CMPUT 313 - Practice Questions

Typical Exam Header
Time: xx minutes — **Closed Book**
Questions: xx — **Calculators Allowed**

- ***Please, no questions during exam time.***
- ***If you are unsure, write down your assumptions.***
- ***Write legibly (else, you risk losing marks!)***
- ***Answer each question on a separate page.***
- ***Hand-in this exam page at the end of the exam.***

1. Introduction

1.1 Briefly explain (in point-form) each of the following:

(a) access networks

(b) circuit switching, packet switching

(c) nodal processing delay, queuing delay, transmission delay, and propagation delay in store-and-forward networks

1.2 Answer the following questions:

(a) **T/F?** Layers four and five of the Internet protocol stack are implemented in the end systems but not necessarily in the routers in the network core.

(b) **T/F?** In a packet-switched network, every router maintains state information for each connection passing through it (e.g., the number of packets served thus far for the connection).

(c) **T/F?** If all routers on a path between two hosts work properly then the `traceroute` program does **not** generate an output similar to the following. (Note that some reported round-trip delays to router 12 are larger than some reported round-trip delays to router 13).

```
...
11   104 ms    99 ms   105 ms  pat1.dcp.yahoo.com [216.115.101.152]
12   110 ms   101 ms   110 ms  msr1.re1.yahoo.com [216.115.108.67]
13    94 ms   102 ms   101 ms  bas-a2.re1.yahoo.com [66.196.112.201]
...
```

1.3 A 30 Mbit long file is sent from host A to host B. There are two links between A and B, with one router connecting the two links. Assume that each link has a transmission rate $R = 10$ Mbps, each link has length $d = 5,000$ km, the propagation speed through each link is $s = 2 \times 10^8$ meters/sec, and there is no congestion, so a message is transmitted onto the second link as soon as the router receives the entire message.

(a) Find the end-to-end delay assuming the file is sent as one message.

(b) Find the end-to-end delay assuming the file is broken into 3 packets, each of length $L' = 10$ Mbits.

1.4 Chapter 1, P2, page 71, on generalizing equation 1.1: $d_{end\_to\_end} = \frac{NL}{R}$ of sending one packet of length L over N links to a formula for sending P such packets back-to-back over the N links.

1.5 Chapter 1, P7, page 72 (5/E: P6, page 74) (on voice-over-IP packetization delay)

2. Performance Analysis

2.1 Briefly explain (in point-form) each of the following:

(a) basic assumptions of a Poisson process

(b) Little's Theorem

2.2 Each time a modem transmits one bit, the receiving modem analyzes the signal that arrives and decides whether the transmitted bit is 0 or 1. The modem makes an error with probability p, independent of whether any other bit is received correctly.

(a) If the transmission continues until the receiving modem makes its first error, what is the PMF of X, the number of bits transmitted (including the bit(s) in error)?

(b) If the probability of error is $p = 0.1$, what is the probability that $X = 10$? What is the probability that $X > 10$?

(c) If the modem transmits 100 bits, what is the PMF of Y, the number of errors?

(d) If the probability of error is $p = 0.01$ and the modem transmits 100 bits, what is the probability of $Y = 2$ errors at the receiver? What is the probability that $Y \leq 2$?

2.3 The count of packets dropped from a router's buffer is known to be a Poisson process of rate 0.1 drops/sec. Starting with some initial observation instant, let $D(t)$ denote the number of packets that have been dropped after t seconds. What is $P_{D(t)}(n)$ (the PMF of the random variable $D(t)$)?

2.4 Chapter 1, P13 part (a), page 73 (5/E: P13, page 75)

2.5 P14, page 74 (5/E: P14, page 75), considers the queueing delay in a router buffer. The problem denotes the traffic intensity by $I = La/R$, and assumes that the queueing delay takes the from $\frac{IL}{R(1-I)}$. In the classroom, I presented a result on the average packet delay (queueing delay + service delay) in a M/M/1 queue. The following table summarizes the notation used in both settings.

	Pkt arrival rate	Pkt transmission time	Traffic intensity	Avg. queueing only delay	Avg. total delay (queueing + service)
P14 notation	a	$\frac{L}{R}$	$I = \frac{La}{R}$	$\frac{IL}{R(1-I)}$ where $I < 1$	**?**
M/M/1 queue notation	λ	$\frac{1}{\mu} = \frac{L}{R}$	$\frac{\lambda}{\mu}$	**?**	$\frac{1}{\mu-\lambda}$ where $\lambda < \mu$

(a) Verify that the average queueing only delay given above (i.e. $\frac{IL}{R(1-I)}$) is the same as the expression $\frac{1}{\mu-\lambda} - \frac{1}{\mu}$.

(b) Use the above result to deduce that the average delay used in P14 is also given by the M/M/1 queue result presented in the classroom. (See also problem P15).

3. The Application Layer

3.1 Briefly explain (in point-form) each of the following concepts/objects:

(a) services provided by the DNS system

(b) iterative versus recursive DNS queries

(c) HTTP persistent connections with pipelining

(d) differences between the HTTP POST and PUT methods

(e) server-side Web page generation

(f) basic architecture of a CDN (Content Delivery Network)

(g) Is it possible for an organizations Web server and mail server to have exactly the same alias for a hostname (e.g., foo.com)? What would be the type of the RR that contains the hostname of the mail server?

(h) **T/F?** The transfer of an HTML file from one host to another is loss-intolerant and time sensitive.

(i) **T/F?** A server can use cookies to determine a user's postal address without the user's consent.

4. The Transport Layer

4.1 Answer the following questions:

(a) Briefly explain (in point-form) each of the following: flow control, and congestion control in data networks

(b) What information is used by a process running on one host to identify a process running on another host?

(c) List at least three broad classes of services that a transport protocol can provide. For each of the service classes, indicate if either UDP or TCP (or both) provides such service.

(d) **T/F?** The stop-and-wait protocol rdt3.0 is unreliable for channels that reorder packets. Explain.

(e) **T/F?** The GBN protocol with window size N works reliably over channels that do not reorder packets if the sequence number space M is set to $N + 1$.

(f) **T/F?** With the GBN protocol, it is possible for the sender to receive an ACK for a packet that falls outside of its current window.

4.2 Chapter 3, R7, page 286 (5/E: R7, page 297) (on UDP demultiplexing)

4.3 Suppose that the rdt 3.0 sender (Figure 3.15) is modified so that packets are numbered 0, 1, and 2 (instead of just 0 and 1). Draw a FSM of a receiver that works with the modified sender. Use the same function names used in Section 3.4.

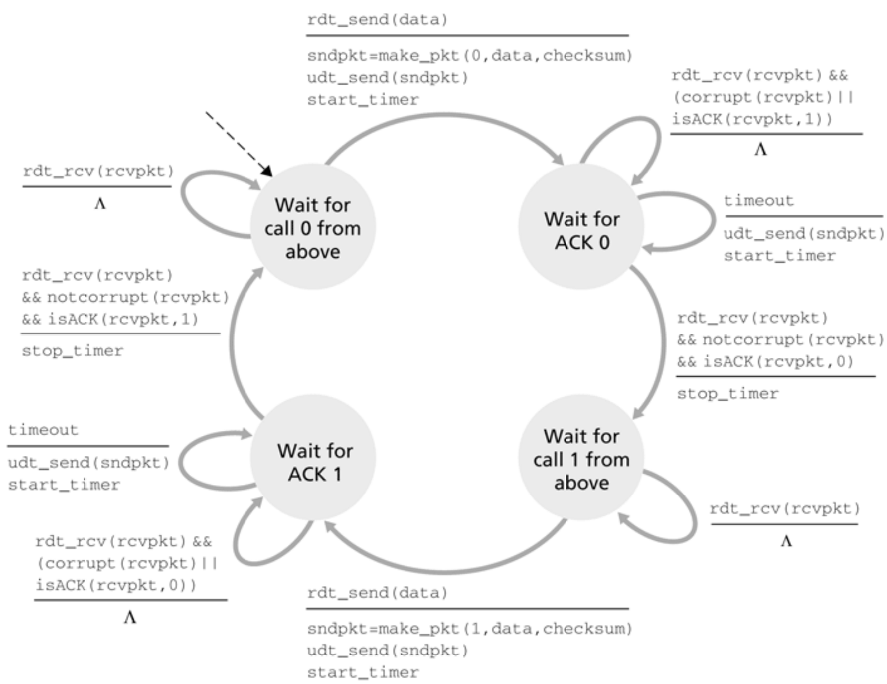

Figure 3.15 ♦ rdt3.0 sender

4.4 In the network shown below, packets are sent from A to C via B. Determine the minimum transmission rate required between B and C so that buffers of B are not flooded (note: in order not to flood the buffers, the average number of packets entering and leaving B must be the same over a long interval).

Assume that

(a) The data rate between A and B is 100 Kbps.

(b) The propagation delay is 10 microsec/mile.

(c) There are full-duplex lines between the nodes.

(d) All data packets are 1000 bits long; ACK packets are separate packets of negligible length.

(e) Between A and B, a sliding window protocol with a window size of 3 is used.

(f) Between B and C, a stop-and-wait protocol is used.

(g) There are no errors.

4.5 A sliding window protocol with a transmission window of size N is used to transmit 8 data packets ($pkt[0]$ through $pkt[7]$) over a channel that does not reorder packets. Assume that

- transmission starts at $t_0 = 0$,
- each packet transmission time $T_{pkt} = 1$ unit, each ACK transmission time is negligible,
- the round-trip time RTT= 5 units, the sender timeout period is set to 6 units, and
- all packets, and ACKs are delivered successfully except for the first transmission of $pkt[1]$ and $pkt[5]$ (both transmissions are corrupted).

For each of the following cases, find the earliest time the sender receives an ACK that allows the sender to conclude that all data packets have been received correctly.

(a) The GBN protocol is used with $N = 4$.

(b) The SR protocol is used with $N = 4$. (**Note:** The SR protocol is **not** part of the midterm exam.)

Note: For each protocol (especially the GBN protocol), assume a careful implementation where if the protocol starts a timeout period for a packet then the period has the duration specified above, and it starts immediately after transmitting the last bit of the packet.

4.6 Assume that the estimated maximum packet lifetime in a network is 2 min, the sender persists in transmitting a packet for 1 minute, the maximum time a receiver can hold a packet before sending an ACK is 500 millisec, and the source does not transmit faster than 2 Mbps. What is the smallest possible sequence number space needed to overcome the problems caused by delayed duplicate packets if the packet size is at least 40 bytes?

4.7 (a) What is the relationship between the variable $SendBase$ in Section 3.5.4, and the variable $LastByteRcvd$ in Section 3.5.5?

(b) What is the relationship between the variable $LastByteRcvd$ in Section 3.5.5, and the variable y in Section 3.5.4?

5. The Network Layer

5.1 Chapter 4, R16, page 414 (5/E: page 422)

5.2 Chapter 4, R36, page 416 (5/E: page 424)

5.3 Chapter 4, P5, page 417 (5/E: page 425)

5.4 Chapter 4, P30, page 423 (5/E: P28, page 431)

5.5 Consider a subnet with prefix 101.101.101.64/26. Give an example of one IP address (of the form `xxx.xxx.xxx.xxx`) that can be assigned to this network. Suppose an ISP owns the block of addresses of the form 101.101.128/17. Suppose it wants to create four subnets from this block, with each block having the same number of IP addresses. What are the prefixes (of the form $a.b.c.d/x$) for the four subnets?

5.6 Chapter 4, P55, page 428 (5/E: P52, page 435):

a. What is the size of the multicast address space?

b. Suppose now that two multicast groups randomly choose a multicast address. What is the probability that they choose the same address?

c. Suppose now that 1,000 multicast groups are ongoing at the same time and choose their multicast group addresses at random. What is the probability that they interfere with each other?

6. Link Layer and Medium Access Control Protocols

6.1 In this question, a *hub* is a simple device that acts as a wire; it has no network interface card.

For the LAN in Fig. 5.33, page 505 (note: the LAN has 3 hubs and 2 routers) (5/E: Fig. 5.38, page 515): Redraw the diagram to include adapters. Assign IP addresses to all of the interfaces: for Subnet 1 use addresses of the form 111.111.111.xxx; for Subnet 2 use addresses of the form 122.222.222.xxx; for Subnet 3 use addresses of the form 133.133.133.xxx. Assign MAC addresses to all of the adapters.

a. Consider sending an IP datagram from Host A to Host F. Suppose all of the ARP tables are up to date. Enumerate all the steps, as done for the single-router example in Section 5.4.1 (5/E: Section 5.4.2).

b. Repeat (a), now assuming that the ARP table in the sending host is empty (and the other tables are up to date).