LiTH, The Institute of Technology at Linköping University
IDA, The Department of Computer and Information Science
Juha Takkinen
2010-10-26


# Written examination in TDTS06 Computer Networks 2010-10-23 at 8–12

## Rooms

TER4.

## Support materials

A basic calculator with memory erased and an English dictionary (not electronical) are allowed. Also four pages with *handwritten* notes on standard *lined* paper, with one line of text on each line on the paper, are permitted.

## Results

The results will be published at latest twelve working days after the exam.

## Points

Maximum is 40 points (46 if you have earned bonus points). For grade 3, 20 points are needed. For grades 4 and 5, 28 points and 36 points, respectively, are needed.

## Teacher on duty

Christian Vestlund, 076-227 55 70, will visit the hall around 9 am and at 11 am.

## Instructions

Write clearly. Explain your answers, if not told otherwise, and show all your steps in calculations. State any relevant assumptions that you make in addition to what is written in the question, but you are not allowed to change the question. Keep the same order on your answers as the questions in the exam. You can answer in either Swedish or English. *Note that only one page of each paper will be graded*. You must also see the wrapper for the common instructions for the exam.

*Good luck!*

## 1. Protocols

a. Define the following terms in the context of computer-network protocols:

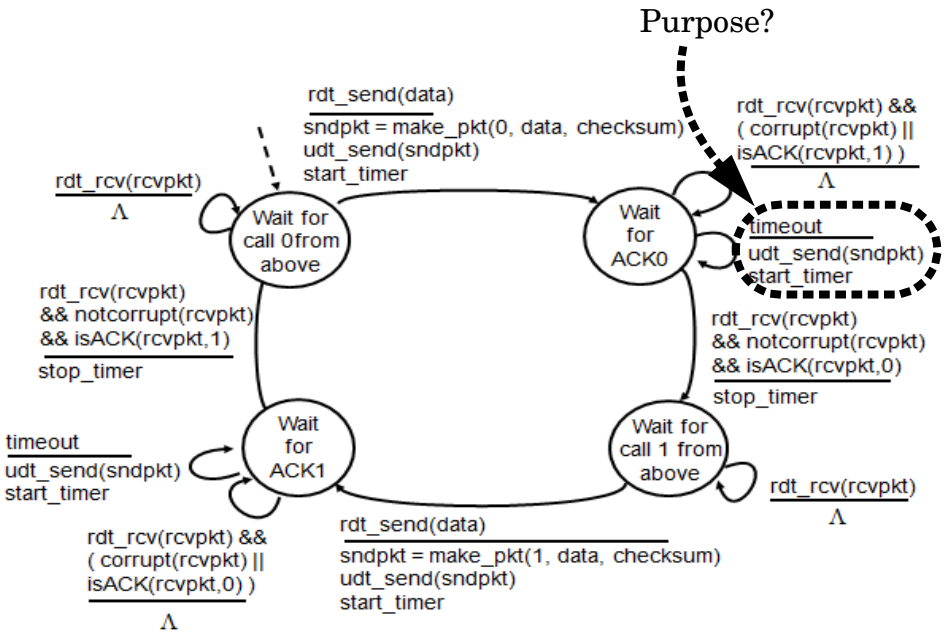
i. protocol interface. (1 p.)

ii. demultiplexing. (1 p.)

b. Refer to the FSM below.

i. Explain the purpose of the transition marked with a dashed circle. (1 p.)

ii. Explain what types of errors this protocol can handle. (2 p.)




## 2. Networking basics

a. Assume a window-size value in bytes, represented by an 8-bit large field in the protocol header, and a flow-controlled network with bandwidth 1 Mbps. Calculate the largest delay for a channel that will still allow a sender to fill the pipeline with one receiver's window worth of data. (2 p.)

b. Describe four typical types of delay that can occur in a computer network. (2 p.)

c. Explain the meaning of store-and-forward in a networking node. (1 p.)

## 3. Applications

a. Assume a client is using the http protocol to access a web server. Calculate the total time to request and receive a web document containing two objects. The objects are 500 KB each, the RTT is 10 ms and the bandwidth is 10 Mbps. You must state your assumptions about the http protocol, i.e., whether it allows pipe-lining or persistency, or both or

neither. (3 p.)

b. See the below output from the *dig* command.

i. What is the default value and type of the resource record sent in the query?(1 p.)

ii. What is the alternative hostname for the host given in the query? (1 p.)

```
% dig static.ak.fbcdn.net
; <<>> DiG 9.6.1-P3 <<>> static.ak.fbcdn.net
;; global options: +cmd
;; Got answer:
;; ->>HEADER<<- opcode: QUERY, status: NOERROR, id: 635
;; flags: qr rd ra; QUERY: 1, ANSWER: 4, AUTHORITY: 8, ADDITIONAL: 0

;; QUESTION SECTION:
;static.ak.fbcdn.net.           IN      A

;; ANSWER SECTION:
static.ak.fbcdn.net.     7004     IN        CNAME    static.ak.face-
book.com.edgesuite.net.
static.ak.facebook.com.edgesuite.net.  21148  IN  CNAME  a749.g.aka-
mai.net.
a749.g.akamai.net.      20      IN      A       130.242.56.232
a749.g.akamai.net.      20      IN      A       130.242.56.238

;; AUTHORITY SECTION:
g.akamai.net.           478     IN      NS      n2g.akamai.net.
g.akamai.net.           478     IN      NS      n0g.akamai.net.
g.akamai.net.           478     IN      NS      n3g.akamai.net.
g.akamai.net.           478     IN      NS      n1g.akamai.net.
g.akamai.net.           478     IN      NS      n5g.akamai.net.
g.akamai.net.           478     IN      NS      n7g.akamai.net.
g.akamai.net.           478     IN      NS      n4g.akamai.net.
g.akamai.net.           478     IN      NS      n6g.akamai.net.

;; Query time: 10 msec
;; SERVER: 130.236.177.12#53(130.236.177.12)
;; WHEN: Thu Oct 21 13:17:53 2010
;; MSG SIZE  rcvd: 288
```

## 4. TCP

a. Suppose that TCP is run over a 1-Gbps link with a delay of 100 ms to transfer a 10-MB file. The TCP receiver's advertised window is 1 MB for the whole connection time.

i. Assume TCP sends 1-KB packets in this network. Calculate how many RTTs it will take until slow start reaches a congestion window of the same size as the advertised window. There is no threshold value. (1 p.)

ii. Work out how many RTTs it will take to send the file in the example, using 1-KB packets. (2 p.)

b. Assume the sender's TCP entity transmits 4 segments after each other that are 2 KB, 2 KB, 1 KB and 500 B large. The sequence number of the first segment is 200. The receiver's buffer is 4 KB large. No delayed or cumulative ACKs are used.

i. What will be the first sequence number acknowledged by the receiving TCP entity? (1 p.)

ii. Assume the receiver's application process reads 1,500 B after receiving

the
first two segments. What value will the receiver put in its Advertised-window field? (1 p.)

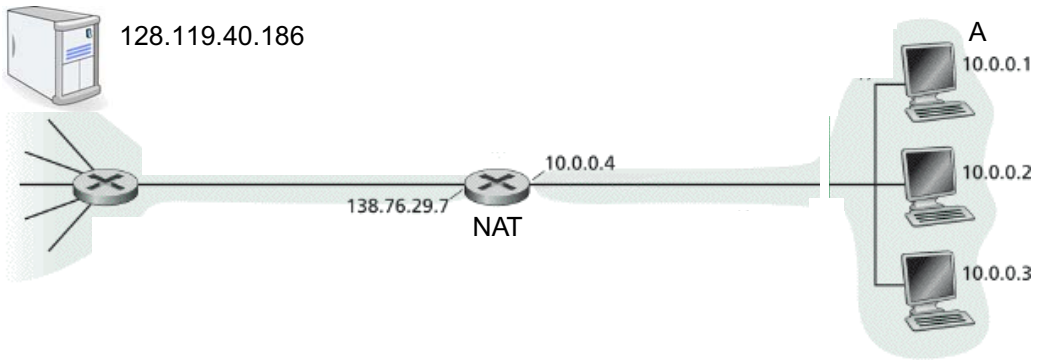
## 5. IP

a. Consider sending a 3,000-byte IP packet into a link that has an MTU of 500 bytes. Explain how many fragments are generated and how the fragments are reassembled on the receiving side. (2 p.)

b. Assume a NAT-enabled router in the network shown below.

i. Describe the steps that enable machine A (10.0.0.1) to request and receive a web document from a server (128.119.40.186) outside machine A's network. (2 p.)

ii. Explain what the network mask looks like in machine A's subnet. (1 p.)




## 6. LANs

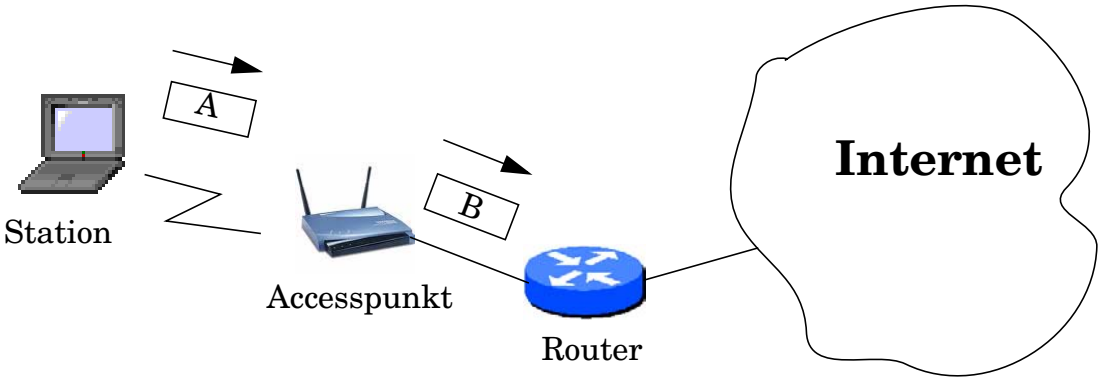
a. Presuppose a 802.3 network with bandwidth 10 Mbps. Station C in this network has just detected a collision and selects K = 3 in its calculation of the exponential binary backoff timer.

i. Discuss briefly what can be said about the number of collisions that station C has had, including this one. (1 p.)

ii. When will C be retransmitting its frame? (2 p.)

b. Assume a 802.11 network at LiU configured as an ESS (Extended Service Set), i.e., a BSS with a distribution system (here, a 802.3 network) connected to the Internet via a portal. The wireless station has previously received an IP packet from a user at Uppsala University. The scenario below shows the link-layer situation when the station has just responded. Describe the address contents of A and B, including the 802.11 header

and the IP header. (2 p.)



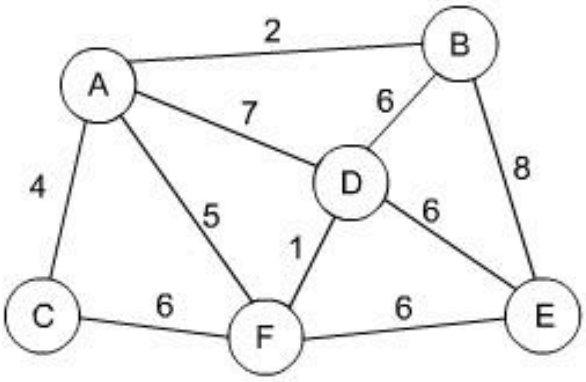

## 7. Routing

a. Define the term *autonomous system* as used in BGP. (1 p.)

b. Assume the network shown below.

i. Calculate the shortest-path tree for the network, as seen from node A. Use Dijkstra's algorithm and the table below. (2 p.)

ii. What Internet protocol implements Dijkstra's algorithm for route computation? Explain what information node F will put into its advertisement. (2 p.)




| Step | N' | D(B), p(B) | D(C), p(C) | D(D), p(D) | D(E), p(E) | D(F), p(F) |
|---|---|---|---|---|---|---|
| 0 | A | | | | | |
| 1 | | | | | | |
| 2 | | | | | | |
| 3 | | | | | | |
| 4 | | | | | | |
| 5 | | | | | | |

**8. Network security**

a. Define what WEP is. (1 p.)

b. See the scenario with an e-mail sender using PGP below.

i. Explain the purpose of MD5 and IDEA (a symmetric-key encryption algorithm) in the PGP framework and what security services they provide. (2 p.)

ii. Explain the purpose of a nonce. Discuss if PGP uses nonces or not. (2 p.)