Dept. Math. & Comp. Sc.	Midterm Computer Networks
Vrije Universiteit	23.03.2004

1a What is the difference between a *point-to-point* network and a *peer-to-peer* network? *5pt*

The difference is mainly a logical one. In a point-to-point network, the nodes that constitute the physical network are pairwise connected through hardware (not all pairs need to be connected, however). In a peer-to-peer network, the connectivity is at a logical level: each node can run client as well as server software; a client can set up a connection to a server. Peer-to-peer networks are generally established at the application level, whereas point-to-point networks are generally realized at layers 1-3 of the OSI model.

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

A connection-oriented service is characterized by the fact that data exchange can take place only through a previously established connection. In a connectionless service, data can be sent by simply providing the destination's address. Note that data that is communicated through a connection does not necessarily follow the same route*! It will cost you points if you mention otherwise.*

2a What does Fourier analysis teach us about sending digital signals? *5pt*

It tells us that a digital signal can be thought of as being constructed as an infinite sum of sine waves of increasing frequency. Because actual media propagate waves differently depending on their frequency, we can then understand why a full-fledged digital signal may look completely different between the place where it is sent through a medium, and where it is received.

2b Consider a network in which a switch can be set by sending it a message (through a separate network) telling it to route packets (from A) coming in on interface In_i to interface Out_j. In this way, it is possible to set up a *virtual circuit* from A to B by properly setting all switches between A and B. Would you call this scheme circuit switching or packet switching? Motivate your answer! *5pt*

In a circuit-switched network, a physical connection is set up between A and B before a packet can be sent. This also happens in this example, although there is clearly a soft side to it. For this reason, you could argue the scheme corresponds to circuit switching. In a packet-switching network, packets are routed independently. One can argue that this independent routing also holds for packets from different sources (even if those sources reside on the same machine). Also, the proposed scheme makes use of store-and-forward transmission. The distinction between the two types of switching has blurred, but offers enough material to start another holy technical war. By the way, ATM networks make use of the proposed scheme.

3a Consider a 1-bit error correcting code that uses 3 redundant bits. If p is the probability that the transmission of a single bit fails, what is the probability of successfully transmitting a frame containing m data bits? Note that the total frame length is $m + 3$ bits. *5pt*

The complete frame contains $m+3$ bits. At most one bit may be damaged. Therefore, the probability of successfully transmitting an entire frame is $\underbrace{(1-p)^{m+3}}_{\text{OK}} + \underbrace{(m+3)p(1-p)^{m+2}}_{\text{1 bit damaged}}$

3b Now consider a 1-bit error-detecting code that uses 1 redundant bit. For which value of p is this code a better alternative if frames are sent only once? *5pt*

We need to compare the chances of a one-shot successful frame transmission. For the error-detecting code, the probability that a frame is successfully transmitted is $(1-p)^{m+1}$. We then need to solve the inequality $(1-p)^{m+1} > (1-p)^{m+3} + (m+3)p(1-p)^{m+2}$, which leads to $p > \frac{m+1}{m+2}$. Note that this will hardly ever be the case.

4a Explain the hidden and exposed station problem in wireless networks, and how these problems are solved. *5pt*

Consider four stations in a straight line: A, B, C, D, each only within range of its neighbor. If A wants to send to B, B must get into receiving mode, and C should not be allowed to send. A is called *a hidden station for C, as C cannot sense that A wants to transmit. Conversely, if B wants to send to A, and C to D, then D will be exposed to the transmission of B, because C does not know that its own transmission will not interfere with that of B. The solution is to make use of RTS (request to send) and CTS (clear to send) packets. When C hears only CTS, it knows it should stay quiet. If C hears only RTS, it knows tit can safely transmit to D.*

4b Consider a home network consisting partly of a 802.3 (10/100 Mbps Ethernet) network and partly of a 802.11b (11 Mbps wireless LAN) network. The two parts are connected by means of a bridge. What are the main problems to solve when a wireless station communicates with a host connected to the Ethernet segment. *5pt*

The main problem is that an Ethernet frame is restricted to 1500 bytes of data, whereas a WLAN frame can contain up to 2312 bytes. Furthermore, WLAN nodes can fragment their frames, which cannot be handled by the Ethernet node. Therefore, unless the bridge can handle fragmentation, fragmentation should be avoided. Finally, there is the speed issue: the Ethernet station should stick to 10 Mbps. By-and-large, bridging 802.3 and 802.11b works quite well.

4c Consider two 10 Mbps Ethernet segments that need to be connected. What is the difference between the use of a repeater and a switch? *5pt*

It's subtle, but important: with the repeater, the two segments together form logically a single Ethernet segment, and are thus restricted to the maximum number of stations and maximum segment length, for example. When using a switch, this is no longer the case: you can have more stations and the total length of the two segments taken together may exceed the maximum as specified for a single segment.

Grading: *The final grade is calculated by accumulating the scores per question (maximum: 45 points), and adding 5 bonus points. The maximum total MT is therefore 50 points. The final exam consists of two parts. Part 1 covers the same material as the midterm. Let $P1$ be the number of points for part 1, and $P2$ the number of points for part 2 (each being at most 50 points). The final grade E is computed as $E = \max\{MT, P1\} + P2$. The midterm exam counts only for first full exam.*