

Name	Initials	Student number	Study

Examination Mobile & Wireless Networking (262001)

April 9, 2009

13.30 – 17.00

Notes:

- Only the overhead sheets used in the course, 2 double sided sheets of notes (any font size/density!), and a dictionary are allowed as reference material. Use of the book by Schiller or any other material is not allowed.
- Use of PDA, laptop, mobile phone etc. is not allowed. Please switch off your mobile phone.
- Although the questions are stated in English, you may answer in English or Dutch, whichever you are more comfortable with.
- Please provide your answers on this form. If you need more space, you may use extra sheets of paper.
- Indications like “[10]” at questions mean that you can obtain 10 points for that question.
- Fill in your name, student number, etc. at the top of this form, and on any extra sheets you are using.

Grading:

Question	1	2	3	4	5	Total
Score						
Maximum	12	18	17	10	12	69

Abbreviations

CDMA	-	Code Division Multiple Access
CSMA/CA	-	Carrier Sense Multiple Access with Collision Avoidance
CTS	-	Clear To Send
CW	-	Contention Window
DCF	-	Distributed Coordination Function
DIFS	-	DCF Inter-Frame Spacing
DSR	-	Dynamic Source Routing
FDD	-	Frequency Division Duplex
FDM	-	Frequency Division Multiplexing
GSM	-	Global System for Mobile Communication
IEEE	-	Institute of Electrical and Electronics Engineers
IP	-	Internet Protocol
ISI	-	Inter Symbol Interference
LAN	-	Local Area Network
OFDM	-	Orthogonal Frequency Division Multiplexing
OVSF	-	Orthogonal Variable Spreading Factor
RTS	-	Request To Send
SIFS	-	Short Inter-Frame Spacing
TCP	-	Transmission Control Protocol
TDD	-	Time Division Duplex
UMTS	-	Universal Mobile Telecommunication System
W-CDMA	-	Wideband CDMA

- f) W-CDMA uses Frequency Division Duplex (FDD). A Time Division Duplex (TDD) technique has also been defined for UMTS. Would it be possible to use Code Division Duplex for UMTS? Why (not)? [2]
- g) In W-CDMA, the chip rate is 3.84 Mchip/s. How can W-CDMA, given this fixed chip rate, support a wide range of different data rates? [2]
- h) Are the OVSF codes 1, -1, 1, -1 and 1, -1, -1, 1 orthogonal? [1]
- i) Is the OVSF code 1, -1, 1, -1, -1, 1, -1, 1 orthogonal to 1, -1, 1, -1 ? [1]
- j) Is 1, 1, 1, 1, -1, -1, -1, -1, -1, -1, -1, -1, 1, 1, 1, 1 orthogonal to 1, -1, 1, -1 ? [1]

3 Wireless LAN [17]

- a) There is a fundamental difference between CSMA/CA and the Aloha access mechanism, which makes that CSMA/CA is much more efficient than Aloha. However, as a consequence of this difference, CSMA/CA cannot be used in all situations where Aloha is currently used. [3]

What is this difference?

How does it make CSMA/CA more efficient?

Why can CSMA/CA not be used in all situations where Aloha is currently used?

- b) In the IEEE 802.11 CSMA/CA access mechanism, how does a station know if a frame it transmits experiences a collision or not? [2]
- c) Why does the IEEE 802.11 CSMA/CA access mechanism use a number of different inter-frame spacings, such as SIFS and DIFS. [2]

In the following subquestions, we explore the IEEE 802.11 CSMA/CA access mechanism further. We make the following assumptions: 1 slot = 20 μ s; SIFS = 10 μ s; DIFS = 2 slots + SIFS; $CW_{\min} = 7$ slots; $CW_{\max} = 255$ slots; transmission of a complete data frame takes 1000 μ s; transmission of a complete acknowledgement frame takes 250 μ s; propagation delay is negligible, no transmission errors occur, and no RTS/CTS is used. Now, suppose two stations A and B want to transmit a data frame to an access point.

- d) How large is the probability that a collision occurs between the frames from A and B if the medium is idle when station A starts the access procedure, and station B starts the access procedure 20 μ s after station A? Explain your answer. [2]
- e) How large is the collision probability if station A and B start the access procedure at exactly the same time, when the medium is idle? Explain your answer. [2]
- f) What is the collision probability if station A and B start the access procedure at exactly the same time, and the medium is still busy (used by some third station) at this time? Explain your answer. [2]

Let us now consider the maximum access delay for these two stations, A and B. We again assume that both stations have (only) one data frame to transmit, and that the medium is busy at the moment they start the access procedure. We consider the case that no collision occurs, i.e., that one of the stations, let's say A, gets access to the channel first.

- g) What is the maximum (worst case) delay from the moment the medium becomes idle until the moment that the first node, A, gets access to the channel (starts transmitting its data frame)? Explain your answer. [2]

- h) What is the maximum delay from the moment the medium **first** becomes idle until the moment that the second node, B, gets access to the channel? Note that this delay includes the time that the medium is busy because of the transmission of node A. Explain your answer. [2]

4 Ad Hoc Networks [10]

The book by Schiller lists four fundamental differences between wired networks and ad-hoc wireless networks. These are (1) asymmetric links, (2) redundant links, (3) interference, and (4) dynamic topology.

- a) Explain for each of these differences why it makes routing in ad hoc networks more difficult than in wired networks. [4]

asymmetric links:

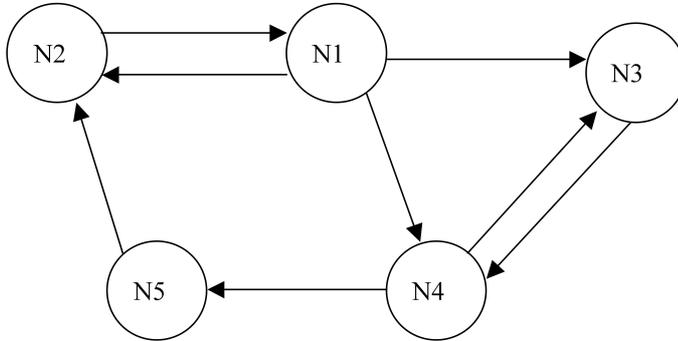
redundant links:

interference:

dynamic topology:

- b) Explain what the principle is of proactive and reactive routing protocols and under what circumstances one is better than the other. [2]

- c) In the following example of an ad hoc network, nodes are linked by asymmetric and symmetric radio links, indicated by the edges in the graph. Consider the case where node N1 wants to send a packet to node N5 for the first time. Show how N1 finds the route from N1 to N5 using Dynamic Source Routing (DSR). Describe the message exchanges and actions taken by nodes. [4]



e) Suppose, the slave receives a transmission from a different piconet. How can it detect that the packet belongs to a different piconet? [2]

f) How does a slave know which frequency to listen to next? [2]