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Information page for written examinations at Linköping University

Examination date	2015-01-09
Room (1)	T1
Time	8-12
Course code	TDDD66
Exam code	TEN1
Course name **Exam name**	Mobile Networks (Mobila nätverk) Written examination (Skriftlig tentamen)
Department	IDA
Number of questions in the examination	10
Teacher responsible/contact person during the exam time	Niklas Carlsson
Contact number during the exam time	013-282644
Visit to the examination room approximately	ca. 9:15 and 11:00
Name and contact details to the course administrator (name + phone nr + mail)	Madeleine Häger Dahlqvist 013-28 23 60 madeleine.hager.dahlqvist@liu.se
Equipment permitted	None (see cover page).
Other important information	
Number of exams in the bag	

TDDD66 (Mobile Networks) and TDDD36/TEN1 (Mobile Systems)
Final Examination: 8:00-12:00, Friday, Jan. 9, 2015
Time: 240 minutes
Total Marks: 40
Grade Requirements: three (20/40); four (28/40); and five (36/40).
Assistance: None (closed book, closed notes, and no electronics)
Instructor: Niklas Carlsson

Instructions:

- Read all instructions carefully (including these)!!!!
- The total possible marks granted for each question are given in parentheses. The entire test will be graded out of 40. This gives you 10 marks per hour, or six minutes per mark, plan your time accordingly.
- This examination consists of a total of 10 questions. Check to ensure that this exam is complete.
- When applicable, please explain how you derived your answers. Your final answers should be clearly stated.
- Write answers legibly; no marks will be given for answers that cannot be read easily.
- Where a discourse or discussion is called for, be concise and precise.
- If necessary, state any assumptions you made in answering a question. However, remember to read the instructions for each question carefully and answer the questions as precisely as possible. Solving the *wrong* question may result in deductions! It is better to solve the *right* question incorrectly, than the *wrong* question correctly.
- Please write your AID number, exam code, page numbers (even if the questions indicate numbers as well), etc. at the top/header of each page. (This ensures that marks always can be accredited to the correct individual, while ensuring that the exam is anonymous.)
- Please answer in English to largest possible extent, and try to use Swedish or "Swenglish" only as needed to support your answers.
- If needed, feel free to bring a dictionary from an official publisher. Hardcopy, not electronic!! Also, your dictionary is not allowed to contain any notes; only the printed text by the publisher.
- Good luck with the exam.

1) Question: Encapsulation (6)

Show the link-layer frames of a *HTTP request* and a *HTTP response* of a small Web page that fits in a single frame (i) when the *request* first arrives to the link layer at the gateway router closest to the client, and (ii) when the *response* first arrives at the mobile client. You can assume that the client is using 802.11. You do not have to show all the details of the different headers; however, you should (i) explain what protocols the different headers are associated with, and (ii) provide the address information associated with the source and destination fields for each of the different headers. You can assume that the client machine uses 802.11, have a MAC address AA:AA:AA:AA:AA:AA, and has obtained a dynamic IP address 111.222.11.22 from a DHCP server, which itself has IP address 111.222.11.1 and MAC address DD.DD.DD.DD.DD.DD. The client uses a local DNS server with IP address 111.222.1.1 and MAC address DD.EE.DD.EE.DD.EE. The closest gateway router to the client has three interfaces, with the interface closest to the client having MAC and IP addresses BB:BB:BB:AA:AA:AA and 111.222.11.11, and the interface on the path to/from the server having MAC and IP addresses BB:BB:BB:BB:BB:BB and 111.222.11.222. The MAC address of the access point that the client is associated is AA:AA:AA:CC:CC:CC. Finally, the MAC and IP addresses of the HTTP server are A1:A1:A1:A1:A1:A1 and 222.222.111.222. (Note: As explained on the cover page, if the necessary address information is not explicitly provided in the question, you are expected to make reasonable assumptions, and carefully motivate these assumptions.)

2) Question: 802.11 collision avoidance (4)

The 802.11 protocol can handle some hidden-terminal problems using the RTS-CTS mechanism. Please illustrate the 802.11 communication sequence when two nodes A and C both want to communicate with an intermediate node B: (i) when the RTS-CTS mechanism is used, and (ii) when it is not being used. Also, please use a concrete example figure that shows the communication overhead as a function of packet size to discuss the performance tradeoffs of using RTS-CTS versus not using RTS-CTS.

3) Question: Roaming and energy (4)

In the context of roaming between 802.11 access points, explain the difference between active and passive scanning. Please use a figure to show the messages being sent and discuss the potential energy tradeoffs in this scenario.

4) Question: Indirect routing in mobile IP (4)

Explain and illustrate the main differences between directed and indirect routing in the context of mobile IP. Please draw and discuss a figure that illustrates what happens with the routing of the network traffic with each of the two approaches.

5) Question: CDMA and chipping codes (4)

With Code Division Multiple Access (CDMA), all users share same frequency, but each user has own "chipping" sequence (i.e., code) to encode data. Please use a concrete example, in which you draw a figure that illustrates how a sender encodes a signal and how the receiver decodes the signal. First use an example without competing traffic. Second, use an example with competing traffic (from a different sender but the same receiver, for example).

6) Question: Routing in ad-hoc networks (4)

Describe and explain how the Dynamic Source Routing (DSR) protocol operates. What does it mean that this protocol is called an on-demand protocol? Also, assuming that all nodes in the network have finite battery capacity, from an energy perspective, please describe the most significant advantages and disadvantages of such an on-demand routing protocols compared to table-driven protocols. For example, try to provide concrete examples scenarios in which DSR may be preferred over the Destination Sequenced Distance Vector (DSDV) protocol.

7) Question: Bluetooth vs WiFi (4)

Both Bluetooth and WiFi (802.11) use the same frequency spectrum. Please compare (i) the frequency usage of the two technologies using a figure, (ii) explain how this channel usage behavior may impact other devices using the same spectrum, and (iii) discuss the relative energy vs. data rate tradeoffs made when selecting between these two protocols.

8) Question: Packet losses and middle boxes (4)

Please consider a mobile client in Sweden watching video from a website in the US. Assume that the last link (closest to the user) is wireless link with much competing traffic on its WLAN.

- **Part a:** Please draw a figure of the topology and explain where the delays and packet losses may occur in this scenario. Where are the loss probabilities bigger/smaller?
- **Part b:** Please explain (using figures, example scenarios, and TCP fairness equations, for example) how the use of a middle-box can help improve the mobile end-users throughput when accessing this website.

9) Question: Packet losses (4)

Give two separate examples how interleaving and piggy backing can be used to handle packet losses in video streaming? Then, discuss the two approaches relative advantages and disadvantages.

10) HTTP-based Adaptive Streaming (4)

In mobile environments, the network conditions experienced by a client may vary significantly over the duration of a session. In this context, you should first explain what the main advantages of HTTP-based adaptive streaming (HAS), used by Netflix, for example, is relative to non-adaptive HTTP-based streaming. Your answer should provide concrete examples (preferably using a figure of buffer conditions, network conditions, and playback quality, for example) of when and why HAS performs better in your example scenarios. Second, in the context of client playback performance, please explain the potential advantages of (i) splitting a file into multiple chunks, and (ii) using HTTP.

Good luck!