Conceptual Exercises on Networking

In this lab we discuss some conceptual exercises like they could be on the exam. See also Lab 2 for further exercises.

Exam Instructions: You are allowed to bring one handwritten A4 cheat sheet with you (both sides may be used). For your answers, it is ok to make assumptions not mentioned in the questions, just tell which assumptions you make.

Protocol Stack

1. Consider a protocol stack with five layers, each of which requires between 1 and 5 milliseconds to process a package. Furthermore, assume that a physical medium between two hosts H1 and H2 has a propagation delay between 10 and 20 milliseconds. What is the minimum, average and maximum round-trip-time in the application layer between H1 and H2? What would be a good value for the retransmit timer?

2. Consider an HTTP package containing 2000 Byte of data, which is transmitted over a physical medium with a maximal transmission unit (MTU) of 1500 Byte. Draw the packages that are transmitted over the physical medium, marking the borders between packages in the various levels of the protocol stack. How many bytes are approximately transmitted over the network?

Physical Layer

3. Is the following translation of analog into binary signals good? Explain why not, and develop a better one.

0-2V	-	000
2-4V	-	001
4-6V	-	010
6-8V	-	011
8-10V	-	100

10-12V - 101
12-14V - 110
14-16V - 111

Link Layer

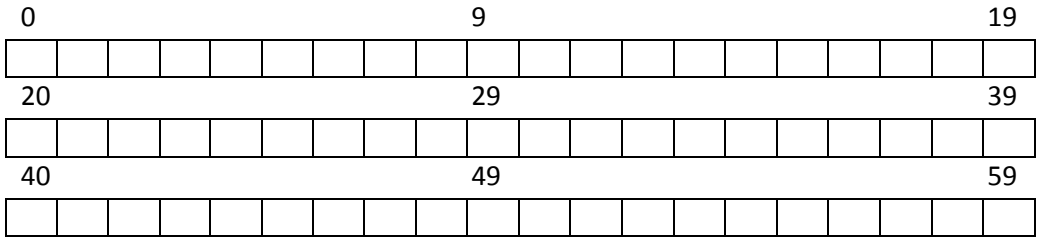
4. For Framing and Hamming codes, see Lab 2.

5. Consider a link layer in which bits get distorted with probability 10^-5, and a frame size of 500 bit. In terms of bandwidth, is it more efficient to correct errors with a Hamming code, or to use an error detecting code and retransmit garbled frames?

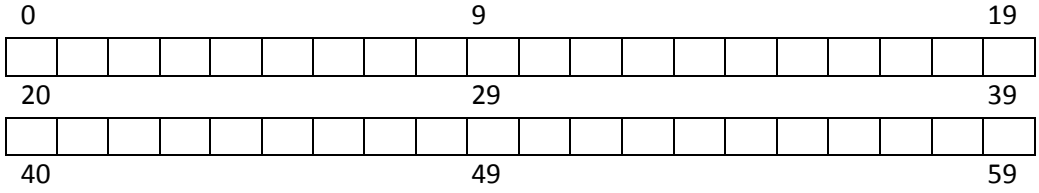
Medium Access Control Sublayer

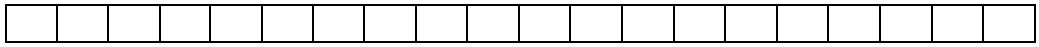
6. Draw the signal on the channel for 4 senders A, B, C and D, which each want to transmit frames of 5 bits length as detailed below, using the CSMA/CD, bitmap, or token ring protocol. Assume zero channel delay.
   A and C want to send one frame immediately, C decides so at time 7, D so at time 15, A decides to send another frame at time 16. Assume a random number generator generating the following sequence: (0,73; 0,24; 0,91; 0,52; 0,48; 0,11; 0,87; 0,02; 0,30; 0,55; …)

Token Ring

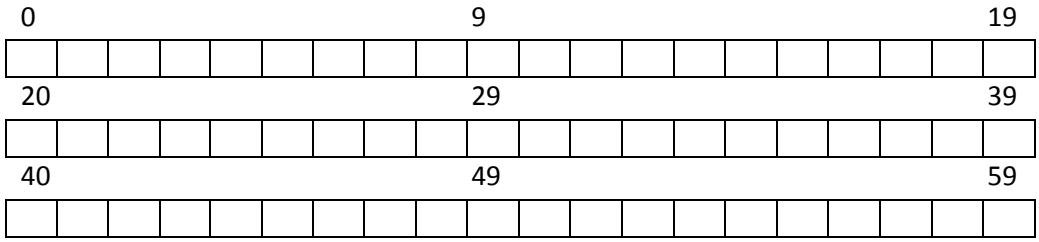


Bitmap





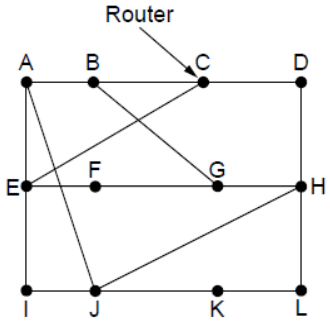
CSMA/CD



7. Mention one advantage/scenario where each of the methods is better than the others, and one disadvantage/scenario where it is worse.

Network Layer

8. The following network uses distance vector routing to compute routing tables. Complete the routing table for router J based on the distance vectors of its neighbors.



To	A	I	H	K	New estimated delay from J	Line
A	0	24	20	21	8	A
B	12	36	31	28		
C	25	18	19	36		
D	40	27	8	24		
E	14	7	30	22		
F	23	20	19	40		
G	18	31	6	31		
H	17	20	0	19		
I	21	0	14	22		
J	9	11	7	10		
K	24	22	22	0		
L	29	33	9	9		

JA delay is 8 | JI delay is 10 | JH delay is 12 | JK delay is 6

Vectors received from J's four neighbors

New routing table for J

9. Why do we need hierarchical routing on the internet?

10. Make sure you also know how to apply the Dijkstra algorithm for finding shortest paths (see Lecture 9).

Transport Layer

11. Give an example of a network architecture and network flows, such that the optimal and the fair network flows are different. Using AIMD, towards which flow would TCP flows converge? Using MIAD, towards which flow would TCP flows converge?

12. Simulate the first eight rounds of TCP flow control using AIMD, for a connection shared by three hosts A, B and C, starting with initial flows of 0%, 30% and 80%, using an increase of +10 and a decrease of *0,8.

13. Would LIAD (logarithmic increase, additive decrease) converge towards the same share as AIMD?

14. Give an example of an application build on top of TCP and one on top of UDP, and explain the choice of the transport protocol.

15. The TCP handshake uses sequence numbers from both hosts. Show what could go wrong if the handshake would use only sequence numbers from (1) host A (2) host B.

Threads

16. Consider bank accounts that are modelled as objects and that each bank account object is identified by its number. Suppose that transfers of money from one account to another one should happen concurrently and are therefore implemented as threads.

    - Which problem may arise if two threads access the same account? How do you avoid this problem?
    - Describe how this solution may cause deadlocks.
    - Describe a technique by which these deadlocks can be avoided.

17. A file server uses caching, and achieves a hit rate of 80%. File operations in the server cost 5 ms of CPU time when the server finds the requested block in the cache, and take an additional 15 ms of disk I/O time otherwise. Estimate the server's throughput capacity (average requests/sec) if it is:

    - single-threaded;
    - two-threaded, running on a single processor;
    - two-threaded, running on a two-processor computer.

Routing

18. Consider a packet network using 8-bit host addresses. Suppose a router uses longest prefix matching and has the following forwarding table:

Prefix Match	Interface
1	0
11	1
111	2
otherwise	3

For each of the four interfaces, give the associated range of destination host addresses and the number of addresses in the range.

Subnetting

19. Consider a router that connects three subnets S1, S2, S3. Suppose all of the interfaces in each of these three subnets are required to belong to the network 223.1.17.0/24. Also, suppose that S1 is required to support up to 125 interfaces and S2 and S3 are each required to support up to 60 interfaces.

    1. Provide three network addresses of the form a.b.c.d/x that satisfy these requirements.

HTTP

20. Suppose, a user requests a Web page that consists of some text and two images. Is it the case that for this page, the client will send one request message and receive three response messages?

21. If you call type “www.google.com” from a university in Italy and from one in Germany, will you get the same page? Explain your answer.