Primary Examination, Semester 1, 2014

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 5 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 is given below.

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

i. Explain what each of the following terms represents (for example: "The time for one peer to download a single copy of the file")

α) F/u_s

β) F/d_{min}

γ) $\frac{NF}{u_s+\sum_{i=1}^{N} u_i}$

[3 marks]

ii. Using the same terms, give an equation for the minimum download time for a client/server file download.

[4 marks]

(b) Two delays that contribute to the total end-to-end delay in networks are propagation delay and transmission delay.

i. Explain what these two delays are and show how to calculate these delays.

[4 marks]

ii. What two other delays contribute to the total end-to-end delay in networks?

[2 marks]

(c) You have a web browser with *two windows* open each viewing a different web page. These two web pages are hosted on the same web server. Give one set of possible values for the source and destination port numbers and IP addresses *for each of the two socket connections* (one connection for each web page). For example: connection 1: src-129.127.6.24, dest-129.127.8.52, src-3456, dest-7892 (note this is *not* a correct answer, it's just to show the format to write your answer in)

[4 marks]

1 a) i. $\frac{F}{u_s}$ = the time for the server to upload the file once

$\frac{F}{d_{min}}$ = the time for slowest downloading peer to download the file

$\frac{NF}{u_s + \sum_{i=1}^{N} u_i}$ = the time for all peers to have downloaded the file.

ii. $D_{cs} \geq \max\left(\frac{F}{u_s}, \frac{F}{d_{min}}\right)$

b) i. Propagation - time for signal to travel across medium = $\frac{\text{Distance}}{\text{speed}}$

Transmission - time to transmit file to/from medium = $\frac{\text{size}}{\text{bandwidth}}$

ii. Processing Delay
Queing Delay

c) connection 1 : src : 128.56.1.2
dest : 130.42.3.1
src : 49152
dest : 80 - HTTP

connection 2 : src : 128.56.1.2
dest 130.42.3.1
src : 49153
dest : 443 - HTTPS

(d) A local DNS server receives a request to resolve the name www.mycom.com.au There is no entry for this name in the local hosts file or the cache. What steps will the local DNS server do to resolve this name to an IP address?

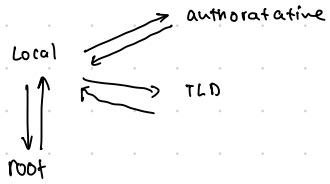
[4 marks]

(e) Explain how persistent connections in HTTP can reduce the latency in retrieving web pages.

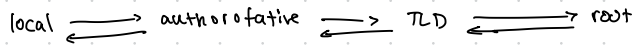
[3 marks]

[Total for Question 1: 24 marks]

d). Iterative - it can query the next highest DNS server until it gets a match



recursive - let the next highest DNS server handle recursively



e). only need to connect terminate once - there are less control messages to send

Transport Layer

Question 2

(a) Explain the purpose of multiplexing and demultiplexing in the transport layer. How do TCP and UDP provide multiplexing/demultiplexing?

[3 marks]

(b) Controlling congestion in a network can be critical to performance.

i. If a network does not have any congestion control, explain what conditions will cause congestion to occur. Be specific. "too much traffic" is not enough detail. You need to explain your answer in terms of router and link resources.

[3 marks]

ii. Explain in detail how TCP provides congestion control.

[6 marks]

(c) TCP uses an estimated RTT plus estimated deviation when determining the timeout value for segments. Why does TCP include the deviation value? What would be more likely to occur if the deviation value were not included?

[4 marks]

(d) We looked at three protocols for providing reliable transport: Alternating Bit, Go-Back-N and Selective-Repeat. Assume we have a delay-bandwidth product of 1MByte and a maximum segment size (MSS) of 1KByte. Assume the local memory available for buffering is not a limiting factor.

i. Assuming the send window size has been set to the delay-bandwidth product (with the exception of alternating bit which has been set to the MSS), what would be size of the receiver buffer for each of the protocols?

[3 marks]

ii. Give one advantage for each of the three protocols

[3 marks]

(e) TCP flow control relies on the receiver to indicate how much buffer space is available for data at the receiver. How does the receiver provide this information to the sender?

[2 marks]

[Total for Question 2: 24 marks]

2a). Combine all data to be sent across the medium (multiplex) and seperate that data to send to individual hosts and sockets (demultiplex)

achieved using source and destination IP and port.

TCP uses 4 tuple to identify connection (source IP, port, dest IP and port)

UDP uses 2 tuple to identify (dest IP and port)

b). i. when the recieving window at the reciever is full due to processing delays, congefion will occur when the sender tries to send more data.

ii. define a congestion window - how much the reciever can handle at once.
ssthreshold - an arbitrary number that defines a congestion threshold.

Set congwin to 1 and ssthresh to some large number. For every properly recieved set of packets, double congwin. 1 → 2 → 4 → 8, etc. Once congwin reaches ssthresh, grow linearly instead of quadratically. 8 → 9 → 10 → 11, etc (called cong avoidance)

If a timeout occurs, reset congwin to 1, halve ssthresh and start again.

tahoe:
fast retransmit: after 3 dupe ACKs, retramsit packet and go into fast recovery
fast recovery: instead of resetting congwin to 1, halve it and go directly into congestion avoidance.

c) deviation is added to account for volatile network conditions. without it, timeouts might occur too frequently or not fast enough.

d) i. AB = 1kb
GBN = 1kb
SR = 1Mb

ii. AB: very simple to implement - always reliable
GBN = more throughput than AB, efficient for low error rates
SR = efficient for high error rates.

e). It sends it as a header field in a control packet whenever the window size changes

Routing and Internet Protocol

Question 3

(a) You are unable to reach hosts on the Internet. Briefly explain how you would test if the problem is within your network or outside your network (ie your service provider or further upstream).

[3 marks]

(b) Clearly explain the difference between unicast, multicast and broadcast traffic at Layer 3.

[3 marks]

(c) Briefly describe three limitations of IPv4 that justify the development and deployment of IPv6.

[3 marks]

(d) For each of the groups of IP addresses below, identify how many distinct networks are represented, provide the network number(s) in each case and give a brief reason for your answer.

i. `10.5.5.1`
`10.5.6.2`
`10.7.8.3`

[3 marks]

ii. `10.5.5.1/16`
`10.5.6.2/16`
`10.7.8.3/16`

[3 marks]

iii. `10.5.5.1/24`
`10.5.6.2/24`
`10.7.8.3/24`

[3 marks]

(e) Suppose datagrams are limited to 1500 bytes (including header) between source Host A and destination Host B. Assuming a 20 byte IP header, how many datagrams would be required to send an MP3 consisting of 5 million bytes.

[4 marks]

(f) Dijkstra's algorithm can be implemented in two different ways, one of which has a complexity of $O(n^2)$ and one of which has a complexity of $O(n \log n)$. Choose one of the implementations and briefly justify its complexity.

[5 marks]

[Total for Question 3: 27 marks]

3a). traceroute. Maps all nodes packet travels through so you can see where it is failing. If all nodes have the same subnet mask, it's a local network error.

b). broadcast - send to every host on the network
multicast - send to multiple devices (but not nessarily all) on the network
unicast - send to a single device on the network

c). 1. not enough addresses - too many devices connected
2. optional security
3. large overhead with lots of headers

d). i. Those are type A addresses (network = 8 bits), all belong to same network.

ii. now uses CIDR - which identifies 16 bit network portion.

10.5.5.1 /16] network A
10.5.6.2 /16]
10.7.8.3 /16] network B

2 different networks

iii. 24 bit network portion

10.5.5.1 /24] A
10.5.6.2 /24] B
10.7.8.3 /24] C

3 different networks

e). datagram = 1480 bytes for data.

$$\frac{5,000,000}{1480} = 3379 \text{ datagrams}$$

f). $O(n^2)$ → for each node, we need to check every other node to find the shortest path from that node.

Switching and Link Layer Protocols

Question 4

(a) Explain how a packet enters a *Multi-Protocol Label Switching* (MPLS) network, how it is routed through the network and how it is ultimately delivered. Consider using a simple diagram to help you explain your answer.

[6 marks]

(b) Briefly explain why we need to use Spanning Tree Protocol to shut down specific ports when we have redundant connections in a Layer 2 network.

[4 marks]

(c) Explain how CSMA/CD is implemented in Ethernet. You may express your answer as an algorithm if you wish.

[6 marks]

(d) How is the address field used in PPP? Justify your answer.

[3 marks]

(e) Why do we carry out error detection and/or correction at Layer 2, given that it is carried out at Layers 3 and 4 as well?

[2 marks]

(f) Explain how the use of full-duplex mode in a LAN can reduce collisions to zero.

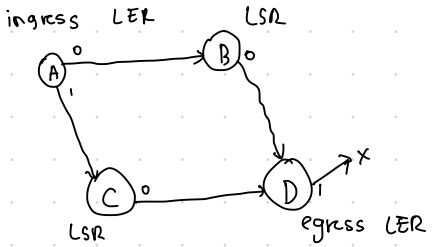
[2 marks]

(g) Given that $\lim_{N\to+\infty}\left(1-\frac{1}{N}\right)^N=\frac{1}{e}$, derive the maximum efficiency of slotted ALOHA.

[8 marks]

[Total for Question 4: 31 marks]

4 a).



node	in label	out label	out interface	destination
A	–	10	0	X
		20	1	X
B	10	30	0	X
C	20	30	0	X
D	30	–	1	X

packets encapsulated with labels at an ingress LER. routed to LSRs where they are given a new label and sent through an interface according to label, eventually leading to egress LER where it is passed along to reciever.

b). To stop broadcast storms (where packets indefinitely progate due to brodcasts in networks with cycles)

e). Layer 2 correction / detection can occur at each host in the path, layer 3 and 4 can only happen at destination increases efficiency and reduces latency.

f). nodes can transmit and reciewe at the same time. These are seperated into different channels where collision is not possible.

g). = 38.5 %. total utilisation

ICMP, SNMP and Security

Question 5

(a) You want to use SNMP to detect when a link interface goes down or comes up. Would a request-response mode or a trap mode be appropriate for this? Explain your choice.

[2 marks]

(b) Provide a detailed description of how you would provide a secure e-mail facility over SMTP. Ensure that you identify which security services you are providing. A diagram will be helpful.

[8 marks]

(c) I generate an MD5 message digest fingerprint of the phrase:
"2012 TR3 NAAEC CNA Supp"
and it produces the string
`80c55979acb8198c4445c25810e4e630`.
I update this for next year and change this message to:
"2013 TR3 NAAEC CNA Supp"
What will happen to the MD5 signature? Briefly explain your answer.

[4 marks]

[Total for Question 5: 14 marks]

c) it will change completely. A hash function produces a unique hash for each different key, MD5 in particular reacts volatiley even to tiny changes.

"2012 ..."

"2013 ..."

End of exam