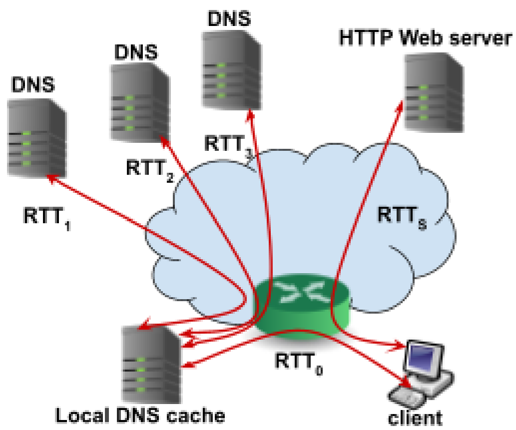
Roll. No.: _______________ Name: _________________________________ Section: ____

CSE232: Computer Networks
Midsem Monsoon 2023 (SOLUTIONS)
Total marks: 31
Duration: 60 mins (10.00 am to 11 am)

Instructions:

(1) Write your Roll. No. and Name on each sheet.
(2) Read the questions carefully and answer.
(3) Answer in brief and to the point as much as possible.
(4) Answer up to 2-point decimal for numerical.

Q.1. Suppose within your Web browser (on client) 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. **[Total: 6 marks]**



Suppose that **four 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 = 2 ms**. The local DNS server uses iterative query resolution to resolve the query via the rest of the three DNS servers. Assume the RTT from the Local DNS to the rest is equal.

$$RTT_1 = RTT_2 = RTT_3 = 20 \text{ ms}$$

Ignore transmission and queueing delays while answering the following questions.

(a) How much time (in msec) elapses from when the client clicks on the link until the client receives the IP address of the associated URL? **[1]**

Ans.

IP resolution time = $RTT_0/2 + RTT_1 + RTT_2 + RTT_3 + RTT_0/2$ = 1 + 20*3 +1 **= 62 ms**

(b) Suppose that the Web page associated with the link contains exactly one base object, consisting of a small amount of HTML text. Suppose the RTT between the client and the HTTP Web server containing the object is **RTT_S = 10 ms**. How much time (in msec) elapses from when the client clicks on the link until the base object is received from the web server at the client, assuming non-persistent HTTP and no parallel TCP connections? **Assume small object size; ignore time to transfer object from server to the client. [1]**

Ans.

Time elapsed = IP resolution time + Time to receive the base object

Time to receive the base object does not depend on whether the HTTP connection is persistent or not.

Time to receive the base object = RTT to setup TCP connection + RTT for HTTP Get/Response to retrieve the object = RTT_S + RTT_S + object transfer time = **20 ms**

(c) **Given the base object is already received** at the client (as said in part b), how much time (in msec) is taken to **receive 10 additional objects from the same web server** at the client, for the following cases (**Assume small object size; ignore time to transfer object from server to the client).**

(i) non-persistent HTTP and no parallel TCP connections? **[1]**

Ans.

Elapsed time = 10 * (TCP connection time + HTTP Get/Response + object transfer time)

= 10 * (2 * RTT_S) = **200 ms**

(ii) non-persistent HTTP and 5 parallel TCP connections? **[1]**

Ans.

Elapsed time = 2 * (TCP connection time + HTTP Get/Response + object transfer time)

= 2 * (2 * RTT_S) = **40 ms**

(iii) persistent HTTP and 5 pipelines supported? **[1]**

Ans.

Elapsed time = Num_objects/Num_pipelines * (HTTP Get/Response + object transfer time)

= 10/5 * (RTT_S) = **20 ms**

(d) How much time (in msec) elapses from when the **client clicks on the link** until all **11 objects (including the base object)** are received at the client, assuming non-persistent HTTP and no parallel TCP connections? **[1]**

Ans.

Elapsed time = Answers (a) + (b) + (c)(i) = 62 + 20 +200 = **282 ms**

Q.2. The figure shown below shows the TCP client and TCP server communication. The socket primitives show the details about each socket at the client processes (*left and right machines*) and the server processes (center machine). **[Total: 5 marks]**

(a) What are the source port and destination port numbers for packets A, B, C, and D shown in the figure? Carefully look at the packet direction. **[2]**

Answer in this format: Packet A (<src_port>, <dest_port>)

Ans.

Packet A (6771, 5910), Packet B (5910, 6771), Packet C (6853, 5910), Packet A (5662, 5910),

(b) Can the ***client on the left*** create a socket binded to port address 6853? Why? **[1]**

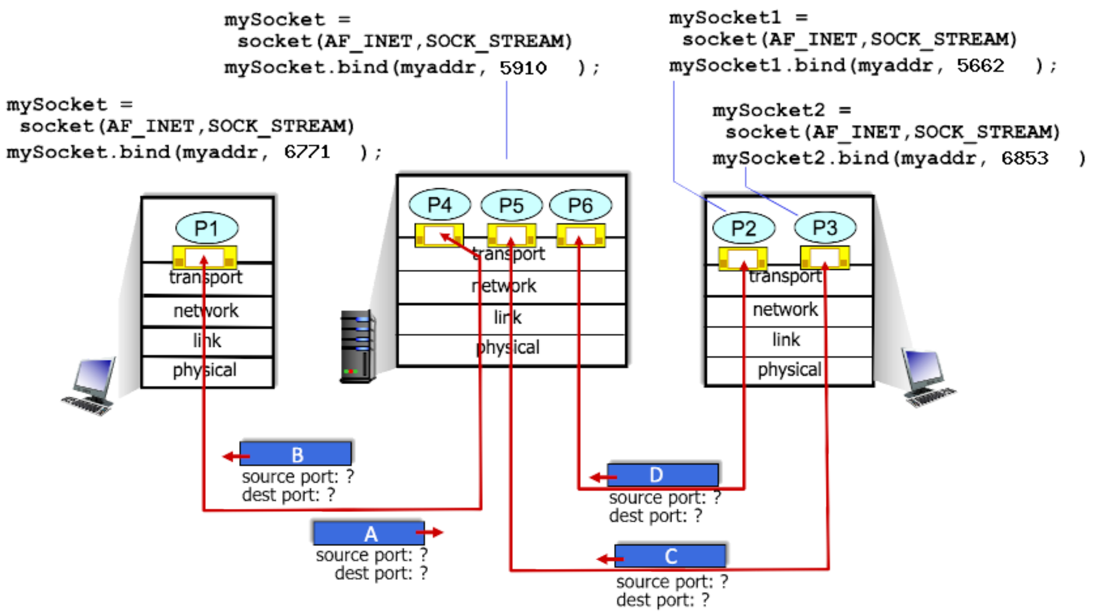
Ans. Yes, port address has to be unique within a node/machine

(c) Can the ***client on the right*** create another socket binded to port address 6853? Why? **[1]**

Ans. No, port address has to be unique within a node/machine

(d) How does the server's TCP protocol distinguish the received packets? Consider all possible packets that the server can receive; do not restrict yourself with the examples in the figure. **[1]**

Ans. TCP uses the four tuple, <source IP, source port, destination IP, destination port>, as the connection identifier.



Q.3. Suppose you are allowed to use the following command line utilities

ifconfig, ping, traceroute, netstat, nslookup, dig

Tell us which of the above utilities can be used for the following. There can be more than one correct answer; in that case list at least TWO. **[Total: 4 marks]**

(a) You have written a TCP client and a TCP server program. You executed the TCP server program but the TCP client is unable to connect with the server's port. You want to check if the TCP server socket is listening at the given port number. **[1]**

Ans. netstat

(b) Given the IP address of a host, you want to know its domain name. **[1]**

Ans. nslookup, dig

(c) Your Internet is not working and you want to find out the reason. **[1]**

Ans. ping, traceroute, netstat

(d) The IT department has asked you to provide your laptop's MAC address to allow Internet access. **[1]**

Ans. ifconfig

Q.4. Which of the following statements are **TRUE**? — can be more than one **[1]**

(A) SMTP is a push-based protocol, and POP3 is a pull-based protocol.

(B) FTP does not guarantee reliable file transfers; it provides best-effort service.

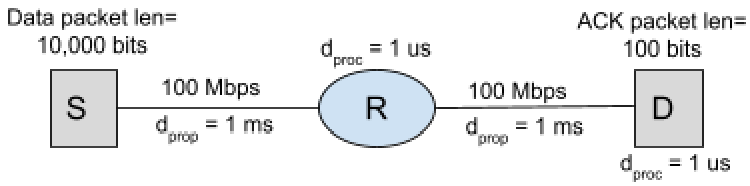
(C) It is possible that a DNS query may return a stale IP address for a domain name request.

(D) In case of a peer-to-peer architecture, the communication fails if one of the peer fails.

Ans. (A) and (C)

Q.5. A sender (S) and a receiver (R) are connected via a router (R) as shown in the figure. The communication link rates between S– R and R–D is 100 Mbps. Assume link propagation delays

between S–R and R–D, d_{prop} = 1 millisec); and processing delays at R and D, d_{proc} = 1 microsec. The sender sends 10K bits packets. The receiver sends 100 bits ACKs.
[Total: 6 marks]



(a) Calculate data packet transmission time (d_trans_packet) and ACK transmission time (d_trans_Ack) **in microsec**. [Transmission time = time required for the sending device to place the packet on the transmission channel.] **[0.5 + 0.5]**
Ans.
d_trans_packet=L/R=(10^4)/10^8=100us,
d_trans_Ack=100/10^8=1us,

(b) What is the throughput if the sender sends 1 packet and waits for an ACK? **[3]**
Ans.
d_trans_packet= d_trans_packet(router) = 100us
d_trans_Ack= d_trans_Ack(router) = 1us
d_prop=1000us
d_proc=1us

D1 = Time to data packet to reach from S to D =
d_trans_packet + d_prop + d_proc + d_trans_packet(router) + d_prop + d_proc
= 100+1000+1+100+1000+1 = **2202 us [1 mark]**

D2 = Time to ACK packet to reach from D to S =
d_trans_ACK + d_prop + d_proc + d_trans_ACK(router) + d_prop
= 1+1000+1+1+1000 = **2003 us [1 mark]**

Throughput = L / (D1+D2) = (10^4) / (2202+2003)*10^(-6) = **2.37 Mbps [1 mark]**

(c) To achieve the maximum throughput, what should be the optimal number of packets that should be sent before waiting for an acknowledgment? **[2]**
Ans.
To maximize throughput, the optimal number of packets sent before waiting for an ACK indicates the number of bits that should be sent to FILL THE PIPE between the sender and the receiver. This is given by the **Bandwidth-Delay Product (BDP)**.
In this context, **BDP = Bandwidth * Round trip time**. **[0.5 mark]**
The round trip time refers to the time to send the first bit from the sender and receive the ACK back; i.e., **RTT= D1 + D2 = 4205 us**
Bandwidth = 100 Mbps
BDP = 10^8 * 4205 * 10^(-6) = 420.5 Kbits; **[1 mark]**

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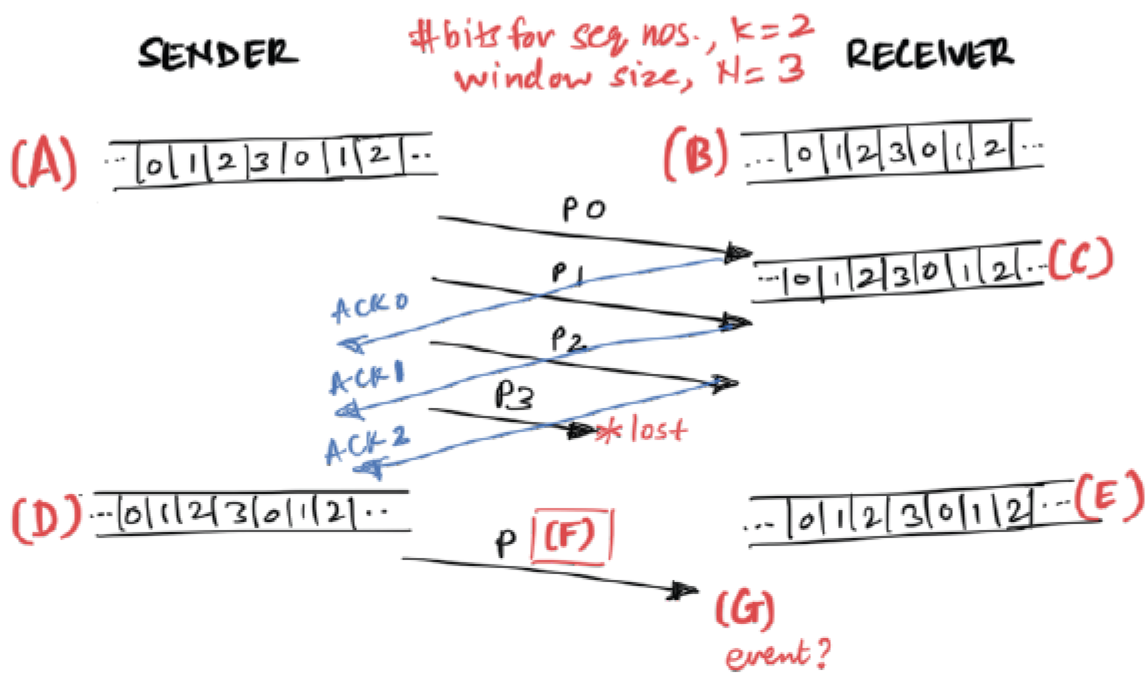
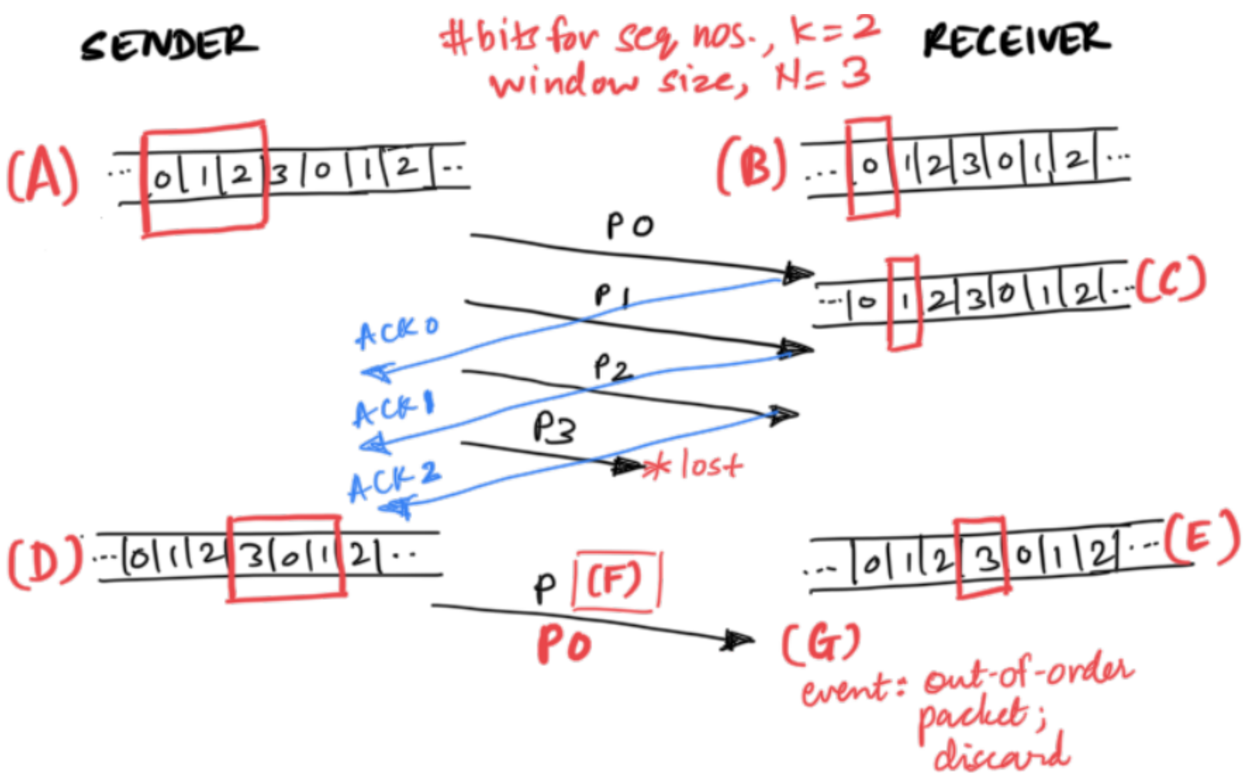
Num_packets= 420.5Kb/10Kb = 42.05 packets **[0.5 mark]**
Consider the answers 42 packets or 43 packets or 42.05 packets

Q.6. Consider the following timing diagram where reliable data transfer protocol **Go-back-N (receiver window size = 1)** is used. Suppose that the **sender window size, N=3,** and two bits are used to represent sequence numbers (**k=2**). The sender sends **3 packets** after which the fourth packet, **P3 is lost**. Assume that the **sender sends a packet, P_i**, and the **receiver sends an acknowledgment, ACK_i**, to acknowledge receipt of P_i. **[Total: 8 marks]**

(a) Complete the timing diagram by showing the instantaneous sender/receiver windows for (A) to (E) in the figure. **[5]**
(b) Assuming that the timer at the sender does not expire, what is the packet sequence number for (F)? **[1]**
(c) What will the receiver do once it correctly receives the packet (answered in (b)), i.e., complete (G)? **[1]**
(d) There is a conceptual problem if you were asked to solve the exactly same question for **Selective Reject**. Explain what is wrong. **[1]**



Ans.
(a) (b) (c)



(d) The sender window size for selective repeat should be half the number of possible sequence numbers to ensure reliable data transfer. i.e., N = 2^(k-1) = 2

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