ETHERNET LANS

CPSC 441 - Tutorial 11

Winter 2018

UNIVERSITY OF CALGARY

WHAT IS ETHERNET?

- **Ethernet**, defined under IEEE 802.3 standard, is one of today's most widely used technologies in local area networks (LAN)
- Originally designed as a 2.94 Mbps system to connect 100 computers on a 1 km cable
- Later, Xerox, Intel and DEC drew up a standard to support 10 Mbps, which was later basis for the IEEE's 802.3 specification

TWO MAIN ELEMENTS OF ETHERNET

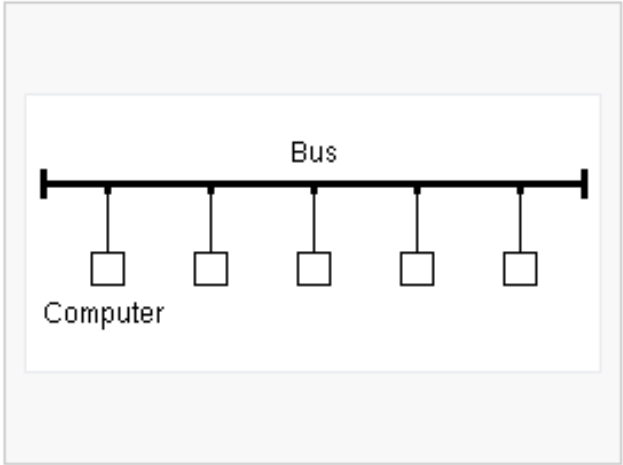
- **The network nodes**: The points to and from which the communication takes place.
  - Data Terminal Equipment: PCs, file servers, print servers.
  - Data Communications Equipment: devices that receive and forward the data frames across the network, e.g., repeaters, switches, routers.

- **Interconnecting media**: The cable that connects the network nodes, the type determines the speed at which the data may be transmitted.
  - Coaxial Cable, Twisted Pair Cables, Fiber Optic Cables

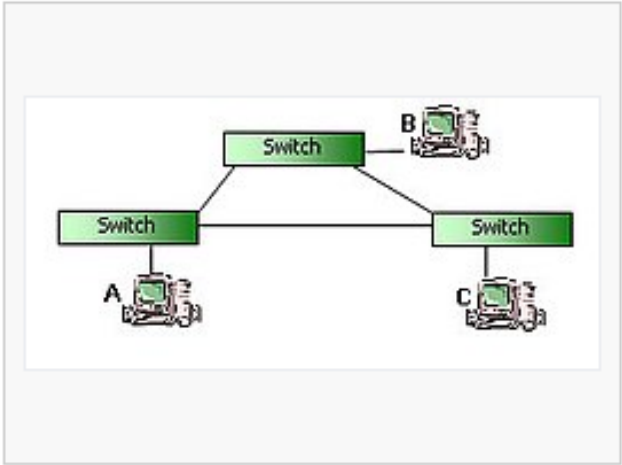
ETHERNET NETWORK TOPOLOGIES

- The two possible topologies for Ethernet are bus and star

Comparison between original Ethernet and modern Ethernet



The original Ethernet implementation: shared medium, collision-prone. All computers trying to communicate share the same cable, and so compete with each other.



Modern Ethernet implementation: switched connection, collision-free. Each computer communicates only with its own switch, without competition for the cable with others.

ETHERNET IEEE 802.3 STANDARDS

- IEEE 802.3 defines the physical layer and data link layer's media access control (MAC) of wired Ethernet

STANDARD SUPPLEMENT	YEAR	DESCRIPTION
802.3a	1985	10Base-2 (thin Ethernet)
802.3c	1986	10 Mb/s repeater specifications (clause 9)
802.3d	1987	FOIRL (fiber link)
802.3i	1990	10Base-T (twisted pair)
802.3j	1993	10Base-F (fiber optic)
802.3u	1995	100Base-T (Fast Ethernet and auto-negotiation)
802.3x	1997	Full duplex
802.3z	1998	1000Base-X (Gigabit Ethernet)
802.3ab	1999	1000Base-T (Gigabit Ethernet over twisted pair)
802.3ac	1998	VLAN tag (frame size extension to 1522 bytes)
802.3ad	2000	Parallel links (link aggregation)
802.3ae	2002	10-Gigabit Ethernet
802.3as	2005	Frame expansion
802.3at	2005	Power over Ethernet Plus

ETHERNET NAMING

Example: 10Base-T and 100Base-T

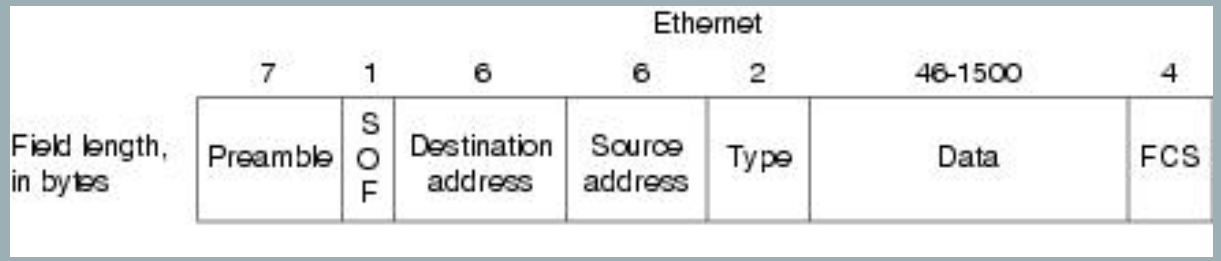
- The first number (typically one of 10, 100, or 1000) indicates the transmission speed in megabits per second
- The second term indicates transmission type:
  - BASE = baseband
  - BROAD = broadband
- The final part refers to the physical media itself
  - T: means unshielded twisted-pair cables. Further numbers indicate the number of twisted pairs available. For example in 100BASE-T4, the T4 indicates four twisted pairs.

MAC ADDRESSES

- **M**edia **A**ccess **C**ontrol **A**ddress:
  - A unique identifier assigned to network interfaces
  - Assigned by the manufacturer, stored in the hardware
  - Usually permanent, no duplication
  - 6-byte address expressed in 12-digit hexadecimal numbers
    - The first 24 bits identify the manufacturer
    - The second half of the address is known as the extension of board ID
  - e.g., broadcast address FF-FF-FF-FF-FF-FF
- Link-layer addressing scheme, used as a network address for most IEEE 802 network technologies, including **Ethernet**.
- Mac address is analogous to a person's SIN number, while IP address is analogous to postal address.

ETHERNET IEEE 802.3 FRAME STRUCTURE

10 / 100 Mbps Ethernet MAC data frame format



- **Header**
  - Preamble (PRE) - informs the receiving stations that a frame is starting as well as enabling synchronization.
  - Start Of Frame delimiter (SOF)
  - Destination Address (DA) – Destination MAC Address
  - Source Address (SA) – Source MAC Address
  - Length / Type - It is used to indicate which protocol is encapsulated in the payload of the frame.
- **Payload**: Data - minimum of 46 bytes, up to 1500 bytes long
- **Trailer**: Frame Check Sequence (FCS) - This field is four bytes long. It contains a 32 bit Cyclic Redundancy Check (CRC).

- **Extension**: When using the 1000Base-X standard, there is a minimum frame size of 416bytes, and for 1000Base-T there is a minimum frame size of 520bytes.

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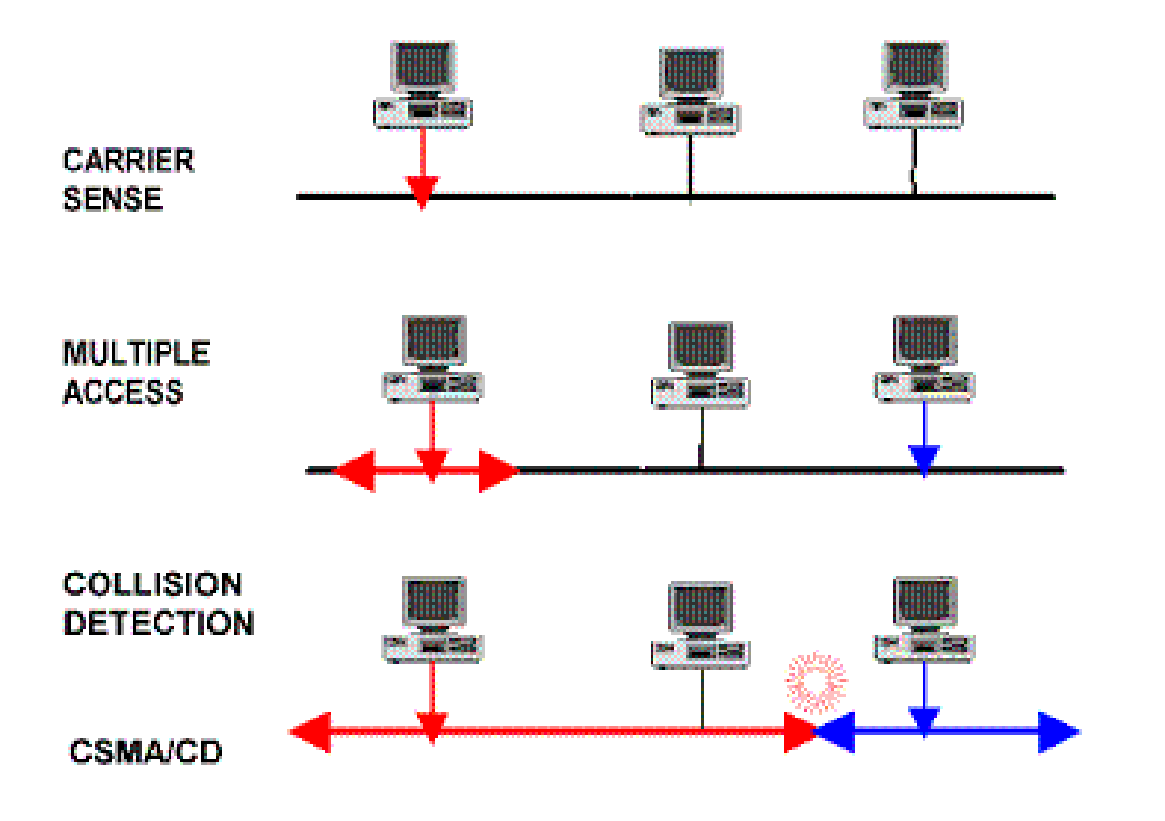
ETHERNET MEDIA ACCESS CONTROL METHOD

- Ethernet uses CSMA/CD:

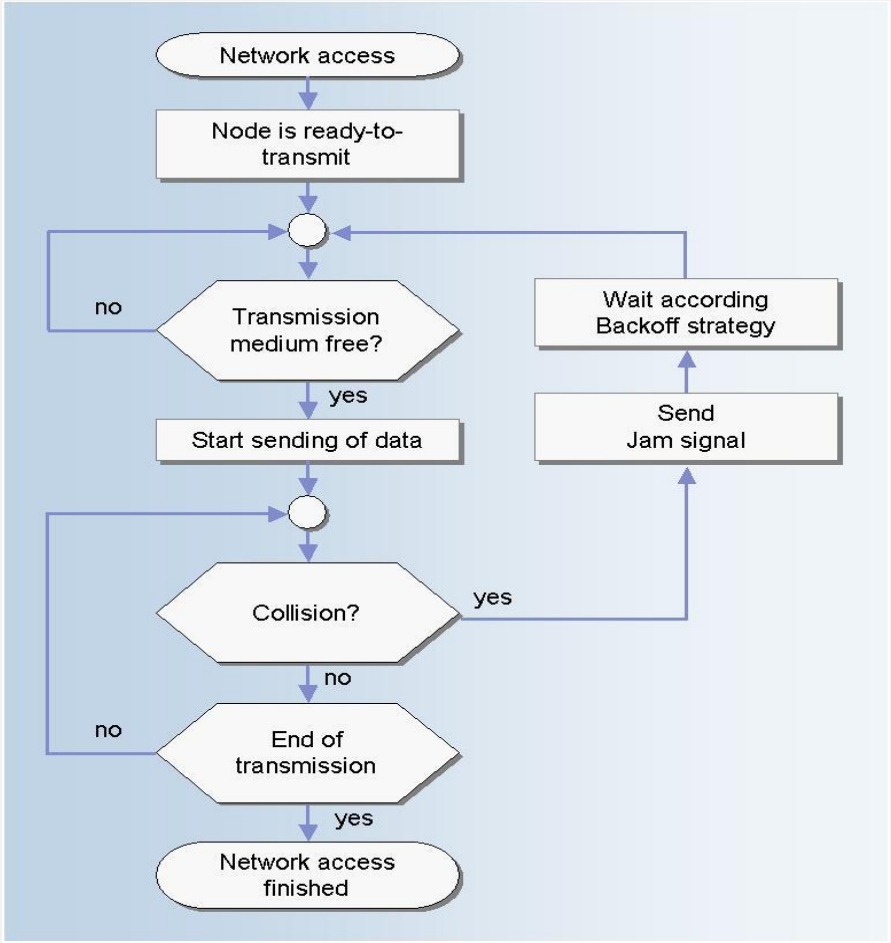
  Carrier Sense Multiple Access / Collision Detection

- Carrier Sense: Each station listens on the network for traffic and it can detect when the network is quiet.
- Multiple Access: the stations are able to determine for themselves whether they should transmit.
- Collision Detect: It is still possible that two stations will start to transmit at virtually the same time. If this occurs then the stations detect collision and will stop transmitting. They then back off a random amount of time before attempting a retransmission.

ETHERNET MEDIA ACCESS CONTROL METHOD



CSMA/CD ALGORITHM



GIGABIT ETHERNET

- The next development of the Ethernet standard beyond the popular 100Base-T version.
- Provides for half and full duplex operation at speeds of 1000 Mbps.
- It is particularly easy to install because the 1000Base-T variant is designed to run over Cat 5 UTP (unshielded twisted pair) that is widely and cheaply available.
- Uses the 802.3 Ethernet frame formats.
- Uses the CSMA/CD access method with support for one repeater per collision domain.
- Provides backward compatibility with 10BASE-T and 100BASE-T technologies.

REFERENCES

- Wikipedia
  - https://en.wikipedia.org/wiki/Ethernet
  - https://en.wikipedia.org/wiki/Ethernet_frame
  - https://en.wikipedia.org/wiki/Carrier-sense_multiple_access_with_collision_detection
- https://www.electronics-notes.com/articles/connectivity/ethernet-ieee-802-3/data-frames-structure-format.php