# Computer Networks

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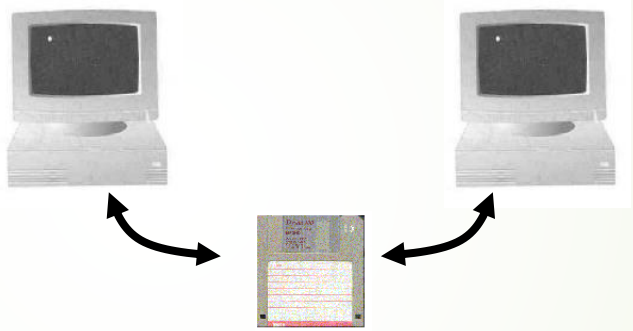
# What is a computer network

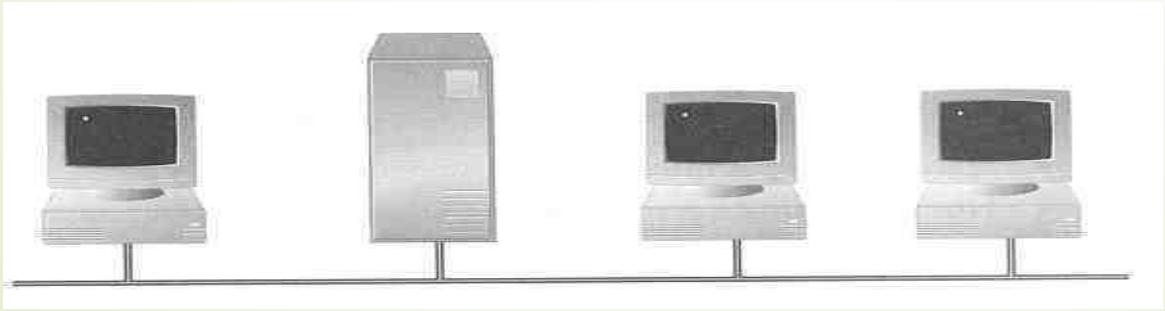
**A network consists of 2 or more computers connected together, and they can communicate and share resources (e.g. information)**

# Why Networking?

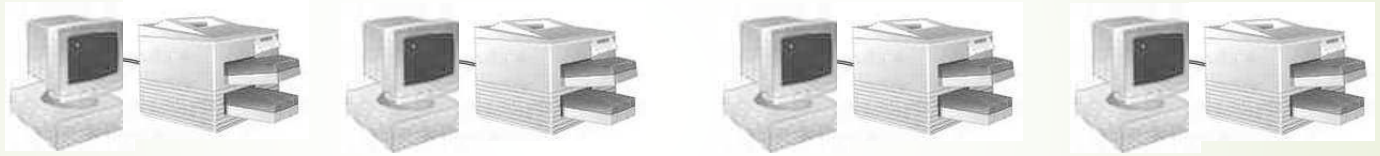
- **Sharing information — i.e. data communication**
  - **Do you prefer these?**



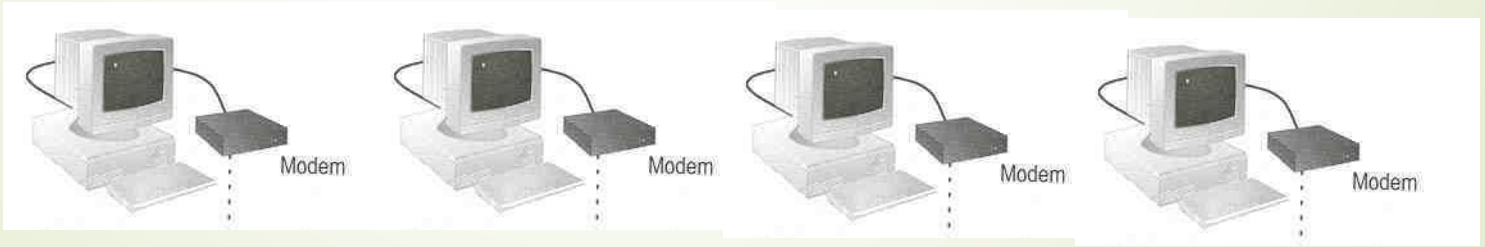
  - **Or this?**



- **Sharing hardware or software**
  - **E.g. print document**



- **Centralize administration and support**



# How many kinds of Networks?

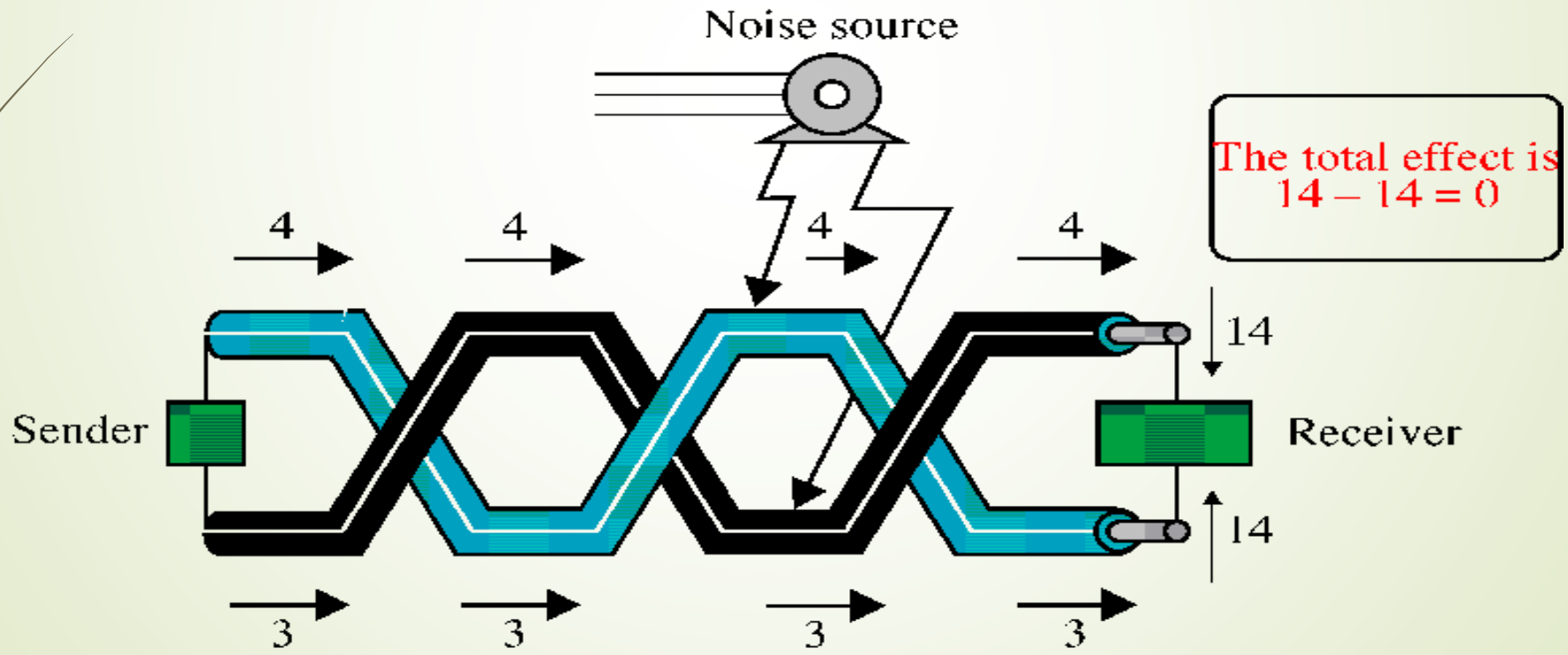
- **Depending on one's perspective, we can classify networks in different ways**
  - **Based on transmission media: Wired (UTP, coaxial cables, fiber-optic cables) and Wireless**
  - **Based on network size: LAN and WAN (and MAN)**
  - **Based on management method: Peer-to-peer and Client/Server**
  - **Based on topology (connectivity): Bus, Star, Ring …**
    - **:**
    - **:**

# Transmission Media

- Two main categories:
  - Guided — wires, cables
  - Unguided — wireless transmission, e.g. radio, microwave, infrared, sound, sonar
- Guided media :
  - Twisted-Pair cables:
    - Unshielded Twisted-Pair (UTP) cables
    - Shielded Twisted-Pair (STP) cables
  - Coaxial cables
  - Fiber-optic cables

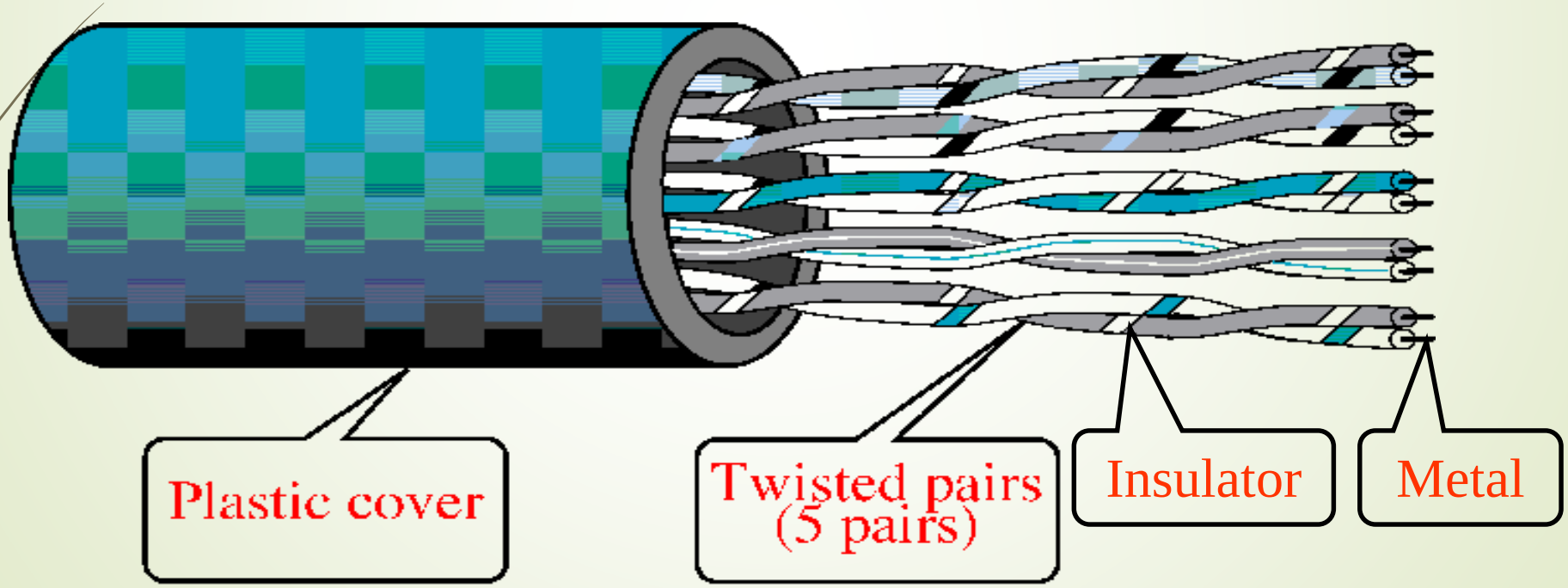
# Twisted-Pair Cables

- If the pair of wires are not twisted, electromagnetic noises from, e.g., motors, will affect the closer wire more than the further one, thereby causing errors



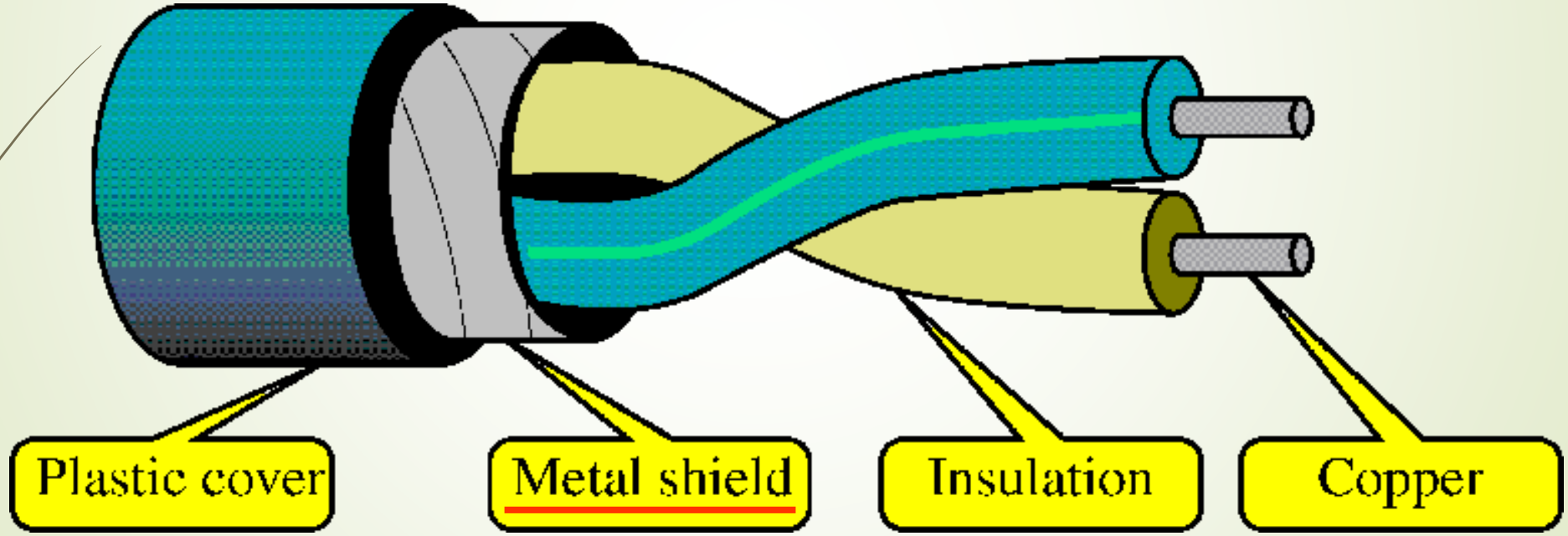
# Unshielded Twisted-Pair (UTP)

- Typically wrapped inside a plastic cover (for mechanical protection)
- A sample UTP cable with 5 unshielded twisted pairs of wires

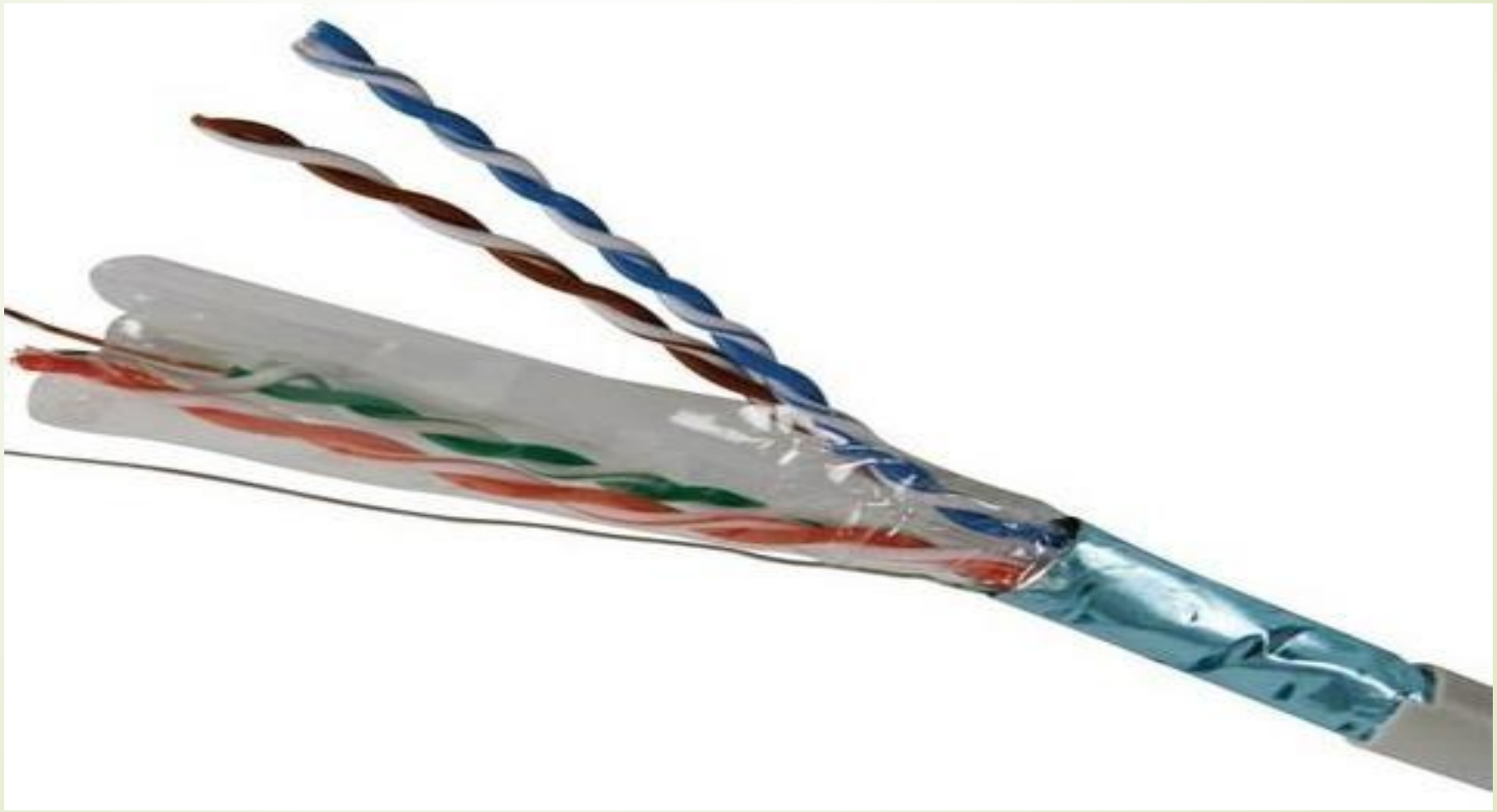


# Shielded Twisted-Pair (STP)

- STP cables are similar to UTP cables, except there is a metal foil or braided-metal-mesh cover that encases each pair of insulated wires



# Shielded Twisted-Pair (STP)



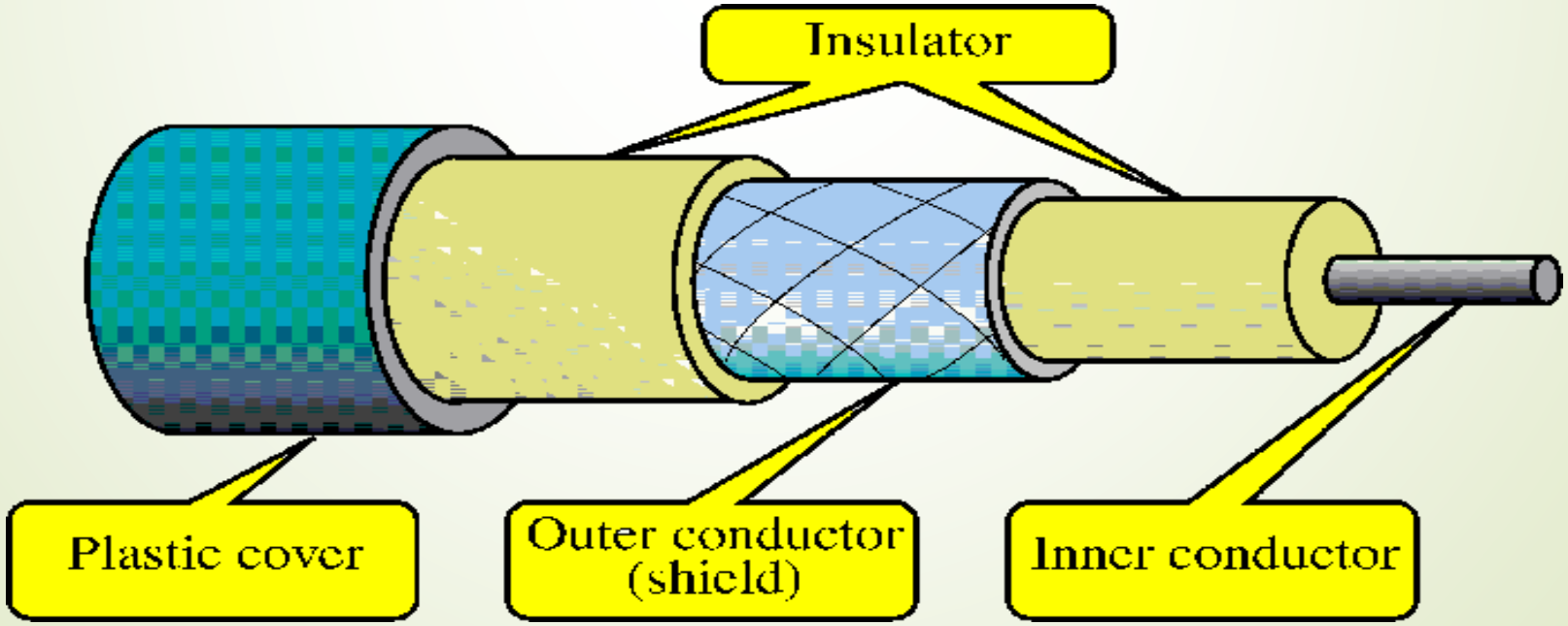
# Categories of UTP Cables

EIA classifies UTP cables according to the quality:

- *Category 1* — the lowest quality, only good for voice, mainly found in very old buildings, not recommended now
- *Category 2* — good for voice and low data rates (up to 4Mbps for low-speed token ring networks)
- *Category 3* — at least 3 twists per foot, for up to 10 Mbps (common in phone networks in residential buildings)
- *Category 4* — up to 16 Mbps (mainly for token rings)
- *Category 5* (or 5e) — up to 100 Mbps (common for networks targeted for high-speed data communications)
- *Category 6* — more twists than Cat 5, up to 1 Gbps

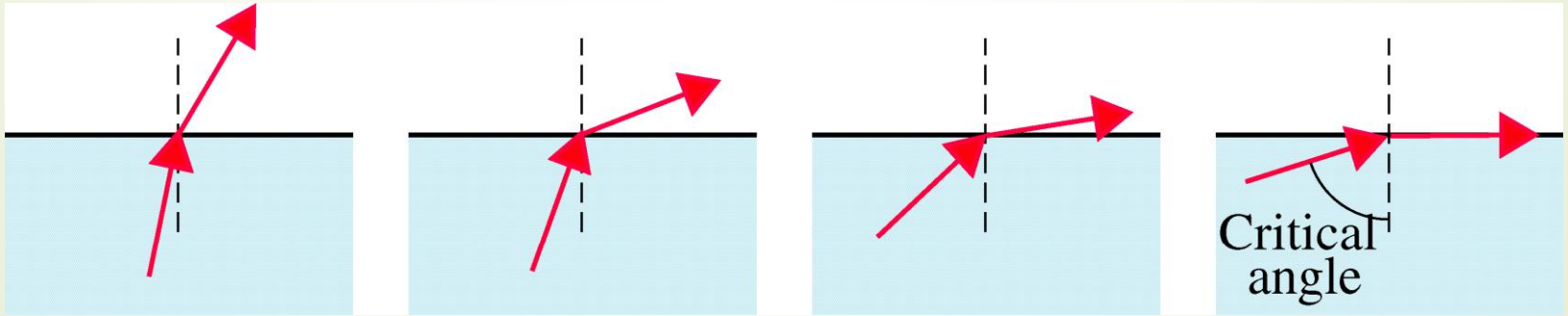
# Coaxial Cables

- In general, coaxial cables, or coax, carry signals of higher freq (100KHz–500MHz) than UTP cables
- Outer metallic wrapping serves both as a shield against noise and as the second conductor that completes the circuit



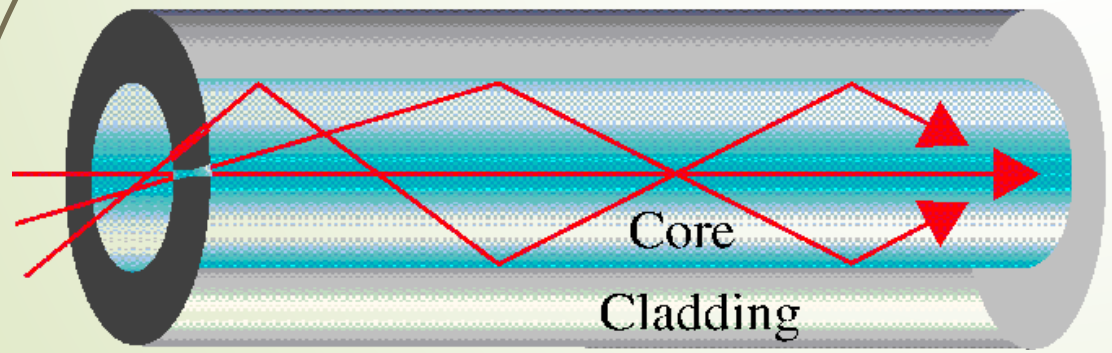
# Fiber-Optic Cables

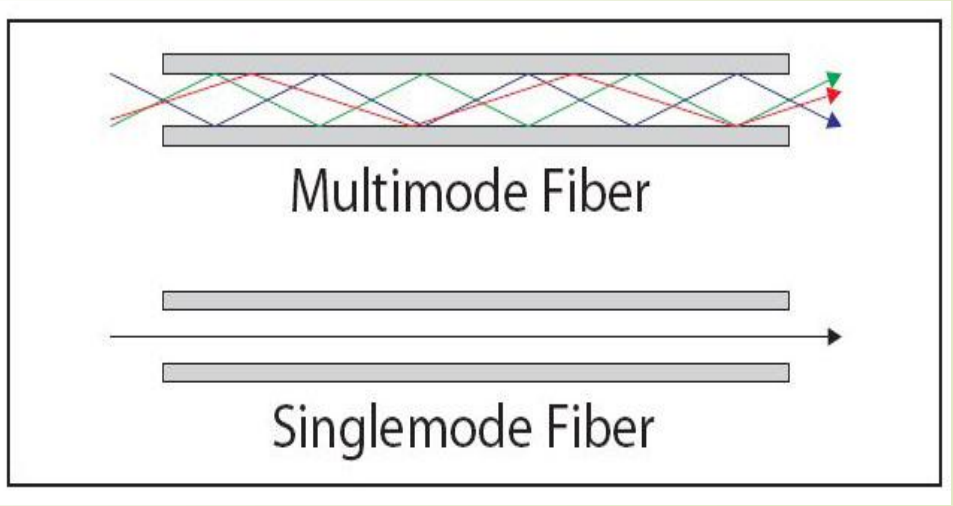
- Light travels at $3\times10^{8}\ ms^{-1}$ in free space and is the fastest possible speed in the Universe
- Light slows down in denser media, e.g. glass
- Refraction occurs at interface, with light bending away from the normal when it enters a less dense medium




- Beyond the *critical angle* ⇒ total internal reflection

- An optical fiber consists of a core (denser material) and a cladding (less dense material)
- Simplest one is a multimode step-index optical fiber
- Multimode = multiple paths,
- Light bounces back and forth along the core
- Common light sources: LEDs and lasers



# Advantages and Disadvantages

- ☺ **Noise resistance** — external light is blocked by outer jacket
- ☺ **Less signal attenuation** — a signal can run for miles without regeneration (currently, the lowest measured loss is about ~4% or 0.16dB per km)
- ☺ **Higher bandwidth** — currently, limits on data rates come from the signal generation/reception technology, not the fiber itself
- ☹ **Cost** — Optical fibers are expensive
- ☹ **Installation/maintenance** — any crack in the core will degrade the signal, and all connections must be perfectly aligned

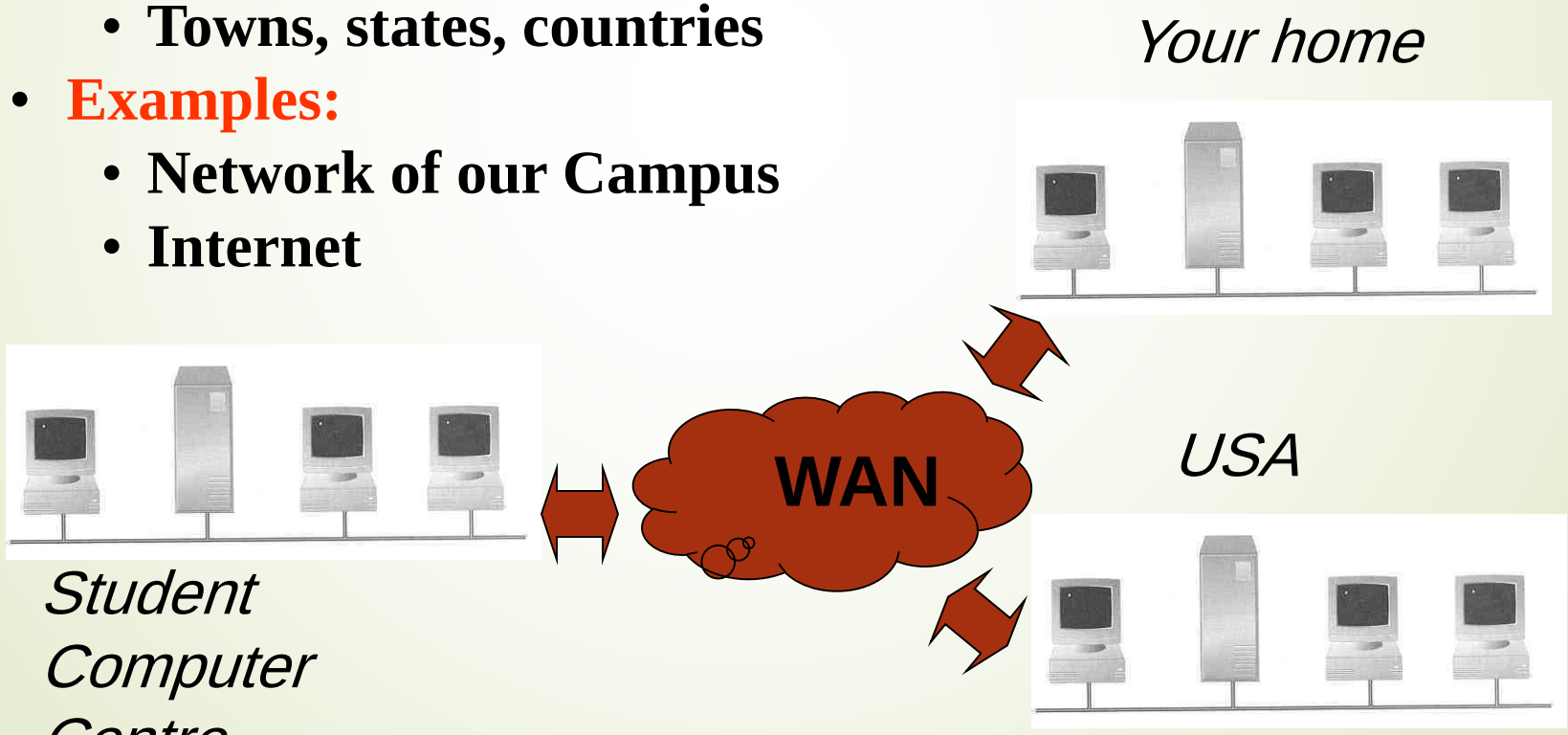
# Types Of Networks:

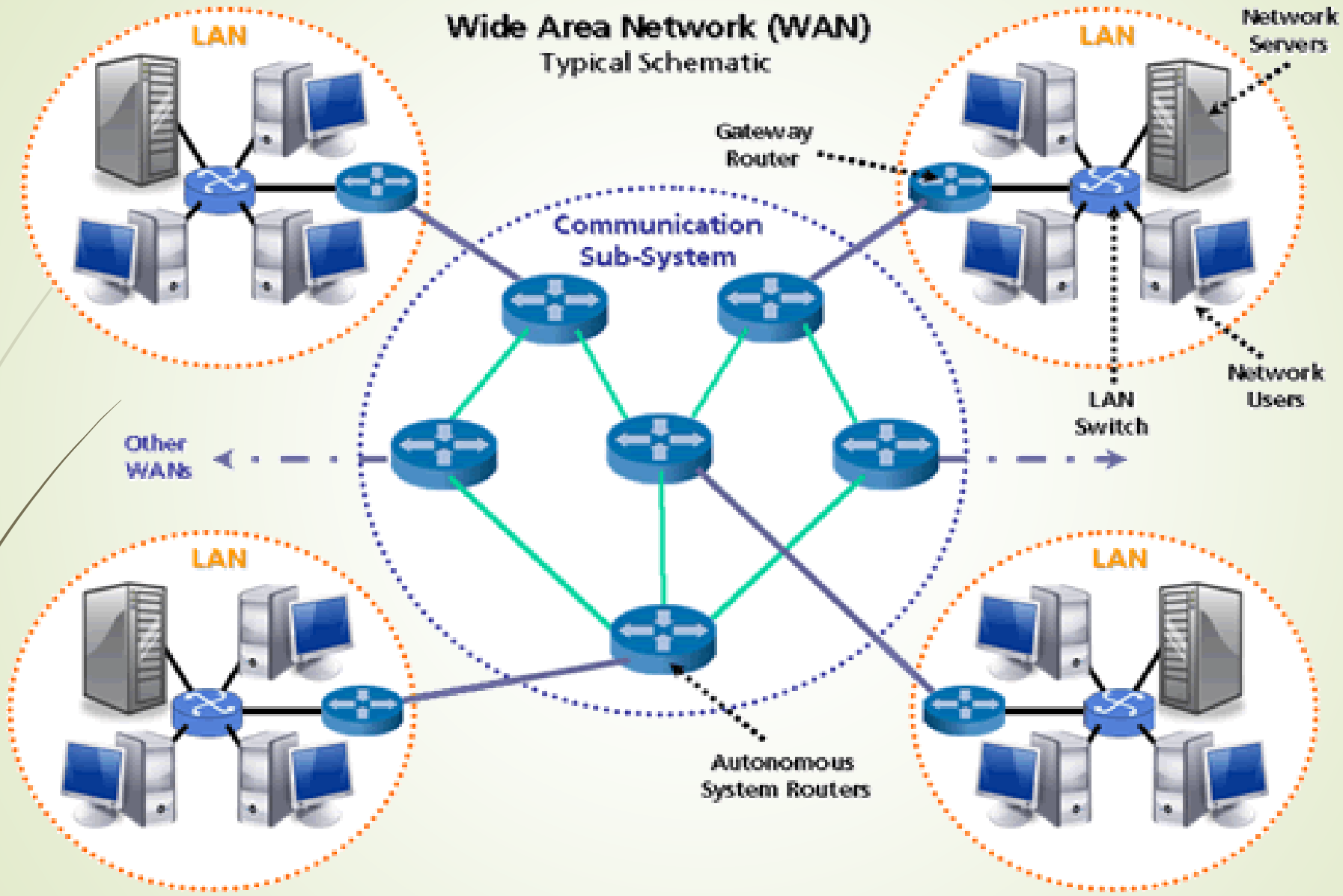
- PAN (Personal Area Network)
- LAN (Local Area Network)
- CAN (Campus Area Network)
- MAN (Metropolitan Area Network)
- WAN (Wide Area Network)
- Internetwork

# LAN and WAN

- **Local Area Network (LAN)**
  - **Small network, short distance**
    - **A room, a floor, a building**
    - **Limited by no. of computers and distance covered**
    - **Usually one kind of technology throughout the LAN**
    - **Serve a department within an organization**
  - **Examples:**
    - **Network inside the Student Computer Room**
    - **Network inside CF502**
    - **Network inside your home**

- **Wide Area Network (WAN)**
  - **A network that uses long-range telecommunication links to connect 2 or more LANs/computers housed in different places far apart.**
    - **Towns, states, countries**
  - **Examples:**
    - **Network of our Campus**
    - **Internet**



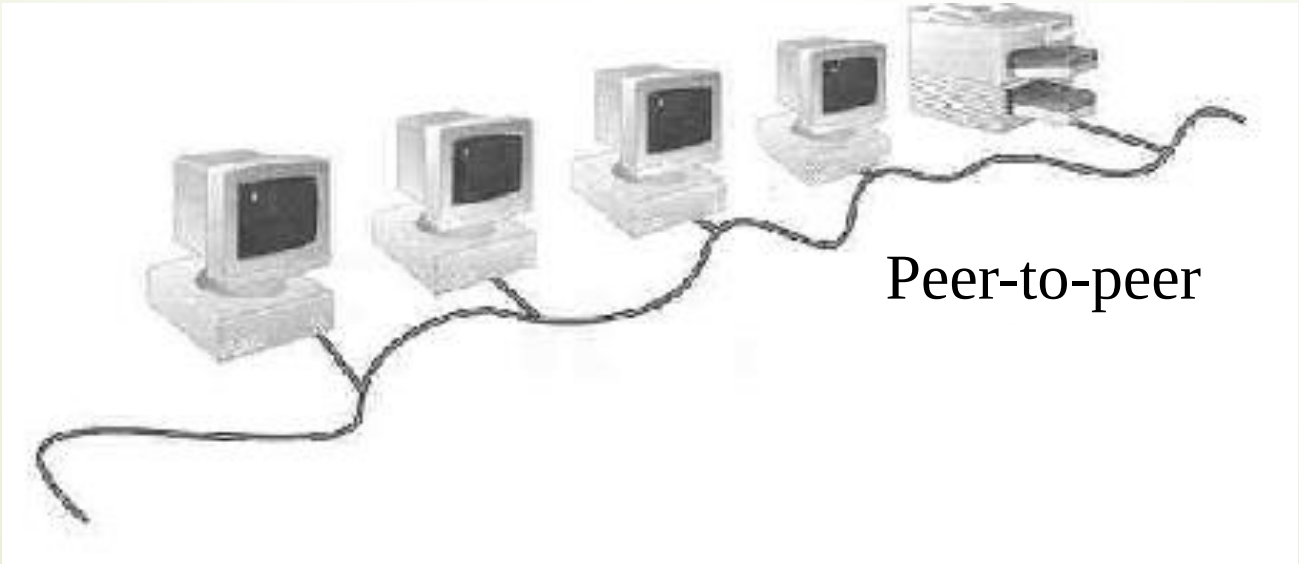

Wide Area Network (WAN)
Typical Schematic
LAN
LAN
LAN
LAN
Network Servers
Gateway Router
Communication Sub-System
LAN Switch
Network Users
Other WANs
Autonomous System Routers

# •Example WAN technologies:

- **ISDN – Integrated Service Digital Network**
  - **Basic rate: 192 Kbps  Primary rate: 1.544Mbps**
- **T-Carriers — basically digital phone lines**
  - **T1: 1.544Mbps  T3: 28×T1**
- **Frame relay**
  - **Each link offers 1.544Mbps or even higher**
- **ATM – Asynchronous Transfer Mode**
  - **Support B-ISDN: 155Mbps or 622Mbps or higher**

# Peer-to-Peer Networks

- **Peer-to-peer network is also called workgroup**
- **No hierarchy among computers ⇒ all are equal**
- **No administrator responsible for the network**



Peer-to-peer

- **Advantages of peer-to-peer networks:**
  - Low cost
  - Simple to configure
  - User has full accessibility of the computer
- **Disadvantages of peer-to-peer networks:**
  - May have duplication in resources
  - Difficult to uphold security policy
  - Difficult to handle uneven loading
- **Where peer-to-peer network is appropriate:**
  - 10 or less users
  - No specialized services required
  - Security is not an issue
  - Only limited growth in the foreseeable future

# Client And Servers

- A client is an application or system that accesses a remote service on another computer system, known as a server, by way of a network. The term was first applied to devices that were not capable of running their own stand-alone programs, but could interact with remote computers via a network. These dumb terminals were clients of the time-sharing mainframe computer.
- A server is a computer dedicated to providing one or more services over a computer network, typically through a request-response routine. These services are furnished by specialized server applications, which are designed to handle multiple concurrent requests. Examples of server applications include mail servers, file servers, web servers, and proxy servers.

# Clients and Servers

- Network **Clients** (**Workstation**)
  - Computers that request network resources or services
- Network **Servers**
  - Computers that manage and provide network resources and services to clients
    - Usually have more processing power, memory and hard disk space than clients
    - Run **Network Operating System** that can manage not only data, but also **users**, **groups**, **security**, and **applications** on the network
    - Servers often have a more stringent requirement on its **performance** and **reliability**

- **Advantages of client/server networks**
  - **Facilitate resource sharing – centrally administrate and control**
  - **Facilitate system backup and improve fault tolerance**
  - **Enhance security – only administrator can have access to Server**
  - **Support more users – difficult to achieve with peer-to-peer networks**

- **Disadvantages of client/server networks**
  - **High cost for Servers**
  - **Need expert to configure the network**
  - **Introduce a single point of failure to the system**

# Questions?