Dept. Math. & Comp. Sc. **Midterm Computer Networks**
Vrije Universiteit **31.03.2006**

1a What did Nyquist show? *5pt*

Nyquist showed that when you send a signal through a channel having a bandwidth of H Hz, that the signal can be completely reconstructed by taking $2H$ samples. Consequently, if there are V different signal values, the maximum transmission speed is $2H \log_2 V$ bits per second.

1b Why do we often need modulation techniques? *5pt*

We need modulation techniques so that we can actually send digital streams through a channel. The problem is that sending a truly digital signal through a channel will be deformed by the time it reaches the end. This deformation is often caused by the limited maximum frequency that a channel can support (i.e., limited bandwidth), along with the fact that propagation speed and attenuation are frequency dependent. For a digital (block) signal, which we can think of as being composed from an infinite series of analog sine waves, this means that the result at the other end will look very different from what was originally sent, potentially making detection of the signal's value difficult or impossible.

1c What is the role of a splitter in ADSL? *5pt*

An ADSL channel is subdivided into a number of channels, each having a bandwidth of 4 KHz. One of these channels corresponds to the original POTS channel used for telephone. The splitter is nothing but a combination of a low-pass and high-pass filter that separates this POTS channel from the other channels. The other channels can then be used for the ADSL communication.

2a Suppose you use the bit string 10101010 as frame delimiter. Show how bit stuffing works by means of an example. *5pt*

*Assume you want to transmit 1010101010101010 as data. We need to prevent that the pattern 10101010 occurs in the payload of a frame. This can be accomplished by sending 101010**1**0 10101**1**010. Admittedly, having 10101010 as frame delimiter is not a very good idea.*

2b Consider the following received bit string while using the Hamming 1-bit correcting code. What was the originally transmitted bit string? Explain you answer. *10pt*

R:	1	1	1	1	1	1	0	0	0	1	1

Using the same notation as in the book and on the sheets, we get the following coding scheme. The string C represents the correction of the bits receieved as R, leading the the (correct) final result F.

	b1	***b2***	*b3*	***b4***	*b5*	*b6*	*b7*	***b8***	*b9*	*b10*	*b11*
1	***X***		*X*		*X*		*X*		*X*		*X*
2		***X***	*X*			*X*	*X*			*X*	*X*
4				***X***	*X*	*X*	*X*				
8								***X***	*X*	*X*	*X*
C:	***1***	***0***	*1*	***0***	*1*	*1*	*0*	***0***	*0*	*1*	*1*
R:	***1***	***1***	*1*	***1***	*1*	*1*	*0*	***0***	*0*	*1*	*1*
F:	***1***	***1***	*1*	***1***	*1*	*0*	*0*	***0***	*0*	*1*	*1*

3a Explain the difference between 1-persistent, nonpersistent, and p-persistent CSMA protocols. *5pt*

1-persistent *Listen whether the channel is free before transmitting. If busy, wait until it becomes free and then immediately start your transmission.*

Nonpersistent *Less greedy – when the channel is busy, wait a random period of time before trying again.*

p-Persistent *Used with slotted systems. If you find the channel idle during the current slot, you transmit with probability p, and defer until next slot with probability $1 - p$.*

3b The contention period in CSMA/CD protocols should be larger than $2T_{prop}$ where T_{prop} is the maximal propgation time for a signal. Why? *5pt*

In order to detect a collision, channel A will need to continue transmitting (and listening at the same time) until its first bit has reached the end of the channel, which takes T_{prop} time. In addition, if just before the arrival of that signal at B, B started a transmission, B signal will have to make it to A before A can detect that a collision has occurred.

3c The IEEE 802.11 protocol supports frame fragmentation. How does this help improve the reliability of frame transmission? *5pt*

Sending long frames increases the chance of an error occurring. Shorter frames have a higher chance of making it to the receiver. Combining this with frame retransmissions now allows us to resend parts of a frame (if necessary), effectively increasing the chance of successively receiving the entire frame.

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.*