Communications and Computer Networks

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Summer term 2023

Exercise 3

Information: If necessary, remove the suffix *.sec* of files downloaded from ILIAS.

1 Data Link Layer

1. What are the main tasks of the data link layer?

   Solution:

   - manage the incoming and outgoing data stream. This is divided into transmission frames or packets, which are transmitted sequentially from the sender to the receiver.
   - addressing of physical endpoints
   - Error detection and correction

2. Explain the difference between *collision domain* and *broadcast domain*.

   Solution: Collision domain includes all devices that have access to a common transmission medium.

   A broadcast domain includes all devices that can be reached via a Layer 2 broadcast.

3. Explain the difference between *collision domain* and *broadcast domain* related to a hub-centric and a switch-centric network.

   Solution: Hub: Collision domain and broadcast domain are the same
   Switch: Collision domain is limited to the connection between switch and host, broadcast domain consists of all members of the network

4. What is the difference between error detection and error correction?

   Solution: *Error detection:* Detects errors with a residual error probability.
   Error correction: Detected errors can be corrected automatically by the receiver if suitable redundant coding is used (FEC: Forward Error Correction) or in the event of an error, the receiver requests the transmitter to retransmit (BEC: Backward Error Correction, e. g. ARQ: Automatic Repeat reQuest).

5. Load the pcap-file *datalink2.pcap* with *Wireshark* and determine the existing data link protocols.

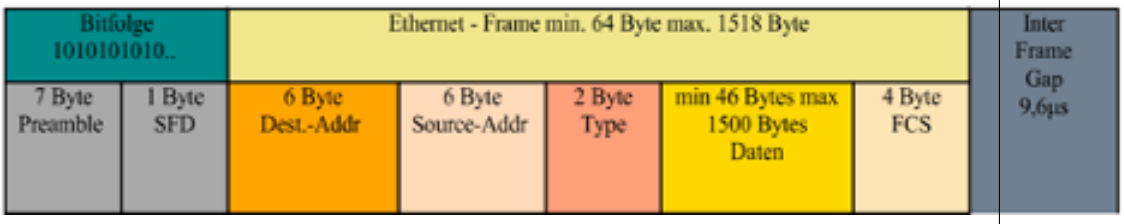
Solution:

- Pkt 1: IEEE 802.3 Ethernet with LLC, because IEEE 802.3 does not provide information of the upper protocols, so LLC is used
- Pkt 2: Frame Relay
- Pkt 3: HDLC
- Pkt 4: HDLC

2 Ethernet II

6. Sketch the individual fields of an Ethernet II frame (designation and length); explain their meaning.

Solution:



- Preamble: Alternating 1 and 0 bit sequence for bit-level synchronization of the receiver
- SFD: Start frame delimiter, marking a frame start and byte level synchronization (10101011), marking the end of the preamble.
- Dest.-Addr: 48 Bit
- Src.-Addr: 48 Bit
- Type: Payload Protokoll (e.g. IPv4 0x0800) Payload
- FCS: Frame Check Sequence, Error Detection
- Inter Frame Gap: Separation of frames, for synchronization on the receiver side, signals the receiver: get ready for the next packet

7. Load the pcap-file *datalink1.pcap* with *Wireshark*. What network protocols are above the ethernet frame? Which Ethernet II packet field provides this information?

Solution: The EtherType field provides this information:
Pkt 1 and 3: 0x0806 (ARP) Pkt 2: 0x0800 (IPv4)

3 MAC-Addresses

8. How long is a MAC address in the IEEE 802 standard? What is the order of the individual octets (bytes) and the bits in the octets of this address?

Solution: Each MAC address has a length of six bytes or 48 bits.
MAC addresses are traditionally represented as a sequence of six two-digit hex numbers separated by colons (different styles are possible).
Transmission begins with the least significant bit (LSB) of an octet.

For example:
MAC: 12-34-56-78-9A-BC
LSB transmission: 01001000 00101100 01101010 00011110 01011001 00111101

Example: 0x12 is 00010010b MSB, but Ethernet uses LSB, so we need to invert the bits to 01001000.

9. What parts does the MAC address consist of and what do they mean?

Solution: The first 24 bits (bits 3 to 24) of a global address contain the manufacturer identification (also OUI - Organizationally Unique Identifier) assigned by the IEEE. The remaining 24 bits (bits 25 to 48) are individually defined by the respective manufacturer.

10. What is the meaning of the first two bits (bit 0 and bit 1) of the MAC addresses (universal addresses)?

Solution: Bit 0 of the first byte decides whether it is a unicast (0) or broadcast/multicast address (1).

Bit 1 of the first byte decides whether the MAC address is globally (0) or locally (1) administered. Network cards have a globally unique MAC address that is administered globally by the IEEE and the manufacturing company.

11. Which command can be used to display your MAC address(es) under Linux?

Solution: ifconfig

note that ifconfig is part of a networking package which may be deprecated on newer systems, newer systems provide the iproute2 package, which has the command ***ip***
ip link show

12. Load the pcap-file *datalink1.pcap* with *Wireshark*, and determine the existing MAC-addresses (excluding the broadcast)?

Solution: MAC-addresses:

- 5c:49:79:8e:23:a3
- 5c:e9:1e:ae:7c:ef
- e6:63:ba:fe:e4:64
- b8:27:eb:a1:c6:18

13. Load the GNS-project *SimpleEth.gns3project*, and start all devices.

Which commands can you use to determine the MAC-address of PC2 (without starting a console on PC2)?

Solution: Choose PC1 on the left side and write the following command in the console:

```
ping  10.0.0.2
arp
```

The last command shows the mac-address of PC2:

```
PC1> ping 10.0.0.2

84 bytes from 10.0.0.2 icmp_seq=1 ttl=64 time=0.708 ms
```

```
84 bytes from 10.0.0.2 icmp_seq=2 ttl=64 time=0.753 ms
84 bytes from 10.0.0.2 icmp_seq=3 ttl=64 time=0.615 ms
84 bytes from 10.0.0.2 icmp_seq=4 ttl=64 time=0.698 ms
84 bytes from 10.0.0.2 icmp_seq=5 ttl=64 time=0.742 ms

PC1> arp

00:50:79:66:68:01  10.0.0.2 expires in 80 seconds
```

14. You have the following MAC-addresses of different NICs. Determine for every address, if it is a locally or globally administrated address. Can you further determine the vendor of the NIC?

    - 5c:e9:1e:ae:64:aa
    - 52:43:da:33:ad:1a
    - 1A:00:0a:3a:ff:7a
    - 00:90:93:39:c1:a2
    - 0E:e9:1d:87:67:63

Solution: If a MAC address second character is a 2, 6, A, or E, then it is a randomized address.

x2-xx-xx-xx-xx-xx x6-xx-xx-xx-xx-xx xA-xx-xx-xx-xx-xx xE-xx-xx-xx-xx-xx

So address 2,3 and 5 are locally administrated.
With a online search for address 1, you can determine the vendor Apple

```
Apple, Inc.
1 Infinite Loop
Cupertino CA 95014
US
```

and for the 4th address the vendor EIZO:

```
EIZO Corporation
153 Shimokashiwano
Hakusan Ishikawa 924-8856
JP
```

4 CRC

15. Assume you want to send the character X to a receiver. X has an ASCII-Code of 78_{10} and 1001110_2. You use the generator polynomial $x^4 + x^2 + 1 = 10101$. Calculate the transmitted data + checksum.

Solution:

```
10011100000 / 10101
10101
-----
0011010
  10101
  -----
  011110
   10101
   -----
    010110
     10101
     -----
     0001100
```

The FCS is 1100, the transferred data is 10011101100.

16. You receive the bit stream 1001110111. The used polynomial is 1101. Check, if the message was received correctly.

Solution: CRC is last 3 bits (because of 3 degree of polynomial) = 111, so, message is 1001110.

```
1001110111 / 1101
1101
---
01001
 1101
 ---
 01001
  1101
  ---
  01000
   1101
   ---
   01011
    1101
    ---
    01101
     1101
 ---
 00001
```

The checksum is != 0, so there might be an error during the transmission.

5 Hardware

17. What principle does a switch work on?

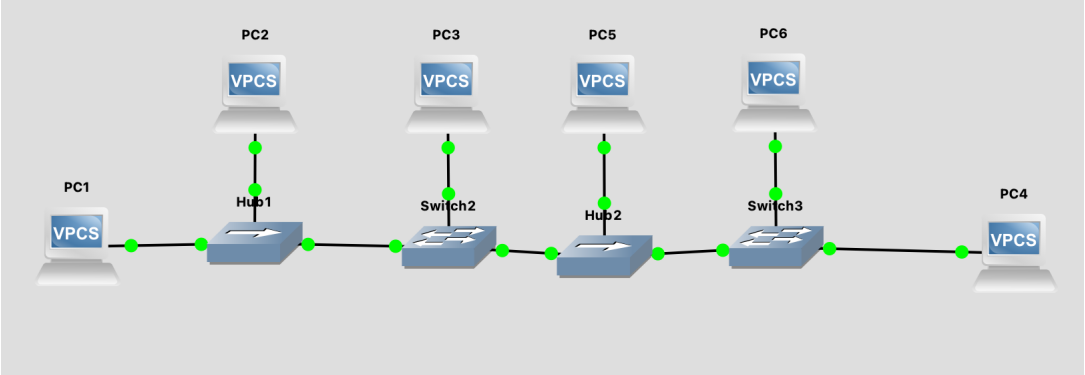
Solution: Switches operate on layer 2 (link layer) of the OSI model. A switch reads the source MAC address and creates an entry in the CAM (Content Addressable Memory), in which the physical port at which the MAC address was received is stored. If an entry already exists, it is updated if necessary. For the destination MAC address the corresponding port is determined from the CAM and the frame is forwarded to this port. If no entry exists, the frame is sent to all ports except the source port.

6 ARP

18. Load the pcap-file *datalink1.pcap* with *Wireshark*, what is the difference between the ARP packets of packet 1 and packet 3?

Solution: Pkt 1 is a reply, Pkt3 is a request. They don't belong together

19. Assume you have a network configured as shown in the figure. PC1 sends an ARP-request to get the IP-address of PC5. Which PCs see the ARP-request, which PCs see the ARP-response?



Solution: The request is seen by every PC in the network, because a request is send to the broadcast address. The reply will be seen on PC1 as the receiver of the response, and PC2, because the packet is forwarded to all clients connected to hub1.

7 VLAN

20. Why is the position of the IEEE 802.1Q VLAN-Tag at the same position as the EtherType in the original Ethernet II frame?

Solution: By this positioning, systems which are unable to understand the VLAN-tag are able to detect the Ethertype of VLAN and are able to ignore the information.

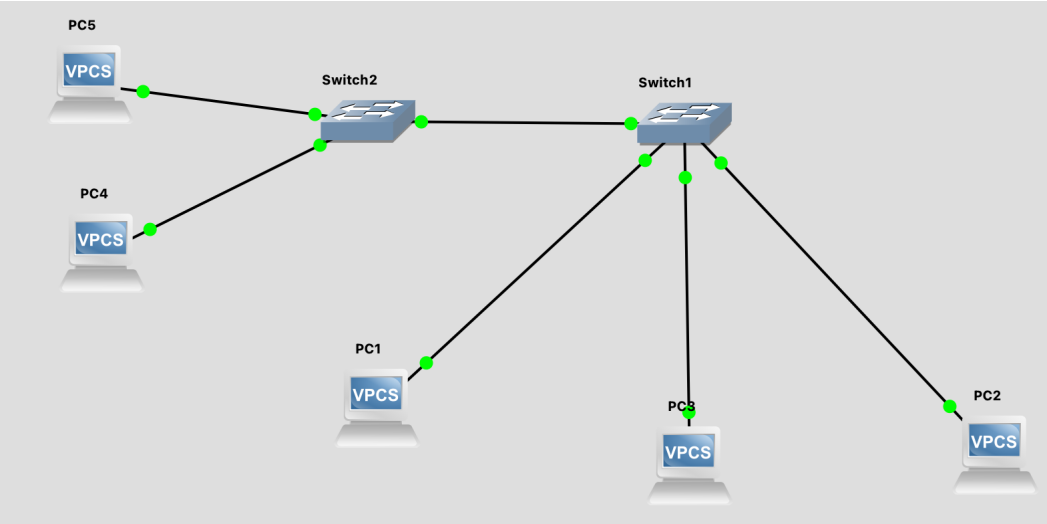
21. Why do you need a tagged or trunk port in a vlan-based network?

> **Solution:** Without these ports, vlan tags can not be delivered between switches. As a result, VLAN communication would be limited to the single switch.

22. You have the following network infrastructure. Each of the PCs has a valid IP-address in the network 10.0.0.x with x = number of the PC (PC1 = 10.0.0.1, PC2 = 10.0.0.2, etc)

    The PCs 1, 3 and 5 are able to communicate, and PC2 and PC4 are able to communicate with each other, but PC1 cannot reach PC2 and PC4, and vice versa, PC4 is unable to communicate with PC1, 3 and 5.

    Explain the configuration of the network.



> **Solution:** PC2 and PC4 are in a different VLAN than PC1, 3 and 5. The link between the switches is configured as a VLAN-trunk.

23. You have the following snipplet of a configuration of a network switch. Detect possible misconfigurations based on the physical properties of the interface:

```
Switch(config-if)#do sh int gi 0/1
GigabitEthernet0/1 is up, line protocol is up (connected)
  Hardware is Lance, address is 0050.0f0b.0819 (bia 0050.0f0b.0819)
 BW 10000 Kbit, DLY 1000 usec,
     reliability 255/255, txload 1/255, rxload 1/255
  Encapsulation ARPA, loopback not set
  Keepalive set (10 sec)
  Half-duplex, 10Mb/s
  input flow-control is off, output flow-control is off
  <snip>

Switch(config-if)# do sh run
interface GigabitEthernet0/1
 switchport access vlan 333
 duplex half
 speed 10
!
!
interface Vlan333
```

```
no ip address
arp timeout 1
```

Solution: Gigabit Interface configured as 10Mbit/s with half duplex
arp timeout is 1 sec, which results in nearly no switch learning