



CD4002/CN4002  
Computer Systems and Networks

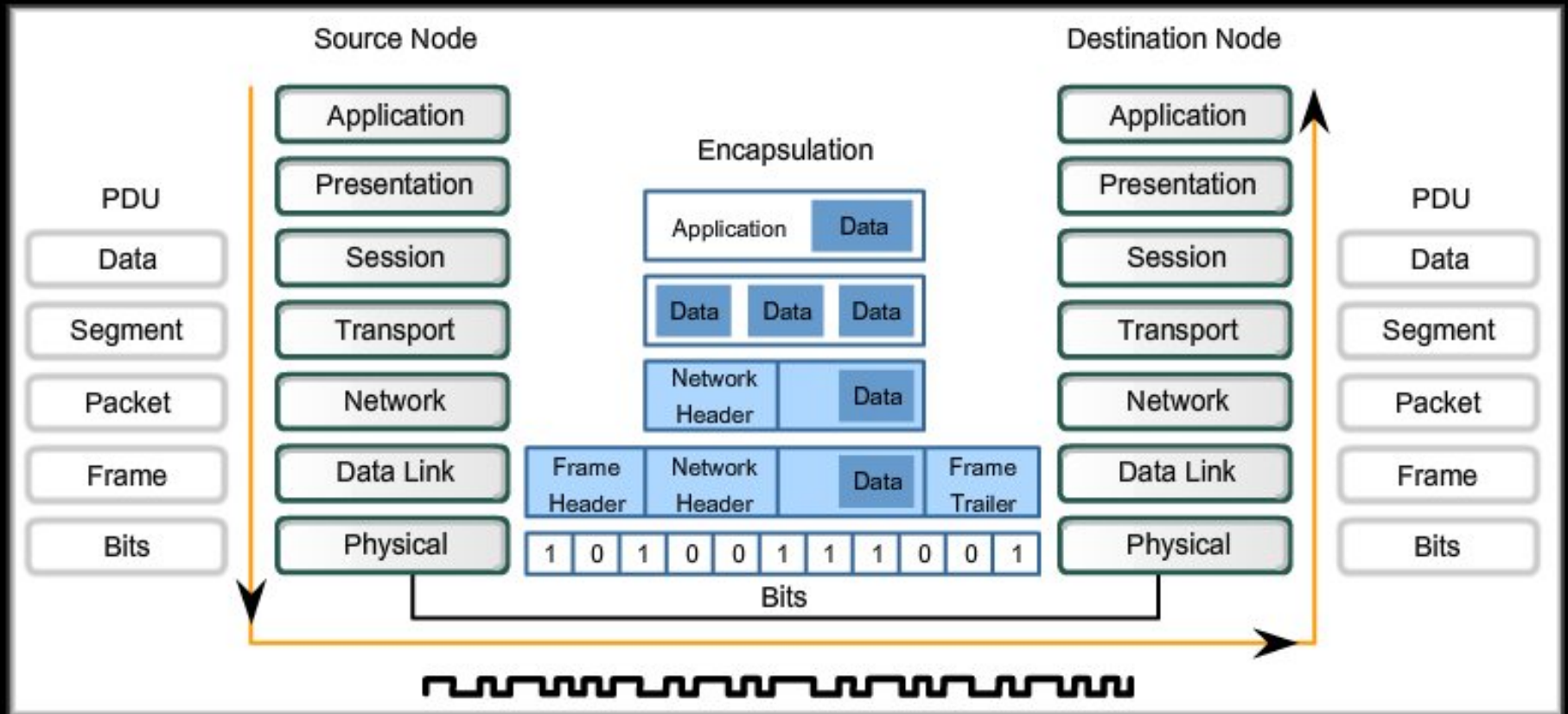
Topic:  
Physical Layer

# Objectives

- Explain the purpose and functions of the physical layer in the network.
- Describe basic principles of the physical layer standards.
- Describe the physical characteristics of several media types.



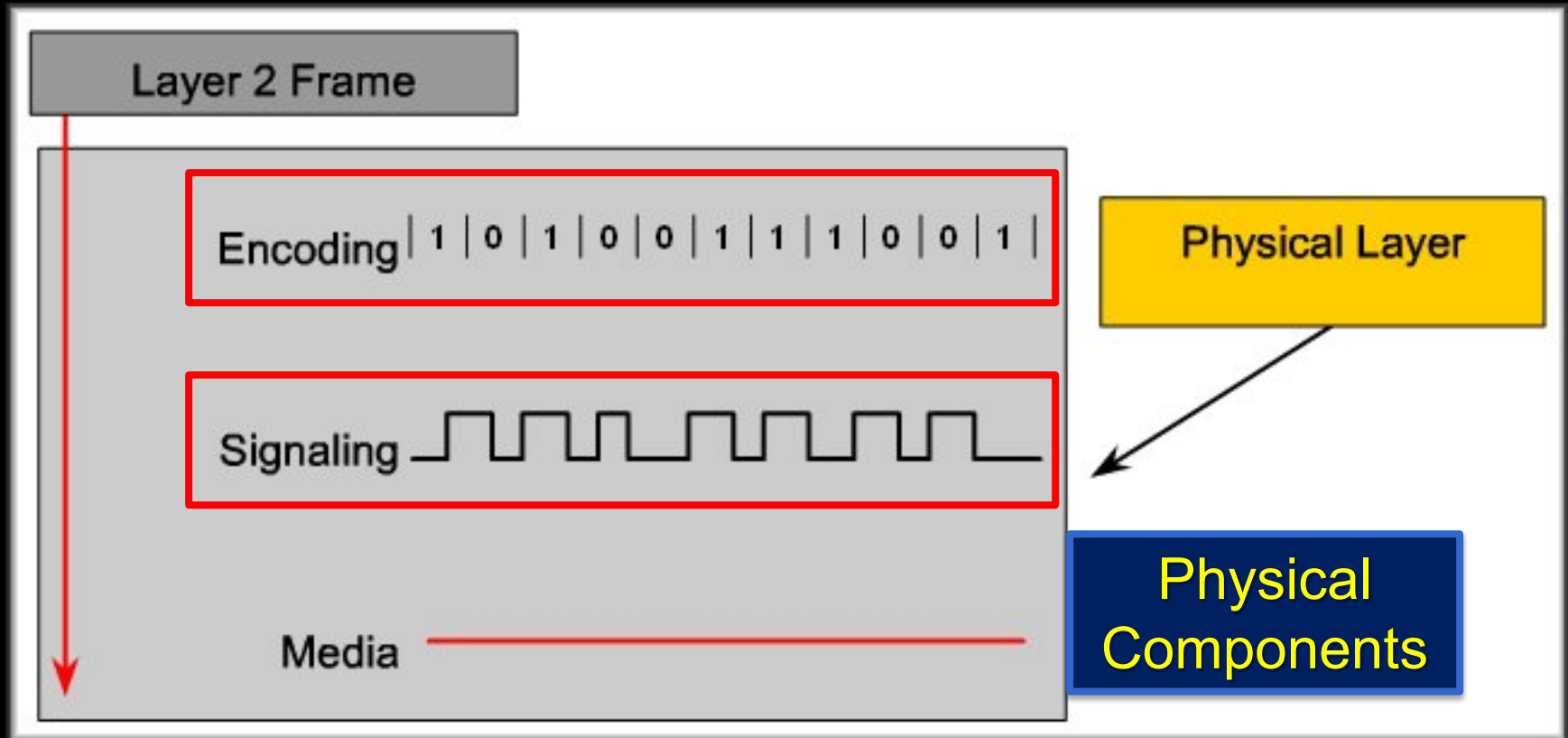
# Purpose of the Physical Layer





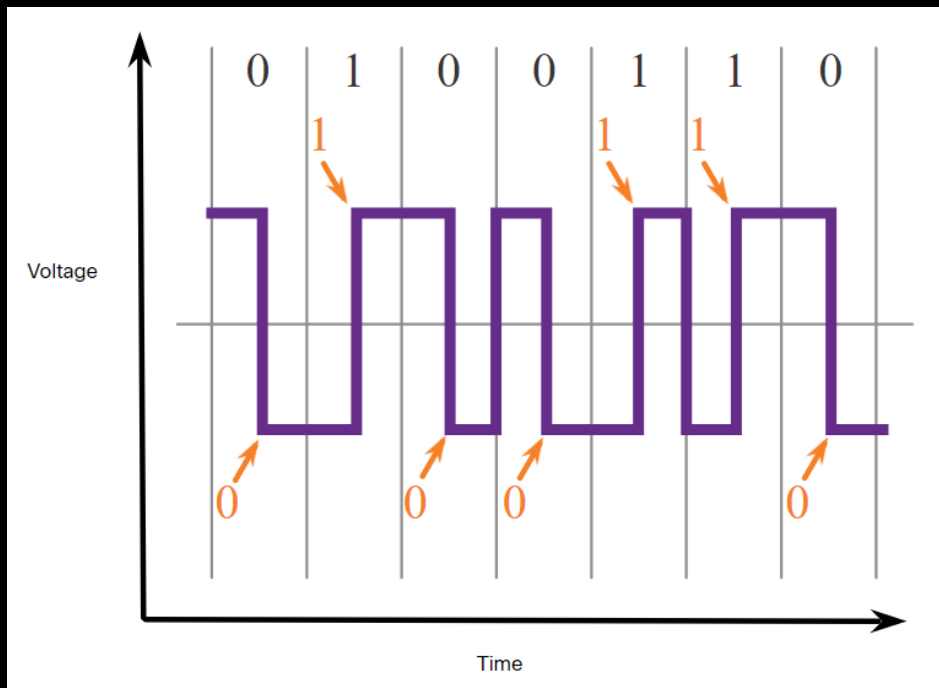
# Physical Layer Fundamental Principles

- Three fundamental functions:



# Encoding

- Encoding is the method used to represent digital information.
  - For example, Manchester encoding (shown in the figure) represents a 0 bit by a high to low voltage transition and a 1 bit is represented as a low to high voltage transition.



# Signaling

- Each medium has a unique method of representing bits:

Copper Cable

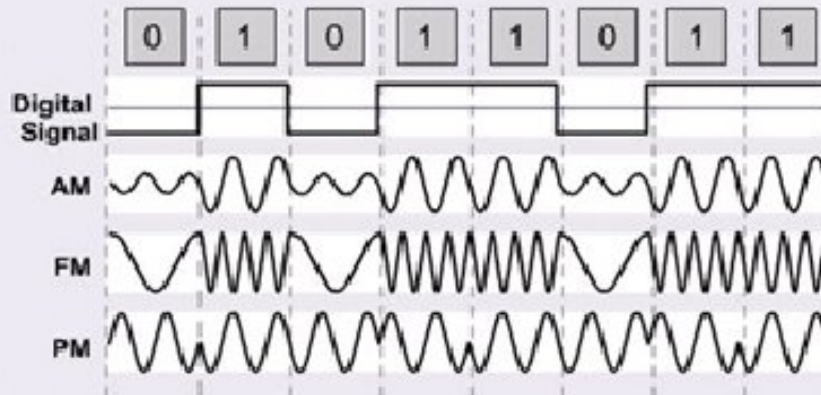
Outbound (Tx) signal



Fiber-optic



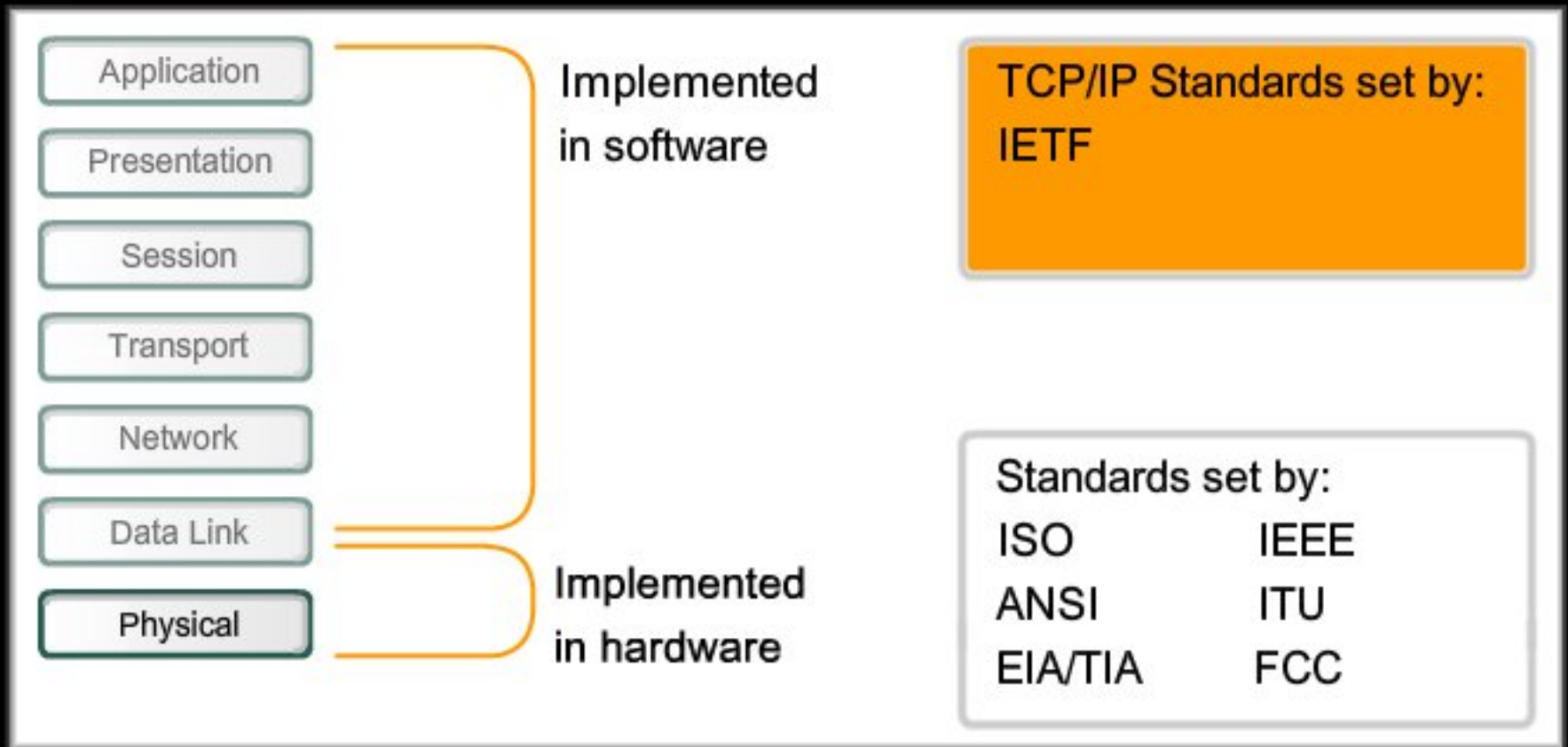
Wireless



# Types of Physical Media

Specification	Media	Maximum Segment Length	Connector
10BASE-T	CAT 3,4 (UTP)	100m	RJ-45
100BASE-TX	CAT 5 UTP	100m	RJ-45
100BASE-FX	62.5/125 multimode fiber	2km	
1000BASE-CX	STP	25m	RJ-45
1000BASE-T	CAT 5e UTP	100m	RJ-45
1000BASE-SX	62.5/50 multimode fiber	62.5 – 275m 50 – 550m	
1000BASE-LX	62.5/50 multimode 9-micron single-mode fiber	62.5/50 – 550m 9 – 10 km	
1000BASE-ZX	9-micron single-mode fiber	70km	
10GBASE-ZR	9-micron single-mode fiber	80km	

# Physical Layer Standards





# Physical Layer Standards

- *Telecommunications Industry Association (TIA) and Electronics Industry Alliance (EIA):*
  - A standards organization covering structured voice and data wiring for LANs.

TIA/EIA-568-B.1	Commercial Building Telecommunications Cabling Standard – General Requirements
TIA/EIA-568-B.2	Balanced Twisted Pair Cabling Components
TIA/EIA-568-B.3	Optical fiber Cabling Components
TIA/EIA-568-B	Cabling Standards
TIA/EIA-569-A	Commercial Building Standard for Telecommunications Pathways and Spaces
TIA/EIA-570-A	Residential and Light Commercial Telecommunications Wiring Standard
TIA/EIA-606	Administration Standard for the Telecommunications Infrastructure of Commercial Buildings
TIA/EIA-607	Commercial Building Grounding and Bonding Requirements for Telecommunications

# Physical Layer Standards

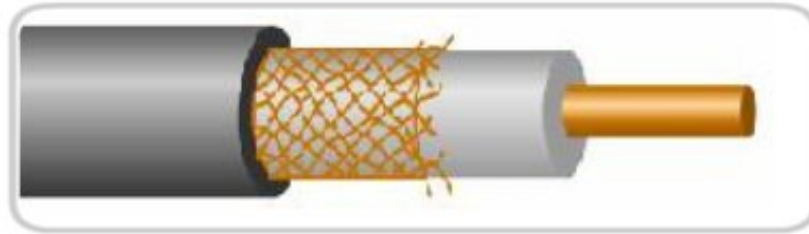
- *The Institute of Electrical and Electronic Engineers (IEEE):*
  - A professional organization that defines the standards for many LAN protocols.

Standard	Use	Standard	Use
802.1	Network Management	802.9	VoIP
802.2	Logical Link Control	802.10	Network Security
802.3	Ethernet	802.11	Wireless
802.4	Token Bus	802.12	Demand Priority Access
802.5	Token Ring	802.13	Unused
802.6	MANs	802.14	Cable Modem
802.7	Broadband	802.15	WPAN
802.8	Fiber Optic	802.16	Broadband Wireless

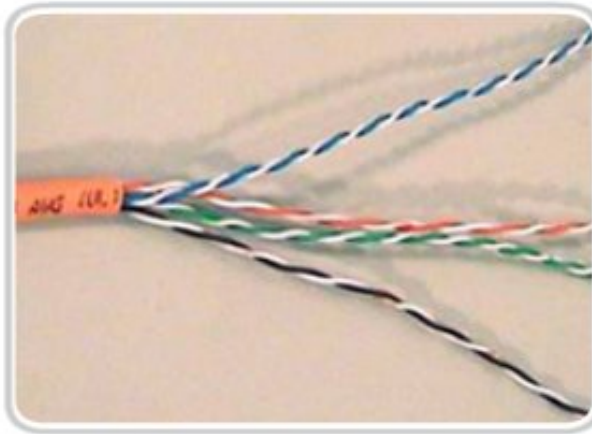
# Copper Media

- *Most common means for connecting network devices.*

- **Standards** been defined for:



Coaxial cable



Unshielded twisted-pair cable



RJ-45 connections

- Type of copper cabling
- Bandwidth
- Type of connector
- Pin out and colour codes of media connections
- Maximum distance

# Copper Media



Sources of interference to data signals on copper media



Fluorescent lighting

Electric motors

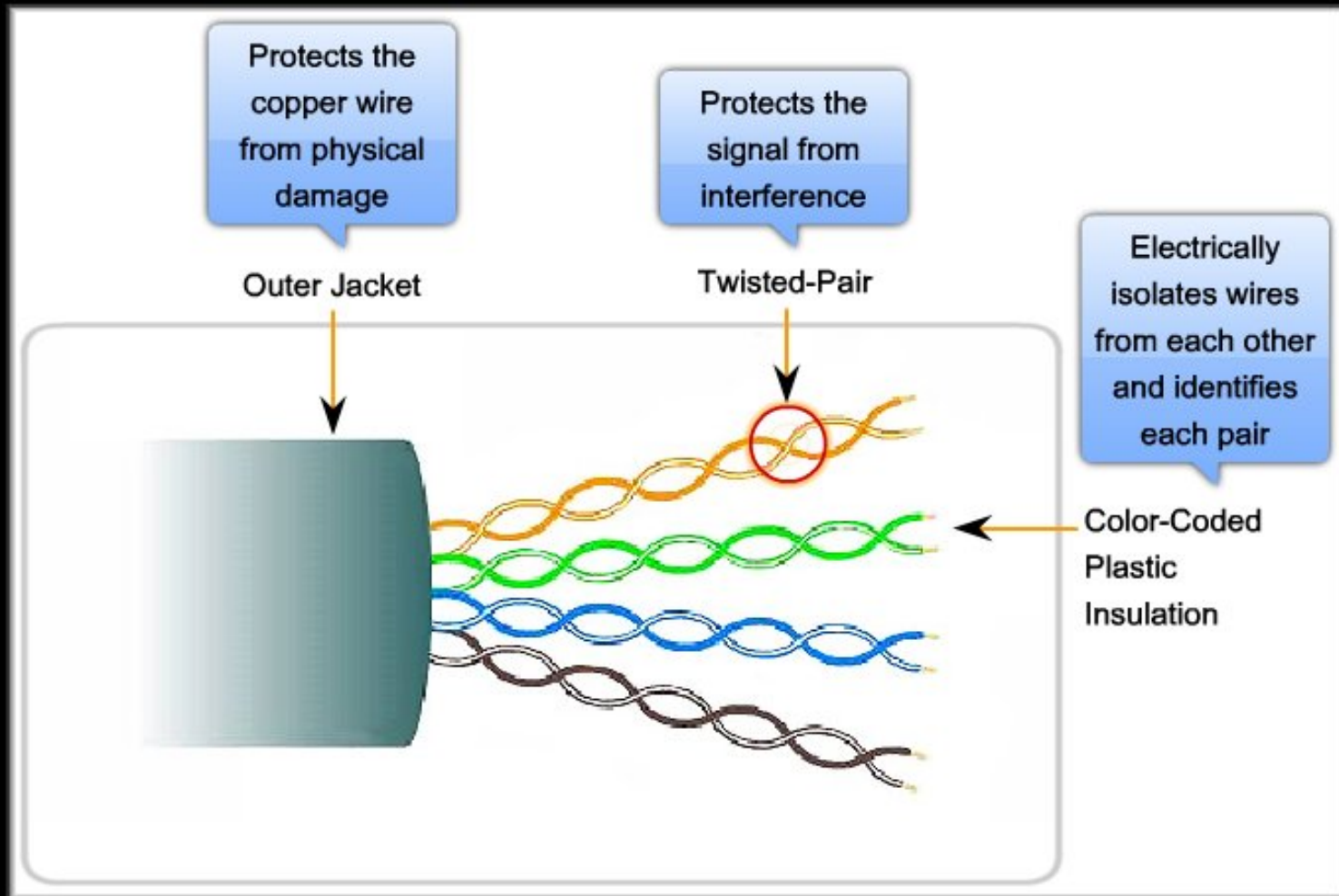


Radio waves

- **Interference:**
  - Data travels as electrical pulses.

# Copper Media

## Unshielded Twisted-Pair (UTP) Cable





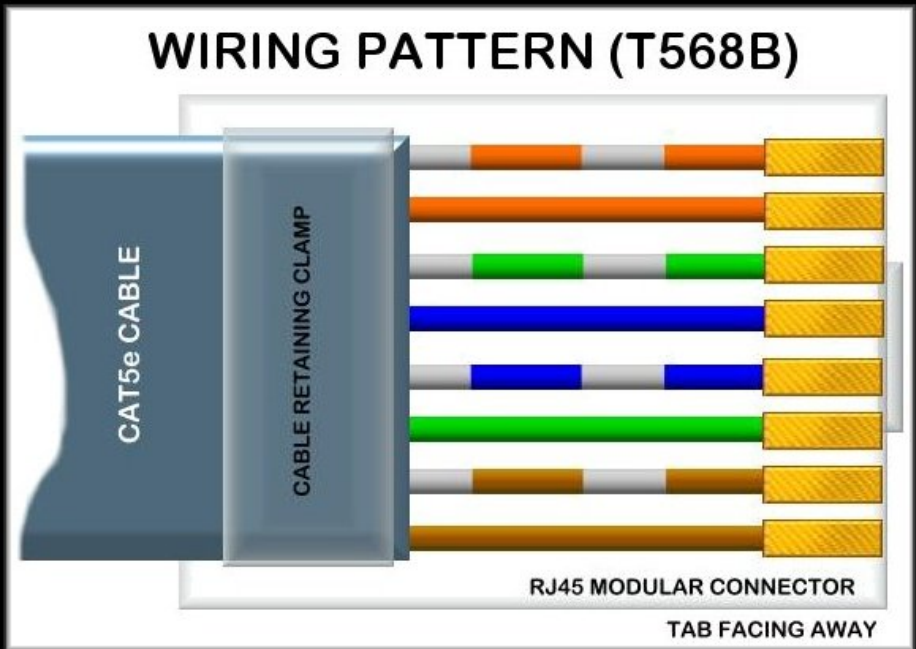
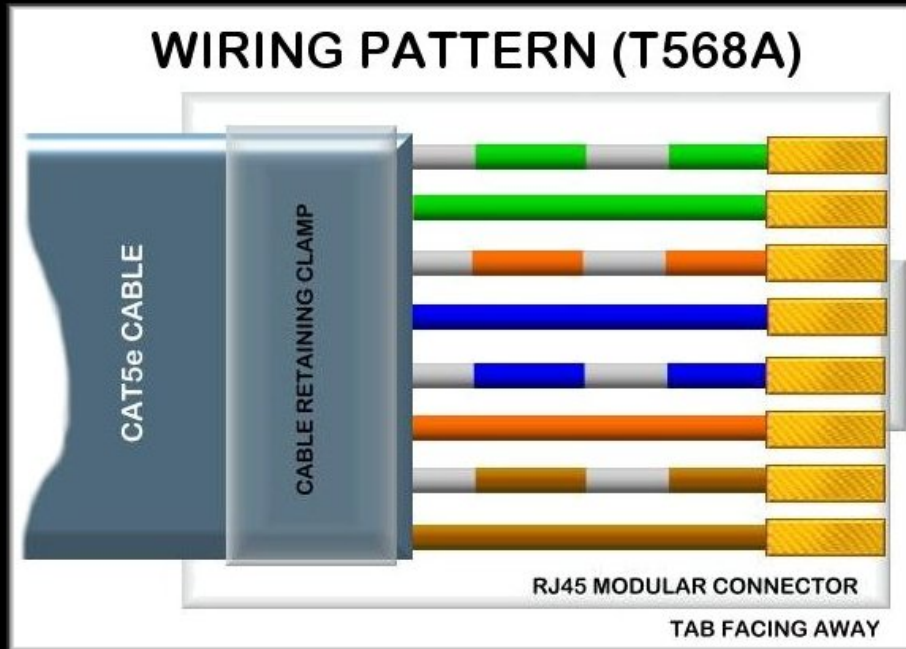
# Copper Media

- Unshielded Twisted-Pair (UTP) Cable:
  - TIA/EIA standards include:
    - Cable types
    - Cable lengths
    - Connectors
    - Cable Termination
    - Methods of testing
  - IEEE assigns categories based on bandwidth performance.
    - Cat 5 – up to 100-megabit
    - Cat 5e – full-duplex up to 1000-megabit (gigabit)
    - Cat 6 – recommended standard for gigabit



# Copper Media

- **Wiring Patterns:**
  - There are two specific TIA/EIA standard wiring patterns:

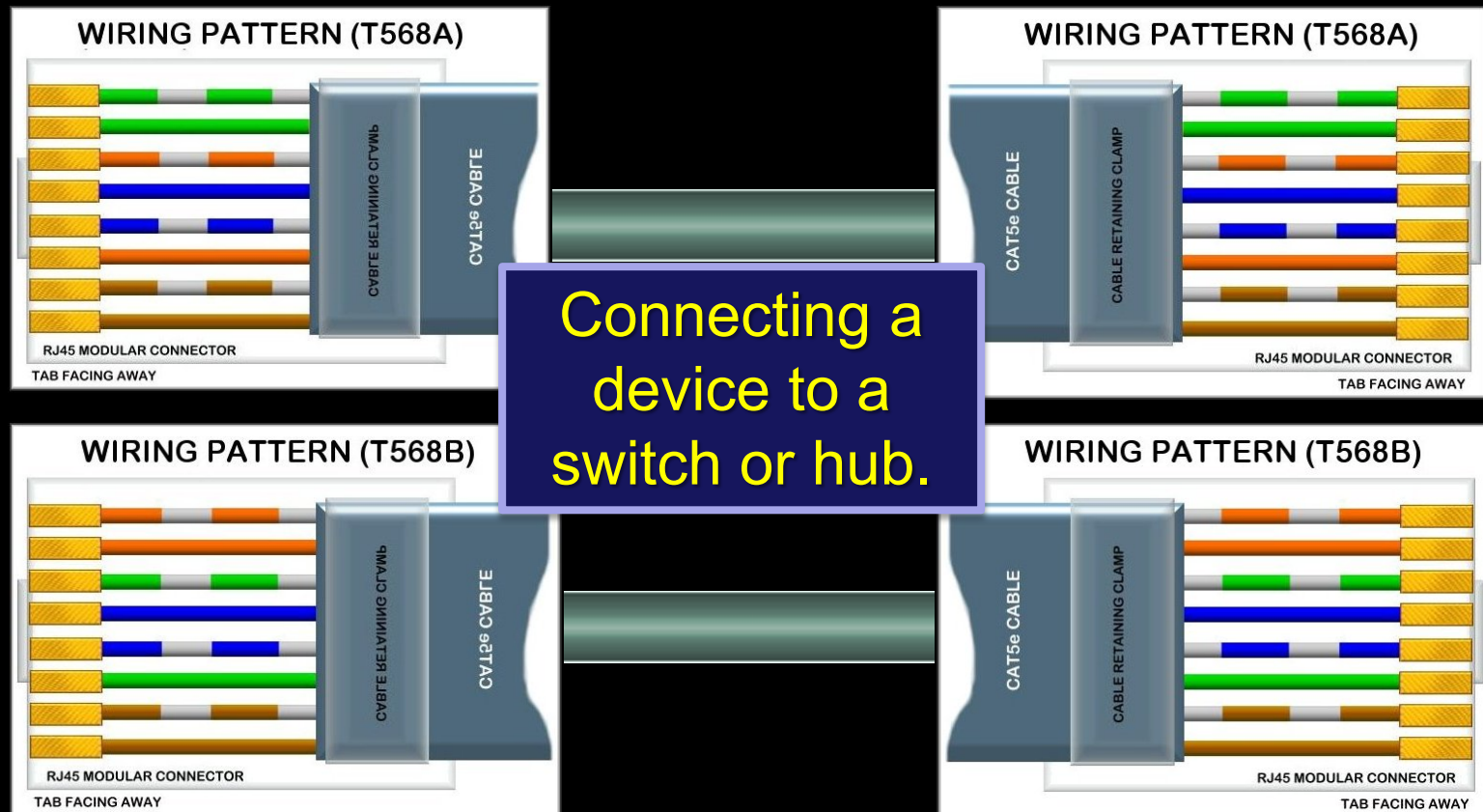


# Copper Media

- UTP Cable Types:
  - Different situations may require UTP cables to be wired according to different wiring patterns:
    - Ethernet Straight-through
    - Ethernet Crossover
    - Rollover Cable (Console Cable)

# Copper Media

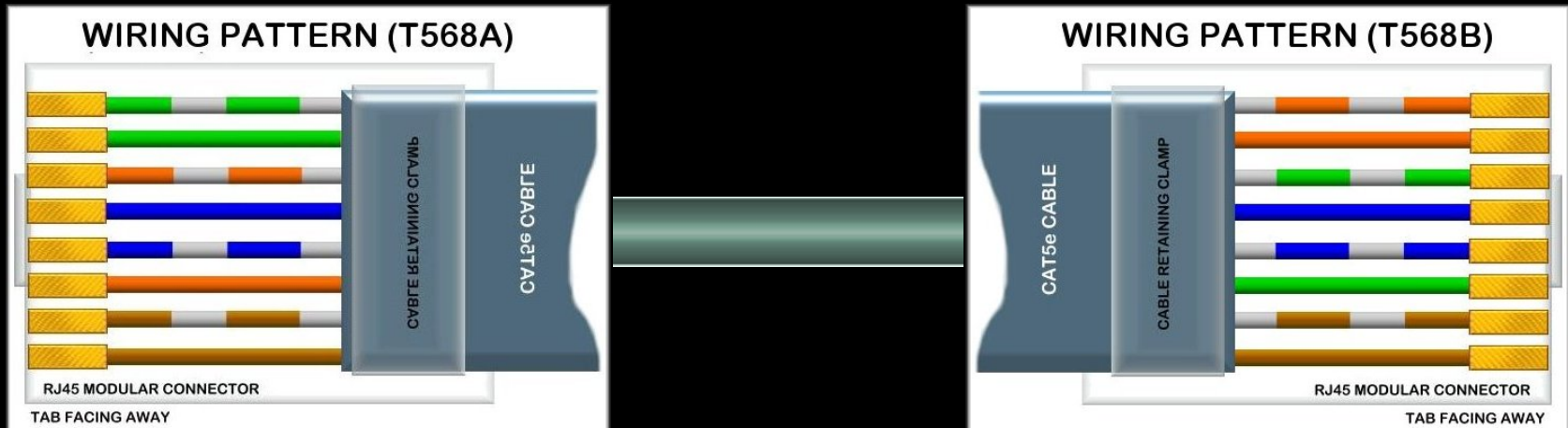
- Ethernet Straight-through:
  - T568A or T568B may be used as long as **the same pattern** is used at both ends of the cable.



# Copper Media

- Ethernet Crossover:

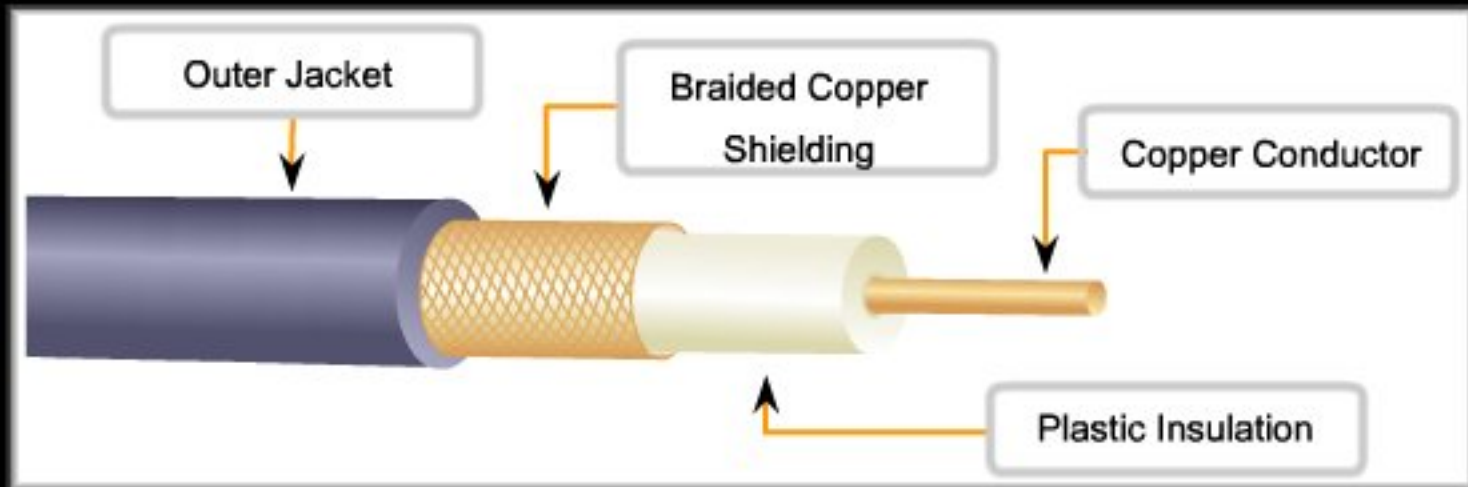
- T568A and T568B are used at either end of the cable.
- Connecting two workstations together.
- Connecting two networking devices.
  - Switch to a switch
  - Router to a router





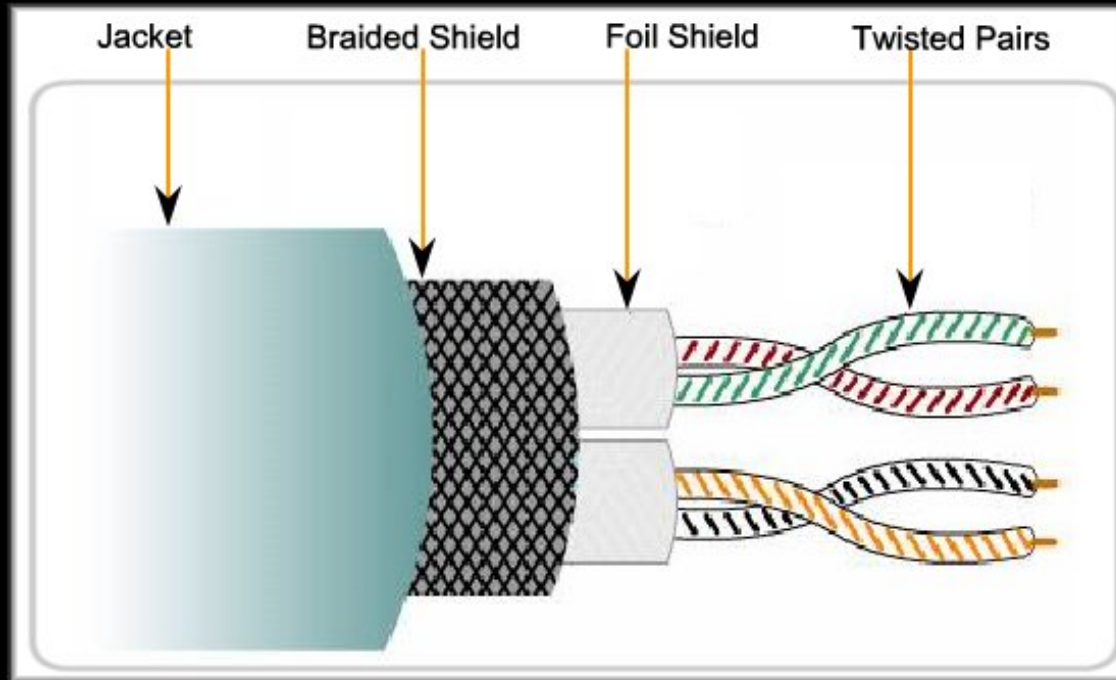
# Copper Media

- Other Copper Cable Types:
  - Coaxial Cable:
    - Used in wireless and cable access technologies.
      - Attach antennas to wireless devices.
      - Transmitting television channels.
      - Can run longer distances than STP or UTP.



# Copper Media

- Other Copper Cable Types:
  - Shielded Twisted Pair (STP):
    - STP cable shields the entire bundle of wires within the cable as well as the individual wire pairs to provide better noise protection than UTP.

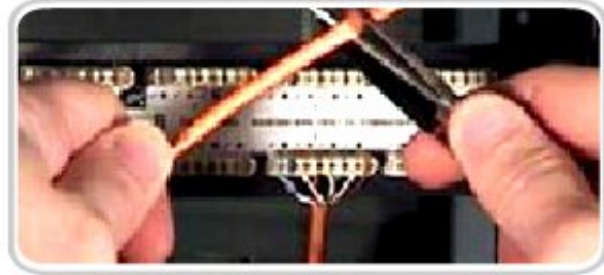


# Copper Media Connectors

- While connectors may appear the same, they may be wired differently depending on the Physical Layer specification.



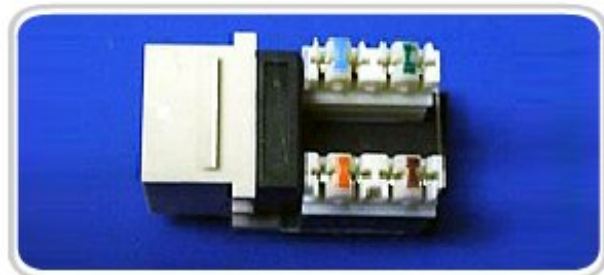
110 punch block



RJ-45 UTP  
Plugs

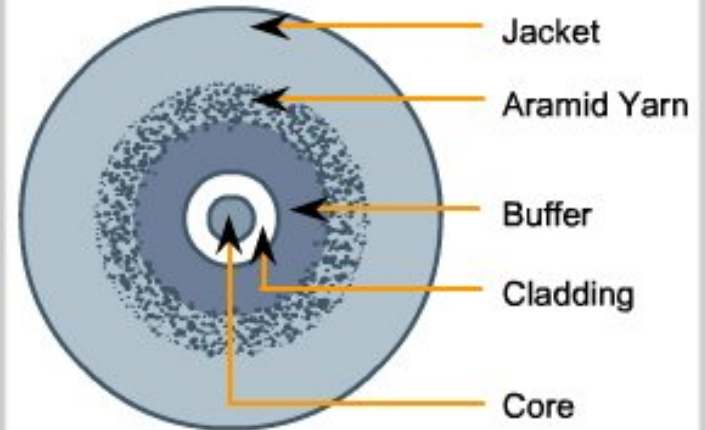
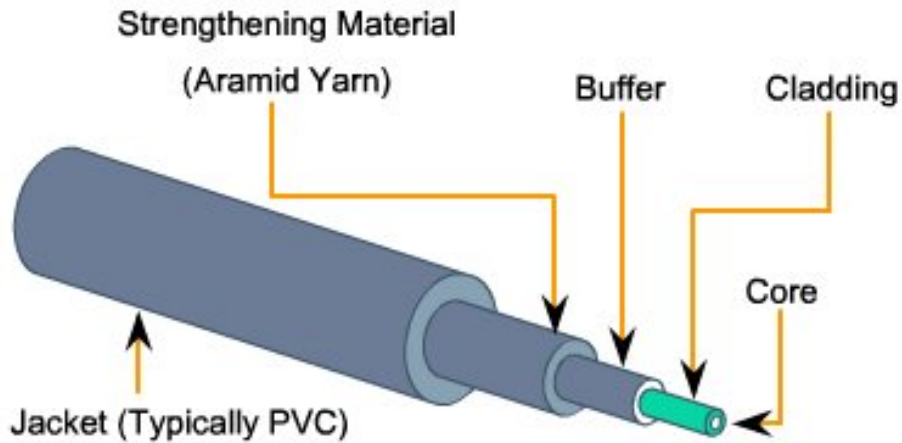


RJ-45 UTP  
Socket



# Fiber Media

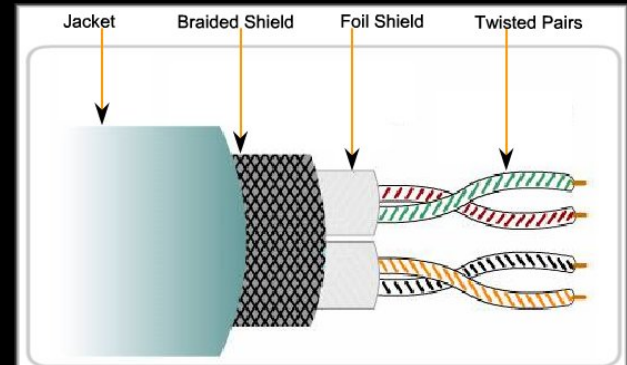
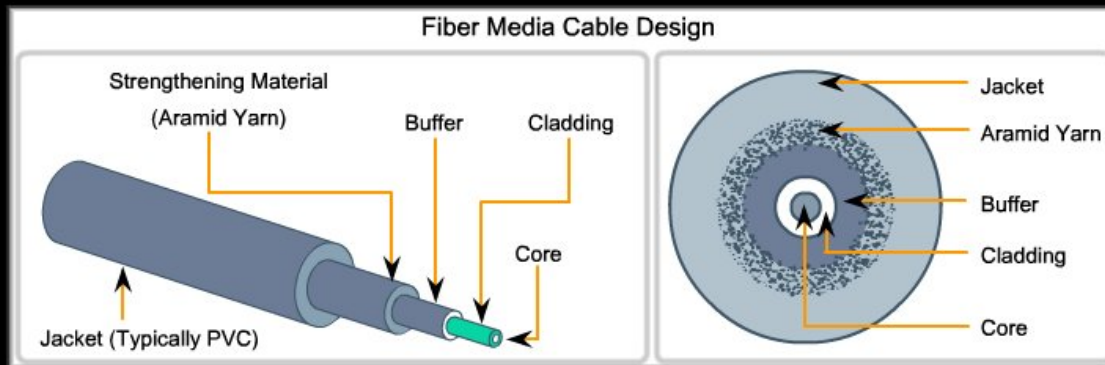
Fiber Media Cable Design



# Fiber Media

- **Fiber vs Copper:**

- More expensive (usually) than copper media over the same distance (but for a higher capacity).
- Different skills and equipment required to terminate and splice the cable infrastructure.
- More careful handling than copper media.
- Immune to electromagnetic interference.
- Much greater lengths than copper media (kilometers).





# Fiber Media

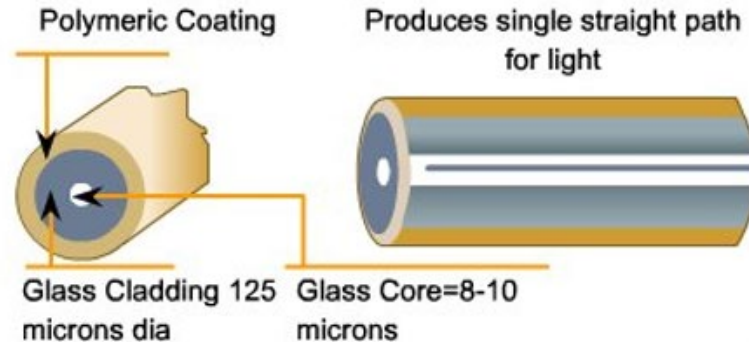
- Cable Construction:

- PVC jacket and a series of strengthening materials that surround the optical fiber and its cladding.
- The cladding surrounds the actual glass or plastic fiber and is **designed to prevent light loss from the fiber**.
- Two fibers are required to support full duplex operation.



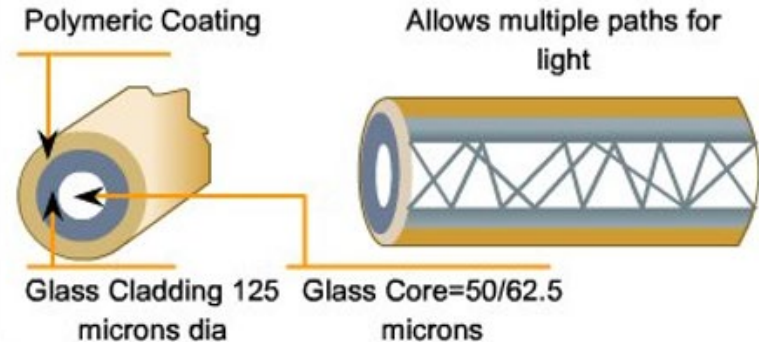
# Fiber Media

## Single-Mode



- Small Core
- Less Dispersion
- Suited for long distance applications (up to 100 km, 62,14 mi.)
- Uses lasers as the light source often within campus backbones for distance of several thousand meters

## Multimode



- Larger core than single-mode cable (50 microns or greater)
- Allows greater dispersion and therefore, loss of signal
- Used for long distance application, but shorter than single-mode (up to ~2km, 6560 ft)
- Uses LEDs as the light source often within LANs or distances of a couple hundred meters within a campus network

# Fiber Media Connectors

ST Connector



Straight Tip (ST) connector is widely used with multimode fiber

SC Connector



Subscriber Connector (SC) is widely used with single-mode fiber

Single-Mode (LC)



Single-Mode Lucent Connector (LC)

Multimode (LC)



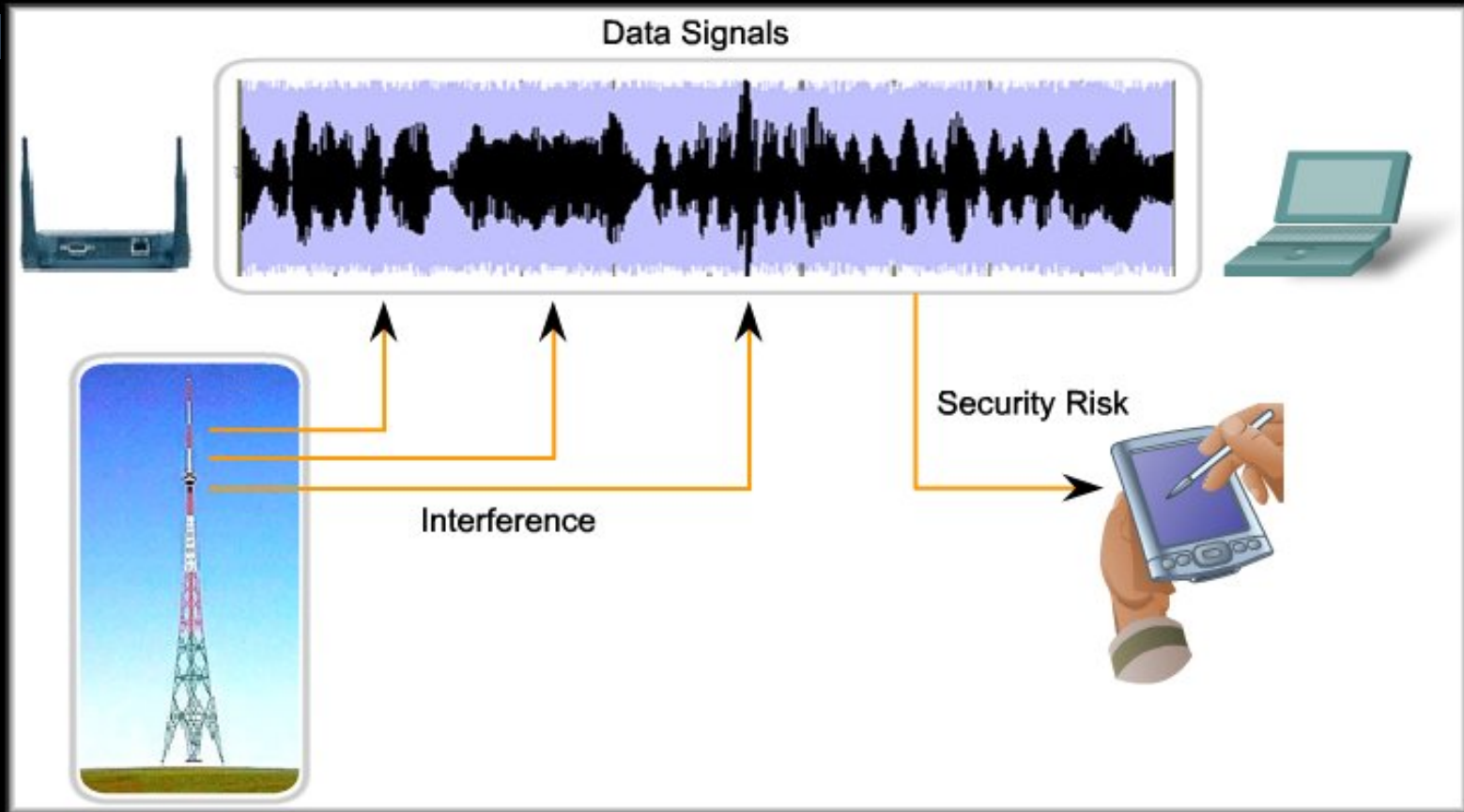
Multimode LC Connector

Duplex Multimode (LC)



Duplex Multimode LC Connector

# Wireless Media



- Wireless media carry electromagnetic signals at radio and microwave frequencies that represent the binary digits of data communications.

# Wireless Media

- Types of Wireless Media:
  - Standards cover both the Data Link and Physical layers.
    - Three common data communications standards:
      - Standard IEEE 802.11: Wireless LAN (WLAN) standard.
      - Standard IEEE 802.15: Wireless Personal Area Network (WPAN) standard.
      - Standard IEEE 802.16: Wireless broadband access.