Examination Mobile & Wireless Networking (192620010)
April 12, 2012
13.45 – 17.15

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.*

- *Indications like "[10]" at questions mean that you can obtain 10 points for that question.*

Abbreviations

AIFS	-	Arbitrary Inter Frame Spacing
AMC	-	Adaptive Modulation and Coding
ARQ	-	Automatic Repeat reQuest
AODV	-	Ad-hoc On-demand Destination Vector (routing)
CDS	-	Channel-Dependent Scheduling
CTS	-	Clear To Send
CW	-	Contention Window
DSR	-	Dynamic Source Routing
EDCA	-	Enhanced Distributed Channel Access
FDM	-	Frequency Division Multiplexing
GSM	-	Global System for Mobile Communication
HSDPA	-	High Speed Downlink Packet Access
LAN	-	Local Area Network
OFDM	-	Orthogonal Frequency Division Multiplexing
OFDMA	-	Orthogonal Frequency Division Multiple Access
OVSF	-	Orthogonal Variable Spreading Factor
RREQ	-	Route REQuest
RTS	-	Request To Send
S/I	-	Signal to Interference ratio
TXOP	-	Transmission OPportunity
UMTS	-	Universal Mobile Telecommunication System
2G	-	2nd Generation (cellular systems)
3G	-	3rd Generation (cellular systems)

1   Wireless Transmission / Medium Access Control [7]

a) Why is reflection of radio waves both useful and harmful? [2]

b) Explain the basic principles of OFDM. What is the essential difference between OFDM and FDM? Explain the meaning of the word "orthogonal" in the acronym. [3]

c) Give the names of 3 different wireless systems that use OFDM (or OFDMA). [2]

2   Cellular systems [16]

a) What is the main advantage of reducing the cell size in a cellular system? What is the main disadvantage? [3]

b) In a cellular system, what is the effect of increasing the location area size on the volume of signaling traffic for the location update procedure? And for the paging procedure? Explain your answer. [3]

c) How is the volume of signaling traffic for the location update procedure influenced by the behavior of the users of the cellular network? And the volume of traffic for the paging procedure? Explain your answer. [3]

The signal to interference ratio (S/I) of a cellular system with omni-directional antenna can be approximated by the following expression (in linear scale), if only the first tier of interferers is taken into account:

$$S/I = \frac{R^{-\nu}}{6D^{-\nu}},$$

where R denotes the cell radius, D the reuse distance, and ν the path loss exponent.

d) For a cellular system with sectorized antenna with 60° sectors, this expression will change to:
$$S/I = \frac{R^{-\nu}}{D^{-\nu}}.$$
Explain why. [2]

e) How would the expression for a system with omni-directional antenna change if not only the first tier, but also the second tier of interferers was taken into account? Give the expression for this improved approximation. [3]

f) How will the signal to interference ratio of the system be affected if power control is used in the system? Why? You should qualitatively describe the effect it will have on the expression. [2]

3 GSM - UMTS [11]

a) In the evolution path from 2G cellular systems (GSM) to 3G cellular systems (UMTS), two main intermediate upgrades to GSM have been defined. Which are these? What was their main improvement in service provided to the end user? In which part of the network (which nodes) was the largest impact, i.e., where had most modifications to be made? [4]

b) Is the OVSF code 1, -1, 1, -1, -1, 1, -1, 1 orthogonal to 1, -1, 1, -1? [1]

c) Is 1, 1, 1, 1, -1, -1, -1, -1, -1, -1, -1, -1, 1, 1, 1, 1 orthogonal to 1, -1, -1, 1? [1]

d) In UMTS, why is soft hand-over so important for good operation of the power control mechanism? [2]

e) HSDPA is an upgrade to the UMTS network, which uses a.o. fast Adaptive Modulation and Coding (AMC), fast Channel-Dependent Scheduling (CDS), and fast Hybrid-ARQ. For each of these 3 mechanisms, explain in your own words what it is, and why it improves the performance of UMTS. [3]

4 Wireless LAN [15]

a) Explain the hidden terminal problem in the context of Wireless LANs. [2]

b) Describe exactly how, and to what extent the RTS/CTS mechanism avoids the hidden terminal problem. [3]

c) Why does a CTS message not need to have a transmitter address? [2]

d) Why does a CTS message need to have a receiver address? What could go wrong if the CTS would not have a receiver address? [2]

e) The IEEE 802.11e Enhanced Distributed Channel Access (EDCA) provides differentiation between different access categories, by means of four different parameters: ($AIFS$, CW_{min}, CW_{max}, and $TXOP\ limit$). Suppose that we have an 802.11e system with two stations A and B, with each 1 transmission queue, filled with packets. For each of the differentiation parameters, describe precisely what happens in the system when station A has a higher value for the parameter than station B (and the 3 other parameters are the same). Will A have an advantage, compared to B or a disadvantage? Why? (Note that you will have to provide 4 answers, one for each differentiation parameter). [6]

5   Ad-hoc Networks [14]

a)   For routing in ad-hoc networks, it is considered a problem that often an ad-hoc network contains many redundant links. What is meant with this, and why is it a problem for routing? [2]

b)   How does AODV reduce the problem of the many redundant links? [2]

c)   Suppose that a source node has just sent a `RREQ` message to find a path to a certain destination (which we will refer to as `RREQ` 1). Now, the source node wants to simultaneously find a path to a different destination, and sends out a new `RREQ` (`RREQ` 2) with a different `Dest_Addr` field. For each of the following fields in the `RREQ` message, describe how the value in `RREQ` 2 relates to the value in `RREQ` 1 (e.g., is the same, is larger, is different, is not related), and explain why: [3]
  - `Broadcast_ID`
  - `Source_Seq#`
  - `Dest_Seq#`

d)   Is it possible that a path found by AODV is not the shortest path? If yes, how? If no, why not? [2]

e)   In principle, AODV only uses bi-directional links. What happens if AODV is operating in a network with some non-bi-directional links (i.e., node *i* can transmit to node *j*, but node *j* not to node *i*)? Is this problematic? If not, why not? If yes, how can it be solved? [3]

f)   DSR has been designed to deal with non-bi-directional links, and use them. Explain how? [2]

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