Computer Networks

Physical Layer

Physical Layer Protocols

You should be able to:

- Identify **device connectivity** options
- Describe the purpose and functions of the **physical layer** in the network
- Describe basic principles of the **physical layer standards**

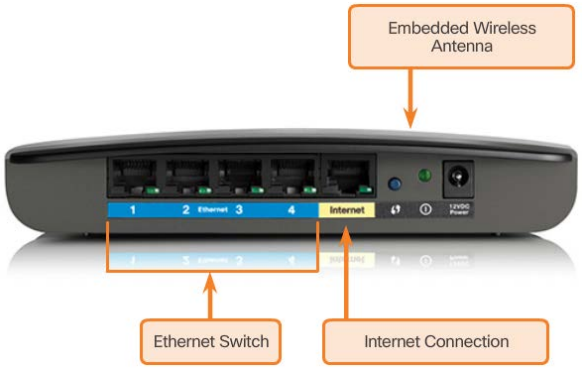
Physical Layer Protocols

- Primary purposes of network is to increase productivity
- The **minimum requirements** for setting up a network are:

  Network Interface Circuit (NIC)

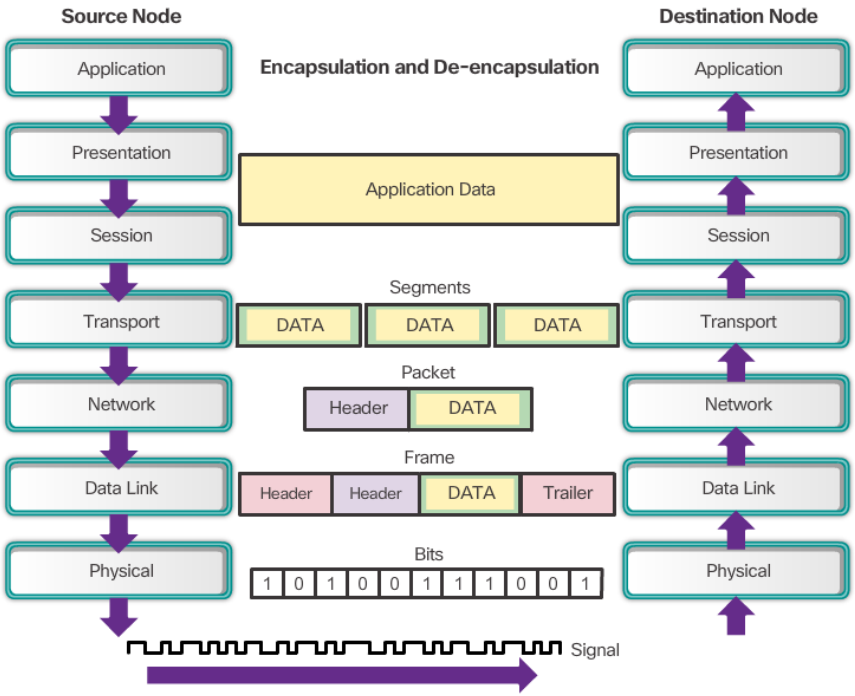
  Network Media

  Connectors



The Physical Layer

- The OSI **physical layer** provides the means to transport the bits that make up a data link layer frame **across the network** media



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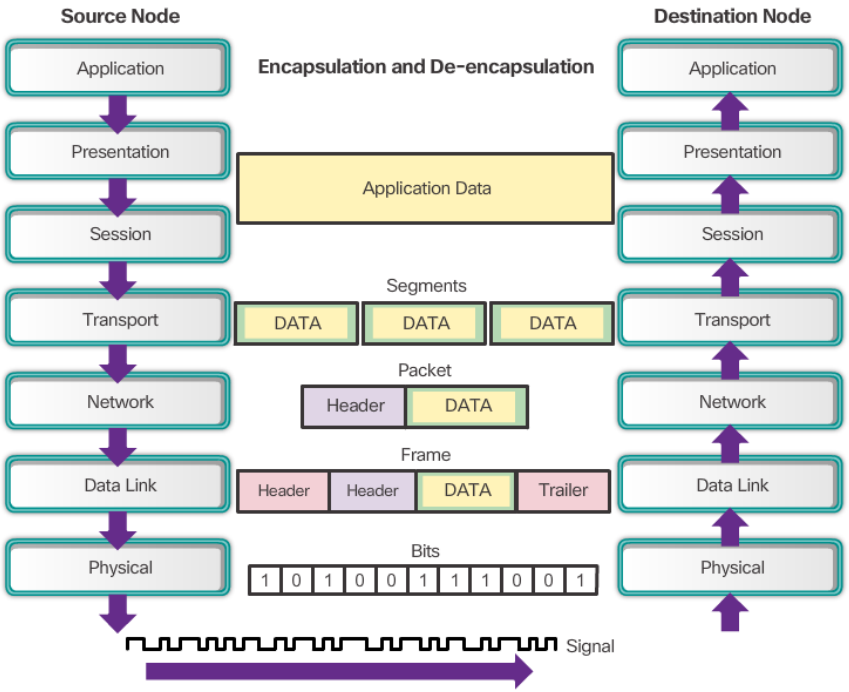


•The physical layer **encodes the frames** and creates the **electrical, optical, or radio** wave signals that represent the bits in each frame

• Signals are then sent on the **media**, one at a time

Installation of LAN cabling

- When planning the installation of LAN cabling, there are four physical areas to consider

  Work area

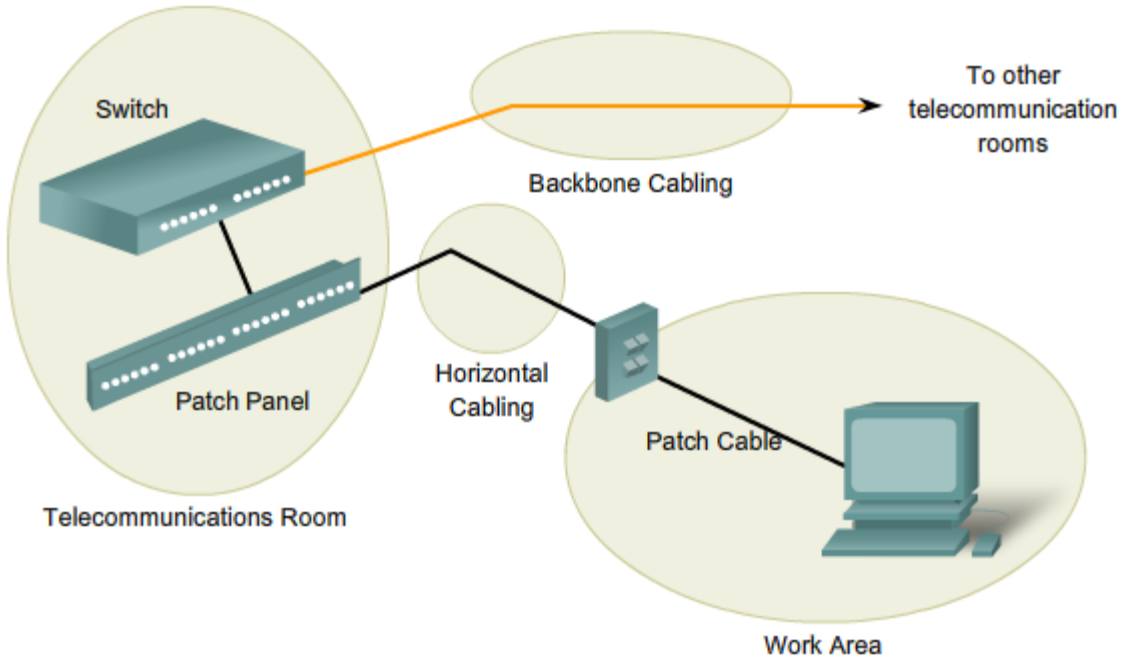
  Telecommunications room, also known as the **distribution facility**

  Backbone cabling, also known as vertical cabling

  Distribution cabling, also known as horizontal cabling

Installation of LAN cabling

- LAN cabling areas



Total Cable Length

- For **UTP** installations, the **ANSI/TIA/EIA-568-B** standard specifies the total combined length is limited to a **maximum** distance of **100 meters** per channel
- This standard specifies there can be up to **5 meters** of **patch cable** for interconnecting patch panels.
- There can be up to **5 meters** of cable from the cable **termination point** on the wall to the telephone or computer

Types of Media

- There are many different **Physical layer** implementations that support multiple media types:
- **UTP** (Category 5, 5e, 6, and 7)
- **Fiber-optics**
- **Wireless**
- Each media type has its **advantages** and **disadvantages**

Types of Media

- Each media type has its advantages and disadvantages
- **Cable length**
- **Cost**
- **Bandwidth**
- **Ease of installation**
- **Susceptible to EMI/RFI**

Fiber Media Cable Design

Jacket

Typically a PVC jacket that protects the fiber against abrasion, moisture, and other contaminants. This outer jacket composition can vary depending on the cable usage.

Buffer

Used to help shield the core and cladding from damage.

Cladding

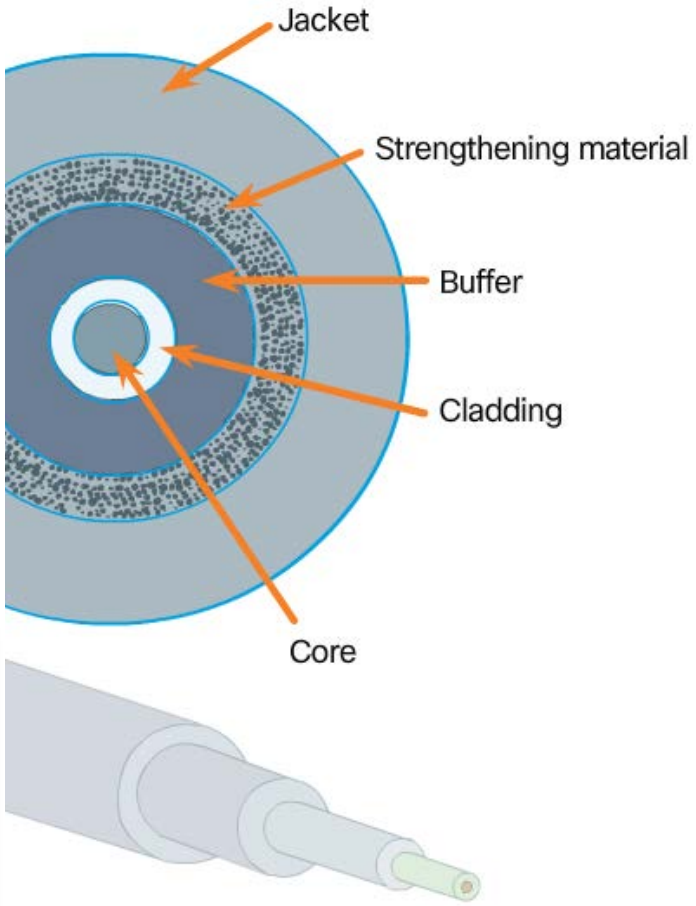
Made from slightly different chemicals than those used to create the core. It tends to act like a mirror by reflecting light back into the core of the fiber. This keeps light in the core as it travels down the fiber.

Core

The core is actually the light transmission element at the center of the optical fiber. This core is typically silica or glass. Light pulses travel through the fiber core.

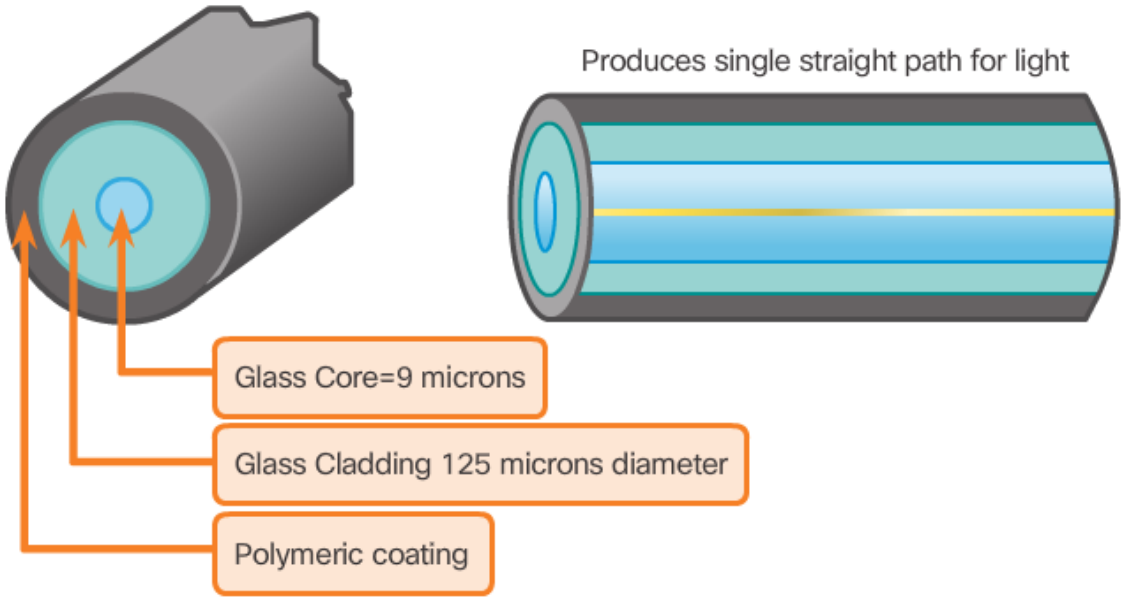
Strengthening Material

Surrounds the buffer, prevents the fiber cable from being stretched when it is being pulled. The material used is often the same material used to produce bulletproof vests.



Types of Fiber Media

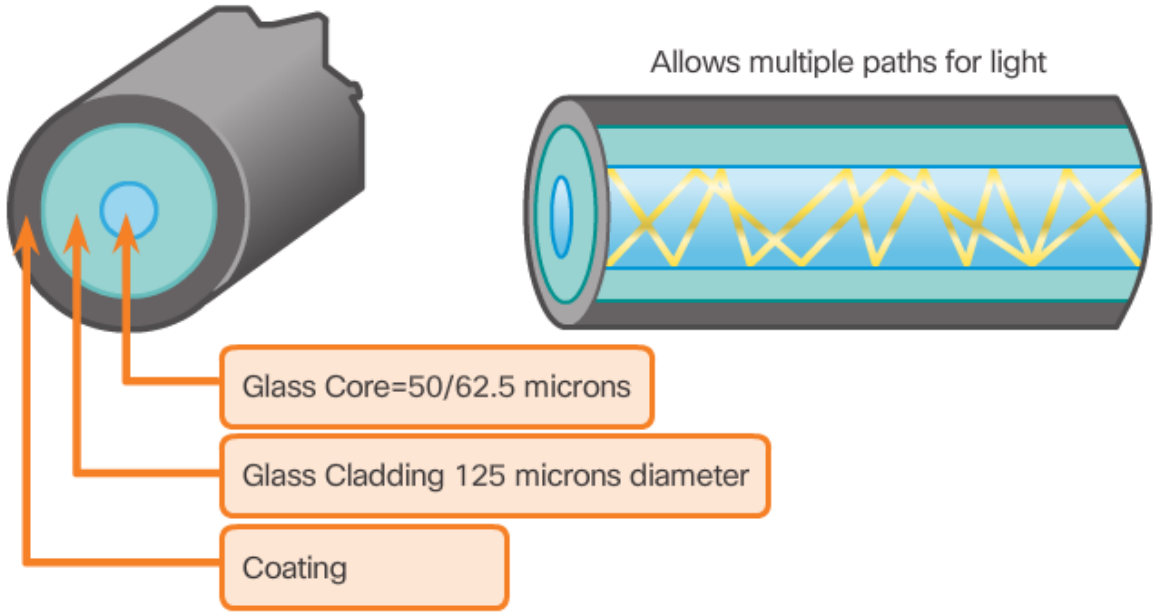
- Single mode



- Small core
- Less dispersion
- Suited for long distance applications
- Uses lasers as the light source
- Commonly used with campus backbones for distances of several thousand meters

Types of Fiber Media

- Multimode



- Larger core than single mode cable
- Allows greater dispersion and therefore, loss of signal
- Suited for long distance applications, but shorter than single mode
- Uses LEDs as the light source
- Commonly used with LANs or distances of a couple hundred meters within a campus network

Network Fiber Connector

- **Fiber**

SC-SC Multimode Patch Cord

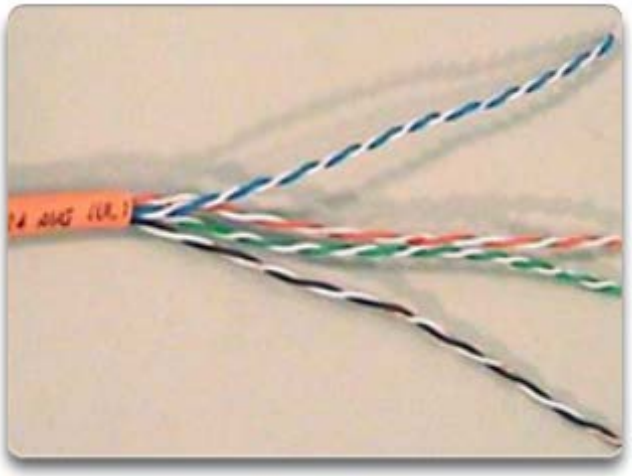
LC-LC Single-mode Patch Cord

ST-LC Multimode Patch Cord

SC-ST Single-mode Patch Cord

Copper Media

- Cu



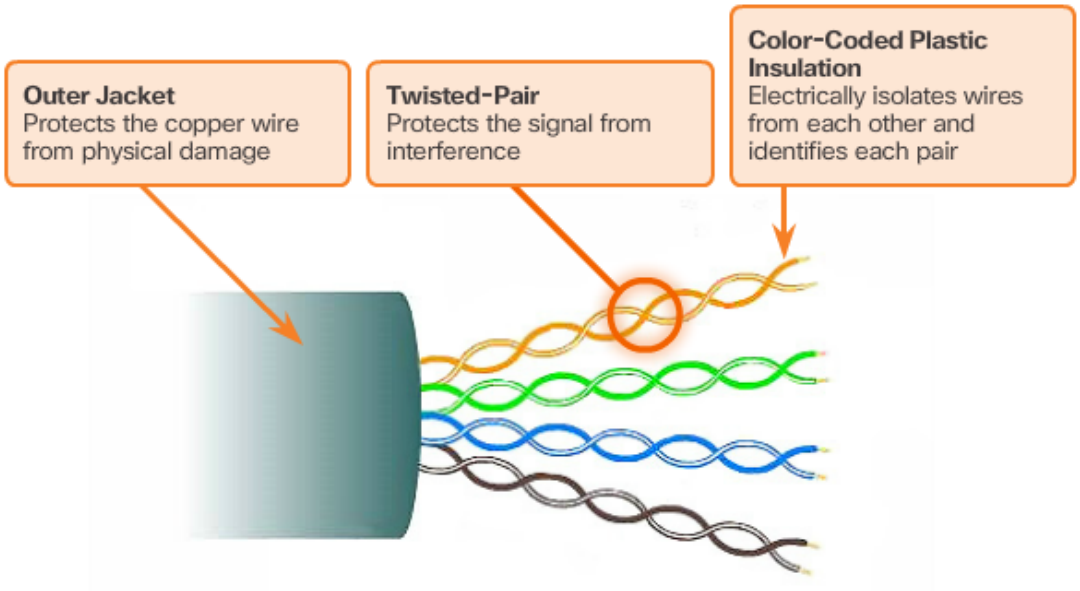
Unshielded Twisted-Pair (UTP) cable

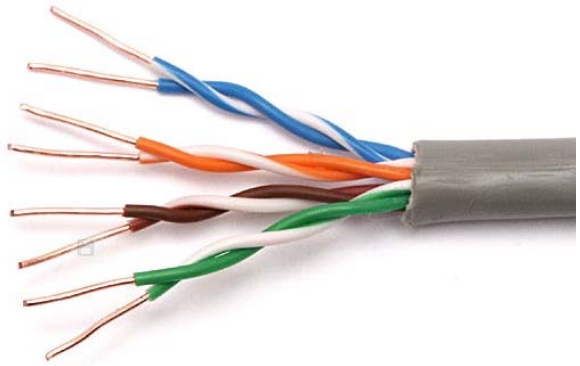
Shielded Twisted-Pair (STP) cable

Coaxial cable

UTP

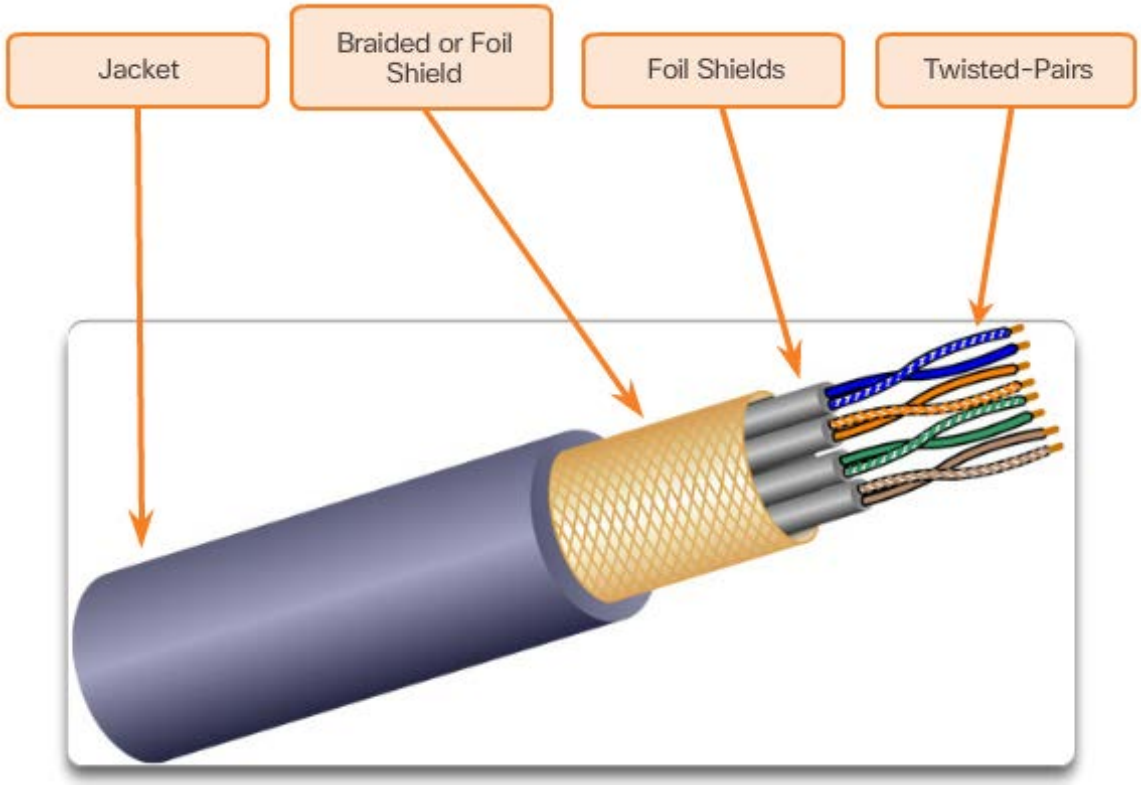
- **UTP** - cable is relatively **lightweight** and **flexible** and has a small diameter, which allows it to fit into small spaces
- The connectors, **RJ-45 plugs**, are relatively **easy to install** and are a standard for all **Ethernet devices**





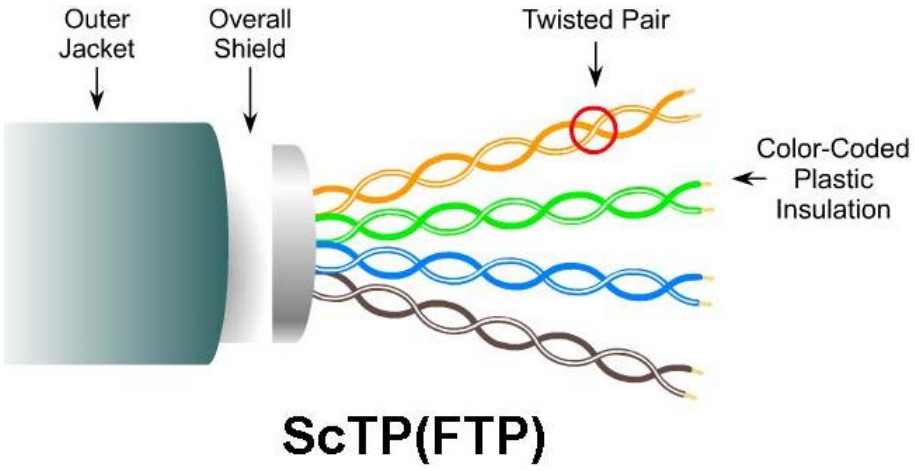
STP

- **STP**



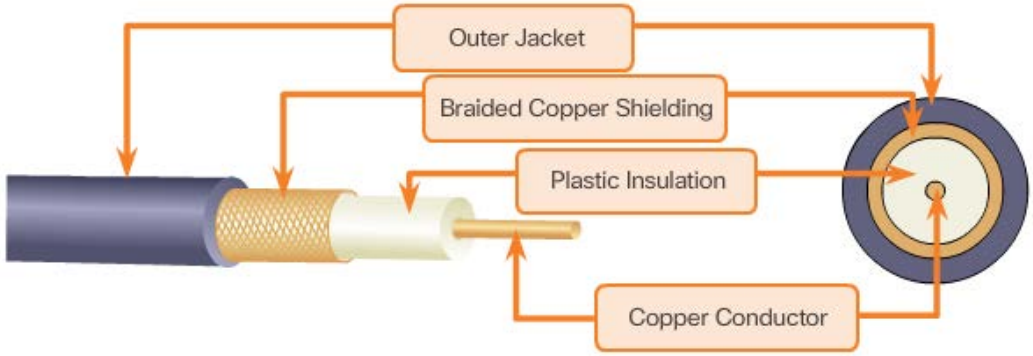
ScTP

- ScTP


Outer Jacket
Overall Shield
Twisted Pair
Color-Coded Plastic Insulation
ScTP(FTP)

Coaxial Cable

- Coaxial Cable



Fiber versus Copper

- UTP vs Cu

Implementation Issues	UTP Cabling	Fiber-optic Cabling
Bandwidth supported	10 Mb/s – 10 Gb/s	10 Mb/s – 100 Gb/s
Distance	Relatively short (1 – 100 meters)	Relatively high (1 – 100,000 meters)
Immunity to EMI and RFI	Low	High (Completely immune)
Immunity to electrical hazards	Low	High (Completely immune)
Media and connector costs	Lowest	Highest
Installation skills required	Lowest	Highest
Safety precautions	Lowest	Highest

Attenuation

- **Attenuation is reduction** of the strength of a signal as it moves down a media
- **The longer** the media, the **more attenuation** will affect the signal. At some point, the signal will **not be detectable**
- **Cabling distance** is a significant factor in data signal performance
- Signal attenuation and exposure to possible interference increase with **cable length**

Electromagnetic Interference/Radio Frequency Interference

- **Electromagnetic** Interference **(EMI**) and **Radio** Frequency Interference (**RFI**) must be taken into consideration when choosing a media type for a LAN. EMI/RFI in an **industrial environment** can significantly impact data communications if the wrong cable is used.
- Interference can be produced by **electrical machines**, **lightning**, and other **communications devices**, including **computers** and **radio equipment**.

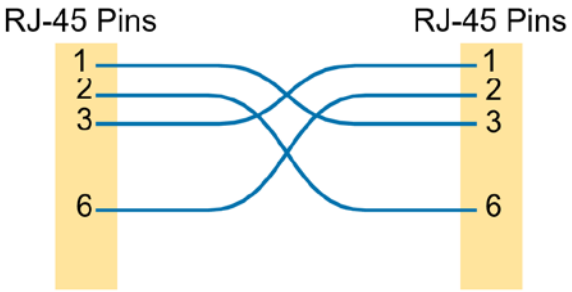
Standards

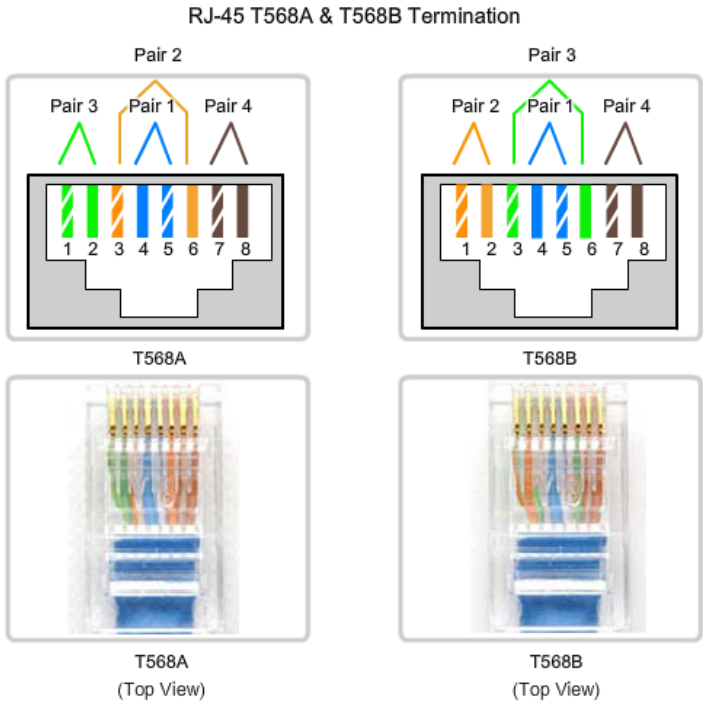
- Distance

Ethernet Type	Bandwidth	Cable Type	Maximum Distance
10Base-T	10Mbps	Cat3/Cat5 UTP	100m
100Base-TX	100Mbps	Cat5 UTP	100m
100Base-TX	200Mbps	Cat5 UTP	100m
100Base-FX	100Mbps	Multi-Mode Fiber	400m
100Base-FX	200Mbps	Multi-Mode Fiber	2Km
1000Base-T	1Gbps	Cat5e UTP	100m
1000Base-TX	1Gbps	Cat6 UTP	100m
1000Base-SX	1Gbps	Multi-Mode Fiber	550m
1000Base-LX	1Gbps	Single Mode Fiber	2Km
10GBASE-T	10Gbps	Cat6a/Cat7 UTP	100m
10GBASE-LX4	10Gbps	Multi-Mode Fiber	100m
10GBASE-LX4	10Gbps	Single Mode Fiber	10Km

Crossover UTP Cables

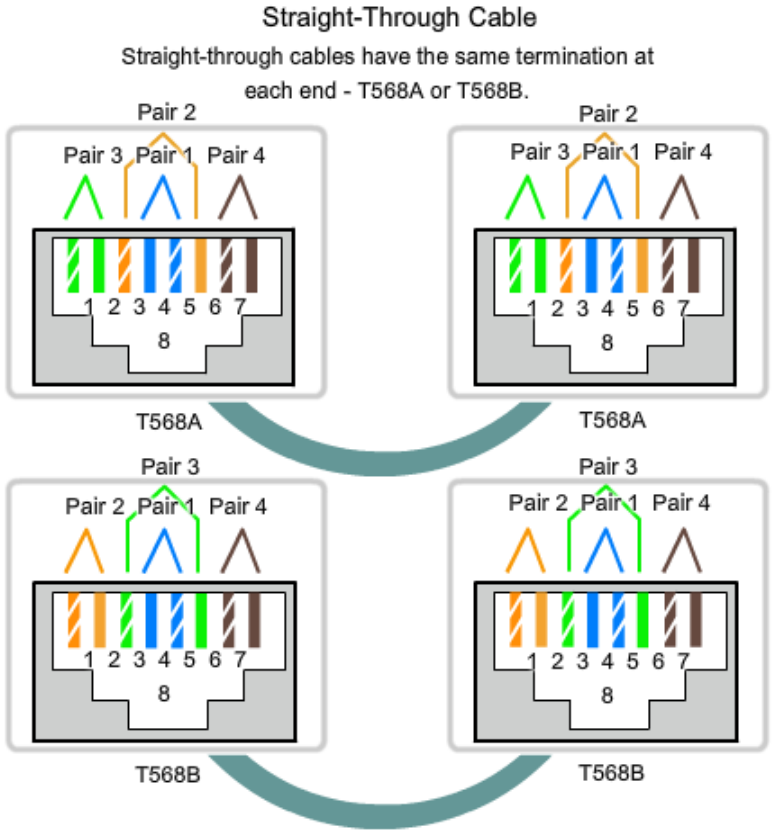
- **The RJ-45 connector**
- Pins 1 and 2 are used for **transmitting** and pins 3 and 6 are used for **receiving**





Straight-through UTP Cables

- RJ 45 Types of Interfaces



Straight-through UTP Cables

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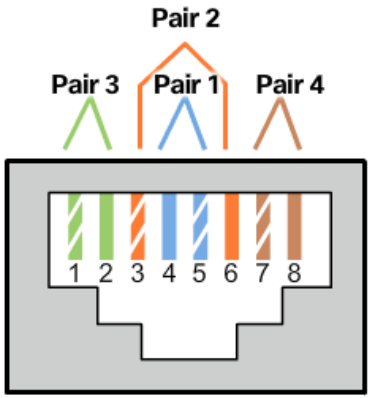
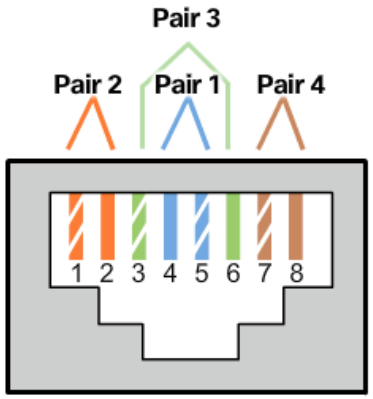


T568A



T568B

Cable Type	Standard	Application
Ethernet Straight-through	Both ends T568A or both ends T568B	Connects a network host to a network device such as a switch or hub.
Ethernet Crossover	One end T568A, other end T568B	• Connects two network hosts • Connects two network intermediary devices (switch to switch, or router to router)
Rollover	Cisco proprietary	Connects a workstation serial port to a router console port, using an adapter.

Types of Interfaces

- Typically, when connecting **different types** of devices, use a **straight-through cable**

  A straight-through cable has connectors on each end that are terminated **the same** in accordance with either the T568A or T568B standards.

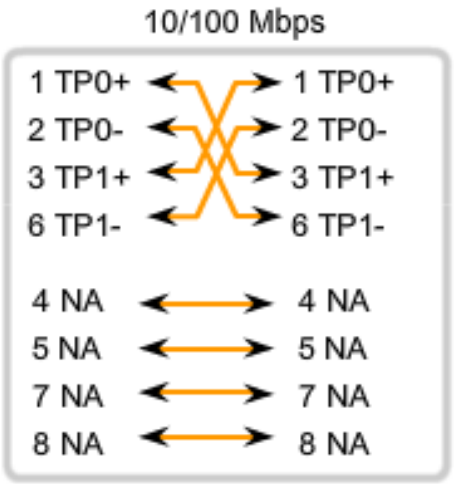
- When connecting **the same type** of device, use a **crossover cable**

Types of Interfaces

- Use **straight-through** cables for the following connections:
- **Switch to a router Ethernet port**
- **Computer to switch**
- **Computer to hub**

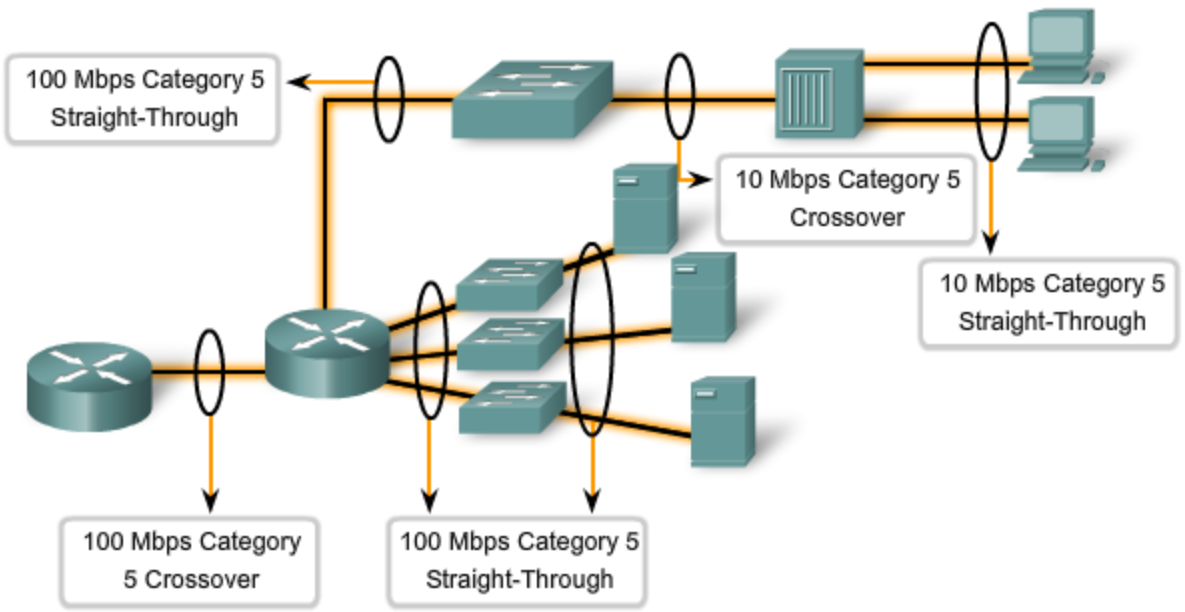
Types of Interfaces

- To summarize, **crossover cables** directly connect the following devices on a LAN:
  - **Switch to switch**
  - **Switch to hub**
  - **Hub to hub**
  - **Router to router Ethernet port connection**
  - **Computer to computer**
  - **Computer to a router Ethernet port**



LAN

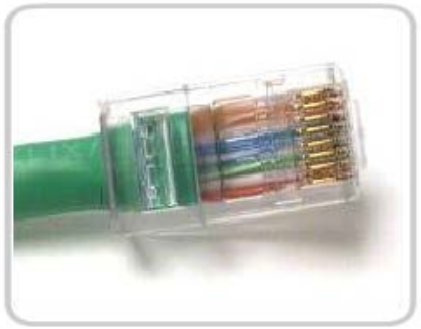
- LAN


100 Mbps Category 5
Straight-Through
10 Mbps Category 5
Crossover
10 Mbps Category 5
Straight-Through
100 Mbps Category
5 Crossover
100 Mbps Category 5
Straight-Through

Connector

- Correct **Connector Termination**
- https://www.youtube.com/watch?v=lullzS740wI
- It is essential that all copper media terminations be of **high quality** to ensure optimum performance with current and future network technologies.

Bad connector - Wires are untwisted for too great a length.



Good connector - Wires are untwisted to the extent necessary to attach the connector.

UTP

Lab 3 Task

Lab

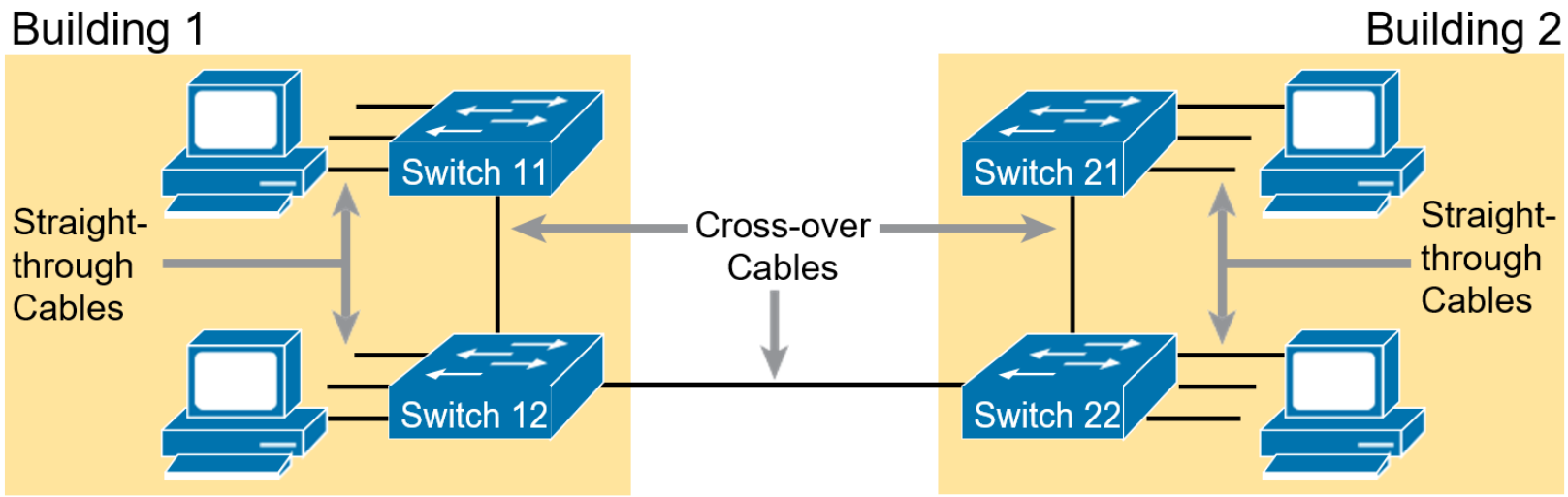
- Task 1

  Crossover UTP Cables

Lab

- Task 2

  Straight-through UTP Cables



Terminate with an RJ45 Connector

- Using a **Crimping Tool**, trim the **end of the cable** you're terminating, to ensure that the ends of the conducting wires are **even**
- Being careful not to damage the **inner conducting wires**, strip off approximately **2 cm** of the cable's jacket, using a UTP cable stripper

Terminate with an RJ45 Connector

- Separate the **4 twisted wire pairs** from each other, and then **unwind each pair**, so that you end up with 8 individual wires
- **Flatten the wires** out as much as possible, since they'll need to be **very straight** for proper insertion into the connector
- **Arrange the wires** in a flat, side-by-side ribbon formation, placing them in the following order: **T568A** or **T568B**

Terminate with an RJ45 Connector

- Holding the RJ45 connector so that its pins are facing away from you and the plug-clip side is facing down, carefully **insert the flattened, arranged wires** into the connector, pushing through until the wire ends emerge from the pins. For strength of connection, also **push as much of the cable jacket as possible** into the connector

Terminate with an RJ45 Connector

- Check **the correct order**; if not, remove them from the connector, **rearrange** into proper formation, and re-insert
- Remember, once the connector is **crimped** onto the cable, **it's permanent**
- If you realize that a **mistake** has been made in wire order after termination, you'll have **to cut the connector** off and start all over again

Terminate with an RJ45 Connector

- Insert the prepared connector/cable **assembly into the RJ45 slot** in your crimping tool
- **Firmly squeeze** the crimper's handles together until you can't go any further
- After the first termination is complete, repeat process on the **opposite end** of your cable