

Module 5

(Wired LAN)

(Data Link Layer and Medium Access Sub Layer: Error Detection and Error Correction - Fundamentals, Block coding, Hamming Distance, CRC; Flow Control and Error control protocols - Stop and Wait, Go back – N ARQ, Selective Repeat ARQ, Sliding Window, Piggybacking, Random Access, Multiple access protocols -Pure ALOHA, Slotted ALOHA, CSMA/CD,CDMA/CA; Wired LAN, Wireless LANs, Connecting LANs and Virtual LANs)

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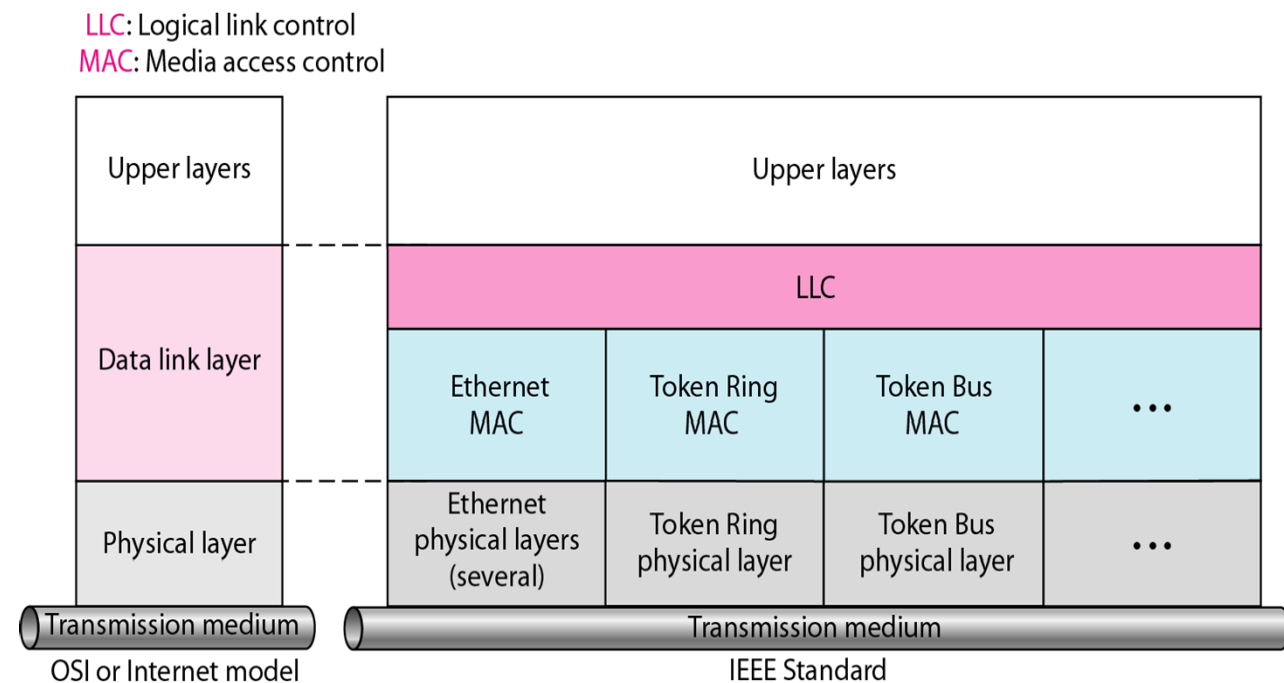
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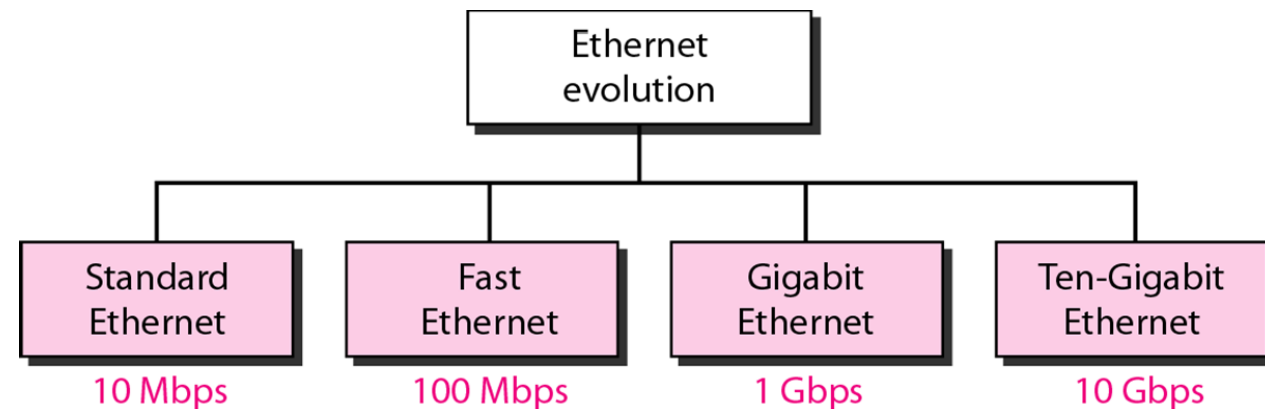
IIST, Shibpur

Wired LAN: Ethernet

- Local Area Network (LAN)
 - Designed for a **limited geographic area** such as a **building** or a **campus**.
 - **Purpose: sharing resources**
 - Most LANs today are also linked to a **Wide Area Network (WAN)** or the **Internet**.
 - Different types of LANs: **Ethernet**, **Token Ring**, **Token Bus**, **FDDI**, **ATM LAN**, etc.
 - **IEEE 802 Project**
 - **LLC: framing, flow control, error control**
 - **MAC: defines specific access method** for each LAN
 - **CSMA/CD** for Ethernet LANs, **token-passing** for Token Ring, Token Bus



IEEE Standard for LAN (802 Project)



Ethernet Evolution for Four Generations

Wired LAN: Standard Ethernet

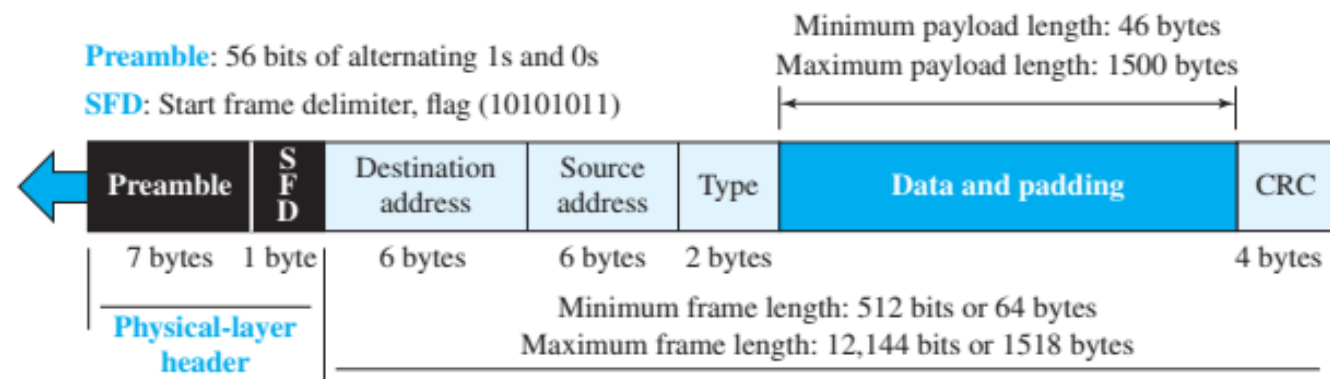
- **Connectionless & Unreliable Service**

- Frames are independent of one another
- No connection establishment/termination phase
- Sender can overwhelm the receiver: frames are dropped
- No error correction service
- It is the duty of high-level protocols to find out about lost frame(s)

- **Ethernet frame**

- Minimum/maximum frame length: **64 bytes/1518 bytes**
- Minimum/maximum data length: **46 bytes/1500 bytes**

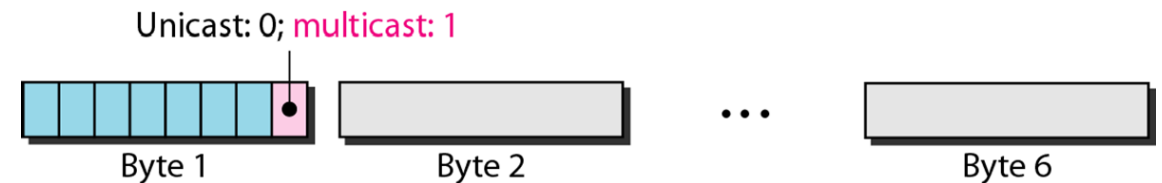
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Ethernet Frame

- **Addressing**

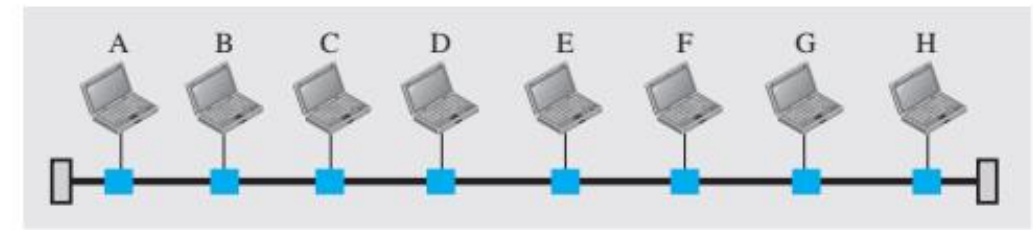
- Network Interface Controller/Card (NIC)
- 48-bit (6-bytes) address in hexadecimal notation
- Byte-by-byte transmission from left to right – LSB of first byte is transmitted first
- Source address: **unicast**
- Destination address: **unicast, multicast, broadcast**
- **Broadcast address: forty-eight 1s.**



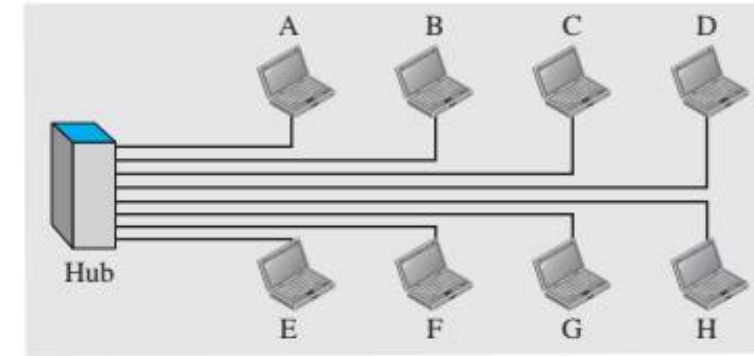
Unicast and Multicast Address

Wired LAN: Standard Ethernet

- Implementation: **bus or star**
- Transmission: **broadcast by default**
 - **Unicast**: the **intended recipient** keeps and handles the frame; the rest discard it.
 - **Multicast**: stations that are **members of the group** keep and handle it; the rest discard it.
 - **Broadcast**: **all** stations (**except the sender**) will receive the frame and **all** stations (**except the sender**) keep and handle it.

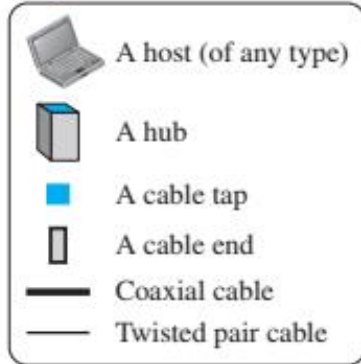


a. A LAN with a bus topology using a coaxial cable



b. A LAN with a star topology using a hub

Legend



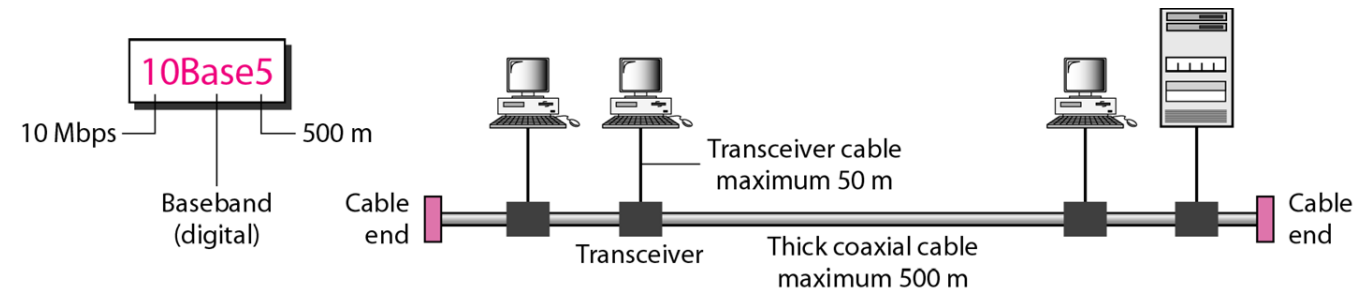
Implementation of Standard Ethernet

- Access method: **CSMA/CD with 1-persistent method**
 - Depends on: **transmission rate, minimum frame size, maximum network length**
 - Maximum length of the cable: **2500 meters**
- Channel efficiency =
$$\frac{1}{1+2BLE/cF}$$

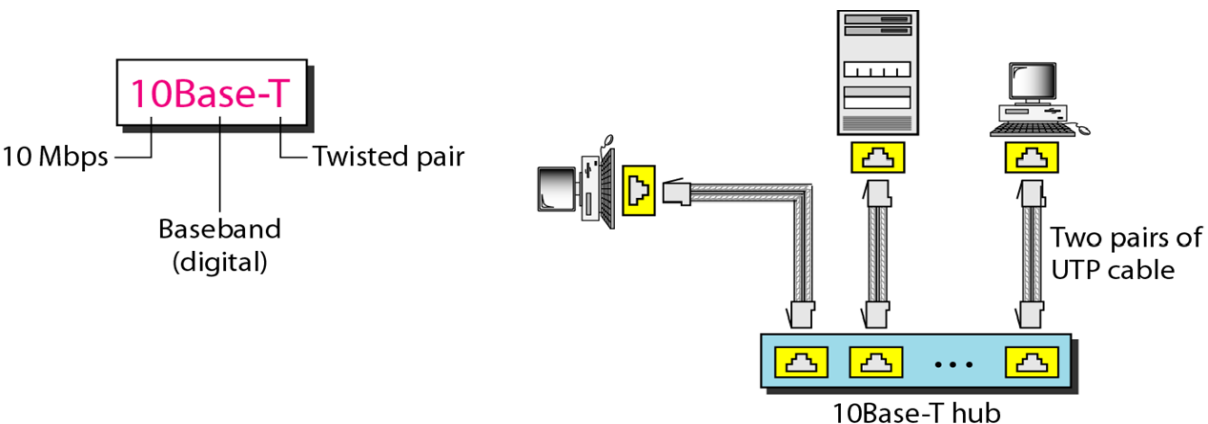
Wired LAN: Standard Ethernet

Implementation	Medium	Medium Length	Encoding
10Base5	Thick coax	500 m	Manchester
10Base2	Thin coax	185 m	Manchester
10Base-T	2 UTP	100 m	Manchester
10Base-F	2 Fiber	2000 m	Manchester

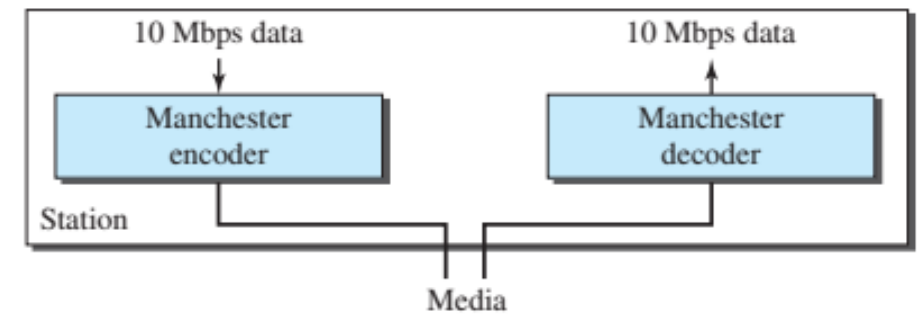
Summary of Standard Ethernet Implementation



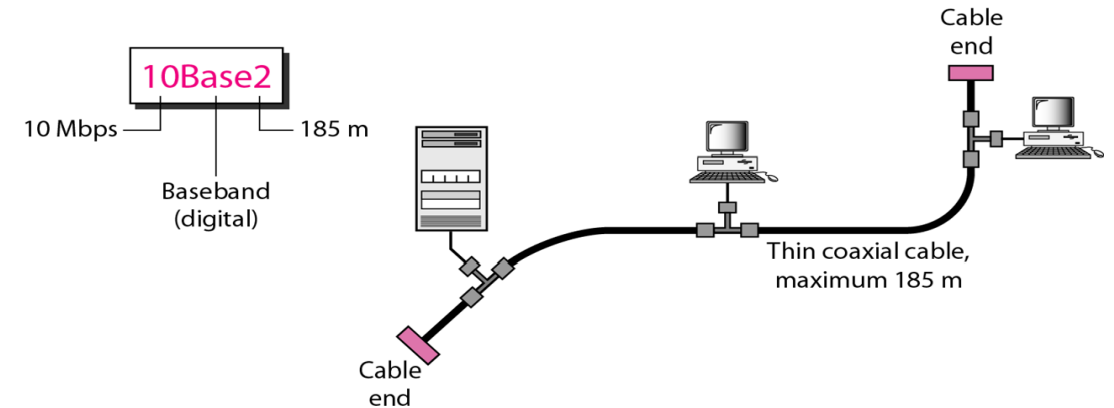
10Base5 Implementation/Thick Ethernet/Thicknet



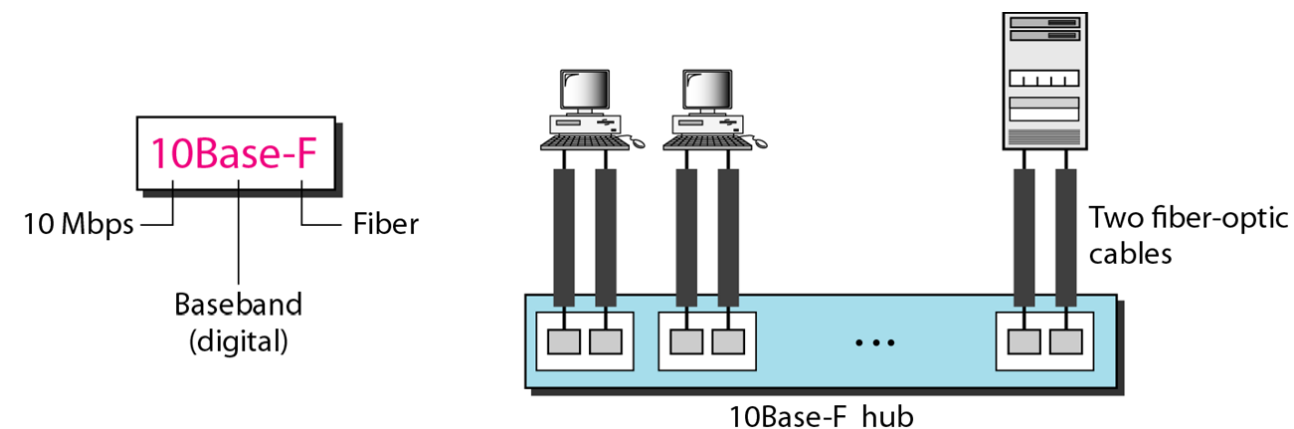
10Base-T Implementation/Twisted Pair Ethernet



Encoding in Standard Ethernet Implementation



10Base2 Implementation/Thin Ethernet/Cheapernet



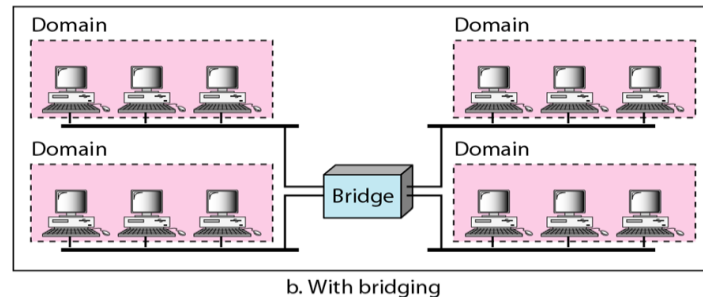
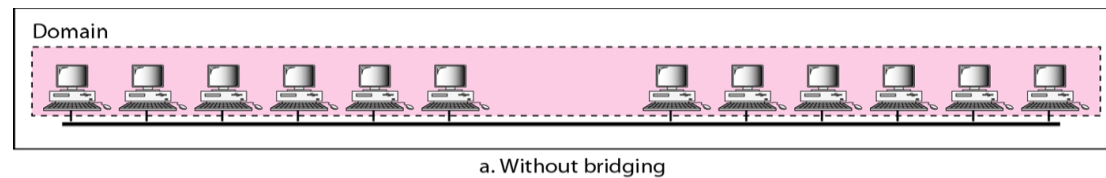
10Base-F Implementation/Fiber Ethernet

Wired LAN: Standard Ethernet

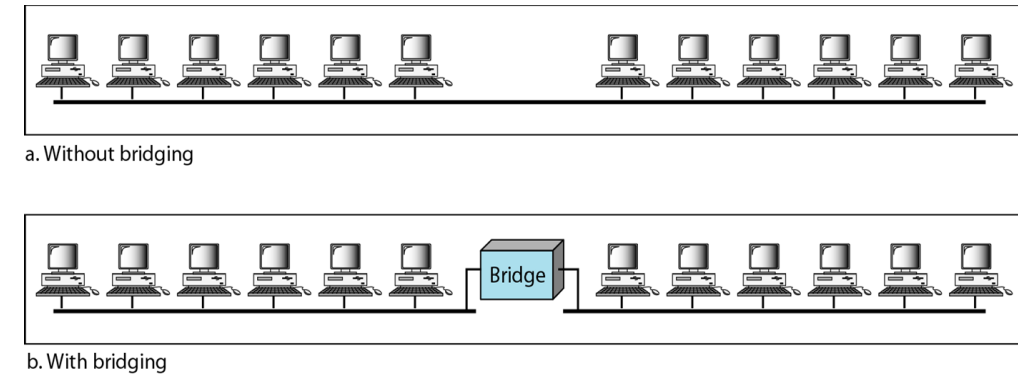
- Changes in the Standard Ethernet

- **Bridged Ethernet**

- Boosting up bandwidth
- Separating collision domains



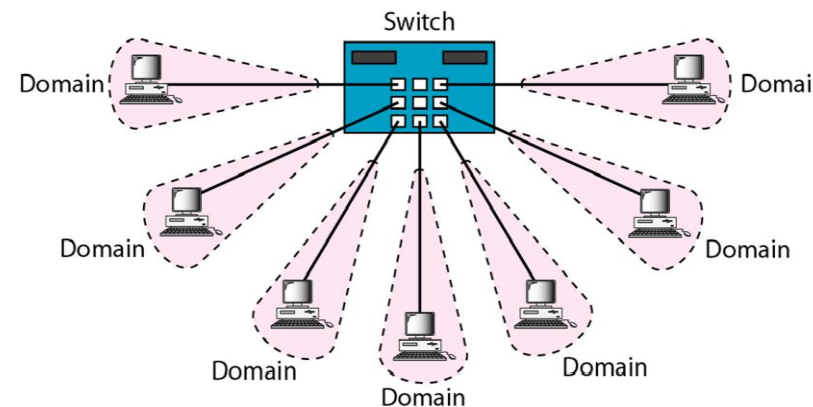
Collision Domains in the Unbridged and Bridged Network



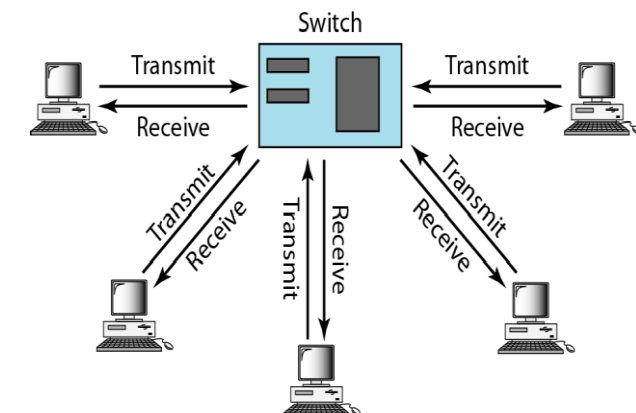
Network with and without Bridge

- **Switched Ethernet**

- Separate collision domain for each port (storing frames in switch's on-board RAM)



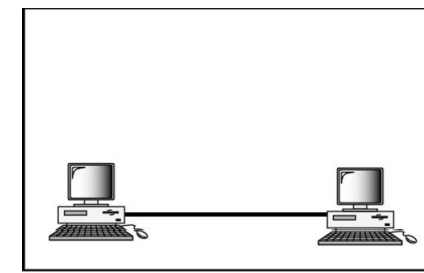
Switched Ethernet



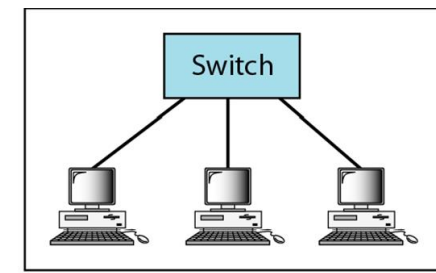
Full-duplex Switched Ethernet

Wired LAN: Fast Ethernet

- Transmission rate: upgraded to **100 Mbps**
- Compatible with Standard Ethernet
 - Frame format, max/min sizes
 - 48-bit address
- Access method: **CSMA/CD**
 - Transmission rate → **increased by 10 times**
 - Frame size → **unchanged**
 - Maximum network size → **decrease by 10 times (i.e., 250 meters)**
- Autonegotiation: negotiate the **mode** or **data rate** of operation
- Topology:
 - Point-to-point.
 - Star topology: hub/switch at the center.

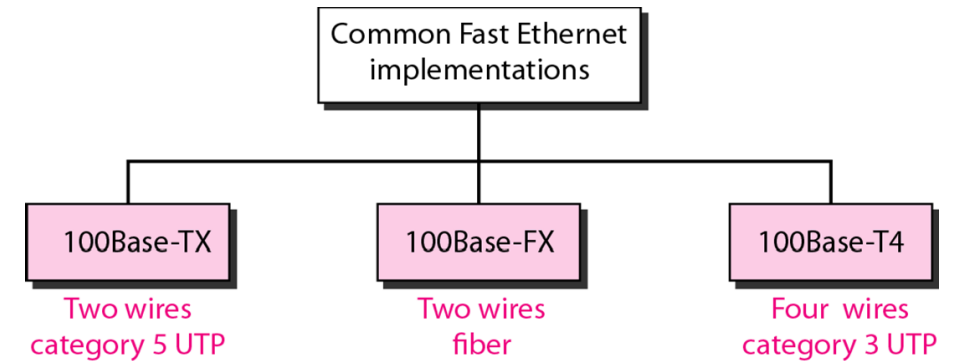


a. Point-to-point



b. Star

Fast Ethernet Topology



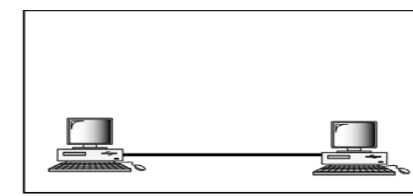
Fast Ethernet Implementations

Fast Ethernet Implementations (Summary)

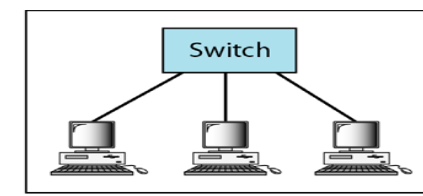
Implementation	Medium	Medium Length	Wires	Encoding
100Base-TX	UTP or STP	100 m	2	4B5B + MLT-3
100Base-FX	Fiber	185 m	2	4B5B + NRZ-I
100Base-T4	UTP	100 m	4	Two 8B/6T

Wired LAN: Gigabit Ethernet

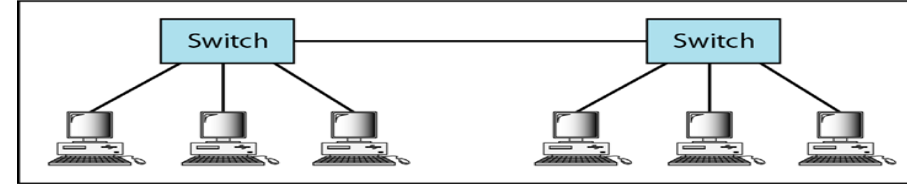
- **IEEE 802.3z** standard
- Transmission rate: scaled-up to **1000 Mbps (1 Gbps)**
- Compatible with Standard Ethernet
 - Frame format, max/min sizes
 - 48-bit address
- **Compatible with Fast Ethernet**
 - Autonegotiation
- Access method
 - Full-duplex mode: **Switched Ethernet**
 - No collision: CSMA/CD not used
 - Maximum length of the cable determined by **signal attenuation in the cable**.
 - Half-duplex mode: **hub** at the center
 - Collision can occur: CSMA/CD is used
 - Maximum length of the cable is totally dependent on the **minimum frame size**



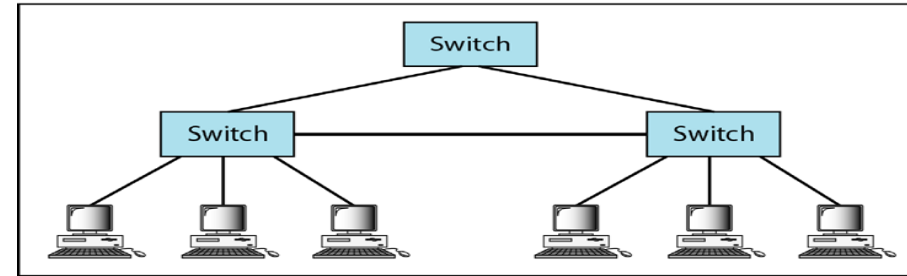
a. Point-to-point



b. Star

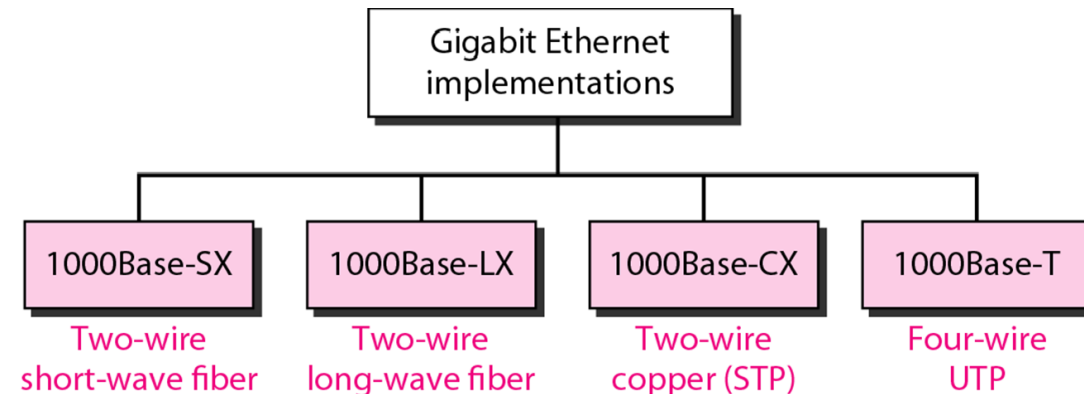


c. Two stars



d. Hierarchy of stars

Gigabit Ethernet Topology



Gigabit Ethernet Implementations 8

Wired LAN: 10 Gigabit Ethernet

- IEEE 802.3ae standard
- Transmission rate: scaled-up to 10 Gbps
- Interconnection of LANs, MANs, and WANs
- Compatible with Standard Ethernet
 - Frame format, max/min sizes
 - 48-bit address
- Data rate is achieved with fiber-optic technology
- Two types of physical layers
 - LAN PHY: supports existing LANs
 - WAN PHY: defines a WAN with links connected through SONET OC-192.
- Access method:
 - Full-duplex: no collision; CSMA/CD not used
- Implementations:
 - 10GBase-SR
 - 10GBase-LR
 - 10GBase-EW
 - 10GBase-X4

10 Gigabit Ethernet Implementation Summary

Implementation	Medium	Medium Length	Number of wires	Encoding
10GBase-SR	Fiber 850 nm	300 m	2	64B66B
10GBase-LR	Fiber 1310 nm	10 Km	2	64B66B
10GBase-EW	Fiber 1350 nm	40 Km	2	SONET
10GBase-X4	Fiber 1310 nm	300 m to 10 Km	2	8B10B