Computer Networks

Interfaces and Cabling

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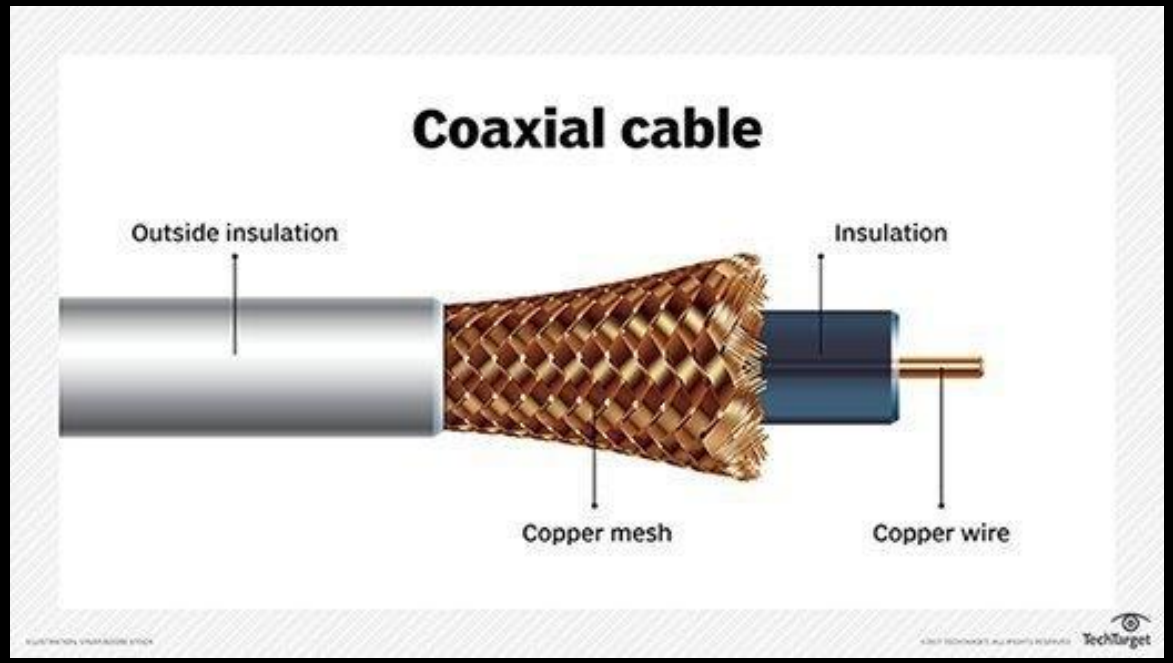
Coaxial Cable and Twinaxial Cable
Twisted-Pair Cable
Cable Pinouts
Cables Wiring
PoE
Fiber Optic Cables
Cable Troubleshooting

Coaxial Cable and Twinaxial Cable

- **Coaxial cable** was the foundation for Ethernet networks in the 1980s.
- You'll most likely never see a coaxial cable network for computers.
- A form of coax is still used for cable Internet, cable TV, and some multimedia connection types.



Coaxial Cable and Twinaxial Cable

- Connectors of coaxial cables

Source: MCM Electronics, Inc

Figure 5-7 F-connector

Igor Smichkov/Shutterstock.com

Figure 5-8 BNC connector

Coaxial Cable and Twinaxial Cable

- Twinaxial cable looks very similar to coax cable except that there are two cores, or conductors, inside the cable.

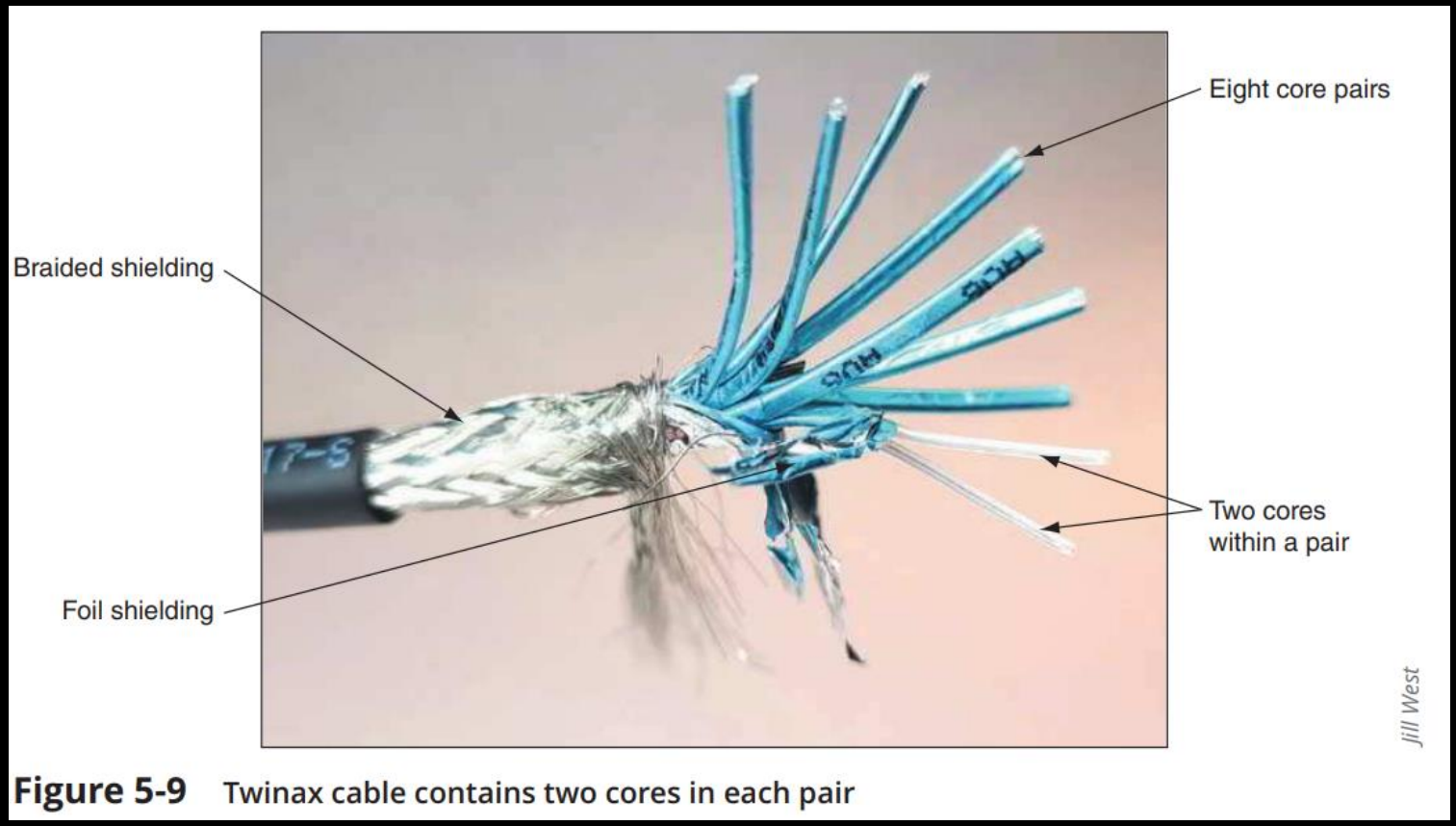


Figure 5-9 Twinax cable contains two cores in each pair

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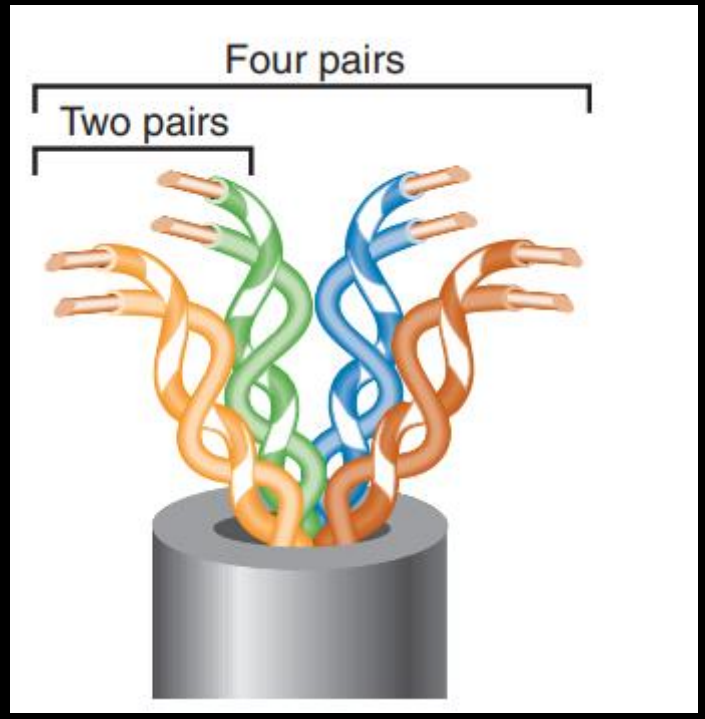
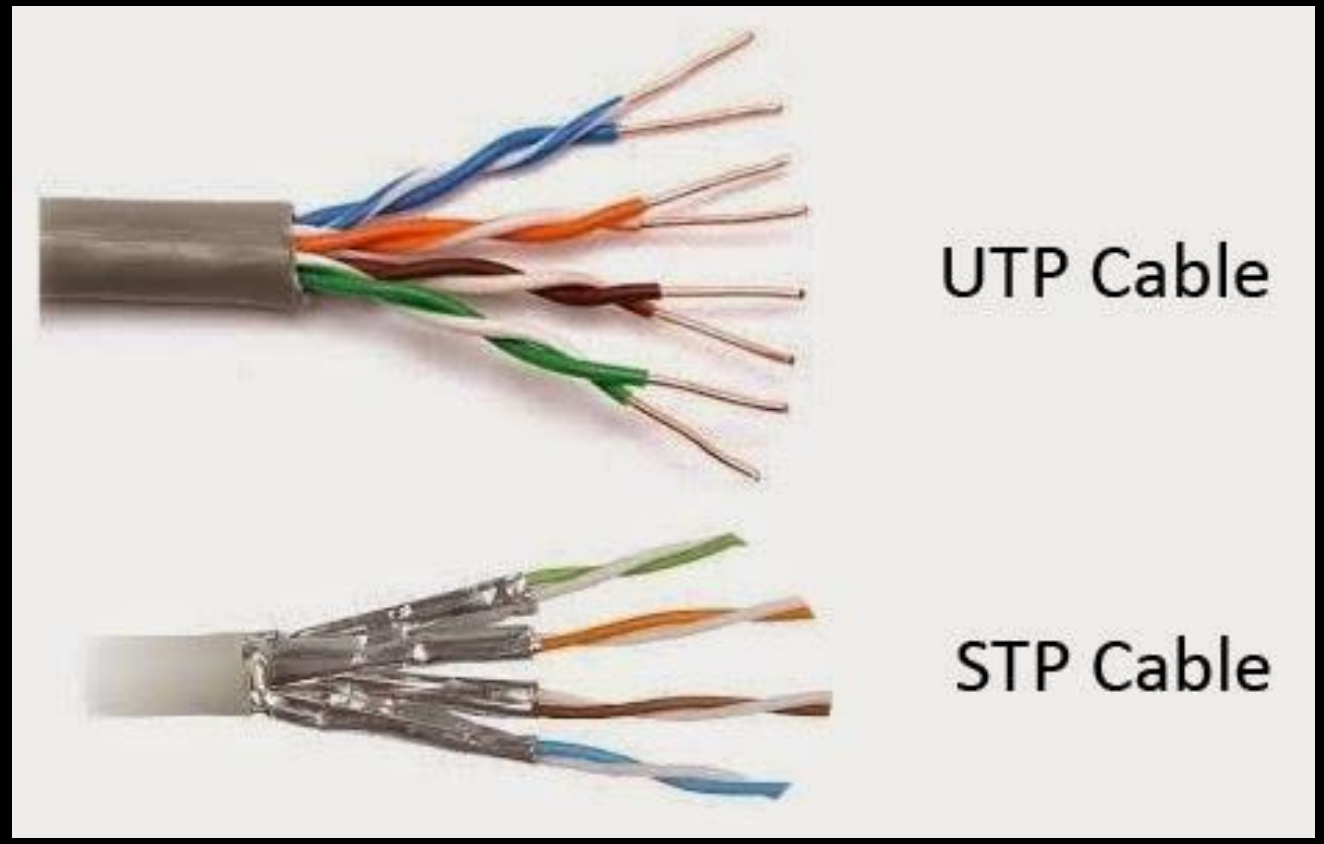
Twisted-Pair Cable

- Twisted-pair cable consists of color-coded pairs of insulated copper wires.
- Every two wires are twisted around each other to form pairs.
  - All the pairs are encased in a plastic sheath



Twisted-Pair Cable

- Twisted-pair cabling in Ethernet networks contains four wire pairs.
  - 8 wires in total.
- There are two types:
  - Shielded Twisted Pair (STP)
  - Unshielded Twisted Pair (UTP)



Twisted-Pair Cable

On **Fast Ethernet** networks:

- Maximum data rate of 100 Mbps.
- One pair sends data, another pair receives data.
- The other two pairs are not used for data transmission.

On **Gigabit Ethernet** and higher standards:

- Data transfer rate of 1000 Mbps or more.
- Use all four pairs for both sending and receiving.

Twisted-Pair Cable

- Twisted pair cabling standards

UTP Categories - Copper Cable				
UTP Category	**Data Rate**	**Max. Length**	**Cable Type**	**Application**
CAT1	Up to 1Mbps	-	Twisted Pair	Old Telephone Cable
CAT2	Up to 4Mbps	-	Twisted Pair	Token Ring Networks
CAT3	Up to 10Mbps	100m	Twisted Pair	Token Rink & 10BASE-T Ethernet
CAT4	Up to 16Mbps	100m	Twisted Pair	Token Ring Networks
CAT5	Up to 100Mbps	100m	Twisted Pair	Ethernet, FastEthernet, Token Ring
CAT5e	Up to 1 Gbps	100m	Twisted Pair	Ethernet, FastEthernet, Gigabit Ethernet
CAT6	Up to 10Gbps	100m	Twisted Pair	GigabitEthernet, 10G Ethernet (55 meters)
CAT6a	Up to 10Gbps	100m	Twisted Pair	GigabitEthernet, 10G Ethernet (55 meters)
CAT7	Up to 10Gbps	100m	Twisted Pair	GigabitEthernet, 10G Ethernet (100 meters)

Twisted-Pair Cable

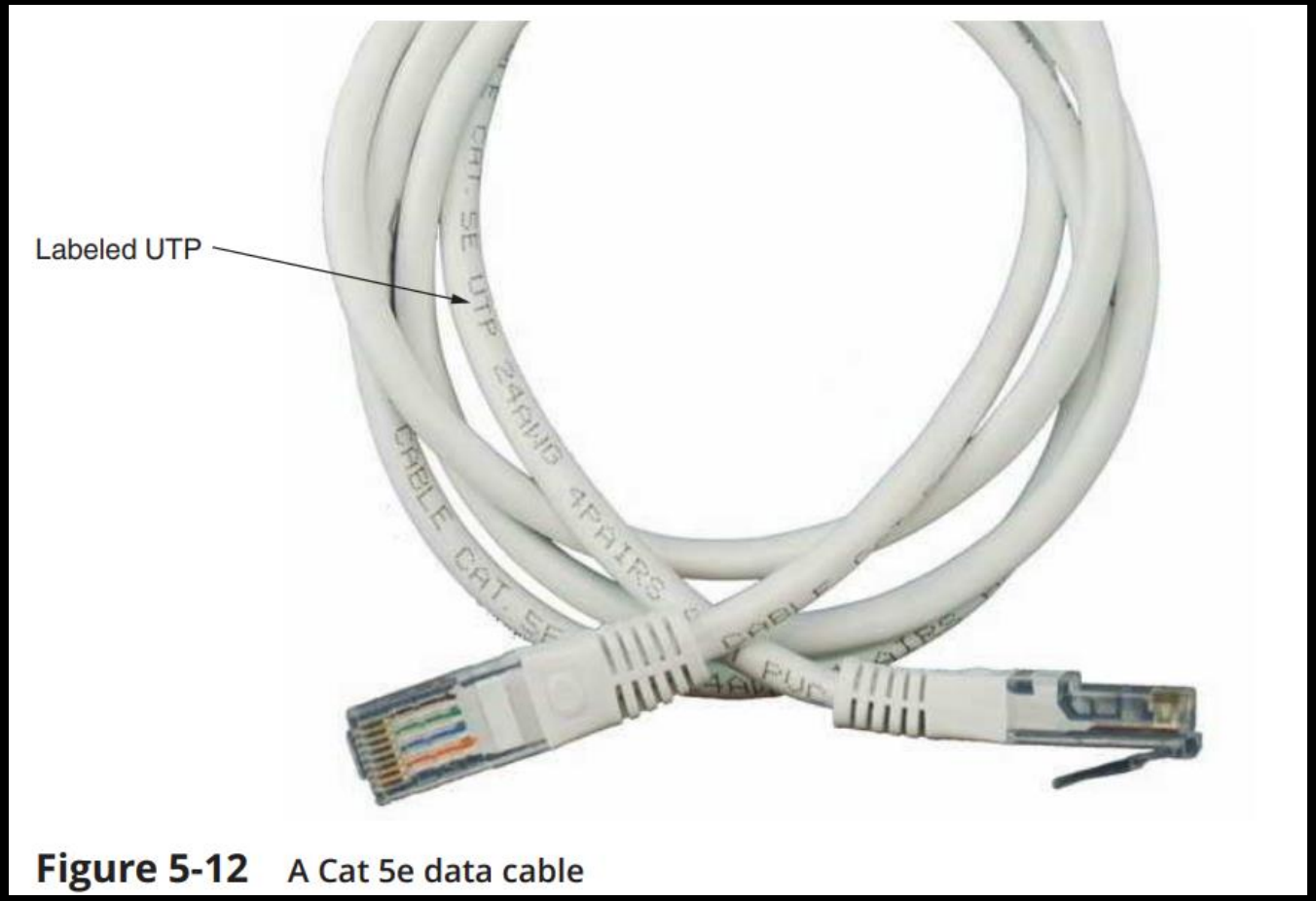


Figure 5-12 A Cat 5e data cable

Twisted-Pair Cable

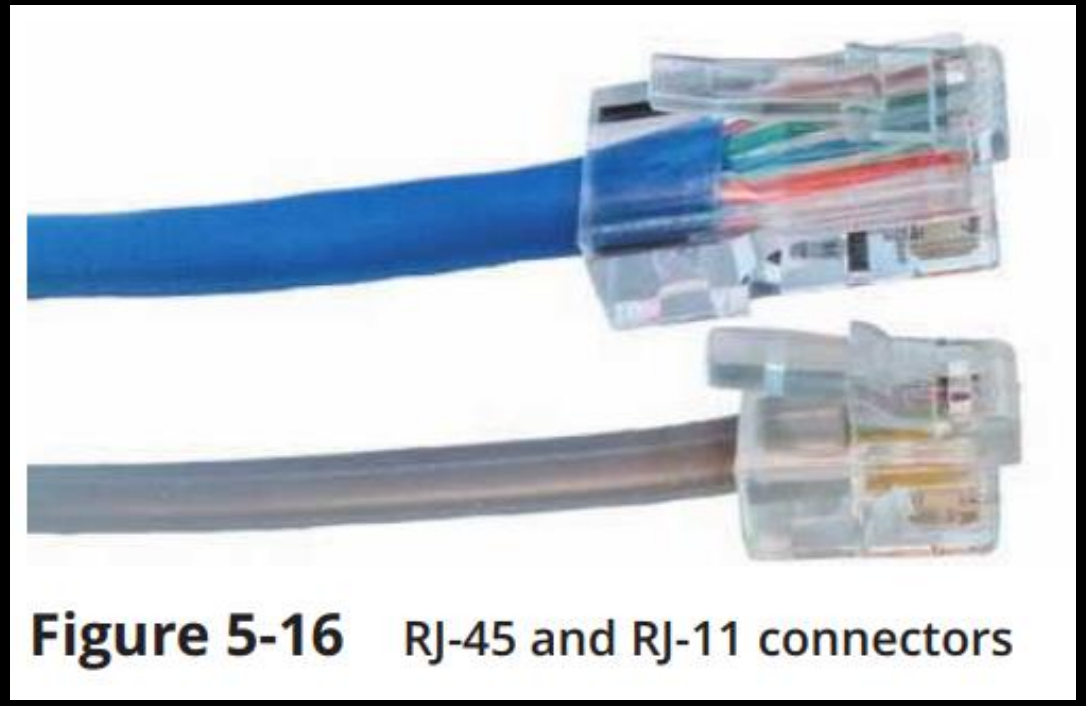


Figure 5-16 RJ-45 and RJ-11 connectors

Twisted-Pair Cable

- A cable's category (such as Cat 5e or Cat 6) determines the fastest network speed it can support.

Standard	Maximum transmission throughput (Mbps)	Maximum distance per segment (m)	Physical media	Pairs of wires used for transmission
10BASE-T	10	100	Cat 3 or better UTP	2 pair
100BASE-T or **100BASE-TX** (*Fast Ethernet*)	100	100	100BASE-T: Cat 5 or better 100BASE-TX: Cat 6 or better	2 pair
1000BASE-T (*Gigabit Ethernet*)	1000	100	Cat 5 or better (Cat 5e is preferred)	4 pair
10GBASE-T (*10-Gigabit Ethernet*)	10,000	100	Cat 6a or Cat 7 (Cat 7 is preferred)	4 pair
40GBASE-T	40,000	30	Cat 8	4 pair

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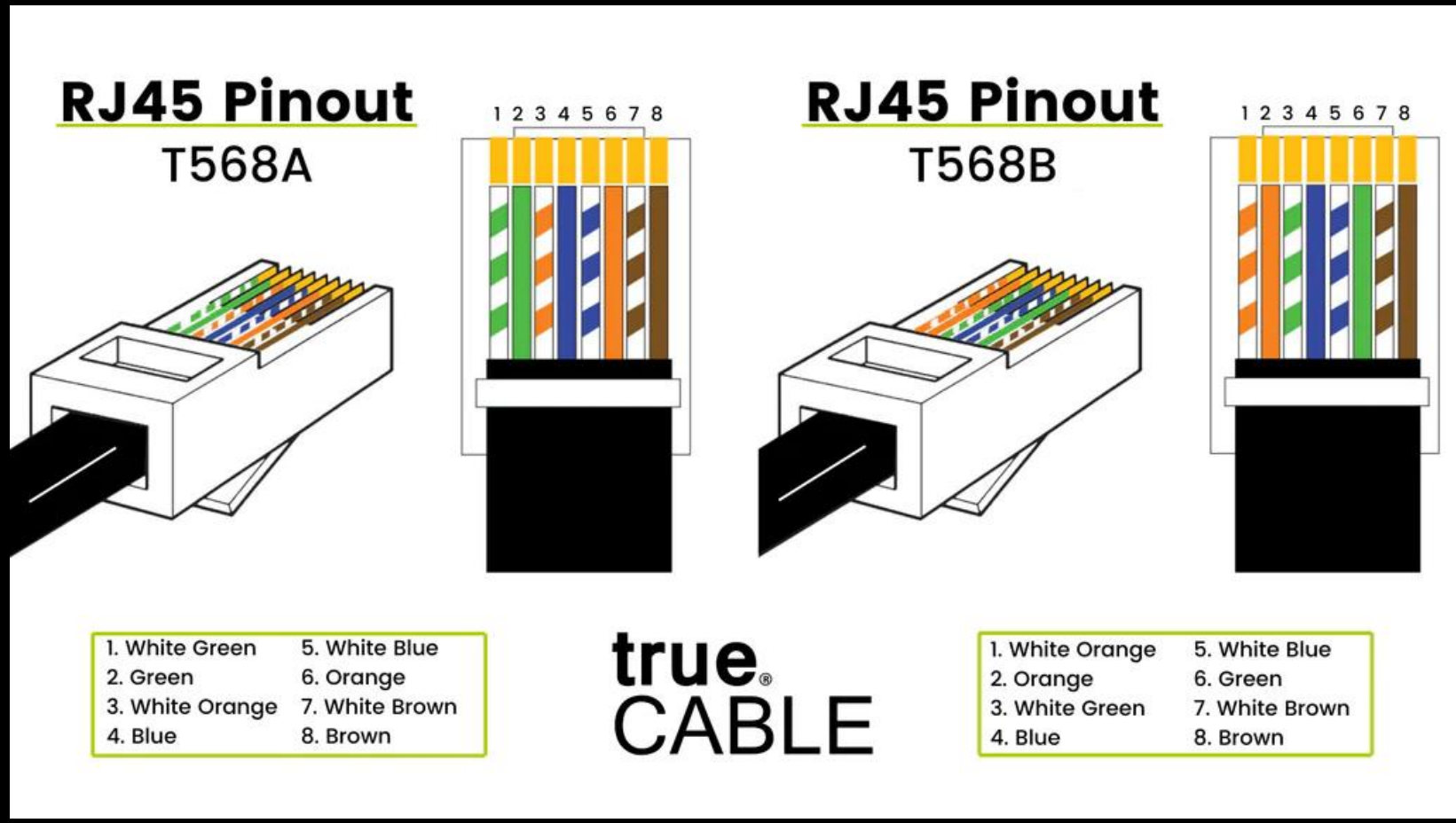
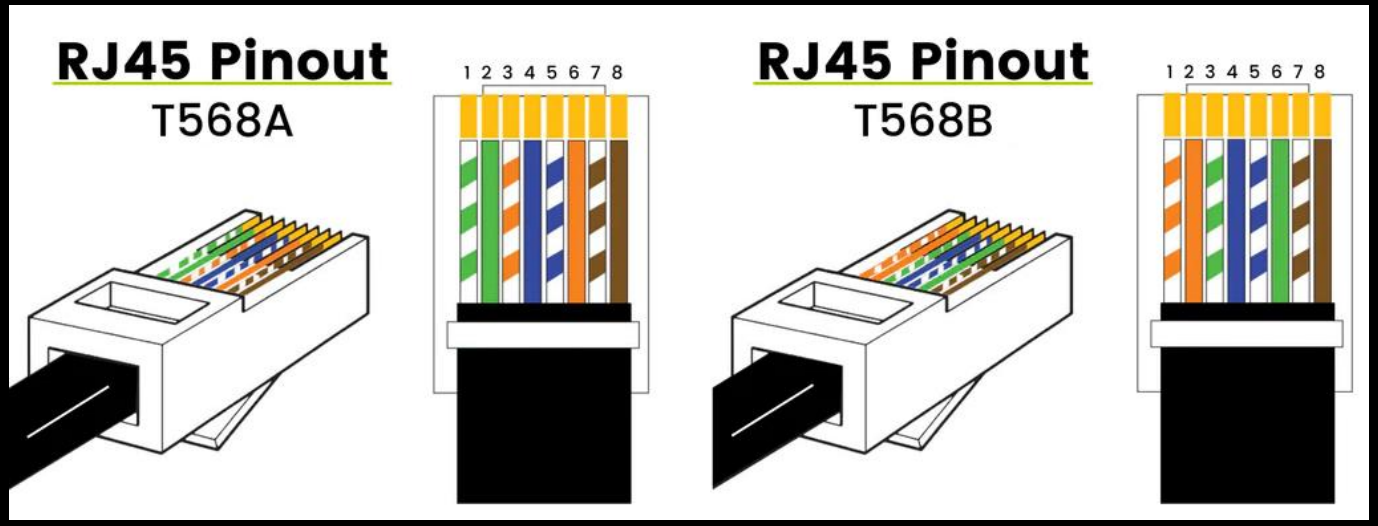
Cable Pinouts

- There are two specifications for inserting twisted-pair cables into RJ-45 plugs:
  - T568A
  - T568B



Cable Pinouts



Pin #	T568A Color	T568B Color	Fast Ethernet function	Gigabit Ethernet function
1	White/green	White/orange	Tx+	Bidirectional+
2	Green	Orange	Tx−	Bidirectional−
3	White/orange	White/green	Rx+	Bidirectional+
4	Blue	Blue	*Unused*	Bidirectional+
5	White/blue	White/blue	*Unused*	Bidirectional−
6	Orange	Green	Rx−	Bidirectional−
7	White/brown	White/brown	*Unused*	Bidirectional+
8	Brown	Brown	*Unused*	Bidirectional−

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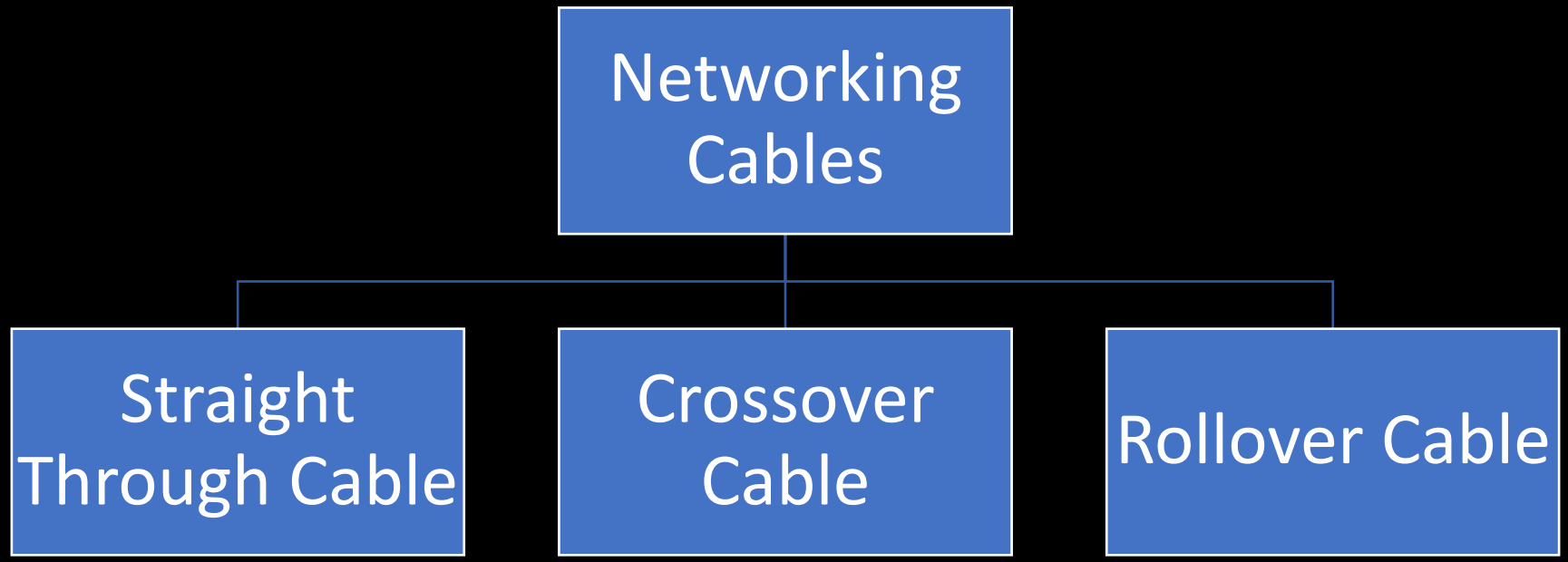
Cables Wiring

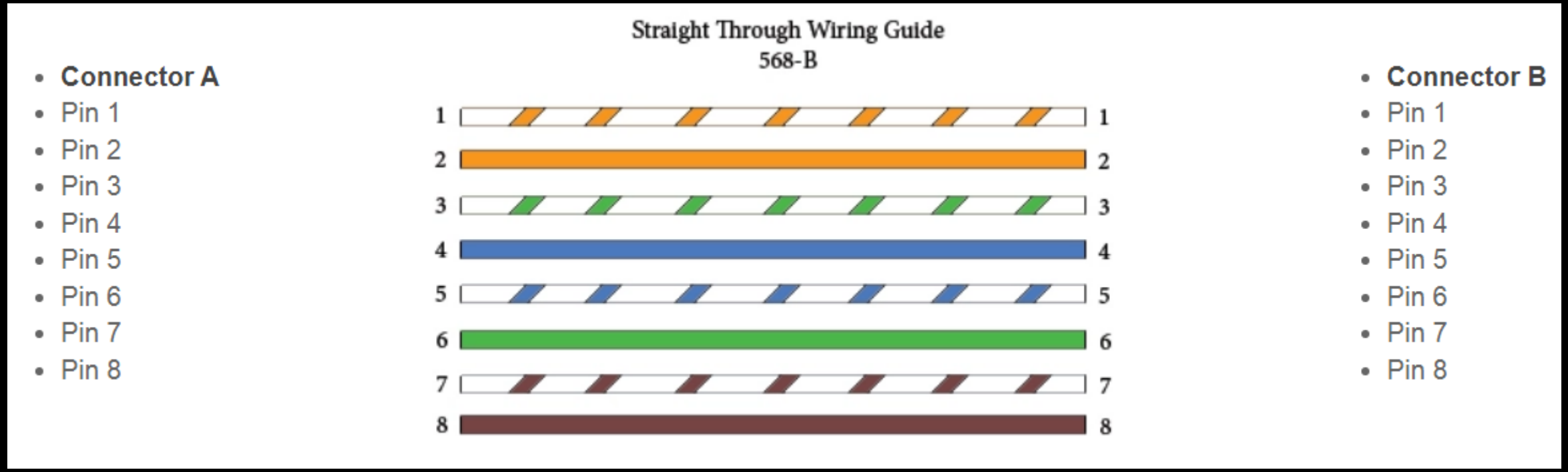
- There are 3 wiring techniques:



Cables Wiring

Straight through cable (patch cable)

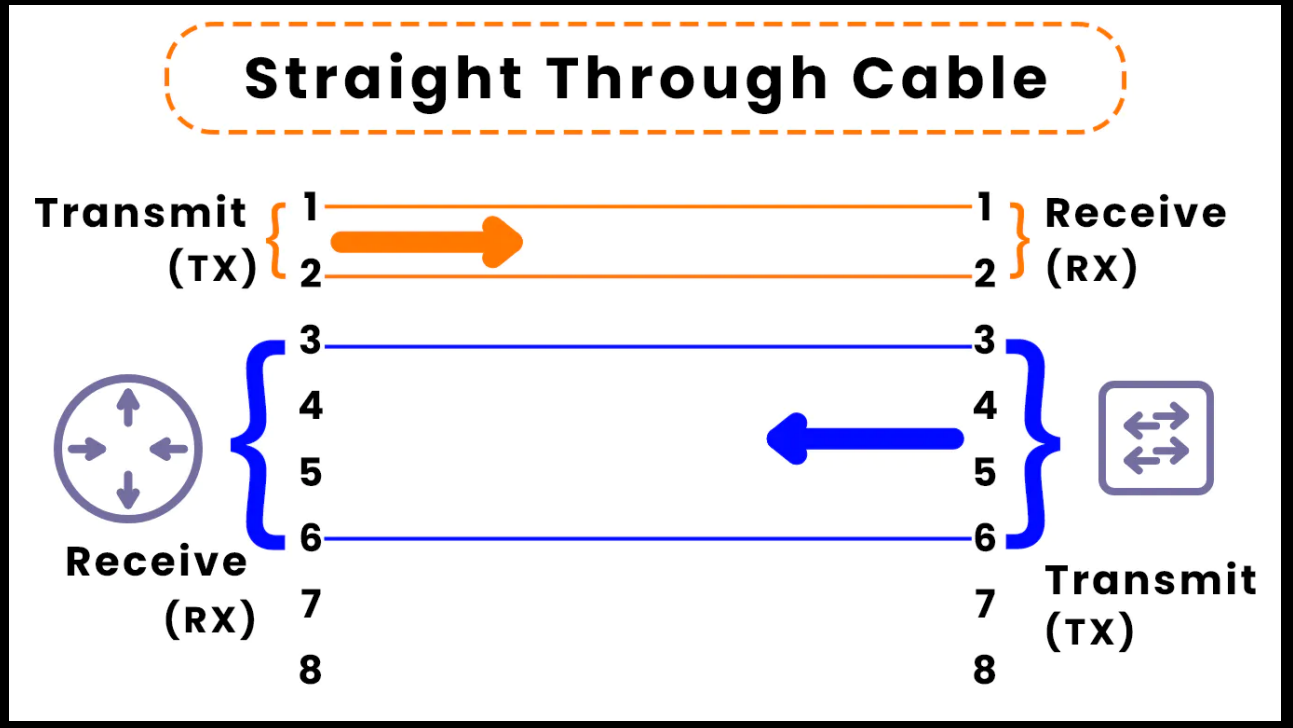
- Cables that have the pin assignments on each end of the cable. In other words, Pin 1 connector A goes to Pin 1 on connector B, Pin 2 to Pin 2, etc.



Cables Wiring

Straight through cable (patch cable)

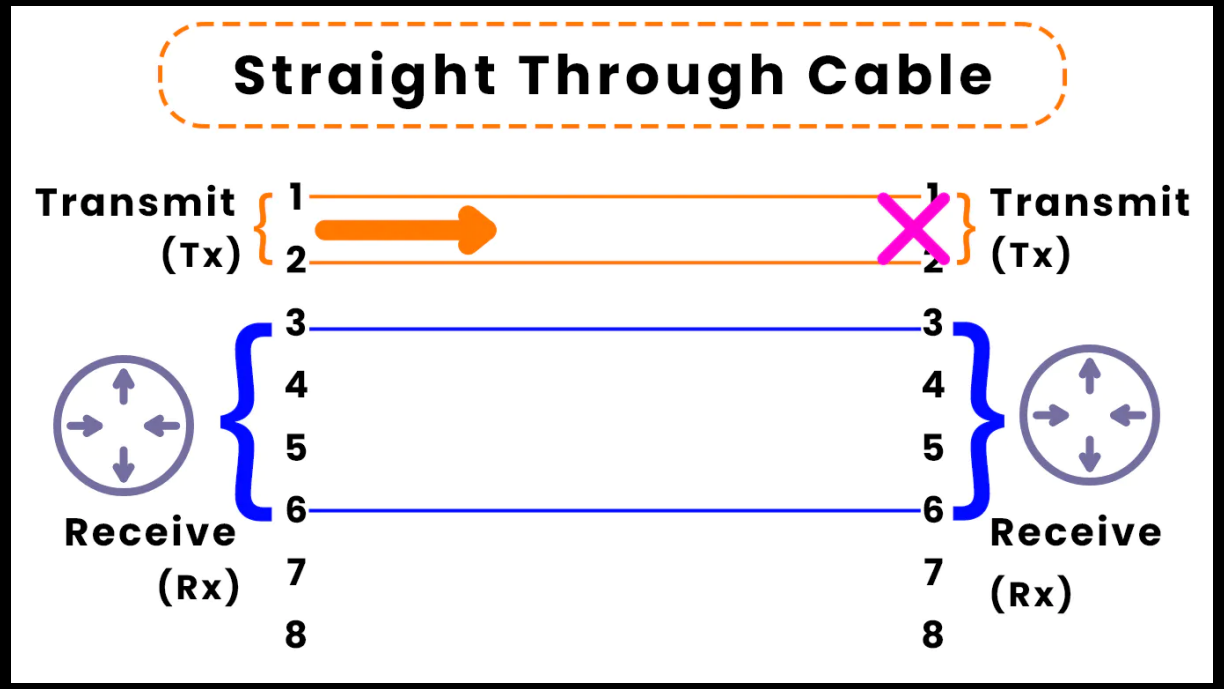
- These straight-through cables are designed for most connections you'll need in a network, such as connecting a workstation to a switch or a switch to a router.



Cables Wiring

Straight through cable (patch cable)

- Connecting two devices that use the same pin pairs to transmit/receive data (for example: router-router, router-PC, PC-PC, switch-switch), the data transmitted from one device will arrive on the Tx pins of the other device, not the RX pins.



Cables Wiring

Crossover Cable

- In a crossover cable, each pin pair on one end connects to the opposite pair on the other end. Pin 1 connects to Pin 3. Pin 2 connects to Pin 6. Pin 3 connects to Pin 1. Pin 6 connects to Pin 2.

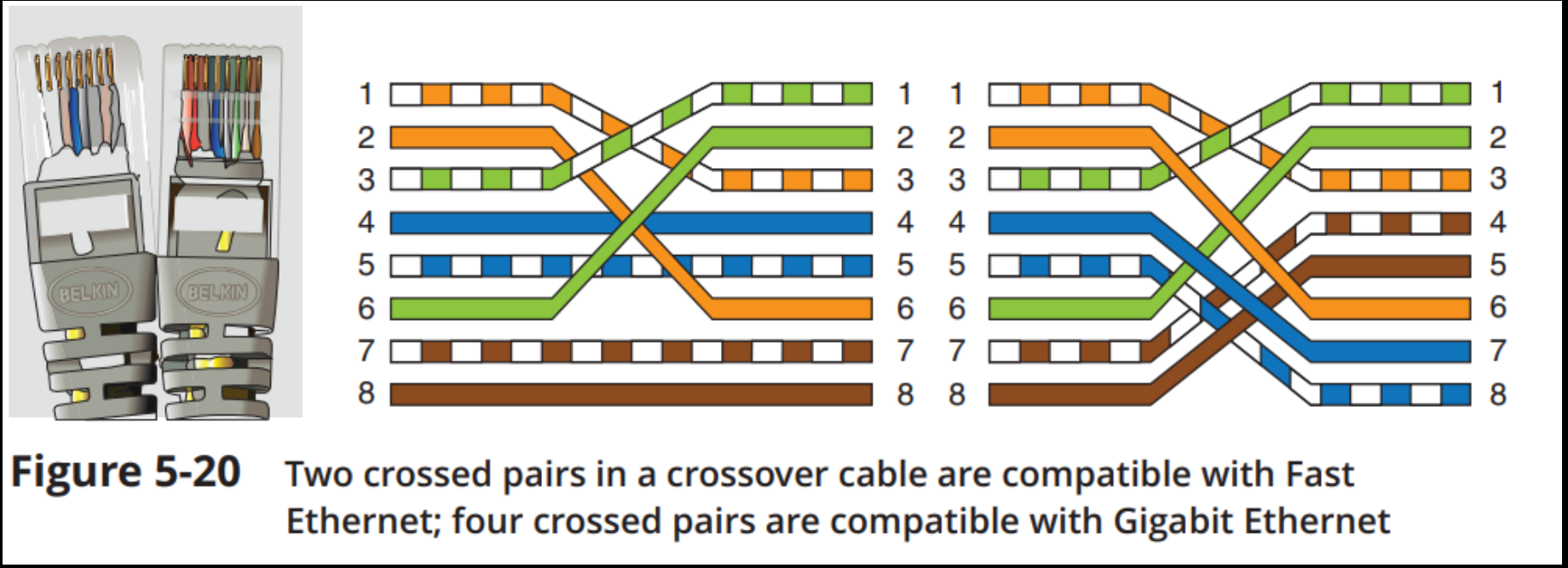
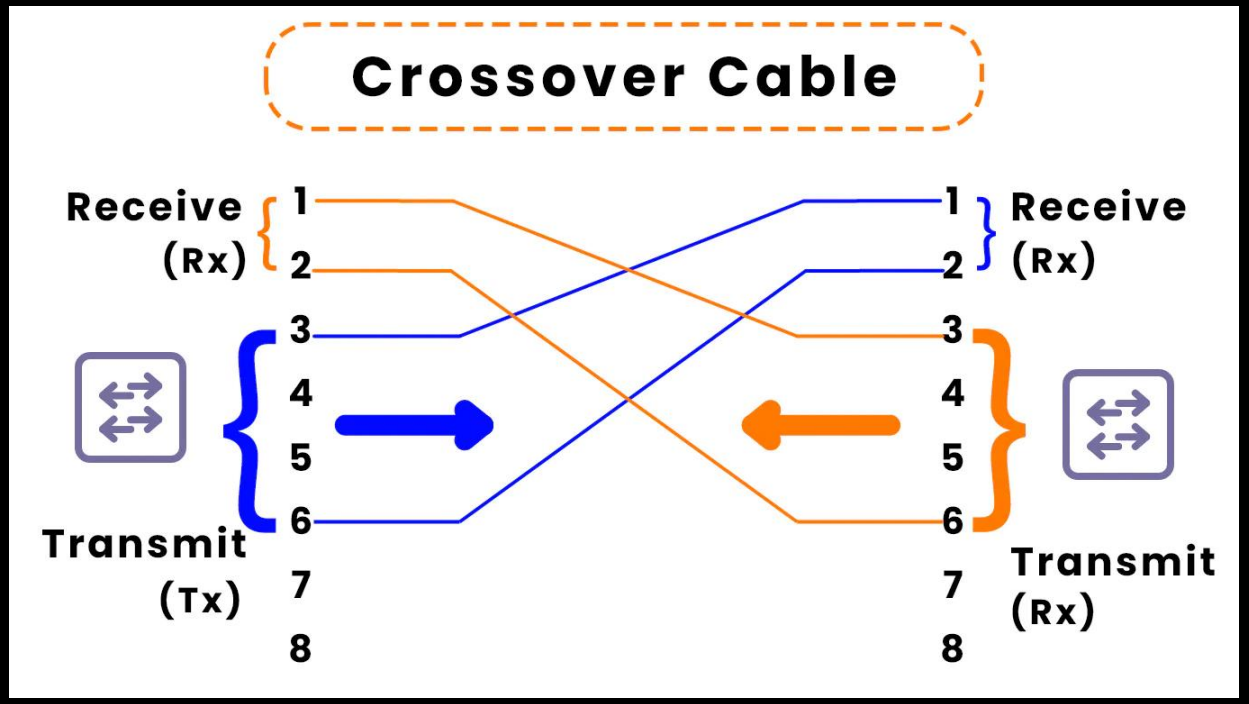
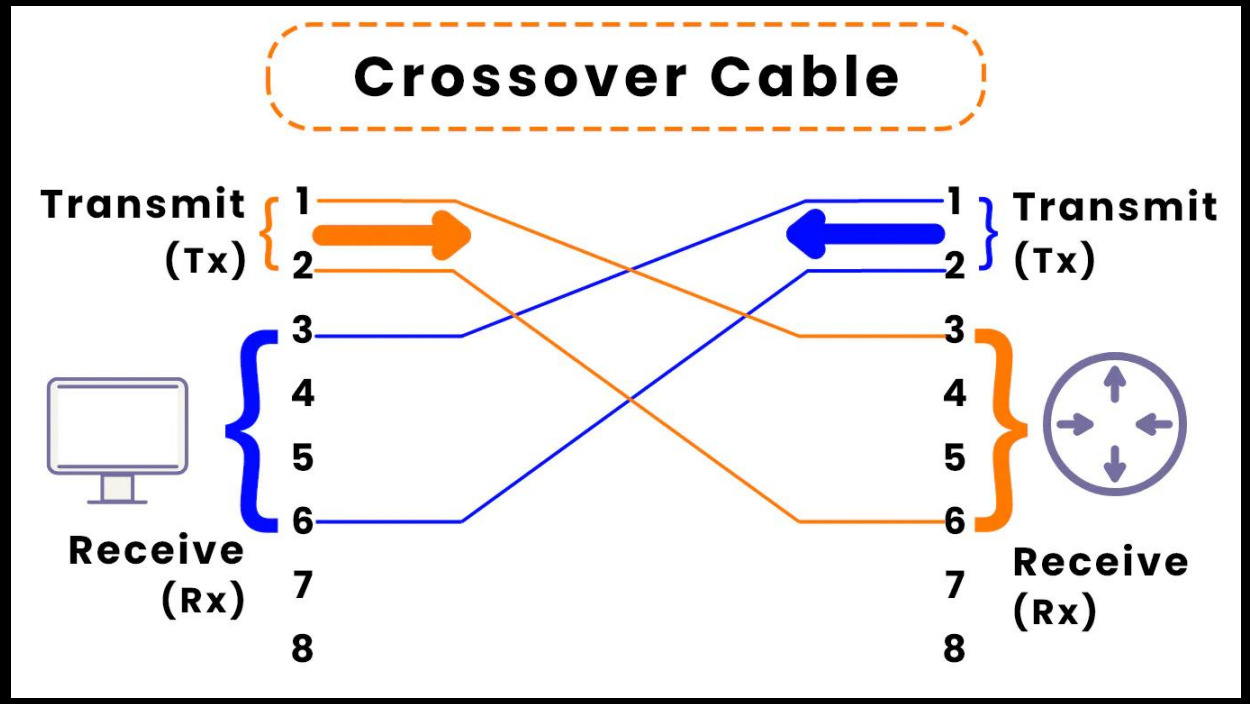


Figure 5-20 Two crossed pairs in a crossover cable are compatible with Fast Ethernet; four crossed pairs are compatible with Gigabit Ethernet

Cables Wiring

Crossover Cable





Cables Wiring

Crossover Cable

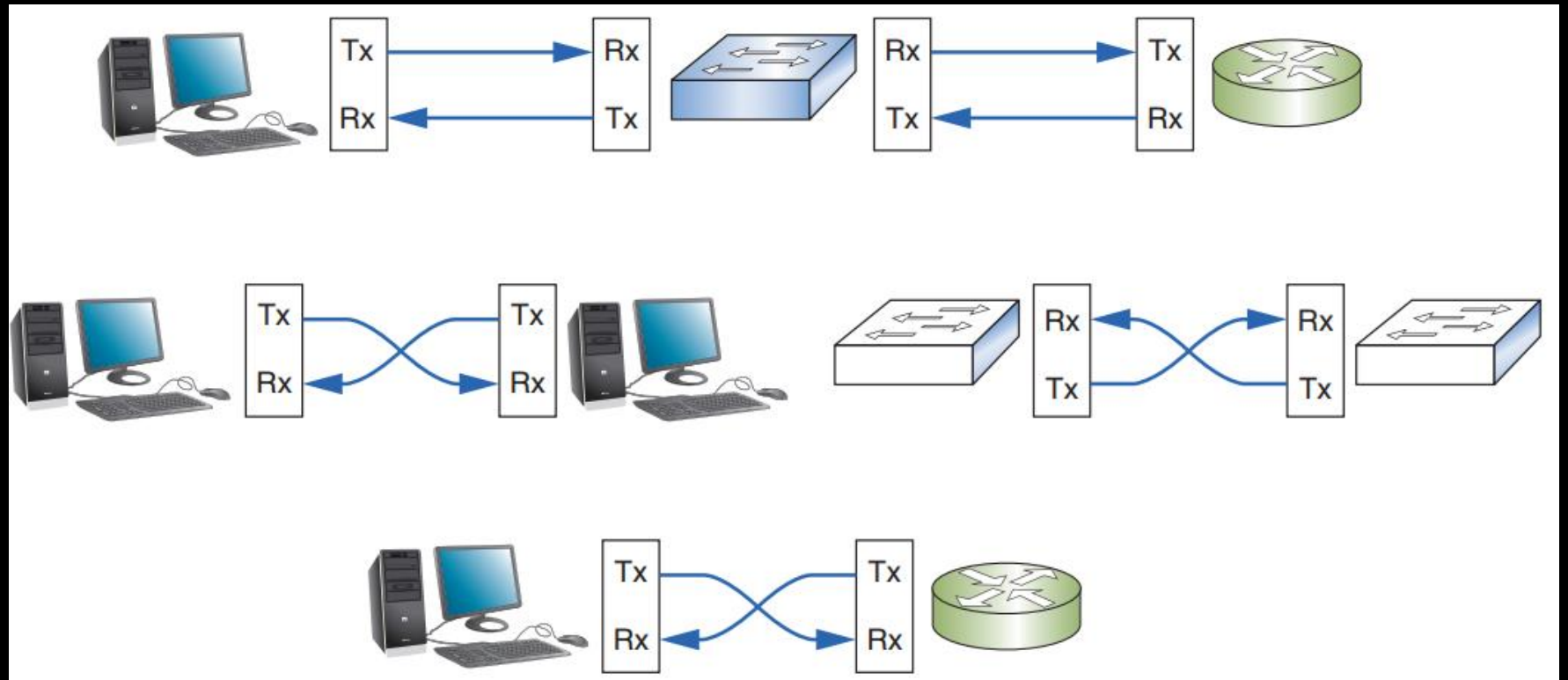
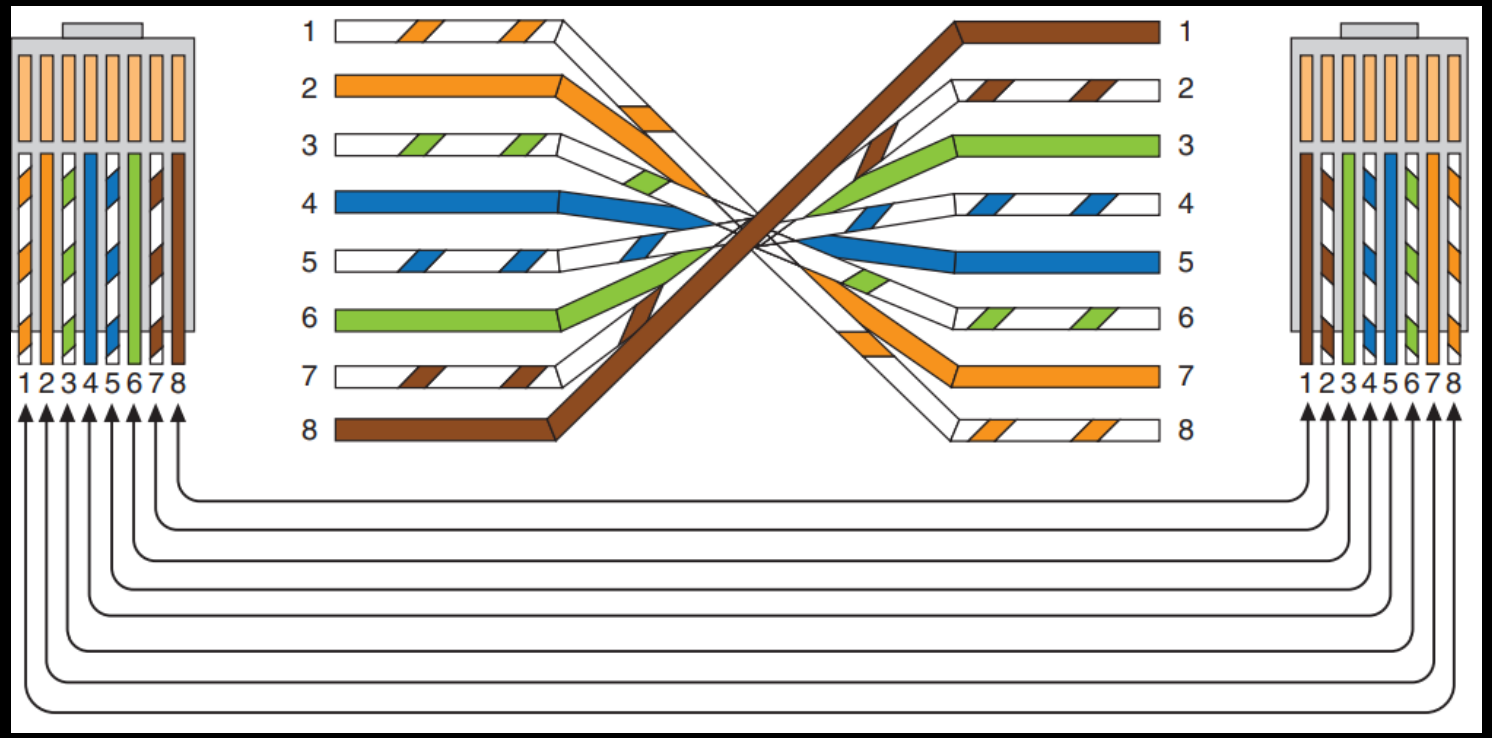


Figure 5-19 On legacy networks, straight-through cables connect unlike devices and crossover cables connect like devices

Cables Wiring

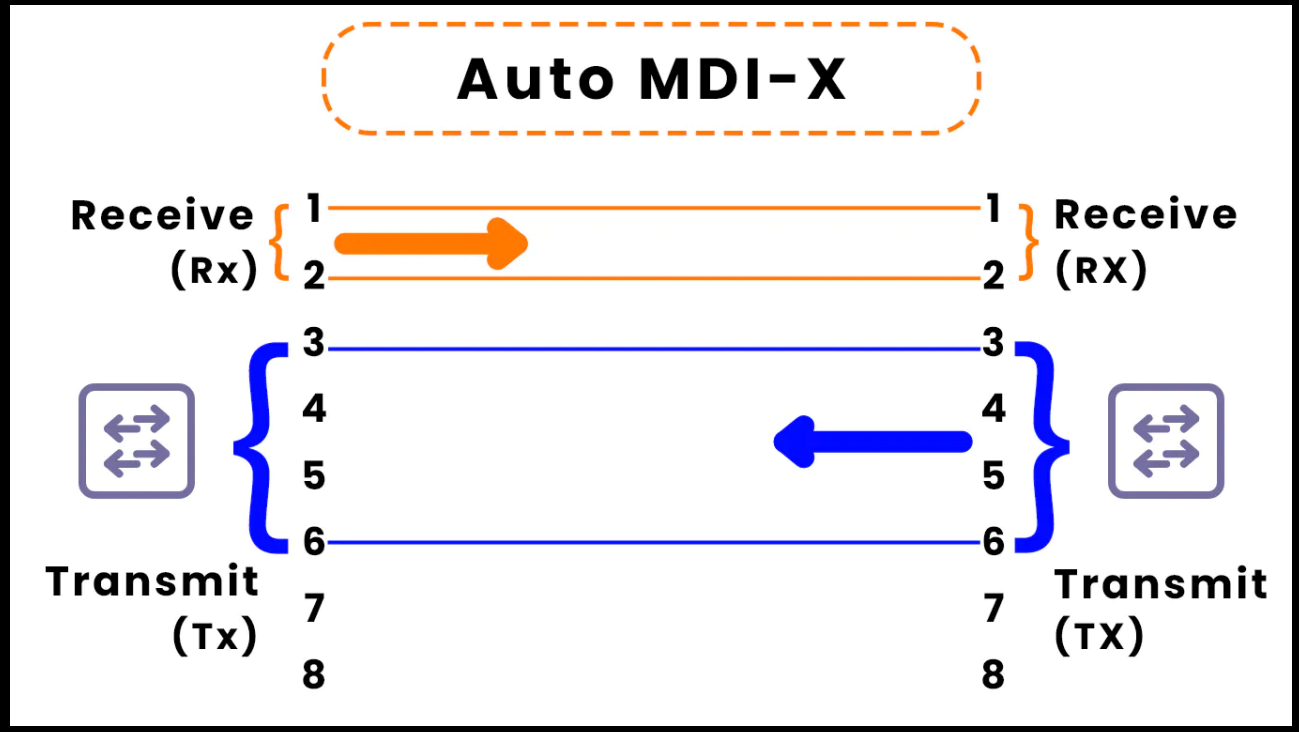
Rollover Cable (console cables)

- A rollover cable reverses all the wires without regard to how they are paired.
- Routers have two types of ports:
  - **Ethernet** ports allow for network communications.
  - **Console** port is used to configure the device.



Cables Wiring

- Newer devices have **auto-MDI-X** ports.
- Auto-MDI-X automatically negotiate the transmit and receive wires between devices, even if you're not using the correct cable for the application.



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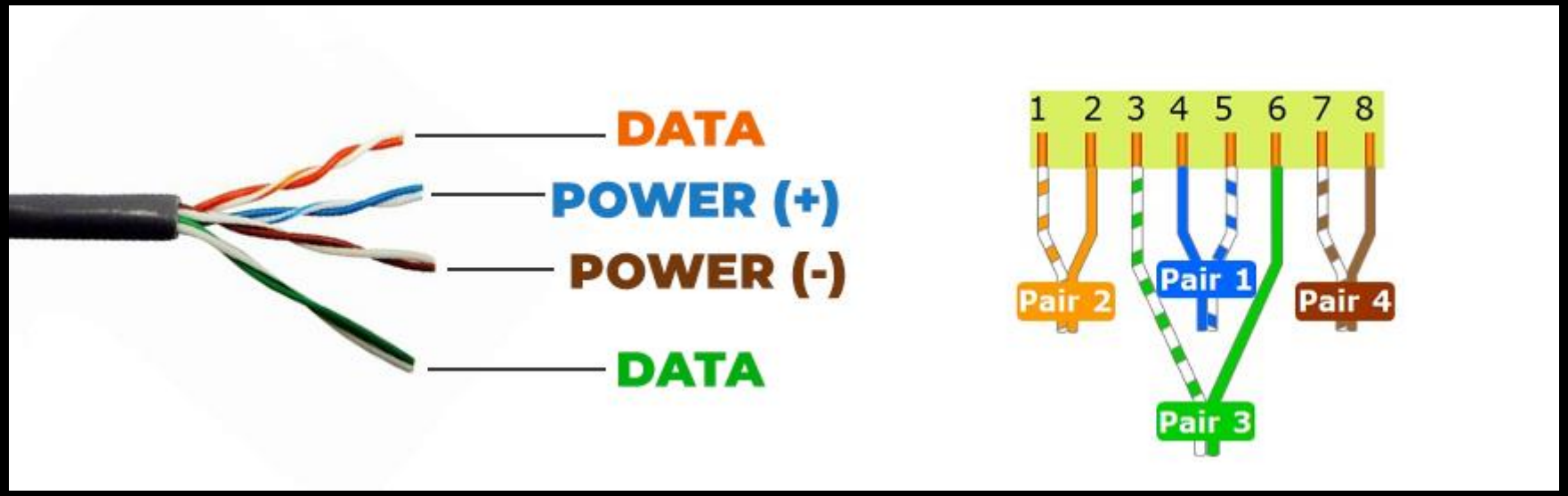
PoE

- Have you ever wondered why landline telephone never loses power?

PoE

- Have you ever wondered why landline telephone never loses power?
- This is because home telephones have long received power from the telephone company over the line that enters a residence.
  - This power is necessary for dial tone and ringing.
- This is known as Power over Ethernet.



PoE

- PoE is useful for sources that require reliable power source.

Figure 5-28 PoE-capable switch

PoE

- PoE is useful for sources that require reliable power source.

Figure 5-29 PoE-capable security camera

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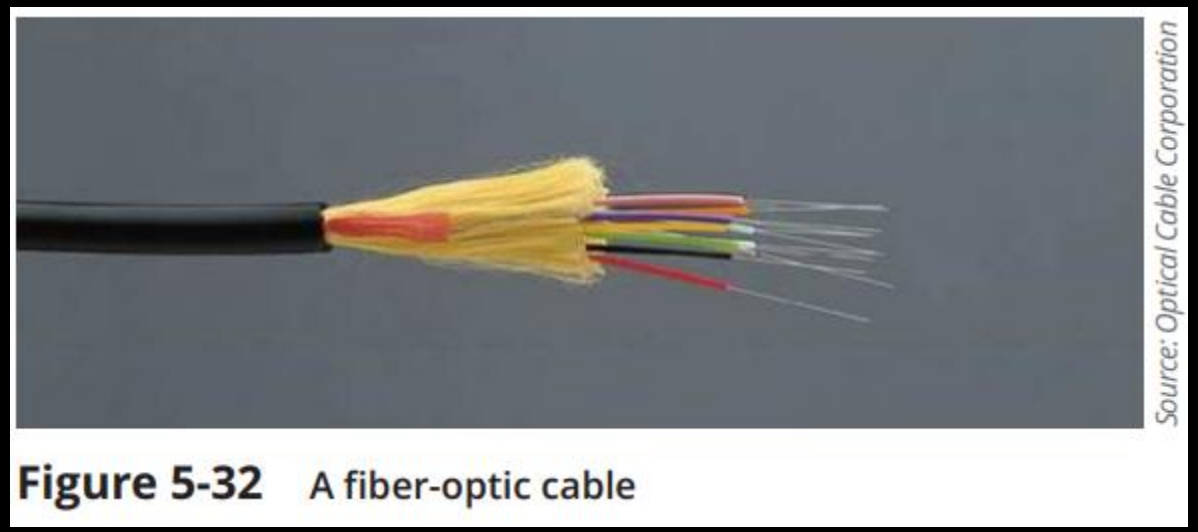
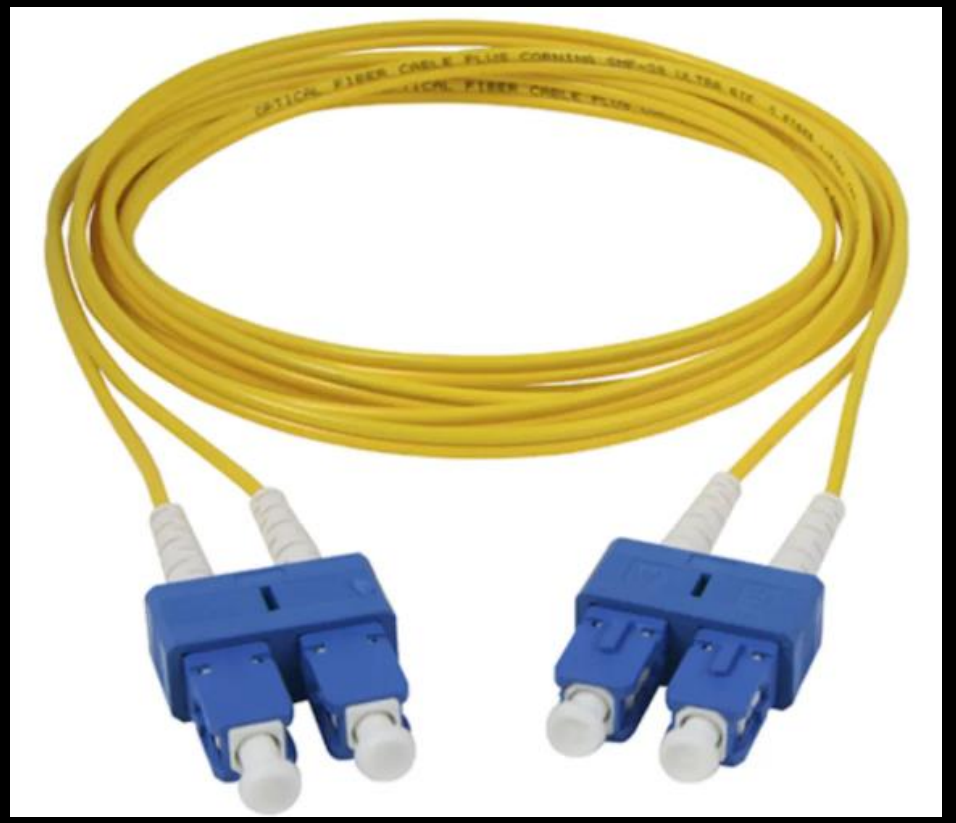
Fiber-Optic Cables

- Fiber-optic cables contain a very fine glass fiber which is used to transmit light, rather than transmitting electricity along a copper cable.

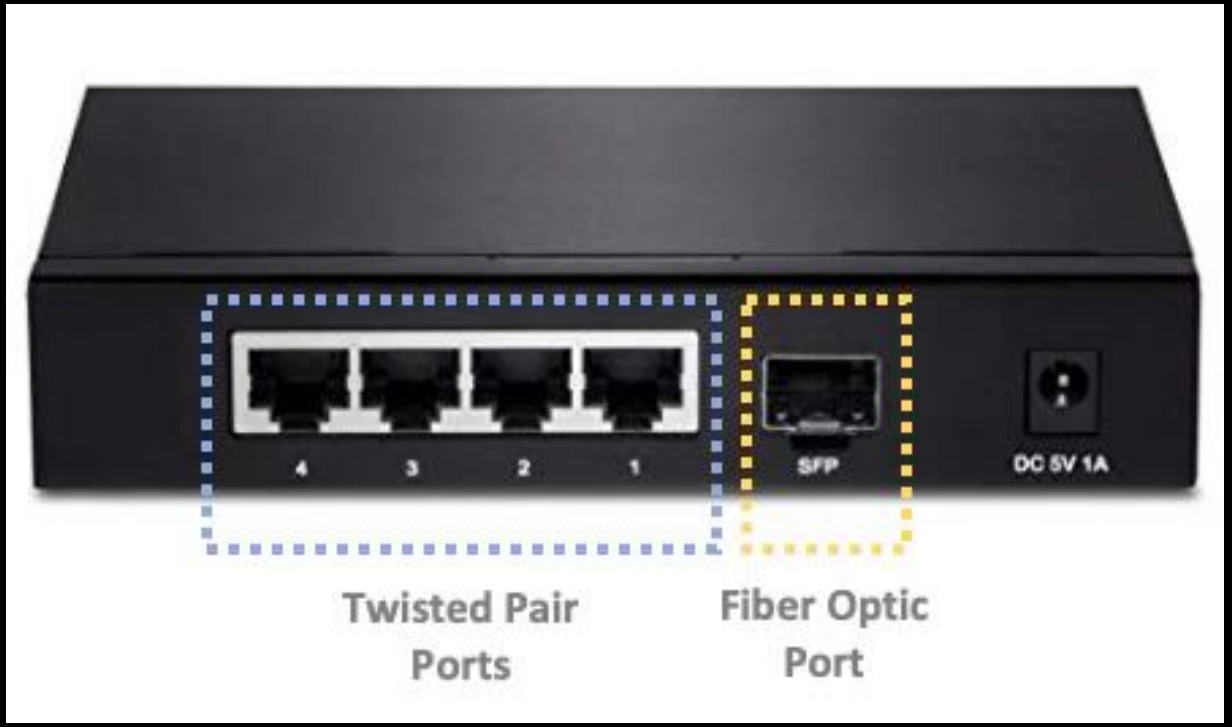


Source: Optical Cable Corporation

Figure 5-32 A fiber-optic cable

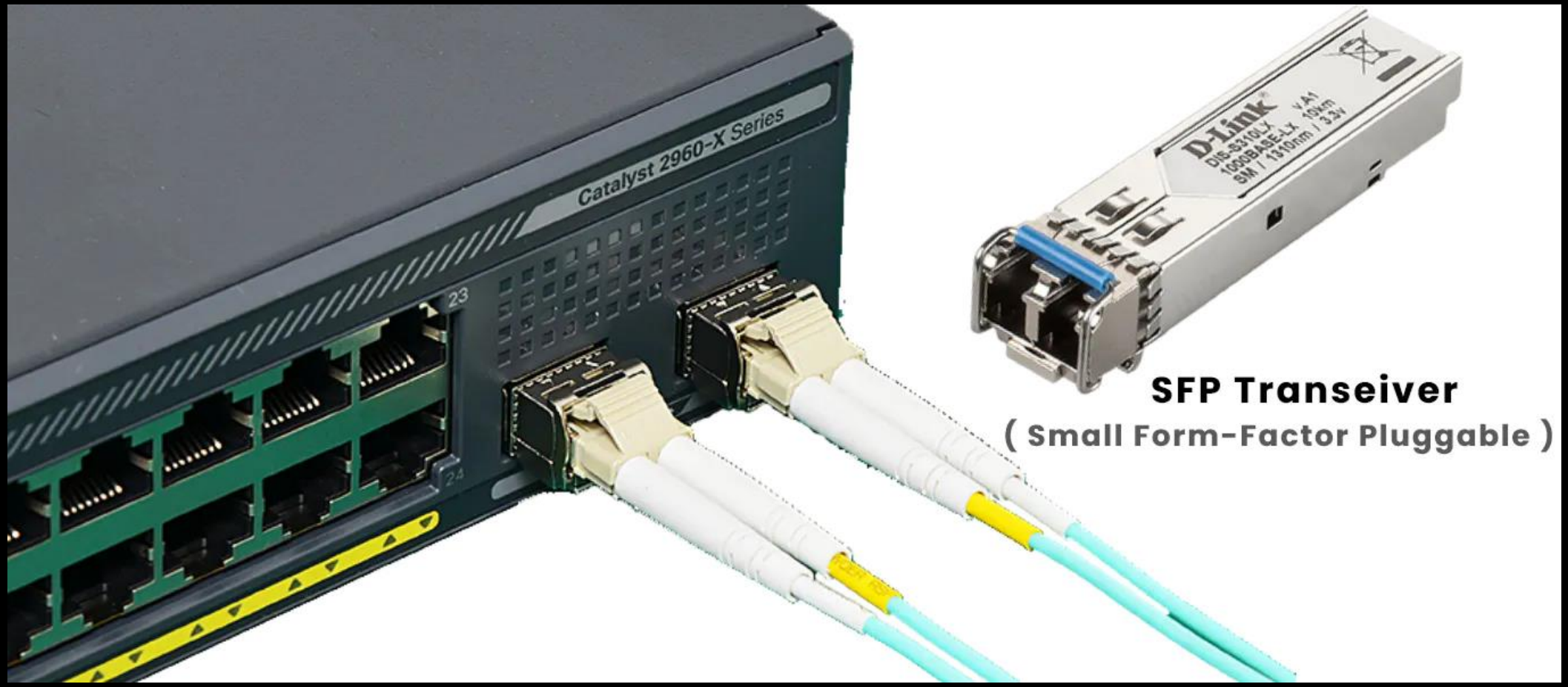


Fiber-Optic Cables

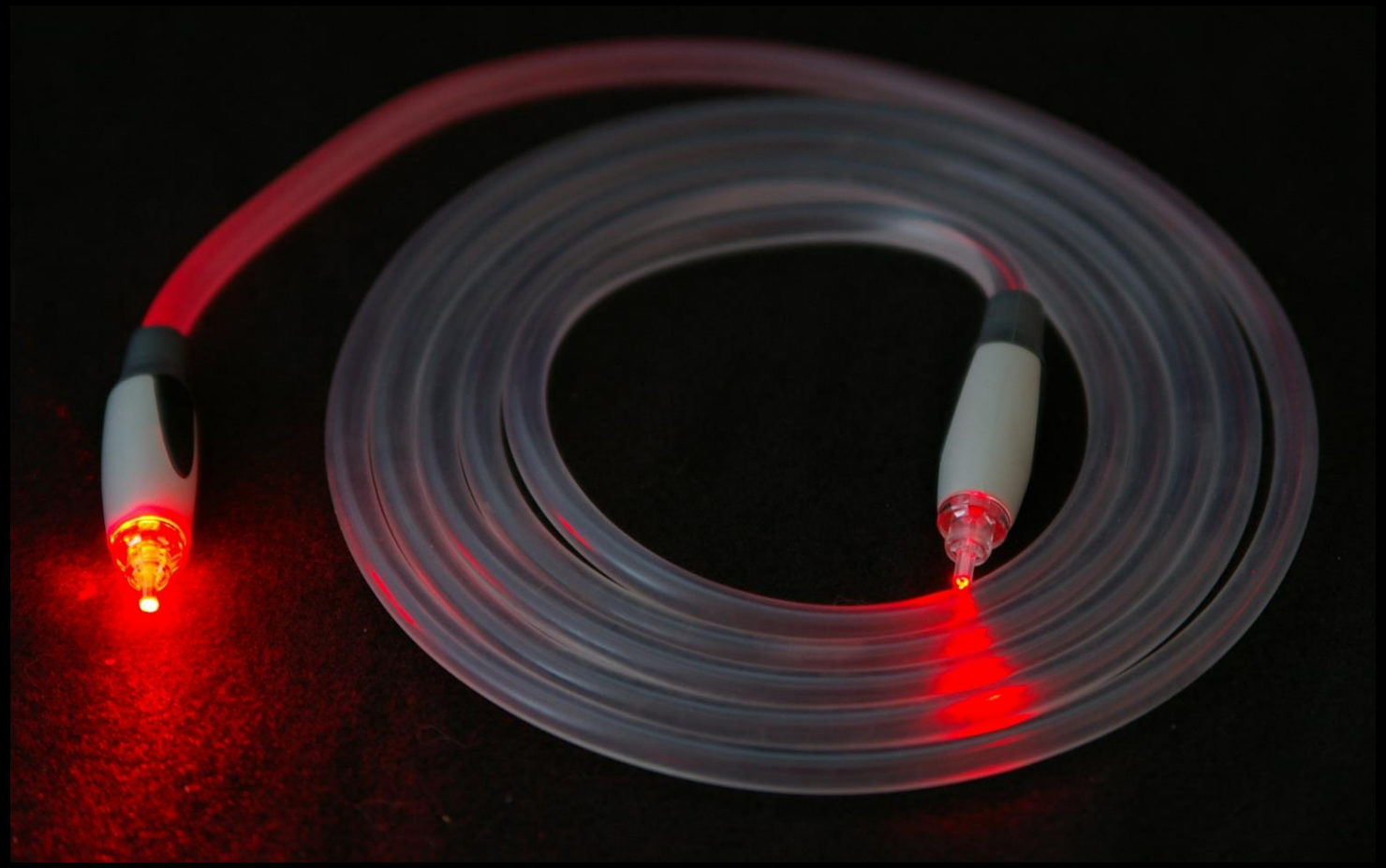


Fiber-Optic Cables

Fiber-Optic Cables

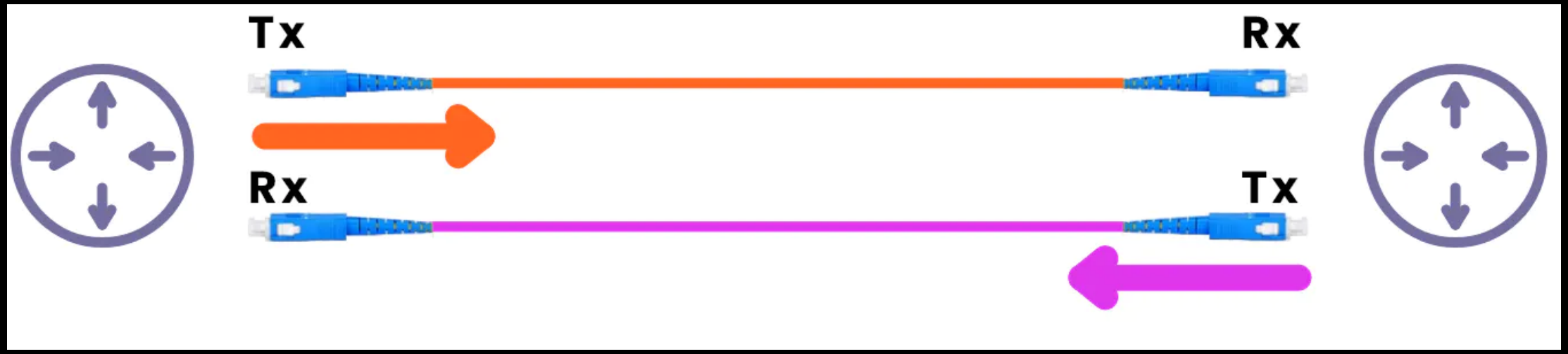


Fiber-Optic Cables



Fiber-Optic Cables

- Each fiber-optic cable has two unidirectional wires, one for transmission and the other for receiving.



Fiber-Optic Cables

Single Mode Fiber (SMF)	Multimode Fiber (MMF)
• SMF consists of a narrow core of 8 to 10 microns in diameter. • Laser-generated light travels a single path over the core, reflecting very little. • Because it reflects little, the light does not disperse as the signal travels along the fiber. • It allows the highest bandwidths and longest distances without requiring repeaters. • The Internet backbone depends on single mode fiber	• MMF contains a core with a large diameter, 50 to 62.5 microns. • Many pulses of light generated by a laser or LED light source travel at various angles. • MMF is not suited to distances longer than a few kilometres. • It used to connect routers, switches, and servers on the backbone of a network or to connect a desktop workstation to the network.

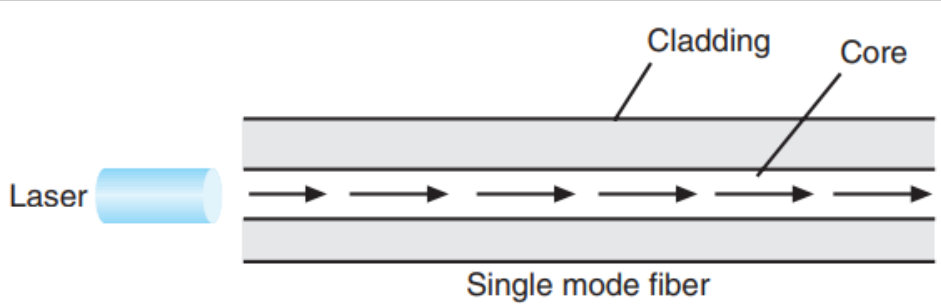


Figure 5-34 Transmission over single mode fiber-optic cable

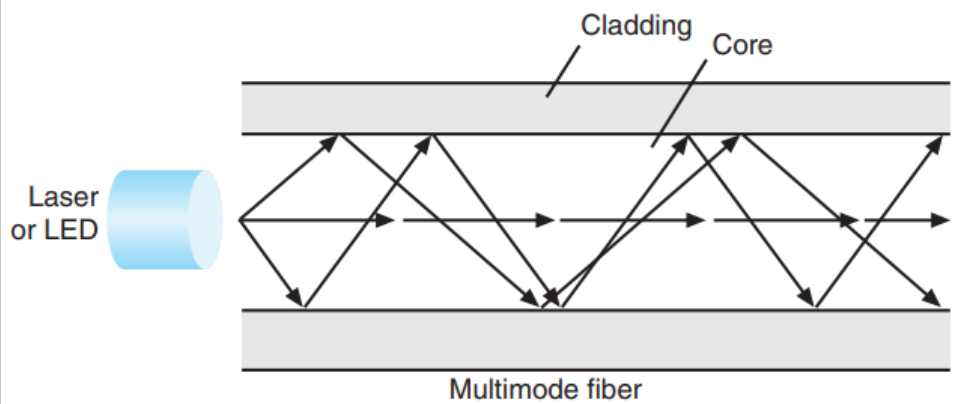


Figure 5-35 Transmission over multimode fiber-optic cable

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Cable Troubleshooting

- A steady light indicates connectivity, and a blinking light indicates activity. A red or amber light, might indicate a problem.

Figure 5-45 Status indicator lights for an onboard network port

Toner and Probe Kit

- They allow you to find cables by tracing electrical signals back to their sources.

Figure 5-46 A toner and probe kit by Fluke Corporation

Toner and Probe Kit

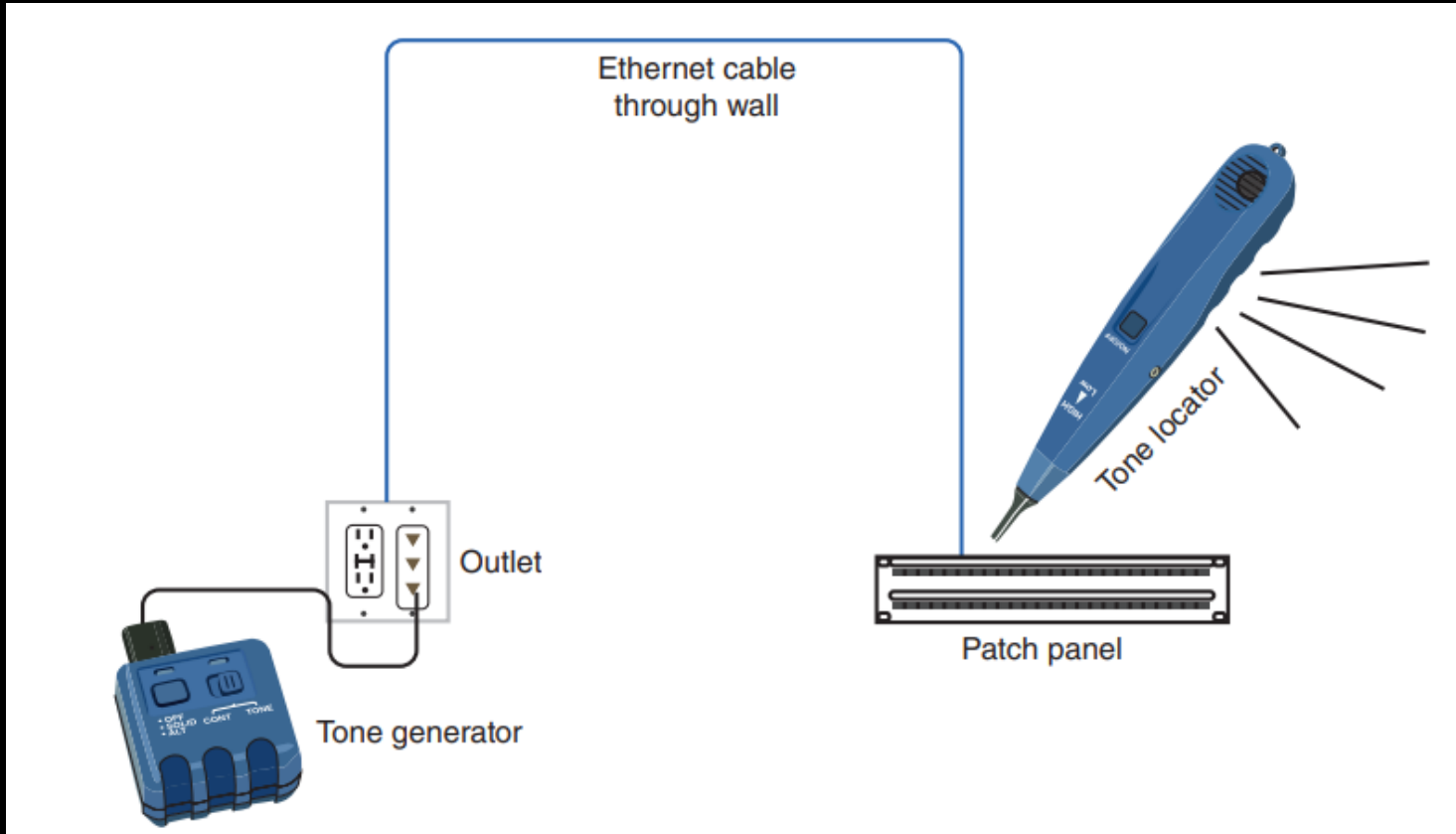


Figure 5-47 A toner and probe kit locates the termination of a wire

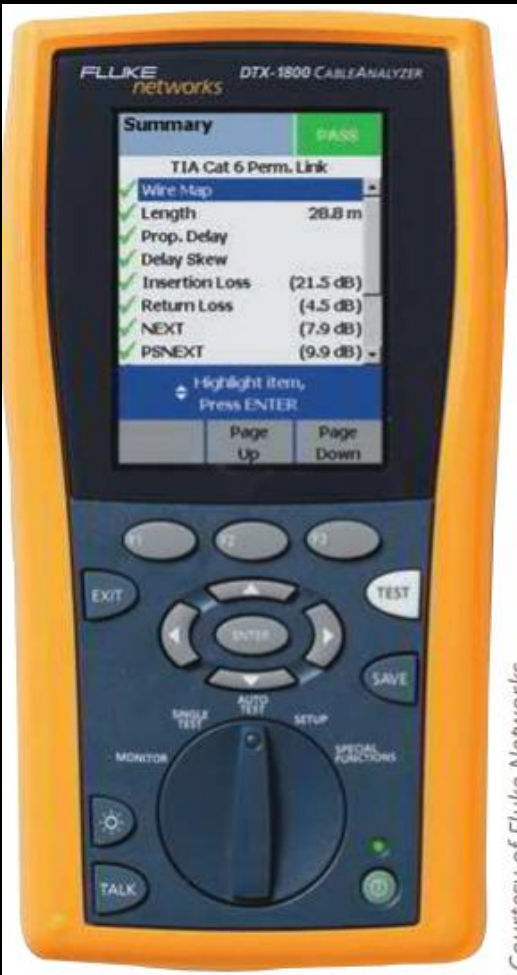
Cable Continuity Tester

- It is used to determine whether it is carrying a signal to its destination.
- A cable continuity tester is battery operated and has two parts:
  - The base unit connects to one end of the cable and generates voltage.
  - The remote unit connects to the other end of the cable and detects the voltage.

Figure 5-49 Use a cable tester pair to determine the type of cable and if the cable is good

Cable Performance Tester

- It is used to measure the overall performance of a cable, including:
  - Measure the distance to a device, termination point, or damage in a cable.
  - Measure attenuation along a cable.
  - Measure NEXT (near end crosstalk) between wires.
  - Store and print cable testing results or directly save data to a computer database
  - Graphically depict a cable's attenuation and crosstalk characteristics over the length of the cable



Courtesy of Fluke Networks

Figure 5-51 The DTX-1800 device by Fluke Networks is a high-end cable performance tester

Cable Performance Tester

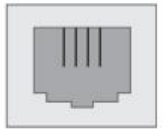
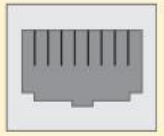
Cable Performance Tester

OPM (Optical Power Meter)

- An OPM measures the amount of light power transmitted on a fiber-optic line.

Summary

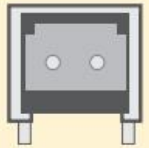
- Cable connectors and their uses

Specification	Male connector (front view)	Male connector (side view)	Female receptacle (front view)	Application
BNC (Bayonet Neill-Concelman)				Used with coaxial cable for broadband cable connections
F-connector				Used on coaxial cable suitable for use with broadband video and data applications; more common than BNC connectors
RJ-11 (registered jack 11)				Used on twisted-pair cabling for telephone systems (and some older twisted-pair networks)
RJ-45 (registered jack 45)				Used on twisted-pair cabling for Ethernet (RJ-45) connections

(continues)

Summary

- Cable connectors and their uses

Specification	Male connector (front view)	Male connector (side view)	Female receptacle (front view)	Application
ST (straight tip), usually multimode				Uses a bayonet locking mechanism; one of the first commercially available fiber connectors
SC (subscriber connector or standard connector)				Widely used; has a snap-in connector
LC (local connector), single-mode				Most common 2.5-mm ferrule; available in full-duplex mode
MT-RJ (Mechanical Transfer Registered Jack), multimode				Most common MMF; contains two strands of fiber per ferrule to provide full-duplex signaling

Summary

- Cabling between devices

	HUB	SWITCH	ROUTER	PC
Hub	Crossover	Crossover	Straight	Straight
Switch	Crossover	Crossover	Straight	Straight
Router	Straight	Straight	Crossover	Crossover
PC	Straight	Straight	Crossover	Crossover

References

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