

Endsem

1. Suppose a web server listening on port 80, has 500 ongoing TCP connections with clients.
 - a. **(0.5M)** How many server-side sockets are used?
 - b. **(0.5M)** How many server-side port numbers are used?
2. A ping between host A to host B connected directly, resulted in a ping time of 10ms for a small packet (64byte) and 12 ms for a large packet (1500bytes). Ignore processing delay and assume ping reply is the same size as ping request.
 - a. **(0.5M)** What is the propagation delay of this link in ms? Format X (e.g. 12)
 - b. **(0.5M)** What is the transmission rate of this link in Mbps? Format X.x (e.g. 7.4)
3. **(1M)** If a cable suffers 1dB attenuation per 100m and if the transmit power is 100mw. What is the received power in mW if the cable length is 2km? Format X (e.g. 6)
4. Consider a new encoding scheme very similar to 4B/5B, where the first four bits of the data are sent unchanged and the 5th bit is always set as "1". E.g. If the input data is 1101, output is 11011.
 - a. **(0.5M)** What is the efficiency of this scheme in percentage? Format X (e.g. 40)
 - b. **(1M)** How many maximum consecutive zeros are possible in the output sequence when using this scheme? Format X (e.g. 10)
5. **(1.5M)** A sysad is coding up NAT protocol and has forgotten to modify some header fields after NAT operation. In this case which of the following header fields can be a source of problem: TCP checksum; IP checksum; Ethernet CRC. Explain why or why not?
6. **(1M)** The Ethernet adaptor for node A hears a frame on the wire and then passes it up to host A. Which of the following are legitimate reasons for the adaptor passing the packet to the host (list all that are legitimate):
 - The adaptor was in promiscuous mode.
 - The destination MAC address was a multicast group to which A belonged.
 - The frame's CRC was damaged.
 - The destination MAC belongs in the same LAN segment as host A.
 - The destination MAC address matched that of the adaptor
 - The destination MAC address was the broadcast address

7. **(1M)** Alice uses a web-based email account to send an email to Bob who is a nomadic user who often accesses email from different devices. Which protocol does Alice use and which protocol does Bob use respectively? Select all that apply.
- (HTTP, SMTP)
 - (HTTP, POP3)
 - (SMTP, POP3)
 - (HTTP, IMAP)
 - (IMAP, SMTP)
 - (POP3, IMAP)
 - (SMTP, IMAP)
8. **(1M)** Suppose a sender using the CRC generator polynomial $x^5 + x^3 + x + 1$ needs to send the bits 11011010100. What bits are actually transmitted on wire? Example: 0011010100 or 001110
9. **(1M)** Consider a CSMA/CD network running in bus topology at 10 Mbps over 2-km cable with no repeaters. The signal speed in the cable is 200,000 km/sec. Suppose a station starts transmitting a frame of size 1K bytes at time T. Which of the following is true? Select all that apply.
- The station can detect a collision at time T+7 micro seconds if there was no collision detected between time T and T+7
 - The station can detect a collision at time T+16 micro seconds if there was no collision detected between time T and T+16
 - The station can detect a collision at time T+25 micro seconds if there was no collision detected between time T and T+25
 - The station can detect a collision at time T+37 micro seconds if there was no collision detected between time T and T+37
10. A certain router B in a network receives the following link state updates from other nodes in the same network.

Update from	Sequence#	Neighbor/cost
C	5	B/8, A/4
A	20	B/2, C/4, G/10
C	10	B/10, A/4
F	50	B/1, G/6
G	100	F/6, A/10

- a. **(1M)** Show the network topology, with nodes, edges and link costs, as constructed by B after it receives the above link state packets.

- b. **(2M)** Suppose that the A—B link goes down. Say, A and B quickly recompute shortest paths to other network nodes, but their link state updates are yet to reach their neighbors. Is there a possibility of packets looping in the network? Why or why not, explain.
11. Suppose an organization is allocated a class B address 130.56.0.0/16. The organization has 5 departments with hosts as shown below.
 Department A: 100
 Department B: 100
 Department C: 50
 Department D: 50
 Department E: 400
 Assume that each department is served by a router named after its department (e.g. Router A serves department A) and there is a router F that connects the organization to the external Internet (via interface0; F has 3 interfaces). And suppose all the routers are connected in the pattern A-B-C-F-D-E.
- a. **(2.5M)** Design an efficient arrangement of subnet numbers and masks to assign to the departments. This assignment should permit flexibility in adding more departments to the organization in the future without disrupting current allocation. For ease of grading, specify the 'subnet portion of relevance' in bits and mask in '/' format. Example: 130.56. 0000 1000. 0000 0000 /21
- b. **(2.5M)** Specify the routing table maintained by router F. Minimize the number of entries that need to be maintained at F.
12. **(4M)** Assume TCP version Tahoe. Workout the packet transmission timeline when packet with sequence number 13 is lost. Assume that the sequence number of packets starts with 0. Assume TCP's RTO is equal to 3 RTTs (ie, TCP will detect loss when the RTO expires). Further assume that RTT dominates all other delays including transmission times. Provide your answer as per the table provided till RTT hits 10.

RTT	Cwnd	Segments-sent	Explanation
0	1	0	Slow-start
1	2	1, 2	
2	3	3, 4, 5, 6	
3	4	7, 8, 9, 10, 11, 12, 13, 14	

13. **(3M)** Assume TCP version Reno. Workout the packet transmission timeline when packet with sequence number 11 is lost. Assume that the sequence number of packets starts with 0. Assume TCP's RTO is equal to 3 RTTs (ie, TCP will detect loss when the RTO expires). Further assume that RTT dominates all other delays including transmission times. Provide your answer as per the table but till RTT hits 6.

RTT	Cwnd	Segments-sent	Explanation
0	1	0	Slow-start
1	2	1, 2	
2	3	3, 4, 5, 6	
3	4	7, 8, 9, 10, 11, 12, 13, 14	

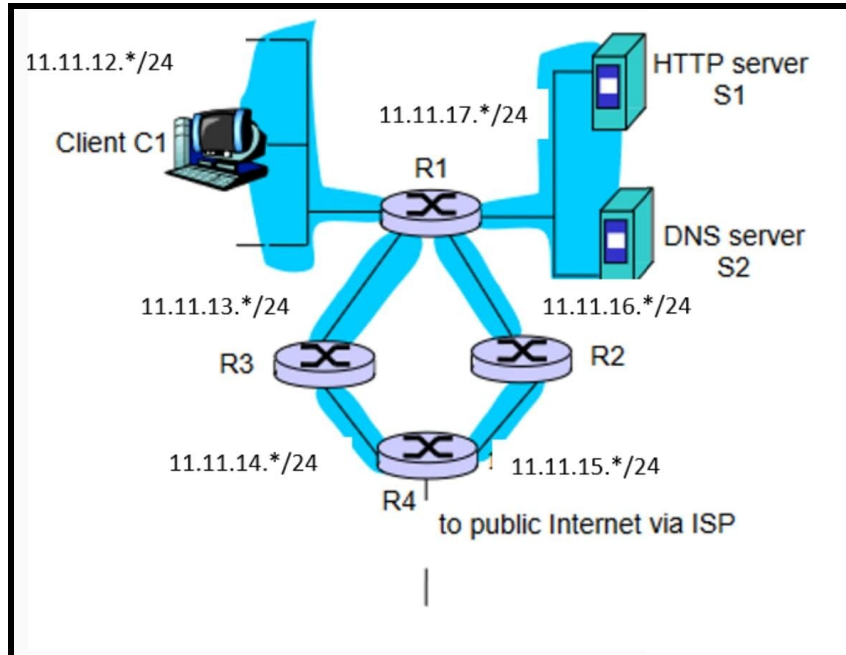
14. Assume that you have a base html file with 10 embedded images that is requested by a client. Assume that the base file and all of the images are small enough that each individually can fit within one TCP segment. Assume that the round trip times dominate all other times including transmission time. Ignore TCP connection close time.
- (1M)** How many round trips are required to retrieve the base file and the images if using non-persistent HTTP (HTTP1.0) and sequential requests. Format X (e.g. 40)
 - (1M)** How many round trips are required to retrieve the base file and the images if using non-persistent HTTP (HTTP1.0) and parallel requests but limited to 5 parallel connections at any given time. Format X (e.g. 40)
 - (1M)** How many round trips are required to retrieve the base file and the images if using persistent HTTP (HTTP1.1) and sequential/non-pipelined requests. Format X (e.g. 40)
 - (1M)** How many round trips are required to retrieve the base file and the images if using persistent HTTP (HTTP1.1) and parallel requests. Note there are no parallel connections here. Format X (e.g. 40)
15. An organization is connected to the Internet via a full-duplex link with capacity 10Mbps (Mega bits per second). The sysad is deliberating on whether or not to invest in a web cache. Assume the following holds true within the organization.
- All GET requests, conditional GET requests, conditional GET responses (when there is no modification of the object) are of size 100 bytes.
 - Users in the organization predominantly request two types of objects (small and large) with equal probability. Small objects are typically of size 100KByte and large objects of size 500KByte.

- The average request rate of the users is 4 requests per second.
- When employing caching, the cache hit rate of the small objects is 0.4 and that of the large objects is 0.6. In this context, cache hit means the object has not been modified on the web server.
 - a. **(1M)** When no web caching is employed, what fraction of the access link bandwidth is being utilized to download the objects? Format X.xx (eg 0.12)
 - b. **(2M)** When caching is employed, what fraction of the access link bandwidth is being utilized for the download? Format X.xx (eg 0.12)

16. Suppose you start a new company “foo” and want to set up your company network. Your network has the following servers:

- DNS server: “dns1.foo.com” with IP as “14.12.30.40”
- Web server: “web.foo.com” with IP address “14.12.30.50”. The outside world however will use the URL www.foo.com to access this server.
- Email server: “mail.foo.com” with IP as “14.12.30.60”
- Your company’s email address is of the format “username@foo.com”.
 - a. **(1M)** What resource records (RRs, relevant ones) do you need to provide to the upper-level “.com” DNS registrar/server so that it can direct messages accordingly? Specify RRs by name, value and type.
 - b. **(2M)** What all RRs do you need to put in your company’s DNS server based on the above information? Specify RRs by name, value and type.

17. Consider the topology inside an organization as shown below. The links between the routers are dedicated point-to-point links, not based on Ethernet; while the routers connect to clients/servers via Ethernet. Suppose the user at C1 enters a URL into the browser for a document at S1 and refers to S1 by its name (e.g., S1.cse.iitb.ac.in). The document stored in S1 is returned to the user at C1 and contains an embedded URL that is at another site that is outside the autonomous system (e.g., www.remotesite.com). Assume that this operation is successfully accomplished thanks to the various protocols we learnt across the stack. Assume OSPF is used within the organization. As part of this operation, answer the following questions. Do not consider any other orthogonal operations.



- a. **(0.5M)** How many networks are there in the organization as per the figure.
- b. **(1M)** Which of the following nodes will run an intra-domain routing protocol (OSPF) to help route packets that are part of the operation? Select all that apply.
 - C1
 - S1
 - S2
 - R1
 - R2
 - R3
 - R4
- c. **(0.5M)** Which of the following nodes will run an inter-domain routing protocol, BGP to help route packets that are part of the operation? Note this is an organization, not an ISP. Select all that apply.
 - C1
 - S1
 - S2
 - R1
 - R2
 - R3
 - R4
- d. **(1M)** Which of the following nodes must be running the ARP protocol to help route packets that are part of the operation? Select all that apply.
 - C1
 - S1

- S2
- R1
- R2
- R3
- R4

e. **(1M)** Which of the following nodes can potentially generate DNS requests as part of the operation? Select all that apply.

- C1
- S1
- S2
- R1
- R2
- R3
- R4

f. **(1M)** Which of the following nodes must be running TCP protocol as part of the operation? Select all that apply.

- C1
- S1
- S2
- R1
- R2
- R3
- R4