National University of Computer and Emerging Sciences, Lahore Campus

Course Name:	Computer Networks	Course Code:	CS307
Degree Program:	BS (CS)	Semester:	Fall 2019
Exam Duration:	150 Minutes	Total Marks:	70
Paper Date:	12-Dec-2019	Weight	40
Section:	ALL	Page(s):	6
Exam Type:	Final Exam		

Student : Name:_____ **Roll No.**_____ **Section:**_____

Instruction/Notes:
- Attempt all questions on the provided question paper.
- Even if you use rough sheets, they should NOT be attached with final paper.
- No need to ask questions. If you have confusions, take assumptions where needed.

Question 01: Answer the multiple-choice questions by choosing one option. Fill the provided table with answers. Any answers outside the table will NOT be marked.

1	C	6	A
2	C	7	B
3	A	8	D
4	D	9	C
5	C	10	C

1 Which of the following mapping does Address Resolution Protocol (ARP) provide to the host:
   a. IPv4 to IPv6
   b. Hostname to IP address
   c. IP address to MAC address
   d. MAC address to interface ID

2 Which of the following is NOT an algorithm used to determine the best routing path in computer networks.
   a. Bellman-Ford Algorithm
   b. Dijkstra's Algorithm
   c. Brent's Algorithm
   d. None of the above

3 Which is the following header fields does a router modify while fragmenting an IPv4 packet.
   a. Flag, Identifier, and offset
   b. Header length, offset, and flag
   c. Protocol, header length, and identifier
   d. Destination IP, Source IP, and flag

4 It is possible to detect and correct multiple bit errors on link layer using
   a. CRC
   b. Ethernet
   c. 2-D parity scheme
   d. None of the above

5 Which of the following is NOT a server-side connection state?
   a. SYN_RCVD
   b. ESTABLISHED
   c. TIME_WAIT

d. CLOSE_WAIT

6 Multiplicative decrease in TCP congestion control means
   a. Decrease the congestion window size by half
   b. Decrease the *ssthreshold* value by half
   c. None of the above
   d. Both a & b

7 A TCP connection consists of
   a. 1 socket
   b. 2 sockets
   c. 3 sockets
   d. 4 sockets

8 Which of the following is a stateless protocol?
   a. TCP
   b. GBN (Go-Back-N)
   c. Stop and wait
   d. None of the above

9 The maximum size of an IPv4 header is
   a. 20 bytes
   b. 40 bytes
   c. 60 bytes
   d. minimum 40 bytes

10 Which layer links the network support layers and user support layers
   a. session layer
   b. data link layer
   c. transport layer
   d. network layer

[20 points] Question 2. A certain organization has been assigned a network address block 201.180.128.0/23.

It has been determined that the organization needs:

- 1 network with at least 240 hosts
- 1 network with at least 55 hosts
- 1 network with at least 28 hosts
- 2 networks with at least 15 hosts

a) Design the complete IP addressing scheme for this organization and **fill in the table below**. Show all your work with appropriate comments (if any). **[15 points]**

Table I

Network	**Network Address**	**Subnet mask**	**First available host address**	**Last available host address**	**# of available host addresses**
Network 1	201.180.128.0	/24	201.180.128.1	201.180.128.254	254
Network 2	201.180.129.0	/26	201.180.129.1	201.180.129.62	62
Network 3	201.180.129.64	/27	201.180.129.65	201.180.129.94	30
Network 4	201.180.129.96	/27	201.180.129.97	201.180.129.126	30
Network 5	201.1180.129.128	/27	201.180.129.129	201.180.129.158	30

b) An internet user wants to examine the path that their data packets follow while accessing www.google.com, for which they use *traceroute* network tool. **[5 points]**

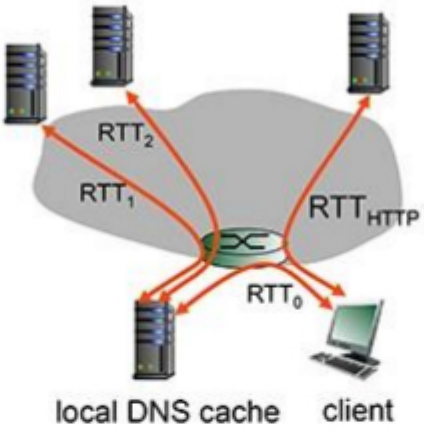
i. What layer-3 *protocol* does *traceroute* use?

ICMP.

ii. Explain (in detail) how *traceroute* uses the available network infrastructure to achieve the desired goal?

3 probes are sent with an increasing TTL value each time to know the number of intermediate nodes between source and destination. This procedure is halted when the probes reach the destination.

[20 points] Question 3: Suppose within your Web browser you click on a link to obtain a Web page. The IP address for the associated URL is not cached in your localhost, so a DNS lookup is necessary to obtain the IP address. Suppose that three DNS servers are visited before your host receives the IP address from DNS. The first DNS server visited is the local DNS cache, with an RTT delay of $RTT_0 = 3$ msecs. The second and third DNS servers contacted have RTTs of 27 and 49 msecs, respectively. Initially, let's suppose that the Web page associated with the link contains exactly one object, consisting of a small amount of HTML text. Suppose the RTT between the local host and the Web server containing the object is $RTT_{HTTP} = 37$ msecs.



1. Assuming zero transmission time for the HTML object, how much time elapses from when the client clicks on the link until the client receives the object?

2. Now suppose the HTML object references 10 very small objects on the same web server. Neglecting transmission times, how much time elapses from when the client clicks on the link until the base object and all 10 additional objects are received from web server at the client, assuming non-persistent HTTP and no parallel TCP connections?

3. Repeat 2. above but assume that the client is configured to support a maximum of 5 parallel TCP connections, with non-persistent HTTP.

4. Repeat 2. above but assume that the client is configured to support a maximum of 5 parallel TCP connections, with persistent HTTP.

Answers:

1.

The time from when the Web request is made in the browser until the page is displayed in the browser is: RTT0 + RTT1 + RTT2 + 2*RTTHTTP = 3 + 27 + 49 + 2*37 = 153 msecs.

Note that 2 RTTHTTPs are needed to fetch the HTML object - one RTTHTTP to establish the TCP connection, and then one RTTHTTP to perform the HTTP GET/response over that TCP connection.

2.

The time from when the Web request is made in the browser until the page is displayed in the browser is: RTT0 + RTT1 + RTT2 + 2*RTTHTTP + 2*10*RTTHTTP = 3 + 27 + 49 + 2*37 + 2*10*37 = 893 msecs.

Note that two RTTHTTP delays are needed to fetch the base HTML object - one RTTHTTP to establish the TCP connection, and one RTTHTTP to send the HTTP request, and receive the HTTP reply. Then, serially, for each of the 10 embedded objects, a delay of 2*RTTHTTP is needed - one RTTHTTP to establish the TCP connection and then one RTTHTTP to perform the HTTP GET/response over that TCP connection.

3.

The time from when the Web request is made in the browser until the page is displayed in the browser is: RTT0 + RTT1 + 2*RTTHTTP + 2*RTTHTTP + 2*RTTHTTP = 3 + 27 + 49 + 2*37 + 2*37 + 2*37 = 301 msecs.

As in 2. above, two RTTHTTP delays are needed to fetch the base HTML object - one RTTHTTP to establish the TCP connection, and one RTTHTTP to send the HTTP request, and receive the HTTP reply containing the base HTML object. Once the base object is received at the client, the maximum of five requests can proceed in parallel, each retrieving one of the 10 embedded objects. Each (in parallel) requires two RTTHTTP delays - one RTTHTTP to set up the TCP connection, and one RTTHTTP to perform the HTTP GET/response for an embedded object. Once these first five objects have been retrieved, the remaining 5 embedded objects can be retrieved (in parallel). This second round of HTTP GET/response to retreive the remaining 5 embedded objects takes two more RTTHTTP delays.

4.

The time from when the Web request is made in the browser until the page is displayed in the browser is: RTT0 + RTT1 + RTT2 + 2*RTTHTTP + RTTHTTP + RTTHTTP = 3 + 27 + 49 + 2*37 + 37 + 37 = 301 msecs.

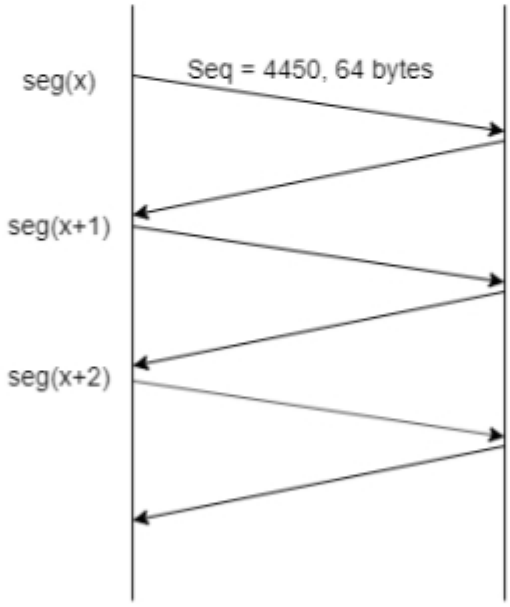
As in 2. and 3. above, two RTTHTTP delays are needed to fetch the base HTML object - one RTTHTTP to establish the TCP connection, and one RTTHTTP to send the HTTP request, and receive the HTTP reply containing the base HTML object. However, with persistent HTTP, this TCP connection will remain open for future HTTP requests, which will therefore not incur a TCP establishment delay. Once the base object is received at the client, the maximum of five requests can proceed in parallel, each retrieving one of the 10 embedded objects. Each (in parallel) requires only one RTTHTTP delay to perform the HTTP GET/response for an embedded object. Once these first five objects have been retrieved, the remaining 5 embedded objects can be retrieved (in parallel). This second round of HTTP GET/response to retreive the remaining 5 embedded objects takes only one more RTTHTTP delays, since the TCP connection has remained open.

[20 points] Question 4: Suppose Node A (sender) and B (receiver) have a TCP connection between them. Assume that a single segment seg (x-1) is timed out. Consider the size of the TCP receiver buffer is 300 bytes. Assuming all

packets of equal size i.e. 64 bytes, if *ssthreshold* = 6, then **answer the following questions in table given below** by looking at the provided figure:

1) Provide
    a. Sequence number of seg (x+2)
    b. Acknowledgement of seg (x+2)
2) Sequence number of bytes of seg (x+4)
3) *Receiver window* field value in acknowledgment of seg (x+3)
4) *Receiver window* field value in acknowledgement of seg (x+4)
5) Value of *window size* and *ssthreshold* after acknowledgement of seg (x+6) is received?
6) TCP receiver sometimes waits for 500ms before sending an acknowledgement of a newly arrived segment. For how long will receiver wait before sending ack for seg (x+4)?
7) Assuming seg (x) to be sent in the first transmission round, how many segments will be sent in the third transmission round?
8) Assume no loss occurs, what will be the last segment that will be sent in the *slow start* phase starting from seg(x)?
9) What is the link utilization during the *slow start* phase if the link capacity is 10 Mbps and the RTT between node A and B is 15ms?
10) Suppose after receiving 50 segments from the source, node B lost synchronization with A. Write the name and value of the field used by destination B to notify source node A.

NOTE: Answer all numbers in decimal number system ONLY (where applies). For segment numbers, use the notation of seg(x) where *x* is the number of a segment.



#	Answers	Points
1	(A) 4578 (B) 4386	2
2	(A) Starting byte number: 4386 Ending byte number: 4449	2
3	44	2
4	300	2
5	Window size: 6 ssthreshold: 6	4

6	It will not wait and send ack 4706	2
7	4	2
8	Seg(x+12)	2
9	(A) Formula used = $\frac{L/R}{RTT+L/R}$ Input values: $\frac{13*64*8/10Mbps}{15ms+64*8/10Mbps}$	2
	(B) Final answer after calculation = 0.044.	2
10	RST bit = 1	2