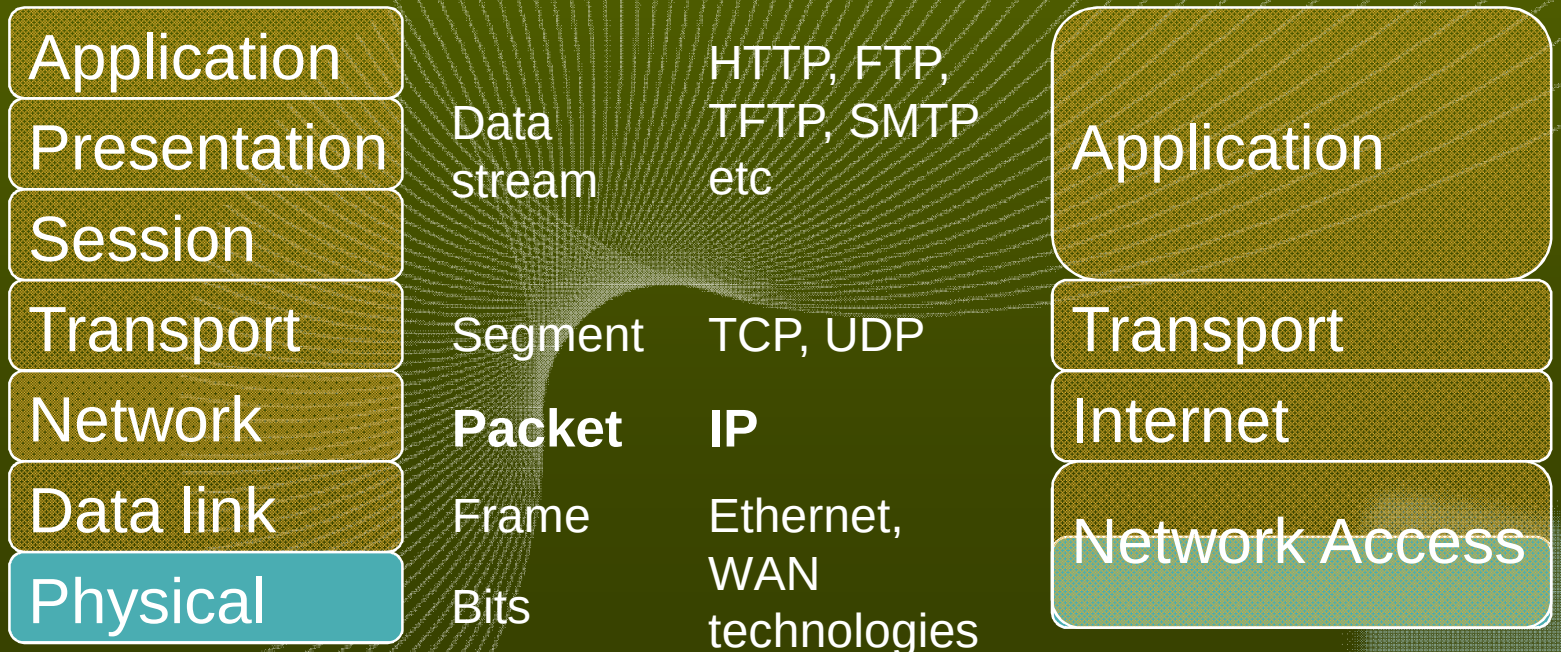
INSTITUT TEKNOLOGI TELKOM

Physical Layer and Cabling

OSI Physical layer

- OSI model layer 1
- TCP/IP model part of Network Access layer

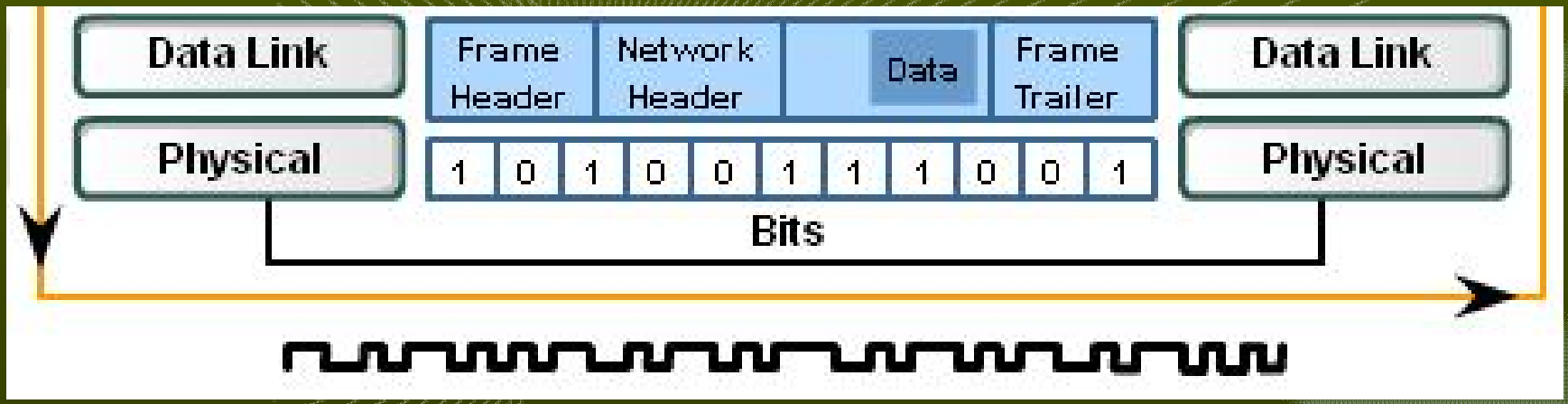


Physical layer topics

- Physical layer protocols and services.
- Physical layer signaling and encoding.
- How signals are used to represent bits. Characteristics of copper, fiber, and wireless media.
- Describe uses of copper, fiber, and wireless network media.

Physical layer tasks

- Takes frame from data link layer
- Sees the frame as bits – no structure
- Encodes the bits as signals to go on the medium



Physical layer standards

Set by engineering institutions

- **The International Organization for Standardization (ISO)**
- **The Institute of Electrical and Electronics Engineers (IEEE)**
- **The American National Standards Institute (ANSI)**
- **The International Telecommunication Union (ITU)**
- **The Electronics Industry Alliance / Telecommunications Industry Association (EIA/TIA)**

Digital Bandwidth

- The amount of data that could flow across a network segment in a given length of time.
- Determined by the properties of the medium and the technology used to transmit and detect signals.
- Basic unit is bits per second (bps)
- 1 Kbps = 1,000 bps, 1Mbps = 1,000,000 bps
  1 Gbps = 1,000,000,000 bps

Throughput and Goodput

- Throughput is the actual rate of transfer of bits at a given time
- Varies with amount and type of traffic, devices on the route etc.
- Always lower than bandwidth
- Goodput measures usable data transferred, leaving out overhead. (headers etc.)

Media

- Copper cable (twisted pair and coaxial)
- Fibre optic cable
- Wireless

Coaxial cable

- Central conductor
- Insulation
- Copper braid acting as return path for current and also as shield against interference (noise)
- Outer jacket

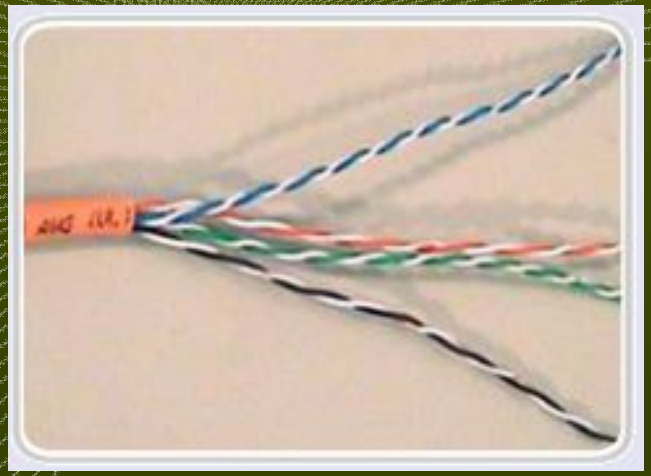
Connectors for coaxial cable

Coaxial cable

- Good for high frequency radio / video signals
- Used for antennas / aerials
- Used for cable TV and Internet connections, often now combined with fibre optic.
- Formerly used in Ethernet LANs – died out as UTP was cheaper and gave higher speeds

Unshielded twisted pair (UTP) cable

- 8 wires twisted together into 4 pairs and with an outer jacket.
- Wires have colour-coded plastic jackets
- Commonly used for Ethernet LANs



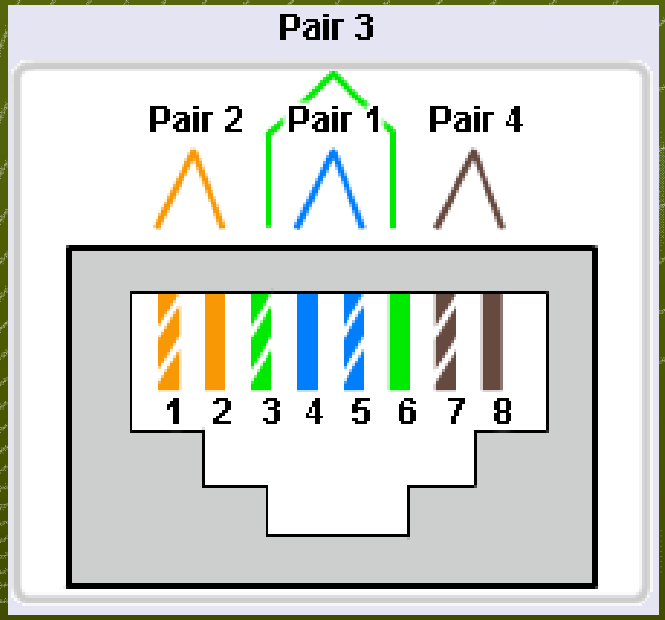
RJ45 connectors

Plugs on patch cables (crimped)

Sockets to terminate installed cabling (punch down)

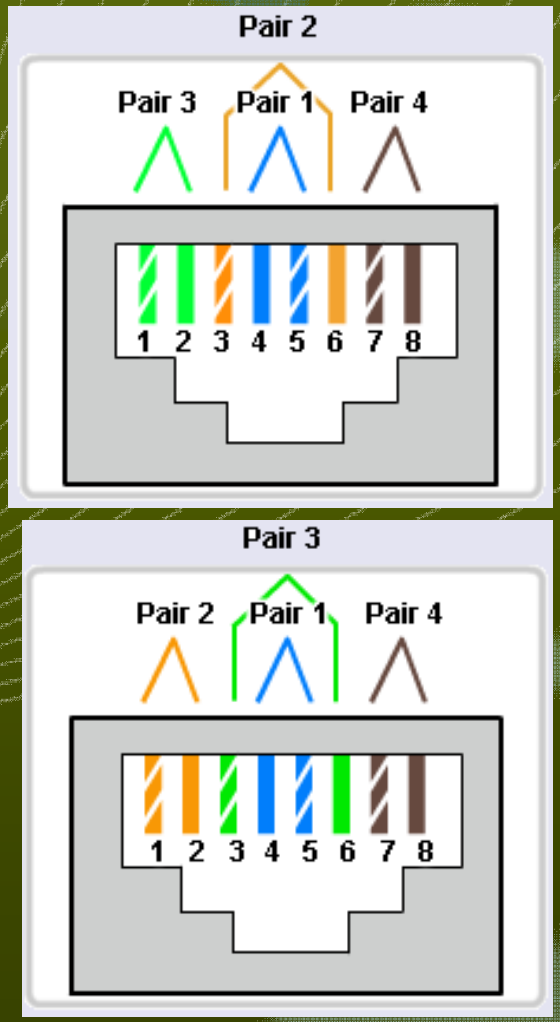
Straight through cable

- Both ends the same
- Connect PC to switch or hub
- Connect router to switch or hub
- Installed cabling is straight through



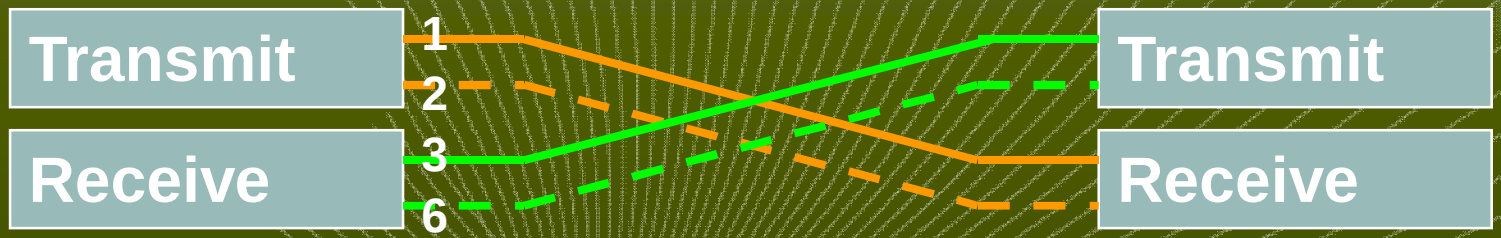
Crossover cable

- Wire 1 swaps with 3
- Wire 2 swaps with 6
- Connect similar devices to each other
- Connect PC direct to router



Why cross over?

- **Transmit needs to connect to receive**



- The crossing over can happen in the cable or inside a device.

Where is the cross over?

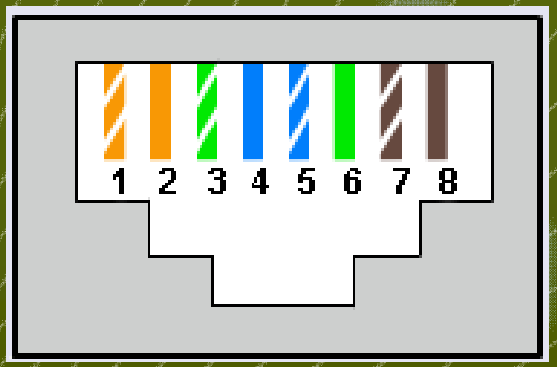
- **Switches and hubs have ports that manage the cross over inside**

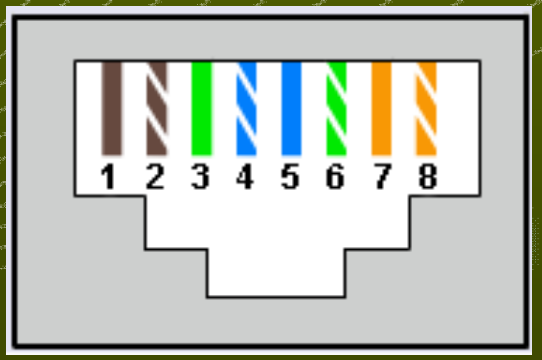
- **PCs and routers have ports where there is no crossover inside**

- Straight through cable needed if you link a device in one group to a device in the other group
- Crossover cable needed if you link devices in the same group

Rollover cable

- Cisco proprietary
- Wire order completely reversed
- Console connection from PC serial port to router – to configure router
- Special cable or RJ45 to D9 adaptor.



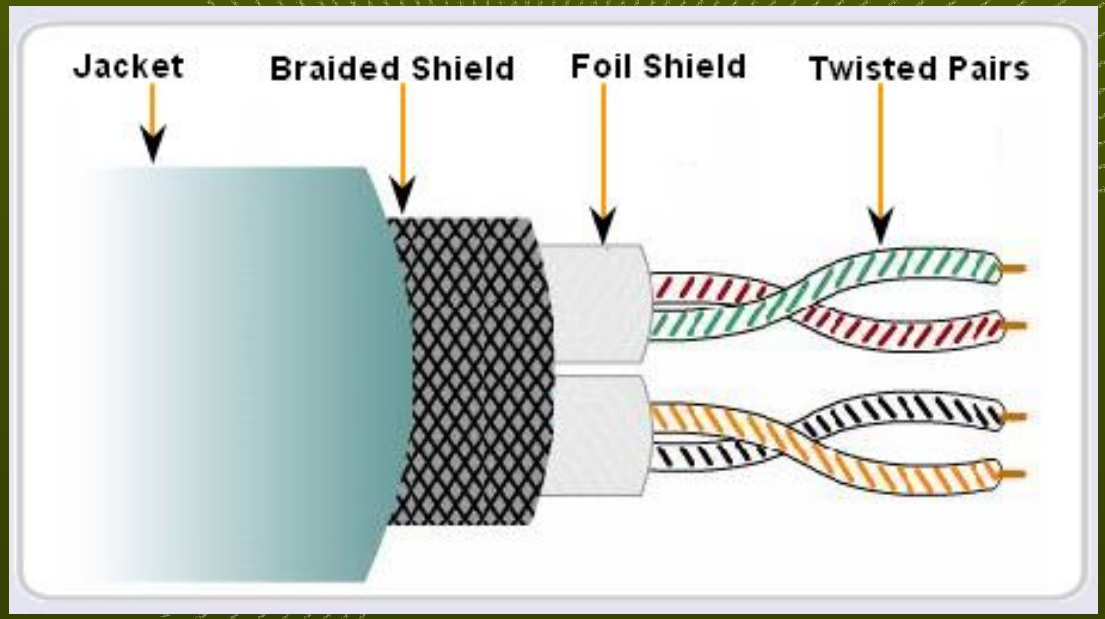


UTP cable

- EIA/TIA sets standards for cables
- Category 5 or higher can be used for 100Mbps Ethernet. Cat 5e can be used for Gigabit Ethernet if well installed.
- We have Cat 5e. A new installation now would have Cat 6.
- The number of twists per metre is carefully controlled.

Shielded twisted pair (STP)

- Wires are shielded against noise
- Much more expensive than UTP
- Might be used for 10 Gbps Ethernet



Noise

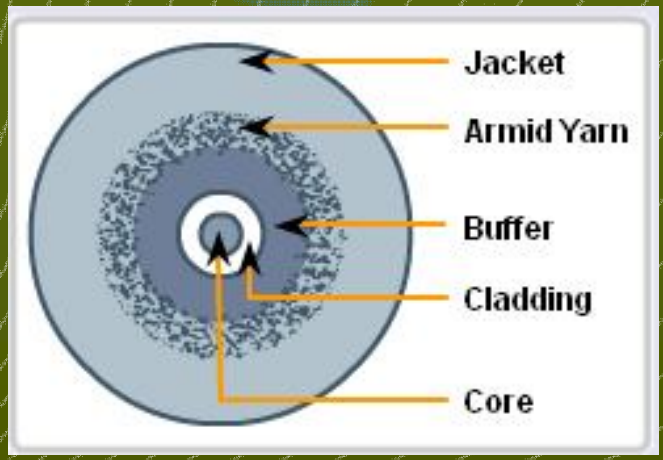
- Electrical signals on copper cable are subject to interference (noise)
- Electromagnetic (EMI) from device such as fluorescent lights, electric motors
- Radio Frequency (RFI) from radio transmissions
- Crosstalk from other wires in the same cable or nearly cables

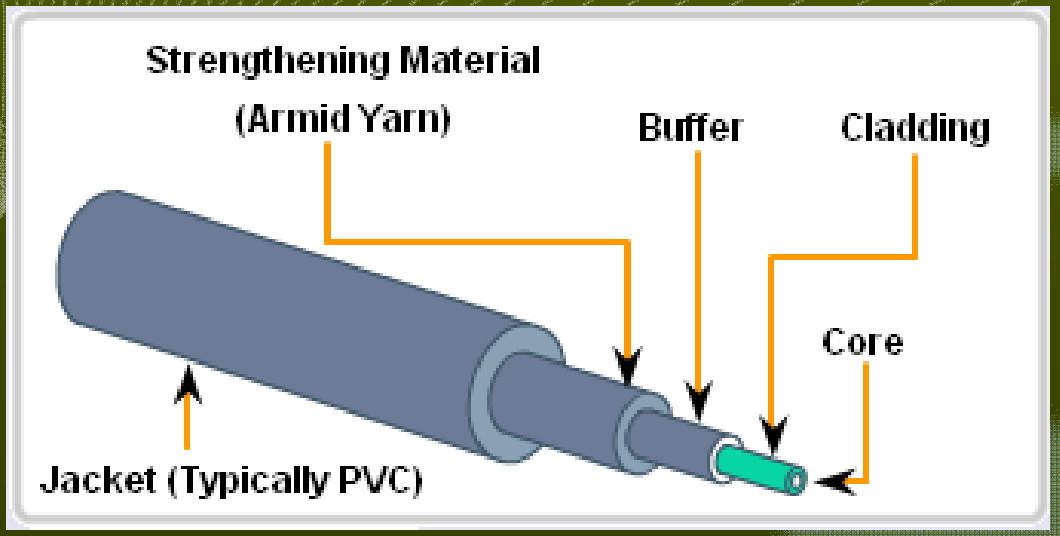
Avoiding noise problems

- Metal shielding round cables
- Twisting of wire pairs gives cancelling effect
- Avoiding routing copper cable through areas liable to produce noise
- Careful termination – putting connectors on cables correctly

Fibre optic cable

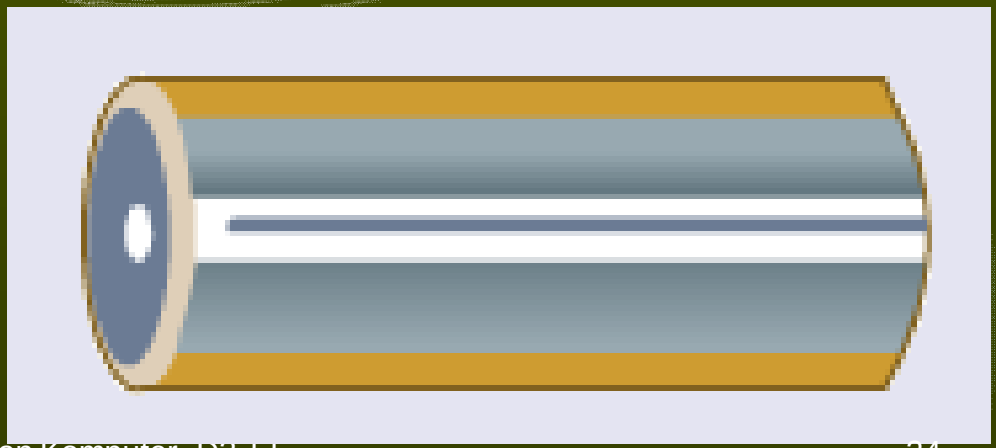
- Transmits flashes of light
- No RFI / EMI noise problem
- Several fibres in cable
- Paired for full duplex





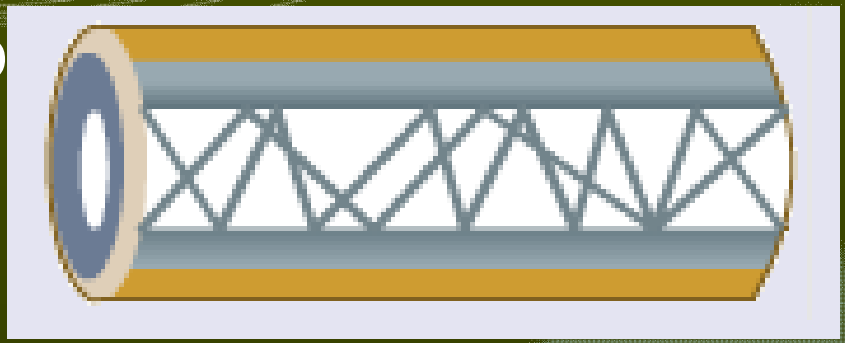
Single mode fibre optic

- Glass core 8 – 10 micrometres diameter
- Laser light source produces single ray of light
- Distances up to 100km
- Photodiodes to convert light back to electrical signals



Multimode fibre optic

- Glass core 50 – 60 micrometres diameter
- LED light source produces many rays of light at different angles, travel at different speeds
- Distances up to 2km, limited by dispersion
- Photodiode recepto
- Cheaper than single mode



Fibre optic connectors

Straight tip (ST) connector
single mode

Subscriber connector (SC)
multimode

Single mode lucent connector

Multimode lucent connector

Duplex multimode lucent connector (LC)

Which cable for the LAN?

UTP copper	Fibre optic
Max 100 m length	100km or 2km
Noise problems	No noise problems
Within building only	Within/between buildings
Cheaper	More expensive
Easier to install	Harder to install

Testing cables

Fluke NetTool for twisted pair cables

Optical Time Domain Reflectometer (OTDR) for fibre optic cables

Wireless

- Electromagnetic signals at radio and microwave frequencies
- No cost of installing cables
- Hosts free to move around

Wireless access point

Wireless adaptor

Wireless problems

- Interference from other wireless communications, cordless phones, fluorescent lights, microwave ovens...
- Building materials can block signals.
- Security is a major issue.

Wireless networks

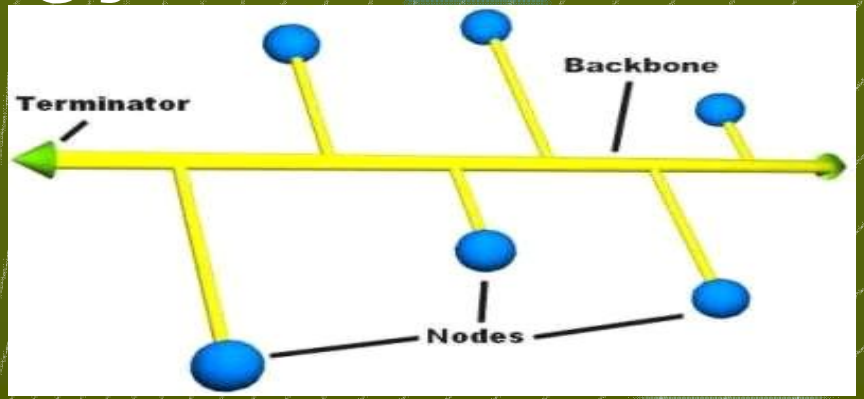
- IEEE 802.11 - Wi-Fi for wireless LANs. Uses CSMA/CA contention based media access
- IEEE 802.15 - Bluetooth connects paired devices over 1 -100m.
- IEEE 802.16 - WiMAX for wireless broadband access.
- Global System for Mobile Communications (GSM) - for mobile cellular phone networks.

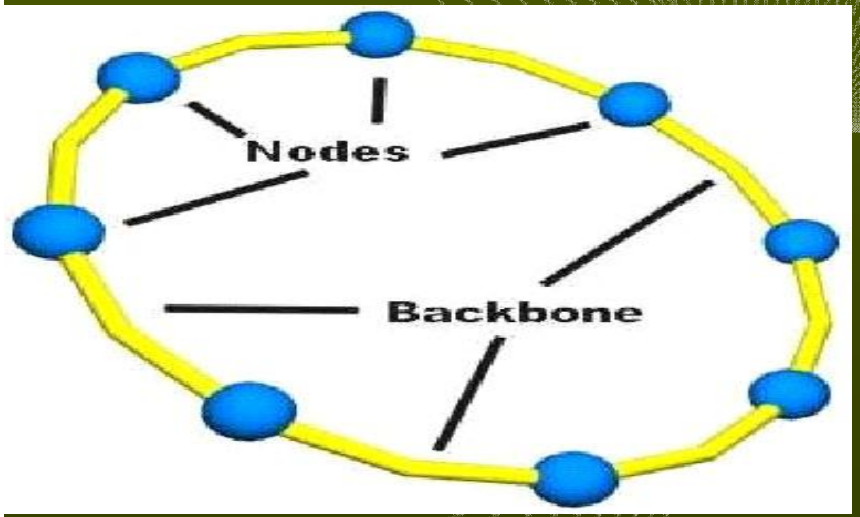
Which cable?

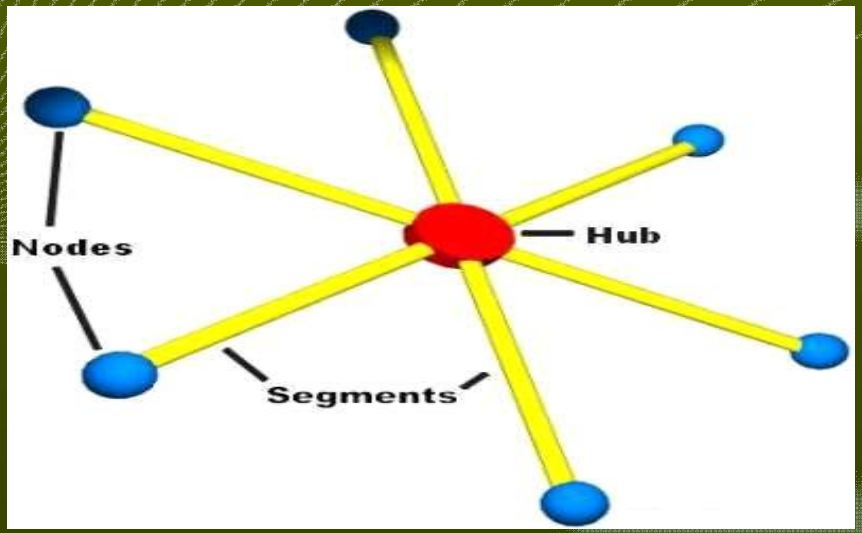
- Length: UTP up to 100m, fibre optic longer
- UTP inside building. Fibre optic in or out.
- Cost: UTP cheaper than fibre optic
- Bandwidth: is it enough to meet requirements?
- Ease of installation: UTP is easier.
- EMI / RFI noise: may need fibre optic.
- High capacity link: may need fibre optic.

Network Topology

- Hub
- Star
- Mesh
- Tree
- Ring

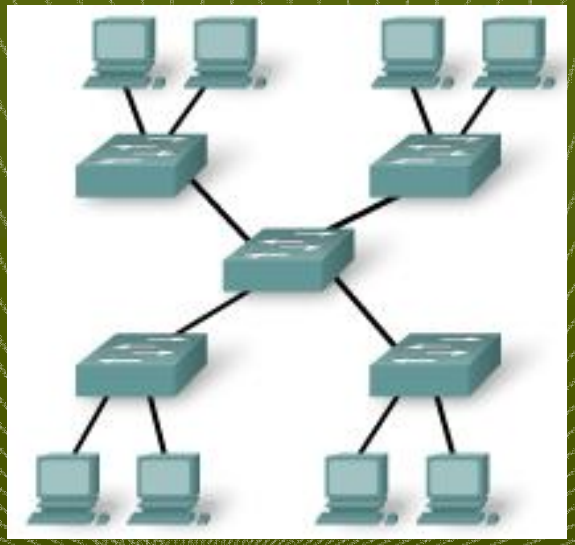




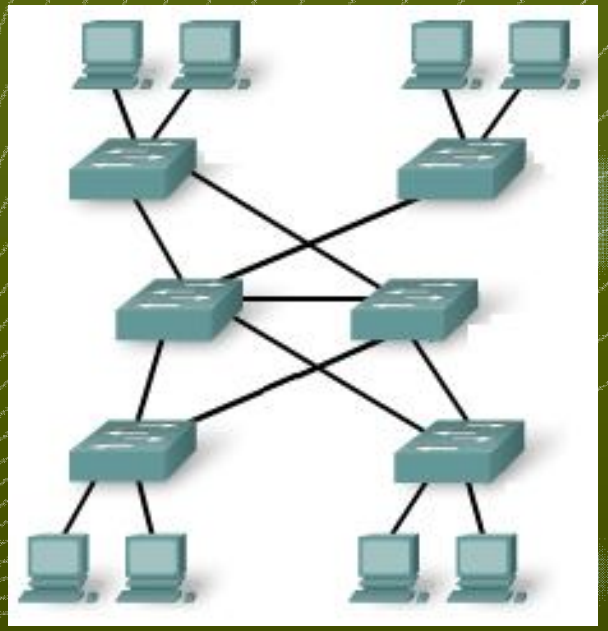


Arranging switches

Star for small networks



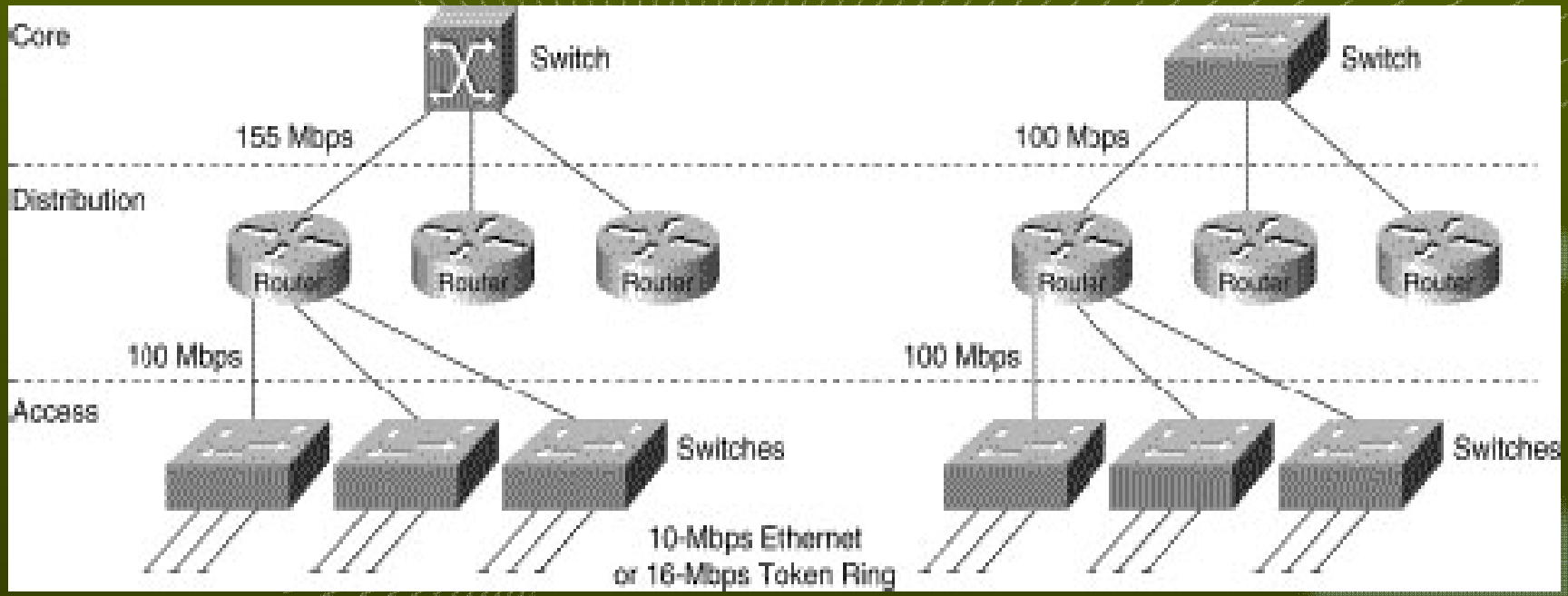
Extended Star for larger networks, perhaps on several floors



Mesh to give redundancy – fault tolerance.

Hierarchical Topology

1. **Core**
2. **Distribution**
3. **Access**



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Thank You

Ref: S Ward Abingdon and Witney College