ETSF05

Quick repetition from KomSys

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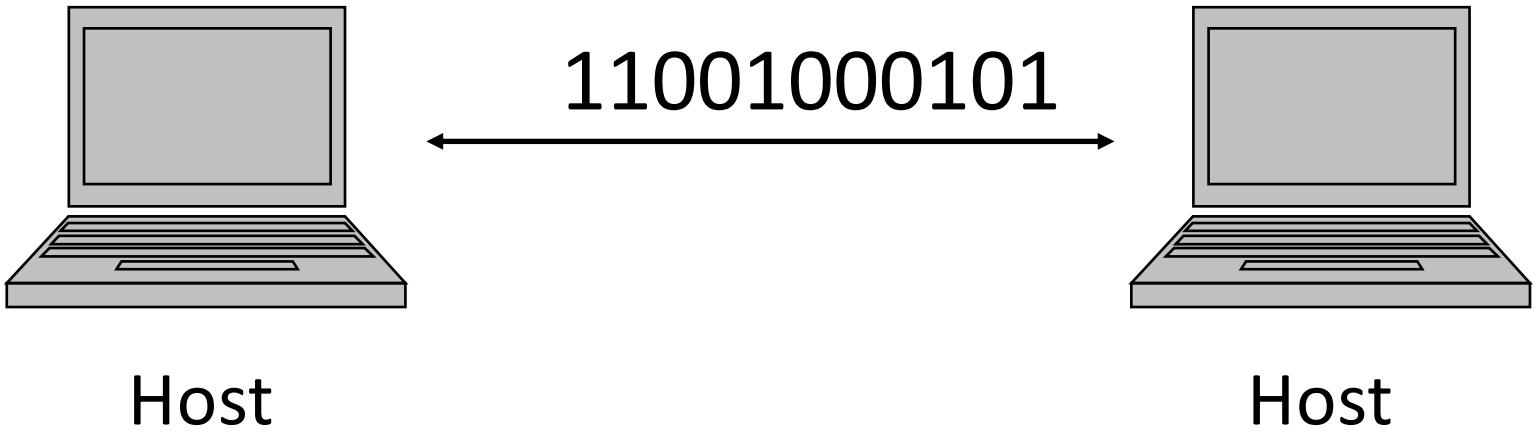
Our main problem!



- Two computing devices want to communicate
- Computers only understand digital information

Digitising sound

Converting audio into digital for happens in three steps:

1) *Sampling*
2) *Quantizing*
3) *Encoding*

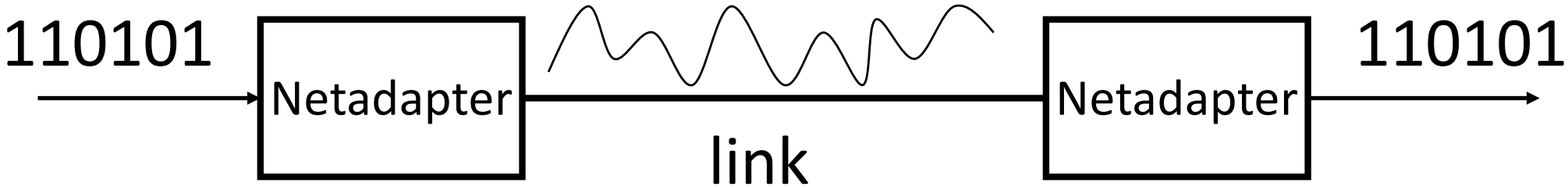
The most basic format is called *Pulse Code Modulation* (PCM).

Data transmission over a link

Two devices communicate over a *link*.

The link uses some form of *medium*.

Digital communication



- The transmitter has a network adapter that transforms the bits into signals, which are transmitted over the link.
- The receiver network adapter converts the signal back to bits.
- Line coding: NRZ, Manchester

Translation from bits to signals (2)

Another way of sending bits over a link is through *modulation*.

Bits are represented by wave forms, i.e. Sine waves, which differ in form depending on bit value (0,1)

Sine wave: $g(x)=\mathbf{A}*\sin(\mathbf{F}x+\mathbf{P})$ $x=0..2\pi$

Link protocols and frames

The lin protocol determines how data is divided into frames

A frame consists of up to three parts:

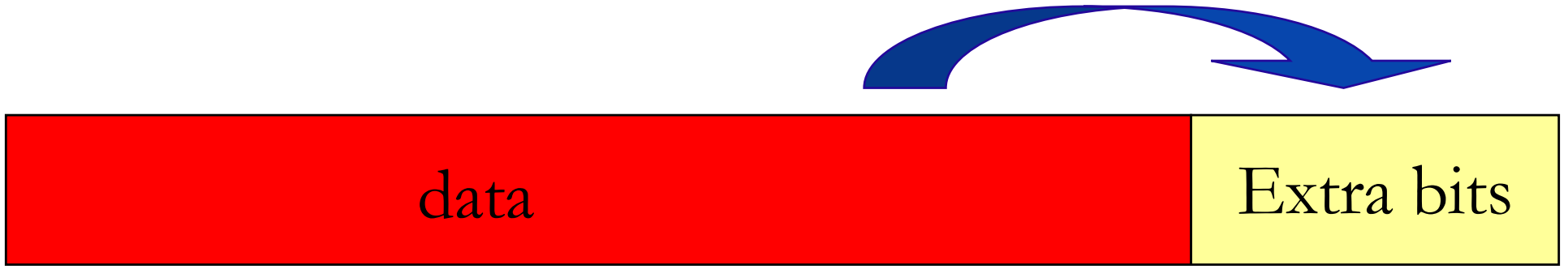
header, data and trailer (tail)

- Header and trailer contain control information
- Possibility to detect errors

Detecting errors

Advantageous that receiver detects errors.

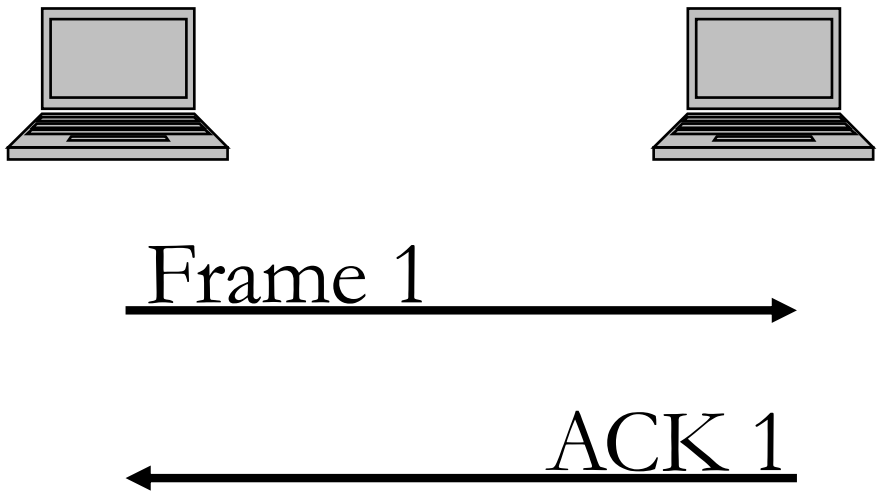
Transmitter adds information (bits) depending on the data.



- Parity bits
- Checksum

Error correction: confirming the frame

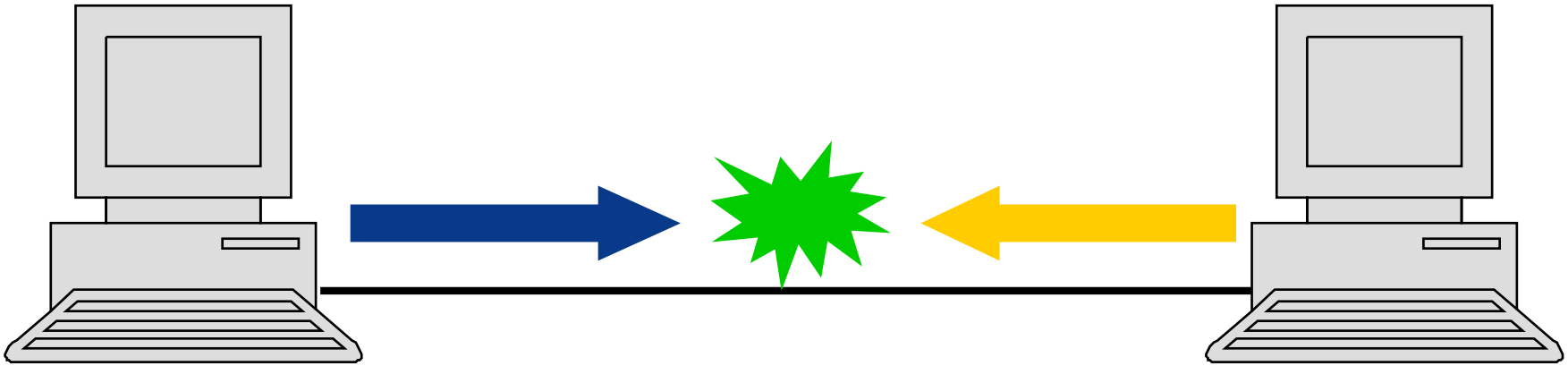
Basic principle: receiver acknowledges all correct frames.



Methods for error correction

- Stop-and-wait
- Go-back-n
- Selective-repeat

Multiplexing



If two devices transmit simultaneously, the signals will be mixed and destroyed.

Data transmission control

- Simplex:
  - One-way transmission.
- Half duplex:
  - Transmission in both directions, not concurrently.
- Full duplex:
  - Both directions concurrently.
  - Requires two channels.

Capacity division

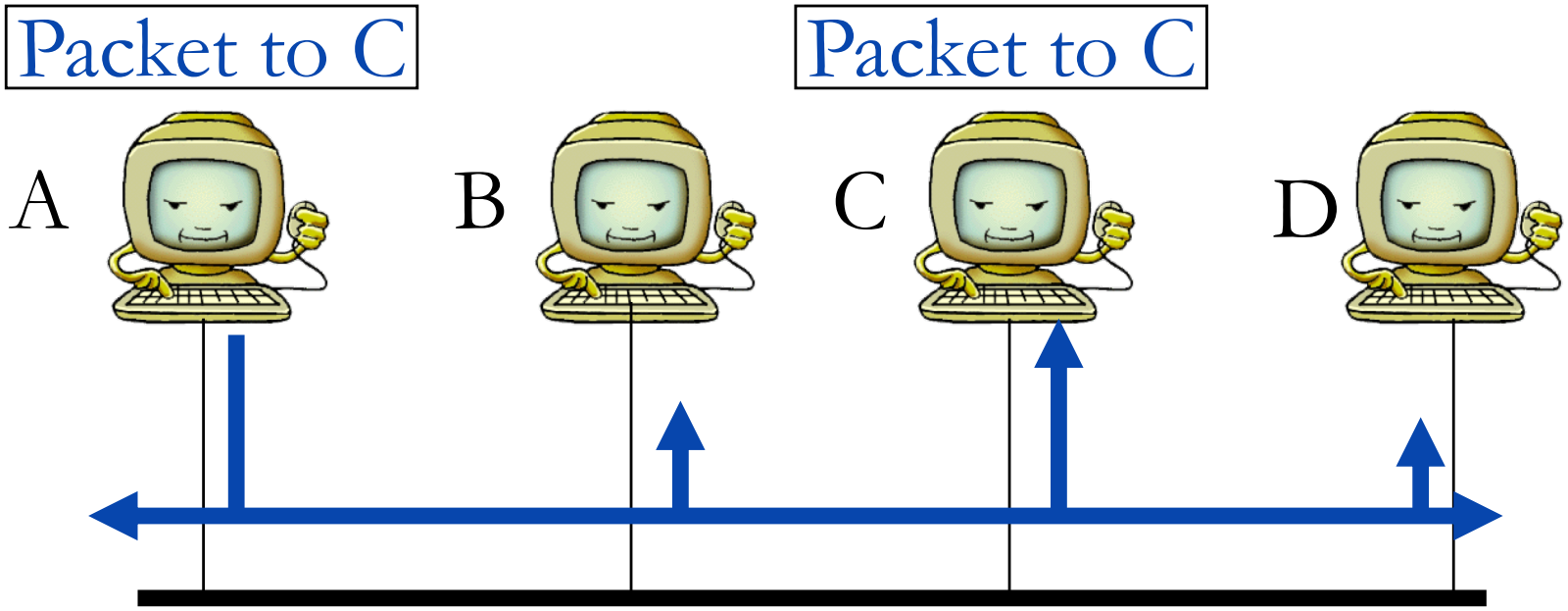
Link capacity can be divided in different ways:

1. Spatial multiplexation
2. Frequency multiplexation
3. Time multiplexation
4. Code division multiplexation

Local networks

- A local network (Local Area Network, LAN) is a data network limited in size
- A LAN may only have a single link to which all hosts are connected.
- A LAN may also comprise several physical links connected by bridges or switches.

LAN transmission over a single link



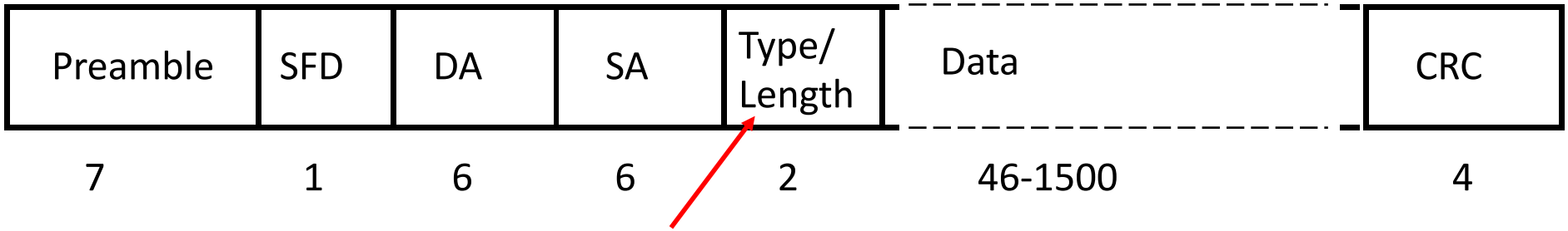
The host with correct address reads in the packet

Access methods

- Hosts need to agree how to access the link.
- Called access method, in LAN could be:
  - Pollning (master – slave)
  - Aloha/Slotted Aloha
  - CSMA/CD
  - (Token Ring)
- Agreement = protocol

Ethernet & IEEE 802

- Ethernet is a standard developed by Xerox, Intel och DEC in 1976.
- IEEE 802.3 extends Ethernet.
- Different frame formats (can co-exist in a LAN).

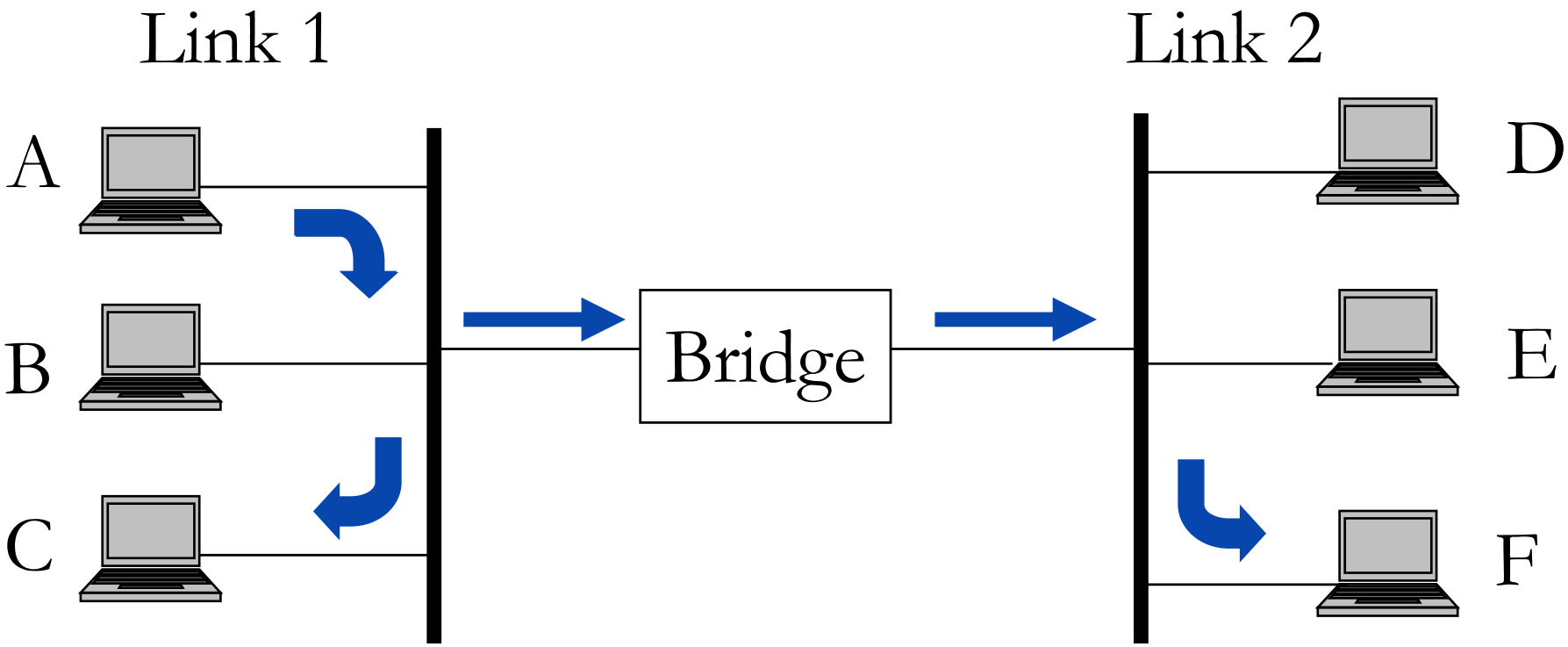


SFD=Start frame delimiter DA=Destination address SA=Source address

IEEE 802.11 (WiFi)

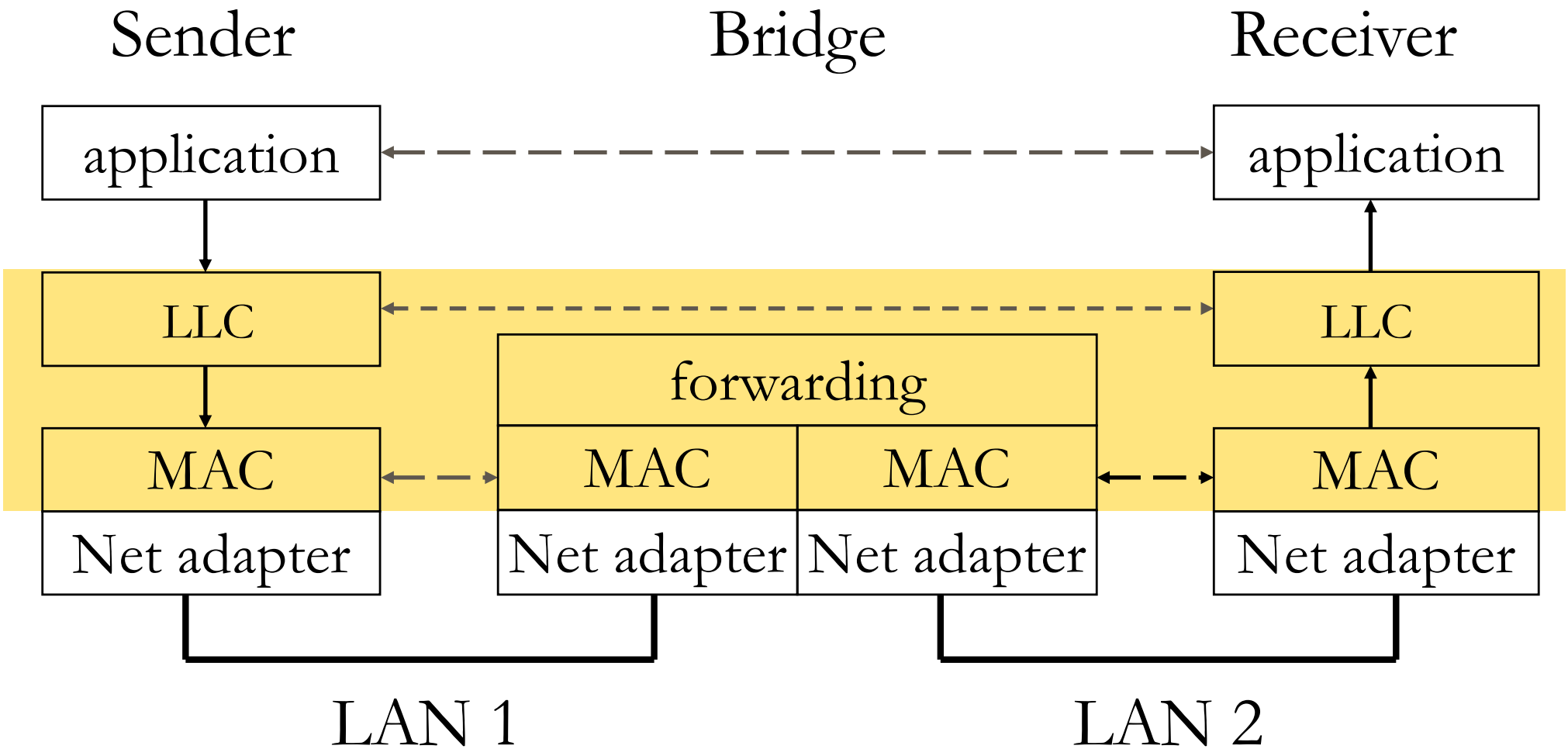
- Normal mode called a Basic Service Set (BSS) One access point (AP) and Stations (STA).
- Can also function without AP in ad-hoc mode.
- Uses CSMA/CA, a modified version of CSMA/CD
  - CD transmit and listen for collision
  - CA listen before transmit

The bridge/ L2 switch



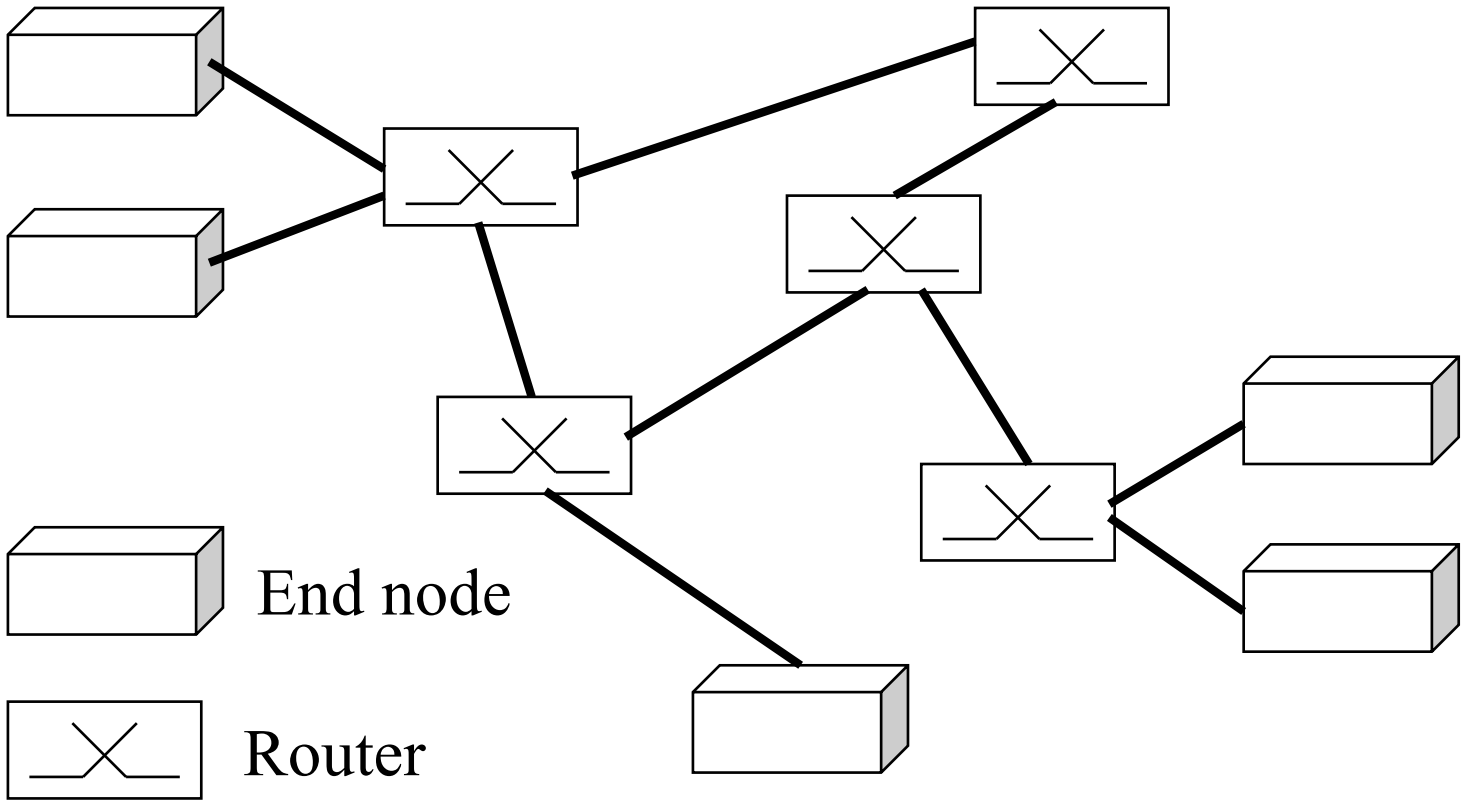
Bridge has an adress table so frames are forwarded to correct link

Protocol structure in a bridge



Network architecture

- Need to connect different LANs
- All big networks consist of nodes and links.



Data transmission in large networks

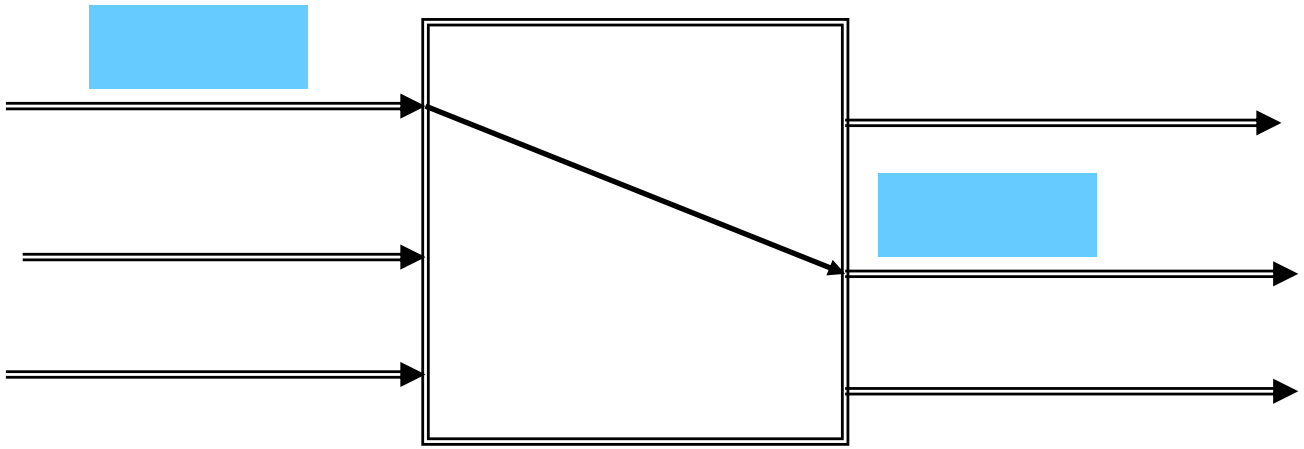
Two basic types:

- Circuit switched
  - A physical or logical path is established between sender and receiver
- Packet switched
  - Data divided into chunks that find their own way through the network
  - Can use logical paths so all packets follow same route.

Routers

Routers examine incoming packets and select next hop node/outgoing link.

Operates in layer 3

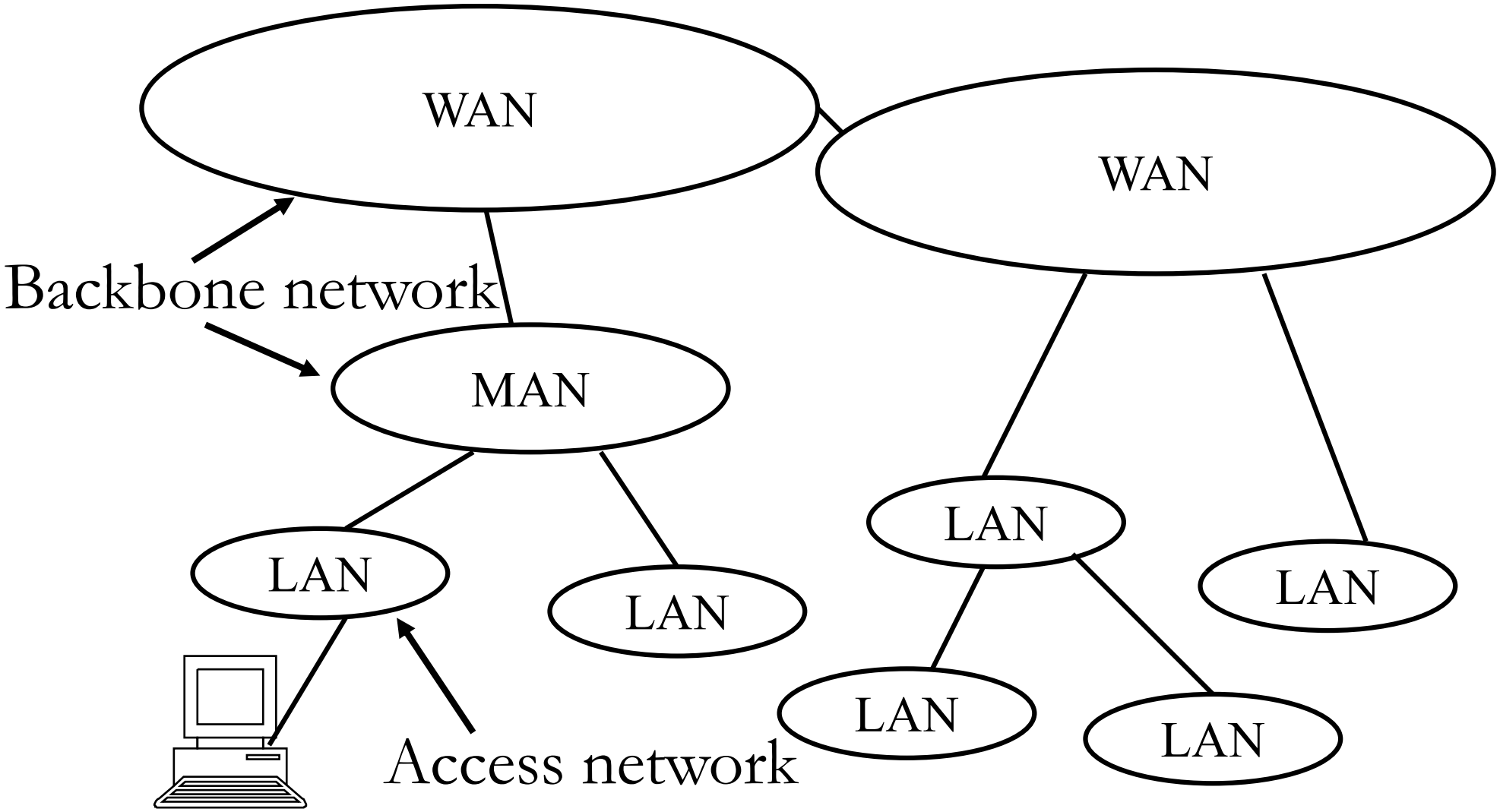


Packet switched transmission

Two types of transmission:

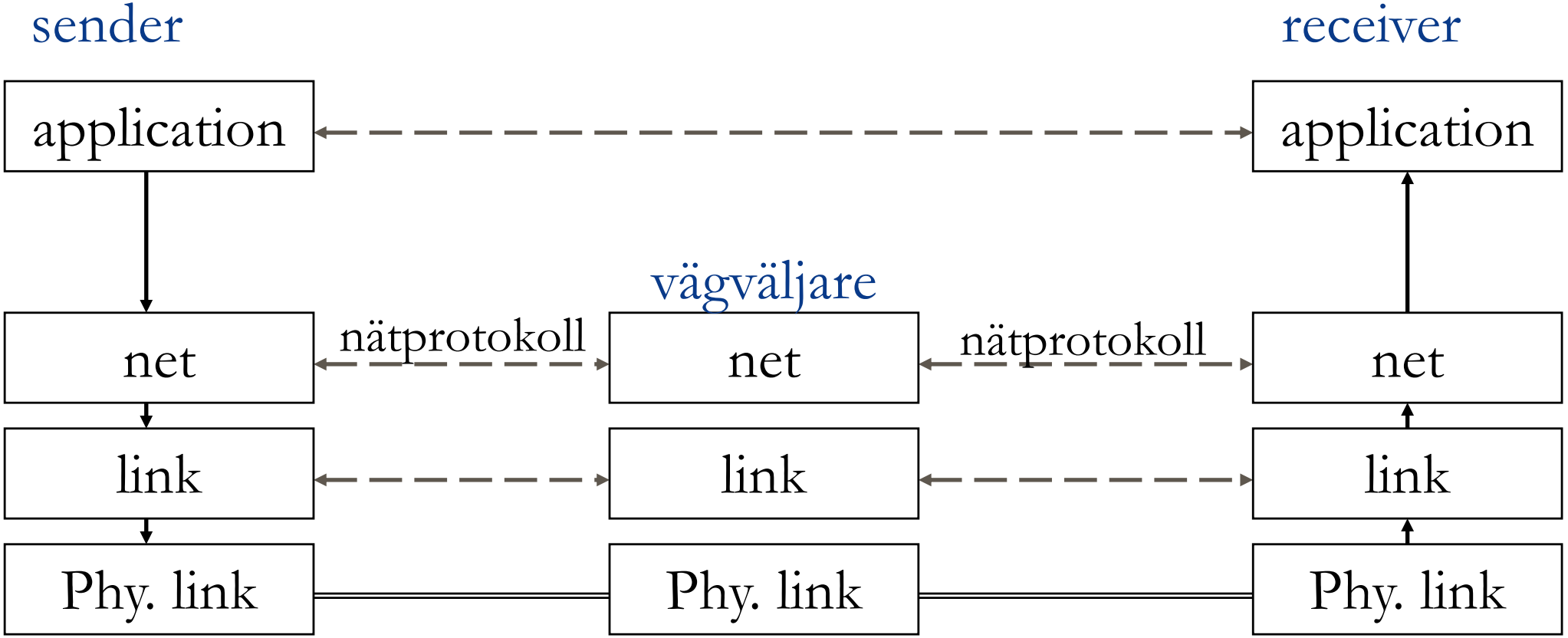
- Connection oriented
- Connectionless

Hierarchy of networks with different access protocols



Network protocol

The core protocol, ties different link protocols together



Global address: Network address

One network protocol to rule them all: IP

- IP = Internet Protocol
- IP only network protocol used in the Internet.
- Uses IP-adresses.
- Data divided into IP-packets.
- Connectionless transfer.
- No error correction or guarantee of delivery.
- Mode called ”best-effort”.

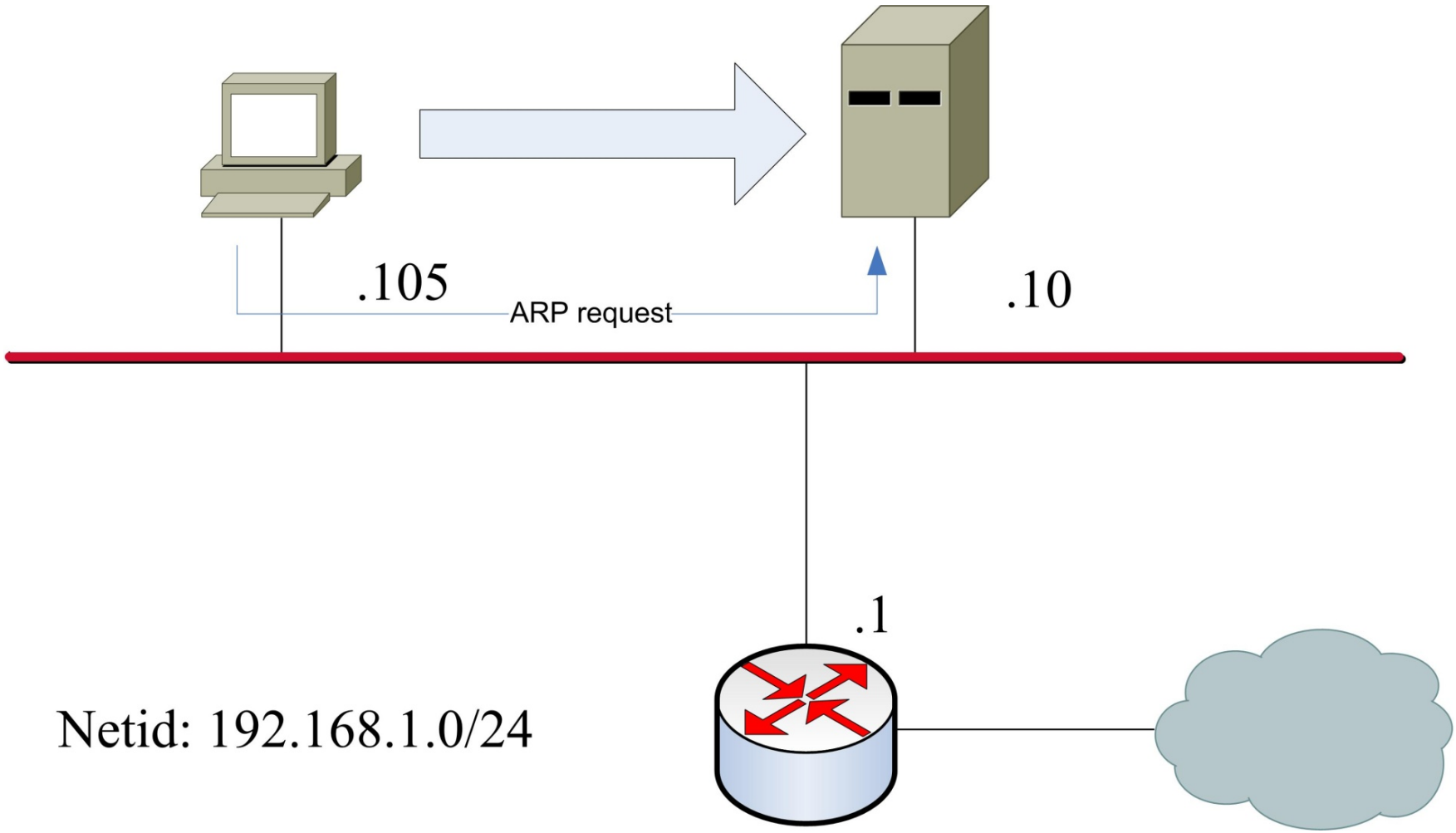
Internet Protocol

Two versions of IP: version 4 (IPv4) and version 6 (IPv6). Any two communicating hosts must use the same version.

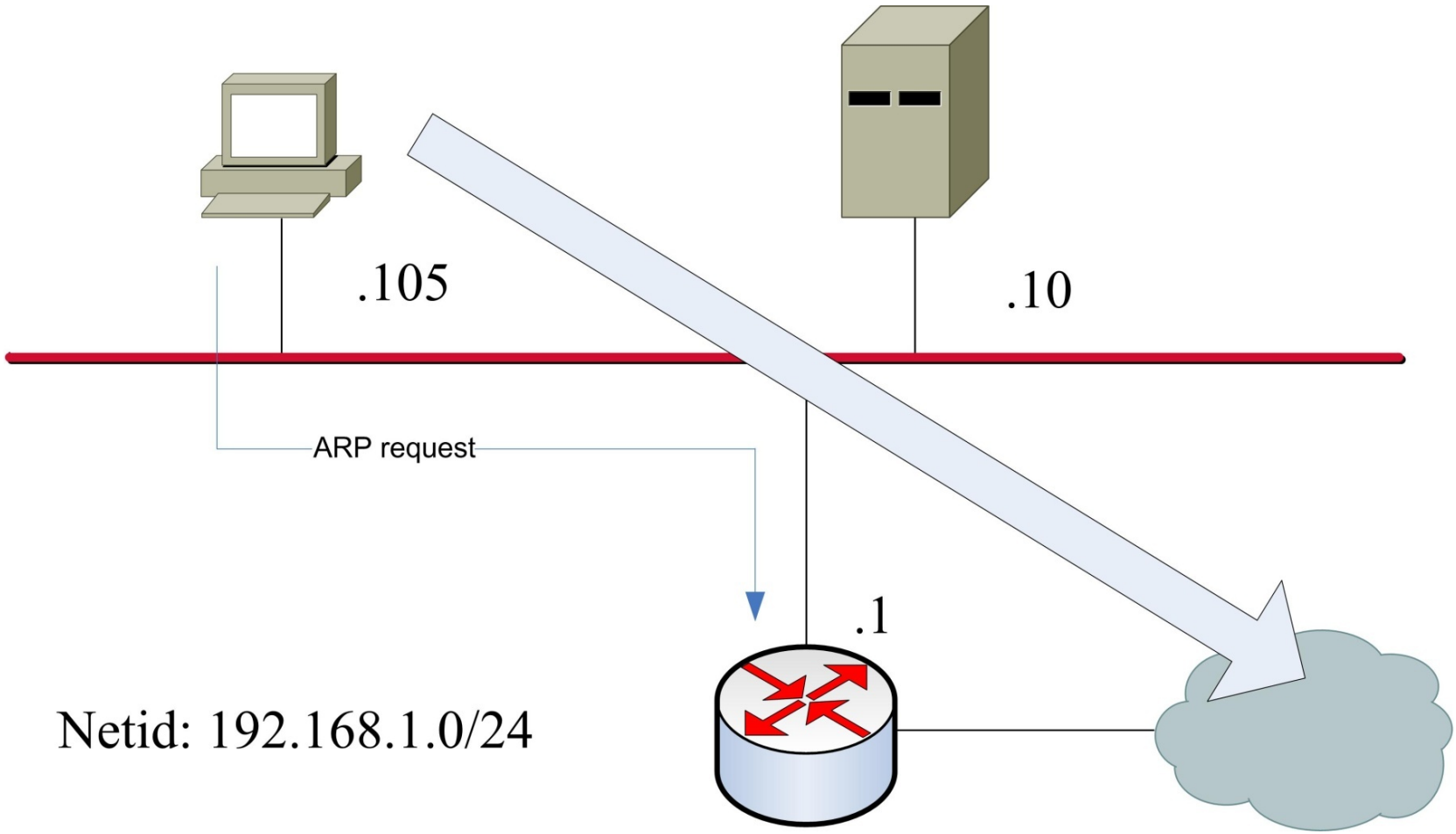
IPv4 is the ”legacy” version, still most common.

IPv6 extends the address space and incorporates new functions, e.g. Security, autoconfiguration.

Address Resolution Protocol, ARP (1)



ARP (2)

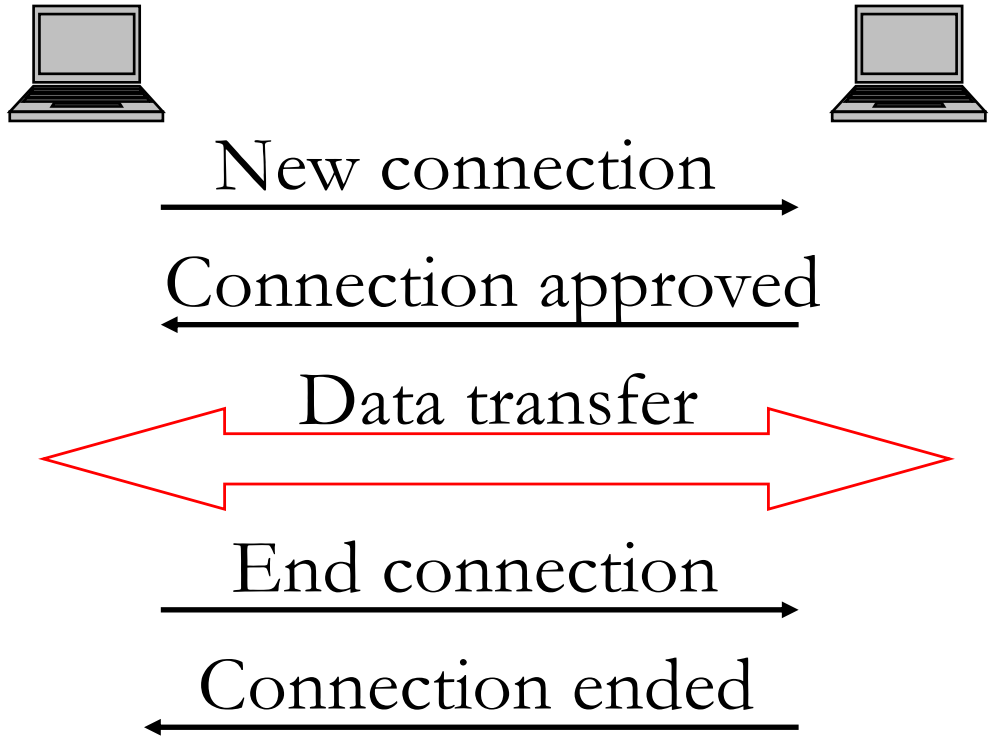


Routing algorithms

- Flooding
- Least-cost path

Connection oriented protocols

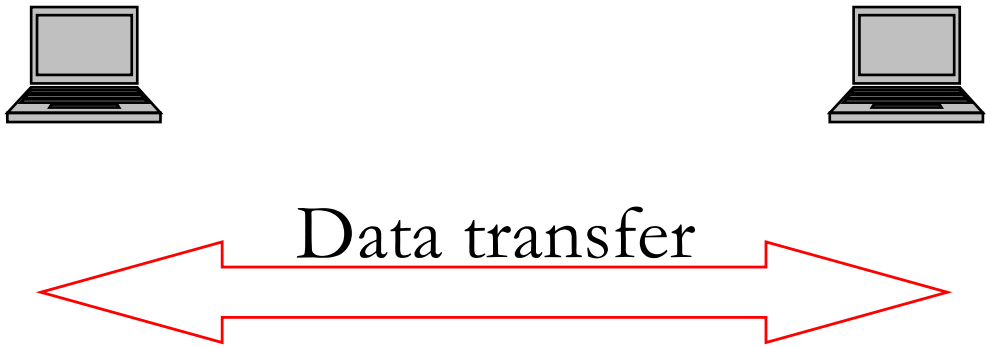
Stateful protocols, agree on transmission, end of transmission



Exemple: TCP

Connectionless transmission

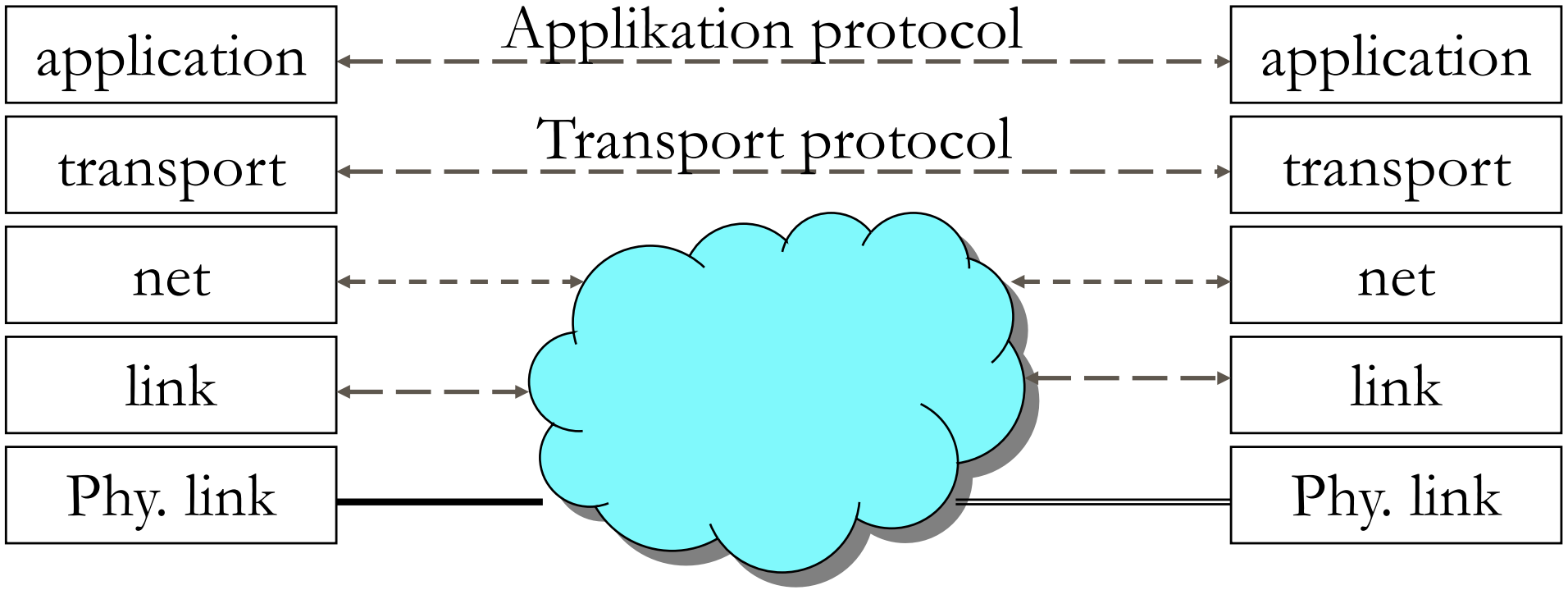
Stateless protocols, just send data when available



Exemple: UDP

Transport protocols

- End-to-end, error correction, flow control etc.



C.f. OSI-model

<table>
<tr><th>OSI-model</th><th>TCP/IP-model</th></tr>
<tr><td>Application</td><td rowspan="3">Application</td></tr>
<tr><td>Presentation</td></tr>
<tr><td>Session</td></tr>
<tr><td>Transport</td><td>Transport</td></tr>
<tr><td>Net</td><td>Net</td></tr>
<tr><td>Link</td><td rowspan="2">Link (sometimes phy. separate)</td></tr>
<tr><td>physical</td></tr>
</table>

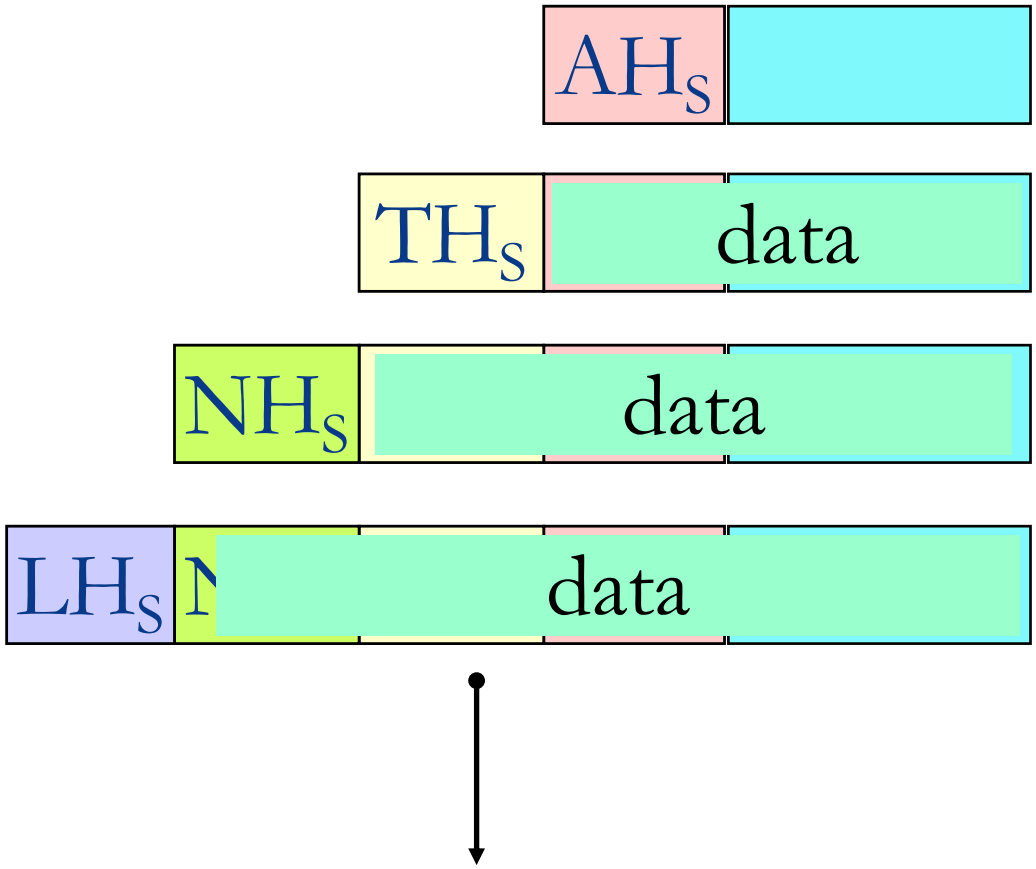
Sender

application

transport

net

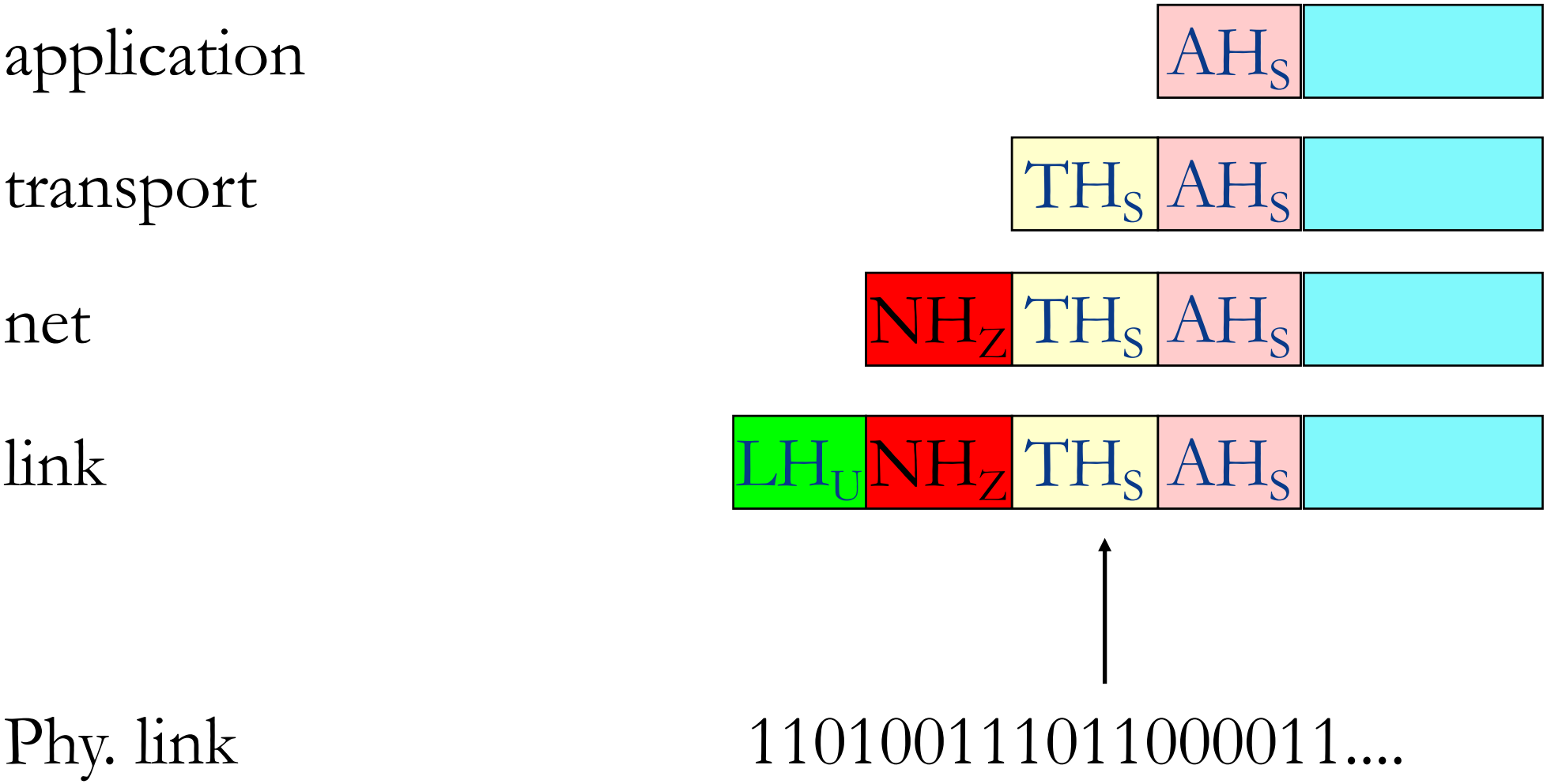
link



Phy. link

1101010110001110001 1....

Receiver


application
transport
net
link
Phy. link
AH_S
TH_S AH_S
NH_Z TH_S AH_S
LH_U NH_Z TH_S AH_S
1101001110110000011....