THE HONG KONG POLYTECHNIC UNIVERSITY
HONG KONG COMMUNITY COLLEGE

Subject Title	: Computer Networking	**Subject Code**	: CCN2238
Session	: Semester Two, 2013/14	**Time**	: 14:00 – 17:00
Date	: 19 May 2014	**Time Allowed**	: 3 hours
Subject Examiner(s)	: Dr Joseph SO Dr Hon-sun CHIU Dr Kwok-wah HUNG		

This question paper has a total of **FOURTEEN** pages (including this covering page).

Instructions to Candidates:

1. There are THREE sections in this paper.

   Section A (30%) – Multiple-choice Questions. Answer ALL questions in this section on the multiple-choice answer sheet provided. Each question carries 1 mark.
   Section B (40%) – Short Questions. Answer any FIVE out of the SIX questions in this section in the answer book provided. Each question carries 8 marks.
   Section C (30%) – Long Questions. Answer any TWO out of the THREE questions in this section in the answer book provided. Each question carries 15 marks.
2. Appendix 1 shows the list of selected well-known TCP and UDP port numbers.
3. Unless specified in a question, you may assume $1k = 10^3$ and $1M = 10^6$.
4. Candidates are required to pay special attention to neatness and clarity of expression in their answers. Marks will be deducted for untidy work.

Authorised Materials:

	YES	NO
CALCULATOR	[✓]	[ ]
SPECIFICALLY PERMITTED ITEMS	[ ]	[✓]

DO NOT TURN OVER THE PAGE UNTIL YOU ARE TOLD TO DO SO

Section B – (40%) Short Questions

Answer any FIVE out of the SIX questions in this section in the answer book provided. Each question carries 8 marks.

Question B1

Consider the following network with a sender S and a receiver R 15 km apart. The connection is divided into 3 links, each 5 km long with attenuation -0.3 dB/km. N is a relay node that just forwards the received signal, while A is an amplifier that amplifies the received signal power by 2 times before forwarding it out. Suppose the signal sent out at S has a power 10 mW.

(a) Assume the bandwidth of the channel is 1 MHz and the receiver R needs to receive data at a rate not less than 3 Mbps.

(i) What is the signal power received at R? (3 marks)

(ii) What is the maximum power of noise that can be tolerated by R? (3 marks)

(b) Even if there is no noise, the signal may have different forms or shapes when it is received at R. Explain why this may happen. (2 marks)

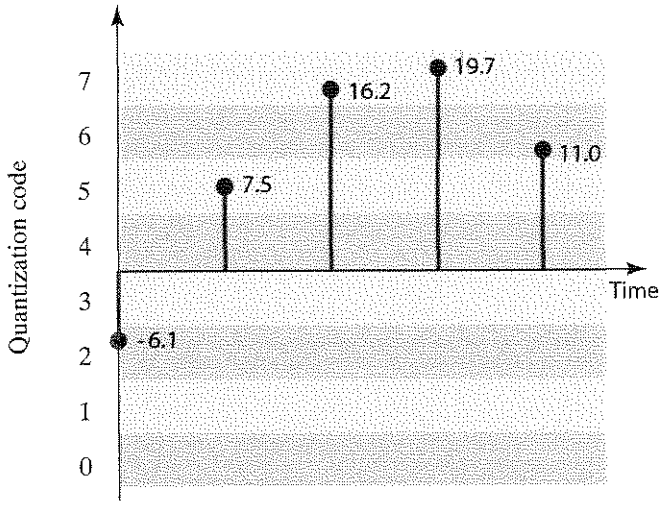
Question B2

(a) A sender wants to send an IP datagram into a link that has an MTU of 660 bytes. The length of the original datagram (including the header) is 4700 bytes. Suppose this datagram is stamped with the identification number (ID) 100 and there is no optional information in the header. Derive the number of fragments needed in sending the datagram through the link. (3 marks)

(b) What are the values of ID, Flag (the M-bit) and Fragment Offset in the corresponding headers of the first, second and the last fragments in (a)? (5 marks)

Question B3

A device converts audio signal into digital format using PCM with 8 quantization levels. Suppose the audio signal has a bandwidth 4 kHz with minimum frequency at 400 Hz. The quantization codes of the samples are given as follows (e.g. sample -6.1 is assigned with quantization code 2):



(a) (i) What is the bit rate of the digitized signal? (2 marks)

(ii) Briefly explain the reason of quantization error. (2 marks)

(b) The five samples are joined together as one digitized signal stream. The stream is sent out with a CRC appended. If the polynormial is x^4+x^3+x+1, what is the codeword at the sender site? (4 marks)

Question B4

(a) State **TWO** major differences between the Pure ALOHA and Slotted ALOHA protocols. (4 marks)

(b) There are four stations A, B, C and D in a bus network adopting the non-persistent CSMA protocol. The data packets may have different lengths in terms of transmission time. When the channel is sensed to be busy or when a packet is collided, the same fixed back-off time will be used for a particular station. However the back-off times of individual stations are different and are indicated as below. Suppose 6 data packets indicated below are ready to be transmitted.

Station	Packet ID	Packet Length	Ready time (at)	Backoff Time
A	A1	5 minutes	2:00 pm	5 minutes
B	B1	5 minutes	2:03 pm	10 minutes
C	C1	5 minutes	2:03 pm	12 minutes
D	D1	5 minutes	2:03 pm	15 minutes
A	A2	10 minutes	2:06 pm	5 minutes
A	A3	7 minutes	2:18 pm	5 minutes

Assume the propagation delay is negligible and the source station can receive the acknowledgement from the destination station immediately after the packet transmission.

(i) Between 2:00 pm and 2:30 pm, how many times will packet collisions occur? You should write down which packets are collided at what time. (2 marks)

(ii) At what time will packets A1 and C1 successfully finish their transmissions? You should write down individual finish time for each packet. (2 marks)

Question B5

The following is the first part of the content (including the header) of a UDP datagram in hexadecimal format

```
5C10 022A 0055 0203 0110 2324 8921 .....
```

(a) What is the source port number in decimal number? (1 mark)

(b) What is the destination port number in decimal number? (1 mark)

(c) What is the total length of the user datagram in decimal number? (1 mark)

(d) What is the length of the data in decimal number? (1 mark)

(e) Is the packet directed from a client to a server or vice versa? (1 mark)

(f) What is the application-layer protocol? (1 mark)

(g) Why is UDP used instead of TCP in some applications? (2 marks)

Question B6

(a) John sends an email by his email account john@aaabbb.com through his email application to his friend Kelly, whose email address is kelly@clocktime.com and Kelly reads the emails by her email application. Describe the interaction of email clients and the email servers and the protocols involved. (4 marks)

(b) How is HTTP related to WWW? (2 marks)

(c) What is the main improvement of HTTP 1.1 over HTTP 1.0? (2 marks)

- End of Section B -

Section C – (30%) Long Questions

Answer any TWO out of the THREE questions in this section in the answer book provided. Each question carries 15 marks.

Question C1

A 3-minute song is encoded into MP3 format with quality 192 kbps, and the MP3 file size becomes 34.56 Mb. The MP3 file is then sent to the server at a distance 5000 km away with data rate 5 Mbps. Suppose the signal travels along the medium at a speed $2x10^8$ m/s and the bandwidth of the channel is 2 MHz. The transmission adopts the Stop-and-wait ARQ protocol.

(a) Briefly describe the flow control and error control mechanism of Stop-and-wait ARQ protocol. (3 marks)

(b) In order to transmit, the MP3 file has to be divided into frames. The maximum size of each frame is 5000 bits including 144 bits overhead due to header and trailer. After sending out each frame, the sender starts a timer of 80 ms. If the frame arrives at the server successfully, the server feedbacks an ACK with frame size 500 bits immediately. Assume processing delay is neglected.

(i) How many frames will be sent? What is the size of the last frame? (2 marks)

(ii) If no frame is lost, what is the total time for the sender to confirm that the first frame has reached the server successfully? (4 marks)

(c) Assume that there are 2 data frames lost in every 100 data frames sent, while the last data frame and all ACK frames are transmitted successfully. What is the total time for sending the MP3 file to the server? (6 marks)

Question C2

(a) Describe briefly the **THREE** main communication phases in a circuit-switched network. (3 marks)

(b) Discuss **THREE** major disadvantages of circuit switching. (3 marks)

(c) In a wide area network the stations are partially connected by point-to-point links and the data rate is 5120 bps on all links. The network uses store-and-forward datagram packet switching. There are two stations A and B which are 4 hops apart and the propagation delay per hop is 0.3 second. The fixed packet size is 1024 bits and the length of the packet header is 64 bits. The nodal processing time is 2 seconds and is the same for all stations. Suppose station A needs to transmit a 7000-bit message to station B. Assume there is only one message to be transmitted in the network and the packets of the same message will follow the same shortest path. (Calculation steps should be shown in answering the following questions.)

(i) How many packets are required to transmit the message? (2 marks)

(ii) Station A starts transmitting the packets at 10:00 am. At what time will station B receive the first packet from station A? (5 marks)

(iii) Compute the end-to-end delay of transmitting the message between station A and station B. (2 marks)

Question C3

In TCP, the round trip time is estimated by the following formula:

$$\texttt{EstimatedRTT} = (1-\alpha) * \texttt{EstimatedRTT} + \alpha * \texttt{SampleRTT}$$

(a) What is the significance of α in the formula? (3 marks)

(b) Consider a host is sending TCP segments. Suppose now $\alpha = 0.4$ and the values of `EstimatedRTT` and `SampleRTT` at 6:30:00 pm are 16 seconds and 10 seconds respectively. The host sends a segment at 6:30:00 pm and receives its corresponding ACK at 6:30:36 pm. The host then sends another segment at 6:30:44 pm and receives its corresponding ACK at 6:30:50 pm. What are the updated values of `EstimatedRTT` after re-computation at 6:30:36 pm and 6:30:50 pm respectively? (6 marks)

(c) Explain how TCP uses the values of EstimatedRTT and SampleRTT to set the timeout interval for ACK. (Hints: β and DevRTT are involved.) (3 marks)

(d) What is the value of the timeout interval for the segment sent at 6:30:36 pm given that $\beta = 0.2$ and the old DevRTT = 3 seconds? (3 marks)

- End of Section C -

Appendix 1: List of selected well-known TCP and UDP port numbers

Port	TCP or UDP	Service or Protocol Name	RFC
7	TCP/UDP	Echo	792
20	TCP	File Transport Protocol (FTP)	959
21	TCP	FTP control	959
22	TCP	Secure Shell (SSH)	4253
23	TCP	Telnet	854
25	TCP	Simple Mail Transfer Protocol (SMTP)	5321
53	TCP/UDP	Domain Name System (DNS)	1034
67	UDP	Bootstrap Protocol Server (BootP, bootps)	951
68	UDP	Bootstrap Protocol Client (bootpc)	951
69	UDP	Trivial File Transfer Protocol (TFTP)	1350
79	TCP	Finger	1288
80	TCP	Hypertext Transfer Protocol (HTTP)	2616
88	TCP	Kerberos	4120
106	TCP	Password Server(Unregistered Use)	-
110	TCP	Post Office Protocol (POP3) Authenticated Post Office Protocol (APOP)	1939
115	TCP	Simple File Transfer Protocol (SFTP)	913
119	TCP	Network News Transfer Protocol (NNTP)	3977
123	TCP/UDP	Network Time Protocol (NTP)	1305
137	UDP	Windows Internet Naming Service (WINS)	-
143	TCP	Internet Message Access Protocol (IMAP)	3501
161	UDP	Simple Network Management Protocol (SNMP)	1157
192	UDP	OSU Network Monitoring System	-
311	TCP	Secure server administration	-
427	TCP/UDP	Service Location Protocol (SLP)	2608
443	TCP	Secure Sockets Layer (SSL, or "HTTPS")	2818
445	TCP	Microsoft SMB Domain Server	-
464	TCP/UDP	kpasswd	3244
500	UDP	ISAKMP/IKE	2408
514	TCP	shell	-
514	UDP	Syslog	-
548	TCP	Apple Filing Protocol (AFP) over TCP	-
554	TCP/UDP	Real Time Streaming Protocol (RTSP)	2326
587	TCP	Message Submission for Mail (Authenticated SMTP)	4409
600-1023	TCP/UDP	Mac OS X RPC-based services	-
626	TCP	AppleShare Imap Admin (ASIA)	-
626	UDP	serialnumberd (Unregistered Use)	-
631	TCP	Internet Printing Protocol (IPP)	2910
636	TCP	Secure LDAP	-
660	TCP	Server administration	-
687	TCP	Server administration	-
749	TCP/UDP	Kerberos 5 admin/changepw	-
985	TCP	NetInfo Static Port	-
1085	TCP/UDP	WebObjects	-
1099 & 8043	TCP	Remote RMI and IIOP Access to JBOSS	-

- END OF PAPER -