Försättsblad till skriftlig tentamen vid Linköpings Universitet

(fylls i av ansvarig)

Datum för tentamen	*January 8, 2013*
Sal	*T2*
Tid	*14-18*
Kurskod	*TDTS06*
Provkod	*TEN1*
Kursnamn/benämning	Computer networks
Institution	*IDA*
Antal uppgifter som ingår i tentamen	*10*
Antal sidor på tentamen (inkl. försättsbladet)	*1+1+3=5*
Jour/Kursansvarig	*Niklas Carlsson*
Telefon under skrivtid	*013-282644*
Besöker salen ca kl.	*15:00 and 17:00*
Kursadministratör (namn + tfnnr + mailadress)	*Madeleine Häger Dahlqvist 013-282360, madha@ida.liu.se*
Tillåtna hjälpmedel	*Dictionary from an official publisher. Hardcopy; not electronic.*
Övrigt (exempel när resultat kan ses på webben, betygsgränser, visning, övriga salar tentan går i m.m.)	*Grades: 5(36/40); 4(28/40); 3(20/40)*
Vilken typ av papper ska användas, rutigt eller linjerat	*Your choice.*
Antal exemplar i påsen	

TDTS06 – Computer networks (TEN1)
Final Examination: 14:00-18:00, Tuesday, January 8, 2013
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)!!!! Some questions have multiple tasks/parts. Please make sure to address *all* of 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.)
- Answers can be provided in either English or Swedish. (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: Forwarding (4)

Show, illustrate, and explain the path of a SYN-ACK packet in the handshake between a Web client (browser) and a Web server. You can make the following assumptions:

- The client machine uses Ethernet, has a single interface with a MAC address AA:BB:AA:BB:AA:BB and an IP address 111.222.111.222
- The MAC and IP addresses of the mail server are DD:AA:DD:AA:AA:DD and 222.222.111.111. Similar to the client, the server has a single interface.
- The gateway router closest to the client has four interfaces. The first is the interface closest to the client and has MAC and IP addresses BB:BB:BB:BB:BB:BB:AA and 111.222.111.111. The second interface has MAC and IP addresses BB:BB:BB:BB:BB:BB:BB and 111.222.122.122. The third interface has MAC and IP addresses BB:BB:BB:BB:BB:BB:CC and 111.222.133.133. Finally, the fourth interface has MAC and IP addresses BB:BB:BB:BB:BB:BB:DD and 111.222.144.144.
- The gateway router closest to the server has three interfaces. The first is the interface closest to the client and has MAC and IP addresses CC:CC:CC:CC:CC:AA and 222.222.111.111. The second interface has MAC and IP addresses CC:CC:CC:CC:CC:BB and 222.222.122.122. Finally, the third interface has MAC and IP addresses CC:CC:CC:CC:CC:CC and 222.222.133.133.
- The routing table at the gateway router closest to the client has many entries. However, for this question, the three most closely matching entries for each interface states 222.222.0.0/16 (over interface 2), 222.222.192.0/18 (over interface 3), and 222.222.0.0/18 (over interface 4).
- The routing table at the gateway router closest to the server has many entries. However, for this question, the three most closely matching entries for each interface states 111.222.0.0/16 (over interface 1), 111.222.192.0/18 (over interface 2), and 222.222.111.0/24 (over interface 3).

In addition to the above answers, you should also draw a picture of the topology and clearly state any assumptions you make about the topology (including parts of the networks not explained above) or anything else needed to solve the question. As with all your answers it is important that you also explain how you derived your answer. For example, why was the packet taking this particular route?

2) Question: Encapsulation (4)

Consider the same scenario as in question 1 (above). Show and illustrate the first link-layer frame for a SYN-ACK message when it reaches the link layer of the Web server. You do not have to show all the details of the different headers; however, you should (i) specify 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 (contained within this frame).

3) Question: HTTP (4)

The Hypertext Transfer Protocol (HTTP) is a stateless protocol. Please (i) explain what this means, (ii) explain pros/cons (advantages and disadvantages) of a stateless protocol, and (iii) show how Web servers can keep state information about users and their interactions with the Web service. For this question you should also draw a picture that illustrates a user that visits a site multiple times (possibly days or weeks apart).

4) Question: TCP fairness (4)

Assume a bottleneck link with four users behind it A, B, C, and D? Assume that they are all downloading large files from different servers, but that their bandwidth bottleneck is the shared link. Assume A uses two connections, B five connections, C two connections and D three connections. The round trip time (RTT) for the connections of clients A and B are 50ms and the RTT for clients C and D are 150ms. Furthermore assume that the total bandwidth of the link is 100Mbps but under the above conditions only can operate at 90% utilization. Estimate the download rate of the different clients?

5) Question: TCP slow start (4)

Consider two machines A and B which are located 100ms apart. Assume that A is requesting a file from B using HTTP. Draw a figure and explain the entire communication sequence, including TCP handshake and connection teardown. You can assume that the payload is 20 packets and each packet can be sent in 1ms, and that the eleventh (11) packet is lost. For simplicity, you can assume that the TCP version is implementing fast retransmit, initially have ssthresh = 4, and the timeout period is constant at 500ms. You should include a figure that clearly show when each packet is sent and received.

6) Question: BGP routing (4)

Consider the routing information at a BGP router in AS A. Assume the following:

- There are four neighboring ASes: B, C, D, and E.
- AS A's internal path costs to the closest gateway routers of each of these three ASes are 1, 3, 2, and 5, respectively.
- A is a customer of B; A is provider to C; and A is peering with both D and E.
- For prefix 11.22.0.0/24 AS A sees the following route announcements: B Y Z; C F Z; D Q P Z; and E Q P Z.
- For prefix 11.22.0.0/16 AS A sees the following route announcements: B Y J; C F G J; D Q J; and E Q J.

Please draw a picture and carefully explain how the routers forwarding table would look, regarding the above prefixes. Please motivate your answer by defining the priority rules used by AS A (which is expected to apply commonly used rules, as discussed in the textbook, for example). Also, explain the route that a packet to IP addresses 11.22.0.22 and 11.22.22.22, respectively.

7) Question: Distance vector routing (4)

Consider a node A with neighbors B, C, and D. Node A currently has the distance table below. (Note that the network currently is not in a very good shape, and a few routing table updates will be needed to get the network back into shape.) Assume that it receives an updated distance vector from neighbor B which looks as follows [∞, 0, 5, 6, 3, 12, 3] and an updated distance vector from neighbor C which looks as follows [∞, 3, 0, 3, 9, 2, 8] . First, update the table below, including A's own distance vector. Second, assume that poison reverse is implemented, and show and explain exactly what information the node sends to each its neighbors (after the table has been updated).

	Costs			
Destination	A (via)	B	C	D
A	0 (A)	∞	∞	∞
B	1 (B)	0	4	2
C	1 (C)	3	0	3
D	1 (D)	3	5	0
E	? (?)	7	7	10
F	? (?)	2	12	7
G	? (?)	11	6	4

8) Question: 802.11 (4)

The 802.11 protocol can handle some hidden-terminal problems using the RTS-CTS mechanism. Please explain the following: (a) What is the hidden-terminal problem? When and how does it occur? (b) How does the RTS-CTS mechanism help towards solving the hidden-terminal problem? Please illustrate with the communication sequence when two nodes A and C both want to communicate with an intermediate node B.

9) IP fragmentation (4)

Consider a 4,000 byte IPv4 datagram which reaches a link with a MTU of 1,500. Please show and explain how the datagram is fragmented. For each datagram of consideration (both before and after fragmentation), please indicate the value of each of the following header fields: (i) offset, (ii) ID, (iii) morefrag, and (iv) length. Finally, explain where and why the original datagram is being reassembled?

10) HTTP-based Adaptive Streaming (4)

Explain what the main difference between typical (non-adaptive) HTTP-based streaming (as used by YouTube, for example) and HTTP-based adaptive streaming. Your answer should be supported with a head-to-head comparison of the behavior of two players (one of each type) under a simple scenario with varying bandwidth availability. Your answer should involve reasonable assumptions, and clearly show the buffer occupancy and video playback quality as a function of time (using appropriate figures/graphs, for example).

Good luck!!