


# 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		

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- 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	D ✗
2	C ✓	7	B ✓
3	A ✓	8	D ✓
4	C ✗	9	C ✓
5	D ✗	10	C ✓

$$\frac{8-1}{10} = 7$$

- Which of the following mapping does Address Resolution Protocol (ARP) provide to the host?
  - IPv4 to IPv6
  - Hostname to IP address
  - IP address to MAC address
  - MAC address to interface ID
- Which of the following is NOT an algorithm used to determine the best routing path in computer networks.
  - Bellman-Ford Algorithm
  - Dijkstra's Algorithm
  - Brent's Algorithm
  - None of the above
- Which is the following header fields does a router modify while fragmenting an IPv4 packet.
  - Flag, Identifier, and offset
  - Header length, offset, and flag
  - Protocol, header length, and identifier
  - Destination IP, Source IP, and flag
- It is possible to detect and correct multiple bit errors on link layer using
  - CRC
  - Ethernet
  - 2-D parity scheme
  - None of the above
- Which of the following is NOT a server-side connection state?
  - SYN\_RCVD
  - ESTABLISHED
  - TIME\_WAIT



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[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]

Network	Network Address	Subnet mask	First available host address	Last available host address	# of available host addresses
Network 1	201.180.128.0/24 ✓	255.255.255.0/24	201.180.128.1	201.180.128.254 ✓	254 hosts 1 network 2 broadcast
Network 2	201.180.129.0/26 ✓	255.255.255.192/26	201.180.129.1	201.180.129.62 ✓	62 hosts
Network 3	201.180.129.64/27 ✓	255.255.255.224/27	201.180.129.65	201.180.129.94 ✓	30 hosts
Network 4	201.180.129.96/28 ✓	255.255.255.240/28	201.180.129.97	201.180.129.126 ✓	30 hosts
Network 5	201.180.129.128/28 ✓	255.255.255.240/28	201.180.129.129	201.180.129.158 ✓	30 hosts

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

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

✓ Tracert uses ICMP protocol of Layer -3.

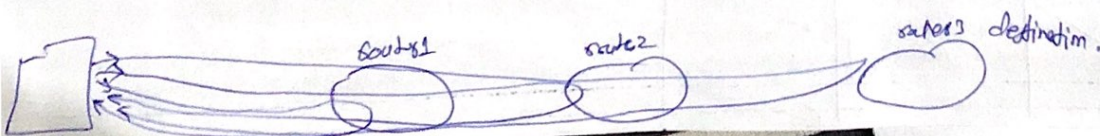
ii. Explain (in detail) how *tracert* uses the available network infrastructure to achieve the desired goal?

→ At start *tracert* sets TTL to 1.  
 → When it reaches 1<sup>st</sup> router,  
 → An ICMP message is created with value 11 and code 0.  
 → It is sent back to host and time is noted and TTL is increased by 1.  
 → When the packet reaches the destination router and port is not available, it generates ICMP message with value 3 code 3, telling "destination port not reachable".  
 → Every ICMP message also contains first 5 bytes of IP datagram.

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→ TTL shows no. of routers visited / to be visited during *tracert*.





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[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 local host, 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.

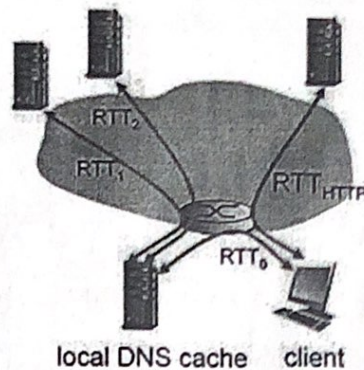
$n=3$  DNS servers

$$RTT_0 = 3$$

$$RTT_1 = 27$$

$$RTT_2 = 49$$

$$RTT_{HTTP} = 37 \text{ msec}$$



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.  $\text{Time} = \text{IP lookup} + \text{HTTP request for connection}$   
to establish connection  
 $= [RTT_0 + RTT_1 + RTT_2] + [RTT_{HTTP}]$

$$= [3 + 27 + 49] + [37]$$

$$= 79 + 37$$

$$\boxed{\text{Time} = 116 \text{ msec}}$$
  
to establish connection.

$$\text{Total Time} = \text{Connection establish} + \text{Object received}$$

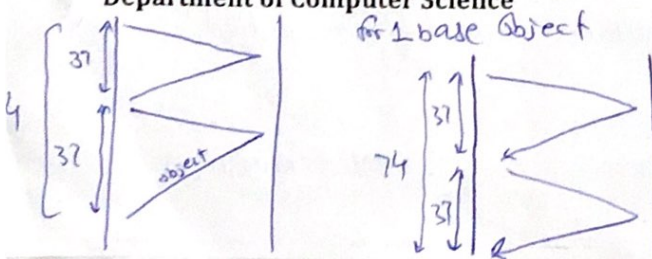
$$= 116 + 37$$

$$\boxed{\text{Total Time} = 153 \text{ msec}}$$

2.

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for 10 base obj no parallel  
 $10 \times 74 = 740$



$$\begin{aligned}
 \text{Total Time} &= \text{IP Lookup} + \text{connection} + \text{base Object} + 10[\text{connection} + \text{additional obj}] \\
 &= \{3 + 27 + 49\} + \{37\} + \{37\} + 10\{37 + 37\} \\
 &= \{79\} + \{74\} + 10\{74\} \\
 &= 153 + 740 \\
 \boxed{\text{Total time} &= 893 \text{ msec}}
 \end{aligned}$$

3. additional Object connection =  $\frac{10}{5} = 2$

$$\begin{aligned}
 \text{Total time} &= \{\text{base Object}\} + 2[\text{additional Objects}] \\
 &= \{\text{IP Lookup}\} + \{2RTT_{\text{HTTP}}\} + 2\{2RTT_{\text{HTTP}}\} \\
 &= 153 + 2\{74\} \\
 &= 153 + 148 \\
 \boxed{\text{Total time} &= 301 \text{ msec}}
 \end{aligned}$$

4.

$$\begin{aligned}
 \text{Total time} &= \text{IP Lookup} + \text{base Object} + 2[\text{additional Object}] \\
 &= 79 + 74 + 2\{37\} \\
 &= 153 + 74 \\
 \boxed{\text{Total Time} &= 227 \text{ msec}}
 \end{aligned}$$

**[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 packets of equal size i.e. 64 bytes, if ssthreshold = 6, then answer the following questions in table given below 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 acknowledgment of seg (x+4)
- 5) Value of window size and ssthreshold after acknowledgment of seg (x+6) is received?
- 6) TCP receiver sometimes waits for 500ms before sending an acknowledgement of a newly arrived segment. 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.