## Always explain your answers concisely and be sure to be to-the-point.

*1a* Explain the difference between a connectionless and a connection-oriented communicaton service.     *5pt*

*1b* Give an example of a connection-oriented service that is implemented by means of a connectionless service, and vice versa.     *5pt*

*1c* What is the difference between a (virtual) circuit and a connection-oriented service?     *5pt*

*2a* Explain how the transmission speed of a modem having a fixed baud rate can be increased.     *5pt*

*2b* Telephone modems such as those for ADSL make use of modulation techniques. Why?     *5pt*

*3* The following program is an implementation of a protocol. Explain the principal working of that protocol (i.e., do *not* describe the program).     *10pt*

```
01 void protocol (void) {
02   seq_nr next_frame_to_send, frame_expected;
03   frame r, s;
04   packet buffer;
05   event_type event;
06
07   next_frame_to_send = 0; frame_expected = 0;
08   from_network_layer(&buffer);
09   s.info = buffer;
10   s.seq  = next_frame_to_send;
11   s.ack  = 1 - frame_expected;
12   to_physical_layer(&s); start_timer(s.seq);
13
14   while (true) {
15     wait_for_event(&event);
16     if (event == frame_arrival) {
17       from_physical_layer(&r);
18       if (r.seq == frame_expected){
19         to_network_layer(&r.info);
20         inc(frame_expected);
21       }
22       if (r.ack == next_frame_to_send){
23         from_network_layer(&buffer);
24         inc(next_frame_to_send);
25       }
26     }
27     s.info = buffer;
28     s.seq = next_frame_to_send;
29     s.ack = 1 - frame_expected;
30     to_physical_layer(&s); start_timer(s.seq);
31   }
32 }
```

*4a* Explain how fragmentation of frames in a wireless protocol can increase reliability.     *5pt*

*4b* IEEE 802.11 frames can have a payload of 2312 bytes, whereas an IEEE 802.3 (Ethernet) frame can carry up to 1500 bytes of data. Assume the 802.11 frames are fragmented into parts containing no more than 1500 bytes of data. Explain what happens at a bridge connecting the two types of networks.     *5pt*

*5a* Explain the principal working of distance vector routing.     *10pt*

*5b* Explain what the count-to-infinity problem is.                                                      *5pt*

*5c* BGP uses distance vector routing, but does not have the count-to-infinity problem. Why not?          *5pt*

*6* Transactional TCP is a refinement of TCP for handling request-reply behavior. Its principal working is sketched below. All T/TCP processes can also follow TCP.
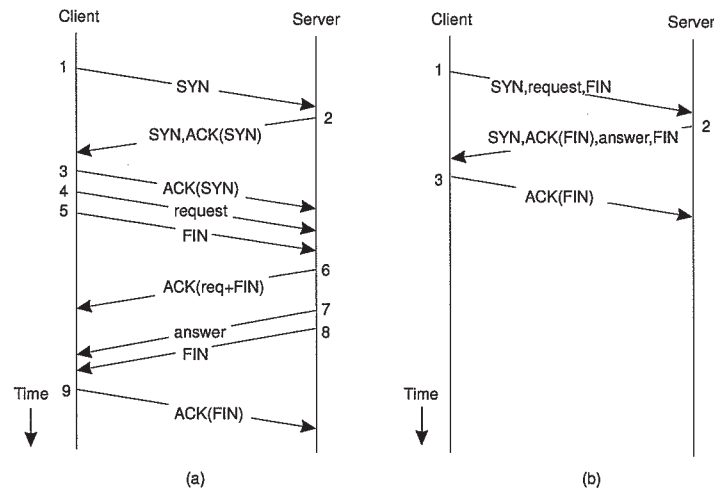


(a) Request-reply behavior for normal TCP; (b) the same for transactional TCP.

*6a* Which messages from TCP correspond to message #1 in transacational TCP? How would you interpret this message #1?                                                                                          *5pt*

*6b* Assume the server does not implement T/TCP, but only TCP. How it will it react after receiving message #1 from the (T/TCP) client? What will the client then do?                                            *5pt*

*7a* Explain why it is useless to provide authentication without checking message integrity and vice versa.                                                                                                       *5pt*

*7b* Give a simple authentication protocol that is based on public-key cryptography.                      *5pt*

*7c* In many security protocols, after Alice sends a message $K(N)$ to Bob, where she encrypts the nonce $N$ with a key $K$, Bob responds with $K^*(N-1)$. Why is Bob forced to change $N$ in his response?          *5pt*

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**Grading:** *The final grade is calculated by accumulating the scores per question (maximum: 90 points), and adding 10 bonus points. The maximum total is therefore 100 points.*