Exercise Sheet 3

Exercise 1   (Guided Transmission Media)

1. Which **cable types** can be used for Ethernet?

2. What is the main difference between **coaxial** and **twisted pair** cables?

3. Which type of twisted pair cable should be used to connect two computers directly with each other?

4. Name the advantages of **fiber-optic** cables over **copper wires**.

5. Explain which information can be derived from the following information printed on twisted pair cables:

   - E188601 (UL) TYPE CM 75°C LL84201 CSA TYPE CMG FT4 CAT.5E PATCH CABLE TO TIA/EIA 568A STP 26AWG STRANDED

   - E324441 RU AWM 2835 24AWG 60°C 30V CHANGJIANG TIA/EIA 568B.2 UTP CAT.5e

   - SSTP ENHANCED CAT.5 350MHZ 26AWG X 4P PATCH TYPE CM (UL) C(UL) E200579 CMG CSA LL81924 3P VERIFIED

# Exercise 2   (Unguided Transmission Media)

1. Explain the difference between **transmission range** and **interference range**.

2. Name two **challenges** for wireless networks that do not occur in wired networks.

3. **Directed** wireless transmission eliminates some of these issues and can achieve higher transmission ranges. Explain why many wireless networks still work with undirected (*omnidirectional*) transmission systems.

4. Any electromagnetic wave is effected by **attenuation** over the distance. Elaborate why this problem affects wireless networks more than wired ones.

5. Metal **shielding** protects against external **interference**. Hence, would it be a good idea to use metal tube for a directed radio transmission? Why or why not?

Exercise 3   (Technologies)

1. Name two popular technologies for networks inside a company or university.

2. Which communication model is used for the *eduroam* **WLAN network** at the university?

3. In which **frequency spectrum** do WLAN networks operate?

4. Bluetooth and WLAN networks work in the same frequency spectrum, but use different transmission power. Name the technology that achieves a higher power output and explain why.

Exercise 4   (WLAN Networks)

You check in to a hotel and perform a WLAN scan with your smartphone. The result looks as shown here:
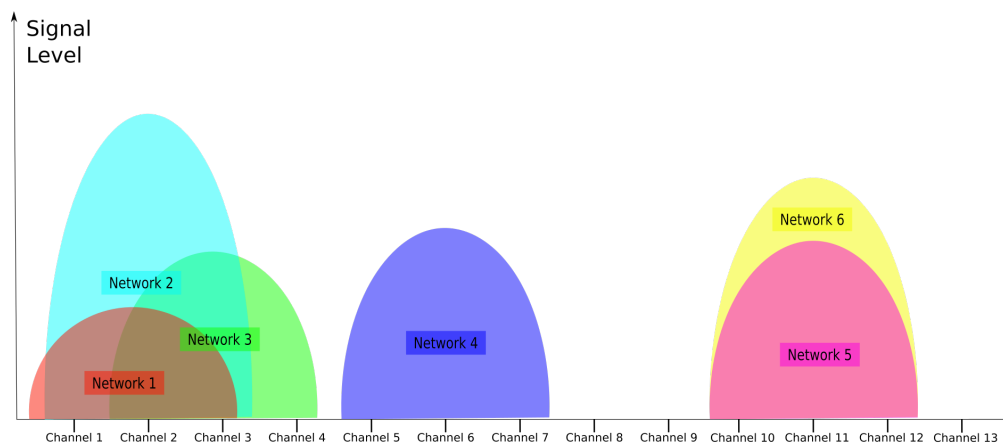

1. Based on the given scan results: Which of the networks do you connect to and why?

2. What could be a reason preventing you from joining the chosen network?

3. **Network 5** and **Network 6** can be identified as **IEEE 802.11b** networks. Which data rate can be expected?

4. The configuration of some of the shown networks is suboptimal. Name them and explain why.

Exercise 5   (Bridges and Switches)

1. What is the purpose of **bridges** in computer networks?

2. What is the difference between **bridges** and **switches**?

3. What is the advantage of **learning bridges** in contrast to "dumb" bridges?

4. What information is stored in the **forwarding tables** of bridges?

5. What happens, if for a network device, no entry exists in the **forwarding table** of a bridge?

6. Why do bridges try to avoid **loops**?

7. Which protocol do bridges use in order to **handle loops**?

8. Explain what a spanning tree is.

9. What is the selection criteria for determining, whether a bridge becomes the **root bridge**?
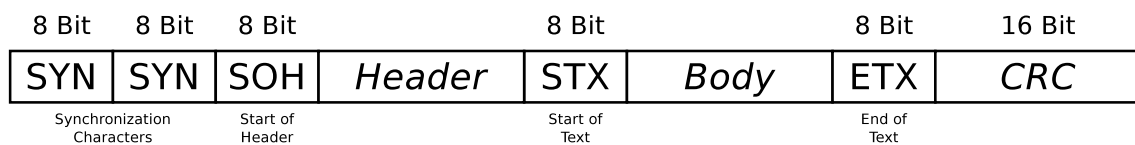
Exercise 6   (Spanning Tree Protocol)

The figure shows the physical connections of a network topology. A-I are physical networks (LANs). B1-B6 are bridges (Switches). All bridges boot up at the same time after a power failure. Highlight in the figure which ports and bridges are not used when the Spanning Tree Protocol is used. *Attention: If multiple paths from a network to the root bridge have the same distance, then take the bridge IDs as decision criterion. The smaller the ID of a bridge is, the higher is its priority.*
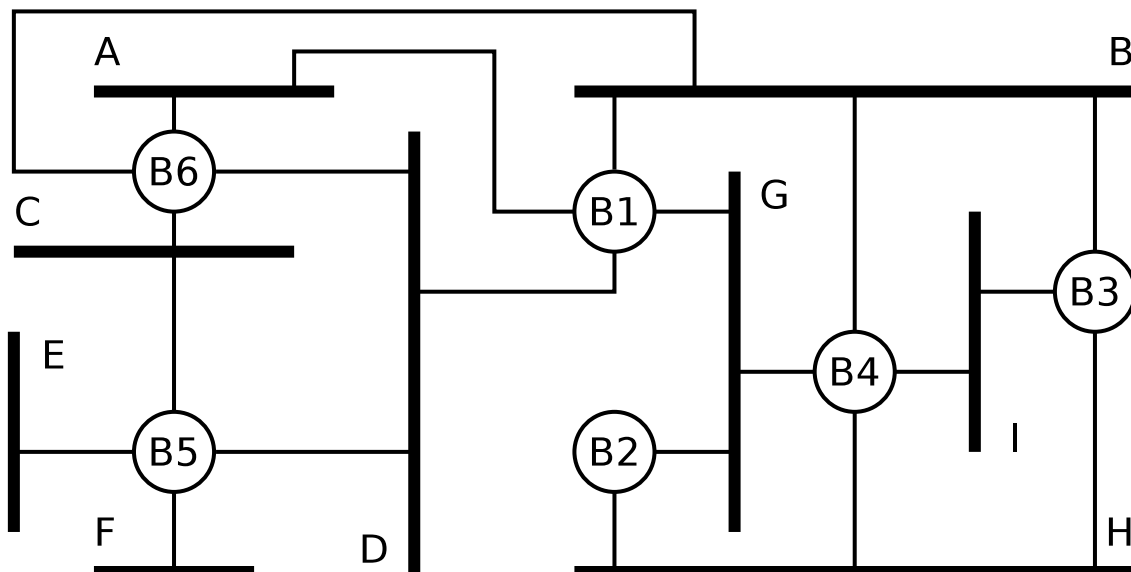
Exercise 7   (Addressing in the Data Link Layer)

1. The format of what **addresses** is defined by Data Link Layer protocols?
   ☐ physical network addresses   ☐ logical network addresses

2. How are **physical network addresses** called?

3. Who receives a frame with the **destination address** `FF-FF-FF-FF-FF-FF`?

4. What is **MAC spoofing**?

Exercise 8   (Byte Stuffing)

8 Bit	8 Bit	8 Bit	8 Bit	8 Bit	8 Bit	8 Bit	16 Bit
SYN	SYN	SOH	*Header*	STX	*Body*	ETX	*CRC*

Synchronization Characters   Start of Header   Start of Text   End of Text

Control character	SOH	STX	ETX	DLE	SYN
Hexadecimal notation	01	02	03	10	16

If the payload (body) contains the control characters `ETX` and `DLE` (*Data Link Escape*), they are protected (*escaped*) by the Data Link Layer protocol with a stuffed `DLE` caracter. A single `ETX` in the payload area is represented by the sequence `DLE ETX`. The `DLE` character itsef is represented by the sequence `DLE DLE`.

Mark the payload inside the following BISYNC frames?

1. `16 16 01 99 98 97 96 95 02 A1 A2 A3 A4 A5 03 A0 B7`

2. `16 16 01 99 98 97 96 95 02 05 04 10 03 02 01 03 76 35`

3. `16 16 01 99 98 97 96 95 02 10 03 10 10 10 03 03 92 55`

4. `16 16 01 99 98 97 96 95 02 10 10 10 10 10 03 01 02 A1 03 99 B2`

Source: Jörg Roth. Prüfungstrainer Rechnernetze. Vieweg (2010) and Wikipedia

Exercise 9   (Bit Stuffing)

The Data Link Layer protocol HDLC (High-Level Data Link Control) uses Bit Stuffing. If the sender discovers 5 consecutive 1 bits in the bitstream from the Network Layer, it *stuffs* a single 0 bit into the outgoing bit stream. If the receiver discovers 5 consecutive 1 bits, followed by a single 0 bit in the bit stream from the Physical Layer, it removes (*destuffs*) the 0 bit.

Give the encoding for each one of the following bit sequences, when the sender *stuffs* after 5 consecutive 1 bits a single 0 bit into the bit stream from the Network Layer.

1. 01111110 10100111 11111000 11110010 10011111 10111111 11100101

2. 00111111 01110001 11110011 11111100 10101010 11001111 11100001

3. 11111111 11111111 11111111 11111111 11111111 11111111 11111111

Exercise 10   (Do some research)

1. What are the special features of the WLAN specification amendments of **IEEE 802.11ad**?

2. **RFC 7668** specifies the transport of **IPv6 over Bluetooth Low Energy (BLE)**. The specification is based on a set of other RFCs which ones?

3. A computer is equipped with four 100BASE-T NICs. It operates Linux as an operating system. Which data rate can be achieved over a **bonding** network interface on this machine?

4. **MTU Path Discovery** can be used to automatically determine the smallest *MTU* between two hosts. Which technique is used when you detect a MTU of **more than 1500 bytes** in a Ethernet network?

Exercise 11   (Lab Exercise: Link Layer Communication)

Layer 2 allows you to communicate between hosts in the same *physical network*, i.e., connect to the same *link*. In this exercise you will open a so called *raw socket* in order to send and receive **frames** between two **Ethernet** devices. Download and compile the sending and receiving applications:

- `https://teaching.dahahm.de/assets/sendRawEth.c`

- `https://teaching.dahahm.de/assets/recvRawEth.c`

1. After booting and logging in, start the NetworkManager again (`sudo dhclient eno2`).

2. Now download the two files above and install a C compiler via `sudo apt install gcc`.

3. Unplug the red *twisted pair* cable from the PC.

4. Connect the same interface to another twisted pair cable and connect the other end to the *switch* on your table.

5. Start a terminal emulator again and bring up the network interface by calling:
   `sudo ip link set eno2 up`

6. Start *Wireshark* and monitor the traffic on the device *eno2*.

7. Start the *recvRawEth* (run `./recvRawEth eno2`) application and keep the terminal emulator open.

8. Figure out your **MAC address** by opening another terminal emulator and running
   `ip link show eno2`

9. Start the *sendRawEth* (run `./sendRawEth eno2` application and provide the MAC address of your neighbor when prompted.

10. Run the application again and provide `ff:ff:ff:ff:ff:ff` as MAC address when prompted.

11. Repeat the previous step but provide `7e:e7:ba:be:08:15` as MAC address.

12. What do you observe on the receiver side? What do you observe on Wireshark? Can you explain your observations?