Examination Mobile & Wireless Networking (262001)
April 8, 2010
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.*

1 Wireless Transmission / Medium Access Control [8]

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. [4]

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

2 Wireless Transmission / Medium Access Control [18]

a) What is the essential difference between Aloha and CSMA? What are the advantages of CSMA, and why can it not always be used? [3]

b) Why can CSMA/CD, as used in Ethernet not be used in Wireless Systems? [2]

c) Explain the hidden terminal problem. [3]

d) For IEEE 802.11, what can be the consequence of the hidden terminal problem, how can it be combated? To what extent does this solve the problem? [3]

e) To what extent is *hidden terminal* a problem in Bluetooth? [3]

f) Explain the concept of (Type II) Hybrid ARQ. How does it work? What is the advantage of Hybrid ARQ over a system using just FEC or just ARQ? [4]

3 Cellular Systems [15]

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

b) Why are both the location update procedure and the paging procedure needed in a cellular system? [2]

c) 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? [3]

d) 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? [3]

The signal to interference ratio (S/I) of a cellular system with sectorized antenna with 3 120˚ sectors can be expressed as (dB scale)

$$[S/I]_{120^\circ} = [S/I]_{omni} + 10 \cdot \log 3.$$

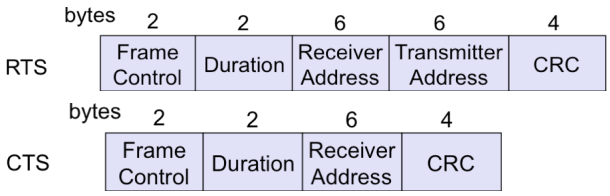
e) Explain this expression. [2]

f) Give a similar expression for a cellular system with sectorized antenna with 60˚ sectors, and explain the expression. [2]

4 IEEE 802.11 [15]

a) In IEEE 802.11 CSMA/CA, a station that finds the medium idle for the duration of a DIFS period, can start sending right away, whereas a station finding the medium busy has to wait for a DIFS period plus a random back-off time after the medium becomes free again. What is the reason for this difference? [3]

Below, you find the layout of the frames for the RTS and CTS messages in IEEE 802.11.



b) Why does the CTS frame not contain a Transmitter Address field? Is it not relevant to the receiver of the CTS message to know the transmitter, or does the receiver know the address of the transmitter in another way? [3]

c) Why can the Receiver Address field in the CTS message not be omitted? What can go wrong? [2]

d) What is the role of the Duration field in the RTS and CTS frame? Why can it not be omitted in the CTS frame, since it is already in the RTS frame? [3]

e) The Enhanced Distributed Channel Access (EDCA) in IEEE 802.11e enables the differentiation of channel access by means of 4 parameters: Arbitrary Inter Frame Spacing (AIFS), Minimum Contention Window (CW_{min}), Maximum Contention Window (CW_{max}), and Transmission Opportunity Limit (TXOP Limit). For each of these parameters, explain how it can be used to differentiate, and how the experienced QoS is affected by the parameter. [4]

5 Ad-hoc Networks [12]

a) Explain why standard routing protocols in general, and why the link-state and distance-vector routing protocols used in fixed networks specifically are not suitable for mobile ad-hoc networks. [4]

b) Explain what the principle is of proactive and reactive routing protocols and under what circumstances one is better than the other. [3]

c) In AODV, why does a route request (RREQ) packet contain a broadcast_id field? What is it used for? [2]

d) In AODV, if a node receives a route request (RREQ) packet for a destination to which it has a path stored (i.e., it has a route entry to that destination), it only returns a route reply (RREP) packet if the destination sequence number in the RREQ packet is smaller than, or equal to the destination sequence number stored in the routing entry. Why does it not return a RREP packet if the destination sequence number in the RREQ packet is larger? What is the meaning of the destination sequence number? [3]

6 TCP [10]

a) What is the reaction of standard TCP in case of packet loss? In what situation does this reaction make sense and why is it quite often problematic in the case of wireless networks and mobility? [3]

b) Explain the principles of snooping TCP for both directions of TCP data transfer (uplink and downlink). [4]

c) In case of a handover, Indirect TCP has to transfer state information and buffer contents of the old access point (foreign agent) to the new one. Explain why? Does the same apply to Snooping TCP? Why (not)? [3]

Abbreviations

AIFS	-	Arbitrary Inter Frame Spacing
AODV	-	Ad-hoc On-Demand Distance Vector
ARQ	-	Automatic Repeat request
CDMA	-	Code Division Multiple Access
CRC	-	Cyclic Redundancy Check
CSMA	-	Carrier Sense Multiple Access
CSMA/CD	-	Carrier Sense Multiple Access with Collision Detection
CTS	-	Clear To Send
CW_{min}	-	Minimum Contention Window
CW_{max}	-	Maximum Contention Window
DCF	-	Distributed Coordination Function
DIFS	-	DCF Inter Frame Space
DSR	-	Dynamic Source Routing
EDCA	-	Enhanced Distributed Channel Access
FDM	-	Frequency Division Multiplexing
FDM	-	Frequency Division Multiple Access
FEC	-	Forward Error Correction
GSM	-	Global System for Mobile Communication
IEEE	-	Institute of Electrical and Electronics Engineers
OFDM	-	Orthogonal Frequency Division Multiplexing
OFDMA	-	Orthogonal Frequency Division Multiple Access
QoS	-	Quality of Service
RREP	-	Route REPly
RREQ	-	Route REQuest
RTS	-	Request To Send
TCP	-	Transmission Control Protocol
TDMA	-	Time Division Multiple Access
TXOP	-	Transmission OPportunity
UMTS	-	Universal Mobile Telecommunication System