

AV-Netzwerktechnik

Grundlagen

Netzwerktechnik

Benny Platte



**HOCHSCHULE
MITTWEIDA**
University of Applied Sciences



hs-mittweida.de

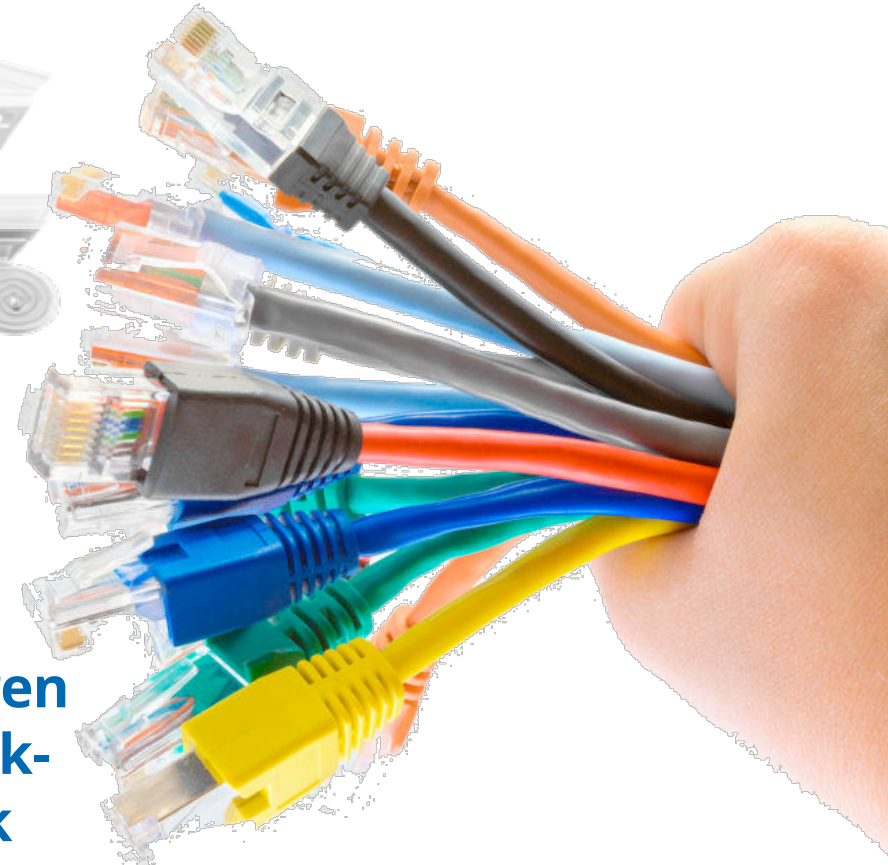


Echtzeit-Audio/Video-Netzwerke

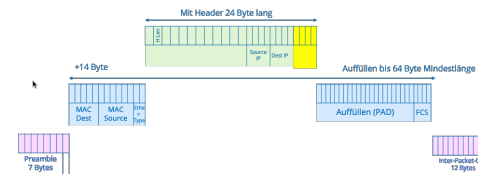
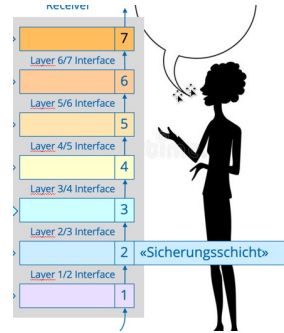
digitale
Übertragung

Töne
und deren
Digitalisierung

Grundlagen
Netzwerk-
technik



Themen



OSI-Layer 3 („over IP“)

SMPT ST 2110 Dante

OSI-Layer 2

WISG REAC Ether ES Sound

AES67 IEEE 802.1 AVB RAVENNA

CobraNet

Paketbasierter Transport

ISO/OSI Referenzmodell

Pakete im Detail

Audio over Ethernet Vs. Audio over IP

- 7 Schichten
- Aufbau Kommunikation
- Funktion der 4 unteren Schichten
- TCP/IP-Modell

- Paket zusammensetzen
- Proberechnung Übertragungsraten

- Vor- und Nachteile
- MAC-Adressen
- IP-Adressen
- Hub, Switch, Router

Sie können

Paketbasierter Transport	ISO/OSI Referenzmodell	Audio over Ethernet Vs. Audio over IP
<ul style="list-style-type: none"> • 4 Vorteile der paketbasierten Übertragung benennen und begründen. • 1 Herausforderung/Problem benennen 	<ul style="list-style-type: none"> • Die maßgebenden Schichten benennen und deren Funktion erläutern • Die Adressierungen der 4 unteren Schichten benennen • Angeben, wie lang ein Paket auf der Leitung wird bei gegebener Nutzdatenmenge 	<ul style="list-style-type: none"> • Die Vorteile und Nachteile der Audioübertragung diskutieren und Empfehlungen ableiten • Den Unterschied Hub, Switch, Router erklären und einen konkreten Modellvorschlag unterbreiten, wenn bestimmte Eigenschaften des Netzwerks gefordert sind (z.B. VLAN)



digitale Audio-Übertragung

Vorb


MADI

MOOST

proprietär
komplett
eigenständig

**Riedel
ROCKNET**

Diretta



SuperMAC AES50

AVIOM
Distributed Audio Networks

OSI-Layer 1

WSG
SOUNDGRID COMPATIBLE

REAC

Ether
IES
Sound

CobraNet

OSI-Layer 2

Dante
With AES67

SMPT | **ST 2110**

**IEEE 802.1
AVB**

RAVENNA

AES67

OSI-Layer 3

Ethernet

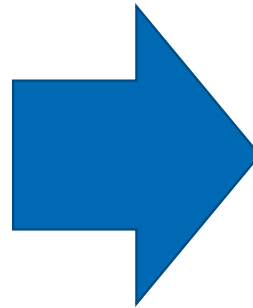
Themen, Einstieg

Ethernet

Komplexität beherrschen: ISO/OSI-Modell

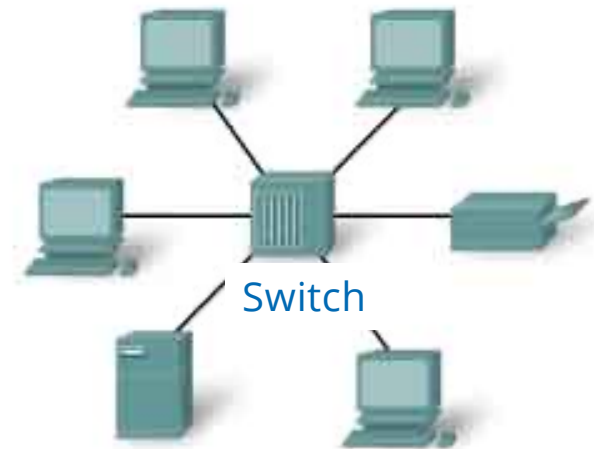
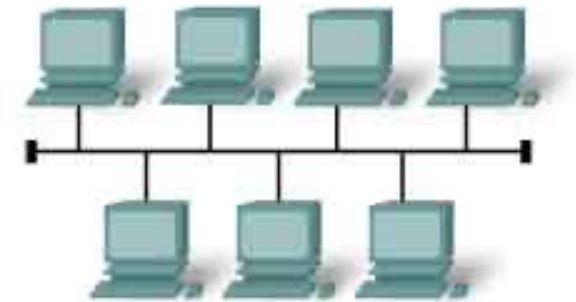
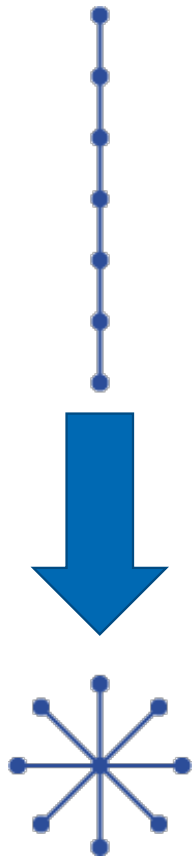
Pakete im Detail

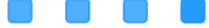
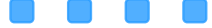
Layer Vor- Nachteile, Switch



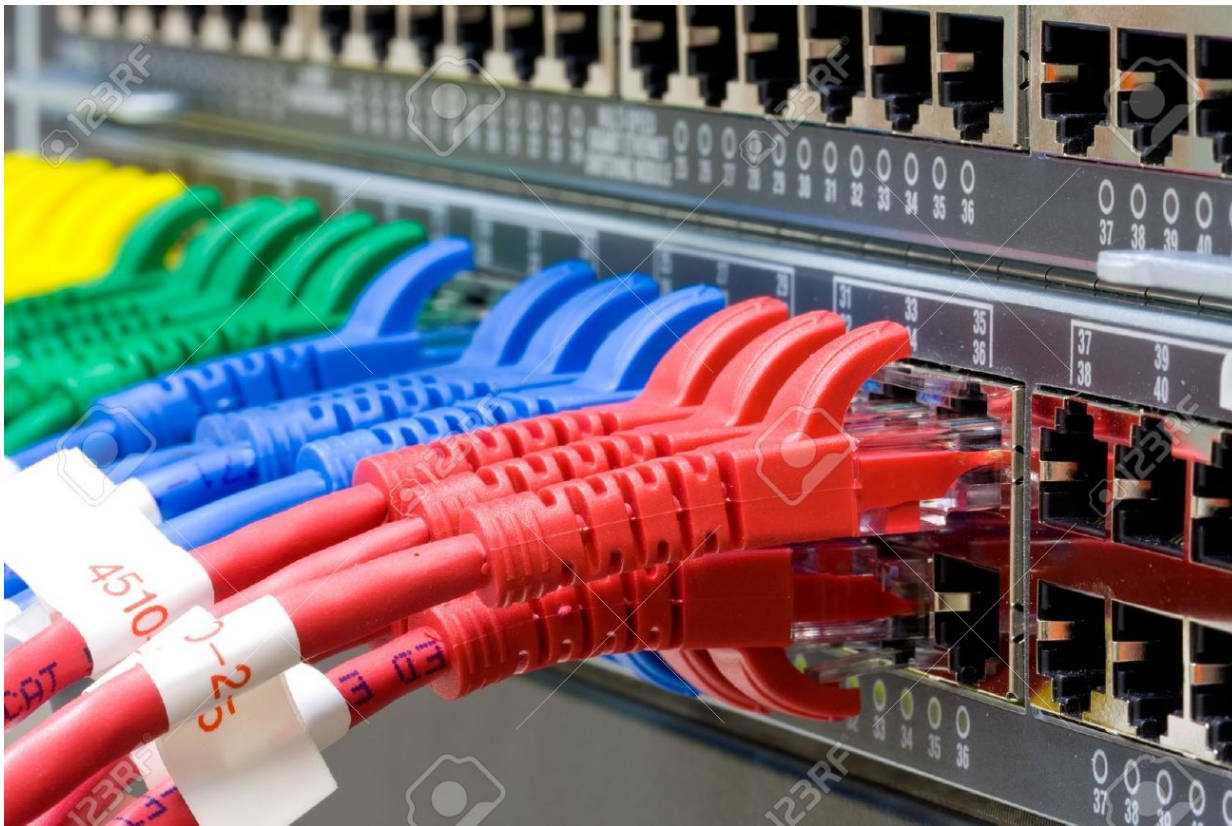
Vorb

90er Jahre: vom Shared-Media-LAN zum Switched-LAN → Ethernet setzt sich durch



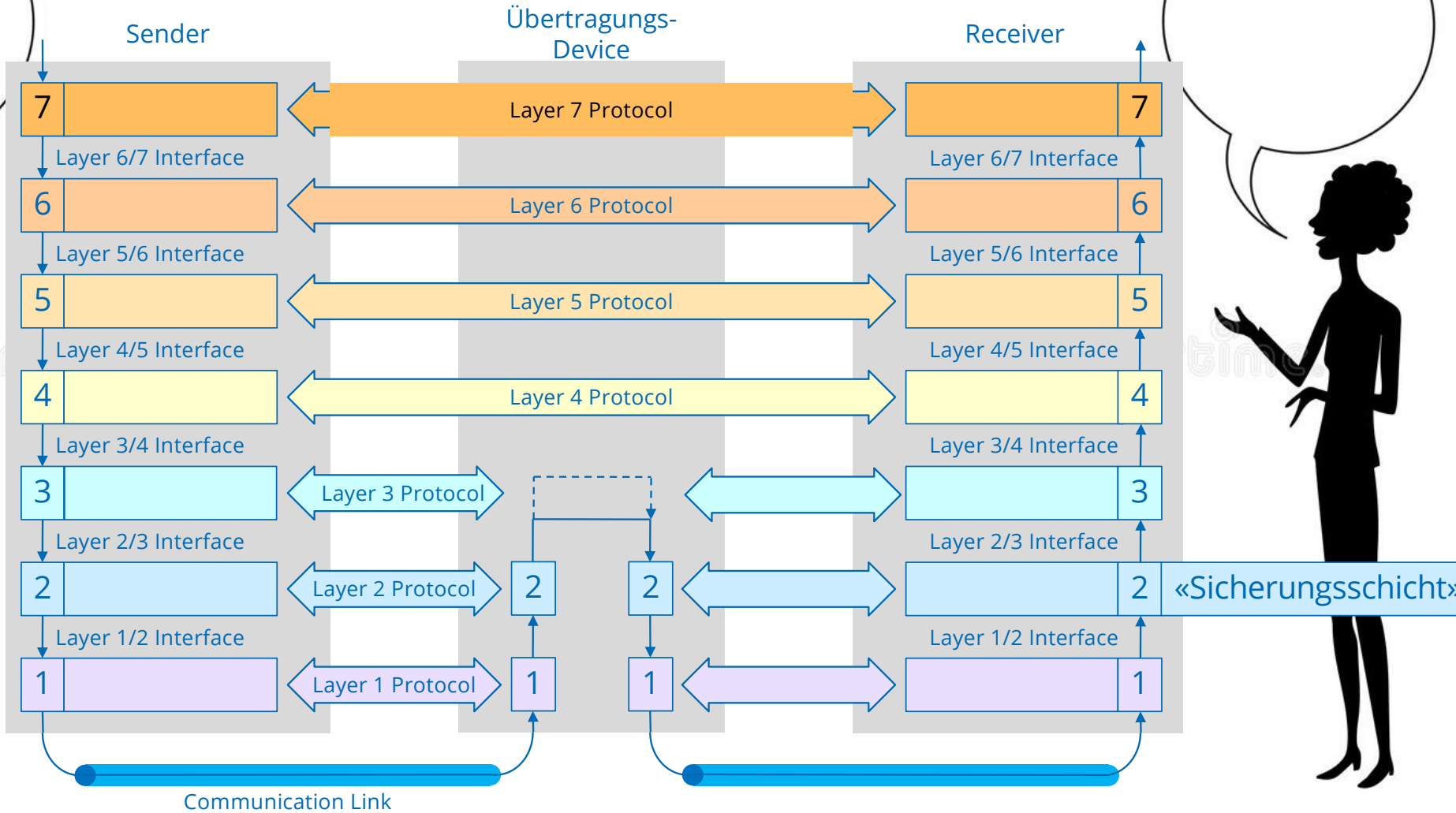


Switched-LAN

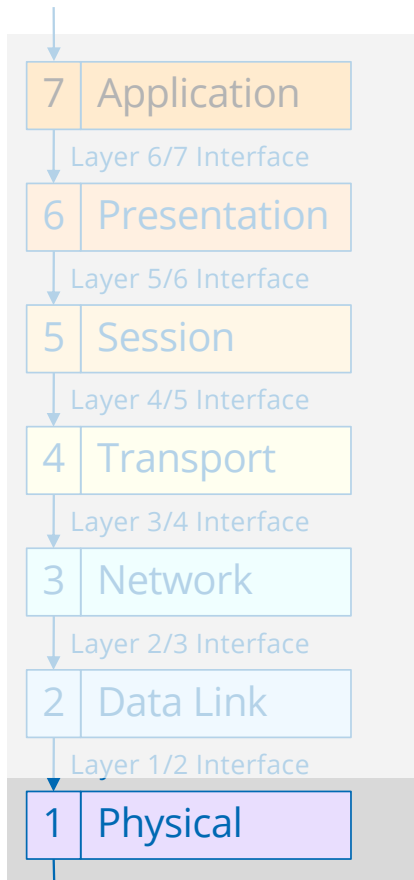


Komplexität beherrschen: ISO/OSI Referenzmodell

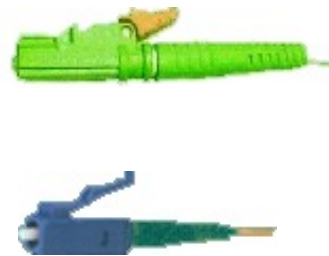
Vorb



OSI-Layer: Bitübertragungsschicht (Physical Layer)



Beispiele: 802.3 Ethernet, 802.11 WLAN,
RS-232, V.34, POTS, DSL, SDH

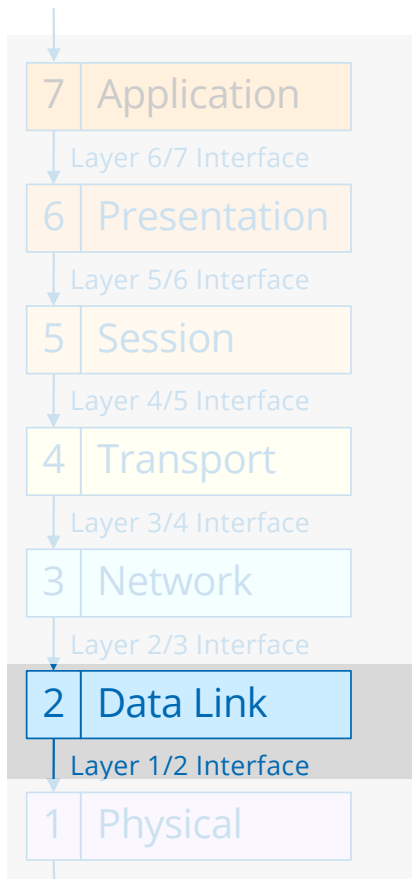


OSI-Layer 2: Sicherungsschicht (Data Link Layer)

gewährleistet zuverlässige (weitgehend fehlerfreie) Übertragung **in einem Netzsegment**



Beispiele: 802.3 Ethernet, 802.11 WLAN

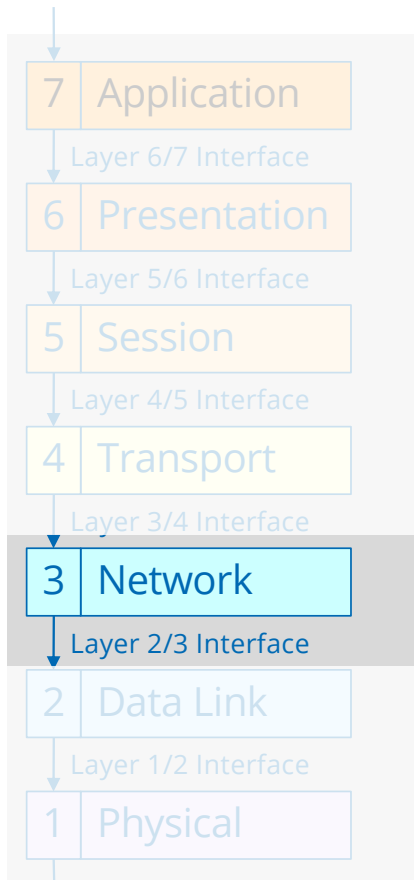


LLC-Schicht
(Logical Link Control)

MAC-Schicht
(Medium Access Control)

OSI-Layer 3: Vermittlungsschicht / Network Layer

= „Routing Layer“
verbindet Hosts zwischen verschiedenen Netzwerken



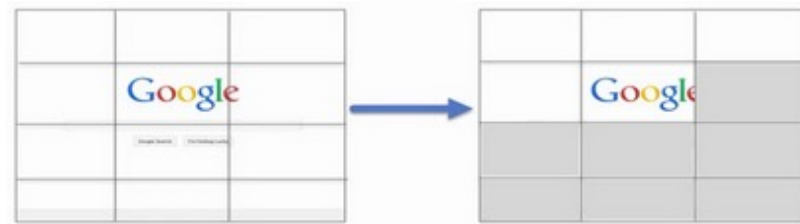
Hardware auf dieser Schicht: Router, Layer-3-Switch

Protokolle und Normen: X.25, IP, IPsec, ICMP.

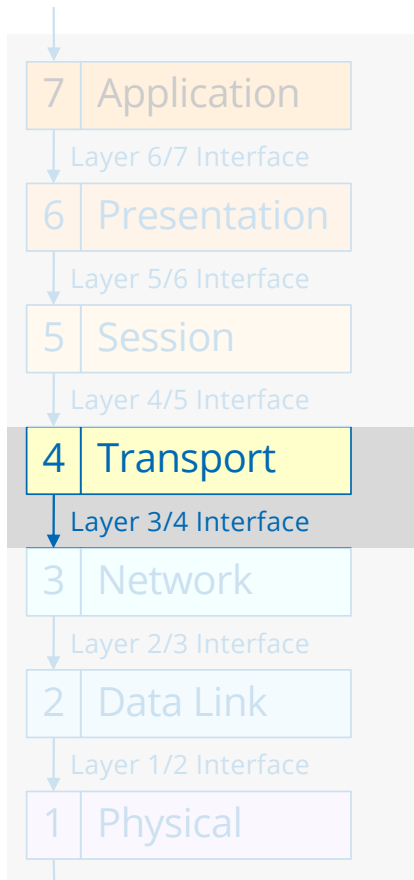
OSI-Layer 4: Transport

= „Ende-zu-Ende-Verbindung“
verbindet Prozesse

- Daten werden segmentiert und am Zielort wieder zusammengesetzt:

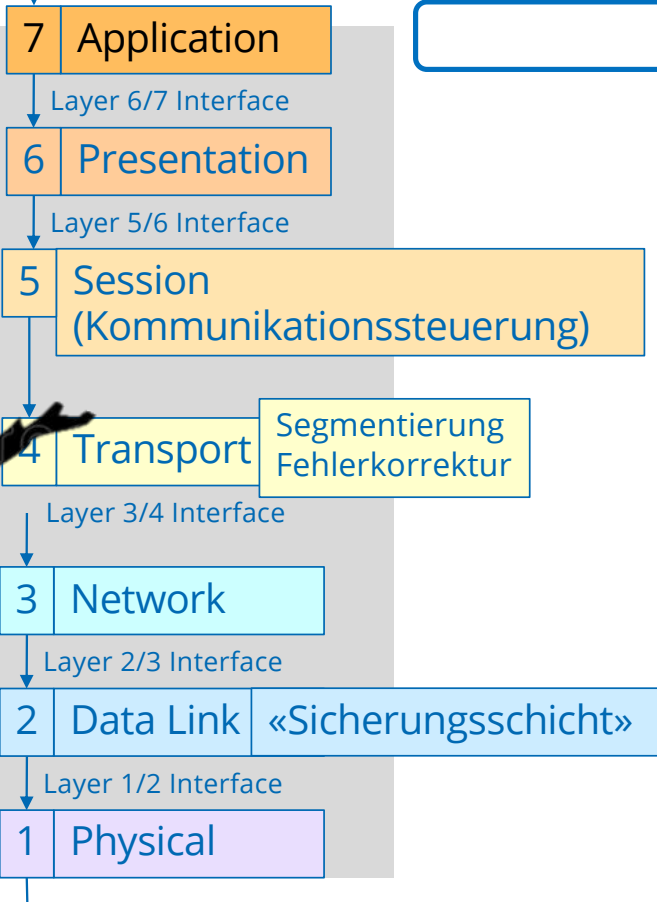


- UDP (User Datagram Protocol)
- TCP (Transmission Control Protocol)
- SCTP: Stream Control Transmission Protocol

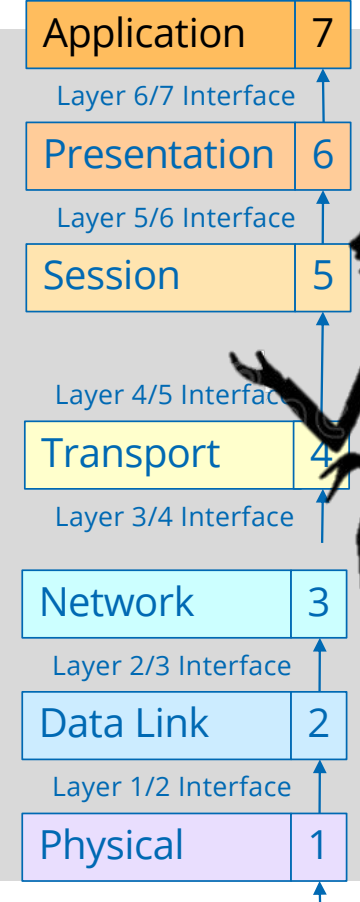


ISO/OSI Referenzmodell: Beispiel

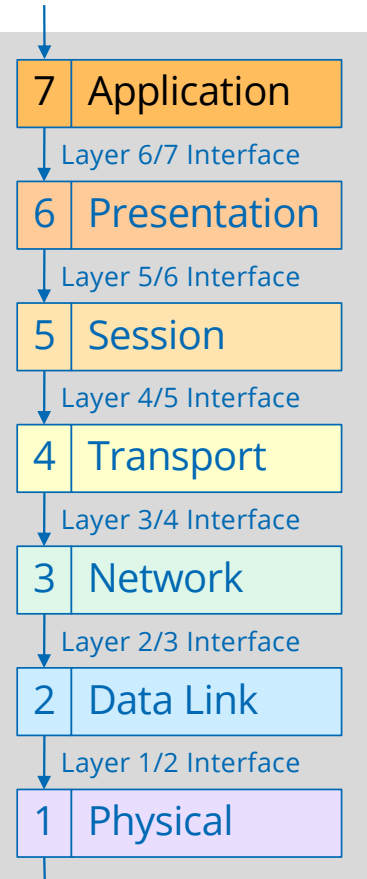
Sender



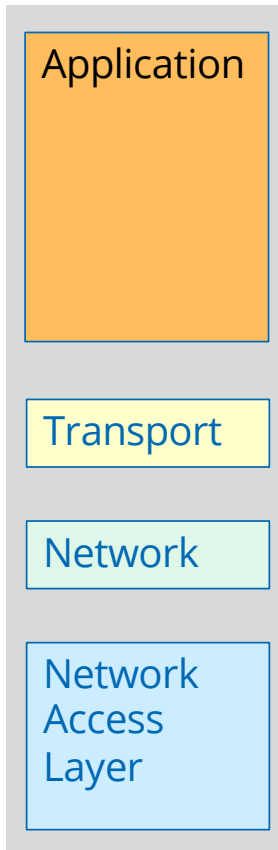
Receiver



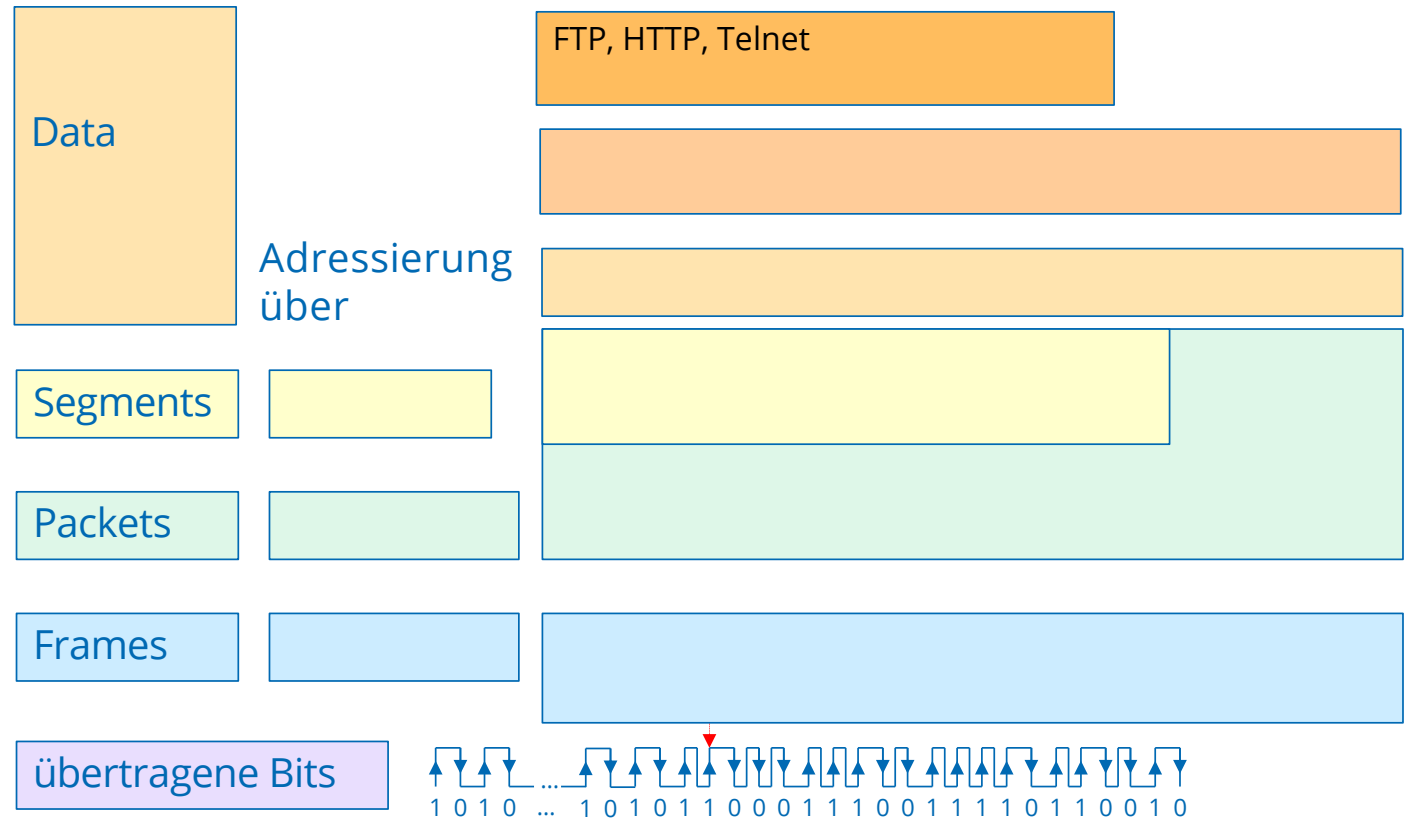
ISO/OSI



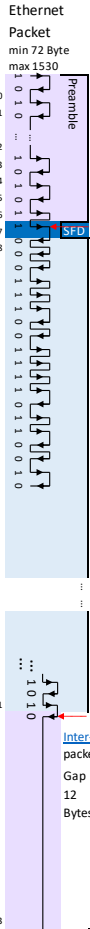
TCP/IP-Modell



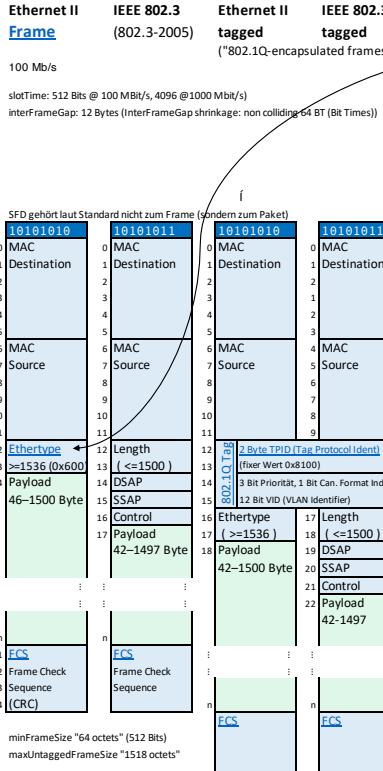
Übertragung, Kommunikation, Reichweite



Layer 1



Layer 2 (Data Link = Sicherungsschicht)

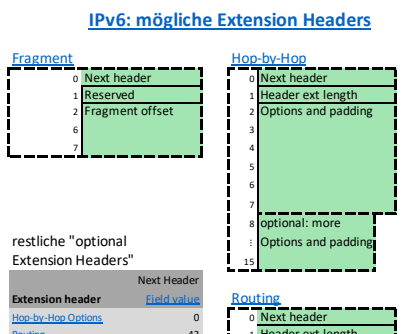
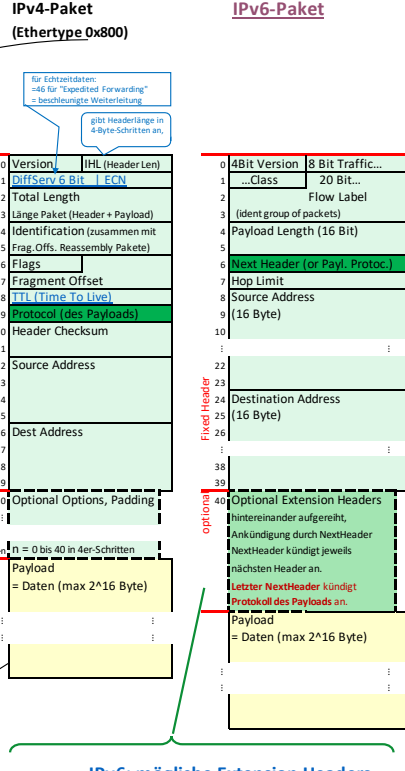


Ethertype Protocol

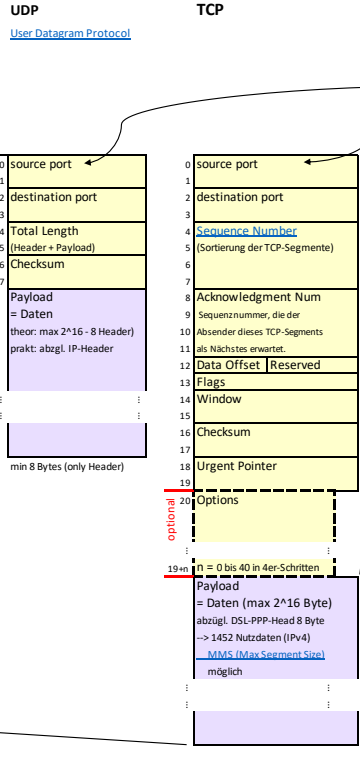
wenn Ethertype < 0x600, dann gibt es die Länge des Payloads an

- 0x0800 Internet Protocol version 4 (IPv4)
- 0x0806 Address Resolution Protocol (ARP)
- 0x0842 Wake-on-LAN^[9]
- 0x22F0 Audio Video Transport Protocol (AVTP)
- 0x809B AppleTalk (Ethernalk)
- 0x80F3 AppleTalk Address Resolution Protocol (AARP)
- 0x8100 VLAN-tagged frame (IEEE 802.1Q) and Shortest Path Bridging
- 0x86DD Internet Protocol Version 6 (IPv6)

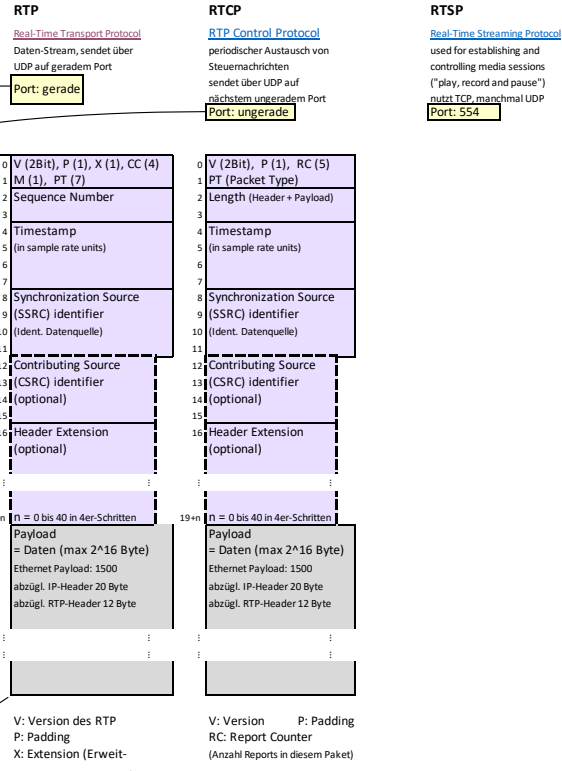
Layer 3 (Network)



Layer 4 (Transport)



Layer 5 - 7



Layer 1

Ethernet

Packet

min 72 Byte
max 1530

Layer 2 (Data Link = Sicherungsschicht)

Ethernet II

IEEE 802.3

Ethernet II

IEEE 802.3

Frame

(802.3-2005)

tagged

tagged

Layer 3 (Network)

IPv4-Paket

IPv6-Paket

(Ethertype 0x800)

Layer 4 (Transport)

UDP

TCP

User Datagram Protocol

Layer 5 - 7

RTP

RTCP

Real-Time Transport Protocol

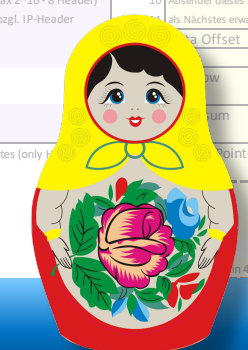
Real-Time Control Protocol

Daten-Stream, sendet über UDP auf geradem Port

periodischer Austausch von Steuermeldungen sendet über UDP auf nächstem ungeradem Port

Port: gerade

Port: ungerade



100 Mb/s
slotTime: 512 Bits @ 100 Mbit/s, 4096 @1000 Mbit/s
interFrameGap: 12 Bytes (InterFrameGap shrinkage: non colliding 64 BT (Bit Times))

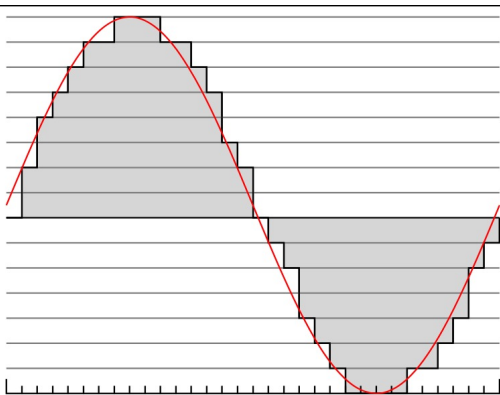
0	MAC	0	MAC
1	Destination	1	Destination
2	Source	2	Source
3	Length	3	Length
4	Type	4	Type
5	Reserved	5	Reserved
6	MAC	6	MAC
7	Source	7	Source
8	Destination	8	Destination
9	Length	9	Length
10	Type	10	Type
11	Reserved	11	Reserved
12	Length	12	Length
13	Type	13	Type
14	Reserved	14	Reserved
15	Source	15	Source
16	Destination	16	Destination
17	Length	17	Length
18	Type	18	Type
19	Reserved	19	Reserved
20	Source	20	Source
21	Destination	21	Destination
22	Length	22	Length
23	Type	23	Type
24	Reserved	24	Reserved
25	Source	25	Source
26	Destination	26	Destination
27	Length	27	Length
28	Type	28	Type
29	Reserved	29	Reserved
30	Source	30	Source
31	Destination	31	Destination
32	Length	32	Length
33	Type	33	Type
34	Reserved	34	Reserved
35	Source	35	Source
36	Destination	36	Destination
37	Length	37	Length
38	Type	38	Type
39	Reserved	39	Reserved
40	Source	40	Source
41	Destination	41	Destination
42	Length	42	Length
43	Type	43	Type
44	Reserved	44	Reserved
45	Source	45	Source
46	Destination	46	Destination
47	Length	47	Length
48	Type	48	Type
49	Reserved	49	Reserved
50	Source	50	Source
51	Destination	51	Destination
52	Length	52	Length
53	Type	53	Type
54	Reserved	54	Reserved
55	Source	55	Source
56	Destination	56	Destination
57	Length	57	Length
58	Type	58	Type
59	Reserved	59	Reserved
60	Source	60	Source
61	Destination	61	Destination
62	Length	62	Length
63	Type	63	Type
64	Reserved	64	Reserved
65	Source	65	Source
66	Destination	66	Destination
67	Length	67	Length
68	Type	68	Type
69	Reserved	69	Reserved
70	Source	70	Source
71	Destination	71	Destination
72	Length	72	Length
73	Type	73	Type
74	Reserved	74	Reserved
75	Source	75	Source
76	Destination	76	Destination
77	Length	77	Length
78	Type	78	Type
79	Reserved	79	Reserved
80	Source	80	Source
81	Destination	81	Destination
82	Length	82	Length
83	Type	83	Type
84	Reserved	84	Reserved
85	Source	85	Source
86	Destination	86	Destination
87	Length	87	Length
88	Type	88	Type
89	Reserved	89	Reserved
90	Source	90	Source
91	Destination	91	Destination
92	Length	92	Length
93	Type	93	Type
94	Reserved	94	Reserved
95	Source	95	Source
96	Destination	96	Destination
97	Length	97	Length
98	Type	98	Type
99	Reserved	99	Reserved

0	Version	4	4Bit Version	8 Bit Traffic...
1	DiffServ 6 Bit	1	...Class	20 Bit...
2	Total Length	2	Flow Label	
3	Länge Paket (Header + Payload)	3	(ident group of packets)	
4	Identification (zusammen mit Frag. Offs. Reassembly Pakete)	4	Payload Length (16 Bit)	
5	Flags	5	Next Header (or Payl. Protoc.)	
6	Fragment Offset	6	Destination Address	
7	TTL (Time To Live)	7	Source Address	
8	Protocol (des Payloads)	8	Destination Address	
9	Header Checksum	9	Source Address	
10	Source Address	10	Destination Address	
11	Destination Address	11	Source Address	
12	Source Address	12	Destination Address	
13	Destination Address	13	Source Address	
14	Source Address	14	Destination Address	
15	Destination Address	15	Source Address	
16	Source Address	16	Destination Address	
17	Destination Address	17	Source Address	
18	Source Address	18	Destination Address	
19	Destination Address	19	Source Address	
20	Optional Options, Padding	20	Optional Options, Padding	
21	Optional Options, Padding	21	Optional Options, Padding	
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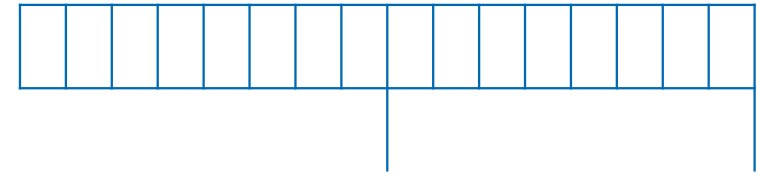
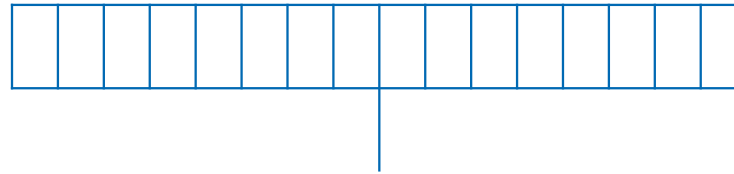
0	source port	0	source port
1	destination port	1	destination port
2	Total Length	2	Sequence Number
3	Checksum	3	(Sortierung der TCP-Segmente)
4	Checksum	4	Acknowledgment Num
5	Checksum	5	Sequenznummer, die der Absender dieses TCP-Segments als Nächstes erwartet.
6	Checksum	6	Offset Reserved
7	Checksum	7	Checksum
8	Checksum	8	Checksum
9	Checksum	9	Checksum
10	Checksum	10	Checksum
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73	Checksum	73	Checksum
74	Checksum	74	Checksum
75	Checksum	75	Checksum
76	Checksum	76	Checksum
77	Checksum	77	Checksum
78	Checksum	78	Checksum
79	Checksum	79	Checksum
80	Checksum	80	Checksum
81	Checksum	81	Checksum
82	Checksum	82	Checksum
83	Checksum	83	Checksum
84	Checksum	84	Checksum
85	Checksum	85	Checksum
86	Checksum	86	Checksum
87	Checksum	87	Checksum
88	Checksum	88	Checksum
89	Checksum	89	Checksum
90	Checksum	90	Checksum
91	Checksum	91	Checksum
92	Checksum	92	Checksum
93	Checksum	93	Checksum
94	Checksum	94	Checksum
95	Checksum	95	Checksum
96	Checksum	96	Checksum
97	Checksum	97	Checksum
98	Checksum	98	Checksum
99	Checksum	99	Checksum

0	V (2Bit), P (1), X (1), CC (4)	0	V (2Bit), P (1), RC (5)
1	M (1), PT (7)	1	PT (Packet Type)
2	Sequence Number	2	Length (Header + Payload)
3	Timestamp	3	Timestamp
4	Timestamp (in sample rate units)	4	Timestamp (in sample rate units)
5	Synchronization Source (SSRC) identifier (Ident. Datenquelle)	5	Synchronization Source (SSRC) identifier (Ident. Datenquelle)
6	Contributing Source (CSRC) identifier (optional)	6	Contributing Source (CSRC) identifier (optional)
7			

Nutzdaten zu Paket zusammensetzen



Bits



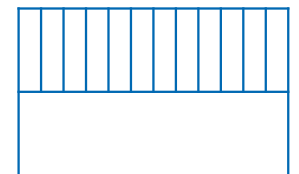
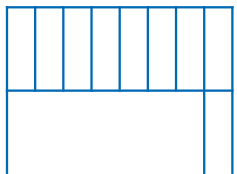
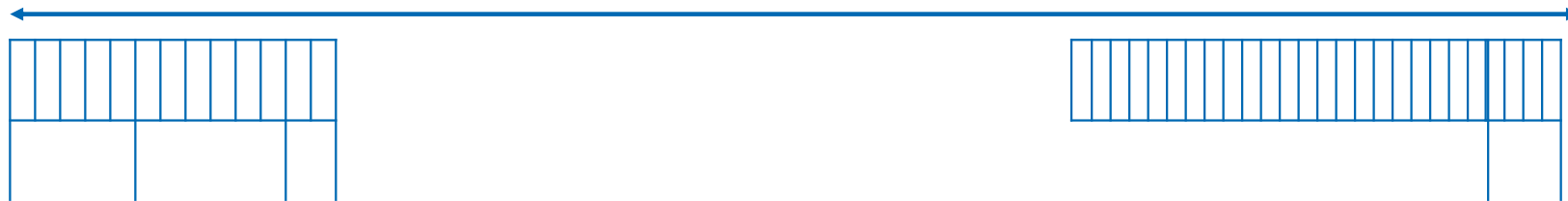
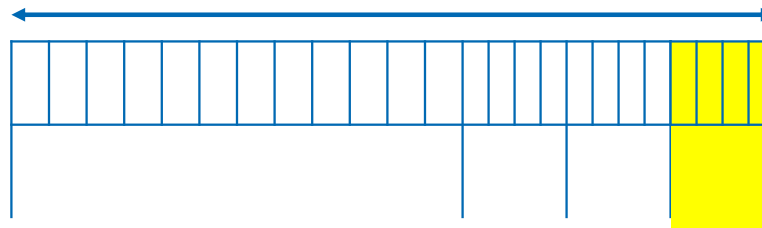
Bytes

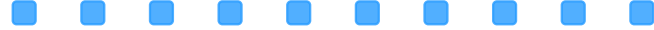
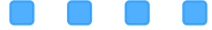


Beispiel Übertragung Audio-over-IP:

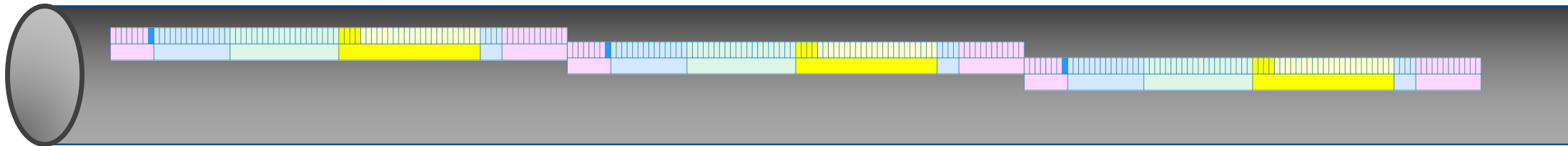
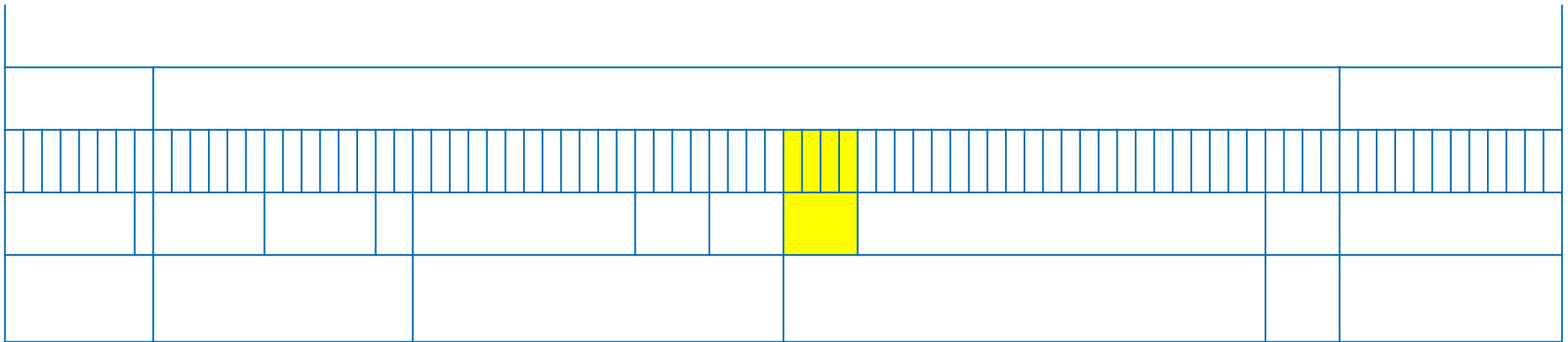
- Eigenes Protokoll, unser Gerät "weiß", wie es mit den Daten umgehen kann
- Sampledaten 16 Bit pro Kanal
- wir übertragen 1 einzelnes Sample pro Datenpaket

Nutzdaten zu Paket zusammensetzen





Was ist los auf der Leitung?



Layer 2 oder 3

Vorteile

Nachteile

OSI-Layer 2

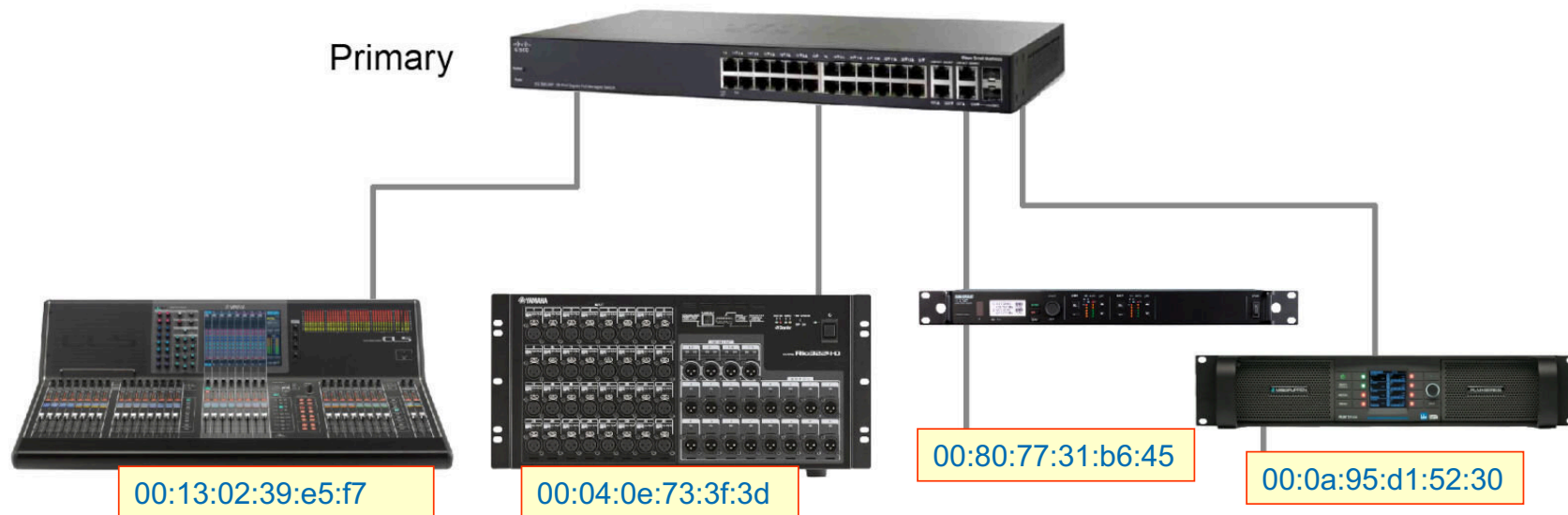


OSI-Layer 3 („over IP“)

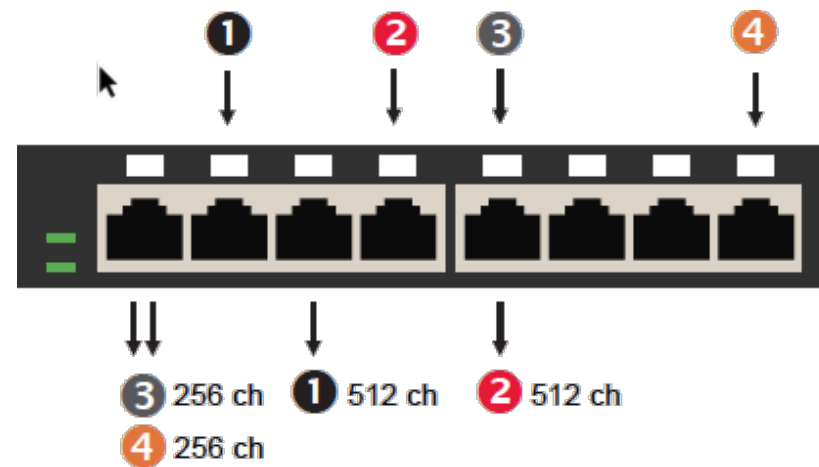
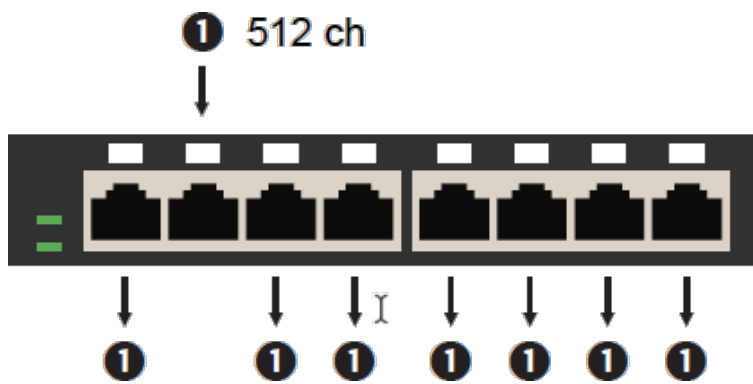


Layer-3-Audio-Netzwerk

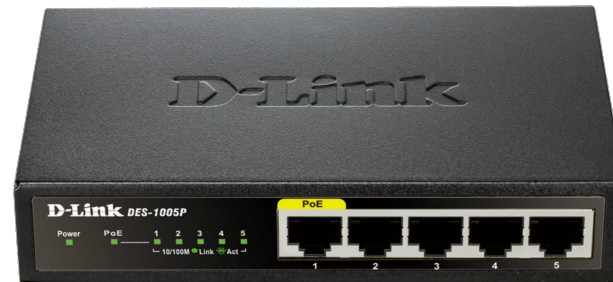
Hub, Switch ODER Geräte direkt verbinden



Vom Hub zum Switch



Switch (unmanaged)



00:80:77:31:b6:1a



00:0a:95:d1:88:bc

100 Mbit/s

1 Gbit/s

1 Gbit/s

100 Mbps

00:0a:95:d1:52:30



00:80:77:31:b6:45

MAC	Port Nummer
00:80:77:31:b6:1a	1
00:0a:95:d1:88:bc	2
00:0a:95:d1:52:30	3
00:80:77:31:b6:45	4

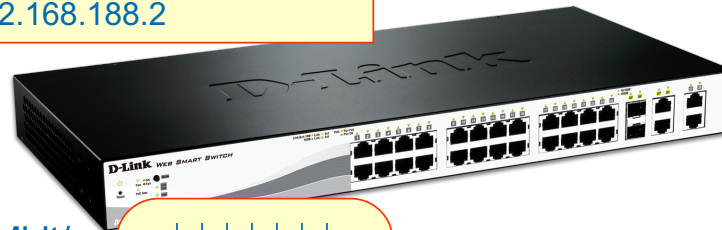
Switch (managed)

Port 1: 00:80:77:31:10:01

...

Port 16: 00:80:77:31:10:16
192.168.188.2

00:80:77:31:b6:1a
192.168.188.10



100 Mbit/s

1 Gbit/s

1 Gbit/s

100 Mbps

00:0a:95:d1:88:bc
192.168.188.41



00:0a:95:d1:52:30
192.168.188.83



MAC	Port Nr
00:80:77:31:b6:1a	1
00:0a:95:d1:88:bc	2
00:0a:95:d1:52:30	3
00:80:77:31:b6:45	4

00:80:77:31:b6:45
192.168.188.74



Layer-3-Audio-Netzwerk

