties of line coding schemes which must be considered while selecting an appropriate line coding scheme for a computer network.

   (40 marks)

   (b) Four channels are multiplexed using TDM. If each channel sends 100 Bytes/s and we multiplex 2 Bytes from each channel to form a frame, determine:

   (i) Size of the output frame
   (ii) Frame rate
   (iii) Duration of a frame
   (v) Bit rate for the link

   (20 marks)

(c) A data word 10011101 is to be transmitted using the standard cyclic redundancy check (CRC) method. The generator polynomial is $x^3 + 1$. Show the actual bit string transmitted. Suppose that the third bit from the left is inverted during transmission. Show how this error can be detected at the receiver's end.

(25 marks)

(d) Explain why collision is an issue in random access protocols but not in channelization protocols?

(15 marks)

3. (a) Draw one flow-diagram for Stop-and-Wait ARQ protocol for the following scenarios :

(i) The first frame is sent but lost.
(ii) The first frame is resent and acknowledged.
(iii) The second frame is sent and acknowledged, but the acknowledgment is lost.
(iv) The second frame is resent and successfully acknowledged.

(25 marks)

(b) A network uses slotted ALOHA protocol to transmit 400-bits frames on a shared channel of 50 kbps. What is the throughput if the system (all stations together) produces

(i) 250 frames per second
(ii) 125 frames per second
(iii) 50 frames per second

(25 marks)

(c) Draw the throughput plots (need not be very precise) for the pure and slotted ALOHA protocols. Discuss their shapes. Which protocol amongst these two yields higher throughput and discuss the reason behind the difference?

(30 marks)

(d) A network using CSMA/CD protocol has a bandwidth of 10 Mbps. If the maximum propagation time (including the delays in the devices) is 25.6 μs, what should be the minimum size of the frame?

(20 marks)

4. (a) An IP datagram has arrived with the following partial information in the header (in hexadecimal) :

$(45000028\ 00010000\ 0106\ldots..)_{16}$

The format of an IP datagram header is shown in Figure 4(a).

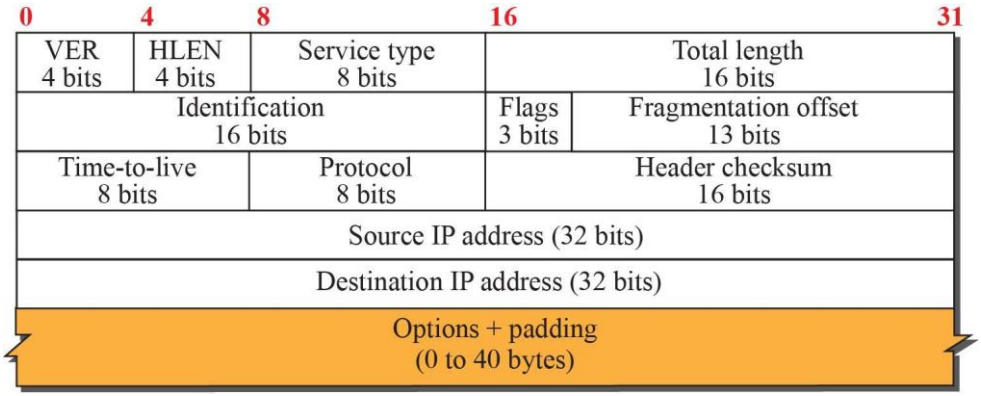

Figure 4(a)

(i) What is the header size?
(ii) Are there any options in the packet?
(iii) What is the size of the data?
(iv) Is the packet fragmented?
(v) How many more routers can the packet travel to?
(vi) What is the protocol number of the payload being carried by the packet?

(45 marks)

(b) Assume a destination computer receives several packets from a source. How can it be sure that the fragments belonging to a datagram are not mixed with the fragments belonging to another datagram?

(15 marks)

(c) Use Dijkstra's algorithm to find the most cost-effective routes from node A to all the other nodes in Figure 4(c). Also, determine the cost of each of these routes.

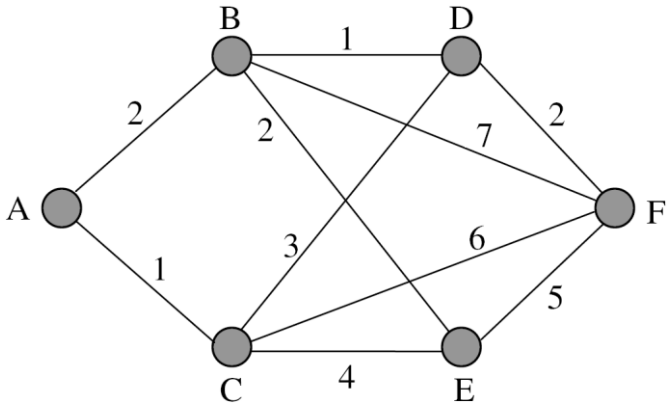

Figure 4(c)

(40 marks)

5. (a) In a network using the Selective-Repeat (SR) protocol with a sending window of size 8, the values of variables are $S_f = 62$, $S_n = 67$, and $R_n = 64$. Packet 65 has already been acknowledged at the sender side. Packets 65 and 66 are received out-of-order at the receiver side.

(i) What are the sequence numbers of pending data packets (in transit, corrupted, or lost)?

(ii) What are the acknowledgment numbers of pending ACK packets (in transit, corrupted, or lost)?

(25 marks)

(b) Design a Selective-Repeat (SR) sliding window protocol for a network in which the bandwidth is 1 Gbps and the average distance between the sender and receiver is 10,000 km. Assume the average packet size to be 25,000 bits and the propagation speed of the signal as 2×10^8 m/s. Find:

(i) The maximum size of the send and receive windows

(ii) The number of bits in the sequence number field (*m*)

(iii) Appropriate time-out value for the timer

(35 Marks)

(c) Describe why an application developer might choose to run an application over TCP rather than UDP? Give an example of application layer protocol which uses the services of TCP.

(20 marks)

(d) Why does UDP exist? Would it not have been enough to just let application *processes* send raw IP packets?

(20 marks)

6. (a) An organization is granted a block of IP addresses with the beginning address 16.12.64.0/23. The organization needs to have 3 subblocks of addresses to use in its three subnets i.e. one subblock of 127 addresses, one subblock of 129 addresses, and one subblock of 57 addresses. Design the three subblocks.

If the organization decides to add another subnet in the future, how many addresses can the new subnet have? What will be the first and last addresses in the subblock allocated to the new subnet?

(45 marks)

(b) Consider an HTTP client that wants to retrieve a Web document at a given URL. The IP address of the HTTP server is initially unknown. Which transport and application layer protocols besides HTTP are needed in this scenario?

(15 marks)

(c) Consider a situation in which a cyber-terrorist makes all the Domain Name System (DNS) servers in the world crash simultaneously. How does this change one's ability to use the Internet?

(20 marks)

(d) Describe how Web caching can reduce the delay in receiving a requested object. Will Web caching reduce the delay for all the objects requested by a user or for only some of the objects? Why?

(20 marks)

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