Computer Networks
31st of March 2011

- This exam consists of 7 questions with subquestions. Every subquestion counts for 10 points.
- Mark every page with name and student number.
- Use of books, or additional course material is prohibited. You may use a calculator.
- Always explain your answers. At the same time, keep your answers short and to the point. Do not use pencil or red ink.

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1. **Yes or no.**

   Please answer yes or no to the following questions. The full question is worth 10 points: you are awarded 1 point for each correctly answered subquestion. However, each wrongly answered question results in -1 point. Don't answer at random since this will decrease your score. Concentrate on the questions you can answer with certainty. *If needed, you are allowed to add one line of explanation to each answer – but no more.*

   i. Stop-and-wait is less wasteful than Go-Back-N (in terms of retransmissions), but provides lower resource utilisation.

   ii. Circuit switching with hard resource reservation is guaranteed to provide better quality of service than best-effort packet switching, regardless of the load of the network.

   iii. One advantage of persistent HTTP connections is that the client browser needs to send the cookies to the server only once, rather than for each HTTP request.

   iv. In an iterative query, all DNS servers between the local DNS server and the eventual authoratitive DNS server receive only one DNS message on behalf of the query, while in a recursive query, these servers receive two messages[1].

   v. SMTP can be used by users to access their mail on the server (e.g., to read the messages).

   vi. CSMA/CD demands that a station has to wait a random time in case of collision before trying a new transmission

   vii. Exponential back-off in Ethernet helps to avoid starvation (i.e., every host will probably have a chance to transmit eventually).

   viii. In Slotted Aloha, hosts must wait until the start of a slot before they can start transmitting. Thus, it is less efficient than non-slotted Aloha, which does not have this constraint.

   ix. Distance vector routing algorithms scale better than link state routing algorithms (e.g., they can handle more nodes).

   x. Bluetooth uses a CSMA/CD protocol

2. **Shared Ethernet**

   In some network technologies, like traditional shared Ethernet, multiple hosts share the same medium - a wire. Assume that the current standard says that the maximum length of the cable is L. If we were to double the maximum length of the wire (e.g., in a new version of the standard) to $2L$, *explain* whether the minimum frame length would (a) increase, (b) decrease, (c) remain the same. Assume the data rate does not change.

[1] So ignore first and last servers

3. **Sockets.** Consider the following Java Code:

```
1:  public class TCPServer {
2:     public static void main(String argv[]) throws Exception {
3:        String clientSentence;
4:        String capitalizedSentence;
5:        ServerSocket welcomeSocket = new ServerSocket(6789);
6:        while(true) {
7:           Socket connectionSocket = ... ;
8:           BufferedReader inFromClient = new BufferedReader(
9:             new InputStreamReader(connectionSocket.getInputStream()));
10:          DataOutputStream outToClient = new DataOutputStream(
11:            connectionSocket.getOutputStream());
12:          clientSentence = inFromClient.readLine();
13:          capitalizedSentence = clientSentence.toUpperCase() + \n;
14:          outToClient.writeBytes(capitalizedSentence);
15:       }
16:    }
17: }
```

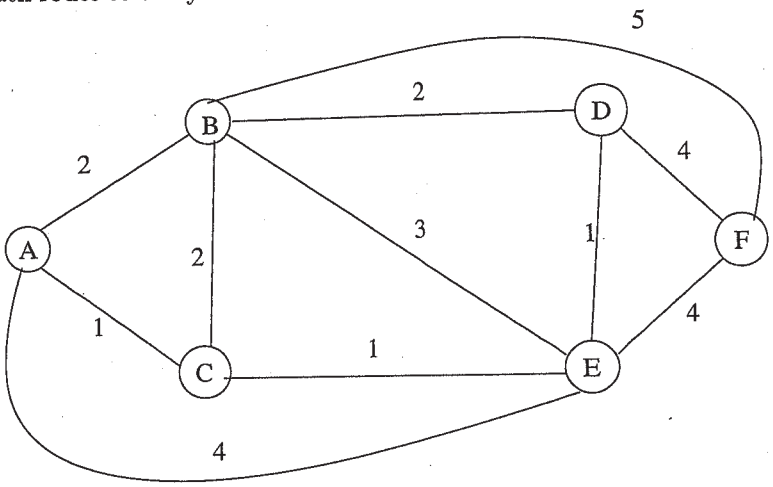
(a) Subquestion (i): Line (7) needs to be completed. Should it read:
(a) `new Socket("hostname", portnumber)`,
(b) `new DatagramSocket()`, or
(c) `welcomeSocket.accept()`
Subquestion (ii): can this server handle multiple connections at the same time? Explain.

(b) Assume that 3 different machines connect to the server (sequentially). As a result, how many Socket objects will be created by the server, and how many TCP ports will be assigned to the server (not including the already assigned port 6789)?

4. **Routing**

The Dijkstra Routing Algorithm is a link state routing algorithm where every node knows the topology of the network and the cost of every link.

(a) For the network shown in the figure, indicate all the steps taken by node A until it establishes the shortest path route to every other node in the network. Show each iteration of the protocol.



(b) Is a misbehaving/lying router (i.e., a router that advertises erroneous routing information) more of a problem in link state routing, or in distance vector routing? Explain why.

5. **Address resolution**

Show the steps taken within a local ethernet network when a machine `herbert` with IP address 192.168.1.10 wishes to send an IP packet to a machine `andy` with IP address 192.168.1.53. Assume that all ARP caches are empty, and that `herbert` already knows `andy`'s IP address, and has a direct IP route to `andy`.

6. **Reliable transmission and TCP**

(a) Sliding windows. Explain the sliding window protocol. What is the interest of using it when compared to a stop-and-wait protocol?

(b) Sliding windows. Draw a timeline diagram for the transfer of frames on a point-to-point network from a sender node to a receiver node. The diagram should show the time period starting with transmission of frame 0 by the sender and up to the time when the sender successfully receives an acknowledgment for frame 7. The following should hold:

- During transmission the third frame (frame 2) is lost.
- The sliding window algorithm is used with sending window size = 4 frames and receiver window size = 3 frames. The receiver uses cumulative ACKs.
- Assume a timeout interval of about 2 x RTT (round-trip time). Moreover, assume that the transmission time (insertion time) of a frame is equal to 0.25 RTT[2].
- At the receiver, assume that frames can be processed instantaneously if they arrive in order.
- On each data frame and ACK frame, indicate the frame number (start from 0).
- In addition, you need to indicate what action is taken by the receiver when a frame is received, for example: Processed, Buffered, or Discarded.

(c) Why is it important to get a good value for the retransmission timeout? How is this value set in TCP?

(d) Explain the TCP connection release procedure. What information is exchanged, for what reason?

(e) Explain why TCP is fair. Is it still fair if one of the parties opens 10 connections for the same application (while all others simply use 1 connection)?

7. **Mobile IP.**

(a) In mobile IP with indirect routing, will the end-to-end delays of datagrams increase (compared to communication with a fixed host)? Justify your answer. What if direct routing is used?

(b) What are the advantages and disadvantages of direct routing over indirect routing?

[2]So, if a frame arrives at time t, the ACK will be sent at $t + 0.25RTT$ (similarly, if an ACK arrives at time t which prompts you to send a new frame, the new frame will be sent at $t + 0.25RTT$).