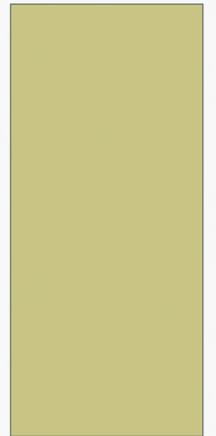


ETHERNET

CPSC 441 TUTORIAL – MARCH 19, 2012
TA: RUITING ZHOU



INTRODUCTION OF ETHERNET

- **Ethernet**, defined under **IEEE 802.3**, is one of today's most widely used data communications standards
 - It finds its major use in Local Area Network (LAN)
 - it has largely replaced competing wired LAN technologies
- **Found** by Xerox Palo Alto Research Center (PARC) in 1975
- Original 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 support 10 Mbps
- Basis for the IEEE's 802.3 specification

ETHERNET NETWORK ELEMENTS

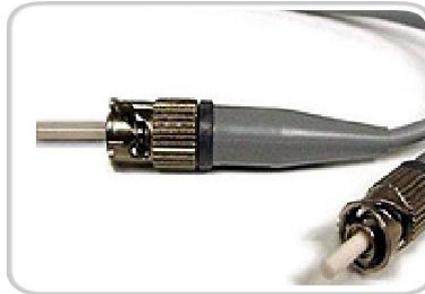
Physical Devices Implementing Ethernet



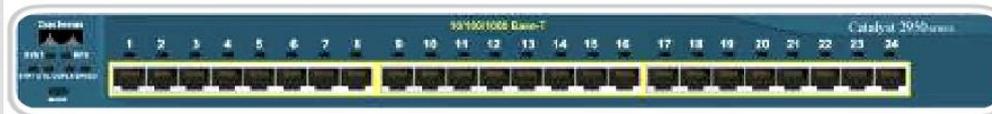
UTP patch panels in a rack



Ethernet switches



Ethernet fiber connectors



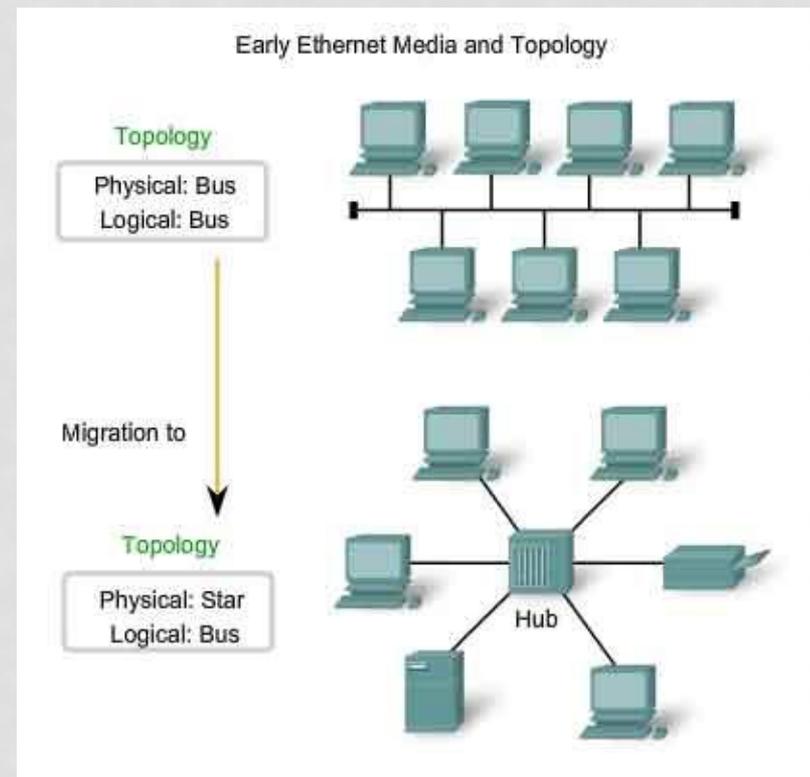
Ethernet switch

ETHERNET NETWORK ELEMENTS

- Two main elements: **Interconnecting media** and **Network nodes**.
- **Interconnecting media**: cable determine the speed at which the data may be transmitted.
 - Coaxial cable, twisted Pair Cables
 - Fiber optic cable: it provides very high immunity to pickup and radiation as well as allowing very high data rates to be communicated.
- **The network nodes**: the points to and from which the communication takes place.
 - Data Terminal Equipment: devices such as PCs, file servers, print servers.
 - Data Communications Equipment: devices receive and forward the data frames across the network, include items such as repeaters, routers, switches..

ETHERNET NETWORK TOPOLOGIES

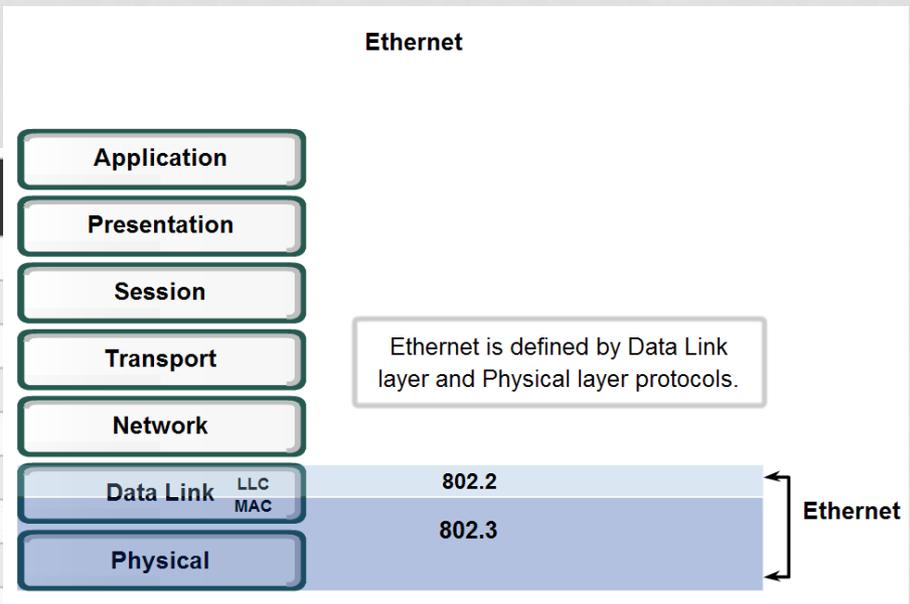
- **Point to point:** This is the simplest configuration as only **two** network units are used.
- **Coaxial bus:** The systems used a coaxial cable (maximum of 500 metres) where the network units **were located along the length of the cable**. it was possible to place up to 1024 DTEs along its length.
- **Star network:** This type of Ethernet network has been the **dominant** topology since the early 1990s. It consists of a central network unit. All the connections to other nodes radiate out from this and are point to point links.



ETHERNET IEEE 802.3 STANDARDS

- 802.3 standard defines both MAC and physical layer details

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 IEEE 802.3 STANDARDS

- **Ethernet terminology:** three parts. Eg: 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 last number indicates segment length
 - A 5 :500-meter (500-m)
 - 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.

ETHERNET IEEE 802.3 FRAME FORMAT / STRUCTURE

- Frame structures are developed within the MAC layer of the protocol stack.
- **10 / 100 Mbps Ethernet MAC data frame format**

Length / type						
PRE	SOF	DA	SA		Data payload	FCS
7	1	6	6	2	46 - 1500	4

- **Header**

- **Preamble (PRE)** - informs the receiving stations that a frame is starting as well as enabling synchronization.
- **Start Of Frame delimiter (SOF)**- signal the start of the actual frame
- **Destination Address (DA)** – first bit: 0-an individual address, 1-a group address. The next bit into the DA indicates whether the address is globally administered (0), or local(1). 46 remaining bits-destination address.
- **Source Address (SA)** - always an individual address the left most bit is always a zero
- **Length / Type** - It provides MAC information and indicates the number of client data types that are contained in the data field 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).

ETHERNET IEEE 802.3 FRAME FORMAT / STRUCTURE

- **1000 Mbps Ethernet MAC data frame format**

- 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. to any frames that are shorter than the MFL.

Length / type							
PRE	SOF	DA	SA	↓	Data payload	FCS	EXT
7	1	6	6	2	46 - 1500	4	Variable

- **Ethernet addresses**

- Every Ethernet network interface card (NIC) is given a unique identifier called a **MAC address**.
- This is assigned by the manufacturer of the card.
- The MAC address comprises of a **48-bit** number.
 - The first 24 bits identify the manufacturer
 - The second half of the address is assigned by the manufacturer and it is known as the extension of board ID.
- The MAC address is usually programmed into the hardware so that it **cannot be changed**. Even if the interface card moves to another location across the world, the user can be reach.

ETHERNET ADDRESSES

00 00 E2 15 1A CA

The image shows a Windows XP desktop environment with several windows open. The 'Control Panel' window is in the background, showing the 'Network' icon circled in red. In the foreground, the 'Network' window is open, displaying the 'Adapters' tab with '(1) Intel EtherExpress PRO Adapter' selected. The 'Properties...' button is circled in red. Overlaid on this is the 'Adapter Properties (557Set)' dialog box. The 'Adapters Installed' list shows '82557-compatible 10/100 Ethernet PCI Adapter 100Base-TX, 100Base-T'. The 'Adapter Information' section lists various details, with the 'Ethernet Address' field containing '0000E2151ACA' and circled in red. A red arrow points from the text '00 00 E2 15 1A CA' at the top left to the circled Ethernet address.

Control Panel

File Edit View Go Favorites Help

Network

Identification Services Protocols Adapters Bindings

Network Adapters:

(1) Intel EtherExpress PRO Adapter

Adapter Properties (557Set)

Adapters Installed:

82557-compatible 10/100 Ethernet PCI Adapter
100Base-TX, 100Base-T

Adapter Information

Memory Address: 0x0

I/O Address: 0x7400

Interrupt: 10

Ethernet Address: 0000E2151ACA

Slot Number: 12 (0xc)

Speed / Duplex: Auto

Adapter Mode: Standard Mode

Keyboard Licensing

Modems Monitoring Agent

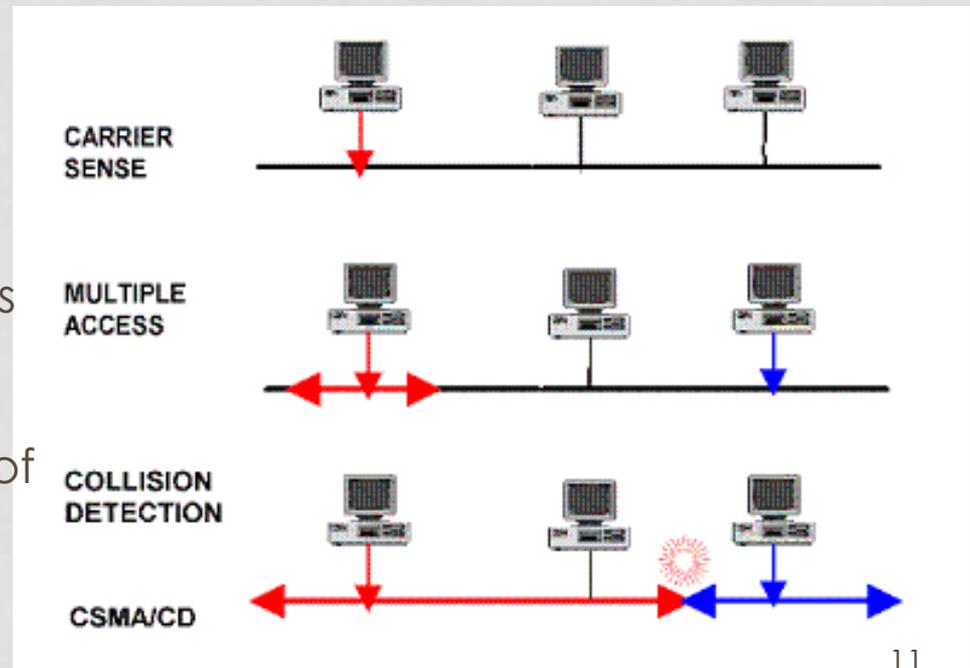
Network ODBC

My Computer

10

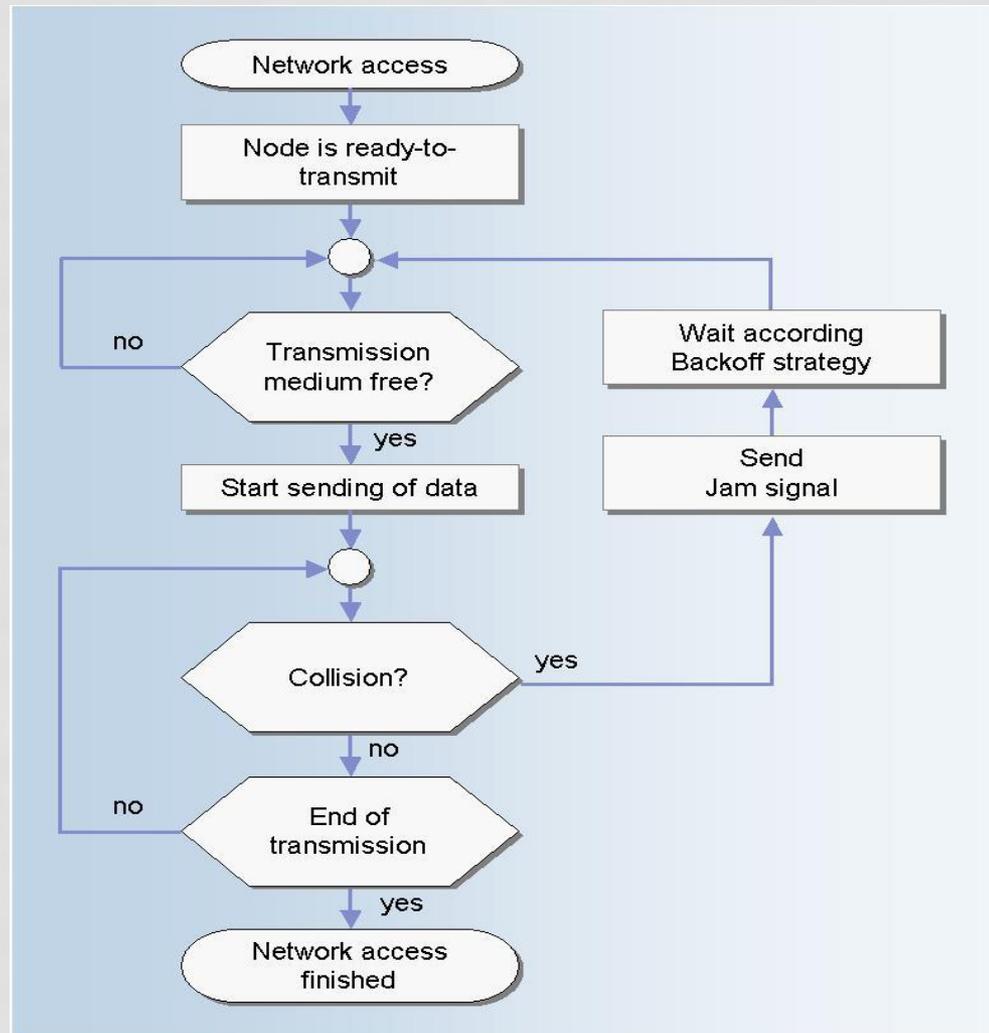
ETHERNET MEDIA ACCESS CONTROL METHOD

- 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**: describe the fact that multiple stations send and receive on the medium
 - **Collision Detect**: it is still possible that two stations will start to transmit at virtually the same time. If this occurs then the stations can detect this and they will stop transmitting. They then back off a random amount of time before attempting a retransmission.



ETHERNET MEDIA ACCESS CONTROL METHOD

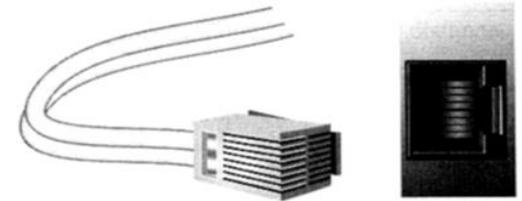
- CSMA/CD Algorithm



10MBPS ETHERNET - 10BASET

- 10BaseT \Rightarrow 10 Mbps, baseband, over Twisted-pair cable
- Running Ethernet over twisted-pair wiring as specified by IEEE 802.3i
- Configure in a star pattern

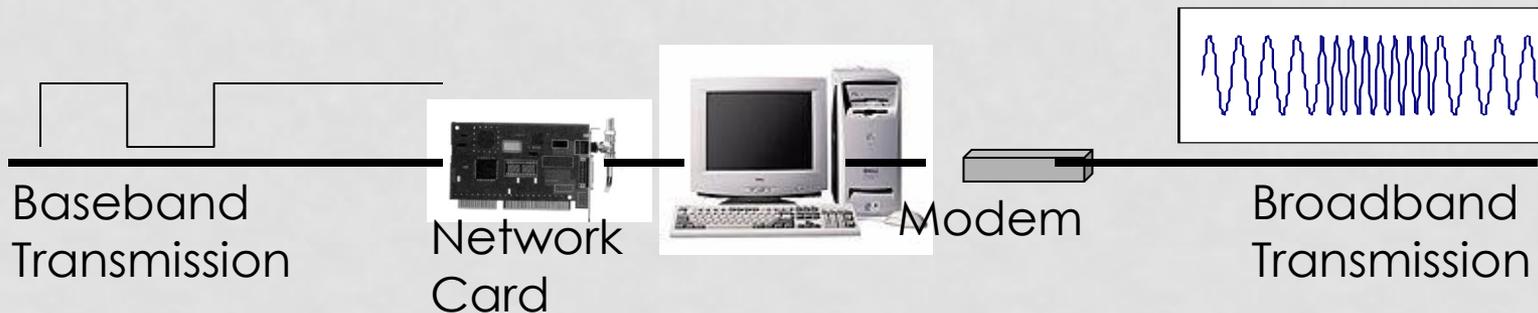
Unshielded twisted-pair



RJ-45 Plug and Socket

10MBPS ETHERNET - 10BASET

- **Baseband** Transmission
 - Entire channel is used to transmit a single digital signal
 - Complete bandwidth of the cable is used by a single signal
 - The transmission distance is shorter
 - The electrical interference is lower
- **Broadband** Transmission
 - Use analog signaling and a range of frequencies
 - Continuous signals flow in the form of waves
 - Support multiple analog transmission (channels)



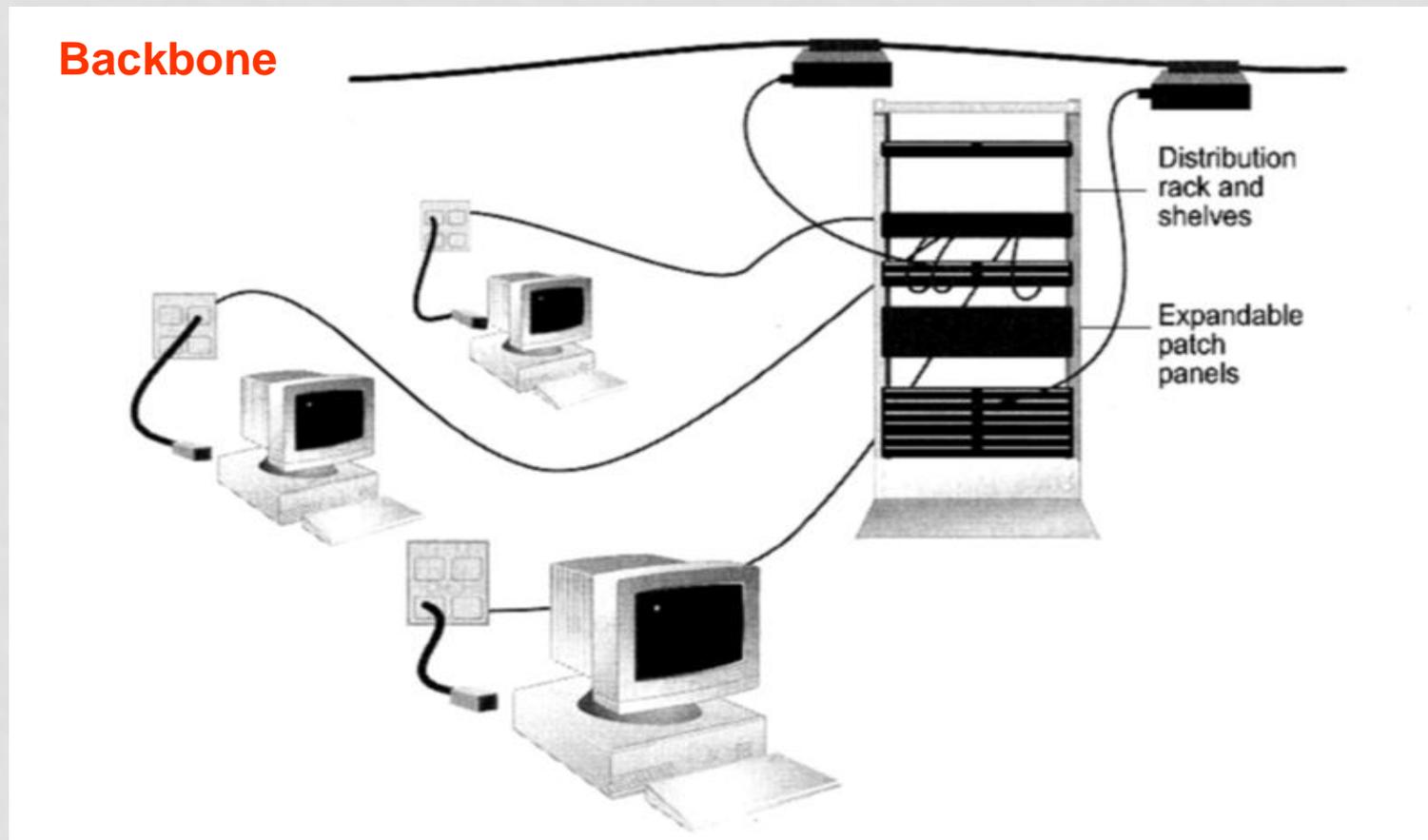
10MBPS ETHERNET - 10BASET

- Twisted Pair Cables: Unshielded Twisted Pair Cable (UTP)
 - most popular
 - maximum length 100 m
 - more susceptible to noise
 - Defined in EIA/TIA 568 Commercial Building Wire Standard

Category 1	Voice transmission of traditional telephone
Category 2	For data up to 4 Mbps, 4 pairs full-duplex
Category 3	For data up to 10 Mbps, 4 pairs full-duplex
Category 4	For data up to 16 Mbps, 4 pairs full-duplex
Category 5	For data up to 100 Mbps, 4 pairs full-duplex
Category 6	For data up to 1000 Mbps, 4 pairs full-duplex

10MBPS ETHERNET - 10BASET

- A typical 10BaseT network



10MBPS ETHERNET - 10BASET

- 10BaseT Summary

- **Cable** Category 3, 4, or 5 UTP
- **Connectors** RJ-45 at cable ends
- **Max. distance between computer to hub** 100 m.
- **Total computers per LAN** 1024

100 MBPS ETHERNET / IEEE 802.3U INCLUDING 100 BASE-T

- **100BaseT** Ethernet (Fast Ethernet) is defined under the 802.3 family of standards under **802.3u**.
- One of the most widely used forms of Ethernet.
- All the nodes within the network share the 100 Mbps bandwidth.
- it uses the CSMA/CD access method, but there are some minor differences in the way the overall system operates.
- It runs on UTP or optical fiber cable and uses a star topology.

100 MBPS ETHERNET / IEEE 802.3U INCLUDING 100 BASE-T

100Base-TX:	uses two pairs of Category 5 UTP
100Base-T4	uses four pairs of Category 3
100Base-T2	uses two pairs of Category 3
100Base-FX	two strands of multi-mode optical fiber. Maximum length is 400 meters for half-duplex connections) or 2 kilometers for full-duplex.
100Base-SX	It is a lower cost alternative to using 100Base-FX, because it uses short wavelength optics can operate at distances up to 300 meters
100Base-BX	single strand of optical fiber (unlike 100Base-FX, which uses a pair of fibers). Single-mode fiber is used, along with a special multiplexer which splits the signal into transmit and receive wavelengths.

GIGABIT ETHERNET

- The next development of the Ethernet standard beyond the popular 100Base-T version.
- Allows the transfer of data at speeds of 1000 Mbps or 1 Gbps.
- 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.

GIGABIT ETHERNET

- Provide for half and full duplex operation at speeds of 1000 Mbps.
- Use the 802.3 Ethernet frame formats.
- Use the CSMA/CD access method with support for one repeater per collision domain.
- Provide backward compatibility with 10BASE-T and 100BASE-T technologies.

REFERENCE

- http://www.radio-electronics.com/info/telecommunications_networks/ethernet/100-mbps-ieee-802-3u-base-t.php
- <http://www.fujitsu.com/downloads/TEL/fnc/pdfservices/ethernet-prerequisite.pdf>
- PPT: Ethernet
A Case study of Physical and Data Link Layer