Primary Examination, Semester 1, 2015

Computer Networks and Applications
COMPSCI 3001, 7039

Official Reading Time:	10 mins
Writing Time:	120 mins
Total Duration:	130 mins

Questions	Time	Marks
Answer all 6 questions	120 mins	120 marks 120 Total

Instructions

- Begin each answer on a new page in the answer book.
- Examination material must not be removed from the examination room.

Materials

- Calculator without alphanumeric memory or remote communications capability permitted.
- Foreign language paper dictionaries permitted.

DO NOT COMMENCE WRITING UNTIL INSTRUCTED TO DO SO

Application Layer

Question 1

(a) The equation for determining the download time for a peer-to-peer file sharing and client/server file sharing is given below.

$$D_{p2p} \geq \max(F/u_s, F/d_{min}, \frac{NF}{u_s + \sum_{i=1}^{N} u_i})$$

$$D_{cs} = \max(\frac{NF}{u_s}, \frac{F}{d_{min}})$$

Match the following terms to what they represent

i) F/u_s	1) Time needed for server to upload one copy of the file
ii) F/d_{min}	2) Time for cooperating peers + server to upload a copy of the file to all peers
iii) $\frac{NF}{u_s+\sum_{i=1}^{N} u_i}$	3) Time for server to upload file to all clients
iv) $\frac{NF}{u_s}$	4) Time for slowest peer to download one copy of the file

[4 marks]

(b) True or False: assuming that the server participates in the peer to peer exchange (as in the equation above), peer to peer download will always be faster than or the same speed as client/server download. Explain your answer

[3 marks]

(c) You are building a communication network based on RFC 1149 "IP over avian carrier". You attach *two* 128GB flash drives to your pigeon. You can write data to the flash drive at the rate of 20 MB/s and you can read data from the flash drive at the rate of 50MB/s. The flying speed of a pigeon is 80km/h and pigeons do not need to stop for food or rest before reaching destination.

i. What is the total time needed for you to send and your friend who lives in Brazil (Rio is 13600 km from Adelaide) to receive a $4 * 10^9$ bit file of your favourite home movies? Solve for the number of seconds delay. Show your work.

[6 marks]

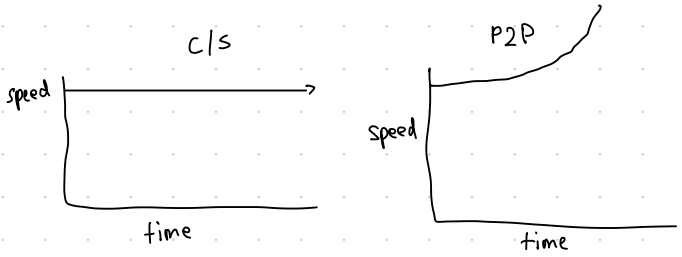
ii. Under what conditions would IP over avian carrier have a lower propagation delay or transmission delay than using the Internet? Explain your answer.

[4 marks]

(d) Give two reasons why iterative DNS queries are preferred to recursive DNS queries. Explain your answer.

[2 marks]

1, b). True. Client/server is limited to the upload speed of the server. P2P will always be at least the speed of the server plus the speed of all additional peers.



C) i. 4×10^9 bits = 476.8 MB ⟶ can fit in 256GB

write speed = $\frac{476.8}{20}$

= 23.84 seconds

propagation delay = $\frac{13600\text{ km}}{80\text{ km/h}}$

= 170 hours

read speed = $\frac{476.8\text{ MB}}{50\text{ MB/s}}$

= 9.572 seconds

total delay = 23.84 + 9.572 seconds + 170 hours

= 170 hours, 38.4 seconds

ii). A very very large file, with low bandwidth will lead to higher transmission delay. Medium of transfer will affect propagation delay. Satelite, cable, etc. Unlikely to be significant over pigeon delay.

d). 1. allows local DNS to cache everything, decreasing resolve time on future queries

2. Better client control over process - find bugs better / choose how/when/who to resolve from.

~~(e) Explain three techniques used by the Web (HTTP) to reduce latency.~~

[3 marks]

(f) One key role of protocols is to define the syntax (ie structure) of requests and responses. To do this, protocols need to define where one exchange ends and the next one begins. Give two plausible ways in which a text based protocols can indicate the end of an exchange.

[2 marks]

[Total for Question 1: 24 marks]

f) an acknowledgment message.

a timeout after period of no messages.

Transport Layer

Question 2

(a) How does a web browser know the destination port to connect to reach a web server?

[2 marks]

(b) Explain in detail how TCP provides congestion control.

[6 marks]

(c) Explain why it is reasonable to assume that receiving 3 duplicate ACKs in TCP is an indication that the network is *not* currently congested.

[2 marks]

(d) We looked at three protocols for providing reliable transport: Alternating Bit, Go-Back-N and Selective-Repeat.

i. Which of these is likely to perform best in the presence of high error rates? Explain.

[3 marks]

ii. What is the optimal size for the sending and receiving window for each of these protocols?

[3 marks]

iii. Given a window size, W, what is the minimum sequence space required for each of these protocols?

[3 marks]

(e) A TCP sender finds out the available receive buffer space through the 'receive window' header field of packets/acknowledgments sent by the receiver to the sender.

The flaw in this approach is that if the receiver has no space, it will send a receive window of 0. This indicates that the sender should not send any more data as there is no space in the receiver's buffer. However, if the sender does not send data, the receiver may never send a packet to tell the sender when there is space.

Assuming we do not want the receiver to gratuitously send packets to the sender just to tell it about window space (ie the receiver should only send packets to the sender if it either has data to send or if it is sending an acknowledgement), what can the sender do resolve this problem?

[3 marks]

(f) Give an example of a case where a two-way handshake to establish a connection could leave one side of the connection live while the other side does not believe there is a connection.

[3 marks]

[Total for Question 2: 25 marks]

2a). Destination port is included in transport headers, there are also defaults for specific web servers, 80, 443, etc. Packets are demultiplexed to the correct application using this port number (among other things)

b) slow start - start by initially setting allowed in packets (congwin) to 1 and a threshold to a large number. For each set of packets that succesfully arrive, double congwin (1 → 2 → 4 → 8 → 16) etc, until threshold is reached. Move to congestion avoidance now - increase congwin linearly (16 → 32 → 33 → 34) etc. If a timeout occurs, reset congwin to 1 and halve the threshold.

threshold

Fast recover (Reno) → instead of resetting to 1, halve congwin and go into congestion avoidance
Fast retransmit (Reno) → after 3 dupe ACKs, retransmit

c) Packet reordering cause duplicate ACKs.

d). i. Selective repeat. No wasted bandwidth trying to retransmit entire windows like GBN. More throughput compared to alternating bit.

ii. W, such that W minimises congestion

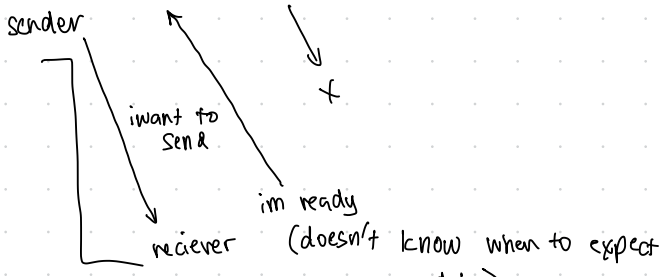
iii. ???

e). Reciever can send an ACK with window size whenever it changes without the sender asking first

f). The initial Syn is to propose a connection. The second and third are to let each node that they're ready.

Without a third, only 1 party says they're ready and sends data when the other is not ready.

Rock climbing:



Network Layer

Question 3

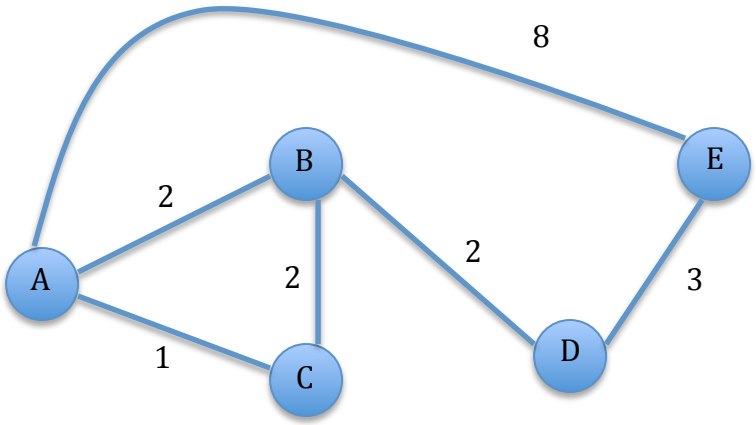


Figure 1: network

(a) Given the network shown above, show the development of the routing table for node A using Dijkstra's algorithm. You must show your work and the final routing table (next hop and path cost for each destination) for full marks.

[6 marks]

1.

Node	A	B	C	D	E
Distance	0	2	1	∞	8
Parent	/	A	A	/	A

visited = {A}

unvisited = {B, C, D, E}

2. shortest is C

Node	A	B	C	D	E
Dist	0	2	1	∞	8
Parent	/	A	A	/	A

visited = {A, C}

unvisited = {B, D, E}

3. shortest is B

Node	A	B	C	D	E
dist	0	2	1	4	8
parent	/	A	A	B	A

visited = {A, C, B}

unvisited = {D, E}

4. shortest is D

Node	A	B	C	D	E
dist	0	2	1	4	7
parent	/	A	A	B	D

visited = {A, C, B, D}

unvisited = {E}

5. shortest is E

Node	A	B	C	D	E
dist	0	2	1	4	7
parent	/	A	A	B	D

visited = {A, C, B, D, E}

unvisited = {}

(b) Node A is using distance vector routing. The current distance table and routing table at Node A are shown below.

Current distance table at Node A

		via B	via C	via D	via E
	B	2			
to	C		1		
	D				
	E				8

Current routing table at Node A

dest	next hop	cost
B	B	2
C	C	1
E	E	8

i. Node A receives the following vector from neighbour Node B $[A, 2\,C, 2\,D, 2\,E, 5]$ Show the updated distance table at A after it processes this vector.

[3 marks]

ii. What vector, if any, will be sent by A after its distance table has been updated?

[2 marks]

[Total for Question 3: 11 marks]

i.

to \ via	B	C	D	E
B	2			
C	2	1		
D	2			
E	5			8

ii). [B, 2, C, 2, D, 2, E, 5]

Internet Protocol

Question 4

(a) Suppose there are three routers between a source host and a destination host. Ignoring fragmentation, an IP datagram sent from the source host to the destination host will travel over how many interfaces? How many forwarding tables will be indexed to move the datagram from the source to the destination?

[2 marks]

(b) What is the binary equivalent of the network address of the IP address 223.1.3.27/16?

[2 marks]

(c) You have a network 115.64.4.0/22 that you want to create subnets on. The subnets need to support up to 60 hosts each. How many bits would you allocate for the host part of the subnets? How many such subnets can you support?

[7 marks]

(d) Briefly describe three limitations (*1 mark per limitation*) of IPv4 that justify the development and deployment of IPv6.

[3 marks]

(e) Suppose Host A sends Host B a TCP segment encapsulated in an IP datagram. When Host B receives the datagram, how does the network layer in Host B know it should pass the segment (that is, the payload of the datagram) to TCP rather than to UDP or to something else?

[2 marks]

(f) IPv6 uses 128 bit addresses compare to IPv4, so it will take longer for routers to process IPv6 datagrams. Explain clearly by providing ***one*** argument why you agree or disagree with this statement?

[2 marks]

[Total for Question 4: 18 marks]

4 a).

source → R_1 → R_2 → R_3 → dest

8 interfaces
→ 2 at each router
→ 1 at host / dest

4 routing tables

b) 223 → 111 → 55 → 27 → 13 → 6 → 3 → 1 → 0
1 1 1 1 0 1 1

1 → 0
1

3 → 1 → 0
1 1

27 → 13 → 6 → 3 → 1 → 0
1 1 0 1 1

223.1.3.27 = 11011111 00000001 00000011 00011011
network host

c) need at least 62 addresses (60 hosts + 2 NI, broadcast)

2^6 = 64 addresses per subnet

there a 10 bits of hosts available

2^{10} = 1024

$\frac{1024}{64}$ = 16 total subnets

d). - Not enough addresses with only 32 bits
- lots of headers : large overhead
- optional security

e) A header (upper layer) defines whether TCP or UDP

f). False. There are significantly less headers in IPv6 even despite large address.

Switching and Link Layer Protocols

Question 5

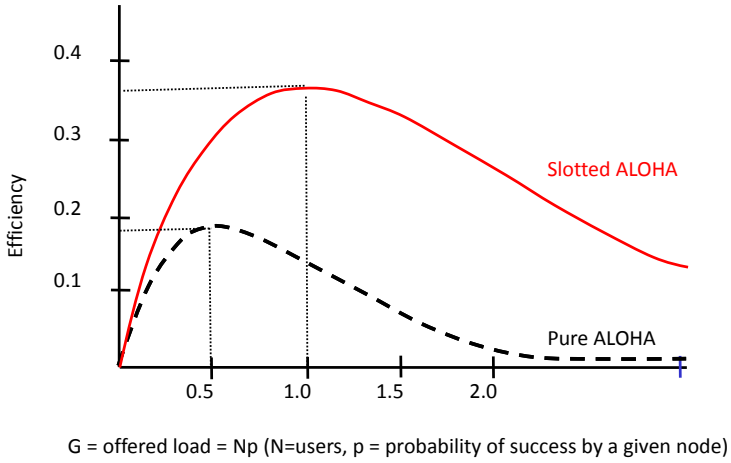


Figure 2: Performance of ALOHA and Slotted ALOHA

(a) Pure Aloha (sender may start transmission during any time) has a maximum efficiency that is half that of Slotted Aloha (sender can only start transmission at synchronised time slots). Explain in detail why Pure Aloha is only able to achieve half the efficiency.

[4 marks]

(b) Suppose 3 hosts share a 2 Mbps data link. Each host transmits at 1 Mbps when it has access to the link. Also suppose each host transmits 20 percent of the time.

You are told to propose an access control mechanism for sharing the 2 Mbps broadcast channel. Clearly explain the data rates achievable with each of the following schemes in this scenario: TDMA, FDMA, slotted ALOHA, pure ALOHA),

[8 marks]

(c) CSMA/CD efficiency is governed by the equation shown. There are two ways to improve the efficiency of a CSMA/CD network 1) increase the transmission delay or 2) decrease the propagation delay. Explain how each of these could be achieved in an actual network without changing the medium of the link (ie you can't change from optical fibre to copper).

$$efficiency = 1/1 + 5t_{prop}/t_{trans}$$

[4 marks]

a) slotted leads to higher channel utilisation by reducing chances of collisions.

b) ???

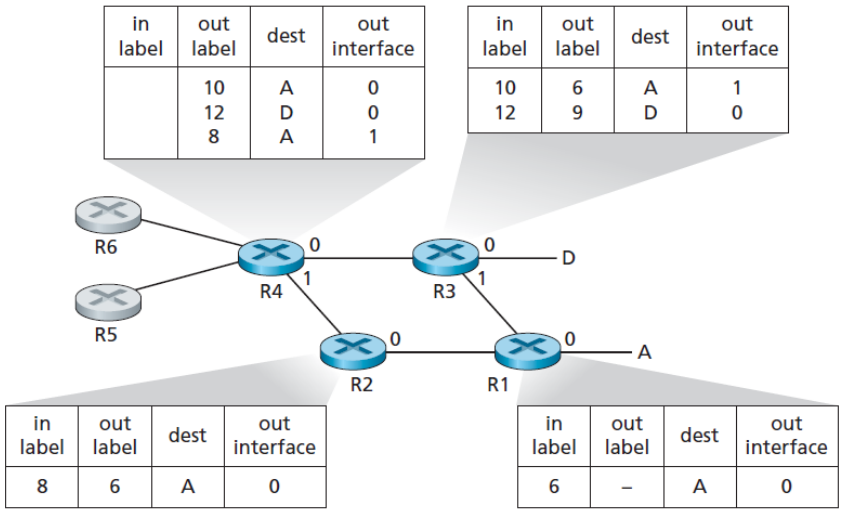


Figure 3: MPLS Network

(d) Consider the *Multi-Protocol Label Switching* (MPLS) network shown in Figure 3, and suppose that routers R5 and R6 are now MPLS enabled. Suppose that we want to perform traffic engineering so that packets from R6 destined for A are switched to A via R6-R4-R3-R1, and packets from R5 destined for A are switched via R5-R4-R2-R1. Show the MPLS tables in R5 and R6, as well as the modified table in R4, that would make this possible. (Clearly indicate the name of the router and clearly draw the routing table where required to show additions or changes to routing tables. You do not need to reproduce the network)

[4 marks]

(e) Why is an ARP query sent within a broadcast frame? Is an ARP response sent within a broadcast frame and why or why not?

[4 marks]

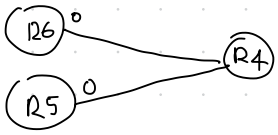
(f) Suppose the information content of a packet is the bit pattern

`1110 0110 1001 1101`

and an even parity scheme is being used. What would the value of the field containing the parity bits be for the case of a two-dimensional parity scheme? Your answer should be such that a minimum-length EDC (error dectection and correction) field is used.

[4 marks]

d) R6 routing table



in	out	dest	interface
–	20	A	0

R5 routing table

in	out	dest	interface
–	30	A	1

R4 routing table

in	out	dest	interface
20	10	A	0
–	12	D	0
30	8	A	1

e). Requesting device does not know where ARP server is. ARP server learns where request came from and is able to directly send to it.

f).

1	1	1	0	1
0	1	1	0	0
1	0	0	1	0
1	1	0	1	1
1	1	0	0	0

EDC: 1100 1011

(g) Given that in a CSMA/CD protocol using binary exponential back-off, the adapter waits $K \times 512$ bit times after a collision, where K is drawn randomly. What is the maximum length of time the adapter will wait until the next transmission attempt given 7 collision has occured so far. Assume that you have a 10 Mbps broadcast channel?

[3 marks]

[Total for Question 5: 31 marks]

ICMP, SNMP and Security

Question 6

(a) Ping (ICMP) is a useful tool for debugging network problems. Give an example of how ping could be used in network testing.

[2 marks]

(b) Explain how Traceroute builds a list of the routers on the path from the host through the network to the destination.

[3 marks]

(c) In what way does a hash provide a better message integrity check than a checksum (such as the Internet checksum)?

[3 marks]

(d) Suppose certifier.com creates a certificate for foo.com. Typically, the entire certificate would be encrypted with certifier.com's public key. True or False? Briefly explain your answer.

[3 marks]

[Total for Question 6: 11 marks]

End of exam