6. Data Link Layer (Kompetenz SA2)

6.1 The MAC address

The most important information contained in the header of a frame is the source and destination media access control address (MAC address). Every Ethernet network card on the world has a unique MAC address.

The MAC addresses are necessary to identify a host within a network.

The MAC address is a 48-bit number. In human-friendly form it is written in six hexadecimal groups.

Example:

01-2B-E4-67-8C-AB or 01:2B:E4:67:8C:AB

Exercise 1:

Convert the above MAC address into a binary number format.

6.2 The ARP table and ARP request

Every host maintains an *ARP Table* where the host saves all the combinations of a MAC address and an IP address that it has been in contact with.

Example of an ARP table:

MAC address	IP address
01-2B-E4-67-8C-AB	192.168.0.1
B5-67-92-AD-D1-CC	192.168.0.2
41-74-AC-FE-6F-77	192.168.0.3

If a host doesn't find the MAC address fitting a certain IP address in its ARP table then the host sends out an *ARP request* to all hosts on the local network. If there is a host in the network with the called IP address, this host will answer the ARP request by sending its MAC address back to the calling client.

With the arp command you can view the contents of the ARP table on a host.

Example:

```
C:\> arp -a

Interface: 192.168.40.5 --- 0x4
  Internet Address      Physical Address      Type
  192.168.40.1          38-10-d5-17-97-4d     dynamic
  192.168.40.4          00-21-5a-9e-03-8e     dynamic
  192.168.40.8          3e-10-d5-8d-ad-6a     dynamic
  192.168.40.9          3e-10-d5-8e-16-48     dynamic
  192.168.40.20         00-08-9b-f8-de-a9     dynamic
  192.168.40.44         00-04-30-77-0f-c4     dynamic
  192.168.40.48         00-26-0f-22-03-57     dynamic
  192.168.40.49         00-08-9b-f8-de-aa     dynamic
  192.168.40.255        ff-ff-ff-ff-ff-ff     static
```

6.3 Switches

Switches in opposite to hubs maintain a *MAC address table* in which they store which MAC address is connected to which switch port. This allows the switch to forward an incoming frame only to that switch port on which the destination host is connected to. If the destination MAC address is not yet contained in the MAC address table, then the frame will be forwarded to all switch ports.

Example of a MAC address table:

MAC address	switch port number
01-2B-E4-67-8C-AB	1
B5-67-92-AD-D1-CC	3
41-74-AC-FE-6F-77	3
3C-2D-E4-AB-21-26	4

The switch will learn automatically which MAC address is connected to which switch port by reading the source MAC address of all incoming frames and completing its MAC address table if necessary.

As switches only deal with MAC addresses they work on the data link layer and not as many believe on the network layer.