



# Computer Fundamentals

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Lecture 13



# How Networks are Structured

- Server based network
  - ❑ Node is any network device
  - ❑ Servers **control** what the node **accesses**
  - ❑ Users gain access by logging in
  - ❑ Server is the most important computer
  - ❑ E.g. file server, application server, web server, network server



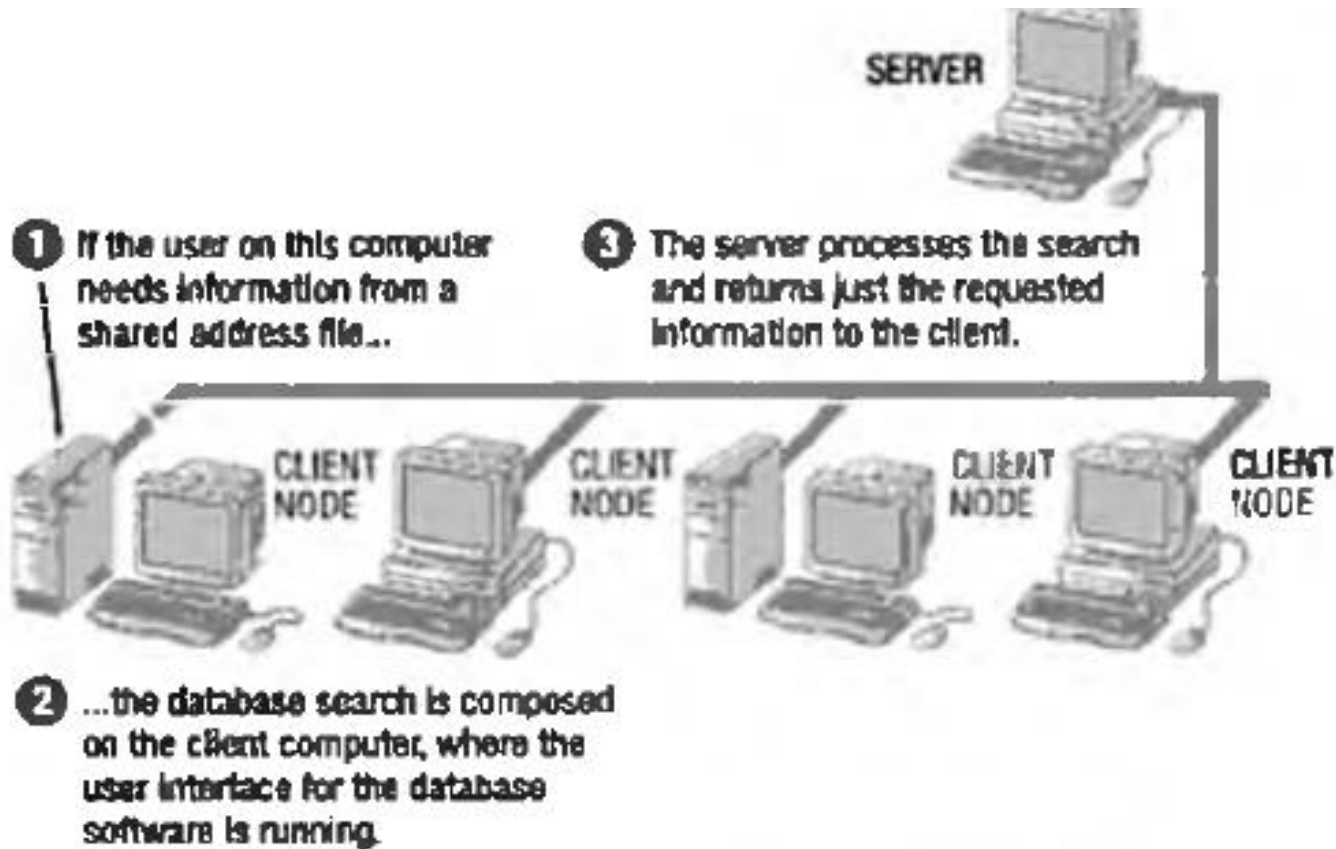
# How Networks are Structured (cont.)

## ➤ Client/Server network

- ❑ *Type of server-based network*
- ❑ Nodes and servers **share processing and storage workloads**
- ❑ Nodes are called clients
- ❑ Servers are used to control access
- ❑ Database software
  - Access to data controlled by server
- ❑ Server is the most important computer



# How Networks are Structured (cont.)





# How Networks are Structured (cont.)

- Peer to peer networks (P2PN)
  - ❑ All nodes are equal
  - ❑ Nodes connected and share resources without going through server
    - E.g. ad-hoc network
  - ❑ Nodes access resources on other nodes
  - ❑ Each node controls its own resources
  - ❑ Most modern OS allow P2PN
  - ❑ Distributed computing is a form
    - Use processing power of other computers



# Network Topologies

- **Topology**
  - ❑ Layout of wires and equipment
  - ❑ Choice affects
    - Network performance
    - Network size
    - Network collision detection
  - ❑ Several different types
    - Logical
    - Physical



# Network Topologies (cont.)

## ➤ Packets

- ❑ Pieces of data transmitted over a network
  - Packets are created by sending node
  - Data is reassembled by receiving node
- ❑ Packet header
  - Sending and receiving address
- ❑ Packet payload
  - Number and size of data
  - Actual data
- ❑ Packet error control
  - Optional



# Network Topologies (cont.)

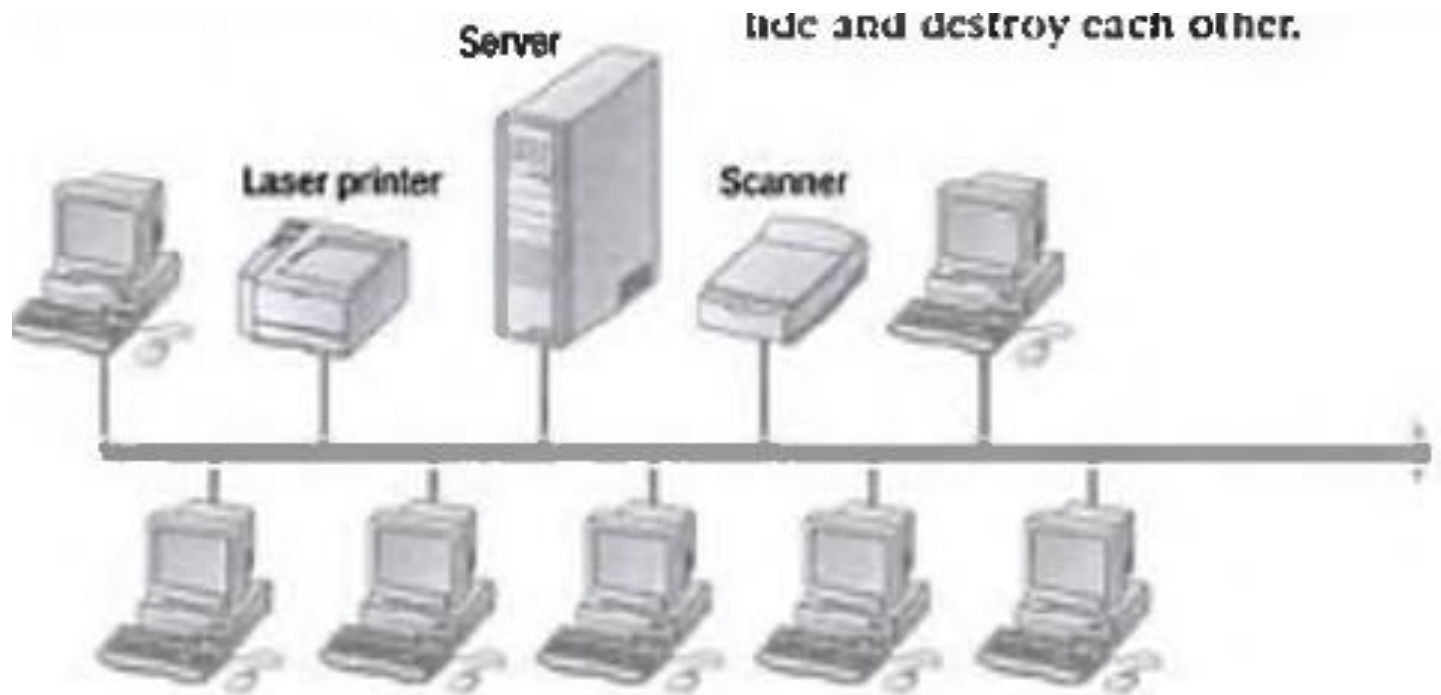
## ➤ Bus topology

- ❑ Also called linear bus
- ❑ One wire connects all nodes
- ❑ Terminator ends the wires
- ❑ Advantages
  - Easy to setup
  - Small amount of wire
- ❑ Disadvantages
  - Slow
  - Easy to crash





# Network Topologies (cont.)





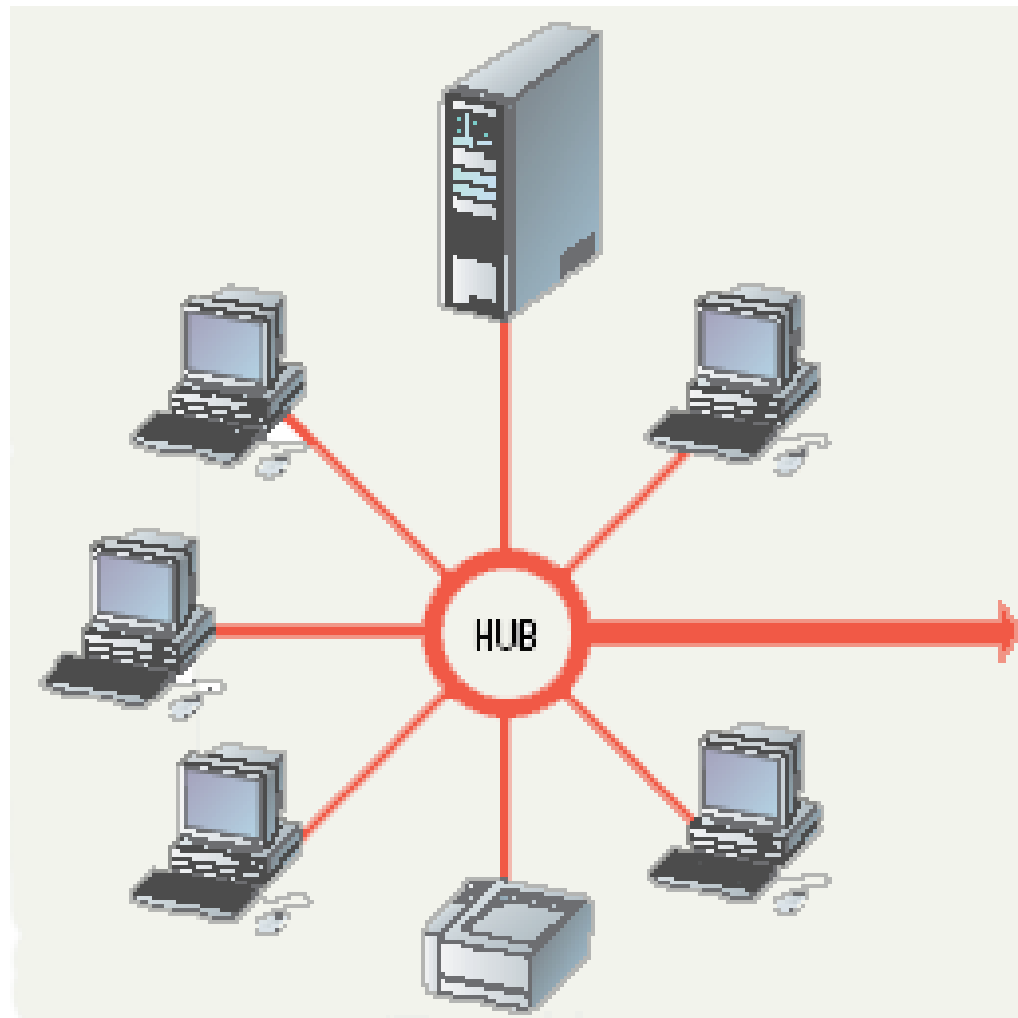
# Network Topologies (cont.)

## ➤ Star topology

- ❑ All nodes connect to a hub
  - Packets sent to hub
  - Hub sends packet to destination
- ❑ Advantages
  - Easy to setup
  - One cable can not crash network
- ❑ Disadvantages
  - One hub crashing downs entire network
  - Uses lots of cable
- ❑ Most common topology



# Network Topologies (cont.)





# Network Topologies (cont.)

## ➤ Ring topology

- ❑ Nodes connected in a circle
- ❑ Tokens used to transmit data
  - Nodes must wait for token to send
- ❑ Advantages
  - Time to send data is known
  - No data collisions
- ❑ Disadvantages
  - Slow
  - Lots of cable



# Network Topologies (cont.)

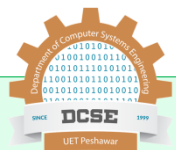




# Network Topologies (cont.)

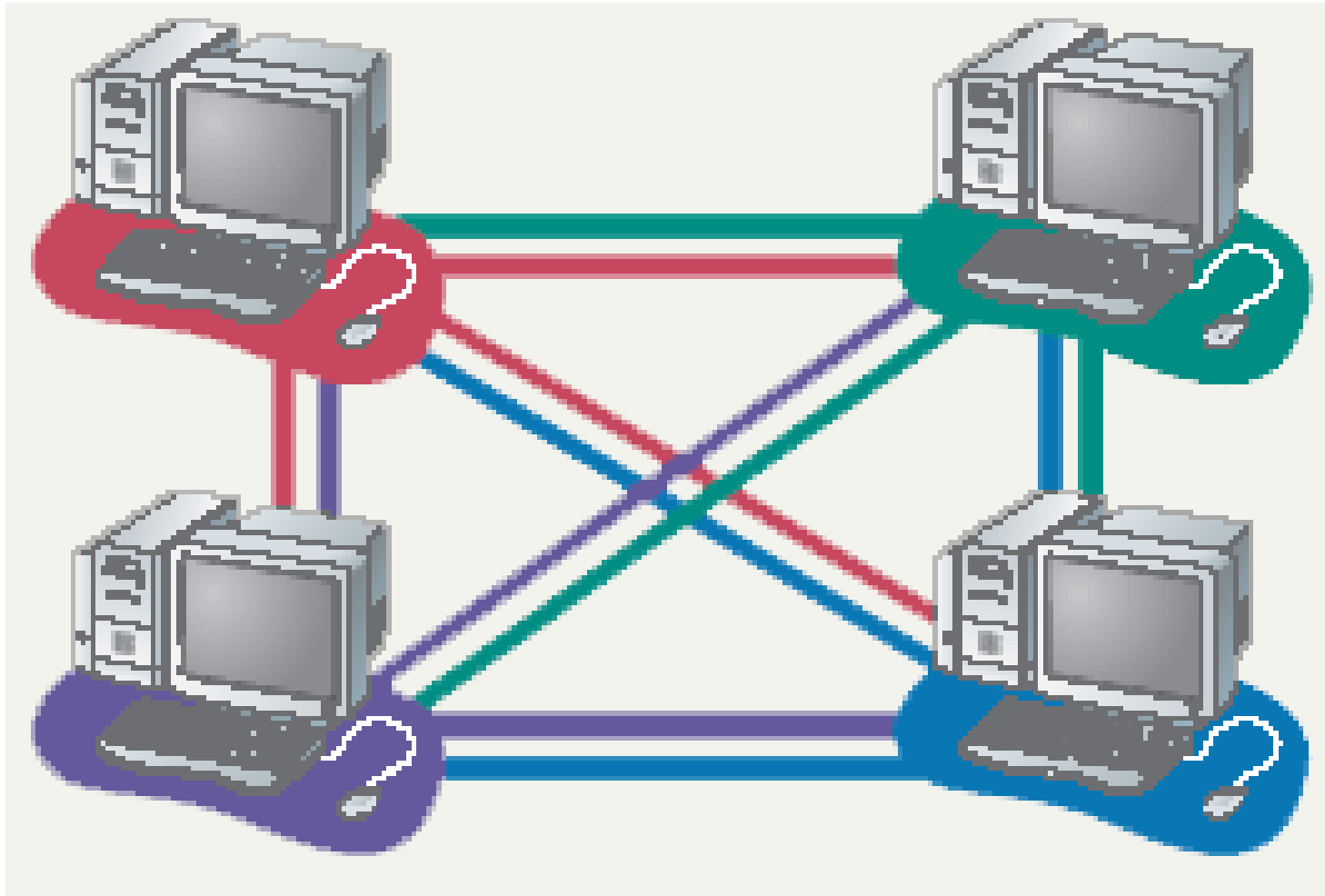
- Mesh topology
  - ❑ All computers connected together
    - $n(n-1)/2$  full duplex links required<sup>1</sup>
  - ❑ Advantage
    - Data will always be delivered
  - ❑ Disadvantages
    - Lots of cable
    - Hard to setup

Source: Shehzad, Batch 19, DCSE, UET Peshawar



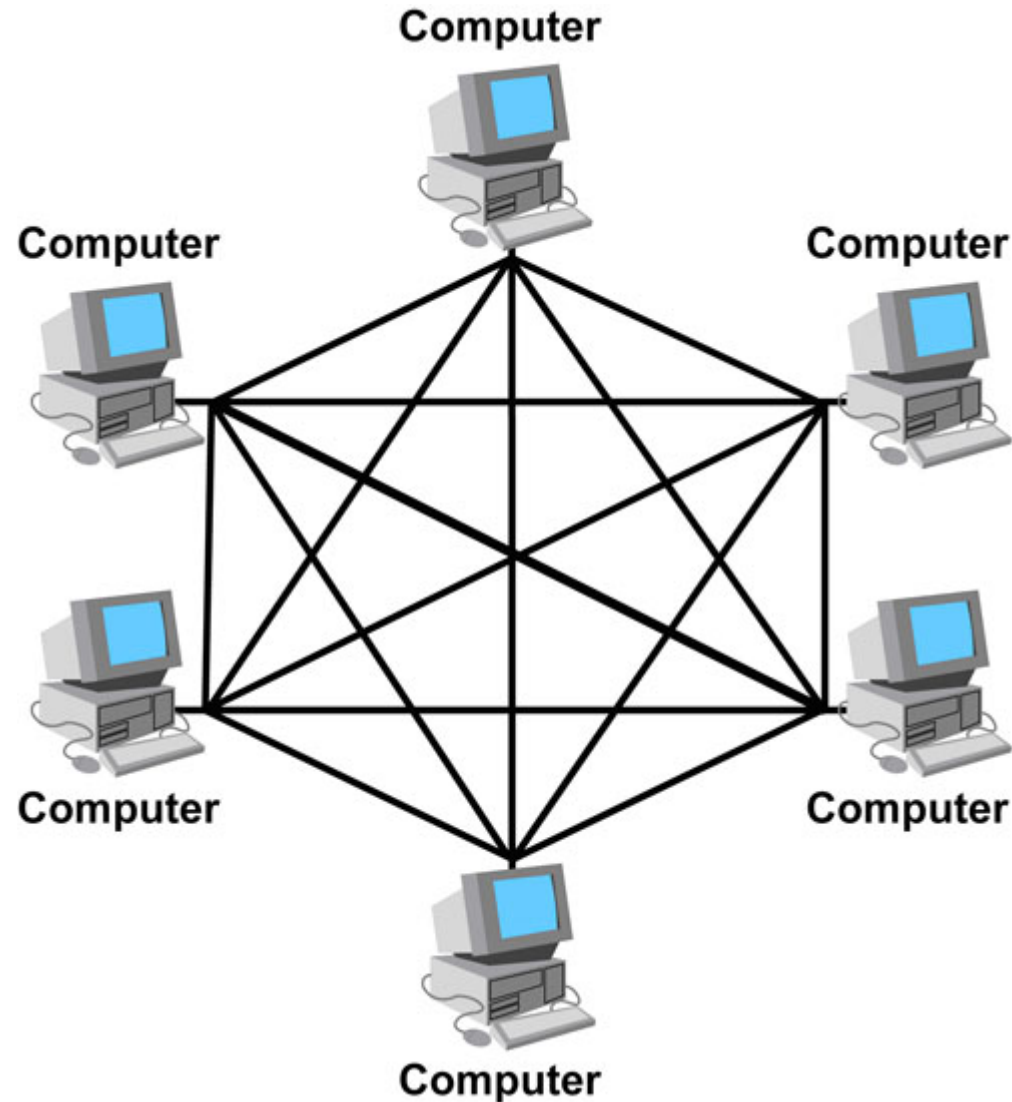


# Network Topologies (cont.)





# Network Topologies (cont.)

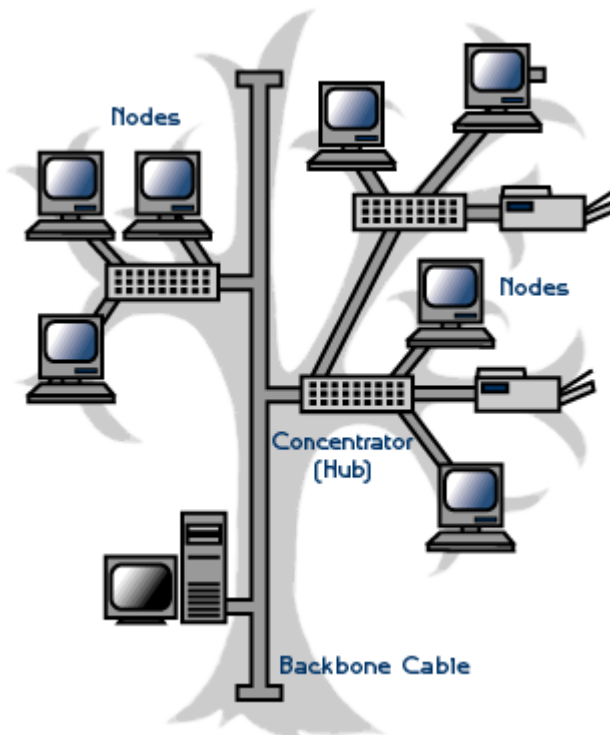






# Network Topologies (cont.)

- Tree topology
  - ❑ Combination of characteristics of star and bus topology





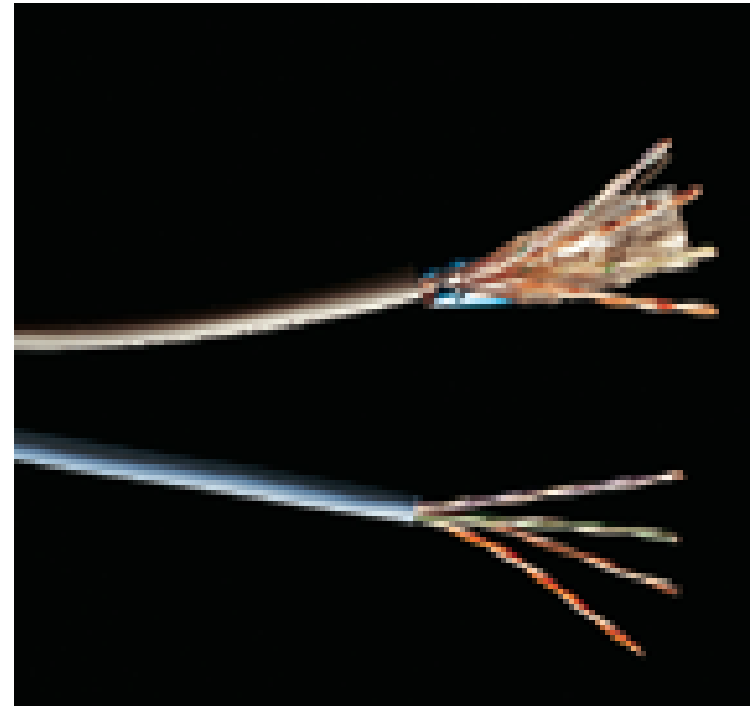
# Network Media

- Network links
  - ☐ Connect network nodes
- Choice of media impacts
  - ☐ Speed
  - ☐ Security
  - ☐ Size



# Wire Based Media

- Twisted-pair cabling
  - ❑ Most common LAN cable
  - ❑ Called Cat5 or 100BaseT
  - ❑ Four pairs of copper cable twisted
  - ❑ May be shielded from interference
  - ❑ Speeds range
    - 1 Mbps to 1,000 Mbps

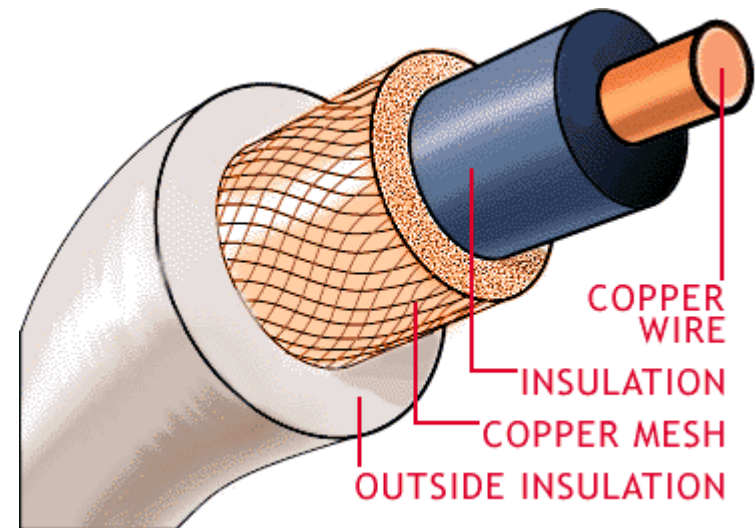




# Wire Based Media (cont.)

## ➤ Coaxial cable

- ❑ Similar to cable TV wire
- ❑ One wire runs through cable
- ❑ Shielded from interference
- ❑ Speeds up to 10 Mbps
- ❑ Nearly **obsolete**





# Wire Based Media (cont.)

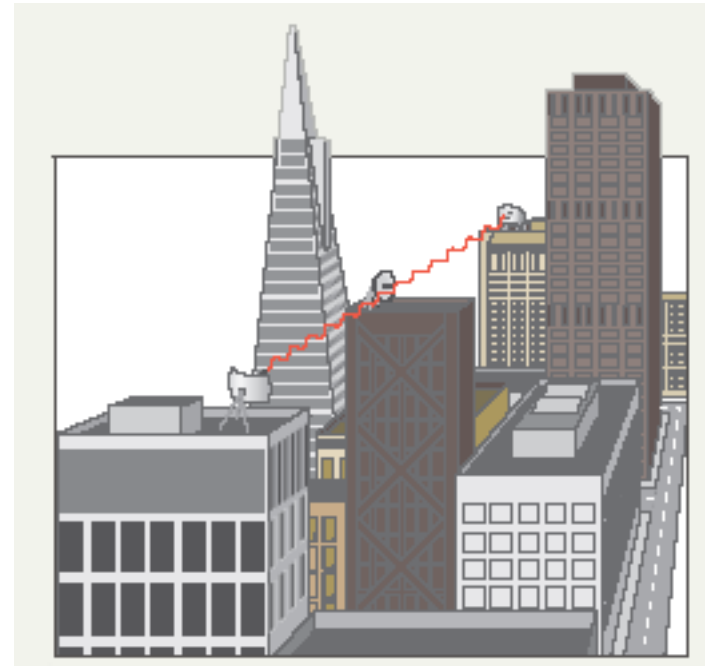
- Fiber-optic cable
  - ❑ Data is transmitted with light pulses
  - ❑ Glass strand instead of cable
  - ❑ Immune to interference
  - ❑ Very secure
  - ❑ Hard to work with
  - ❑ Speeds up to 100 Gbps





# Wireless Media

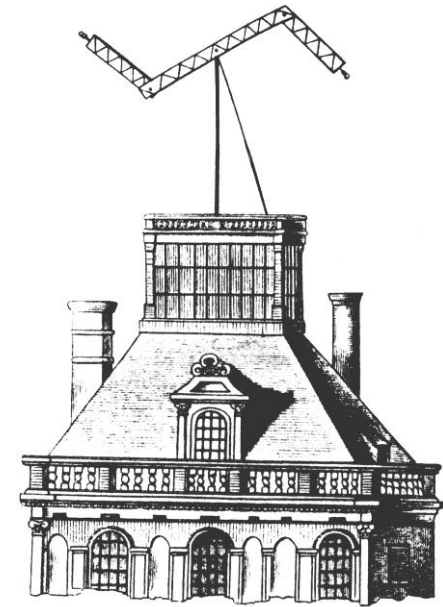
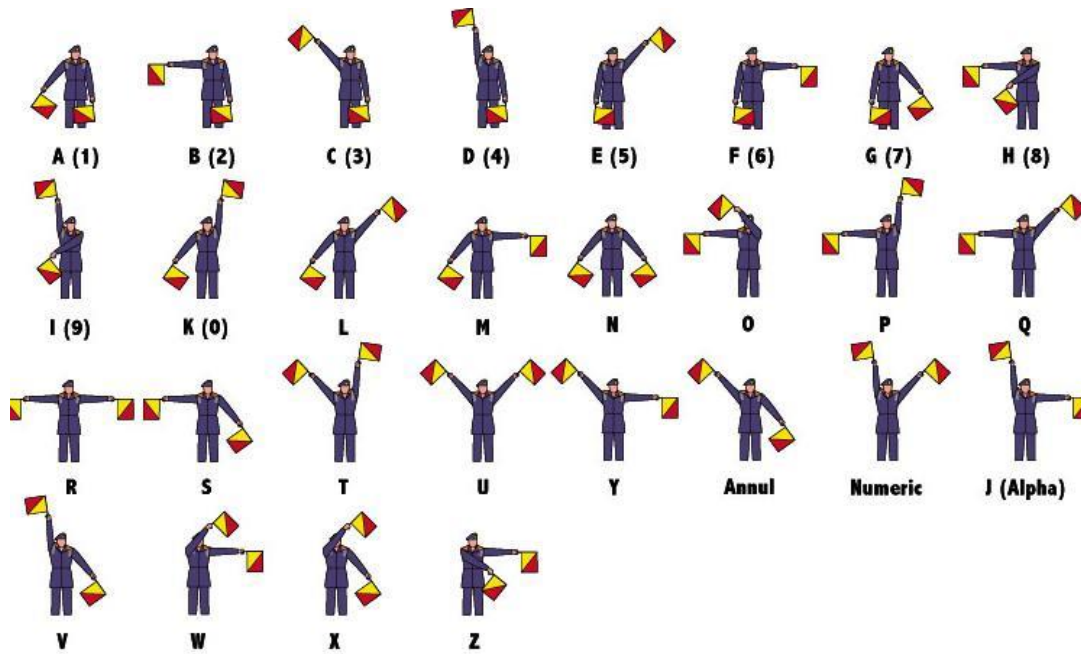
- Data transmitted through air
- LANs use radio waves
- WANs use satellites and microwave signals
- Easy to setup
- Difficult to secure





# History

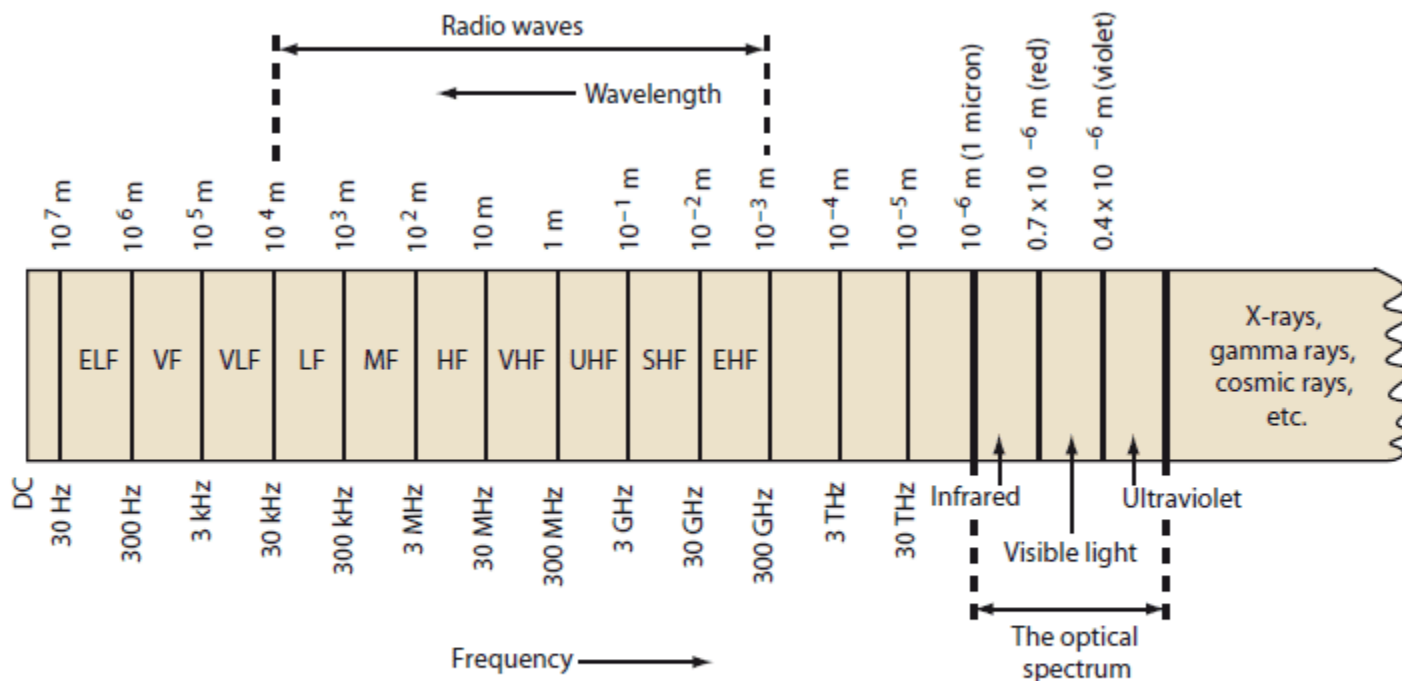
- Light for communication
  - ❑ Torches, flags (semaphore), ...
  - ❑ Signaling towers of Han-Dynasty in China (206 BC - 24 AD)
  - ❑ Smoke signals for communication in Greece (150 BC)
  - ❑ Optical telegraph of Claude Chappe (1794 esp. French Revolution)



Source: <https://cflagexpressions.wordpress.com/2010/03/23/history-behind-semaphore-flags>



# Frequency Spectrum



1. The electromagnetic frequency spectrum ranges from dc to light. The lower radio frequencies are designated mainly by frequency. The optical ranges are referred to by wavelength.

ELF = Extremely Low Frequency, VF = Voice Frequency, VLF = Very Low Frequency, LF = Low Frequency, MF = Medium Frequency, HF = High Frequency, VHF = Very High Frequency, UHF = Ultra High Frequency, SHF = Super High Frequency, EHF = Extremely High Frequency

Frequency and wavelength:  $\lambda = c/f$

With wavelength  $\lambda$ , speed of light  $c = 3 \times 10^8 \text{ m/s}$ , frequency  $f$

Source: <http://electronicdesign.com/communications/understanding-solutions-crowded-electromagnetic-frequency-spectrum>





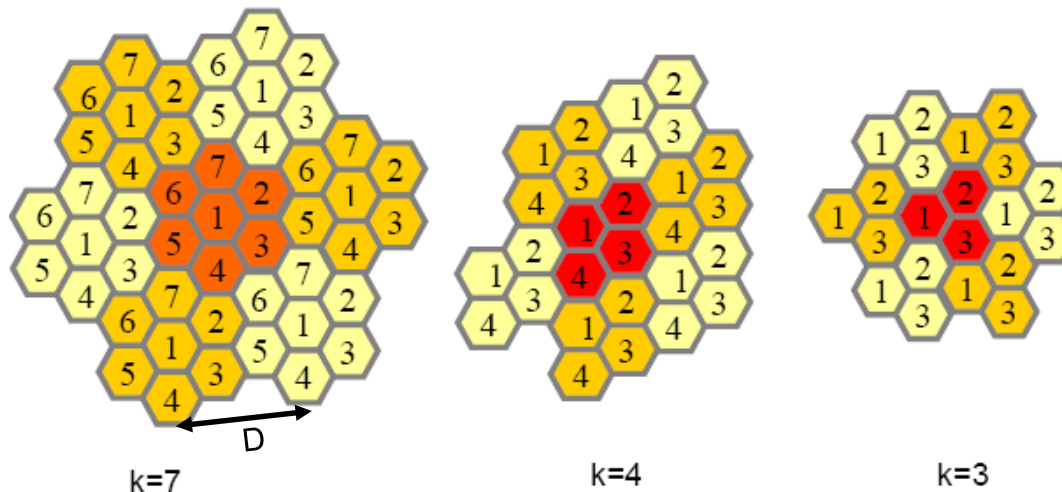
# Mobile Networks

## ➤ Cellular principle

- ❑ Segmentation of coverage area in smaller areas (Bell Labs patent 1972)

## ➤ Spatial frequency reuse

- ❑ Modelling of cells as hexagons
- ❑ Every cell uses a particular frequency
- ❑ Frequency reuse factor,  $k$  (also called cluster size)
- ❑ Adjacent cells should use a different frequency
- ❑ Frequency reuse separation,  $D$



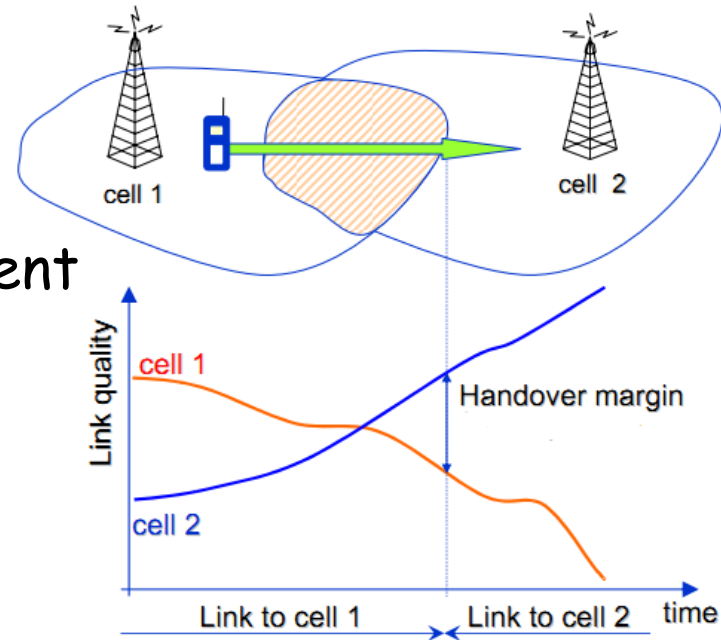
$$D = R\sqrt{3k}$$

Source: Dr. U. Türke, *UMTS-3G Mobile Communication Systems*, University of Bremen



# Mobile Networks (cont.)

- Handover
  - ❑ Handoff to another base station
- Mandatory handover
  - ❑ Distance too large
  - ❑ Receive level too low
- Handover for performance improvement
  - ❑ Better receive level of adjacent cell
  - ❑ High traffic load
- Threshold for handover
  - ❑ Avoid ping-pong effect



Source: <http://telecommunicationengineeringconcepts.blogspot.com/2012/05/gsm-handoverhandoff.html>