COE 431 – Computer Networks

Welcome to
The Midterm Exam
Thursday April 11, 2012

Instructor: Dr. Wissam F. Fawaz

Name: _____

Student ID: _____

Instructions:

1. This exam is **Closed Book**. Please do not forget to write your name and ID on the first page.
2. You have exactly **85 minutes** to complete the **seven** required problems.
3. Read each problem carefully. If something appears ambiguous, please write your assumptions.
4. Do not get bogged-down on any one problem, you will have to work fast to complete this exam.
5. Put your answers in the space provided only. No other spaces will be graded or even looked at.

Good Luck!!

Problem I: Multiple choice questions (**15 minutes**) [15 Points]

1. Consider an institutional network employing a web cache with a hit rate of 60%. Assume that this network is connected to the internet through a 20 Mbps access link. Suppose that the average object size is 1 Mbps and that the average request rate from the institution's browsers is 15 requests per second. What is the traffic intensity on the access link?
   a. 1
   b. 0.4
   c. 0.6
   d. Other (give your answer):
2. Which of the following cannot be employed as a push protocol?
   a. HTTP
   b. FTP
   c. SMTP
   d. None of the above
3. A **purely recursive** DNS query from a requesting host would follow the path:
   a. Root name server, local name server, TLD name server, authoritative name server.
   b. Local name server, root name server, local name server, authoritative name server.
   c. Local name server, root name server, TLD name server, authoritative name server.
   d. Authoritative name server, root name server, local name server, TLD name server.
4. Which of the following methods is **often** used in conjunction with web publishing tools?
   a. POST
   b. HEAD
   c. GET
   d. None of the above
5. Consider a server socket object: `socket = new ServerSocket(12345);` What does the invocation `socket.accept()` return?
   a. A TCP connection attached to the server socket.
   b. A socket attached to a new TCP connection.
   c. True if there is a new TCP segment in the socket's buffer; false otherwise.
   d. True if a new TCP connection request has arrived; false otherwise.
6. Under HTTP with persistent connections,
   a. Each requested object suffers a delivery delay of two RTTs.
   b. Each requested object suffers a delivery delay of one RTT.
   c. The first requested object suffers a delivery delay of two RTTs and each of the subsequently requested ones a delivery delay of one RTT.
   d. The first requested object suffers a delivery delay of one RTT and each of the subsequently requested ones a delivery delay of two RTTs.
7. DNS queries typically follow a pattern where
   a. The query from the requesting host to the root DNS server is iterative and the remaining ones are recursive.
   b. The query from the querying host to the local DNS server is recursive and the remaining ones are recursive.
   c. The query to the local DNS server is recursive and the remaining ones are iterative.
   d. None of the above

8. Which of the following maps an alias name to a canonical name?
    a. Type CNAME Record
    b. Type MX Record
    c. All of the above
    d. None of the above.
9. Which of the following actions may reduce the load of HTTP traffic on a local network?
    a. Allowing local machines to store HTTP cookies.
    b. Setting up a local HTTP proxy that caches web content.
    c. Configuring local machines to use UDP instead of TCP for their HTTP connections in order to reduce the connection setup overhead.
    d. All of the above
10. For SMTP, which of the following is **false**?
    a. It uses TCP as its transport layer protocol.
    b. It uses non-persistent TCP connections.
    c. It follows a specific format for the header and the body of mail messages.
    d. None of the above
11. Compared to the TCP/IP protocol stack, which of the following additional layers does the OSI protocol stack contains?
    a. Session layer
    b. Logical Link Control layer
    c. Presentation layer
    d. Both (a) and (c)
12. Which of the following is **true** about TCP?
    a. A TCP segment is guaranteed to reach its destination within RTT seconds.
    b. A message eventually reaches its destination, even if individual TCP segments get dropped.
    c. Packet switches never drop TCP segments.
    d. None of the above
13. Assume that you are accessing your email through a webmail interface. What protocol does your web browser use to communicate with the mail server and retrieve your incoming email messages?
    a. IMAP
    b. POP3
    c. Either of the above
    d. None of the above
14. Which of the following is **true** about the DNS protocol?
    a. It uses UDP because UDP offers unreliable message delivery.
    b. It uses TCP, because TCP is faster than UDP.
    c. It uses UDP because UDP is connectionless.
    d. None of the above
15. Which of the following regarding UDP is **true**?
    a. UDP segments have a smaller segment header size as compared to TCP segments.
    b. Routers always give higher priority to UDP segments. This is because real-time applications are known to use UDP as their transport layer protocol.
    c. An application using UDP can never have reliable data transfer
    d. None of the above

Problem II: Comparing terminologies (**10 minutes**) [10 Points]

What is the difference between each of the following pairs of concepts?

1. HTTP and HTTP coupled with cookies

2. HTTP Request and HTTP Response

3. UDP socket and TCP socket

4. OSI protocol stack and TCP/IP protocol stack

5. Packet switching and circuit switching

Problem III: Web Cache (**10 minutes**) [10 Points]

Consider an institutional network that is connected to the Internet via a 15 Mbps access link. Suppose that the average object size is 900 Kbits and that the average request rate from the institution's browsers to the origin servers is 15 requests per second. Also suppose that the amount of time it takes from when the router on the Internet side of the access link forwards an HTTP request until it receives the corresponding response message is two seconds on the average. Model the total average response time as the sum of the average access delay (that is, the delay from Internet router to institution router) and the average Internet delay. For the average access delay, use $\Delta/(1-\Delta\beta)$, where Δ is the average time required to send an object over the access link and β is the arrival rate of objects to the access link.

1. Find the total average response time

2. Now suppose a cache is installed in the institutional LAN. Suppose the hit rate is 0.4. Find the total response time

Problem IV: Queueing delay (**10 minutes**) [15 Points]

1. A packet switch receives a packet *P* and determines the outbound link to which the packet *P* would be forwarded. When the packet *P* arrives, one other packet is halfway done being transmitted on this outbound link and three other packets are waiting to be transmitted. Packets are transmitted in order of arrival. Suppose all packets are 1250 bytes long and the link rate is 1 Mbps. What is the queueing delay for the newly arriving packet *P*?

2. Suppose *N* packets arrive simultaneously to a link to which no packets are currently being transmitted or queued. Each packet is of length *L* and the link has a transmission rate of *R*. What is the average queueing delay for the *N* packets?

Problem V: Persistent/non-persistent (**10 minutes**) [15 Points]

Suppose within your web browser you click on a link to obtain a Web page. The IP address for the associated URL is not cached in your local host, so a DNS lookup is necessary to obtain the IP address of the server. Suppose that the usual four DNS servers of the DNS hierarchy of servers are visited before your host receives the IP address from DNS; the successive visits incur an *RTT* of RTT_1, RTT_2, RTT_3, and RTT_4. Further suppose that the web page associated with the link contains a base HTML file that references 3 very small objects. Let RTT_0 denote the *RTT* between the local host and the server containing these objects. Neglecting the transmission time of all the objects that make up the webpage, how much time elapses from when the client clicks on the link until the client receives the entire webpage with:

1. Non-persistent HTTP with no parallel TCP connections?

2. Persistent HTTP with no pipelining?

3. Non-persistent HTTP with a maximum of 3 parallel connections?

4. Persistent HTTP with a maximum of 3 pipelined requests?

Problem VI: Internet delays (**10 minutes**) [15 Points]

Consider a packet of length L that begins at end system A, travels over one link to a packet switch, and then travels from the packet switch over a second link to a destination end system B. Let d_i, s_i, and R_i denote the length, propagation speed, and the transmission rate for link i, for i=1, 2. The packet switch delays each packet by d_{proc}.

1. Assuming no queueing delays, write the total end-to-end delay (from A to B) in terms of d_i, s_i, R_i, and L?

2. Suppose now the packet length is 1000 bytes, the propagation speed on both links is 2.5×10^8 m/s, the transmission rates of both links are 1 Mbps, the packet switch processing delay is 2 msec, the length of the first link is 6000 km, and the length of the second link is 3000 km. For these values, what is the end-to-end delay?

Problem VII: Socket Programming (**20 minutes**) [20 Points]

Consider the following Java program:

```
1: public class UDPServer {
2:    public static void main(String[] args) throws IOException {
3:          DatagramSocket serverSocket = new DatagramSocket(9876);
4:          byte[] sendData = new byte[128];
5:          byte[] receiveData = new byte[128];
6:          while(true) {
7:                String line;
8:                String modifiedLine;
9:                DatagramPacket receivePacket = ...;
10:               ...                              ;
11:               line = new String(receivePacket.getData());
12:               System.out.println("Line received: "+line);
13:               modifiedLine = line.toUpperCase();
14:               InetAddress IPAddress= ...;
15:               int port = ...;
16:               sendData = modifiedLine.getBytes();
17:               DatagramPacket sendPacket = ...;
18:               System.out.println("Line sent: "+modifiedLine);
19:               ...                             ;
20:         }
21:   }
22: }
```

1. Complete the lines where an ellipsis appears (i.e., lines 9, 10, 14, 15, 17, and 19).

2. Extend the server to print the IP address of every connecting client. Use line numbers to indicate which lines should be changed/removed and where a new code should be added?

3. Assume that 3 different machines connect to the server (sequentially) . As a result, how many Socket objects will be created by the server? How many UDP ports will be assigned to the server (not including the already assigned port number 9876)?

4. Complete the code of the UDP client given below. This client reads one line from the user, sends it to the server, and displays the answer on its screen. For simplicity, ignore exception handling.

```
public class UDPClient {
      public static void main(String[] args) throws Exception {









      }
}
```

5. Implement a program that lists the ports between 4096 and 8192 that are already busy (i.e., assigned to UDP servers or clients on the local machine). The information printed out to the screen should be of the following format: “UDP port # is busy”. Complete the code skeleton given below.

```
public class UDPScanner {
      public static void main(String[] args) {
            for(int i=4096; i < 8192; i++) {
                  try {









                  } catch(Exception e) {









                  }
            }
      }
}
```