# Network Computing courses

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ENSIBS - UBS

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Figure: teaching.auzias.net

# Course details

## Objectives

- How do *computers* communicate?
- What are the mechanisms **under** an HTTP request or a telegram message?
- Networks are all around us, better study them!

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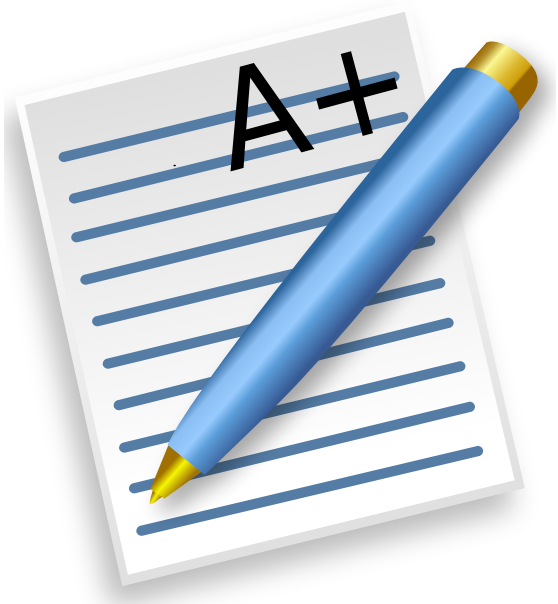


## Evaluation

- Short test at the beginning of every lesson (5 min) ?
- Project
- Final exam (1 hour)
- All same weighting

## Material

- Slides available at teaching.auzias.net (github too)

# Presentation Outline

# Definitions

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- **IP:** Internet **Protocol** provides the functions necessary to deliver a package of bits from a source to a destination over a network
- **(world wide) Web: network** consisting of a collection of Internet websites using HTTP

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- **RFC:** Request For Comments (Internet Draft (ID), RFC, Internet Standard)

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- **NAT:** Network Address Translation, router modifying IP address into another IP address.

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- **Thin client: application** where most functions are carried out on a central server

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- **WAN:** Wide Area Networks cover a broad area (Internet)

# Topologies

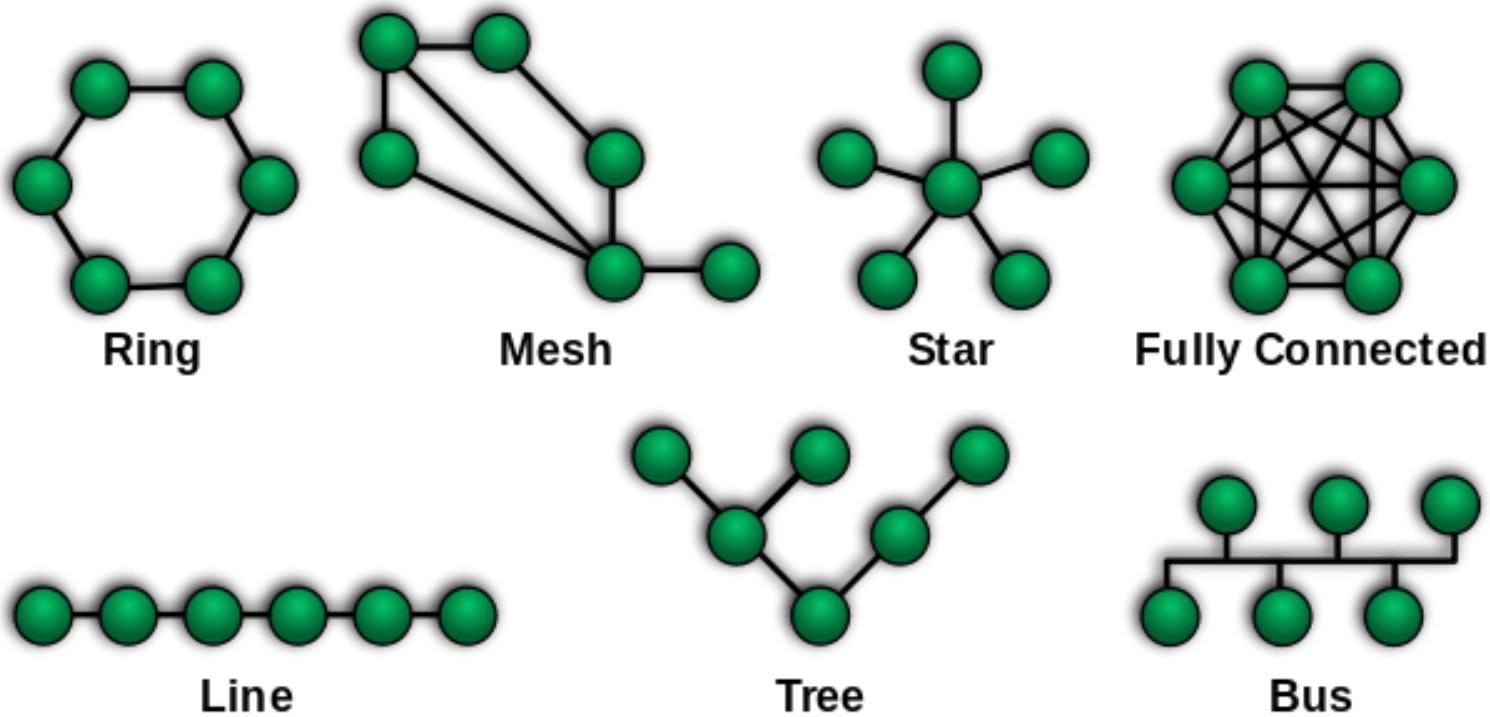


Figure: upload.wikimedia.org

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- **Tree:** hierarchical topology, such as a binary tree.

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# Bonus

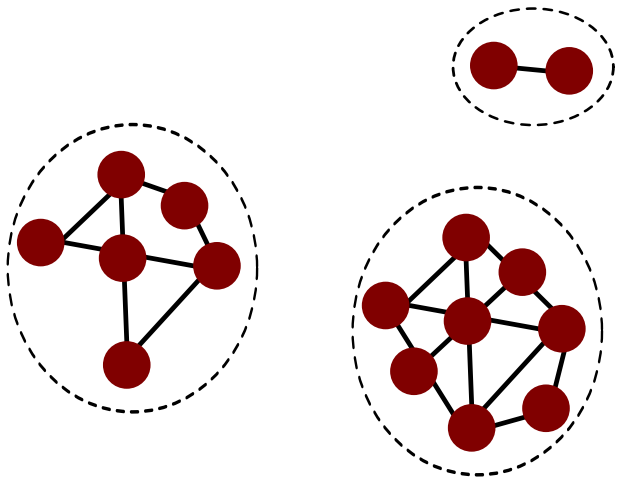

Figure: Disconnected MANET illustration [1]

# Bonus

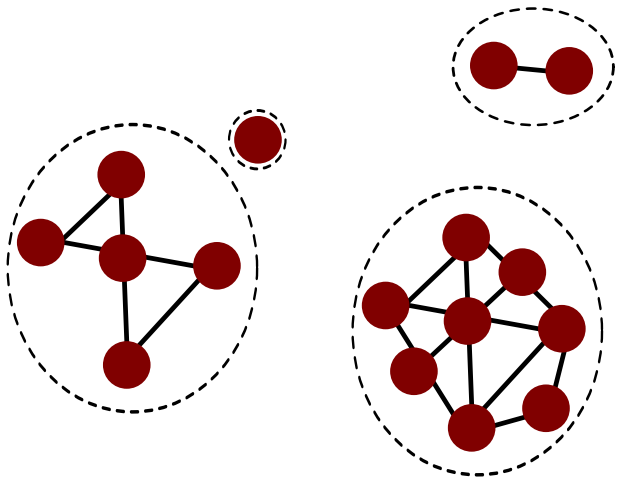

Figure: Store-carry-and-forward [1]

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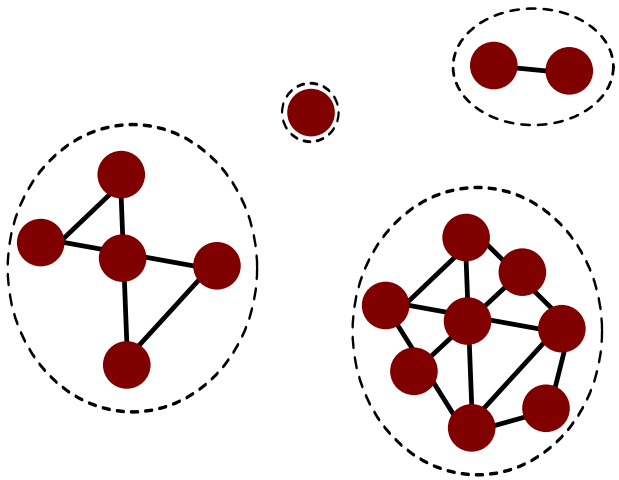

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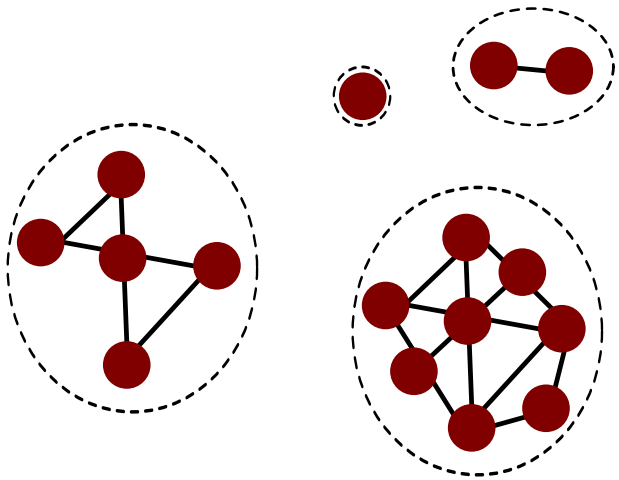

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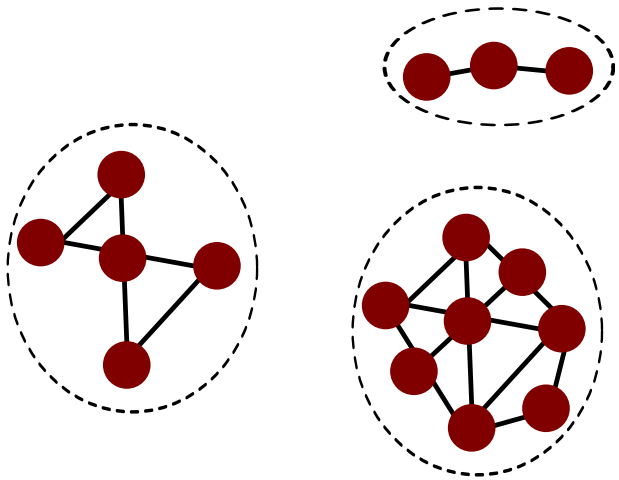

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# HTTP request/response example

Enter getbootstrap.com in your browser

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| Source | Destination | Protocol | Length | Info |
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| 192.168.0.48 | 208.67.222.222 | DNS | 76 | Standard query 0x4797 A getbootstrap.com |
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| 127.0.0.1 | 127.0.0.13 | TCP | 74 | 36159 > http [SYN] Seq=0 Win=43690 Len=0 MSS=65495 SACK_PERM=1 TSval=12 |
| 127.0.0.13 | 127.0.0.1 | TCP | 74 | http > 36159 [SYN, ACK] Seq=0 Ack=1 Win=43690 Len=0 MSS=65495 SACK_PERM |
| 127.0.0.1 | 127.0.0.13 | TCP | 66 | 36159 > http [ACK] Seq=1 Ack=1 Win=43776 Len=0 TSval=122257 TSecr=12225 |
| 127.0.0.1 | 127.0.0.13 | HTTP | 356 | GET /index.html HTTP/1.1 |
| 127.0.0.13 | 127.0.0.1 | TCP | 66 | http > 36159 [ACK] Seq=1 Ack=291 Win=44800 Len=0 TSval=122259 TSecr=122 |
| 127.0.0.13 | 127.0.0.1 | HTTP | 354 | HTTP/1.1 200 OK (text/html) |
| 127.0.0.1 | 127.0.0.13 | TCP | 66 | 36159 > http [ACK] Seq=291 Ack=289 Win=44800 Len=0 TSval=122259 TSecr=1 |
| 127.0.0.1 | 127.0.0.13 | HTTP | 357 | GET /favicon.ico HTTP/1.1 |
| 127.0.0.13 | 127.0.0.1 | HTTP | 565 | HTTP/1.1 404 Not Found (text/html) |
| 127.0.0.1 | 127.0.0.13 | TCP | 66 | 36159 > http [ACK] Seq=582 Ack=788 Win=45952 Len=0 TSval=122269 TSecr=1 |

Figure: HTTP request/response

# How do messages reach their destination?

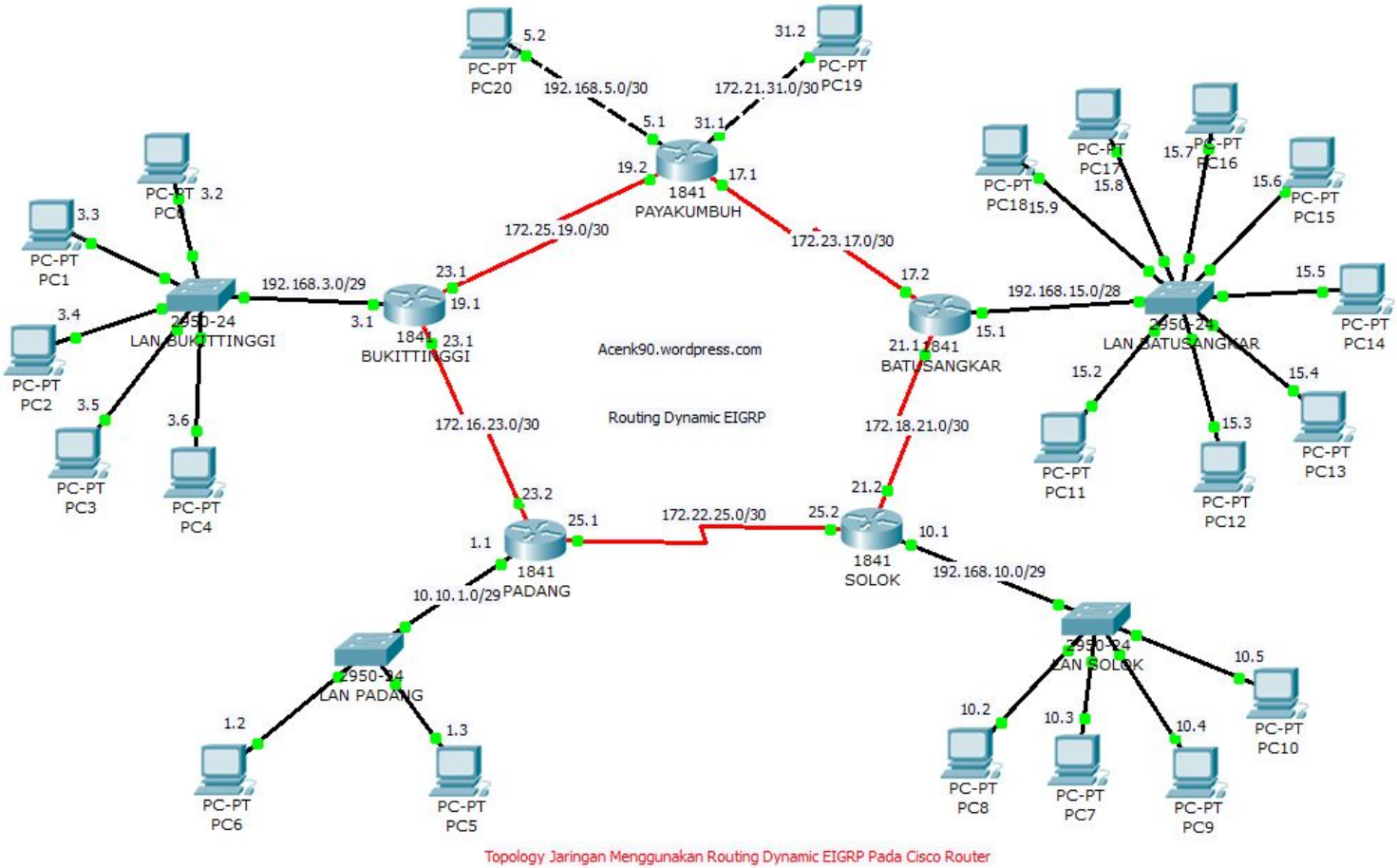



Figure: acenk90.files.wordpress.com

# More like this...

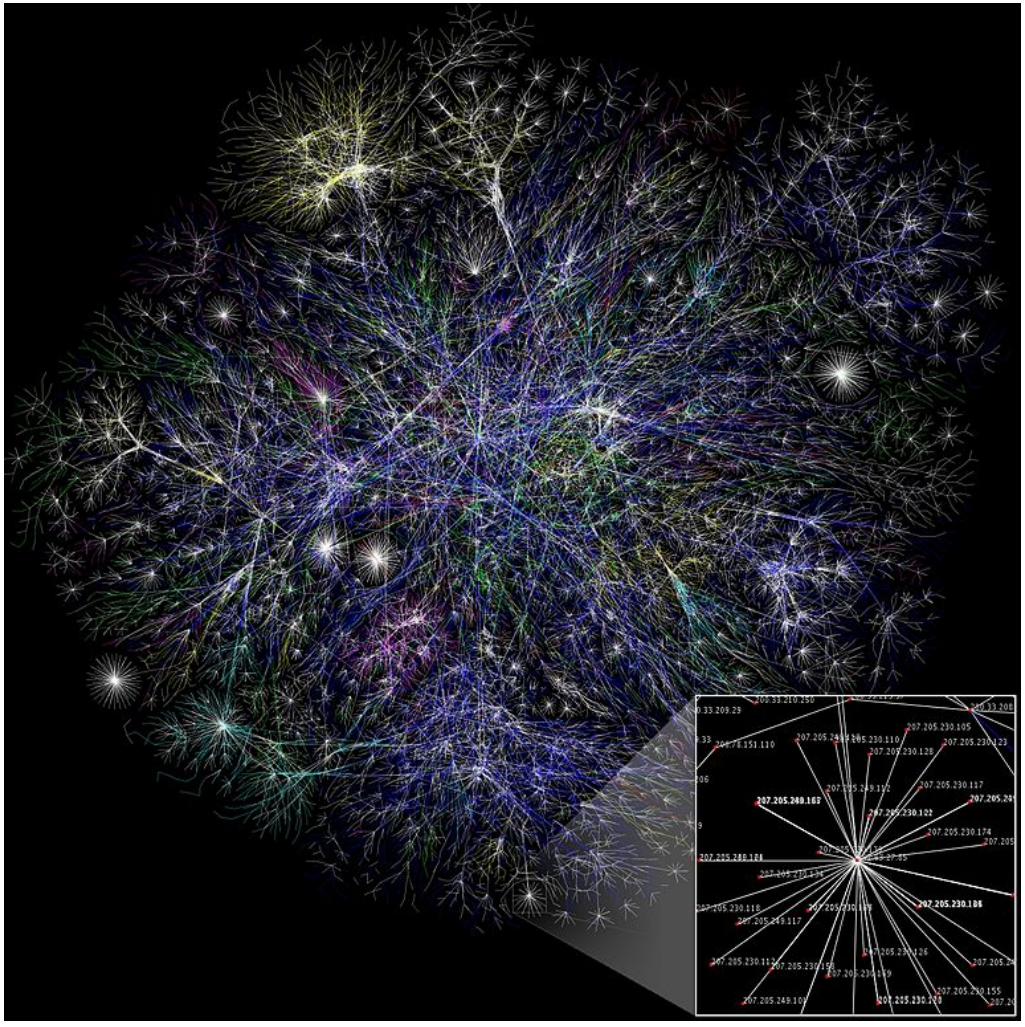


Figure: wikimedia.org

# How does it work? From signal to application...

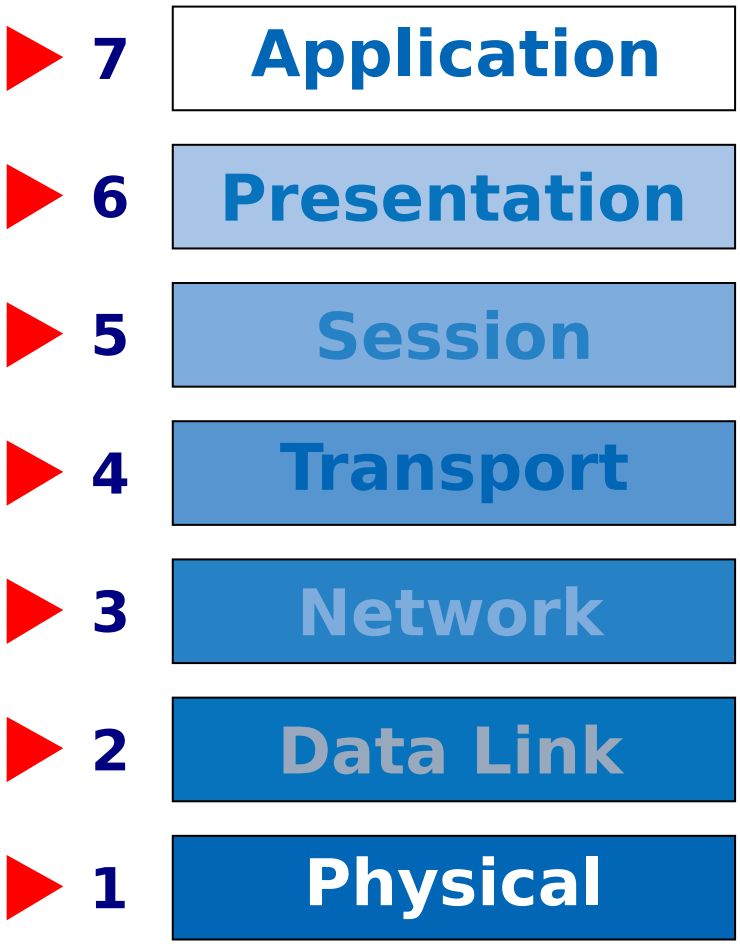
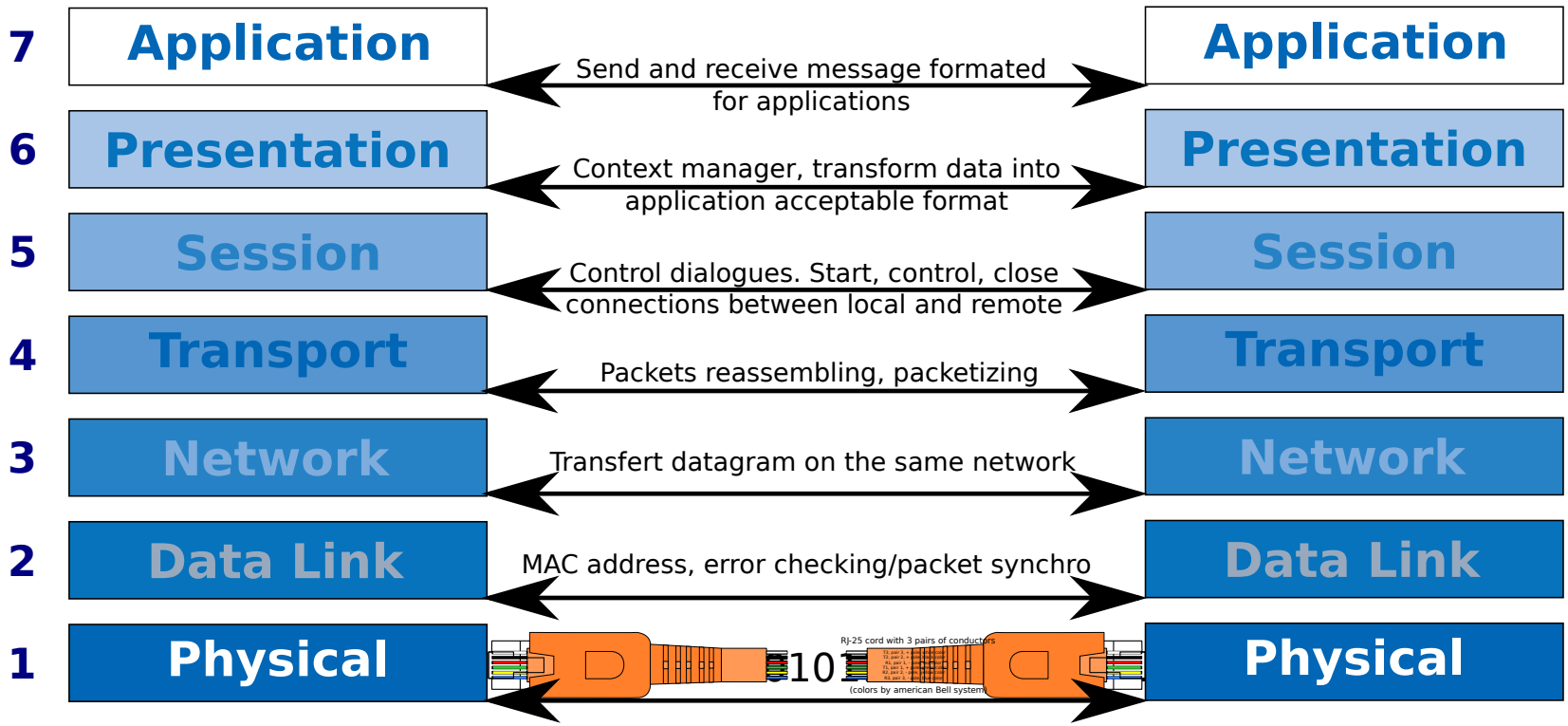
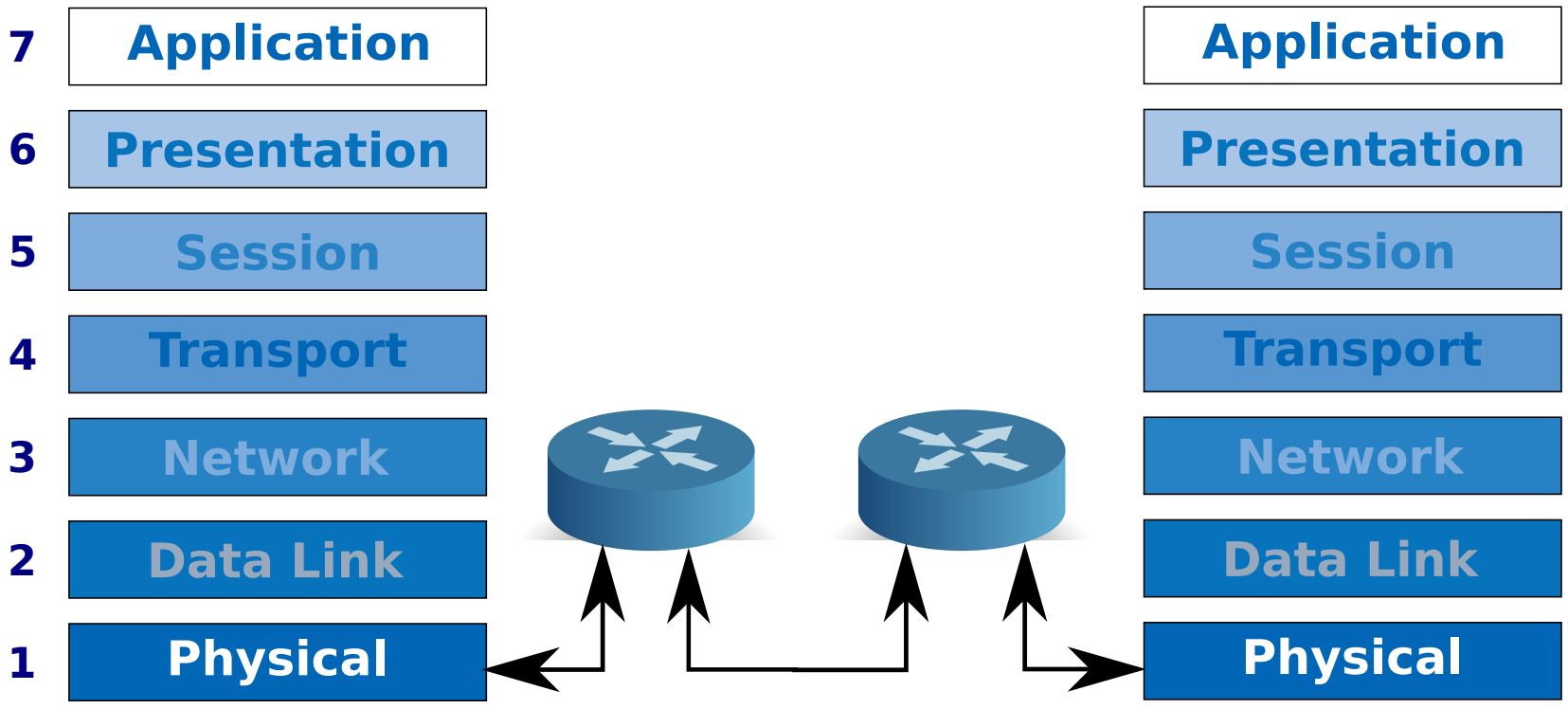



Figure: OSI model

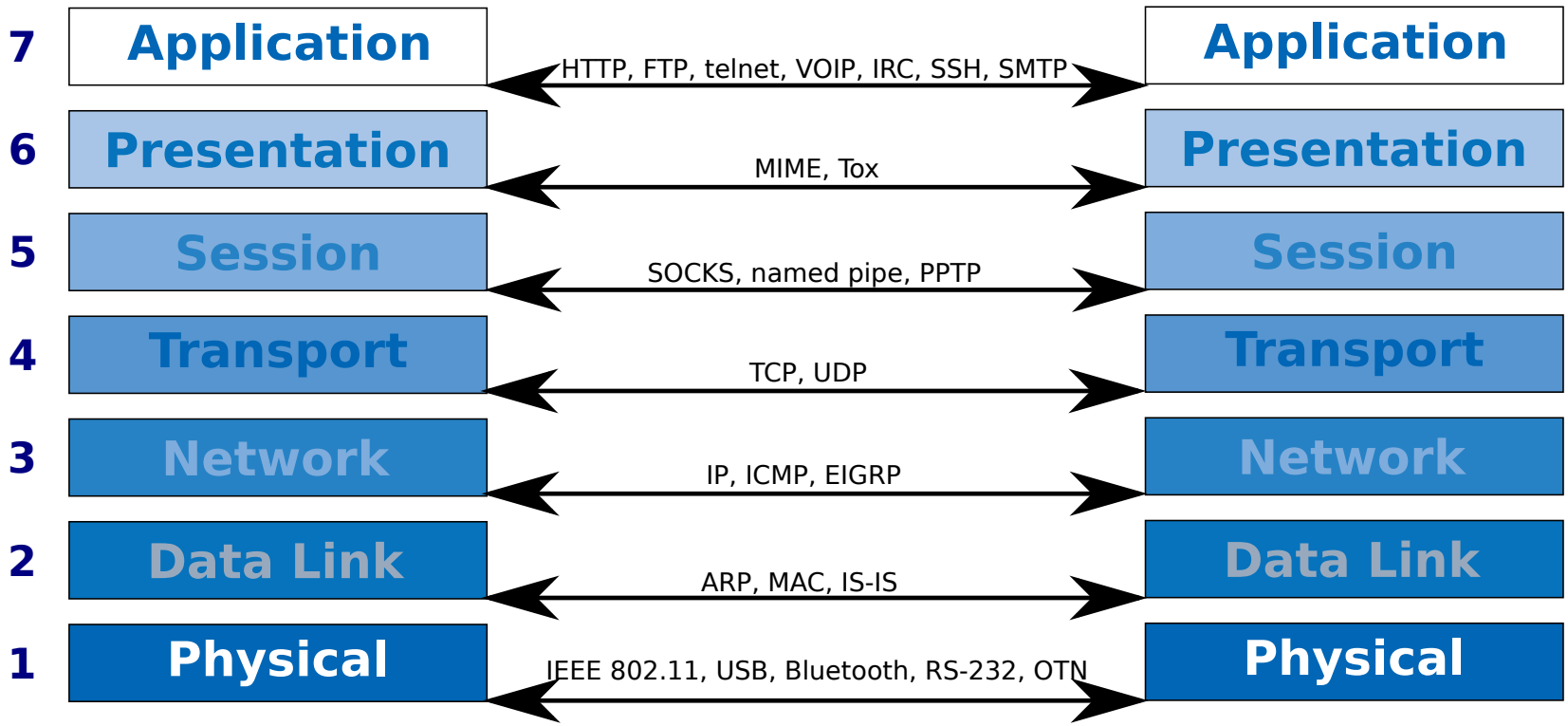
# $N^{th}$ layer communicate with $N^{th}$ layer..



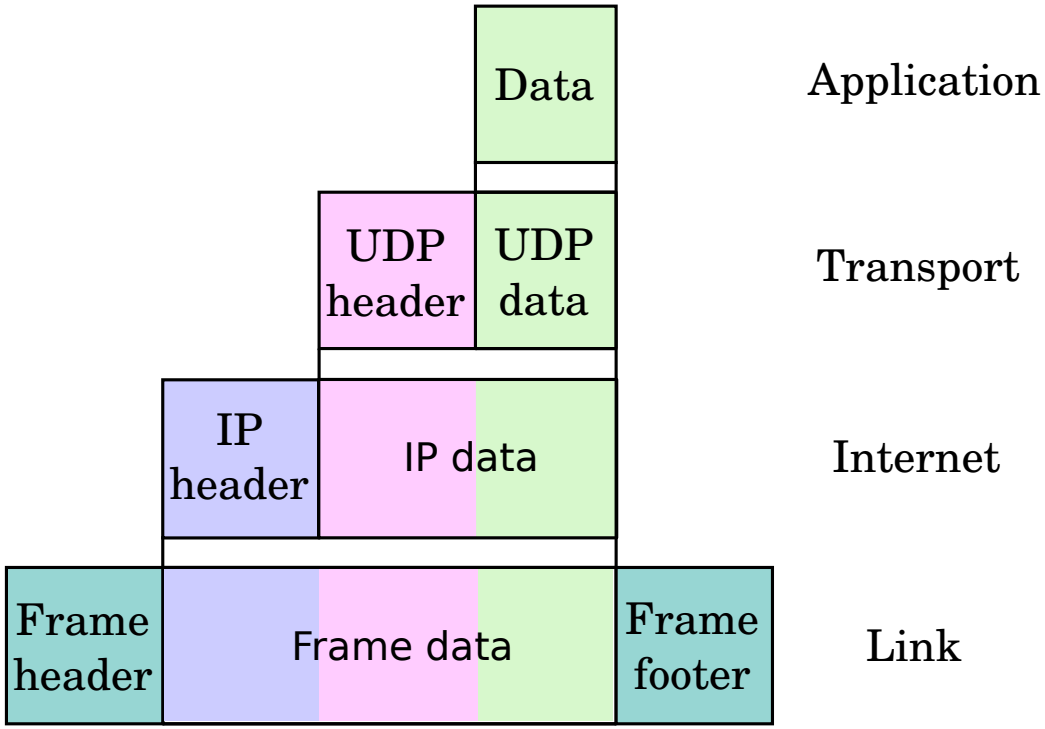
# .. thanks to 3-$^{th}$ layers



# One single protocol, one single layer



# Encapsulation

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# Presentation Outline

# Aims

- Interface data link layer,

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- Transmit: 1 after 0 (after 0 or 1, after 0... or 1)

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- IEEE 1394 (a.k.a. Firewire): <3200 Mbit/s
- USB, serial port such as RS-232...

# Hardware medium: IEEE 802.3 (Ethernet)

Figure: RJ45 connector

# Hardware medium: IEEE 802.15.1 (Bluetooth)

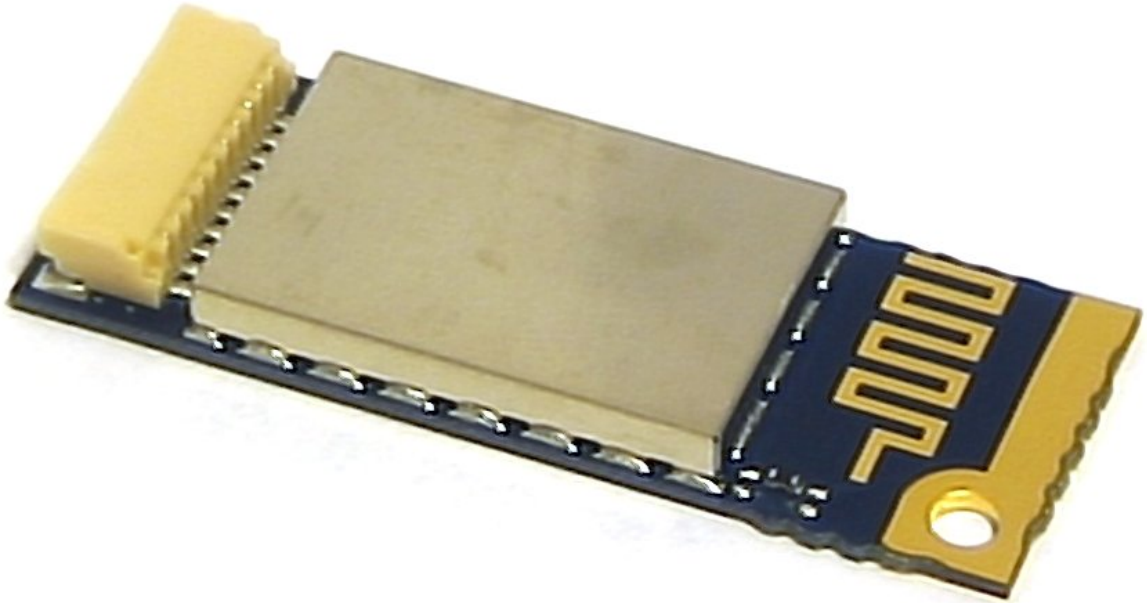

Figure: Bluetooth card

# Hardware medium: IEEE 802.15.4 (ZigBee)

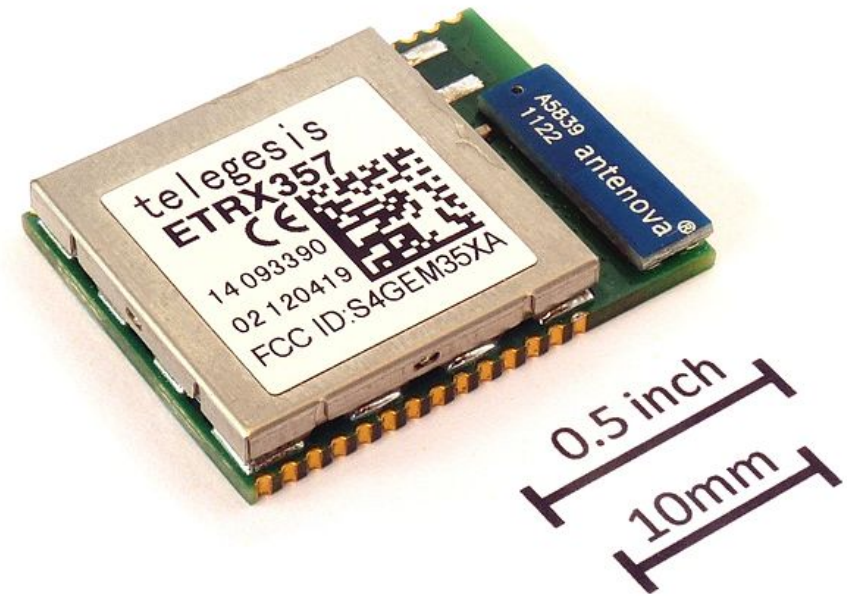


Figure: ZigBee card

# Hardware medium: IEEE 802.16 (Wi-Max)


Figure: Wi-Max antenna

# Hardware medium: IEEE 1394 (Firewire)

Figure: Firewire connector

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- and so on...

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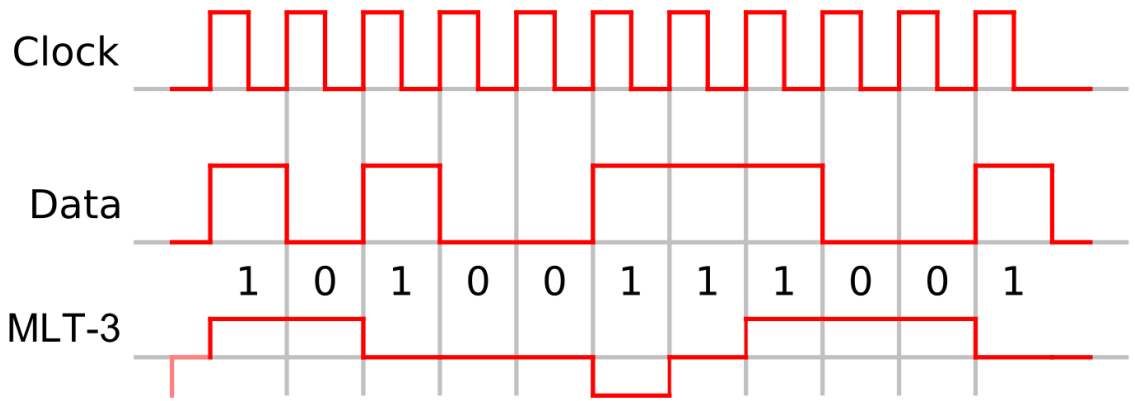


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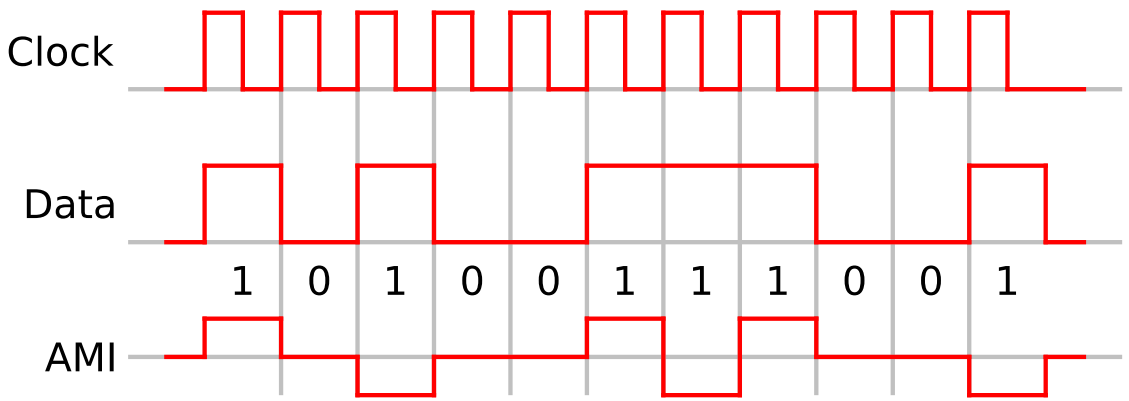


Figure: Alternate Mark Inversion

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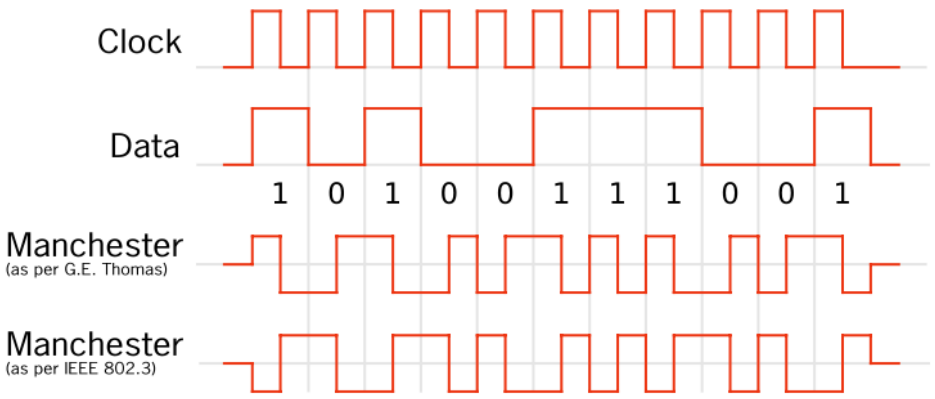


Figure: Manchester

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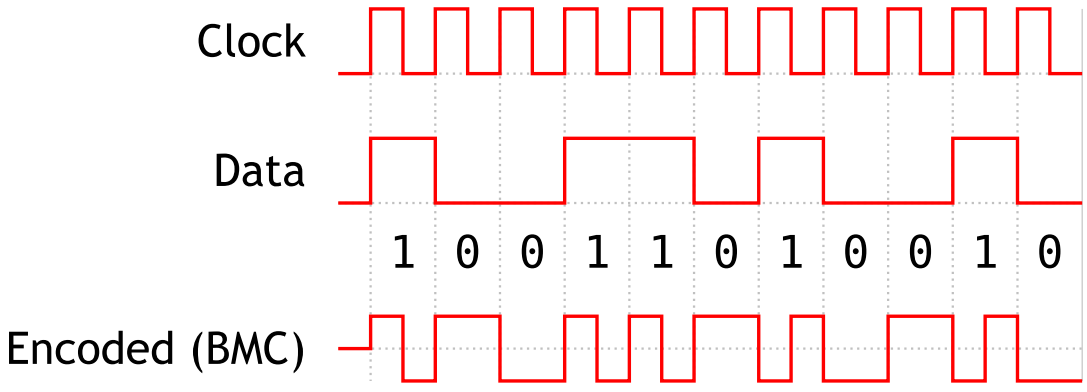


Figure: Biphase Mark Code

# Transmitting

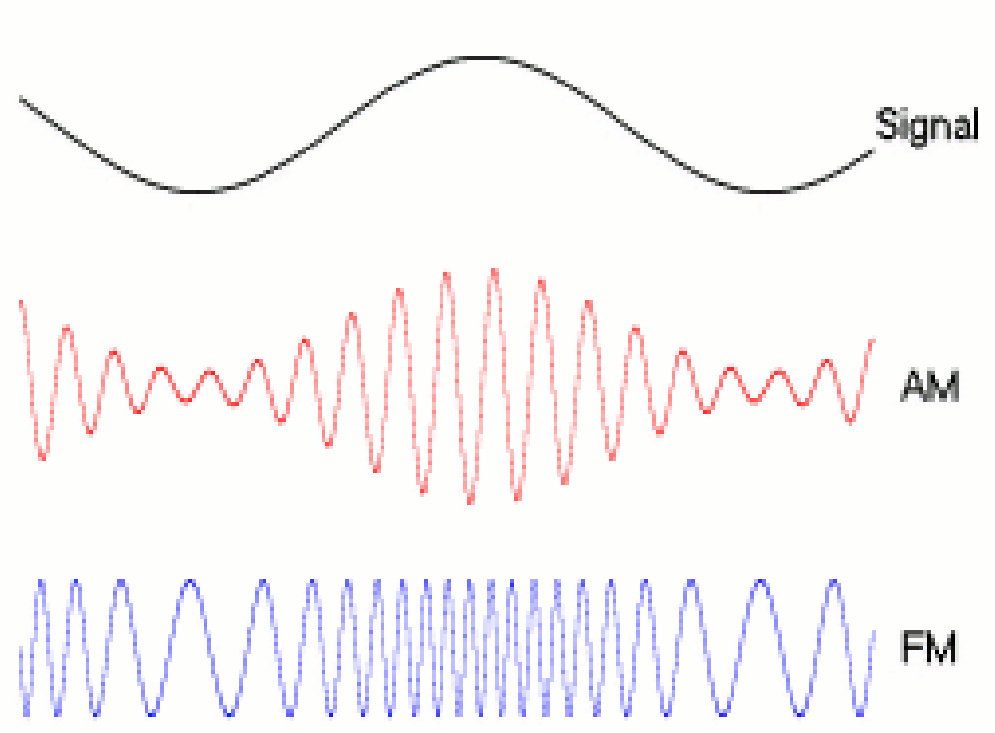


Figure: Amplitude and phase modulation

# Error detection

- Repetition (hum...)

# Error detection

- Repetition (hum...)
- Parity (XOR)

# Error detection

- Repetition (hum...)
- Parity (XOR)
- Checksum

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- Hash

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- Repetition (hum...)
- Parity (XOR)
- Checksum
- CRC (Cyclic redundancy check): with a polynomial divison
- Hash
- and so on...

# Error correcting

- Repetition (again)

# Error correcting

- Repetition (again)
- Hamming

# Error correcting

- Repetition (again)
- Hamming
- MDPC (Multidimensional parity-check code)

# Correction: MDPC

Raw data to send: 0x01 02 03 04

| | | |
|---|---|---|
| 0x01 | 0x02 | 0x03 |
| 0x03 | 0x04 | 0x07 |
| 0x04 | 0x06 | |

Figure: Data received with MDPC

Data sent (with MDPC): 0x01 02 03 03 04 07 04 06

# Aims

- Interface network layer,

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- Interface network layer,
- Delivery to unique(?) hardware addresses,

# Aims

- Interface network layer,
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- Framing,

# Aims

- Interface network layer,
- Delivery to unique(?) hardware addresses,
- Framing,
- Data transfer

# Layer composition (of its two sublayers)

1. Logical Link Control (LLC):
   - end to end flow control
   - end to end error control
   - (transmitting/receiving) protocols, over MAC sublayer, multiplexing

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   - collision detection and retransmission
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# Carrier Sense Multiple Access with Collision Avoidance

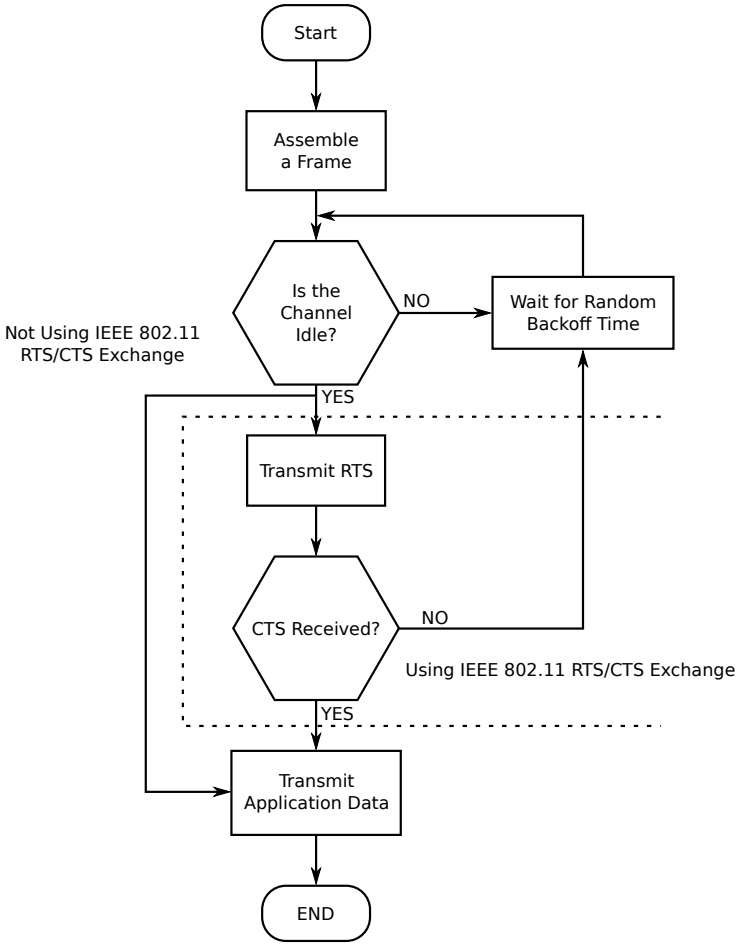


Figure: CSMA CA

# Layer 2 Ethernet packet

| MAC dest. (6) | MAC src. (6) | VLAN tag* (4) | Ethertype (2) |
|---|---|---|---|
| Payload (42-1500) | | Frame check sequence (4) | |

Figure: Layer 2 Ethernet packet

optional, Content (size in bytes)

| **Ethertype 0x** | **Protocol** |
|---|---|
| 0800 | IPv4 |
| 0806 | ARP |
| 0842 | Wake-on-LAN |
| 86dd | IPv6 |

Figure: Data received with MDPC

# ARP example

| | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **0000** | ff | ff | ff | ff | ff | ff | fa | ba | 00 | ab | ab | af | 08 | 06 | 00 | 01 |
| **0010** | 08 | 00 | 06 | 04 | 00 | 01 | fa | ba | 00 | ab | ab | af | ac | 11 | 22 | 37 |
| **0020** | 00 | 00 | 00 | 00 | 00 | 00 | ac | 11 | 00 | f9 | 00 | 00 | 00 | 00 | 00 | 00 |
| **0030** | 00 | 00 | 00 | 00 | 00 | 00 | 00 | 00 | 00 | 00 | 00 | 00 | | | | |

Figure: ARP request

MAC address destination MAC address source Ethertype Hardware type Protocol type OpCode (1 request, 2 reply) IP address source IP address destination

# ARP example

| | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **0000** | ff | ff | ff | ff | ff | ff | fa | ba | 00 | ab | ab | af | 08 | 06 | 00 | 01 |
| **0010** | 08 | 00 | 06 | 04 | 00 | 01 | fa | ba | 00 | ab | ab | af | ac | 11 | 22 | 37 |
| **0020** | 00 | 00 | 00 | 00 | 00 | 00 | ac | 11 | 00 | f9 | 00 | 00 | 00 | 00 | 00 | 00 |
| **0030** | 00 | 00 | 00 | 00 | 00 | 00 | 00 | 00 | 00 | 00 | 00 | 00 | | | | |

Figure: ARP request

MAC address destination MAC address source Ethertype Hardware type Protocol type OpCode (1 request, 2 reply) IP address source IP address destination

# ARP example

| | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **0000** | fa | ba | 00 | ab | ab | af | be | be | 00 | 00 | eb | eb | 08 | 06 | 00 | 01 |
| **0010** | 08 | 00 | 06 | 04 | 00 | 01 | be | be | 00 | 00 | eb | eb | ac | 11 | 00 | f9 |
| **0020** | fa | ba | 00 | ab | ab | af | ac | 11 | 22 | 37 | 00 | 00 | 00 | 00 | 00 | 00 |
| **0030** | 00 | 00 | 00 | 00 | 00 | 00 | 00 | 00 | 00 | 00 | 00 | 00 | | | | |

Figure: ARP reply

MAC address destination MAC address source Ethertype Hardware type Protocol type OpCode (1 request, 2 reply) IP address source IP address destination

# ARP example

| | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **0000** | fa | ba | 00 | ab | ab | af | be | be | 00 | 00 | eb | eb | 08 | 06 | 00 | 01 |
| **0010** | 08 | 00 | 06 | 04 | 00 | 01 | be | be | 00 | 00 | eb | eb | ac | 11 | 00 | f9 |
| **0020** | fa | ba | 00 | ab | ab | af | ac | 11 | 22 | 37 | 00 | 00 | 00 | 00 | 00 | 00 |
| **0030** | 00 | 00 | 00 | 00 | 00 | 00 | 00 | 00 | 00 | 00 | 00 | 00 | | | | |

Figure: ARP reply

MAC address destination MAC address source Ethertype Hardware type Protocol type OpCode (1 request, 2 reply) IP address source IP address destination

# Course details

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# References


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