Examination Mobile & Wireless Networking (192620010)
April 7, 2011
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 [11]

a) For a wireless transmission, how is the transmission range defined? What is the detection range? What is the interference range? [3]

b) Explain how OFDM reduces the Inter-Symbol Interference (ISI), compared to a traditional system with the same data rate. [2]

c) 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]

d) What is the hidden terminal problem? [2]

e) IEEE 802.11 uses the RTS/CTS mechanism to deal with the hidden terminal problem. How, and to what extent does the mechanism solve or decrease this problem? [3]

2 Hybrid ARQ [6]

Three different error correction mechanisms often used in wireless systems are Forward Error Correction (FEC), Automatic Repeat request (ARQ), and Hybrid ARQ (H-ARQ).

a) Explain why ARQ typically performs better than FEC in a good channel, i.e., a channel with few bit errors. Explain why FEC performs better than ARQ in a bad channel. Note: a mechanism is considered to perform better if the (average) bit rate after correction is higher. [3]

b) The bit error ratio in a channel may vary over time. Explain why Hybrid ARQ performs better than FEC and ARQ in a time-varying channel. [3]

3 Cellular Systems [17]

a) 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]

b) Explain how the reuse distance in a cellular system is affected by the required signal to interference ratio of the mobile receiver. [3]

c) Why can the reuse distance be decreased when sectorized antennas are used? [2]

Wireless systems, in particular cellular systems, are always limited in the number of simultaneous active users they can support. This limit is mainly determined by some scarce resource that has to be allocated to users for their communication. Assume a single base station that can use a given frequency band. Further, for simplicity assume that all active users use the same average data rate.

d) What is limiting the number of users that can be supported in a TDMA/FDMA system, such as GSM? Does the location of active users in the cell have an effect on this? If yes, how? If no, why not? [3]

e) What is limiting the number of users in a CDMA system, such as UMTS? Does the location of active users in the cell have an effect on this? If yes, how? If no, why not? [3]

f) What is limiting the number of users in an OFDMA system such as LTE? Does the location of active users in the cell have an effect on this? If yes, how? If no, why not? [3]

4 UMTS [10]

a) 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? [3]

b) 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)? [3]

c) Are the OVSF codes 1, -1, 1, -1 and 1, -1, -1, -1 orthogonal? [2]

d) Is the OVSF code 1, -1, 1, -1, -1, 1, -1, 1 orthogonal to 1, -1, 1, -1 ? [2]

5 Zigbee / IEEE 802.15.4 [11]

When Zigbee (IEEE 802.15.4) is used in superframe mode, time on the medium is divided into superframes. A superframe consists of an active period and an inactive period. The inactive period is divided into 16 time slots. The first time-slot is always a beacon. The beacon is followed by the contention access period (CAP), after which a contention free period (CFP) of a number of slots may be defined.

a) For what purpose is an inactive period defined in a superframe? [2]

b) The length of a superframe can be anywhere between a few milliseconds and several minutes. What is the trade-off that has to be made for deciding on the duration of the superframe for a specific network? [3]

c) How is access to the medium controlled during the CFP? Explain what a node has to do before being allowed to access the medium. [3]

d) How is access to the medium controlled during the CAP. Explain what a node has to do before being allowed to access the medium. [3]

6 Mobile IP [13]

Consider a scenario where two mobile hosts (host A and host B) using standard Mobile IP are both in the same foreign network. Both are using co-located care-of addresses. They both have the same home network and home agent, HA.

a) Explain the flow of data packets in both directions between host A and host B using a diagram. Via which nodes are the packets going? [3]

Assume that the various nodes have the following IP addresses (some nodes may have other IP addresses as well.):
- host A has home address 130.89.18.2 and care-of address 130.89.20.2
- host B has home address 130.89.18.3 and care-of address 130.89.20.3
- HA has IP address 130.89.16.1

Suppose host A is sending data packets to host B.

b) For each part of the path from host A to host B (as given in the answer to (a)), give the IP addresses that can be found in the headers of the data packets. [4]

c) Why does Mobile IP need tunnels to route packets to mobile hosts, whereas ad-hoc routing protocols (such as DSDV) do not? [3]

In order to avoid packet loss during the handover, FMIPv6 (Fast handovers for Mobile IPv6) forwards packets from the previous access router (PAR) to the new access router (NAR), and buffers them in the NAR, during the handover.

d) Argue why the use of FMIPv6 instead of standard Mobile IPv6 can be beneficial for the behavior of the TCP protocol. Does FMIPv6 solve all problems for TCP, related to handover? [3]

Abbreviations

ARQ	-	Automatic Repeat request
CAP	-	Contention Access Period
CDMA	-	Code Division Multiple Access
CFP	-	Contention Free Period
CTS	-	Clear To Send
DSDV	-	Destination Sequence Distance Vector
FDD	-	Frequency Division Duplex
FDM	-	Frequency Division Multiplexing
FDMA	-	Frequency Division Multiple Access
FEC	-	Forward Error Correction
FMIPv6	-	Fast handovers for Mobile IPv6
GSM	-	Global System for Mobile Communication
HA	-	Home Agent
H-ARQ	-	Hybrid ARQ
IP	-	Internet Protocol
ISI	-	Inter-Symbol Interference
LTE	-	Long-Term Evolution
NAR	-	New Access Router
OFDM	-	Orthogonal Frequency Division Multiplexing
OFDMA	-	Orthogonal Frequency Division Multiple Access
OVSF	-	Orthogonal Variable Spreading Factor
PAR	-	Previous Access Router
RTS	-	Request To Send
TCP	-	Transmission Control Protocol
TDD	-	Time Division Duplex
TDMA	-	Time Division Multiple Access
UMTS	-	Universal Mobile Telecommunication System
W-CDMA	-	Wideband CDMA