



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



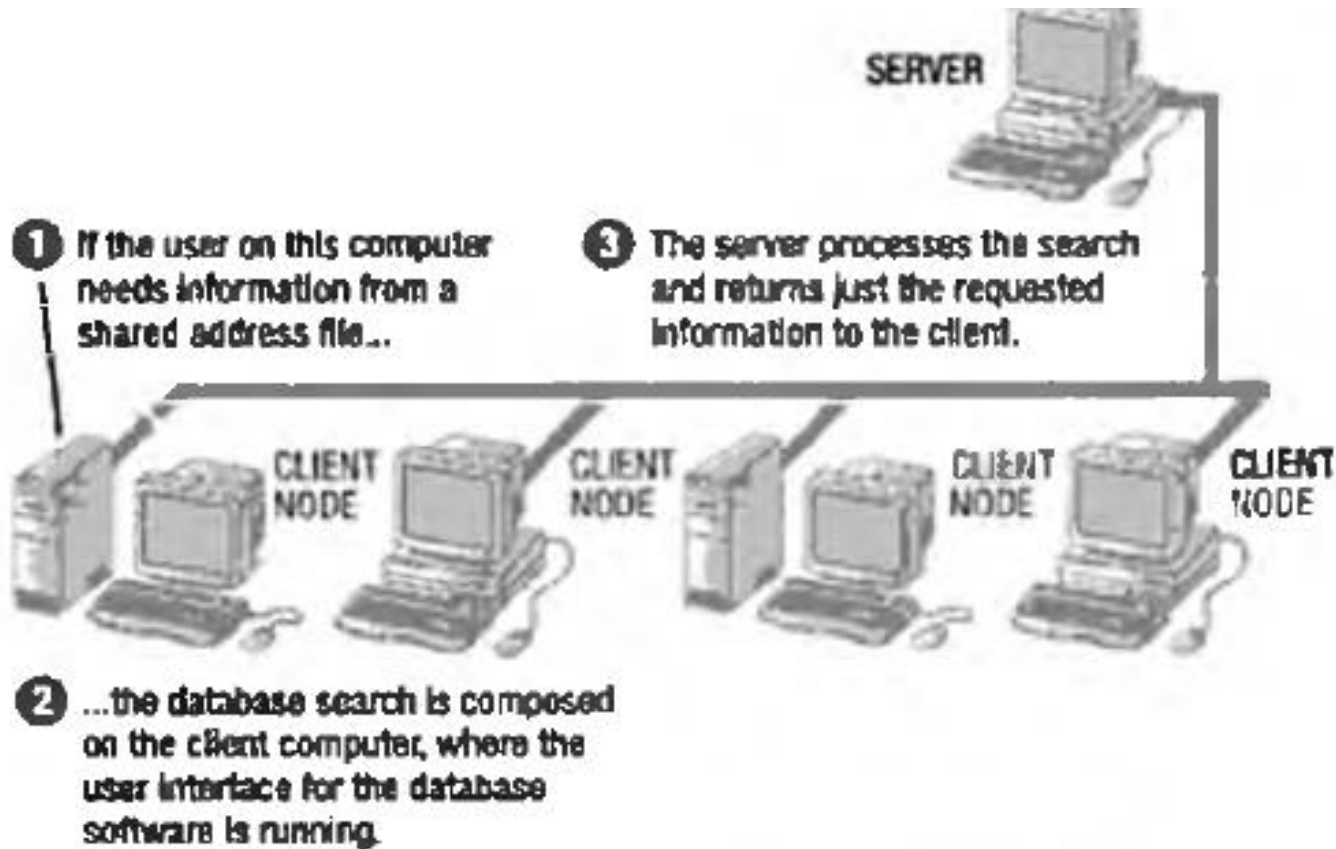
How Networks are Structured (cont.)

➤ 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



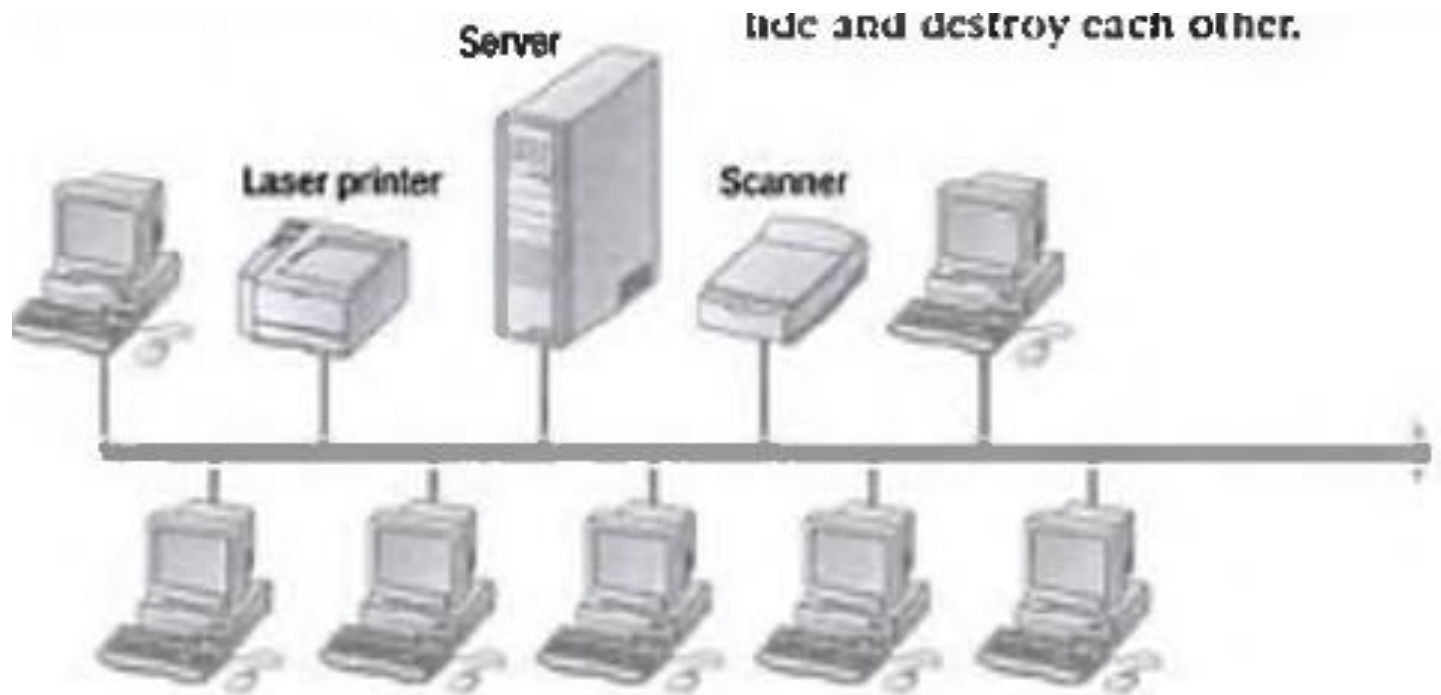
Network Topologies (cont.)

➤ 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.)





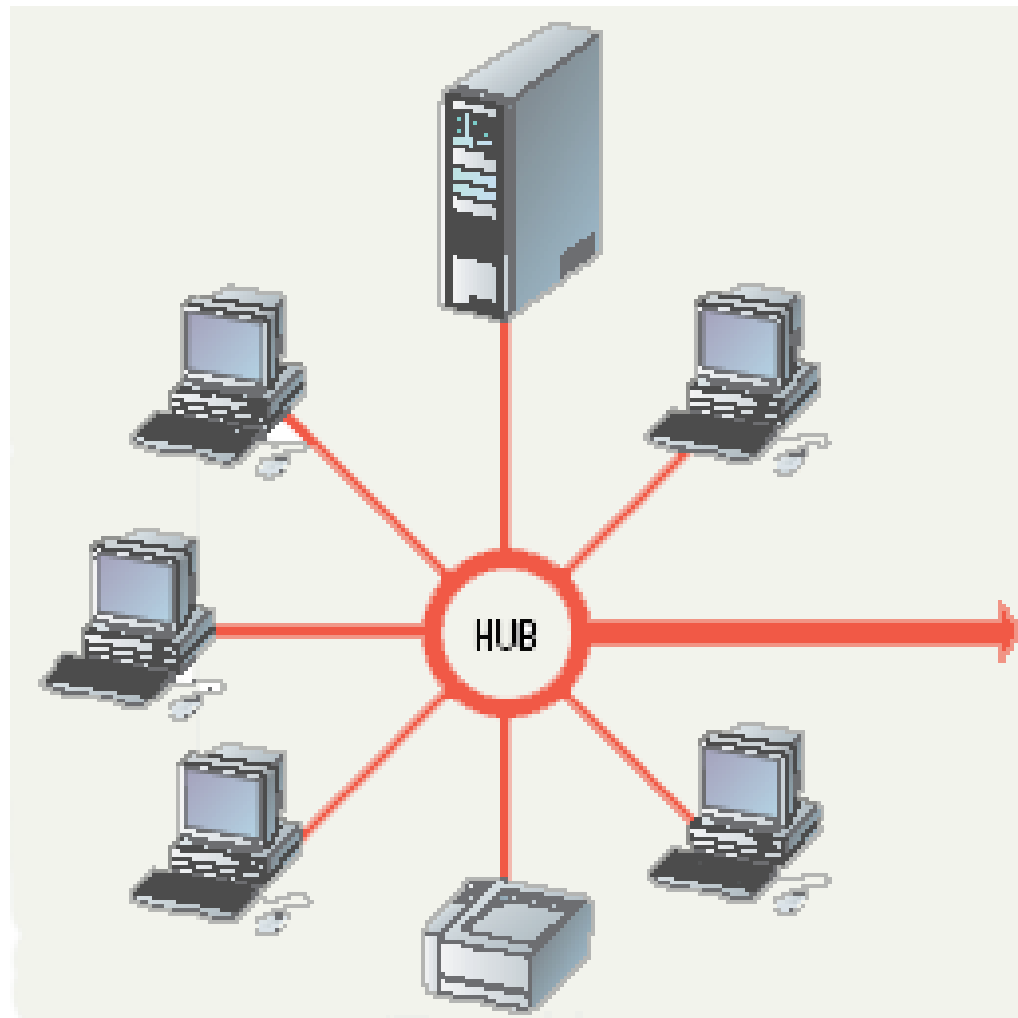
Network Topologies (cont.)

➤ 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.)

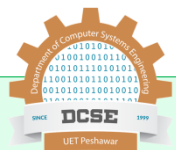




Network Topologies (cont.)

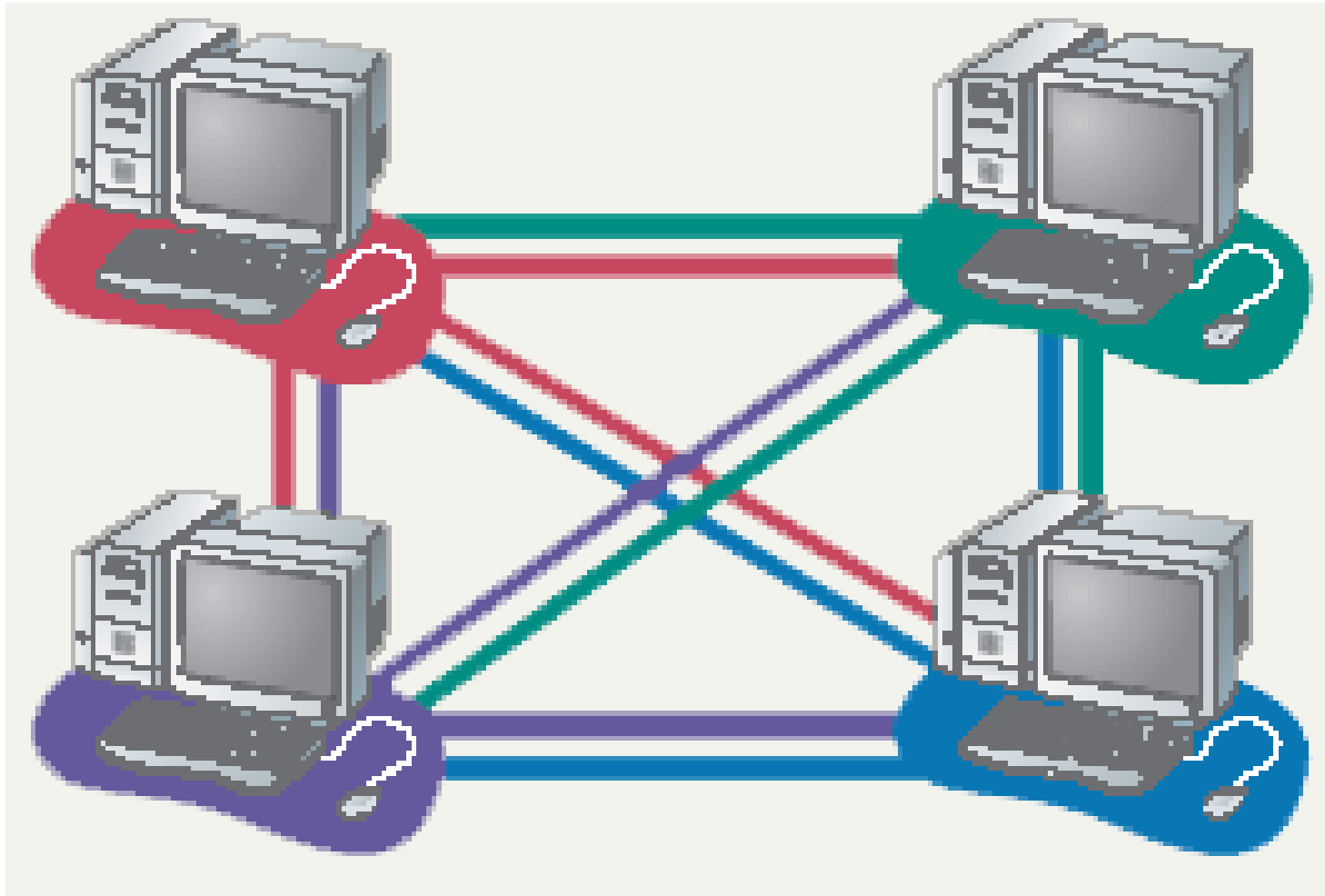
- Mesh topology
 - ❑ All computers connected together
 - $n(n-1)/2$ full duplex links required¹
 - ❑ Advantage
 - Data will always be delivered
 - ❑ Disadvantages
 - Lots of cable
 - Hard to setup

Source: Shehzad, Batch 19, DCSE, UET Peshawar



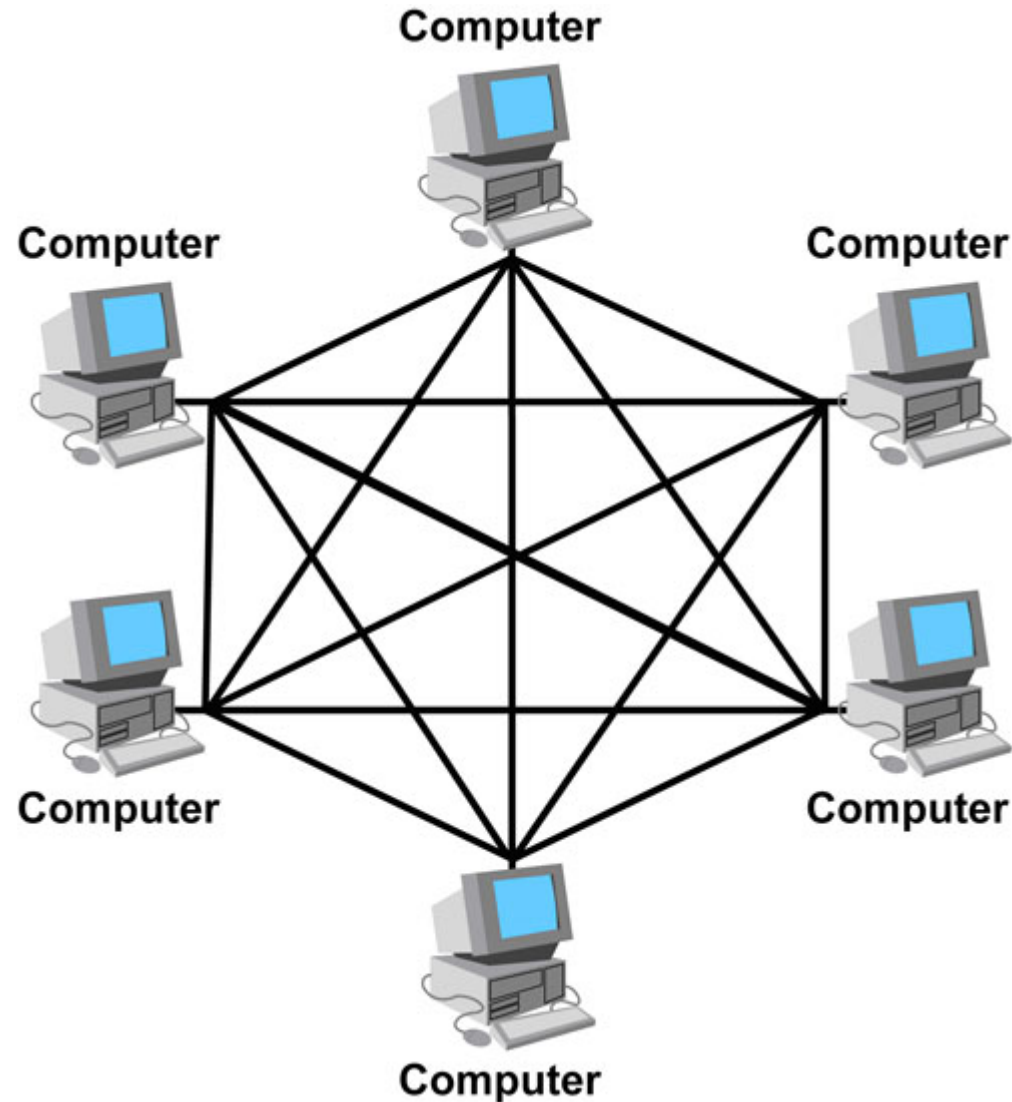


Network Topologies (cont.)





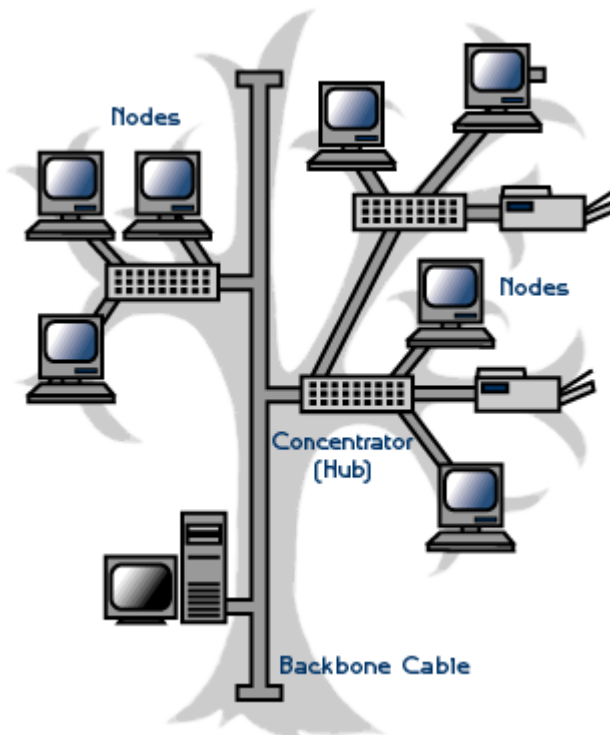
Network Topologies (cont.)





Network Topologies (cont.)

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





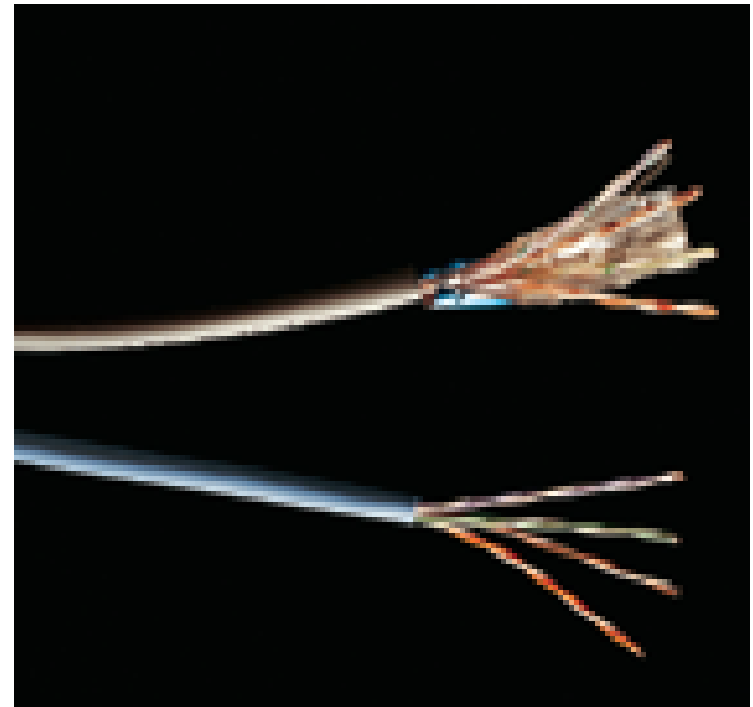
Network Media

- 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

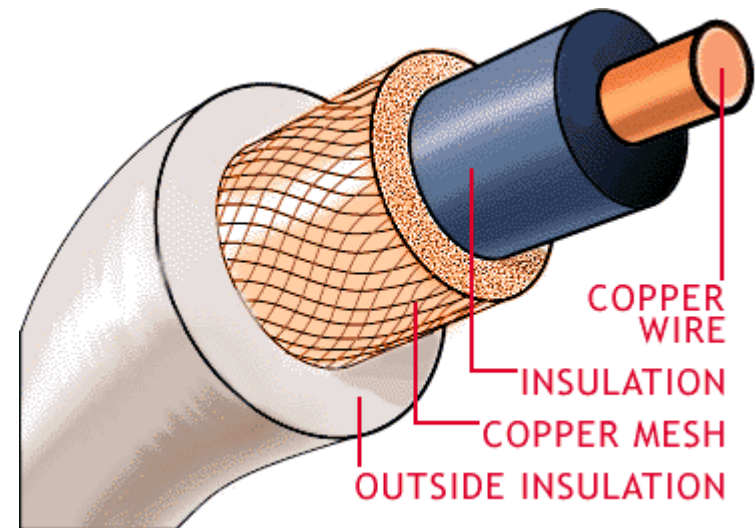




Wire Based Media (cont.)

➤ 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.)

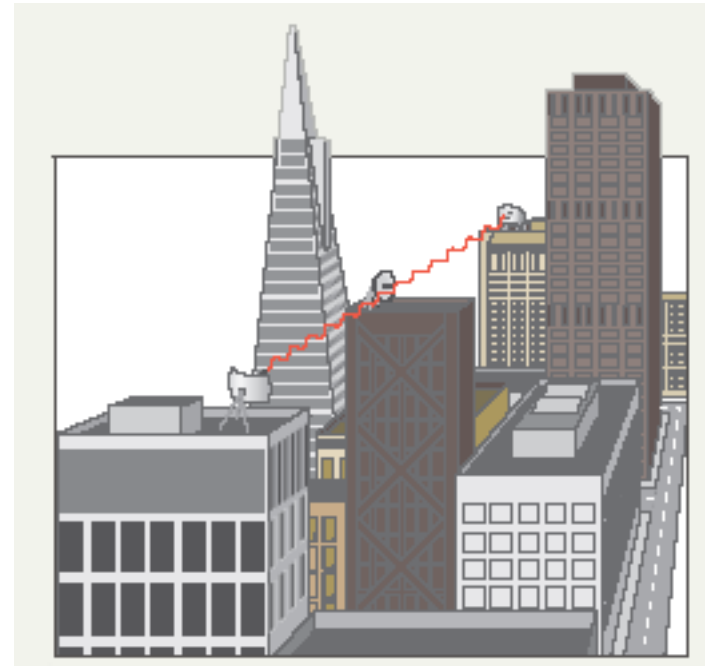
- Fiber-optic cable
 - ❑ Data is transmitted with light pulses
 - ❑ Glass strand instead of cable
 - ❑ Immune to interference
 - ❑ Very secure
 - ❑ Hard to work with
 - ❑ Speeds up to 100 Gbps





Wireless Media

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

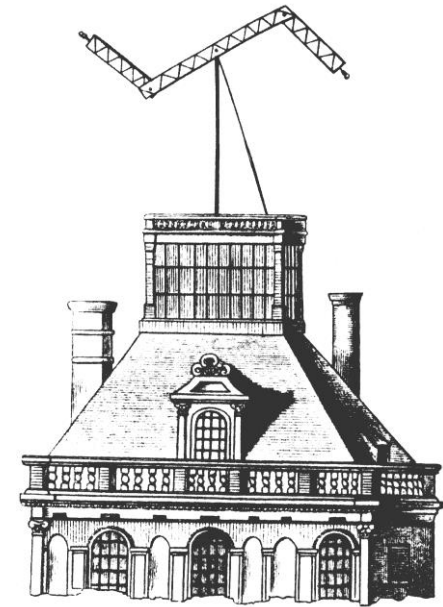
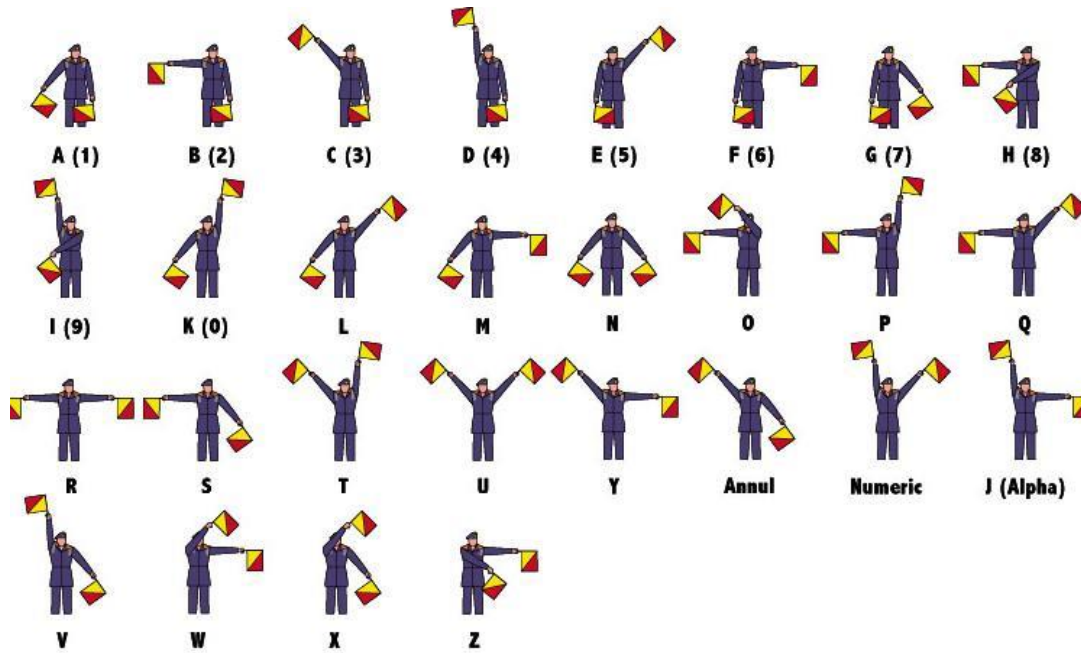




History

➤ Light for communication

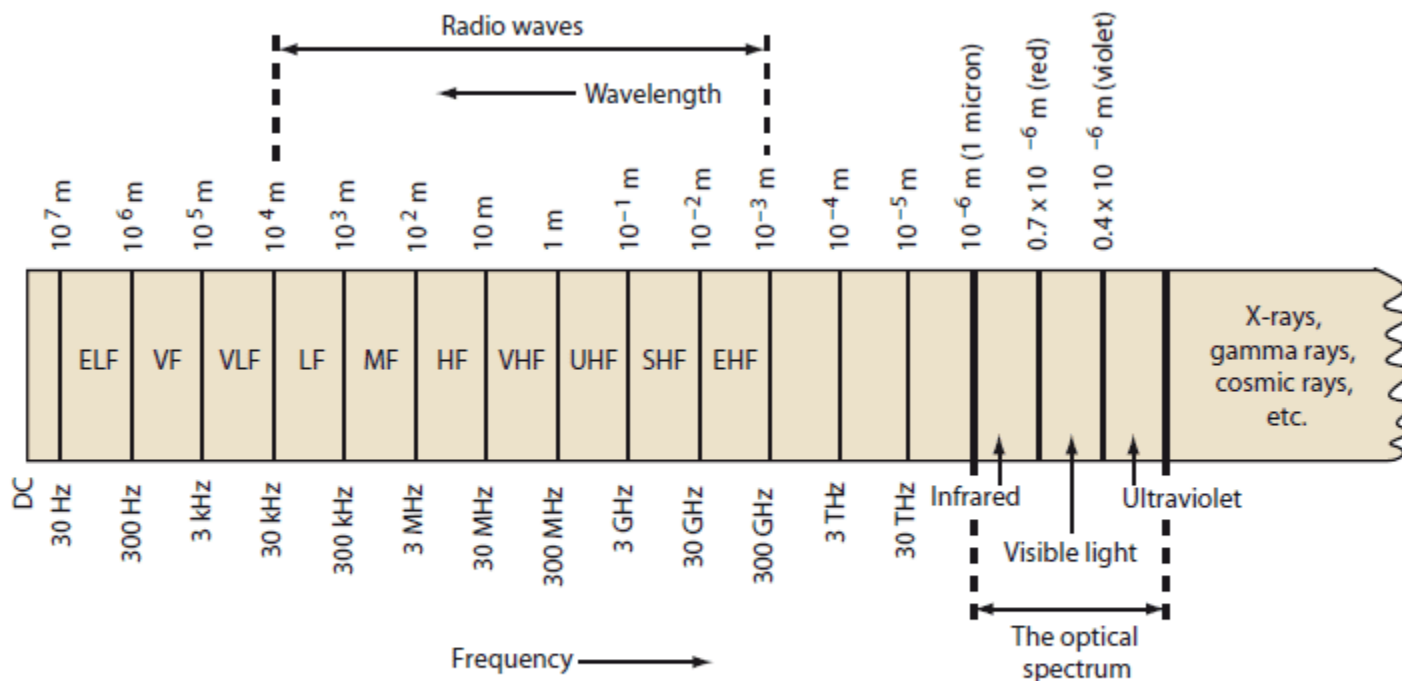
- ❑ Torches, flags (semaphore), ...
- ❑ Signaling towers of Han-Dynasty in China (206 BC - 24 AD)
- ❑ Smoke signals for communication in Greece (150 BC)
- ❑ Optical telegraph of Claude Chappe (1794 esp. French Revolution)



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

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



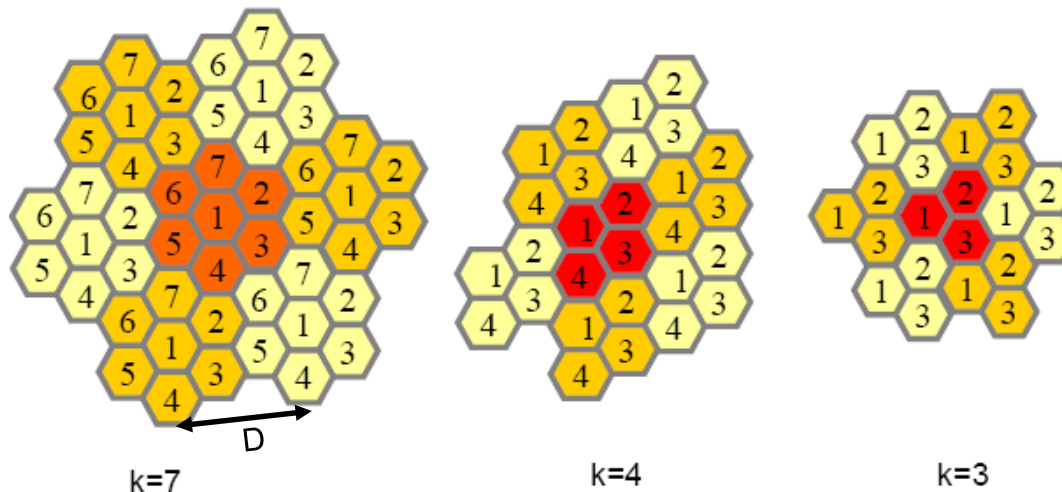
Mobile Networks

➤ 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



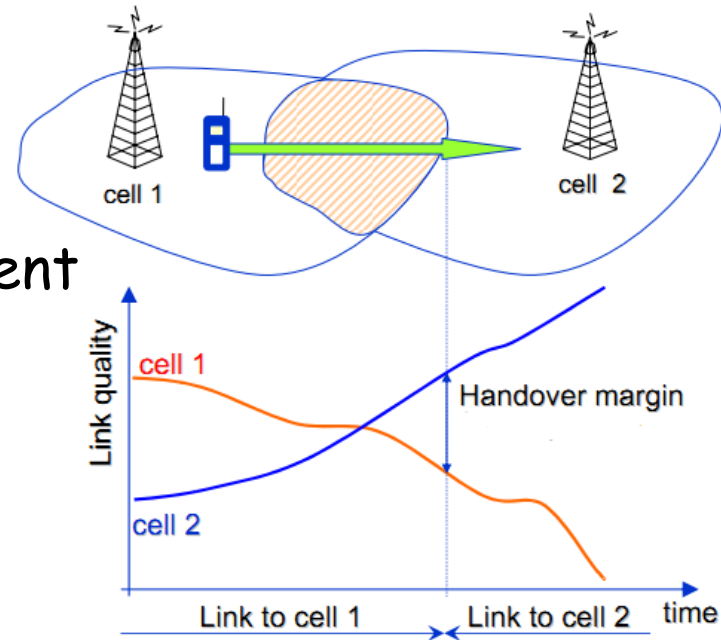
$$D = R\sqrt{3k}$$

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>