Internetworking/Internetteknik, Examination 2G1305
Date: August 18th 2004 at 9:00 – 13:00

KTH/IMIT/LCN

- ***No help material is allowed - You are not allowed to use dictionaries, books, or calculators!***
- *You may answer questions in English or Swedish.*
- *Please answer each question on a separate page.*
- *Fill in the table on page 2 for each question you have addressed.*
- *The grading of the exam will be completed no later than September 8 2004.*
- *After grading, the exams will be available for inspection at STEX (Q-building).*
- *Deadline for written complaints is September 22 2004.*
- *Course responsible is Olof Hagsand, phone 08-790 42 61.*

Your name:…………………………………………………………………………………

Your social security number (personnummer): ………………………………………………

Your major (utbildningslinje):…………………………………………………………..

Total Points: …….	Grade: ………..

Question	Answered	Potential points	Received points
1		5	
2		5	
3		5	
4		5	
5		5	
6		5	
7		5	
8		5	
9		5	
10		5	
11		5	
12		5	

Total	60	

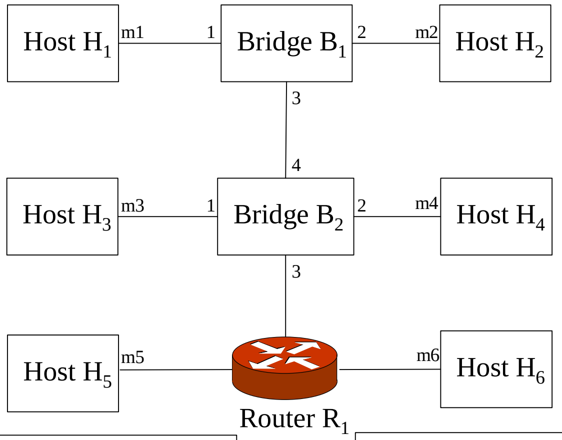
1. General (5p)

a) The so-called “hourglass” model (sometimes referred to as a “wine-glass”) has been used to illustrate the power of the Internet protocol design. Briefly describe the hourglass model. How does it illustrate the power of the Internet design in terms of support for applications and different link-layer technologies? (3p)

b) Typically, every layer in the TCP/IP protocol stack adds a header (or trailer) containing protocol-specific data. What is this mechanism called? (1p)

c) The Internet protocols are mainly standardized by the IETF (the Internet Engineering Task Force). The IETF produces and maintains a set of standard documents according to a standards track (from Internet drafts to Internet standards). What are these documents called? (1p)

2. Link Layer: bridging (5p)



Bridge B_1, Learning Table	
MAC	Port

Bridge B_2, Learning Table	
MAC	Port

The figure above illustrates six hosts H_1- H_6 running IPv4 over a bridged and routed network. The MAC addresses of the hosts and routers (m1-m6) are shown in the figure. The bridges B_1 and B_2 are learning bridges which switch packets(frames) between its ports. The port numbers are shown in the figure. The empty learning tables (station caches) of B_1 and B_2 are also shown in the figure. The router R1 performs IP routing between its interfaces.

a) Assume the network is in an initial state (no traffic has been sent). Now, host H_1 sends a unicast message to host H_4. H_4 then sends a reply unicast message to host H_1. Complete the bridging tables of B1 and B2 after these two packets have been sent. Assume no other traffic has occurred.(2p)

Bridge B_1, Learning Table	
MAC	Port
m1	1
m4	3

Bridge B_2, Learning Table	
MAC	Port
m4	2
m1	4

b) Assume the network is in the state after the traffic in the previous exercise has been sent. If H_3 now sends a unicast packet to H_2, to which nodes (hosts and routers) will the packet arrive? (1p)

c) Assume now H1 sends a broadcast message on the link it is attached to. To which nodes (hosts and routers) will the broadcast message arrive? (1p)

d) Assume H5 sends a broadcast message on the link it is attached to. To which nodes will the broadcast message arrive? (1p)

3. ARP (5p)

ARP – the Address Resolution Protocol – is primarily used to resolve IPv4 addresses to link-layer addresses. ARP typically works with a cache and a number of timeouts.

a) What is the purpose of the ARP cache? If no cache were used in the ARP protocol, what would happen? (2p)

b) Under what circumstance would the ARP cache be useless? (1p)

c) The entries in the ARP cache are controlled by timers. There are two variants of ARP cache timeouts that are used in two different situations. Which are the two variants and what is the purpose of each? What happens when the timers expire? (2p)

4. IPv4 Addressing (5p)

Assume a network N with address/prefix 143.12.34.64/26. Two nodes are attached to the network: Router R with address 143.12.34.65 and host H with address 143.12.34.66.

a) H sends a datagram to the net-directed broadcast address of N. Which are the source and destination addresses of the IP datagram? (1p)

b) H sends a datagram to the limited broadcast address of N. Which are the source and destination addresses of the IP datagram (1p)

c) H sends a datagram to the loopback interface (to itself). Which are the source and destination addresses of the IP datagram (1p)

d) Assume H has not yet retrieved its IP address and H sends an initial DHCP request. Which are the source and destination addresses of the IP datagram (1p)

e) What is the subnet mask of N? (1p)

5. IPv4 and ICMP (5p)

a) Traceroute is a tool to explore the path to a given destination. Traceroute uses two methods where ICMP messages are involved to detect each hop on the way to the destination. Describe these two methods and name the ICMP messages involved. (3p)

b) Using IP options, an alternative method to traceroute can be used to find the path to a given destination. Describe this method, and name at least one reason why it is of limited use. (2p)

6. TCP/UDP (5p)

a) A UDP datagram is sent and the optional checksum is used. Upon reception of this packet, the receiving UDP calculates the checksum over the UDP datagram (including the checksum field itself). The result of this check is 0. Is this packet considered corrupted? Why/why not? (1p)

b) You are writing an application to send interactive unicast real-time audio over the Internet, such as an IP telephony service. Should you use TCP or UDP as your transport protocol? Briefly motivate you answer. (2p)

c) You are writing an application to send video files over IP multicast. Is it possible to use TCP as your transport protocol? Briefly motivate your answer. (2p)

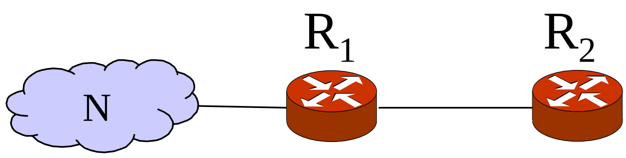
7. TCP (5p)

a) A TCP connection is using a window size of 16,000 bytes. The sending side receives a segment with acknowledgement number 48,001. Give the window at the sending side, as a range of byte numbers after the reception of this ACK. (1p)

b) TCP sends a segment at 4:30:20. It does not receive an acknowledgement. At 4:30:28, it retransmits the previous segment. It receives an acknowledgement at 4:30:30. Give the values of both the RTT (Round Trip Time) and the RTO (Retransmission Time-Out) after reception of the ACK according to Karn's algorithm. When the original TCP segment was sent, the RTT was 4 seconds. (2p)

c) Briefly describe the slow start phase of TCP's congestion control mechanism. (2p)

8. Dynamic routing (5p)



RIP uses the distance-vector routing algorithm. In the figure above, network N is reachable via routers R_1 and R_2. Suppose R_1 and R_2 runs RIP. If the link between R_1 and N is broken, the count-to-infinity problem may occur.

a) What is the count-to-infinity problem and why does it occur? (2p)

b) Suppose you implement the *split horizon* algorithm in the RIP implementation to solve the problem. How does *split horizon* work? (1p)

c) BGP uses path-vector instead of distance-vector. Describe how path-vector enhances distance-vector and how the count-to-infinity problem is avoided in BGP. (2p)

9. DHCP (5p)

a) What is the major improvement of DHCP over BOOTP? (2p)

b) A diskless client is powered on. Since the machine has no disk, there is no configuration available during start-up. Describe how DHCP can be used to assist the client during the start-up phase in addition to providing the client's IP address. Mention at least three other pieces of information that the client can get through DHCP. (3p)

10. MPLS (5p)

a) Briefly explain how packet forwarding in MPLS differs from regular IPv4 packet forwarding. (2p)

b) There are two basic mechanisms to do path selection in MPLS. Which are the two and how do they differ? (3p)

11. NAT/NAPT (5p)

Assume you are administrating a private network 172.16.0.0/16, and you have just been assigned the public IP address 193.12.3.4 by your ISP. On your private network, you have many hosts and servers, all who you wish be able to access public hosts on the Internet. You therefore setup a NAT/NAPT box, which you attach to the Internet, with the global IP address on the “WAN” port and the private network on the “LAN” port. You also turn on the dynamic native address port translation (NAPT).
Assume now that host 172.16.0.2 on your private network wants to access the public web server 212.4.208.117, for example. The host issues an http request and the server replies with a corresponding http update message. Which source and destination IP address and which TCP source and destination port numbers will the datagram have in the following locations: (1) when the http request is on the private network; (2) when the http request is on the Internet; (3) when the http reply from the server is on the Internet; and (4) when the http reply is on the private network. Assume that the web service uses the standard port 80, and that the source port used by 172.16.0.2 is already in use on the NAT/NAPT box WAN-side. (5p)

12. IPv6 (5p)

a) Show the shortest form of the following IPv6 address:
2340:0000:0000:000F:7000:119A:A001:0000 (1p)

b) What is the difference between fragmentation in IPv6 versus IPv4? (2p)

c) Name two main problems in IPv4 that were addressed by the original design IPv6. (2p)