NATIONAL UNIVERSITY OF SINGAPORE

CS2105 – INTRODUCTION TO COMPUTER NETWORKS

Sample Exam Paper 3

Please DO NOT upload questions and answers onto the Internet.

Time allowed: 2 hours

INSTRUCTIONS TO CANDIDATES

1. This assessment paper contains 7 questions and comprises 7 printed pages, including this page.
2. This is a **CLOSED BOOK** assessment. You may bring in one piece A4 size help sheet.
3. Calculators are allowed, but not laptops, PDAs, or other electronic devices.

Q1. Multiple Choice Questions (MCQs)

1.1 Which of the following is NOT a network protocol?

A. RIP
B. ICMP
C. ARP
D. PAP
E. CSMA

1.2 Which of the following command will NOT cause a DNS query to be issued?

A. `dig www.comp.nus.edu.sg`
B. `nslookup www.nus.edu.sg`
C. `telnet localhost 9000`
D. `ping sunfire.comp.nus.edu.sg`
E. `traceroute ivle.nus.edu.sg`

1.3 Which of the following statement about 2-dimensional parity bits is FALSE?

A. It can detect any one-bit error.
B. It can correct any one-bit error.
C. It can detect any two-bit error.
D. It can correct any two-bit error.
E. It may not be able to detect a four-bit error.

1.4 Two hosts are communicating using CRC as an error detection scheme, with a generator of 110. Every byte sent consists of six bits of data and two bits of the CRC value. Suppose the following four bytes are received. Which bytes would pass the CRC test and considered as containing no bit error?

i. 11011000
ii. 11011101
iii. 10010110
iv. 11111100

A. (i) and (ii) only
B. (i) and (iv) only
C. (i), (iii) and (iv) only
D. (iii) and (iv) only
E. (i), (ii) and (iii) only

1.5 Which of the following statement about IP header is TRUE?

A. The source and destination port numbers in the IP header determine which application on the receiving host will process the datagram.
B. The TTL field in the IP header determines the time period within which the source IP address is valid.
C. The 16-bit identifier field in the IP header are not changed during IP fragmentation.
D. The checksum field in the IP header allows the receiver to check if the IP header is corrupted.
E. The protocol field in the IP header determines which link layer protocol should be used to transmit the datagram.

1.6 Consider a noisy channel with a Shannon capacity of 100 kbps and a bandwidth of 10 kHz. The signal-to-noise ratio of this channel is

A. 3.3
B. 5
C. 9
D. 10
E. 1023

1.7 A subnet contains two hosts with IP addresses 137.132.80.16 and 137.132.67.94 respectively. Which of the following is/are possible address block assigned to the subnet?

i. 137.132.64.0/18
ii. 137.132.64.0/19
iii. 137.132.64.0/20
iv. 137.132.0.0/17

A. (i) only
B. (i) and (ii) only
C. (i), (ii) and (iii) only
D. (iii) and (iv) only
E. (i), (ii) and (iv) only

1.8 Which of the following digital-to-analogy modulation scheme can support the highest data rate?

A. PSK at 8000 baud
B. QPSK at 8000 baud
C. 4-QAM at 6000 baud
D. 8-QAM at 4000 baud
E. 16-QAM at 2000 baud

1.9 Consider the following Java implementation of the rdt 3.0 protocol, using classes and methods similar to your Assignment 2. A student has implemented the sender correctly according to the state diagram of the protocol. In the receiver, the student implemented the following:

```
byte[] recv() throws Exception {
   DataPacket p = udt.recv();
   while (p.isCorrupted || p.seq != seq) {
      p = udt.recv();
   }
   udt.send(new AckPacket(p.seq));
   seq = 1 - seq;
   return deliverData(p);
}
```

Here, **`seq`** is the expected sequence number (either 0 or 1) at the receiver, and **`deliverData`** is a method that extracts and returns the payload from packet **`p`**.

The protocol is used over a channel that may lose or corrupt a packet, but always delivers packets in the order that they are sent.

We say that the receiver *waits forever*, if it is blocked at the call **`udt.recv()`**, waiting to receive a packet that will never be sent. We say that the sender *loops forever*, if it repeatedly retransmits the same packet over and over again.

Which of the following statement CORRECTLY describes the behavior of the protocol implemented above?

A. A single corrupted data packet is sufficient to cause the sender to loop forever.
B. A single corrupted data packet is sufficient to cause the receiver to wait forever.
C. A single loss ACK packet is sufficient to cause the sender to loop forever.
D. A single loss ACK packet is sufficient to cause the receiver to wait forever.
E. A single premature timeout is sufficient to cause the sender to loop forever.

Q2.

Two hosts A and B are communicating over a wireless channel with a signal to noise ratio of 15 and a bandwidth of 100 MHz. The nodes are 300 meters apart. The signal propagation speed over the air is the $3 * 10^8$ m/s.

(a) What is the maximum data rate that can be supported by the wireless channel?

(b) Suppose that A transmits at 20 MBaud using 64-QAM as the modulation scheme. What is the transmission rate of A in Mbps?

(c) Suppose that A transmits a frame of size 1000 bytes at 100 Mbps, starting at time t = 0. At what time will the frame reach B completely? Give your answer in the unit of μs (Note: 1 μs = $1 * 10^{-6}$ s).

Q3.

Two hosts A and B are 2000 km apart and are connected directly using a link with propagation delay of 800 bit times and propagation speed of $2.5 * 10^8$ m/s. A is sending a sequence of packets, each is 100 bytes in size, to B.

(a) How long does it take for B to receive a packet?

(b) A is using a sliding window protocol to communicate with B. What is the minimum window size A should use for the link to be fully utilized?

Q4.

To preserve message confidentiality and authenticity, the following information is contained in a secured message sent from Alice to Bob.

- Encrypted hash of the message
- Encrypted message
- Encrypted session key

Briefly describe the purpose of each piece of information and the key used in generating that information.

Q5.

Figure 1 shows the finite state machine of a protocol designed to run over a channel with the following properties: (P_1) can corrupt packet, (P_2) can lose packets, and (P_3) has an unknown round trip time.

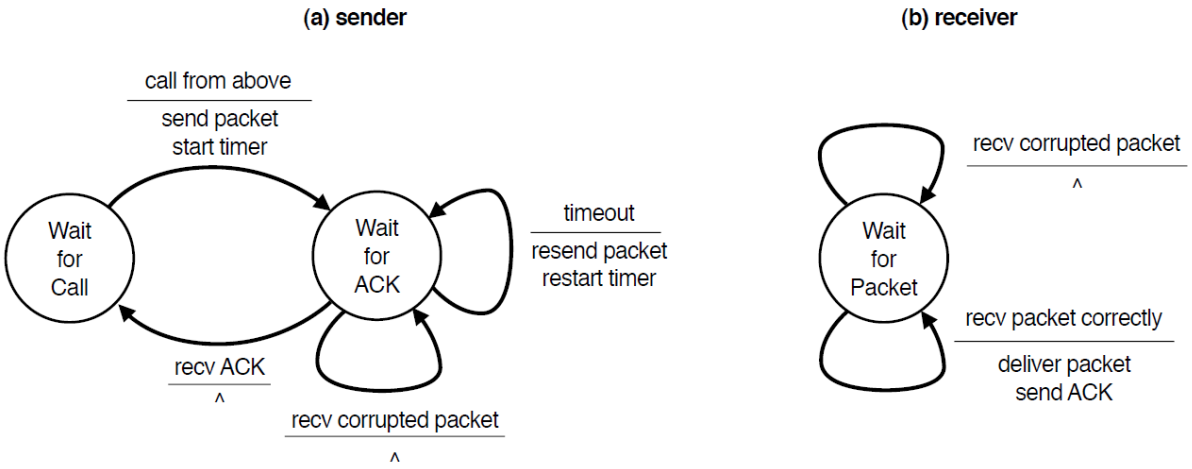


Figure 1: Finite State Machine of a Protocol

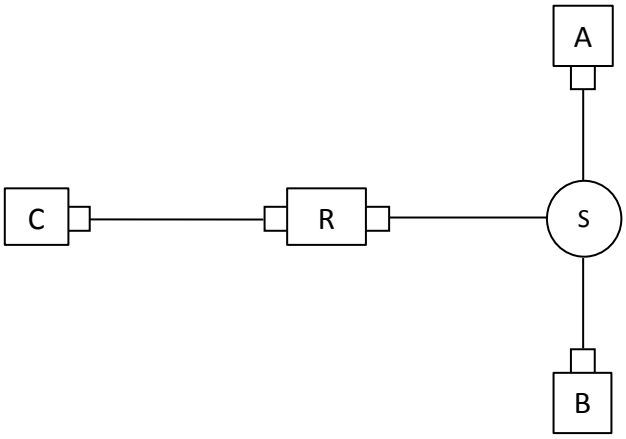
(a) Is it possible for this protocol to deliver the same packet twice to the application? Either give an example where the same packet is delivered twice by drawing a timing diagram, or argue why every packet will only be delivered once.

(b) Is it possible for this protocol to not detect a lost data packet? Either give an example where a lost packet is not detected by drawing a timing diagram or argue why a packet loss is always detected.

(c) Can we remove only one of the network properties P1, P2, P3 so that the protocol works as intended without modification? Justify your answer.

Q6.

The diagram below shows a small network with five entities: hosts A and B are connected to a router R through a switch S. Host C connects to R directly. There is no other host, switch, or router in the network.



(a) What is the maximum number of entries that could be in the switching table of S?

(b) What is the maximum number of entries that could be in the ARP table of A?

(c) What is the maximum number of entries that could be in the ARP table of C?

(d) How many IP addresses are used in this network?

Q7.

A node x is part of a network running distance vector routing protocol. x has three entries in its routing table:

Destination	Cost	Next Hop
w	4	w
y	α	z
z	β	w

α and β are two unknown values (unknown to you, but known to x). Assume that the distance vector routing protocol has converged and the minimum cost from x to every other node has been found. We denote $c(x, y)$ as the link cost between x and y, and $d_x(y)$ as the cost of the minimum cost path from x to y. The link cost is a positive integer.

We know that $c(x, w)$ is 4, and $c(x, z)$ is 10.

(a) What is the minimum possible value for α?

(b) What is the value for $d_w(z)$?

=== END OF PAPER ===