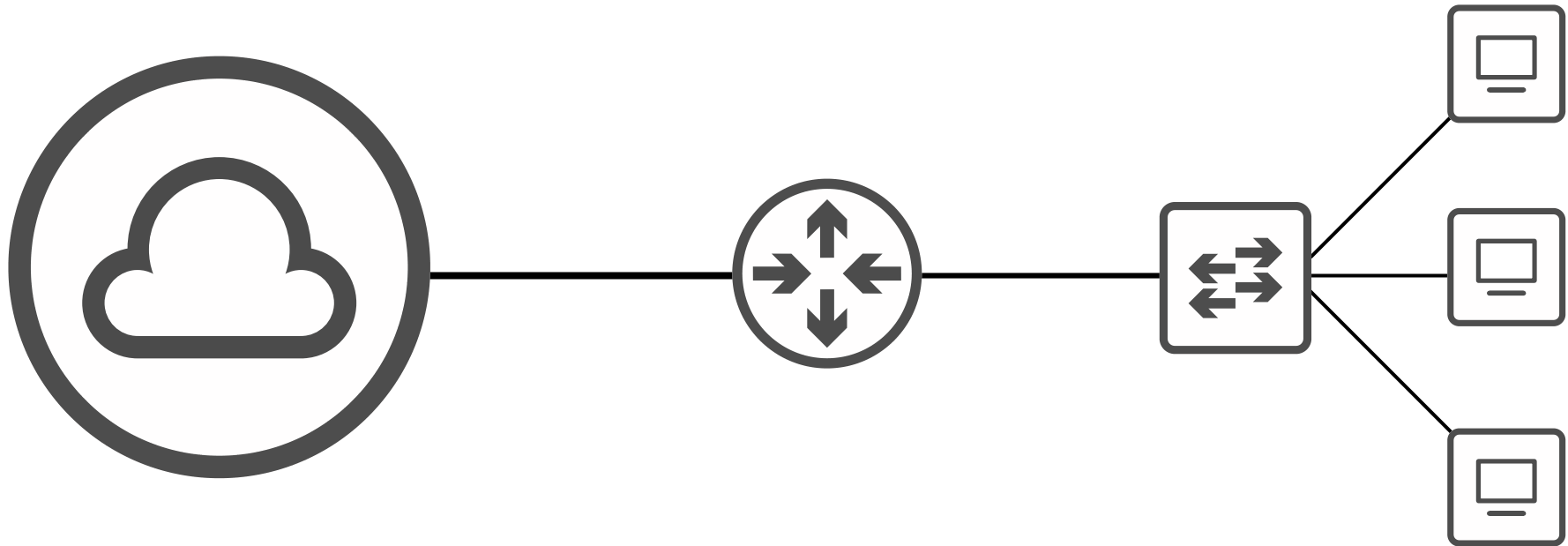
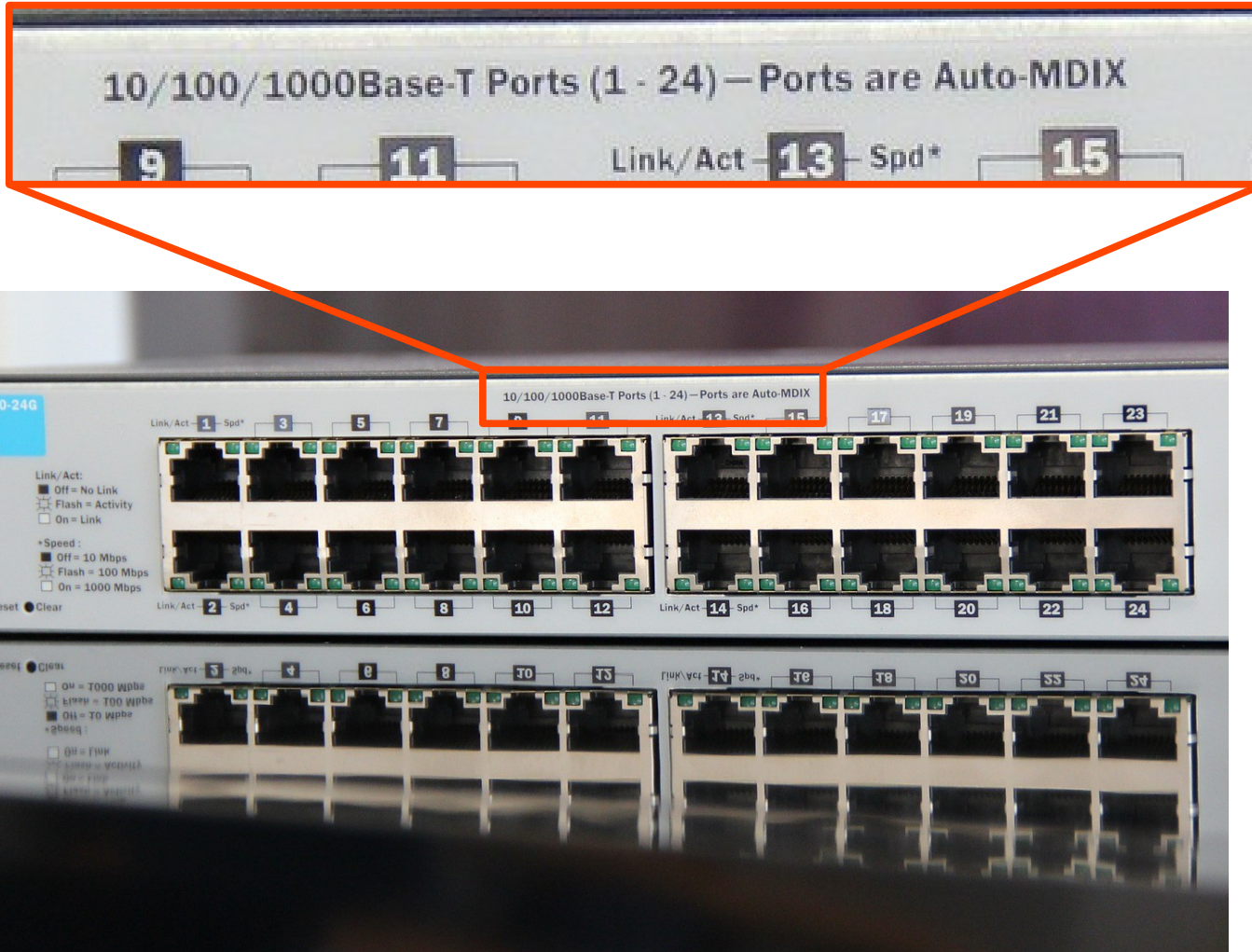


# CCNA 200-301 Day 2

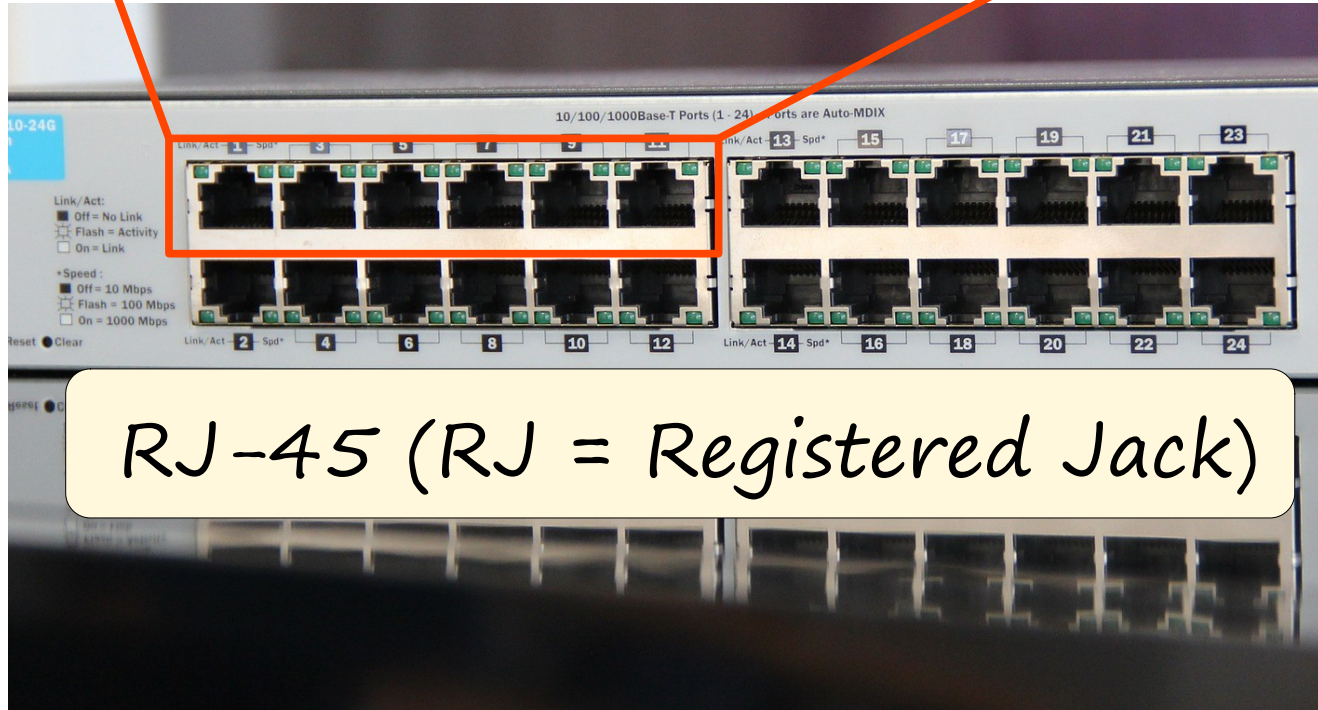
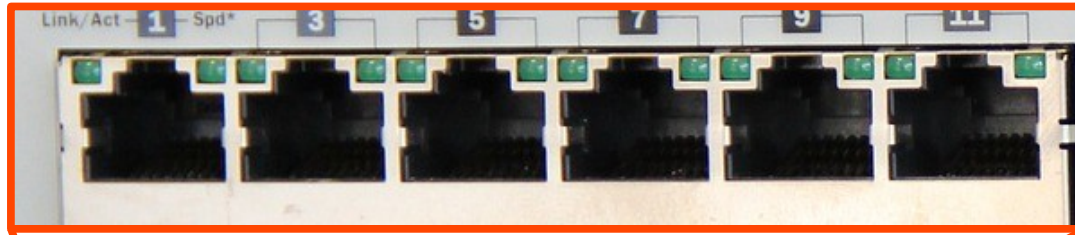
## Interfaces and Cables



# Interfaces and Cables

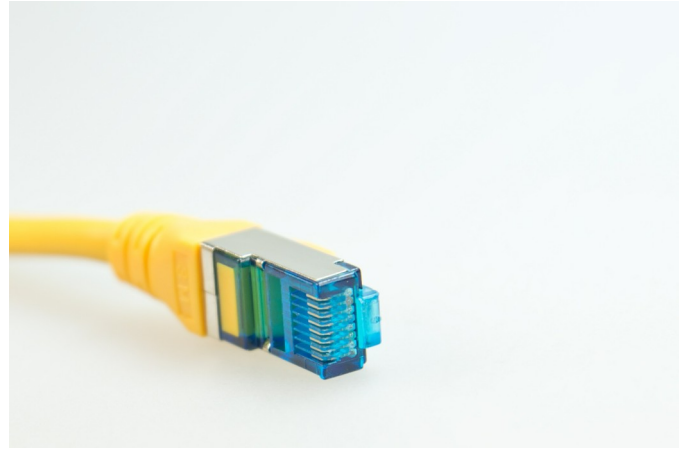


# RJ-45



RJ-45 (RJ = Registered Jack)

# RJ-45



# Ethernet

- Ethernet is a collection of network protocols/standards.
- For the purpose of this lesson, we will focus on types of cabling as defined by Ethernet standards.
- In future lessons, we will learn other aspects of Ethernet.

Why do we need network protocols/standards?

Got any CCNA study tips?



意味わからない、、、





# Network Protocols

Sorry, your cable doesn't fit.



Time to connect to the switch.



# Bits and Bytes

- 0
- 1
- 1
- 0
- 0
- 1
- 1
- 1

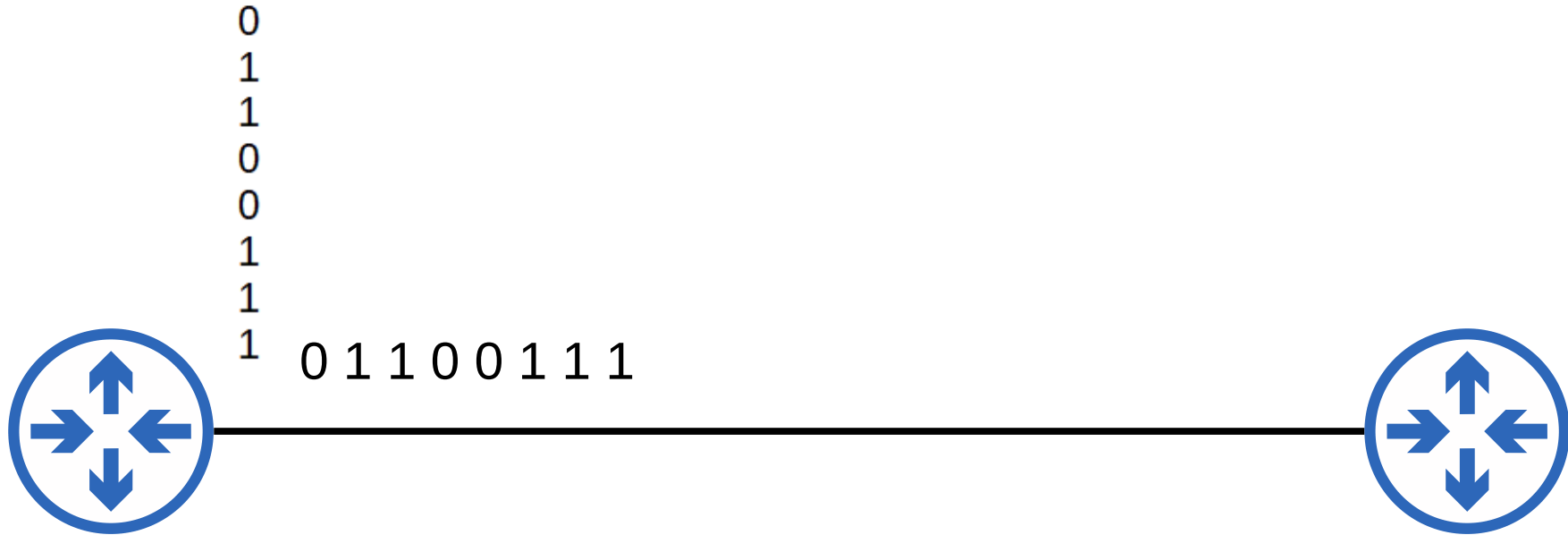


8 bits = 1 byte

- 0
- 1
- 1
- 0
- 0
- 1
- 1
- 1



# Bits and Bytes

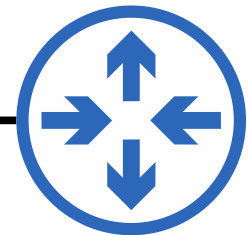
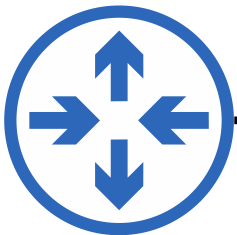


*Speed is measured in bits per second (Kbps, Mbps, Gbps, etc), not bytes per second.*

# Bits and Bytes

- 1 kilobit (Kb) = 1,000 bits
- 1 megabit (Mb) = 1,000,000 bits
- 1 gigabit (Gb) = 1,000,000,000 bits
- 1 terabit (Tb) = 1,000,000,000,000 bits

Decimal			
Value			SI
1000	10 <sup>3</sup>	kbit	<b>kilobit</b>
1000 <sup>2</sup>	10 <sup>6</sup>	Mbit	<b>megabit</b>
1000 <sup>3</sup>	10 <sup>9</sup>	Gbit	<b>gigabit</b>
1000 <sup>4</sup>	10 <sup>12</sup>	Tbit	<b>terabit</b>
1000 <sup>5</sup>	10 <sup>15</sup>	Pbit	<b>petabit</b>
1000 <sup>6</sup>	10 <sup>18</sup>	Ebit	<b>exabit</b>
1000 <sup>7</sup>	10 <sup>21</sup>	Zbit	<b>zettabit</b>
1000 <sup>8</sup>	10 <sup>24</sup>	Ybit	<b>yottabit</b>



# Ethernet Standards

- Defined in the IEEE 802.3 standard in 1983
- IEEE = Institute of Electrical and Electronics Engineers

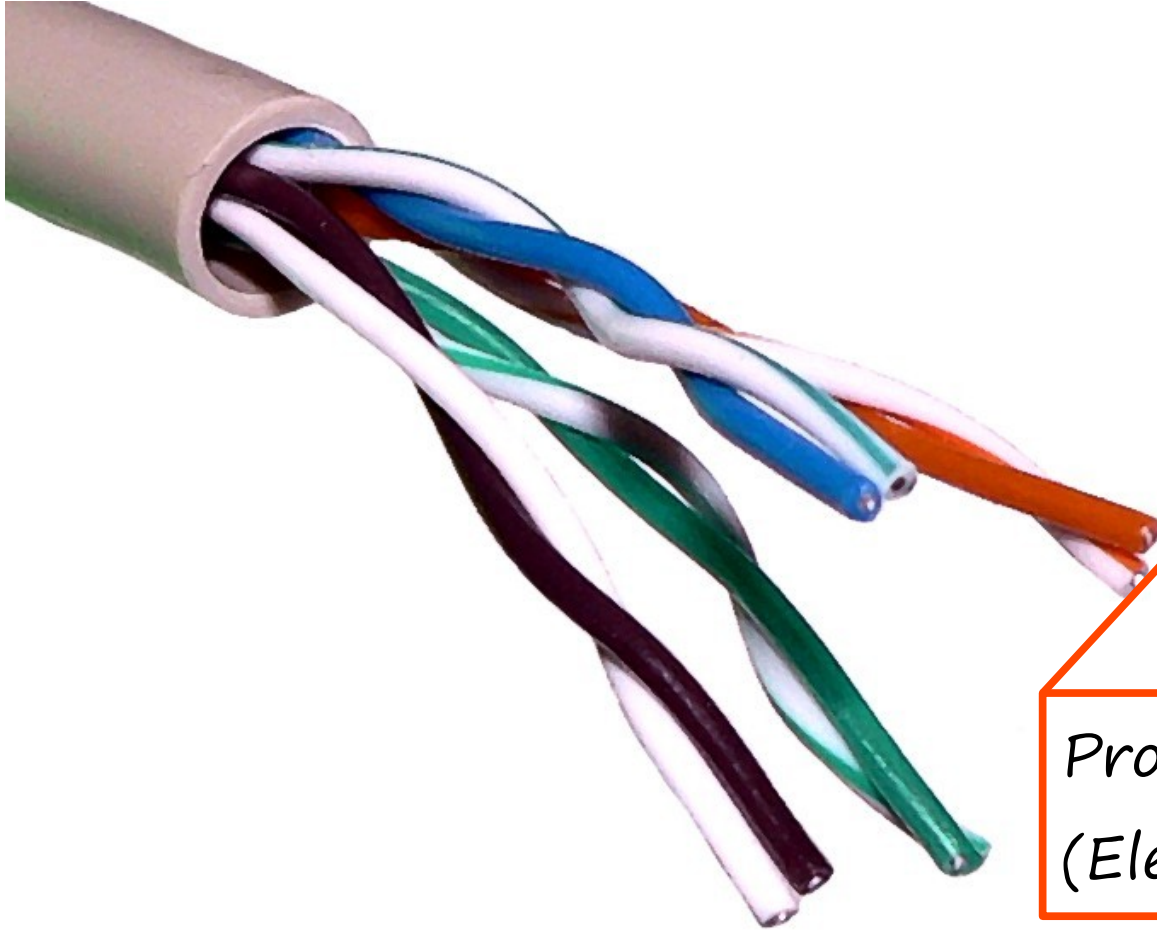


IEEE

# Ethernet Standards (copper)

Speed	Common Name	IEEE Standard	Informal Name	Maximum Length
10 Mbps	Ethernet	802.3i	10BASE-T	100 m
100 Mbps	Fast Ethernet	802.3u	100BASE-T	100 m
1 Gbps	Gigabit Ethernet	802.3ab	1000BASE-T	100 m
10 Gbps	10 Gig Ethernet	802.3an	10GBASE-T	100 m

# UTP Cables



Unshielded

Twisted

Pair

Protects against EMI  
(Electromagnetic Interference)

# UTP Cables



10BASE-T

100BASE-T

= 2 pairs (4 wires)

1000BASE-T

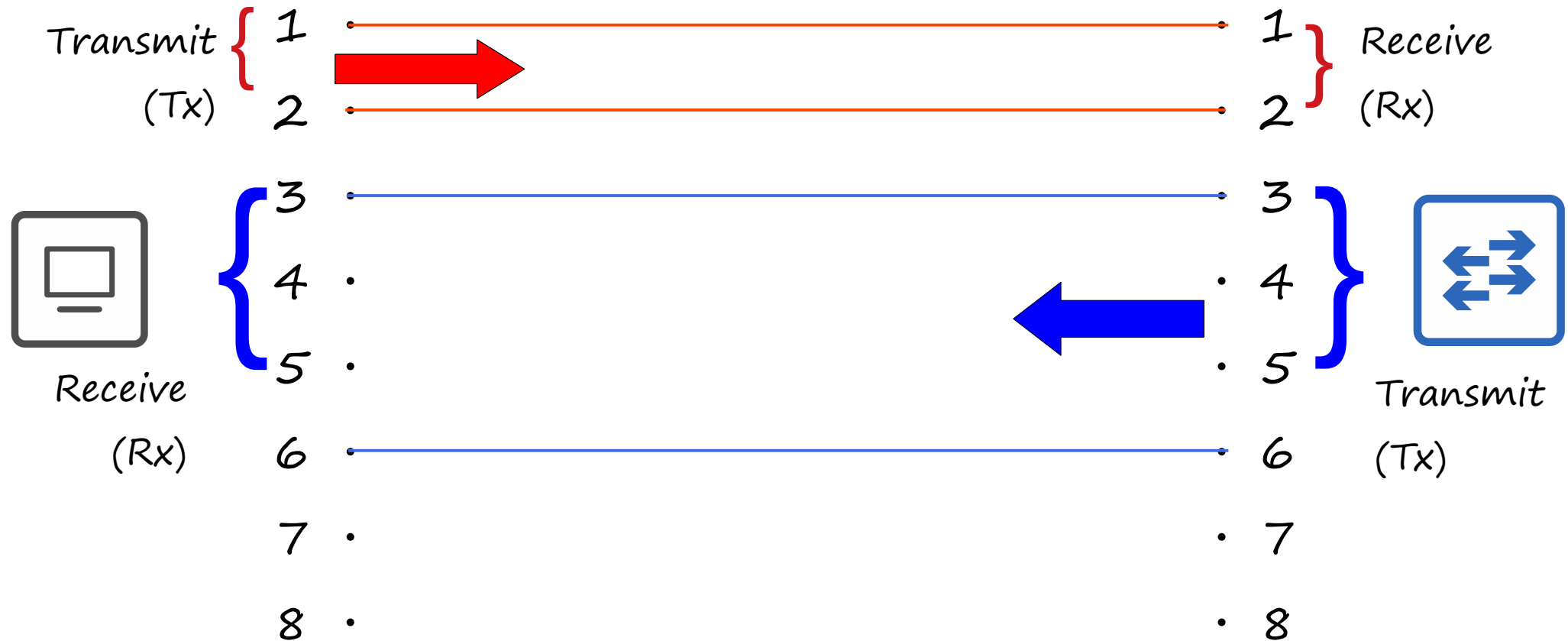
10GBASE-t

= 4 pairs (8 wires)



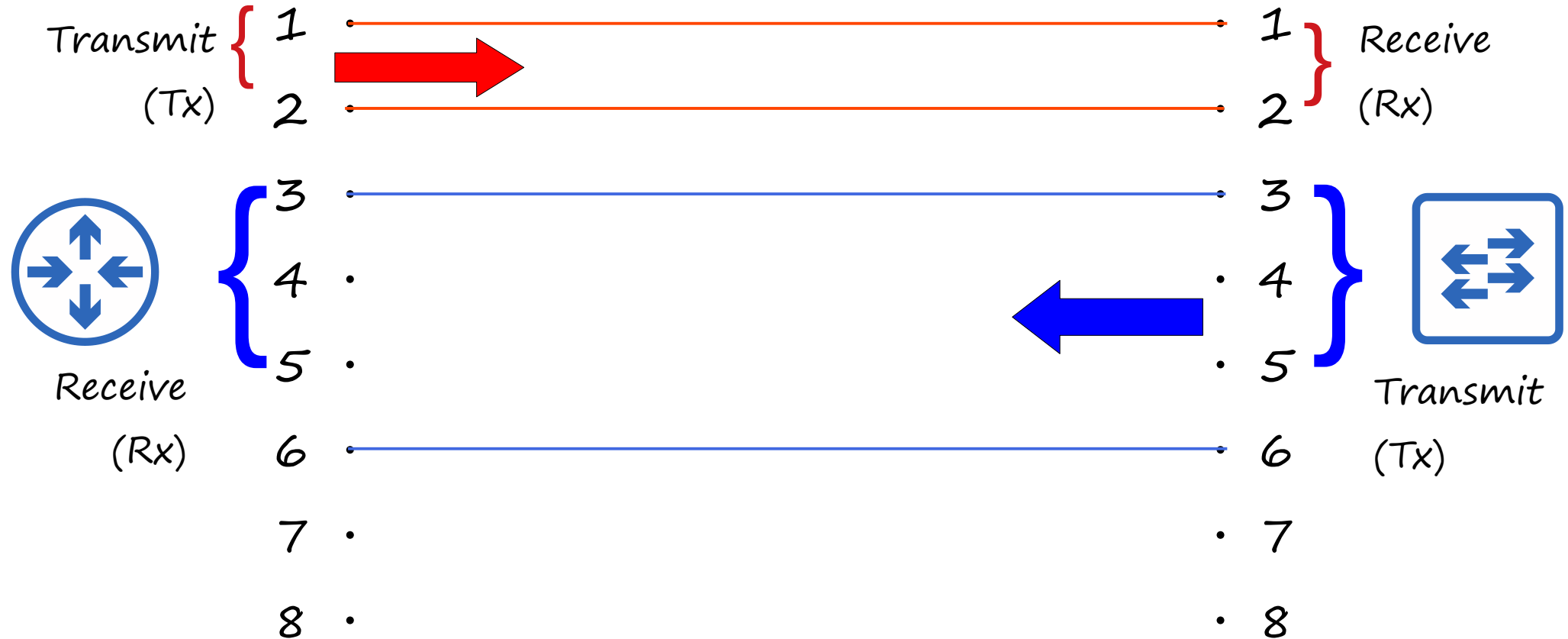
# UTP Cables (10BASE-T, 100BASE-T)

## Full-Duplex



# UTP Cables (10BASE-T, 100BASE-T)

## Straight-through cable



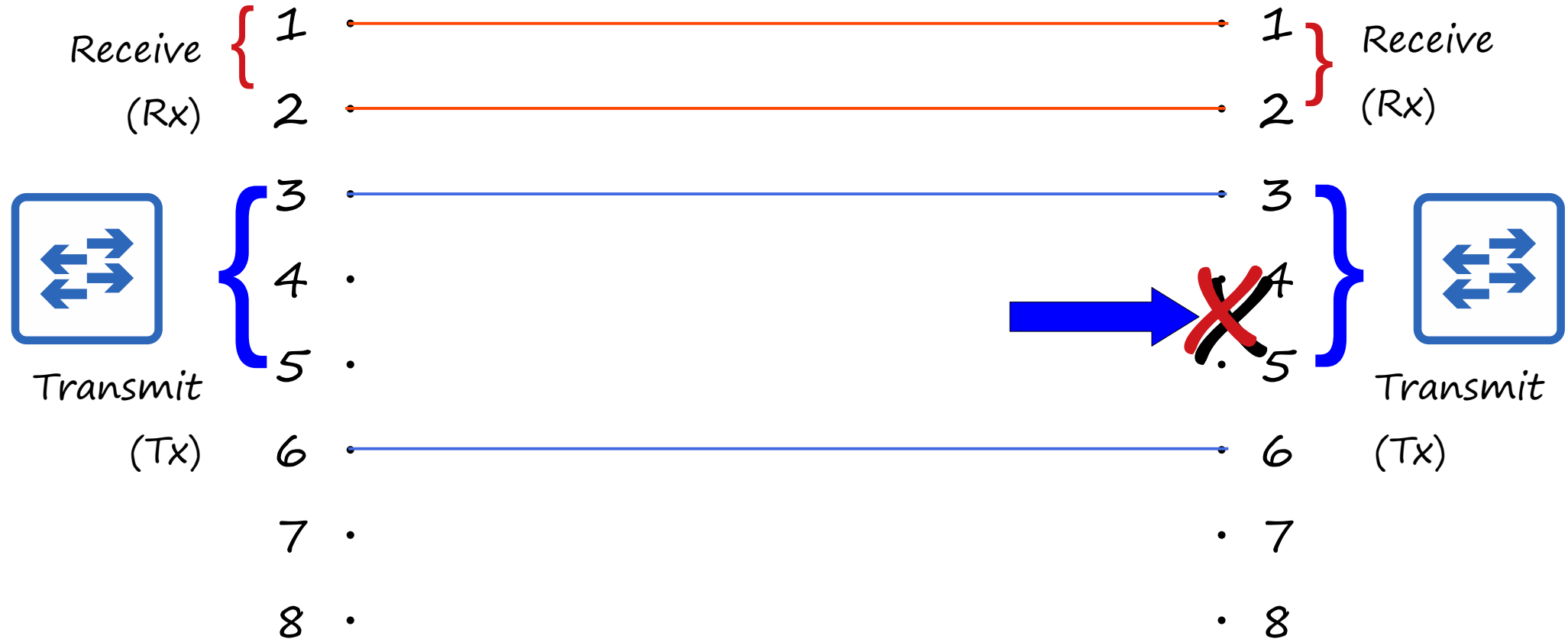
# UTP Cables (10BASE-T, 100BASE-T)

## Straight-through cable



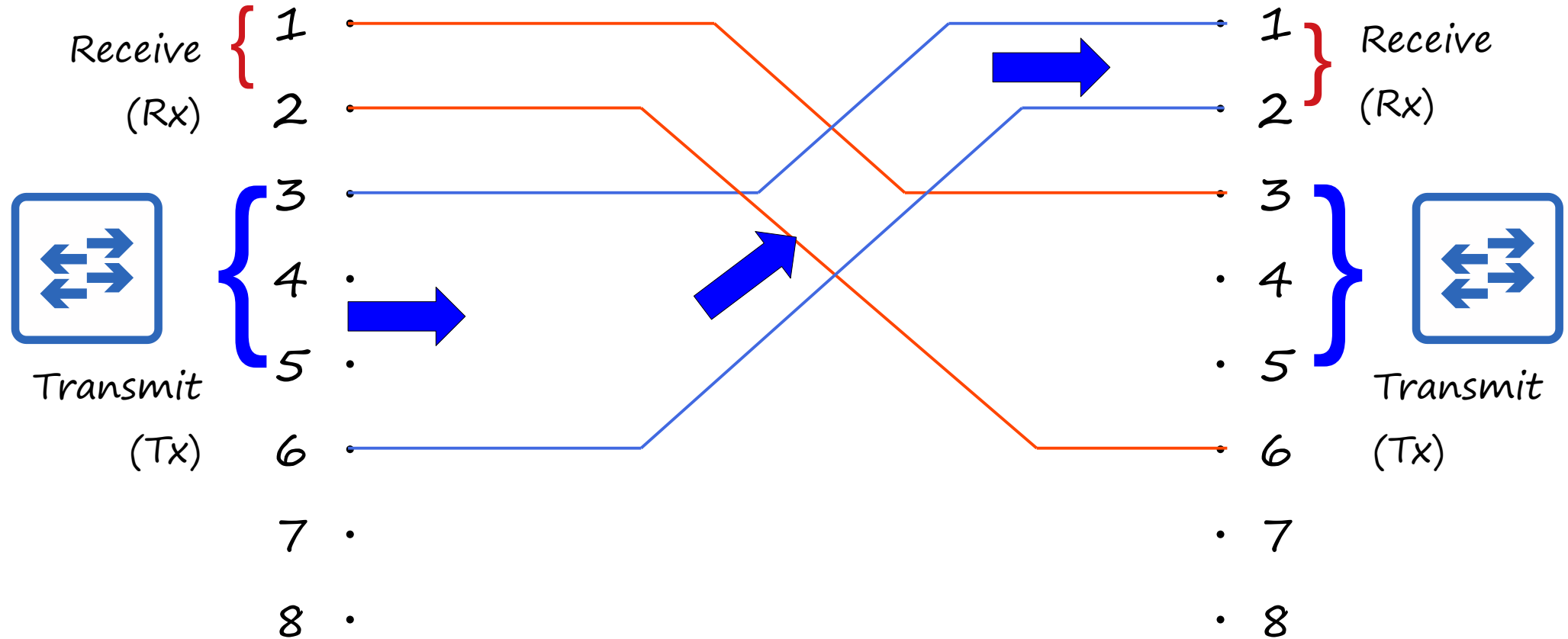
# UTP Cables (10BASE-T, 100BASE-T)

## Straight-through cable



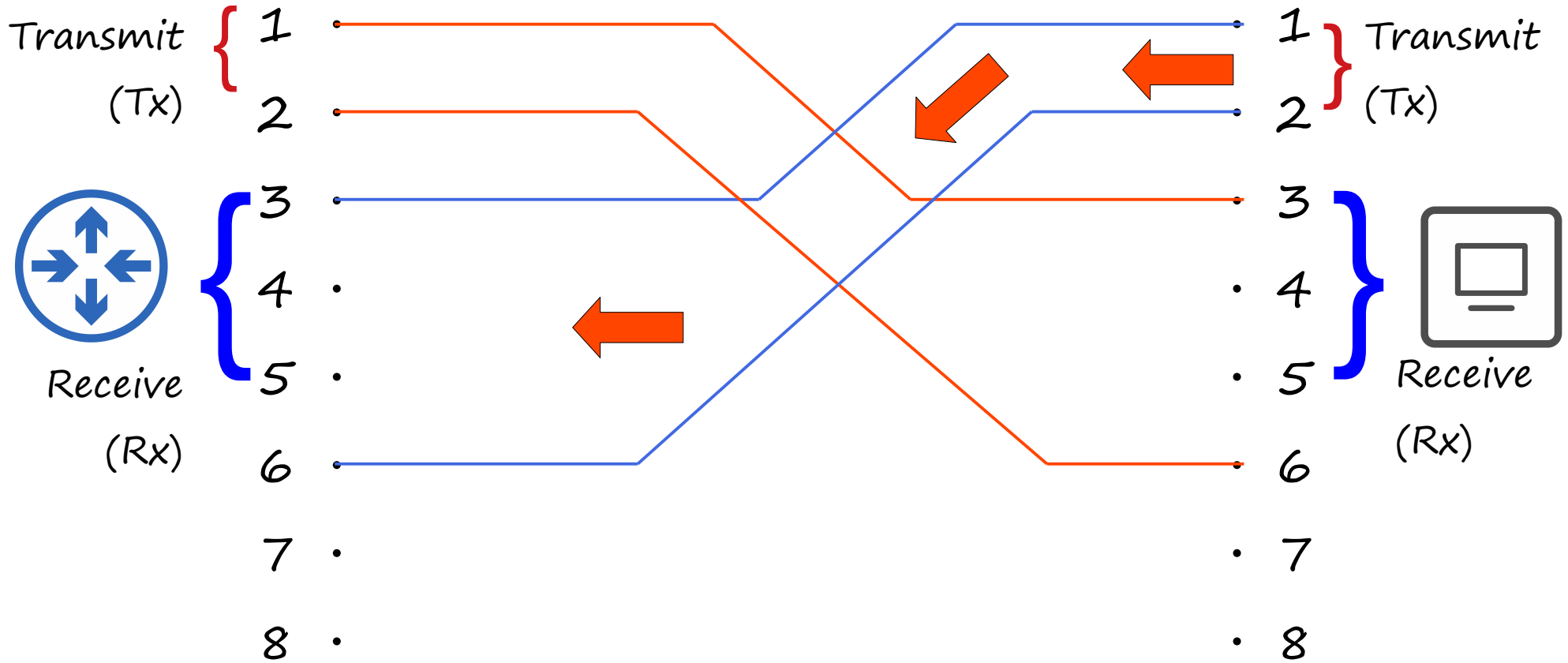
# UTP Cables (10BASE-T, 100BASE-T)

## Crossover cable






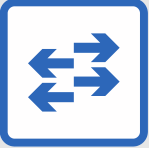
# UTP Cables (10BASE-T, 100BASE-T)

Crossover cable



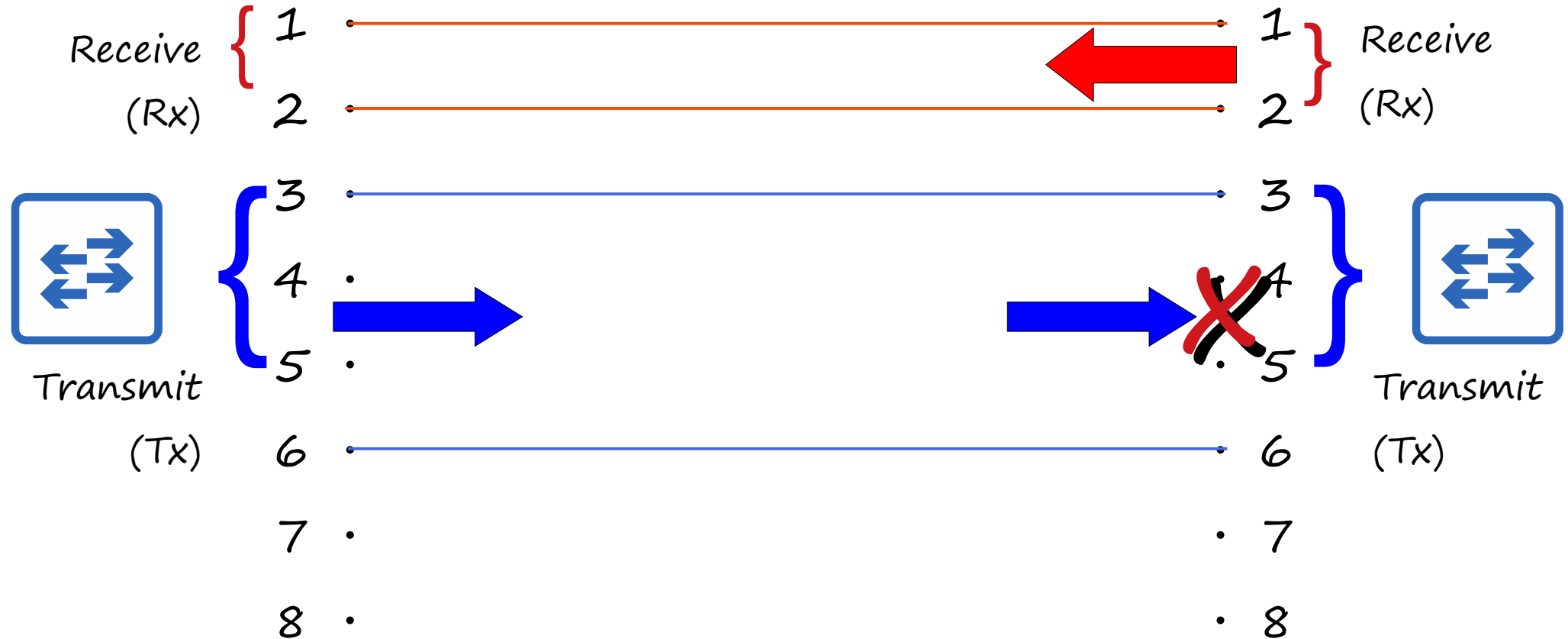


# UTP Cables (10BASE-T, 100BASE-T)

Device Type	Transmit (Tx) Pins	Receive (Rx) Pins
Router 	1 and 2	3 and 6
Firewall 	1 and 2	3 and 6
PC 	1 and 2	3 and 6
Switch 	3 and 6	1 and 2

# UTP Cables (10BASE-T, 100BASE-T)

Auto MDI-X

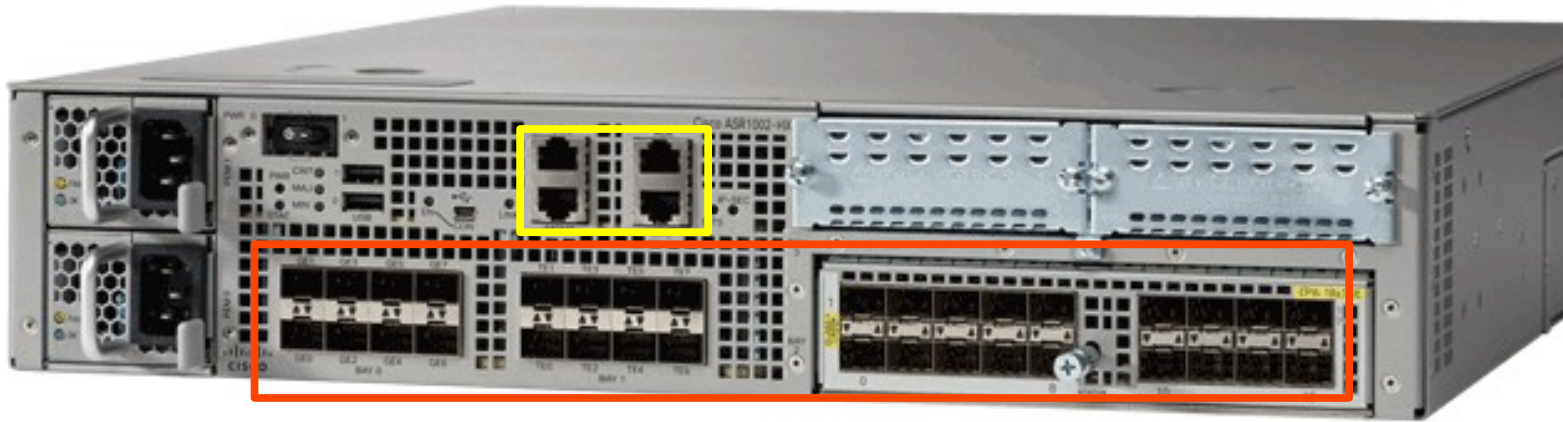


# UTP Cables (1000BASE-T, 10GBASE-T)

Each pair is bidirectional.



# Fiber-Optic Connections

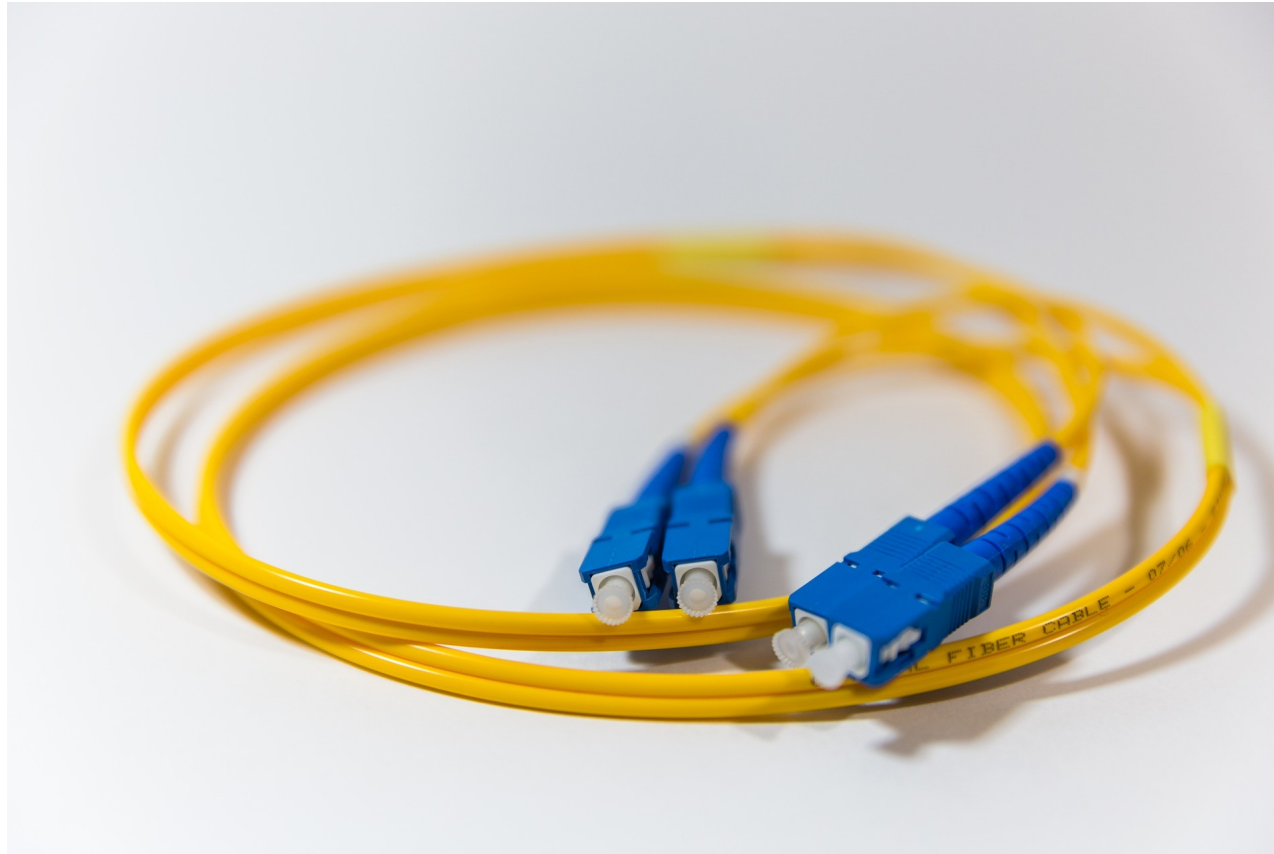


# Fiber-Optic Connections



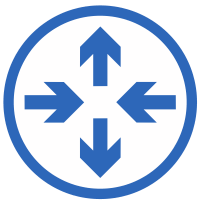
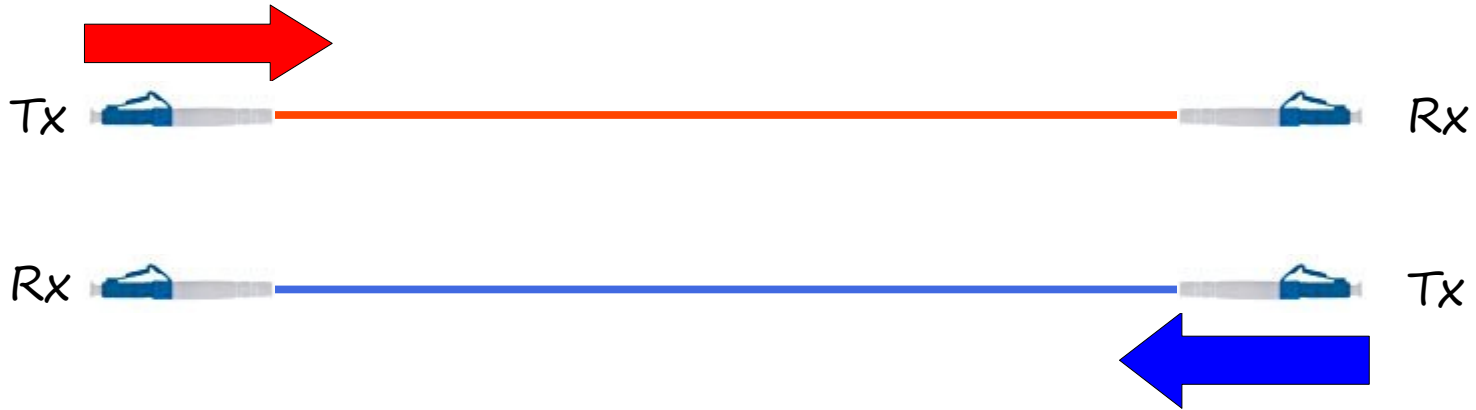
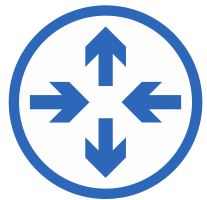
SFP Transceiver  
(Small Form-Factor Pluggable)

# Fiber-Optic Connections

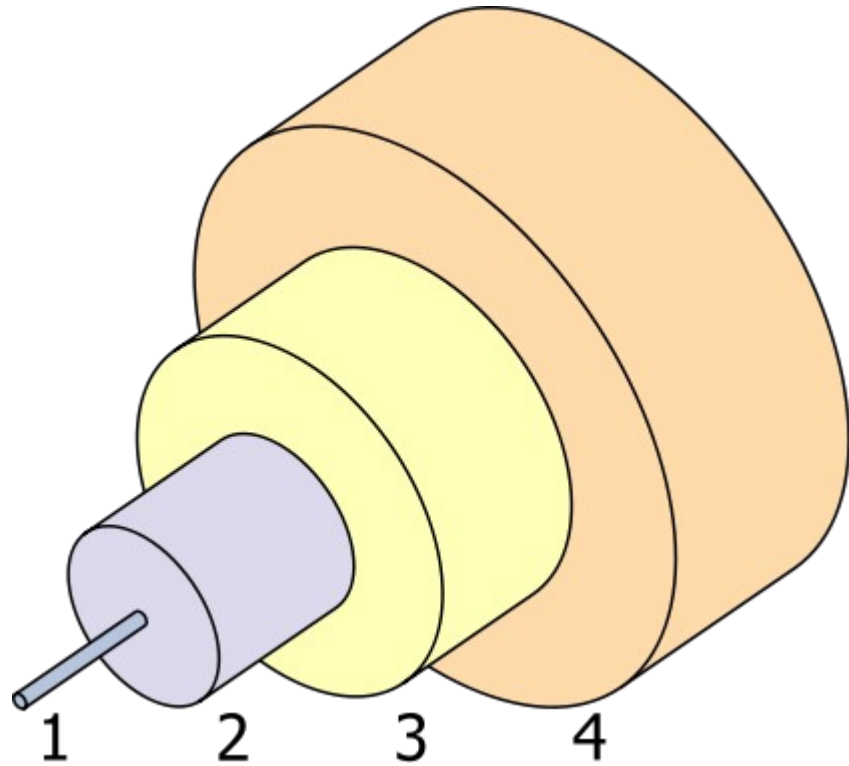




# Fiber-Optic Connections



# Fiber-Optic Connections



1: the fiberglass core itself

2: cladding that reflects light

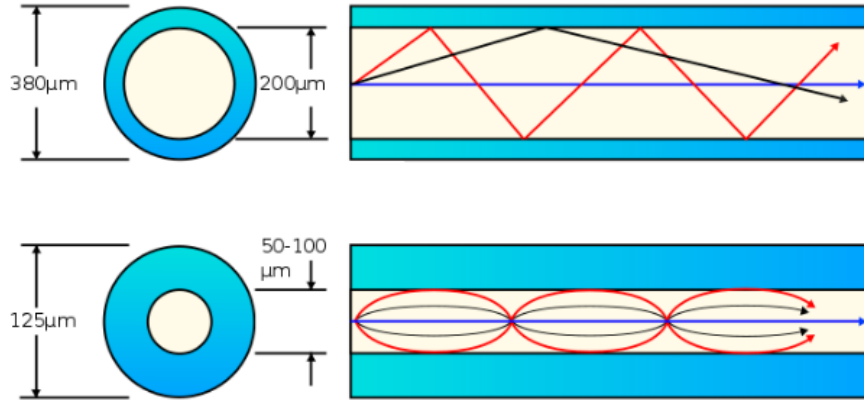
3: a protective buffer

4: the outer jacket of the cable

*single-mode*

*multimode*

# Multimode Fiber



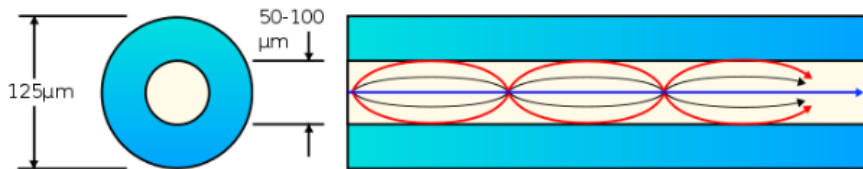
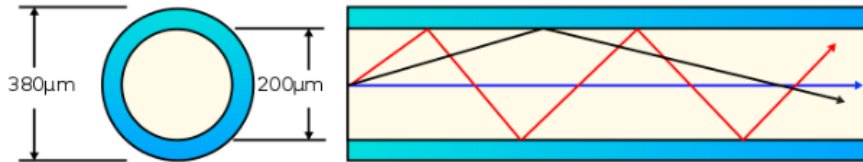
Mrzeon ([https://commons.wikimedia.org/wiki/File:Optical\\_fiber\\_types.svg](https://commons.wikimedia.org/wiki/File:Optical_fiber_types.svg)),  
„Optical fiber types“, edited,  
<https://creativecommons.org/licenses/by-sa/3.0/legalcode>

- Core diameter is wider than single-mode fiber.
- Allows multiple angles (modes) of light waves to enter the fiberglass core.
- Allows longer cables than UTP, but shorter cables than single-mode fiber.
- Cheaper than single-mode fiber (due to cheaper LED-based SFP transmitters).

# Single-Mode Fiber



Mrzeon ([https://commons.wikimedia.org/wiki/File:Optical\\_fiber\\_types.svg](https://commons.wikimedia.org/wiki/File:Optical_fiber_types.svg)), „Optical fiber types“, edited, <https://creativecommons.org/licenses/by-sa/3.0/legalcode>



- Core diameter is narrower than multimode fiber.
- Light enters at a single angle (mode) from a laser-based transmitter.
- Allows longer cables than both UTP and multimode fiber.
- More expensive than multimode fiber (due to more expensive laser-based SFP transmitters)

# Fiber-Optic Cable Standards

Informal Name	IEEE Standard	Speed	Cable Type	Maximum Length
1000BASE-LX	802.3z	1 Gbps	Multimode or Single-Mode	550 m (MM) 5 km (SM)
10GBASE-SR	802.3ae	10 Gbps	Multimode	400 m
10GBASE-LR	802.3ae	10 Gbps	Single-Mode	10 km
10GBASE-ER	802.3ae	10 Gbps	Single-Mode	30 km

# UTP vs Fiber-Optic Cabling

## UTP

- Lower cost than fiber-optic.
- Shorter maximum distance than fiber-optic (~100m).
- Can be vulnerable to EMI (Electromagnetic Interference).
- RJ45 ports used with UTP are cheaper than SFP ports.
- Emit (leak) a faint signal outside of the cable, which can be copied (=security risk)

## Fiber-Optic

- Higher cost than UTP.
- Longer maximum distance than UTP.
- No vulnerability to EMI.
- SFP ports are more expensive than RJ45 ports (single-mode is more expensive than multimode).
- Does not emit any signal outside of the cable (=no security risk).



# Quiz Question 1

You connect two old routers together with a UTP cable, however data is not successfully sent and received between them. What could be the problem?

- a) They are connected with a straight-through cable.
- b) They are connected with a crossover cable.
- c) They are operating in Auto MDI-X mode.

# Quiz Question 1

~~X~~) They are connected with a crossover cable.

A crossover cable is not the issue. A crossover cable would likely fix the issue.

Because both routers transmit data on pins 1 and 2, a crossover cable is necessary to properly connect the transmit pins on one side of the connection to the receive pins (3 and 6) on the other side.

Modern devices with Auto MDI-X enabled don't have this issue, but it is possible that the old routers do not have Auto MDI-X.

# Quiz Question 1

~~X~~ They are operating in Auto MDI-X mode.

Auto MDI-X allows devices to detect which pins and wires their neighbor is using to transmit and receive data, and adjust their own operations to match.

Auto MDI-X would likely fix this issue, but since the routers are old they might not have the Auto MDI-X function.

# Quiz Question 1

★ a) They are connected with a straight-through cable.

*On old devices without Auto MDI-X, a straight-through cable cannot be used to connect devices of the same type. A crossover cable is necessary.*

## Quiz Question 2

Your company wants to connect switches in two separate buildings that are about 150 meters apart. They want to keep costs down, if possible. What kind of cable should they use?

- a) UTP
- b) Single-mode fiber
- c) Multimode fiber

## Quiz Question 2

~~X~~) UTP

Although UTP would keep the costs down, it does not support distances over 100 meters.

## Quiz Question 2

~~X~~) Single-mode fiber

Although single-mode fiber supports distances much longer than 150 meters, it is more expensive than multimode fiber.

★ c) Multimode fiber

Multimode fiber supports distances over 150 meters and is less expensive than single-mode fiber.



## Quiz Question 3

Your company wants to connect two offices that are about 3 kilometers apart. They want to keep costs down if possible. Which kind of cable should they use?

- a) UTP
- b) Single-mode fiber
- c) Multimode fiber

# Quiz Question 3

~~X~~) UTP

Although UTP keeps costs down, it does not support distances of 3 kilometers.

## Quiz Question 3

~~X~~) Multimode fiber

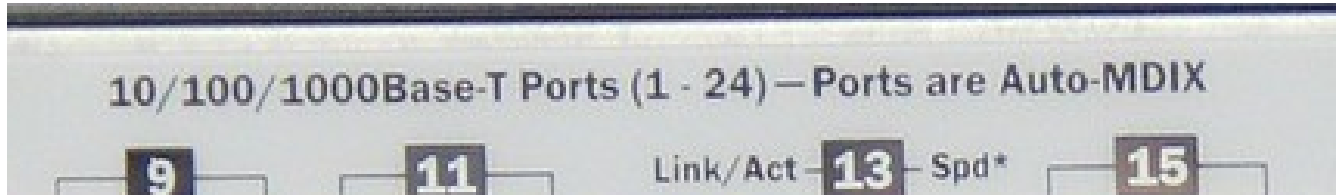
Although multimode fiber is cheaper than single-mode fiber, it does not support distances of 3 kilometers.

## ★ b) Single-mode fiber

Many single-mode fiber standards support cable lengths much longer than 3 kilometers. Although single-mode fiber is more expensive than the other options, it is necessary in this case.

# Quiz Question 4

A switch has the following indication over its network interfaces:



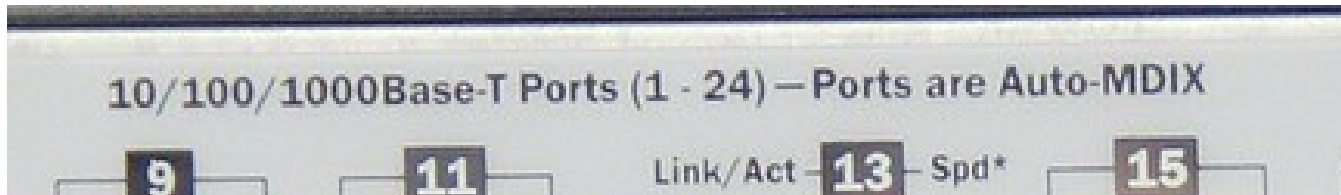
What would happen if you connect it to an identical switch with a straight-through cable?

- They would operate normally.
- They would operate at a reduced speed.
- They would be unable to communicate.

# Quiz Question 4

~~X~~) They would operate at a reduced speed.

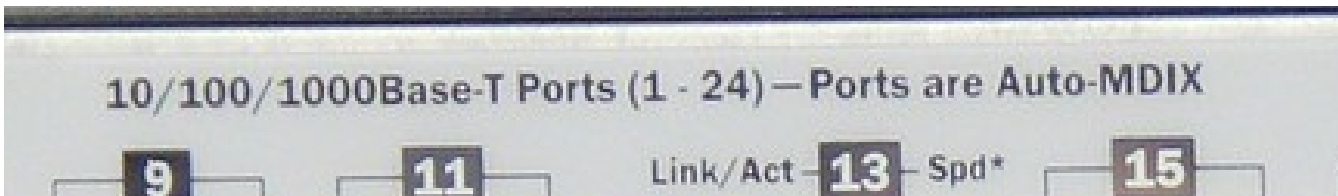
They would not operate at a reduced speed. The ports are Auto MDI-X enabled. However, even if they didn't have Auto MDI-X, they wouldn't operate at a reduced speed. They simply wouldn't operate.



# Quiz Question 4

~~X~~) They would be unable to communicate.

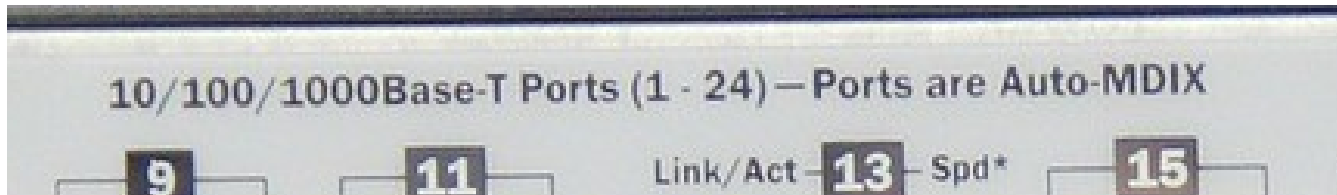
Because the ports are Auto MDI-X enabled, they would be able to communicate, even though they are connected with a straight-through cable.



# Quiz Question 4

★ a) They would operate normally.

Because the ports are Auto MDI-X enabled, they would operate normally, regardless of whether they are connected with a straight-through or crossover cable.





## Quiz Question 5

Your company needs to connect many end hosts to a switch which is in a wiring cabinet on the same office floor as the hosts. What kind of cable should they use?

- a) UTP
- b) Single-mode fiber
- c) Multimode fiber

## Quiz Question 5

- ~~b) Single-mode fiber~~
- ~~a) Multimode fiber~~

Most hosts do not have the capability to connect to a switch via fiber cabling, and most switches do not have enough SFP interfaces to support many end hosts.

# Quiz Question 5

★ a) UTP

UTP cables are the standard for wired connections to switches.

Switches typically have many RJ45 ports for end hosts to connect to, and end hosts will have an RJ45 port on their network interface card (NIC) to connect a UTP cable to.