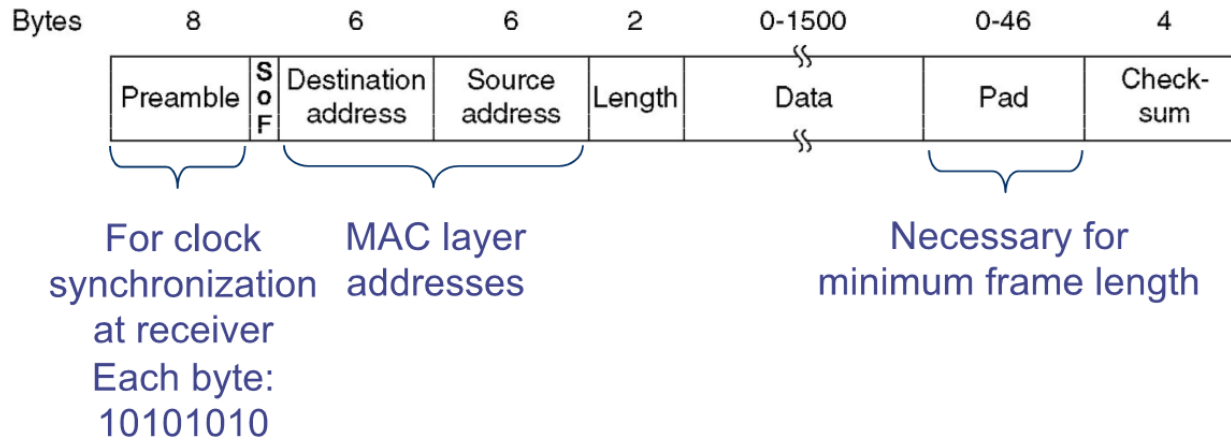
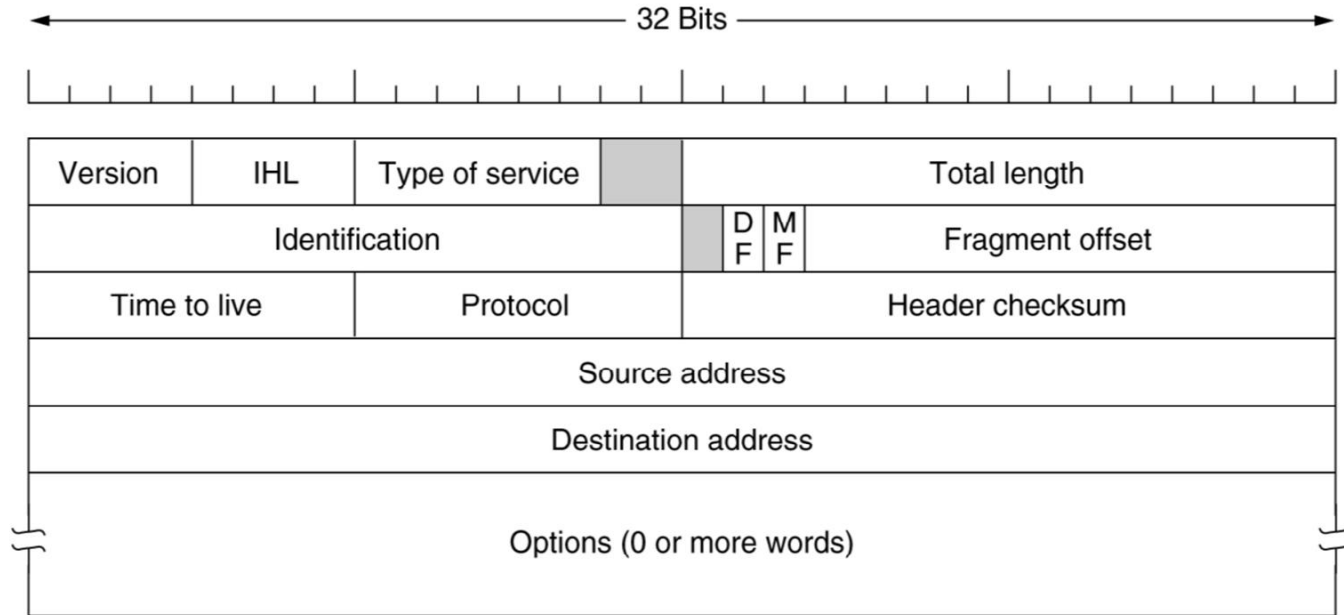


Ethernet MAC sublayer

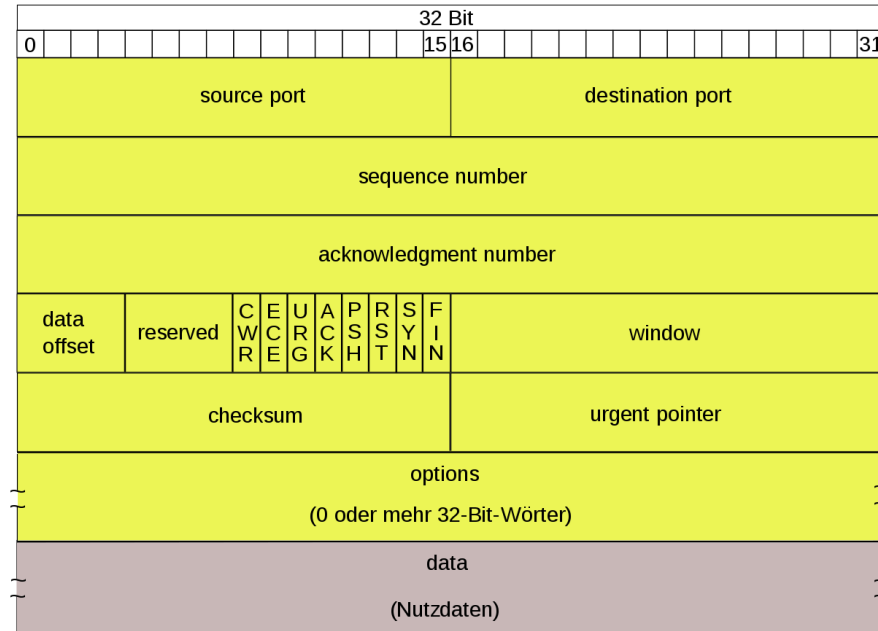
- Essentially: CSMA/CD with binary exponential backoff
- Frame format:



An IPv4 packet header

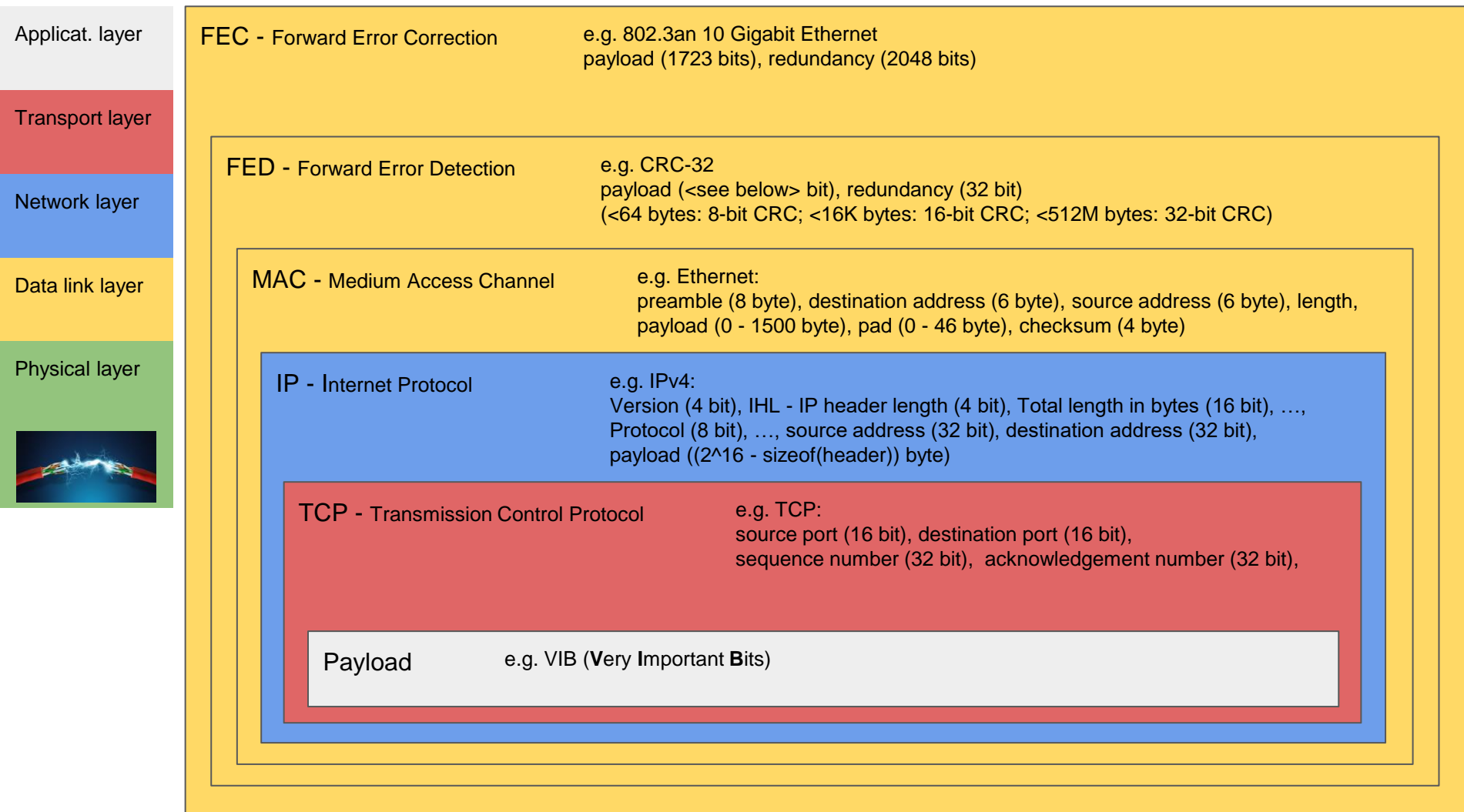


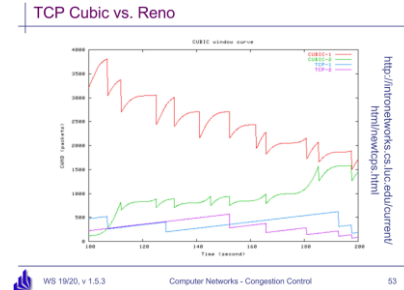
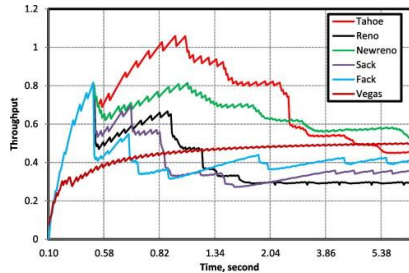
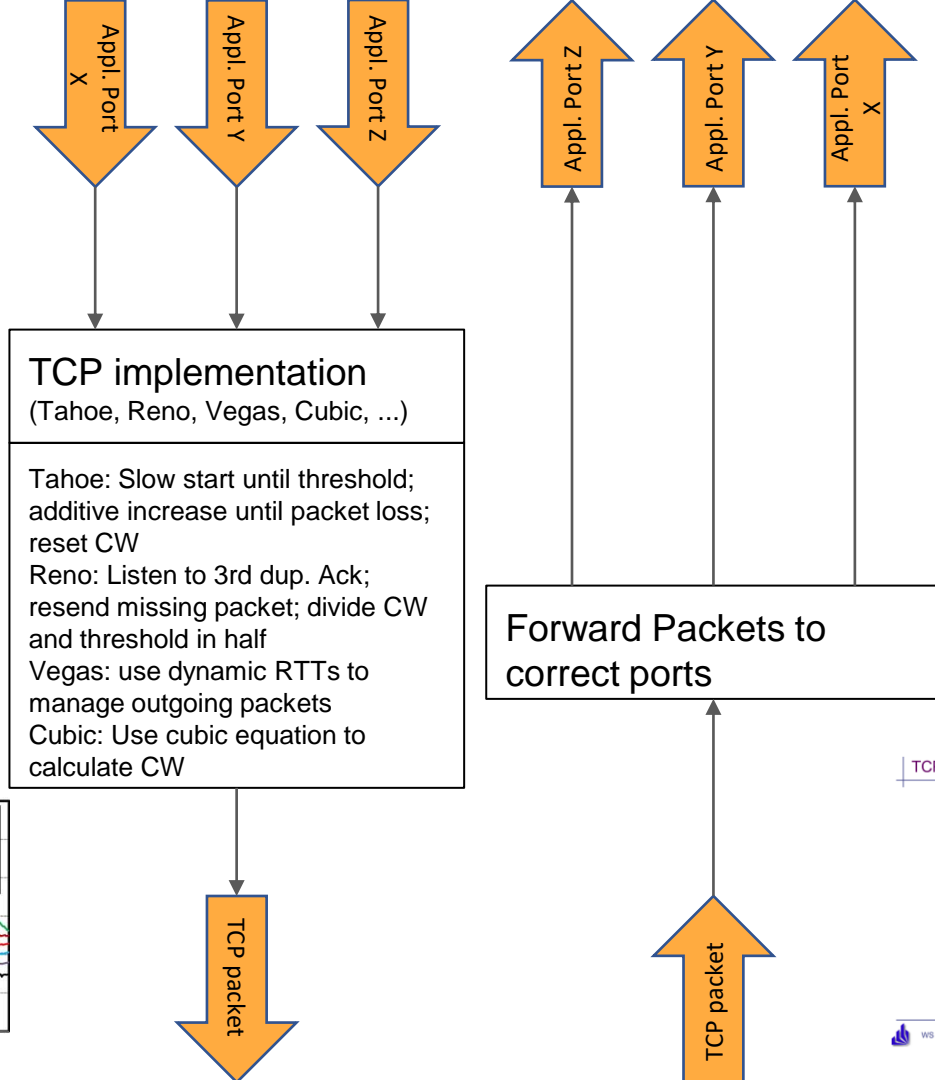
TCP Header



TCP-Header

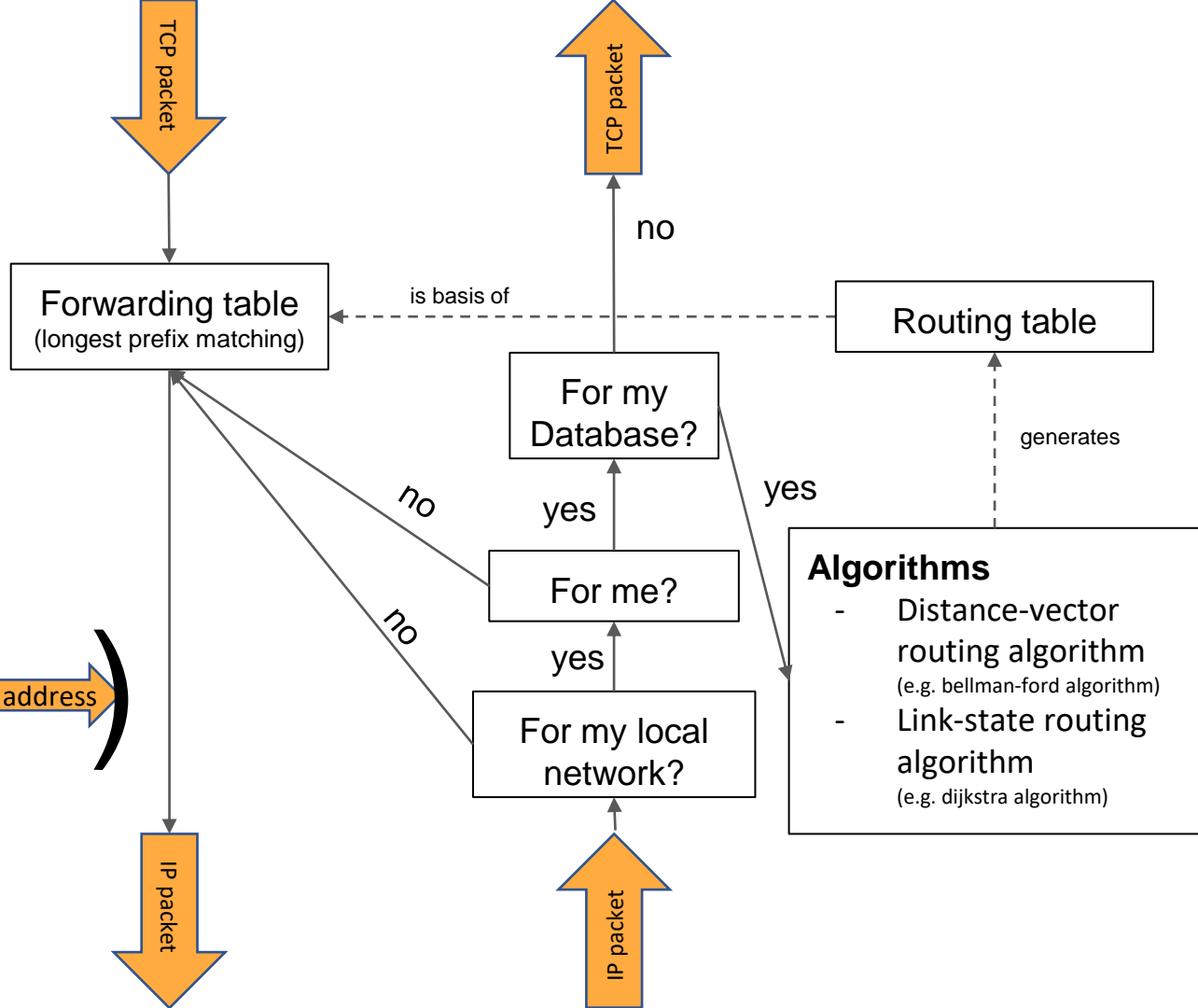
Source: https://de.wikipedia.org/wiki/Transmission_Control_Protocol#Aufbau_des_TCP-Headers





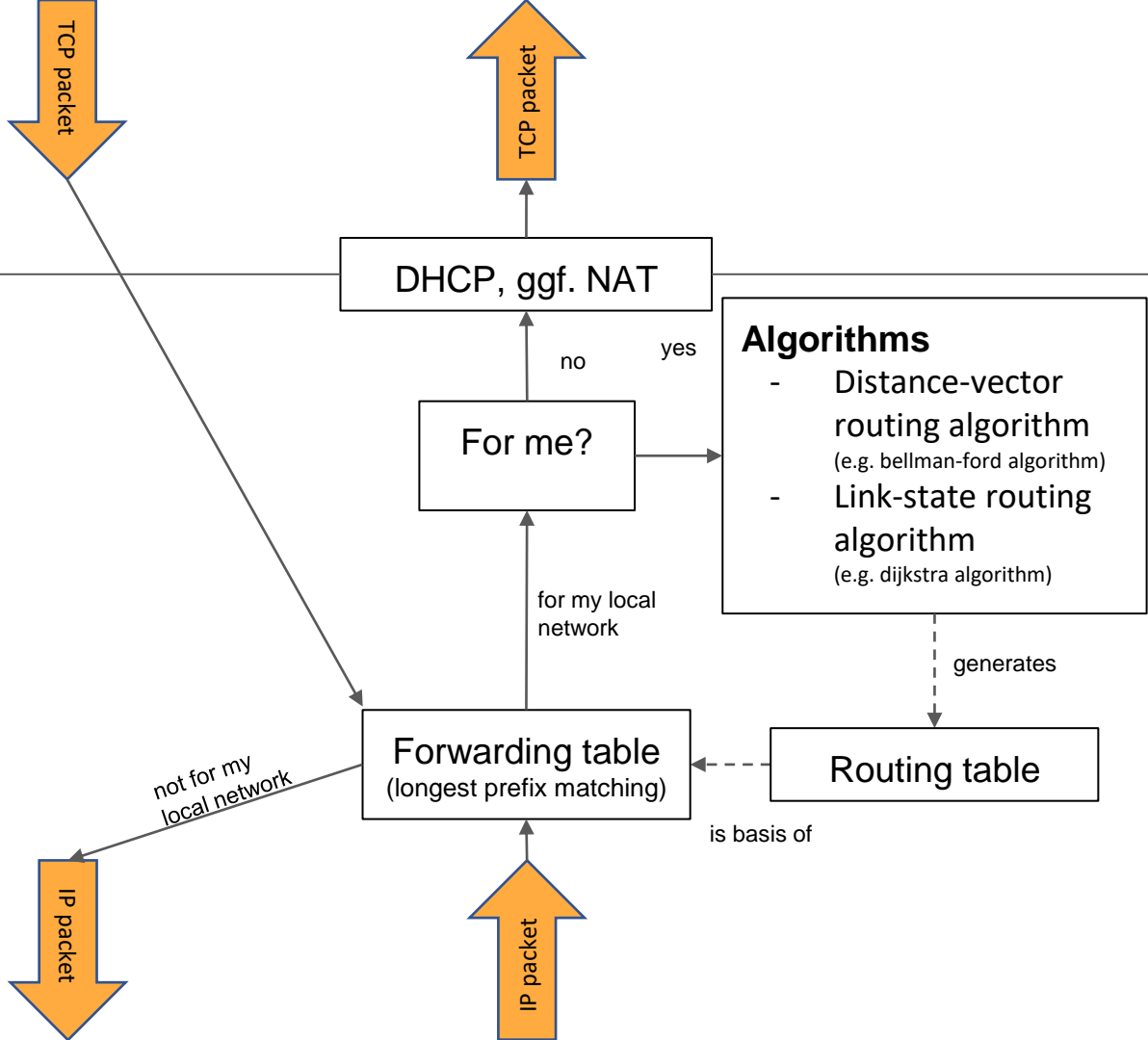
(DHCP
(Dynamic Host
Configuration Protocol))

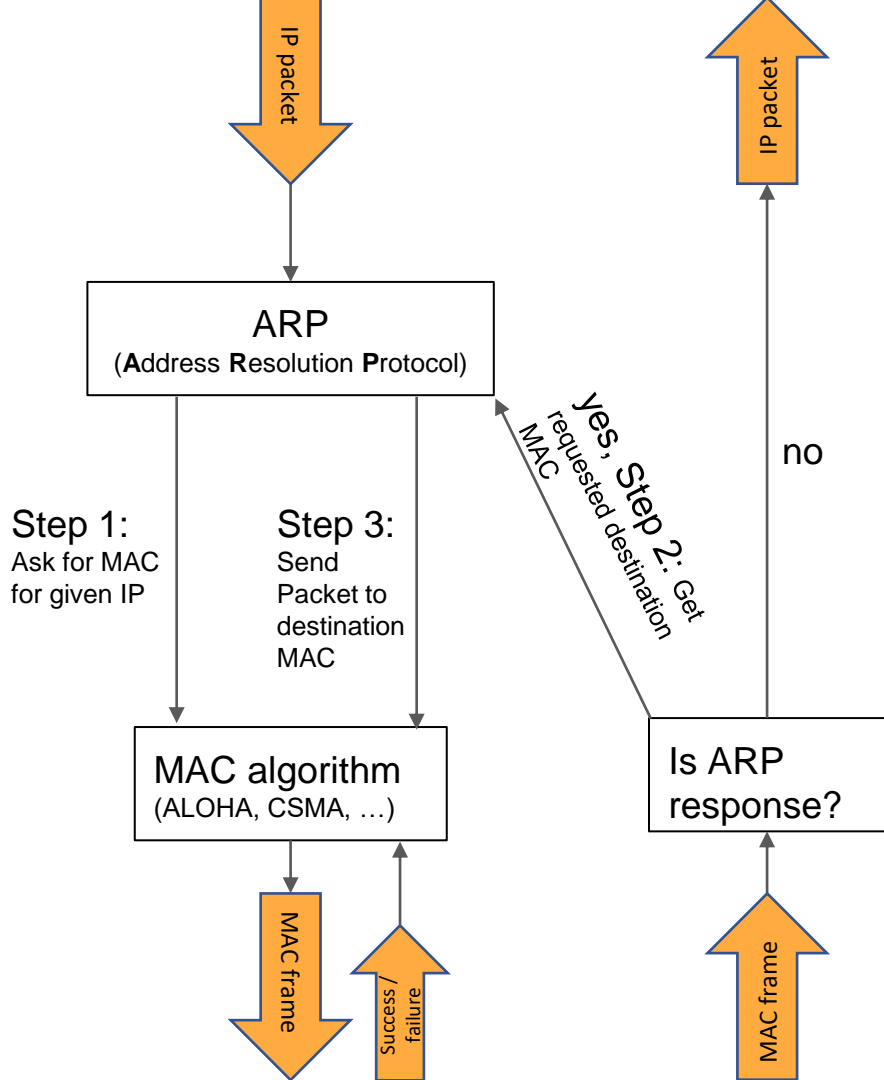
ask for IP address



Local IP address space

Global IP address space

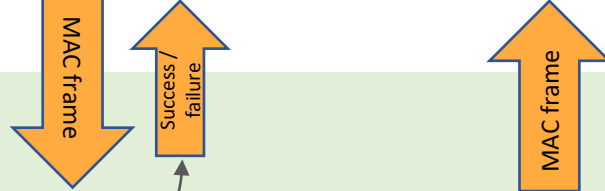




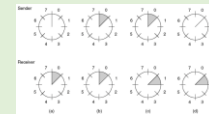
Backward
error
correction

ARQ

(Automatic Repeat reQuest protocol)



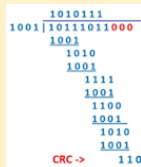
Sliding window



Error
detection

CRC (Cyclic Redundancy Check)

e.g. 32-bit CRC



Odd / even parity



Interleaving

Forward
error
correction

systematic / non-systematic block codes

$$\begin{pmatrix} 1 & 0 & 0 & 1 \end{pmatrix} \cdot \begin{pmatrix} 0 & 0 & 0 & 0 & 1 & 1 & 1 & 0 \\ 0 & 1 & 0 & 0 & 0 & 1 & 0 & 0 \\ 0 & 0 & 1 & 0 & 0 & 0 & 1 & 1 \\ 0 & 0 & 0 & 1 & 0 & 0 & 0 & 0 \end{pmatrix} = \begin{pmatrix} 1 & 0 & 0 & 1 & 0 & 0 & 0 & 1 \end{pmatrix}$$

$$\begin{pmatrix} 1 & 0 & 0 & 1 \end{pmatrix} \cdot \begin{pmatrix} 0 & 1 & 1 & 0 & 1 & 1 & 1 & 0 \\ 1 & 1 & 0 & 1 & 1 & 0 & 0 & 0 \\ 1 & 0 & 1 & 1 & 0 & 1 & 1 & 1 \\ 0 & 0 & 0 & 1 & 0 & 0 & 0 & 0 \end{pmatrix} = \begin{pmatrix} 0 & 0 & 1 & 1 & 0 & 0 & 0 & 1 \end{pmatrix}$$

Generator matrix G Payload Codeword

Code books

(Hamming distance)

0011 | 1111
1100 | 0000

Convolutional code

encode using a state machine

decoded by

Viterbi algorithm
decoding conv. codes

Turbo codes

e.g. multiple conv. codes

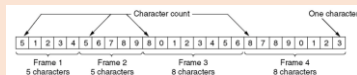
BCH codes

e.g. Hamming7,4

special case

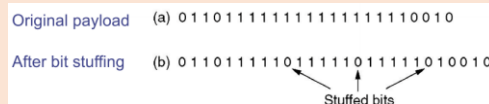
Reed-Solomon codes

Character



Byte stuffing

Bit stuffing



e.g. manchester encoding

_ | - | _ | - | _ | - | _ | - |

Code violations

Framing





Data rate
bit/s



Buffer

Shannon Limit
Max. Rate without bit errors $< H \cdot \log_2(1 + S/N)$
H: Channel bandwidth
S: Signal power
R: Noise power

Nyquist limit
Max. Rate without bit errors $< 2H \cdot \log_2(V)$
H: Channel bandwidth
V: Number of unique Symbols

Baseband

Broadband

Constellation Diagram

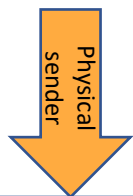
Signal bandwidth

Channel bandwidth

BER

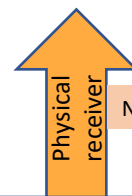
Sampling

Symbol rate (baud rate)
baud/s



Clock drift

SNR



Noise

Data rate delay product
Data in channel = rate * τ

Channel coefficient

Shannon capacity

Channel

Attenuatio

Distortion

Additional information - Forwarding / Routing Table

Routing Table			Cost
Destination		222.123.0.0/16	222.123.32.0/24
Outgoing link	1	12	2
	2	3	7

Forwarding Table	
Address prefix	Outgoing link
222.123.32.0/24	1
222.123.0.0/16	2

Additional information - ARP

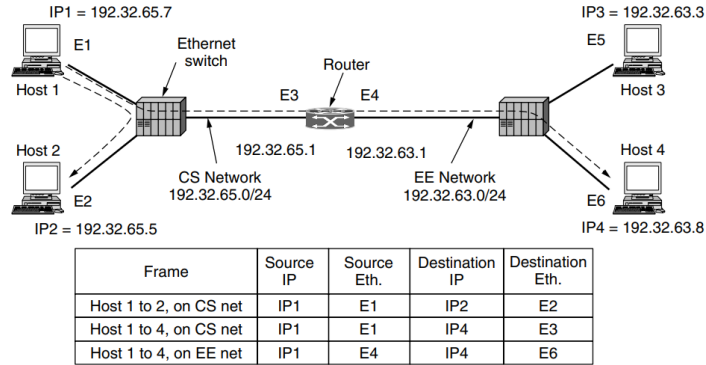
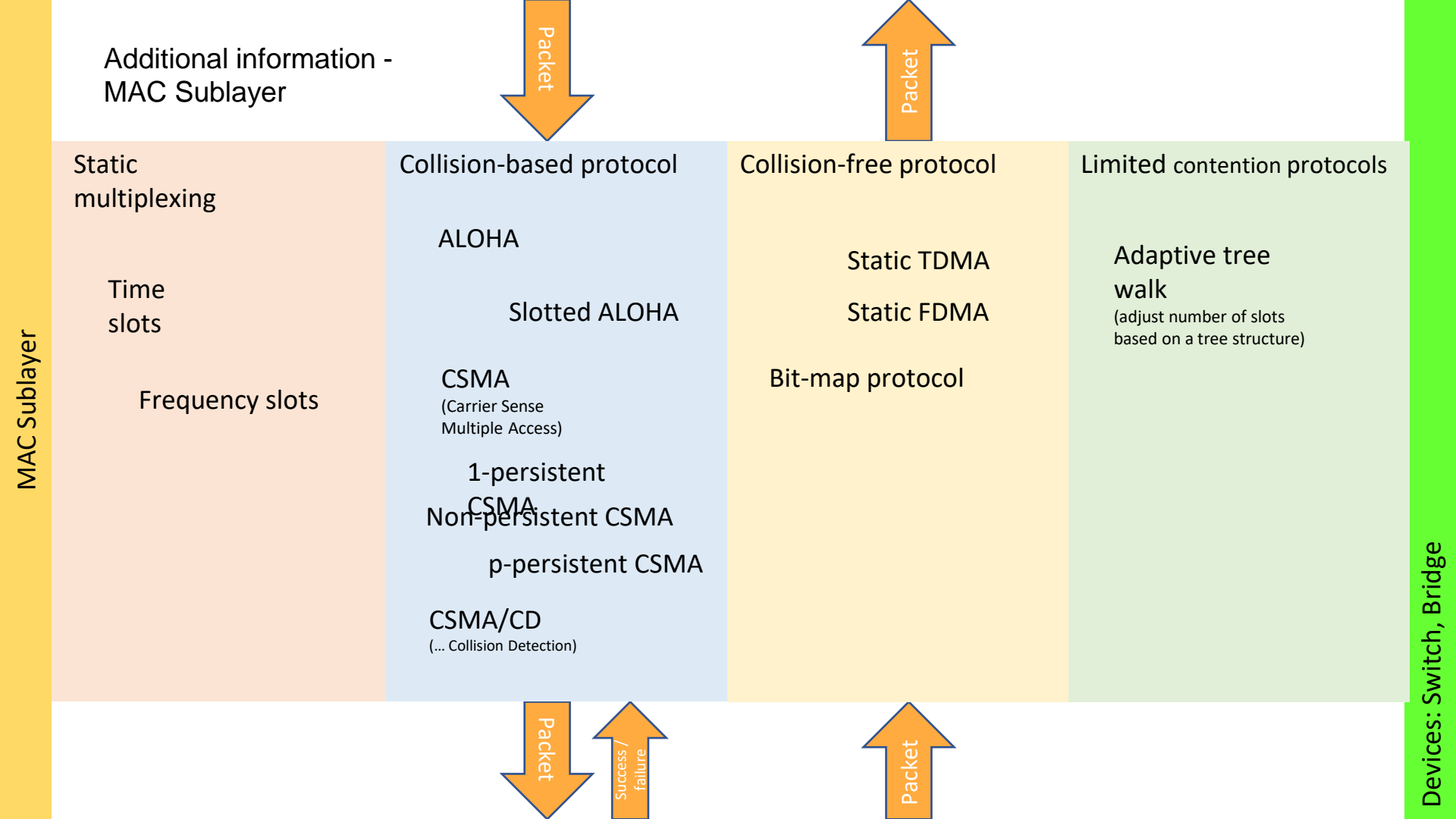


Figure 5-61. Two switched Ethernet LANs joined by a router.

this solution is certainly possible, for organizations with thousands of machines keeping all these files up to date is an error-prone, time-consuming job.

A better solution is for host 1 to output a broadcast packet onto the Ethernet asking who owns IP address 192.32.65.5. The broadcast will arrive at every machine on the CS Ethernet, and each one will check its IP address. Host 2 alone will respond with its Ethernet address (E2). In this way host 1 learns that IP address 192.32.65.5 is on the host with Ethernet address E2. The protocol used for asking this question and getting the reply is called **ARP (Address Resolution Protocol)**. Almost every machine on the Internet runs it. ARP is defined in RFC 826.

The advantage of using ARP over configuration files is the simplicity. The system manager does not have to do much except assign each machine an IP address and decide about subnet masks. ARP does the rest.



Weg - Zeit - Diagramm

