Chair of Distributed Systems and Security
School of Computation, Information and Technology
Technical University of Munich

Computer Networking and IT Security (INHN0012)

Tutorial 6

Problem 1 Media Access Control

a)* Briefly explain the principle of *ALOHA*.

b) How collisions are detected in *ALOHA*?

c) Briefly explain the principle of ***Slotted*** *ALOHA*.

d) What is the advantage of *Slotted ALOHA* over normal *ALOHA*?

e)* Briefly explain the principle of *CSMA*.

f) Briefly explain which additions *CSMA/**CD*** has compared to pure *CSMA*.

g) How are successful transmissions recognized for *CSMA/CD* with Ethernet?

h) Briefly explain which additions *CSMA/**CA*** has compared to pure *CSMA*.

i)* What is meant by *Binary Exponential Backoff*?

Problem 2 Packet Pair Probing – Old Exam Problem

Packet Pair Probing is a method to determine the bandwidth of a link section by cleverly exploiting serialization and delay times. We will demonstrate this using the example network shown in Figure 2.1.
Nodes 1 and 4 are each connected to their routers via Ethernet with a data rate of 1 Gbit/s. However, the connection between routers 2 and 3 is significantly slower. This transmission rate r_{23} is to be determined by 1 and 4 by generating as little load as possible on the already slow connection.

Figure 2.1: Network topology

In this task, we first derive a general procedure by means of which nodes 1 and 4 can determine the required transmission rate. We then evaluate the procedure for given numerical values and discuss possible problems that will occur in practice.

a)* Specify the serialization time $t_s(i, j)$ between two neighboring nodes i and j as a function of packet size p and transmission rate r_{ij}.

b)* Give the propagation delay $t_p(i, j)$ between two adjacent nodes i and j as a function of distance d_{ij}.

c)* Briefly explain how 1 can determine the maximum MTU on the path to 4 when using IPv4.

1 now sends two packets of length p to 4 in immediate succession. You can assume that no other traffic will affect the transmission. Let the length p be such that no fragmentation is necessary. You can neglect any processing times at the nodes.

d) Draw a path-time diagram that correctly represents the transmission of the two packets qualitatively. In particular, consider $r_{23} < r_{12} = r_{34}$ as mentioned at the beginning.

Due to the low transmission rate between 2 and 3, a transmission pause Δt occurs at node 3 between the two forwarded packets. This can be measured by 4 and used to determine the transmission rate between 2 and 3.

e) Mark Δt in your solution of subtask d). On which factors does Δt depend?

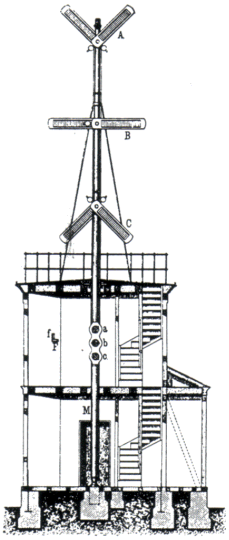
f) Specify an expression for Δt. Simplify the expression as much as possible.

g) Give an expression for the data rate r_{23} you are looking for. Simplify the expression as much as possible.

Repeated measurements on 4 give an average value of $\overline{\Delta t} = 1.2\,\text{ms}$ for a packet size of $p = 1500\,\text{B}$.

h) Determine r_{23} as a numerical value in Mbit/s.

Problem 3 Homework: Optical Telegraph – Old Exam Problem



In this task we consider optical telegraphs. The distance between two neighboring telegraph stations is 15 km. The mast of such a station (see adjacent figure) has three wings (indicators) on the left and right, each of which can take up four different positions (|, ╲, — and ╱).
A *symbol* is the configuration of all indicators.
To set a symbol, 10 s is required. The reading at the receiver takes place in parallel and therefore requires no additional time.

a)* How many bits can be transferred with each symbol?

b) Determine the data rate achieved in B/s.

c)* The available (gross) data rate is usually not fully used for user data. Name two other useful tasks that take up part of the data rate in common systems.

A message of length 72 B is now to be transmitted.

d) Calculate the serialization time required for this message.

e)* Calculate the propagation delay of this message between two stations. The reduction in the speed of light due to the air can be neglected here.

We now consider a chain of a total of 4 telegraph stations, which are each 15 km apart. This message of length 72 B is now to be transmitted using packet switching. The protocol used on layer 2 can only transfer frames up to a size of 36 B.

f)* How many packets must the message be divided into if a header of 4 B must be added to each packet?

g) Calculate the duration of a completely packet-based transmission of the message over the entire telegraph chain. Assume that the transmissions are always successful and therefore no confirmations are required.

h) How much does the duration deviate with continuous message switching? Assume that no header is used for message transfer.