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Endsem
CSE232 Computer Networks
Duration-2 hours, Full marks-

December 9, 2023

Q.1. Match the columns **[3]**

(1) Data link layer	(a) can provide guarantees for bound on delays
(2) Network layer	(b) performs caching
(3) Transport layer	(c) ensures process to process communication
	(d) uses CRC for error detection

(1) ________ (2) __________ (3) _________

Ans. (1) __(d)__ (2) _(a)__ (3) __(c)__

Q.2. Suppose the server-to-client HTTP RESPONSE message is the following.

```
HTTP/1.0 404 Not Found
Date: Thu, 07 Dec 2023 03:53:29 +0000
Server: Apache/2.2.3 (CentOS)
Content-Length: 254
Connection: Close
Content-type: image/html
```

Answer the following questions **[0.5+0.5+0.5=1.5]**

(a) Was the server able to send the document successfully? Yes or No
(b) Is the connection persistent or nonpersistent?
(c) What is the name of the web server?

Ans:

(a) No
(b) Non-persistent
(c) Apache web server; version 2.2.3

Q.3. A browser generates a DNS request for **columbia.edu,** and the browser cache does not contain the IP address. Suppose the **client DNS uses recursive query** whereas **all other DNS servers use iterative query**. Specify the path followed by the DNS request from the client browser until the IP address of the URL is received by the client browser in the following format "client -> ___ -> ….___ ->client" under the following conditions. **[1+2+1=4]**

(a) The local DNS server contains **columbia.edu** IP address in its cache.
(b) The client browser uses an iterative query, and the local DNS server DOES NOT contain **columbia.edu** IP address in its cache.

(c) Which type of query is considered best practice: iterative or recursive? Why?

Ans.

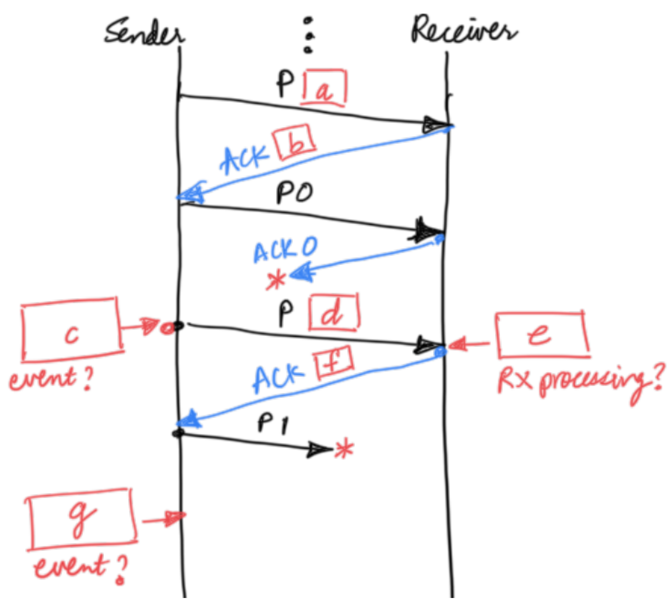
(a) client -> local DNS server -> client

(b) client -> local DNS server -> Root DNS server -> local DNS server -> TLD DNS server -> local DNS server -> Authoritative DNS server -> local DNS server -> client

(c) An iterative query is considered best practice because it puts less strain on the Root and TLD DNS servers

Q.4. Consider a reliable data transfer protocol that implements the **Stop and wait** mechanism. The **sender sends a packet, P_i**, where "i" is the sequence number, and the **receiver sends an acknowledgment, ACK_i**, to acknowledge receipt of P_i. No packet losses or errors occur except those explicitly shown in the figure using the * mark.

The figure shows the communication snapshot. Provide sequence numbers for (a), (b), (d), and (f). Specify the event that occurs at the sender for (c) and (g), and specify the action taken by the receiver for (e). Assume no other events occur or packets sent/received except those shown. **[0.5 * 7 = 3.5]**



Ans.

(a) 1

(b) 1

(c) Timer expires OR timeout

(d) 0

(e) Out-of-order packet detected; packet is discarded by the receiver

(f) 0

(g) Timer expires OR timeout

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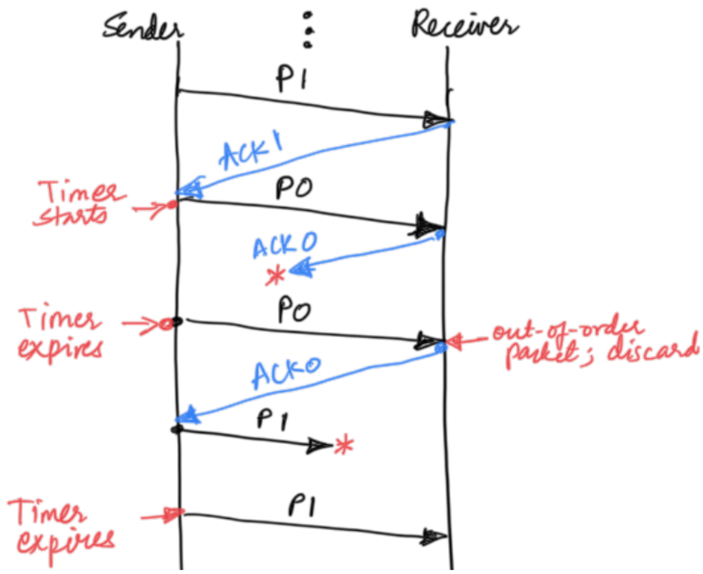

Q.5. "A" and "B" are the endpoints of a TCP connection. "A" initiates the connection (i.e., client), and "B" accepts the connection (i.e., server). The table below shows the TCP header field & flag values. Do not care about the fields whose values are not mentioned.
Identify the packet type (i.e., Data, Data+ACK, Connection establishment request, etc.) and the packet sender. The sender could be A, B, A or B. [0.5 * 8 = 4]

TCP header values	Packet type	Sender
(a) SYN bit = 1, ACK bit = 1		
(b) SYN bit = 0, ACK bit = 1, packet length = 0		
(c) SYN bit = 0, ACK bit = 1, packet length = 1000		
(d) FIN bit =1, ACK bit = 0		

Ans.

TCP header values	Packet type	Sender
(a) SYN bit = 1, ACK bit = 1	Connection request/establishment acknowledgement	B
(b) SYN bit = 0, ACK bit = 1, packet length = 0	Acknowledgment	A or B
(c) SYN bit = 0, ACK bit = 1, packet length = 1000	Data + ACK	A or B
(d) FIN bit =1, ACK bit = 0	Connection termination request	A or B

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Q.6.

Three routers are connected via a store-and-forward packet switch with **1 Mbps** links. Each link is **100 km** long and supports **a signal speed of 2x10^8** meters per second. The size of a packet is **10K bits**. **Ignore processing delays at the router and both the hosts. [1+1+1+1+2 = 6]**

(a) Compute frame transmission time
(b) Compute propagation delay
(c) What is the time elapsed between the transmission of the first bit of the packet at S and the reception of the last bit of the packet, at D?
(d) We want to continuously send 1000 packets. What is the time elapsed between transmitting the first bit of the first packet at S and the reception of the last bit of the last packet at D?
(e) The protocol requires the sender to receive an ACK after sending every 1000 packets. There are no losses/errors, and the size of **ACK packet is 1000 bits**. What is the maximum achievable throughput?

Ans:
L=10K bits, R=1 Mbps, Link_length, l =100 km, Signal speed, s = 2x10^8 m/s, d_proc=0

(a) d_trans (10K bit packet) = L/R = 10 ms
(b) d_prop= l/s = 0.5 ms; [d_prop*4 = 2 ms allowed if you find the prop delay from S to D]
(c) t(S to D) = (d_trans+d_prop) + (d_proc+d_trans+d_prop)* 3
= 10.5 +10.5*3
= 42 ms
(d) t(S to D) = (1000 * d_trans + d_prop) + (d_proc+d_trans+d_prop)* 3
= (1000*10.5) + 10.5*3
= 10531.5 ms
(e) d_ACK=1000/10^6 =1 ms **[0.5]**
t(D to S) = (d_ACK+d_prop) + (d_ACK+d_prop)* 3 = 1.5*4 = 6 ms **[0.5]**
Maximum achievable throughput = Total data sent/Total Time taken **[1]**
= (1000*10K)/((10531.5+6)*10^(-3))
= **948.99 Kbps**

Acceptable answers: 948Kbps, 949Kbps, 948.99Kbps

Q.7. Consider the router is attached to three subnets, viz., A, B, and C. The administrator has assigned the prefix **10.179.124.0/24** to this network. You must provision IP addresses for **99, 30, and 28 hosts** to the subnets A, B, and C, respectively. What should be the **network addresses** and the **host IP address range with CIDR notation** for A, B, and C so that there is **minimal wastage of IP addresses**? Assign the addresses in the order, subnet A, B, and C. Note that the range should not include network/broadcast addresses. **[2+2+2 = 6]**

Ans:
Subnet A: #hosts=99; #host bits, n=7
Subnet B: #hosts=30; #host bits, n=5
Subnet C: #hosts=28; #host bits, n=5

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Subnet A: 10.179.124.1/25 to 10.179.124.99/25 **[1+1]**
Subnet B: 10.179.124.129/27 to 10.179.124.158/27 **[1+1]**
Subnet C: 10.179.124.161/27 to 10.179.124.188/27 **[1+1]**

Alternative solution
Subnet A: 10.179.124.1/25 to 10.179.124.127/25
Subnet B: 10.179.124.129/27 to 10.179.124.158/27
Subnet C: 10.179.124.161/27 to 10.179.124.190/27

Note: If CIDR notation not specified, deduct 1 mark

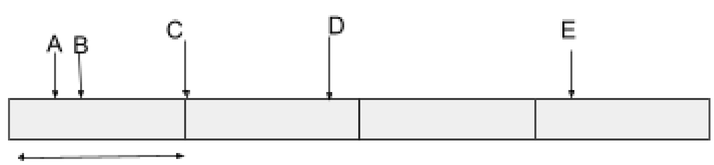
Q.8. Suppose a router fragments an IPV4 packet whose size including 20 bytes of IP header is 2000 bytes, i.e., packet data is 1980 bytes. The link MTU is 420 bytes. **[2+1+1]**

(a) How many fragments will this router create? Justify your answer.
(b) What is the size of the last fragment (in bytes)?
(c) Given that the MF(More fragments) flag of the packet fragmented by this router was "1", what can you comment about the MF flag for the fragments created by this router?

Ans:

(a) Every fragment includes the IP header, so maximum data per fragment = 420 - 20 = 400 bytes.
Packet data = 1980 bytes; Num fragments = 1980/400 = 4.95 = **5 fragments**
Note that if you divide by 420, marks will not be awarded
(b) Last fragment size = 380 bytes **(Though incorrect, "400" will be allowed only if you specify that IP header is included)**
(c) Since the original packet was NOT the last fragment, none of the fragments would the last fragments, i.e. the MF flag for all fragments would be "1"

Q.9. Suppose two kinds of medium access control techniques are implemented, Pure Aloha and Slotted Aloha. The figure shows the timeline with each slot equal to the frame transmission time. Points A to E show the time when a device attempts to transmit, and the decision to transmit depends on the access control technique used. **[1+1=2]**



Each time slot = frame transmission time

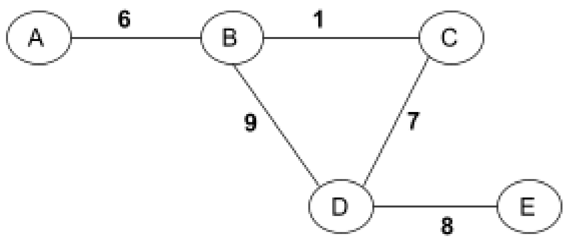
(a) Given that Pure Aloha is implemented, specify the transmission attempts from A to E when the frame will collide.
(b) Given that Slotted Aloha is implemented, specify the transmission attempts from A to E when the frame will collide.

Ans:

(a) A, B, C, D

(b) A, B, C (since A & B will wait for the next start of the slot)

Q.10. Consider the network topology shown in the figure below. We have 5 routers, A to E, and the edge weights represent the same cost in both directions. Assume Distance Vector Routing (DVR) is used. **[2.5+4+1 = 7.5]**



(a) Assuming that the routes have converged, show the distance vector shared by router C with the neighbors.

(b) The distance vector state at the routers is shown in the figure. Assume that the link cost, BC, changes to 20. After this update, without sharing the distance vectors, the routers execute DVR algorithm. Show the new routing table generated at routers B and C.

Router B's state

cost to → / from ↓	A	B	C	D	E
A	0	6	7	14	22
B	6	0	1	8	16
C	7	1	0	7	15
D	14	8	7	0	8

Router C's state

cost to → / from ↓	A	B	C	D	E
B	6	0	1	8	16
C	7	1	0	7	15
D	14	8	7	0	8

(c) Will this example have a count-to-infinity problem? Justify your answer using what you observe in (b)'s answer.

Ans:

Below are the routing tables at each router after the routes have converged.

NOT NEEDED IN ANSWER; ADDED FOR UNDERSTANDING THE SOLUTION

Routing table: A			Routing table: B			Routing table: C			Routing table: D			Routing table: E		
Dest	Cost	Next hop	Dest	Cost	Next hop	Dest	Cost	Next hop	Dest	Cost	Next hop	Dest	Cost	Next hop
A	0	NA	A	6	A	A	7	B	A	14	C	A	22	D
B	6	B	B	0	NA	B	1	B	B	8	C	B	16	D
C	7	C	C	1	C	C	0	NA	C	7	C	C	15	D
D	14	B	D	8	C	D	7	D	D	0	NA	D	8	D
E	22	B	E	16	C	E	15	D	E	8	E	E	0	NA

(a) **Deduct 0.5 marks if “next hop” is shown in the table**

Dest	Cost
A	7
B	1
C	0
D	7
E	15

(b)

Solution:

Router B's state

Neighbor cost		A	B	C	D	E
6	A	0	6	7	14	22
	B	6	0	13	9	17
20	C	7	1	0	7	15
9	D	14	8	7	0	8

Router C's state

Neighbor cost		A	B	C	D	E
20	B	6	0	1	8	16
	C	21	15	0	7	15
7	D	14	8	7	0	8

(c) Yes. Cost from B to C in B’s routing table is incorrect. Cost form C to A and C to B are incorrect. These incorrect entries will take a long time to converge.

At least one example is expected

Q.11. The figure shows the TCP congestion window (cwnd) when TCP Reno is used as the congestion control algorithm. The initial slow start threshold value is 1 MSS. **[2+2]**

(a) Identify the ongoing congestion control phase between the following points:
(i) A to P, (ii) P to B, (iii) C to D, and (iv) E to F

(b) What event must have occurred at points
(i) P (ii) D

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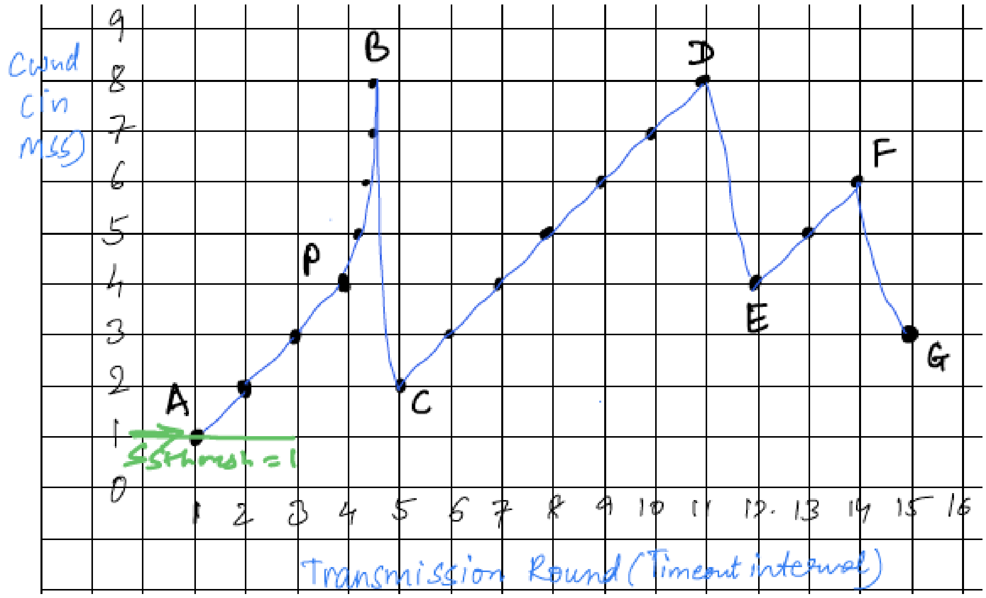
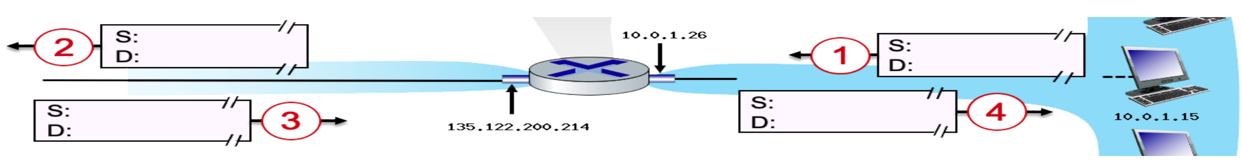


Ans:

(a) Identify the ongoing congestion control phase between the following points:
 (i) A to P: congestion avoidance,
 (ii) P to B: fast recovery,
 (iii) C to D: congestion avoidance,
 (iv) E to F: congestion avoidance

(b) What event must have occurred at points
 (i) P: Three Duplicate ACKs
 (ii) D: Timeout OR Three Duplicate ACKs

Q.12. Figure shows the communication between the client machines within the LAN and the server machine on the WAN (Internet). As shown in the figure, the server IP address is 130.1.1.1, the client IP address is 10.0.1.15, and the router IP addresses are 10.0.1.26 and 135.122.200.214
The router implements NAT (Network Address Translation).
Fill out the source and destination IP addresses for packets shown from (1) to (4). **[4]**



Ans:

Source IP	Destination IP
(1) 10.0.1.15	130.1.1.1
(2) 135.122.200.214	130.1.1.1

(3) 130.1.1.1	135.122.200.214
(4) 130.1.1.1	10.0.1.15

------------------*THE END*------------------