

Ethernet (1/12)

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Ethernet is the most important LAN technology, originally based on a simple bus topology

Beginnings:

- Conceived at XEROX PARC (R. Metcalfe, D. Boggs) in early 1970s
- First Ethernet could link up to 256 computers with a max. cable length of 1,000 m and a bandwidth of 2,94 Mbps
- IEEE ratified 10 Mbps Ethernet specification of the alliance of Xerox, Digital, Intel

Basic components:

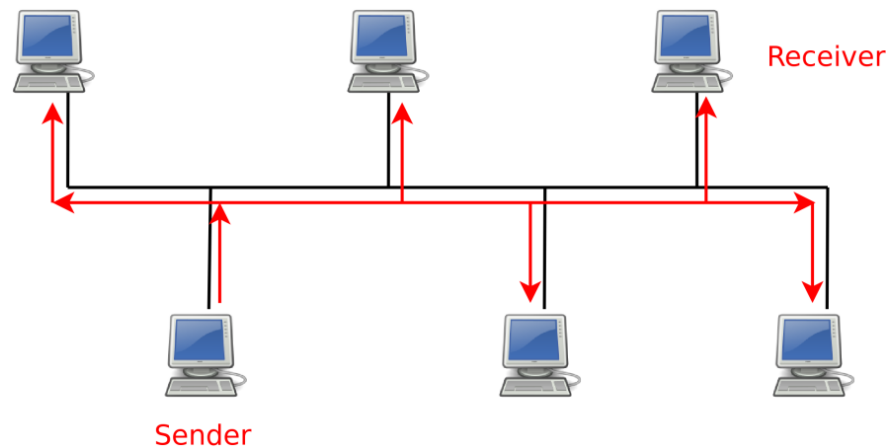
- **Ethernet cable** – physical medium
- **CSMA/CD** – Framework for concurrent access and collision control to the transmission medium
- Data are sent in form of Ethernet data packets, so-called **frames**

Ethernet (2/12)

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Fundamental Principle of Ethernet:

Data packets are sent along a cable “ether”:



All computers receive each data packet,
but only destination computer processes it

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CSMA/CD – Ethernet Multiple Access Algorithm (1/3)

- As soon as one computer sends a packet, it is received by all of the other connected computers – **broadcast**
- At each moment, a maximum of one packet can be transferred – if two packets are transferred simultaneously this results in a collision
- **CSMA/CD – Carrier Sense Multiple Access / Collision Detection** regulates
 - Concurrent transmission access of the computers and
 - Resolution of collisions

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CSMA/CD – Ethernet Multiple Access Algorithm (2/3):

Ground rules:

■ **Carrier Sensing:**

- Computer “listens” to the Ether, before sending
- If Ether is busy, it waits for a random time period before proceeding - “backoff time”

■ **Collision Detection:**

- Computers listen to whether a collision has occurred
- If yes, the transfer is interrupted - “jam signal”

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CSMA/CD – Ethernet Multiple Access Algorithm (3/3):

- Ethernet offers a connectionless service
- Ethernet offers non-reliable service
 - Packets contain checksums for error correction, but
 - no explicit acknowledgment is sent to a sender, neither in case of success or failure in packet transmission
 - Protocols of a higher layer are needed to take care of error correction

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Ethernet Data Packet Format:

The basic structure of the data packet is the same for all Ethernet technologies

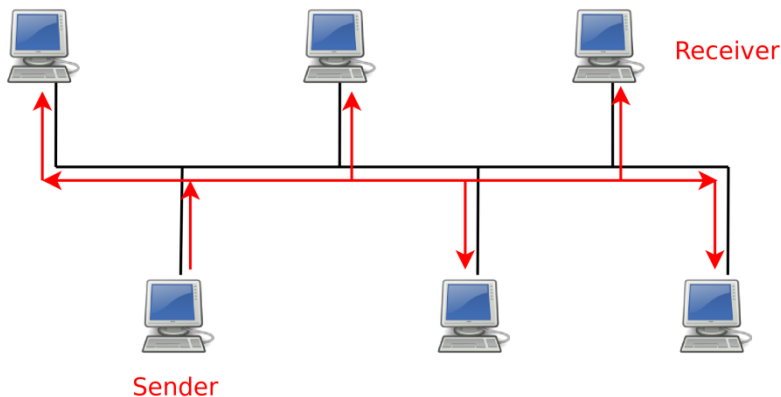
- Preamble – 7 or 8 bytes
 - 7 bytes beginning with “10101010” – alerts receiver and facilitates synchronization
 - Last byte ends with “10101011” – shows the beginning of the actual packet
- Header
 - Destination address and source address – each 6 bytes
 - Type field – identifies the packet as a packet of the Ethernet protocol (i.e. of the Data-Link-Layer)
- Payload – 46 to 1500 bytes – with final checksum – 4 bytes

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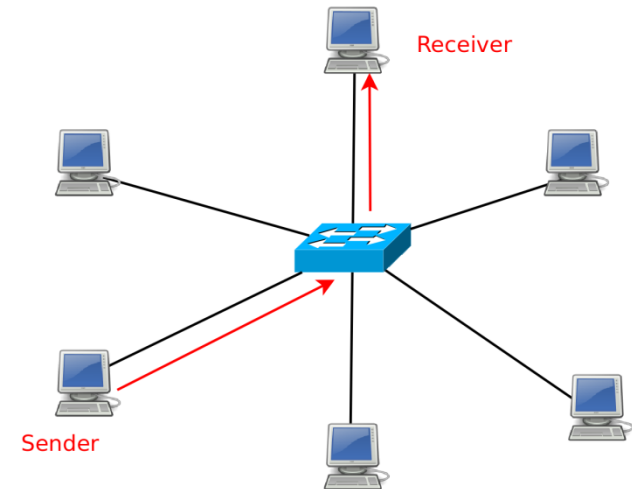
Ethernet topologies:

Bus:



All computers receive the data packet,
but only destination computer processes it

Star:



Data packets could be
directly sent to the receiver

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Ethernet Hardware Components:

- **Ethernet segment** consists of a group of computers connected to a bus (cable)
- Ethernet segment forms a collision domain
- Ethernet segments can be interconnected via
 - **Repeaters** – connect individual segments into a larger network that acts like a collision domain
 - **Bridges** – connect different physically separated collision domains. Communication can take place in parallel in the different collisions domains
 - **Routers** – can connect different Ethernet-LANs with each other

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Ethernet Variants (1/3)

- Ethernet variants distinguish themselves by their:
 - Transmission media – coaxial cable, twisted pair, fiber optic cable, ...
 - Limiting parameters, number of connectable computers, bandwidth, topology, ...
- **10 Mbps – Variants**
 - 10BASE5 – original standard, uses expensive cable (Thick Ethernet)
 - 10BASE2 – uses cheaper cable (Thin Ethernet)
 - 10BASE-T – uses simple telephone cable (twisted pair) as transmission medium, star wiring with a central hub
 - 10BASE-F – uses less-prone-to-error fiber optical cable

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Ethernet Variants (2/3)

100 Mbps Ethernet – Fast Ethernet

- Bandwidth of 100 Mbps can also sustain bursts in multimedia applications
- Follows the line of development from 10BASE-T
- Uses different conductor material , e.g. twisted pair cable, shielded double twisted pair cable or fiber optic cable
- All Fast Ethernet variants use the star topology

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Ethernet Variants (3/3)

1 Gbps Ethernet – Gigabit-Ethernet

- Backbone technology for connecting subnetworks with varying bandwidths, today also used in local networks

10 Gbps Ethernet

- Further development of the backbone technology, implementation in MAN and WAN

Broadband Ethernet

- Transmits no digital baseband signal, rather modulates the carrier over several frequencies (analog transmission); via frequency multiplexing procedures multiple Ethernet systems can be operated via signals on coaxial cables

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Ethernet at a Glance:

- Can link several hundred computers in the perimeter of approximately 1 km
- Relatively high data rate
- Minimum delay by sacrificing storage and transport logic
- Very simple addressing and algorithms for accessing the transmission medium
- Efficient use and fair access for all participants
- High reliability, no central control
- High stability, even under load