

# Computer Networks

## Lecture 1: Basics. Physical layer

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# Communication (1)

**Communication** = the process of sending data between sender and receiver

# Communication (2)

## Depending on the number of participants

- broadcast
- unicast
- multicast

# Communication (3)

## Depending on the connection model

- client-server
- peer-to-peer

# Communication (4)

## Depending on the channel capabilities

- simplex
- half duplex
- full duplex

# Communication (5)

## Is connection established?

- connectionless (e.g., post office)
- connection-oriented (e.g., phone)

## Acknowledgements?

- With (letter with advice of delivery, dictating over a phone)
- Without (normal unregistered letter, video conference)

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# Communication (6)

## Successful communication requires:

- communication channel (medium: e.g., cable)
- communication protocol:

## Protocol

- fixed (or negotiated for a single session) scheme
- defines data format and transition function
- necessity of open protocols (widespread protocols)



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## Protocol

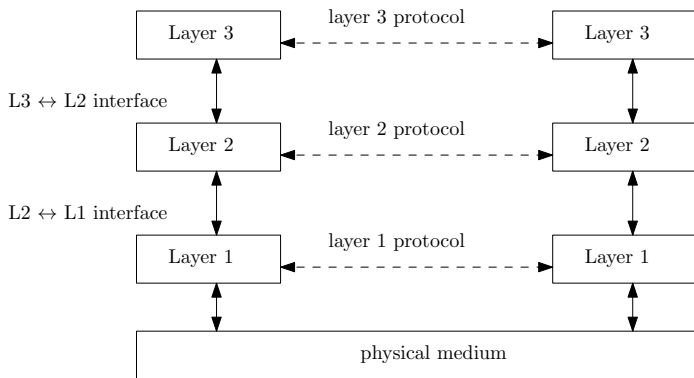
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# Protocols

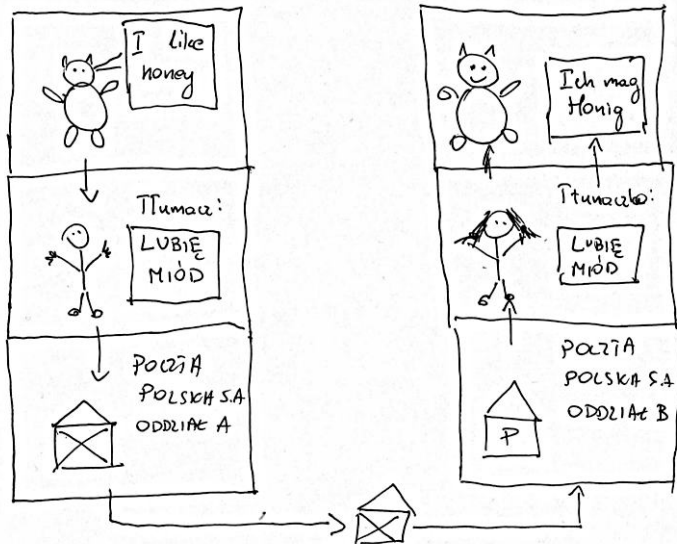
- RFC documents: <http://www.rfc-editor.org/>
- Produced mainly by IETF workgroups (*Internet Engineering Task Force*)
- Undergo formal process of standardization (Normal RFC document → Proposed Standard → Draft Standard → Internet Standard)

# Layered approach

Each protocol is based on something and enables something else (otherwise the protocol would have to encompass everything starting from description of single bit transmission).



# Example of layer communication



# Internet reference model

5. application	user-space protocols (FTP, HTTP, SMTP, ...)
4. transport	accepting data from layer 5, dividing it into smaller segments, assuring that these segments arrive, combining them back (TCP, ...)
3. network	routing (IP, ...)
2. data link	sending frames of data, access to shared media (Ethernet, ...)
1. physical	can send and receive a bit

Note 1: this model with layers 1 and 2 glued is called TCP/IP model

Note 2: OSI model has two additional layers: session and presentation (between 4th and 5th)

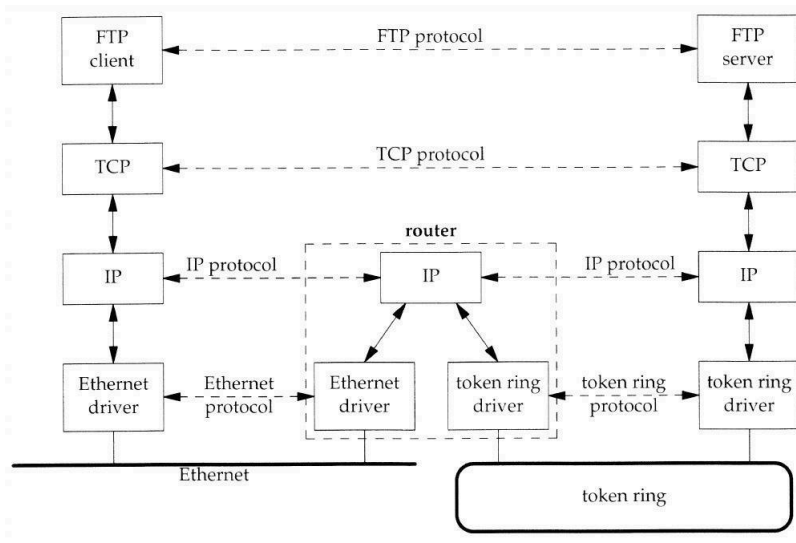
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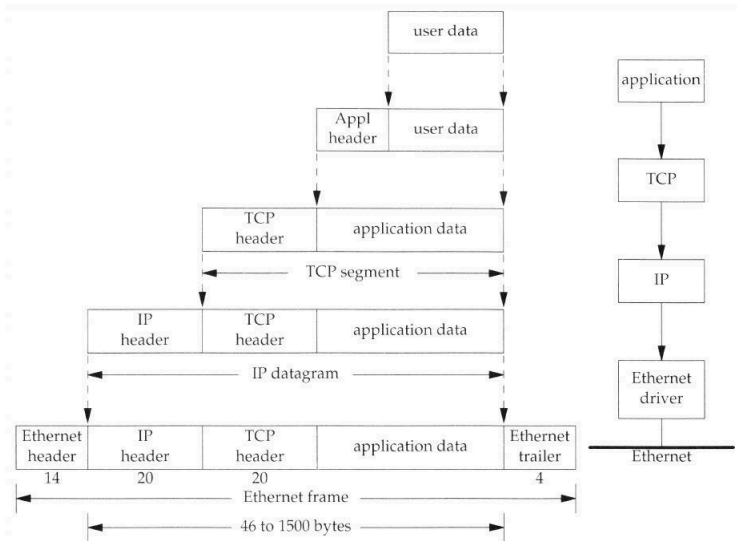
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# Logical connections: point-to-point or chained



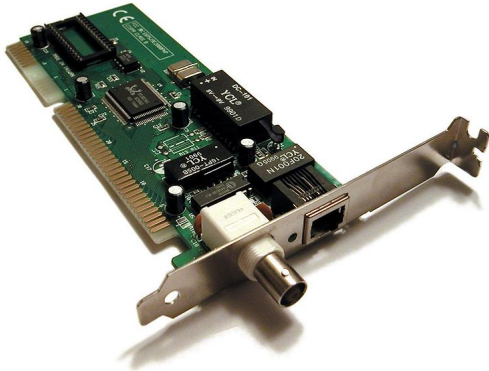
# Encapsulation





# Physical layer

# Network card (1)



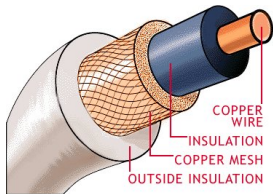
Network card vs. network interface

Figure from [http://en.wikipedia.org/wiki/Network\\_card](http://en.wikipedia.org/wiki/Network_card)

## Network card (2)

- Send bits as electric signals, e.g., 1 as 5V, 0 as -5V.
- Fixed frequency of transmission → bandwidth (in kbit/s, Mbit/s or Gbit/s). Note: 1 kbit = 1000 bits, 1 Mbit = 1000 kbits.
- Signal propagates on the medium (cable) and is received by another card

# Cables: coaxial cable



- Cable up to 200m
- half duplex transmission

Figure from <http://www.phy.davidson.edu/StuHome/phstewart/IL/speed/Cableinfo.html>

# Cables: optical fibre

- Rather used at higher bandwidths
- Invulnerable to electric and electromagnetic signals
- Could be very long
- Hard to tamper with → security
- Usually simplex transmission: sending and receiving diodes

# Cables: unshielded twisted pair (UTP) (1)



- Cheapest and most popular solution
- Different categories
  - cat. 3 - 16 Mhz
  - cat. 5 - 100 Mhz
  - cat. 6 - 250 Mhz
- Works up to 100m, afterwards repeaters needed.

## Cables: unshielded twisted pair (UTP) (2)

- 8 wires inside
- Point-to-point: computer with computer or computer with network device
- In both cases, cables are the same but the permutation of wires in the connectors is different.
  - straight-through cable
  - crossover cable
- Full duplex possible