



Mehran University of Engineering and Technology, Khairpur

Department of Software Engineering



To Work with cable
specification, installation, and
troubleshooting

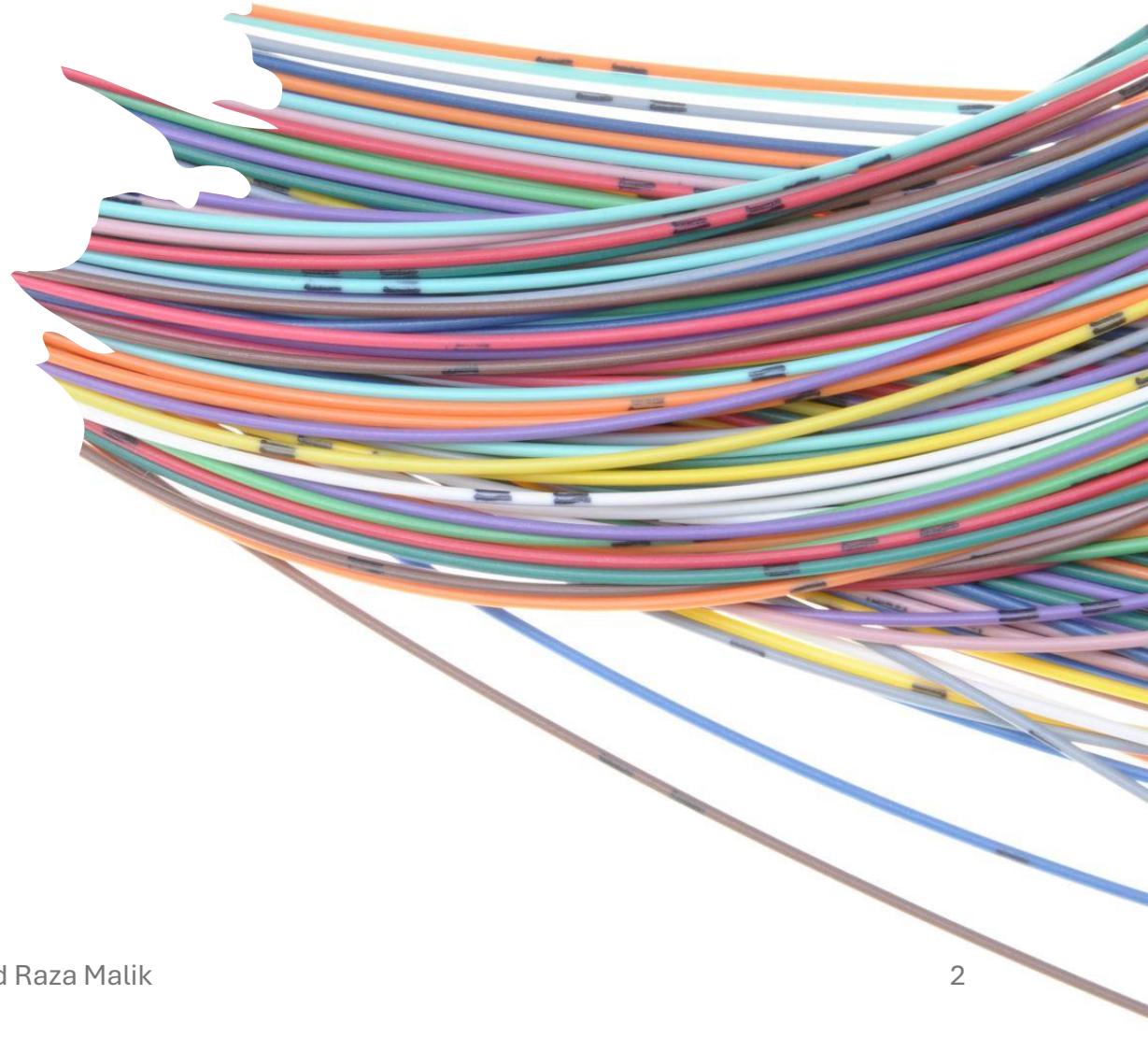
Computer Network Practical Lab-01

Teacher: Dr. Asad Raza Malik



Objectives

- Understand different types of network cables and their specifications.
- Learn the proper techniques for cable installation
- Develop troubleshooting skills for network cabling issues.



What is the Ethernet?

- Ethernet is the technology of connecting computers and electronic devices over short distances to form a local area network (LAN). Ethernet networks may include cable-connected and wirelessly connected devices.

Who invented the Ethernet?

- Ethernet was founded by Robert Metcalfe and David Boggs in 1973. The first network connecting computers across the United States was called the ARPAnet. Harvard University refused to let Robert Metcalfe work on connecting their computers to the ARPAnet. He then worked for Xerox PARC with David Boggs, an electrical engineer. Together, they co-invented Ethernet. Robert Metcalfe conceived the idea, and David Boggs built the first Ethernet system.



CABLE TESTER



UTP CABLE



CRIMPER



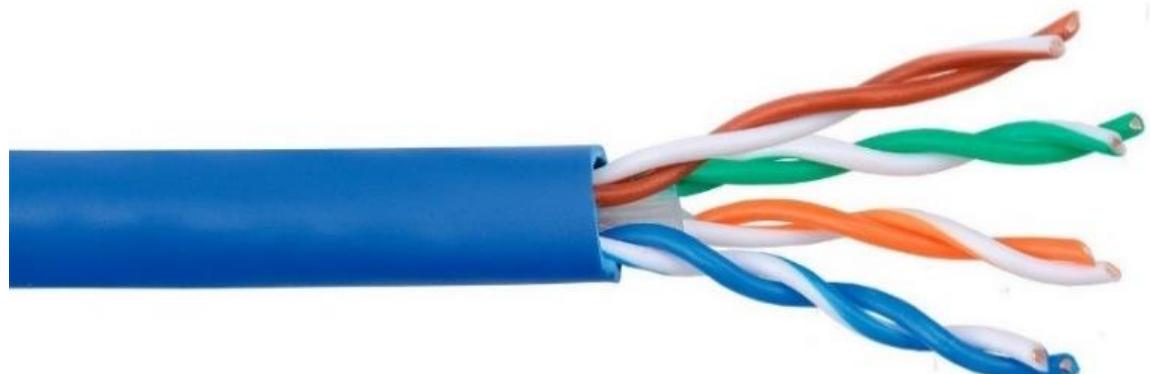
CABLE STRIPPER



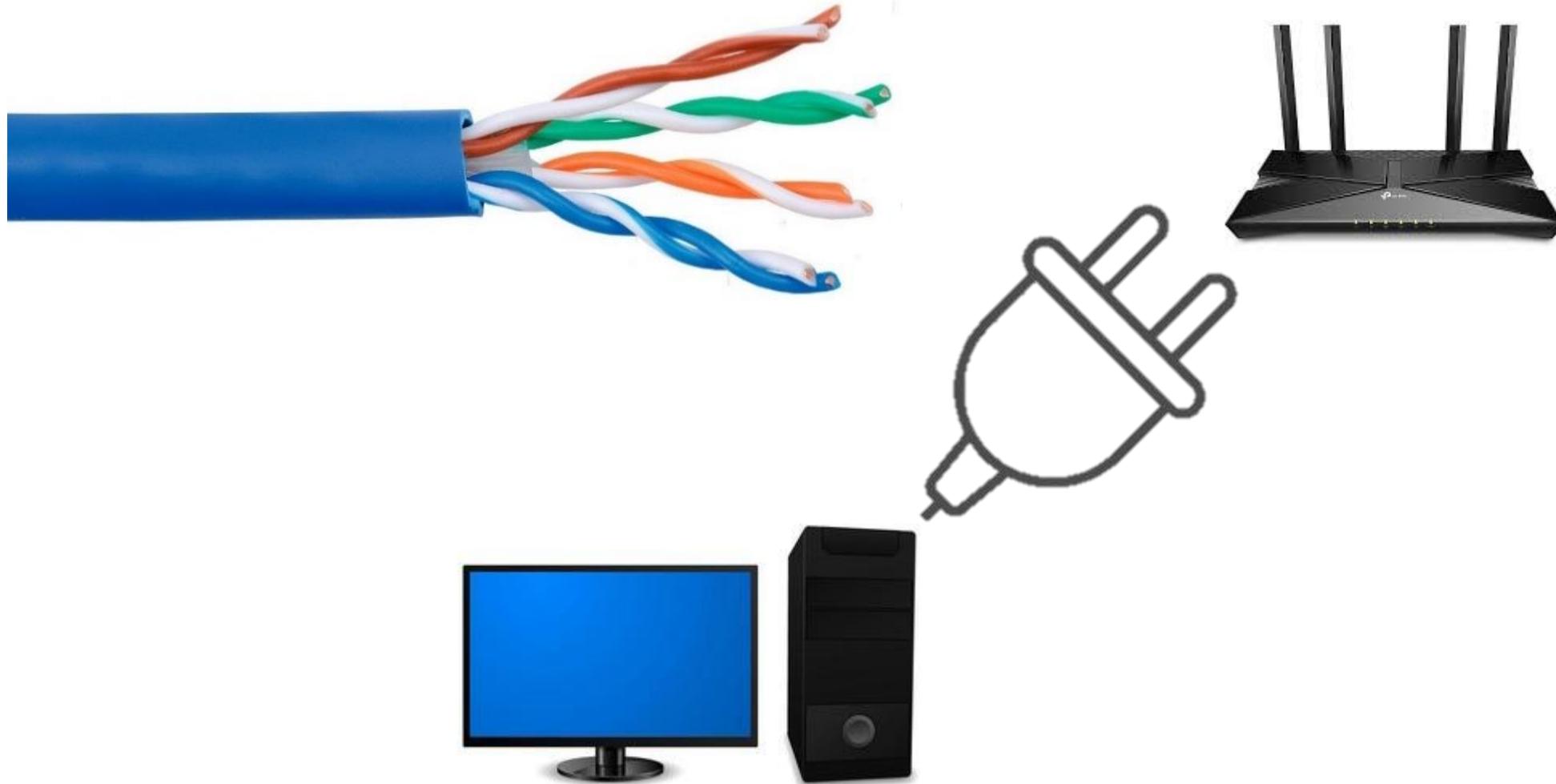
**RJ45
CONNECTOR**

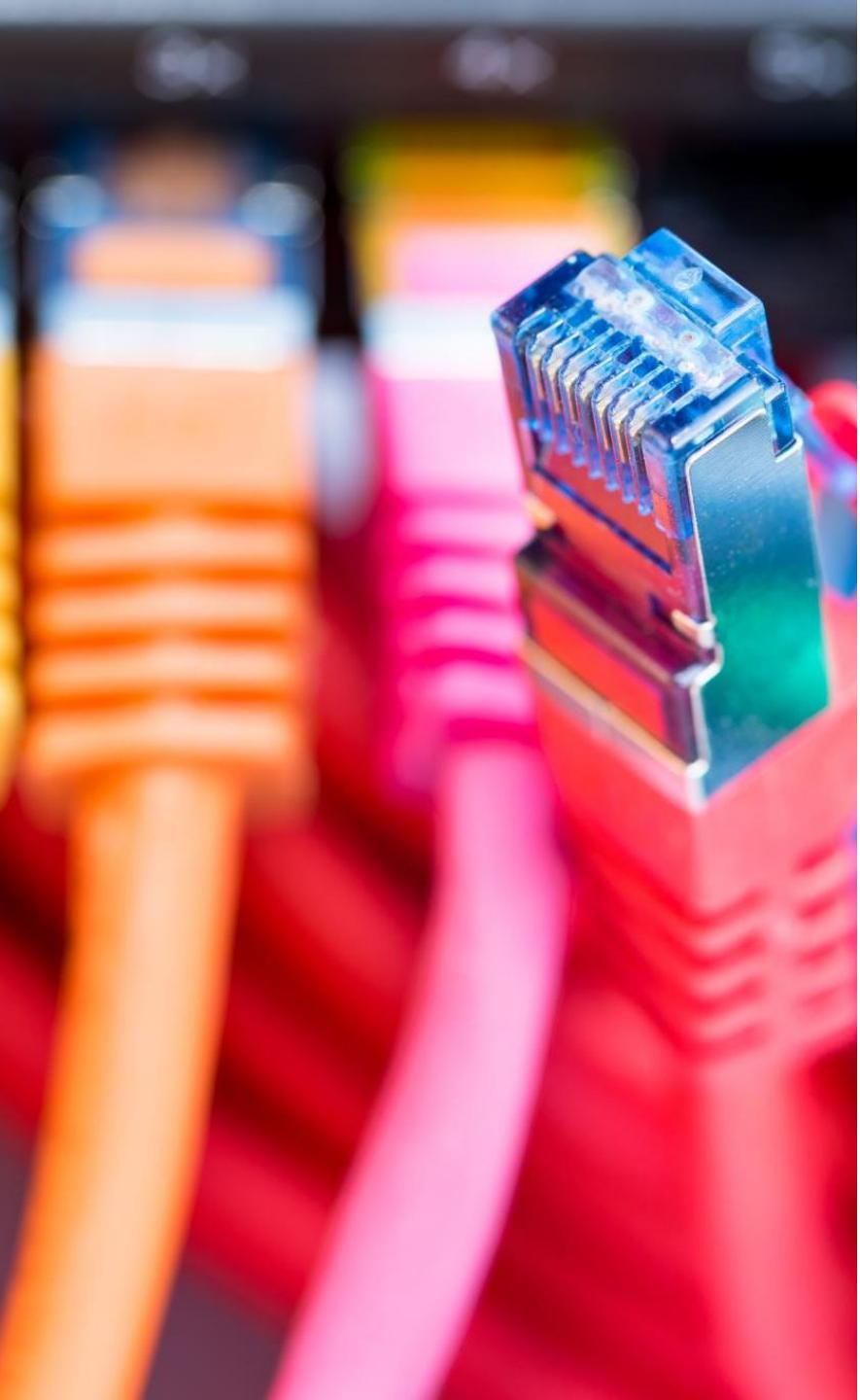
Types of Network Cables

- Twisted Pair Cables
 - UTP (Unshielded Twisted Pair)
 - STP (Shielded Twisted Pair)
- Coaxial Cables
- Fiber Optic Cables



Twisted Pair Cable

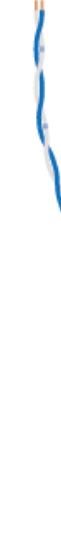
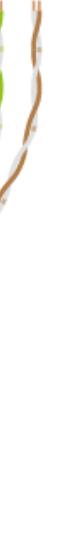




Categories of Ethernet LAN Cables

- Ethernet LAN cables are categorized to differentiate their generation, structure, frequency, and bandwidth (speed). The categories of Ethernet LAN cables include CAT1, CAT2, CAT3, CAT4, CAT5, CAT5e, CAT6, CAT6A, CAT7, CAT7A, and CAT8.1.

History of Ethernet Lab Cables' Categories

											
CAT 1	CAT 2	CAT 3	CAT 4	CAT 5	CAT 5e	CAT 6	CAT 6A	CAT 7	CAT 7A	CAT 8.1	CAT 8.2
1 Mbps	4 Mbps	10 Mbps	16 Mbps	100 Mbps	1 Gbps	1 Gbps	10 Gbps	10 Gbps	10 Gbps	25 Gbps	40 Gbps
400 KHz	4 MHz	16 MHz	20 MHz	100 MHz	100 MHz	250 MHz	500 MHz	600 MHz	1000 MHz	2000 MHz	2000 MHz
1983	1987	1991	1993	1995	2001	2002	2008	2010	2013	2016	2018

Category 1 Ethernet

1983 - 128~1000 Kbps

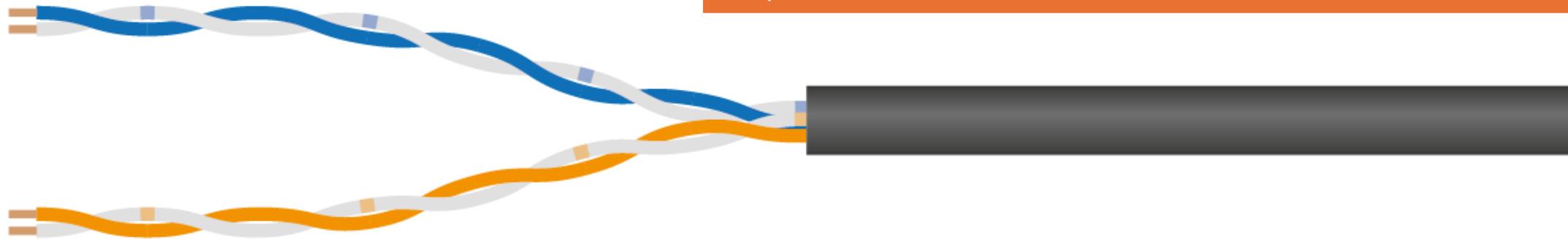
The first generation of Ethernet cables, Category 1 (CAT1) cables, were officially introduced around 1983 and were only capable of transferring data as voice in telephone networks. CAT1 cables consisted of only one pair of insulated copper wires and usually had a thick outer jacket. Category 1 cables functioned at a frequency from 100 KHz to 400 KHz, or up to 1000 KHz at most, and could only transfer voice at a theoretical speed of 1 Megabit per second. CAT1 Ethernet cables did not typically use connectors; they were terminated directly to phone panels.²



100-400 KHz

Category 2 Ethernet LAN Cables

1987 - 1~4 Mbps

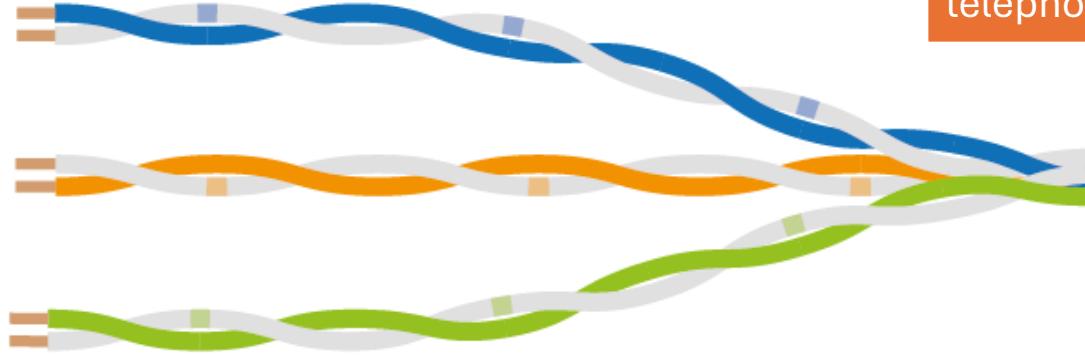


The second generation of Ethernet cables is Category 2 (CAT2), which was introduced in 1987 and first used for Token Ring networks. In telephone networks, CAT2 cables are capable of transferring data as voice signals. Category 2 (CAT2) cables consist of two pairs of insulated copper wires and usually have an outer jacket. Category 2 cables function at a frequency from 1 MHz to 4 MHz, and they can transfer data at speeds from 1 to 4 Megabits per second. CAT2 Ethernet cables were used with RJ11 connectors, which are compatible with older voice telephones.



Category 3 Ethernet LAN Cables

1991 - 10 Mbps

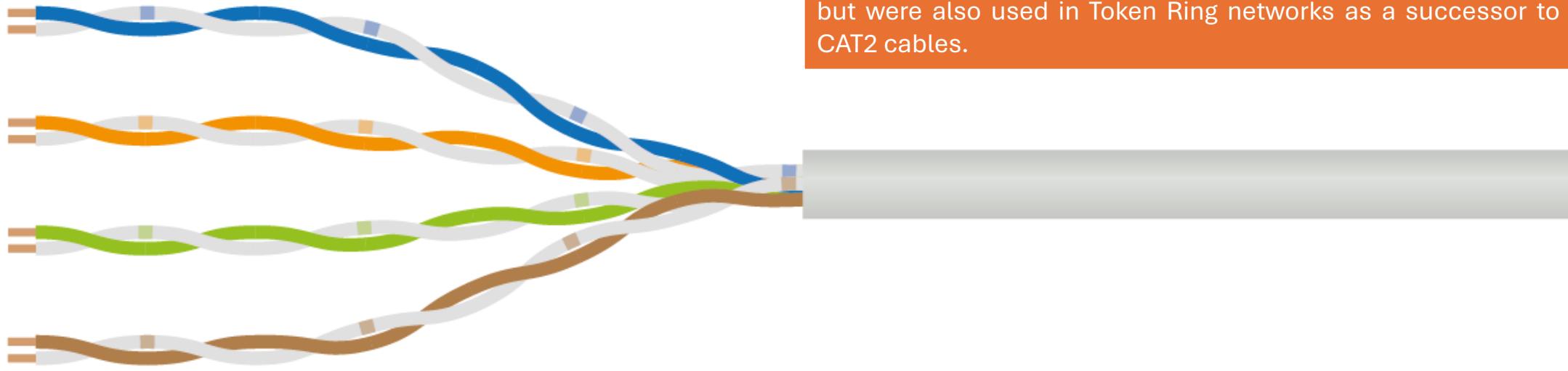


The third generation of Ethernet cables is Category 3 (CAT3). It consists of three pairs of insulated copper wires within an outer jacket. CAT3 Ethernet cables were first used in 1991, and they introduced the 10Base-T Ethernet standard. Category 3 (CAT3) cables can operate at frequencies up to 16 MHz, allowing for data transfer speeds of up to 16 Megabits per second. However, the higher speed of CAT3 over CAT2 limited their layout distance to 100 meters, which became the standard distance for most subsequent Category cables. CAT3 Ethernet cables were used with RJ12 connectors, which are compatible with older voice telephones, just like RJ11 connectors.



Category 4 Ethernet LAN Cables

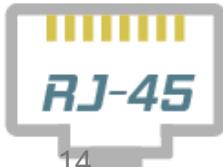
1993 - 16 Mbps



The fourth generation of Ethernet cables, Category 4 (CAT4), contains four pairs of insulated copper wires within an outer jacket. The four pairs of twisted copper wires used in CAT4 became the standard for all subsequent CAT cables. Consequently, CAT4 cables were the first to use the RJ45 connector in 1993, which has remained the most common Ethernet network connector for many years, even today. Category 4 (CAT4) cables have a frequency range of up to 20 MHz, allowing for a data transfer capacity of 16 Megabits per second. CAT4 cables work with the 10Base-T Ethernet standard but were also used in Token Ring networks as a successor to CAT2 cables.

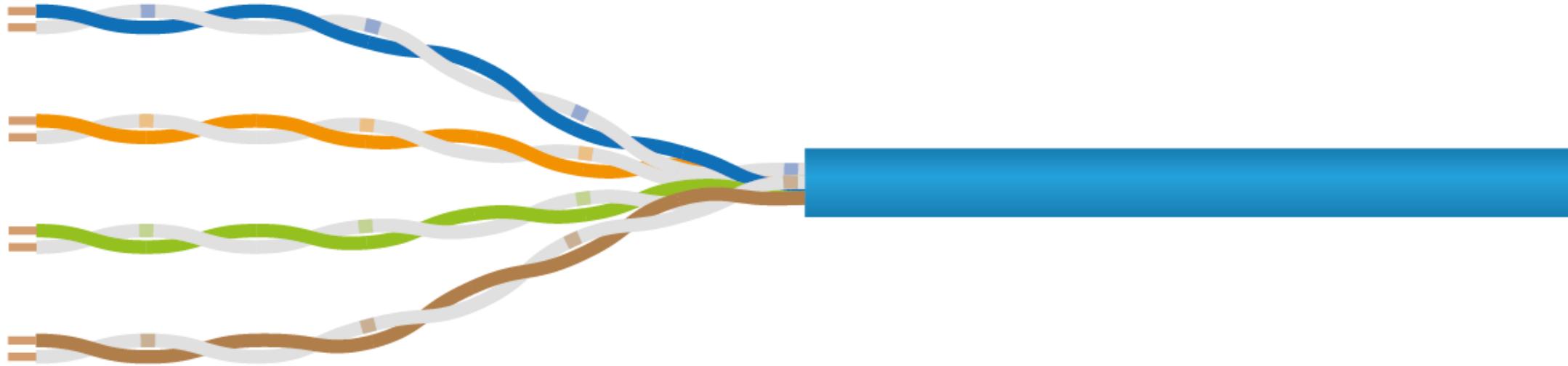


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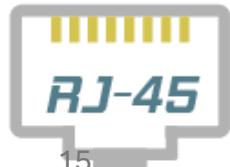


Category 5 Ethernet LAN Cables 1995 - 100 Mbps

The fifth generation of Ethernet cables, Category 5 (CAT5), continued the use of four twisted pairs of wires but were the first to support the widely-used 100Base-T Ethernet standard introduced in 1995. CAT5 cables increased the signal frequency from 20 MHz to 100 MHz and could achieve a bandwidth of 100 Megabits per second over a distance of 100 meters. The Category 5 generation coincided with the internet boom from 1995 to 2001, making it the most well-known Ethernet cable standard in history. CAT5 cables are typically terminated with RJ45 connectors, which remain the most common standard.

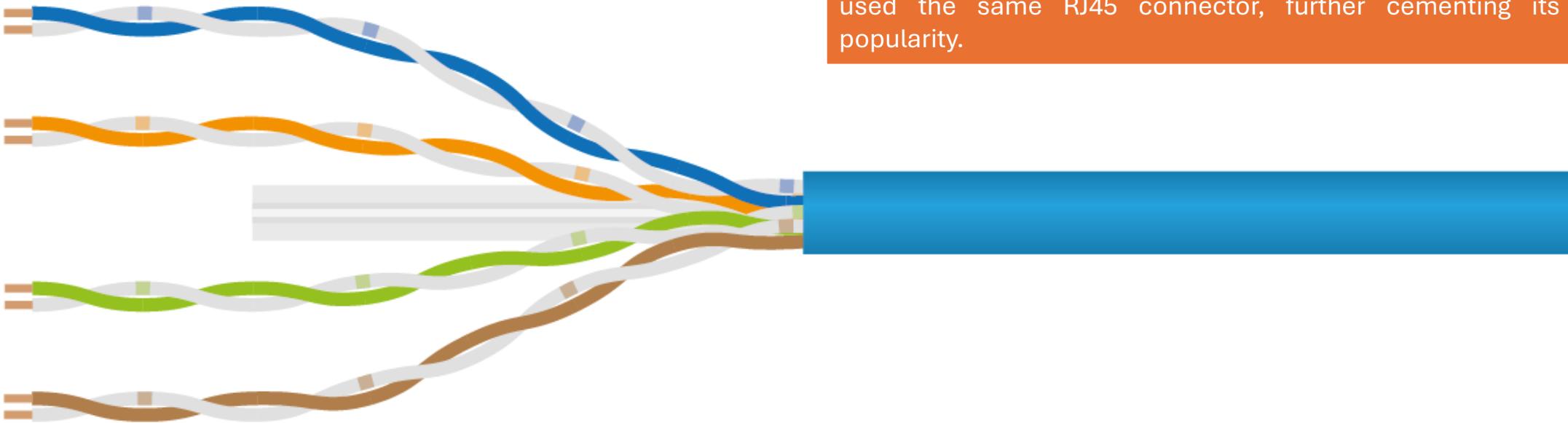


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Category 5E Ethernet LAN Cables

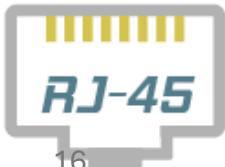
2001 - 1000 Mbps / 1 Gbps



CAT5e is an improved version of CAT5, the fifth generation of Ethernet cables. Introduced in 2001, Category 5e cables were designed to increase bandwidth tenfold over CAT5 cables. CAT5e cables were the first to support the 1000Base-T Ethernet standard, achieving a speed of 1 Gigabit per second, while maintaining the same 100 MHz frequency as CAT5. CAT5e allowed technicians to create larger and more complex LAN network structures, although they had a range limitation of 55 meters for optimal performance. They also used the same RJ45 connector, further cementing its popularity.

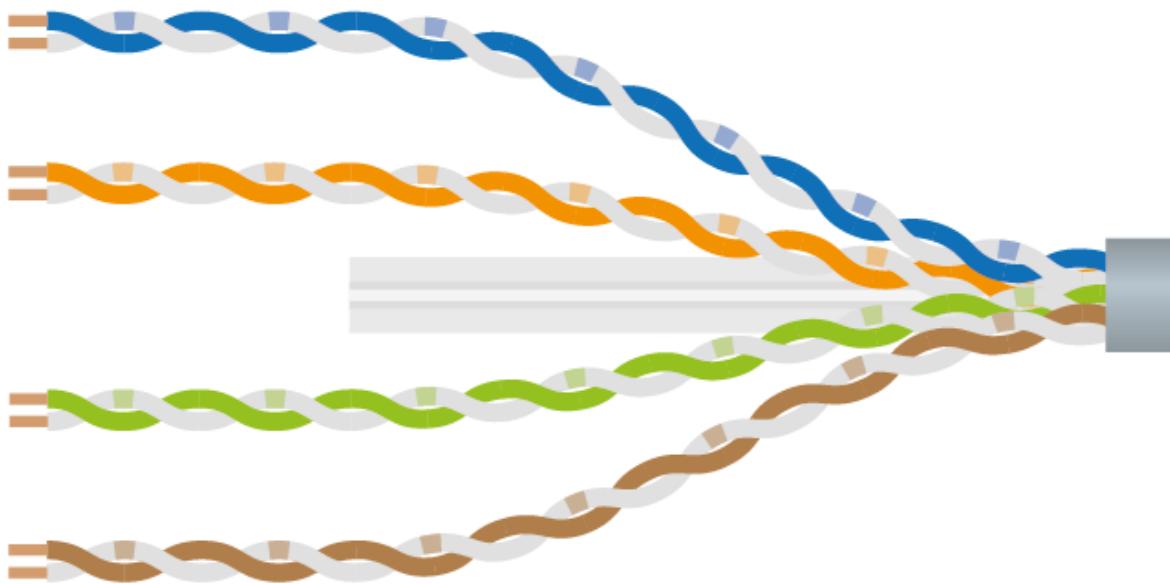


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Category 6 Ethernet LAN Cables

2002 - 1 Gbps



Category 6 (CAT6) Ethernet Cables

- **Introduction Year:** 2002

- **Key Structural Change:**

- Central cross-shaped divider to isolate four pairs of insulated copper wires
- Reduction in crosstalk

- **Design Features:**

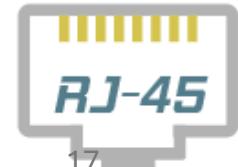
- Tighter and shorter twists in wire pairs
- Some cables include an electromagnetic shield under the jacket

- **Performance:**

- Frequency: 250 MHz
- Bandwidth: 1 Gigabit per second (same as CAT5e)
- Full distance: 100 meters

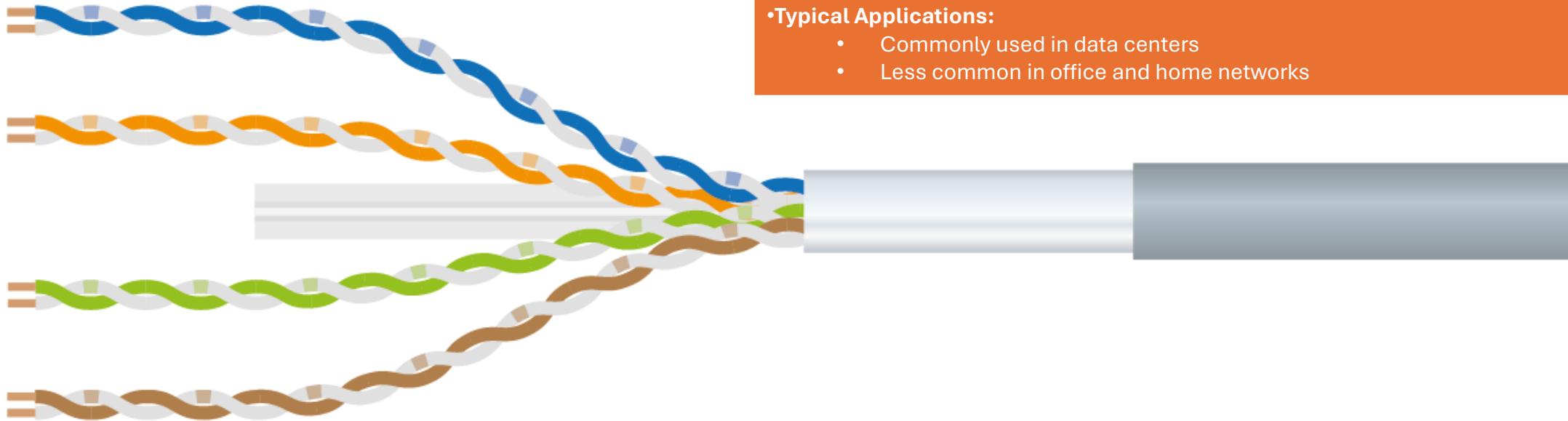
- **High-Speed Use:**

- Can support 10 Gigabit per second networks
- Limited distance for 10 Gbps: 55 meters



Category 6A Ethernet LAN Cables

2008 - 10 Gbps



Category 6A (CAT6A) Ethernet Cables

- **Introduction Year:** 2008

- **Key Improvement:**

- First to support the 10GBase-T Ethernet standard

- **Frequency and Performance:**

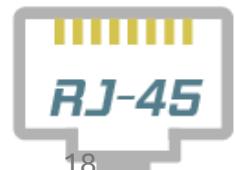
- Frequency: Up to 500 MHz (double that of CAT6)
- Bandwidth: 10 Gigabits per second
- Distance: Full standard of 100 meters at 10 Gbps

- **Design Features:**

- Maintained the structural design of CAT6
- Uses RJ45 connectors as standard

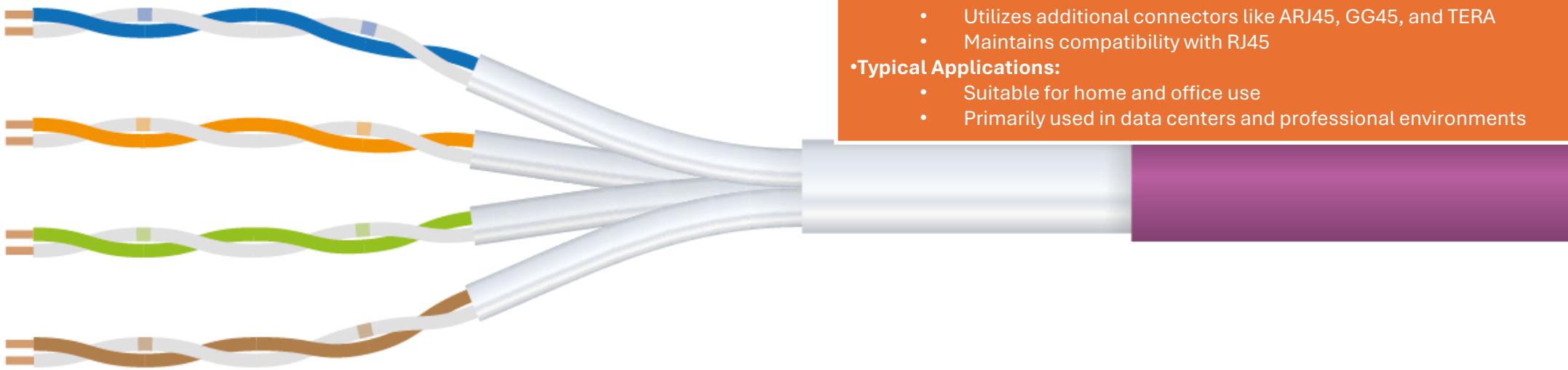
- **Typical Applications:**

- Commonly used in data centers
- Less common in office and home networks



Category 7 Ethernet LAN Cables

2010 - 10 Gbps



Category 7 (CAT7) Ethernet Cables

- **Introduction Year:** 2010

- **Key Differences from CAT6A:**

- Mandatory shielded cable structure
- Increased frequency up to 600 MHz

- **Design Features:**

- Inner shield around each twisted pair, in addition to the central cross-shaped divider

- **Performance:**

- Maintains 10GBase-T Ethernet standard
- Bandwidth: 10 Gigabits per second
- Distance: Full standard of 100 meters at 10 Gbps

- **Connectors:**

- Utilizes additional connectors like ARJ45, GG45, and TERA
- Maintains compatibility with RJ45

- **Typical Applications:**

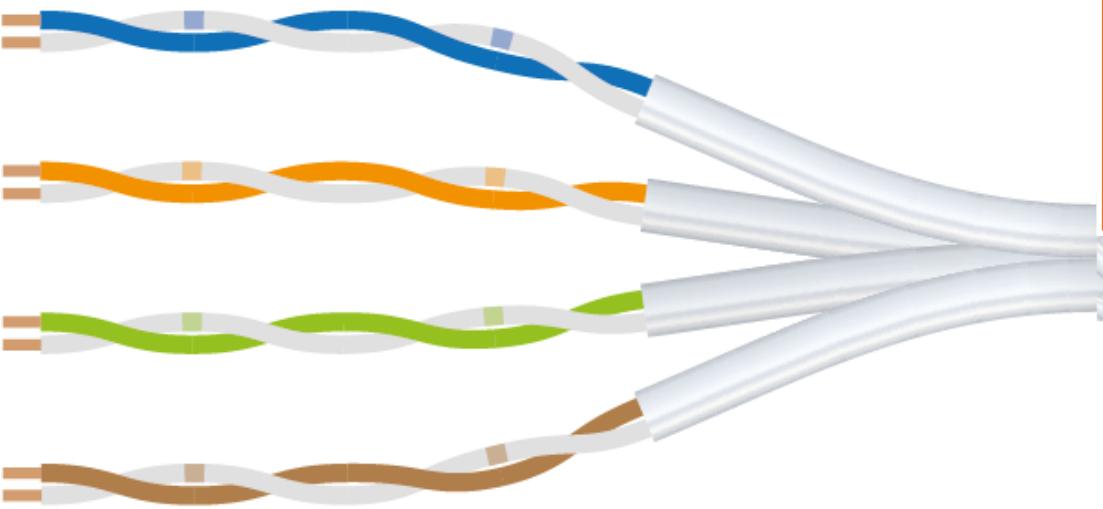
- Suitable for home and office use
- Primarily used in data centers and professional environments

600 MHz



Category 7A Ethernet LAN Cables

2013 - 10 Gbps



1000 MHz

Category 7A (CAT7A) Ethernet Cables

- Key Improvement:

- Enhanced version of CAT7

- Frequency and Performance:

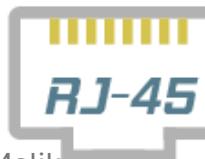
- Frequency: Up to 1000 or 1200 MHz
- Data Transfer Speed: Up to 40 Gigabits per second over 55 meters
- Can support up to 100 Gigabits per second over 15 meters

- Connectors:

- Compatible with RJ45, ARJ45, GG45, and TERA connectors

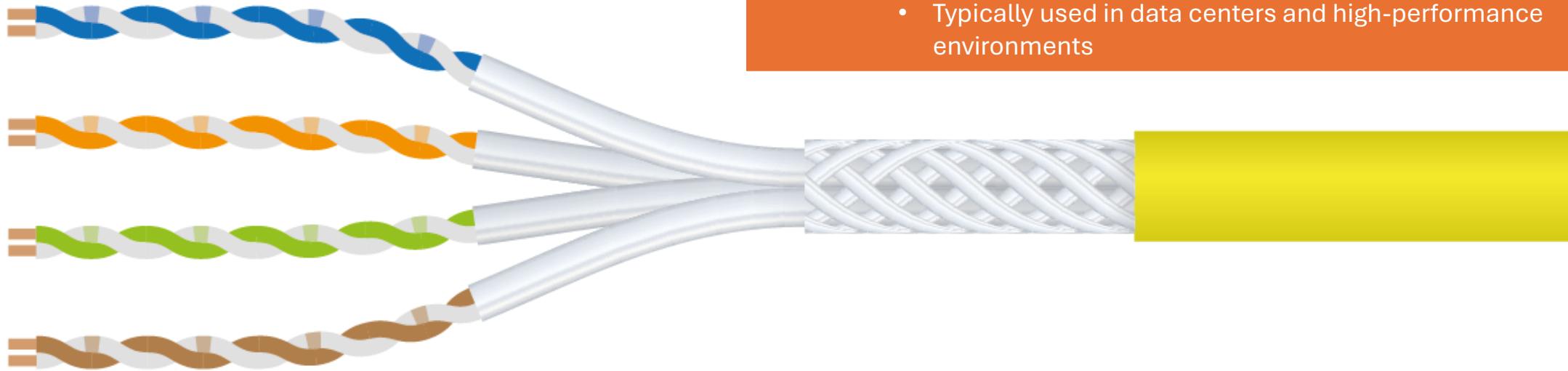
- Typical Applications:

- Mostly used in data centers
- Suitable for professional applications



Category 8.1 Ethernet LAN Cables

2016 - 25 Gbps



Category 8 (CAT8) Ethernet Cables

•Key Advancements:

- First to support a frequency of 2000 MHz
- Compatible with 25GBase-T Ethernet standard

•Subcategories:

- **CAT8.1:**
 - Supports speeds up to 25 Gigabits per second
 - Suitable for data center applications
- **CAT8.2:**
 - Supports speeds up to 40 Gigabits per second
 - Typically used in data centers and high-performance environments

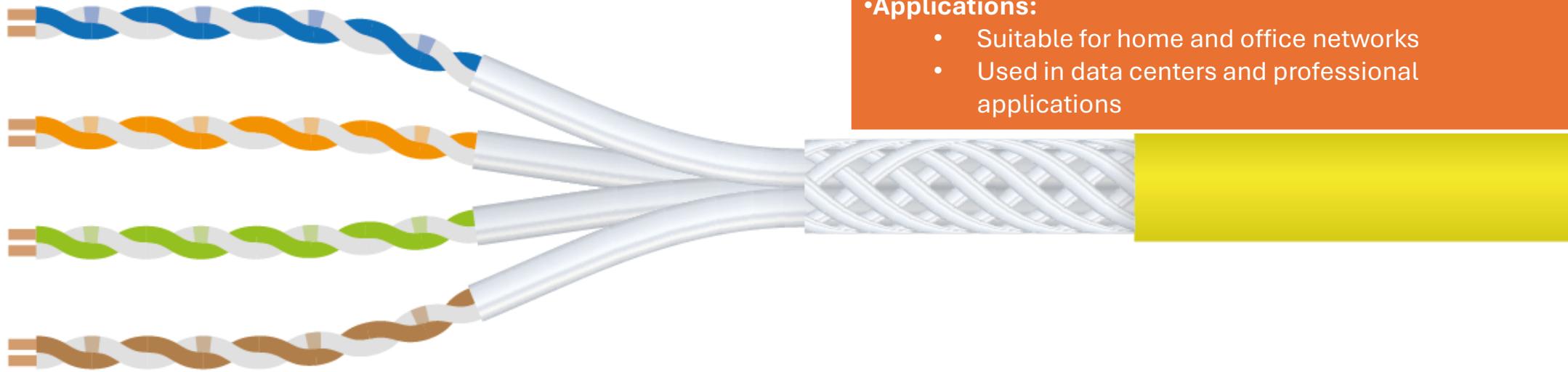
2000 MHz

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Category 8.2 Ethernet LAN Cables

2018 - 40 Gbps



Category 8.1 (CAT8.1) Ethernet Cables

- **Introduction Year:** 2016 (Initially called CAT8)

- **Performance:**

- Transfer Speed: Up to 25 Gigabits per second over 100 meters
- Can also support 40 Gigabits per second, but only up to 33 meters

- **Connectors:**

- Compatible with RJ45, ARJ45, GG45, and TERA connectors

- **Applications:**

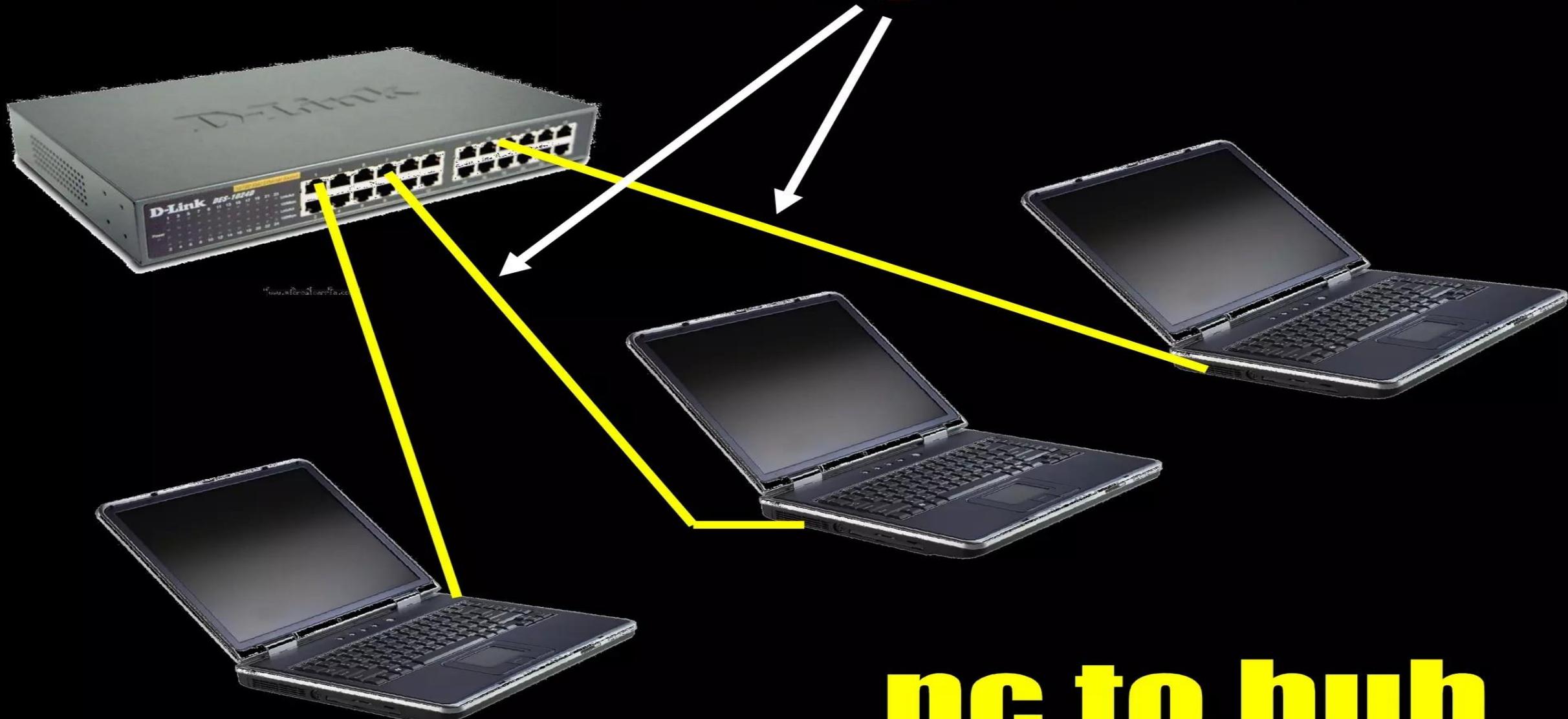
- Suitable for home and office networks
- Used in data centers and professional applications



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straight cable



pc to hub

A diagram illustrating network connectivity. At the top left, there are two light-colored metal Ethernet hubs. A yellow curved arrow connects the bottom port of the top hub to the top port of the bottom hub. Below the hubs, two dark grey laptops are shown. A yellow straight line connects the bottom port of the bottom hub to the top port of the laptop on the left. Another yellow straight line connects the top port of the bottom hub to the top port of the laptop on the right.

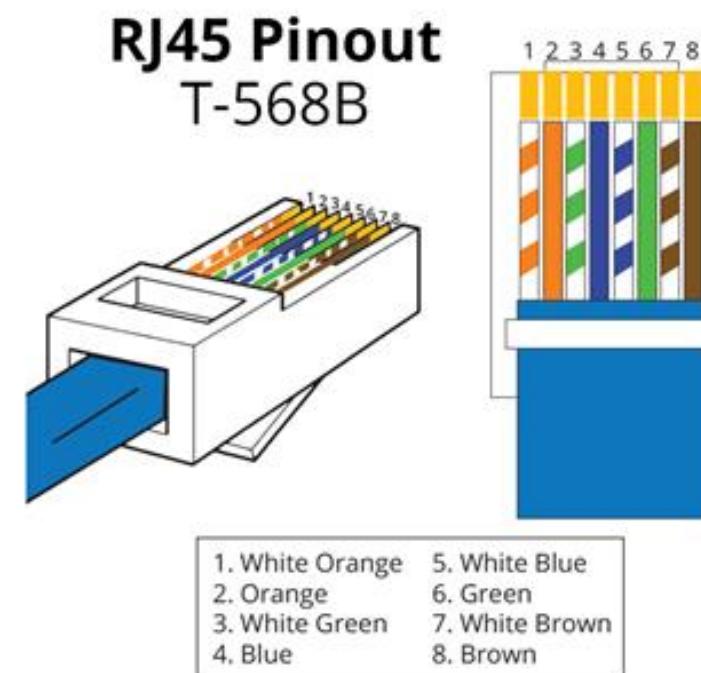
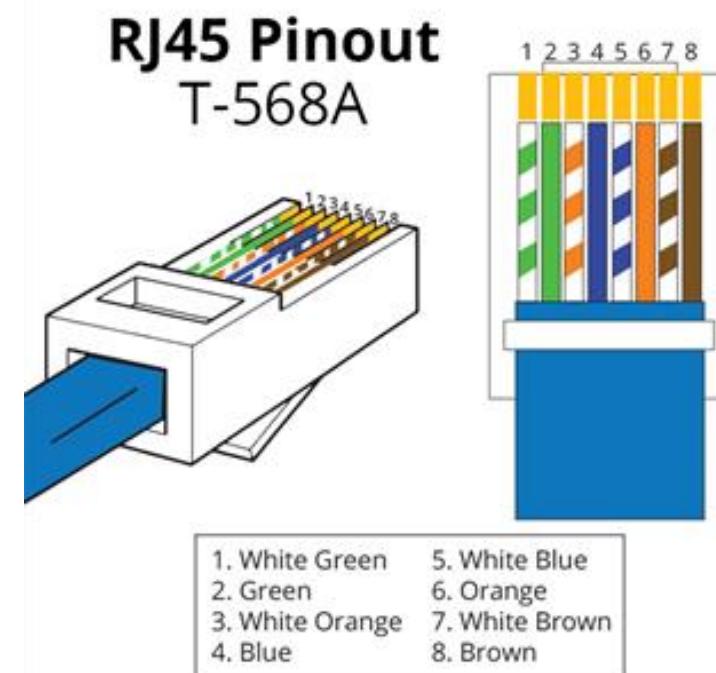
crossed cable

hub to hub

pc to pc

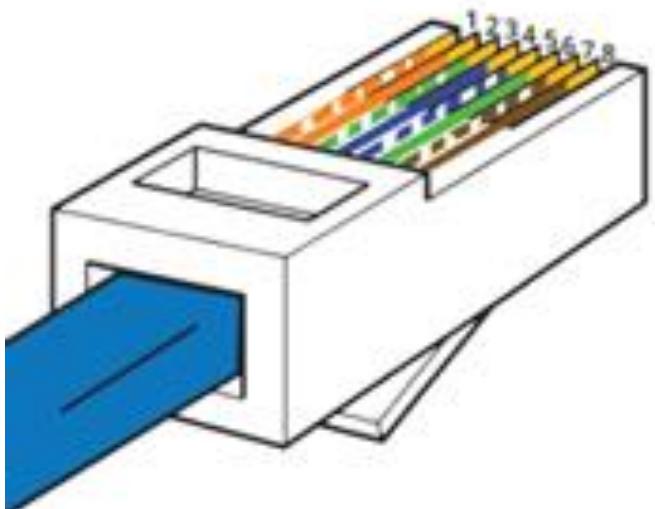
Cable Standards

- T568A and T568B: Wiring standards for RJ45 connectors
- Differences and Application: Choosing the right standard



STRAIGHT-THROUGH

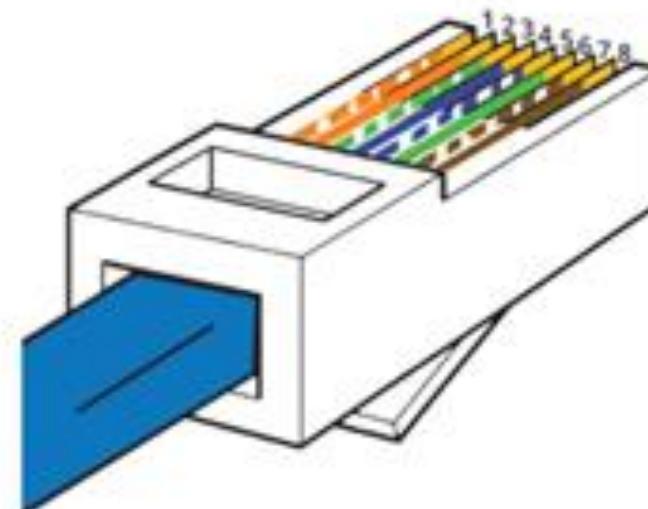
SIDE ONE



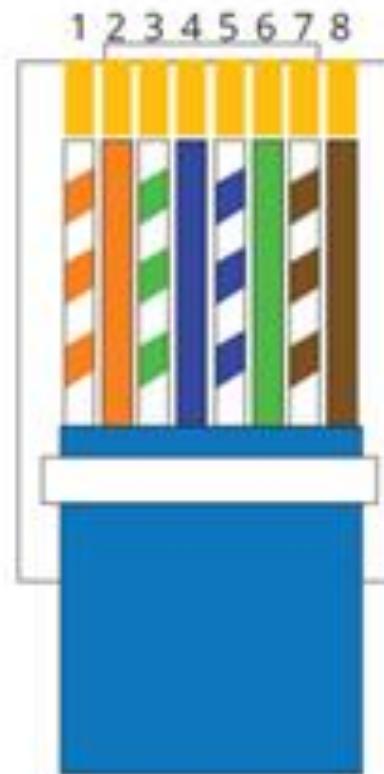
- | | |
|-----------------|----------------|
| 1. White Orange | 5. White Blue |
| 2. Orange | 6. Green |
| 3. White Green | 7. White Brown |
| 4. Blue | 8. Brown |



SIDE TWO

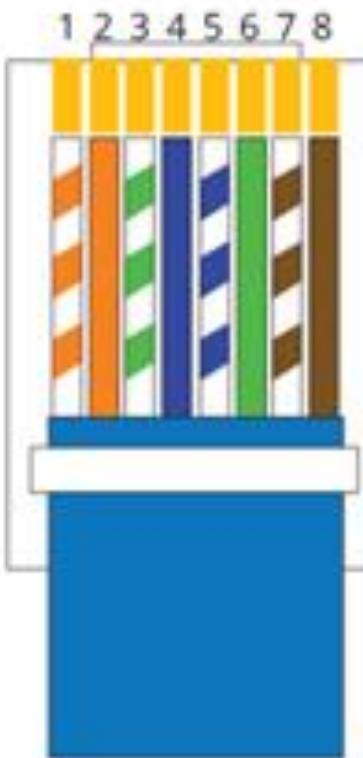
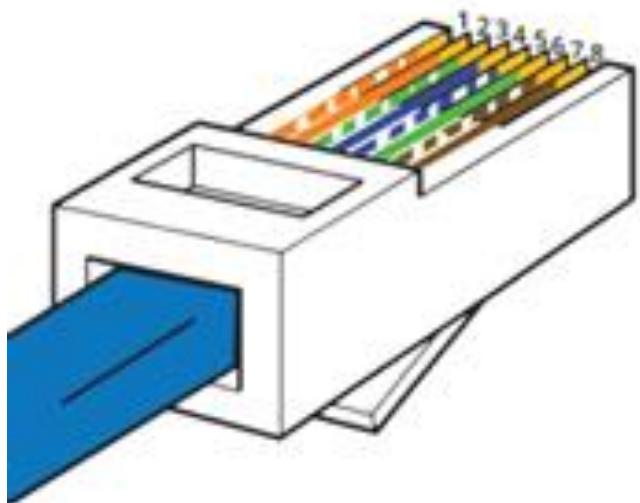


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|-----------------|----------------|
| 1. White Orange | 5. White Blue |
| 2. Orange | 6. Green |
| 3. White Green | 7. White Brown |
| 4. Blue | 8. Brown |



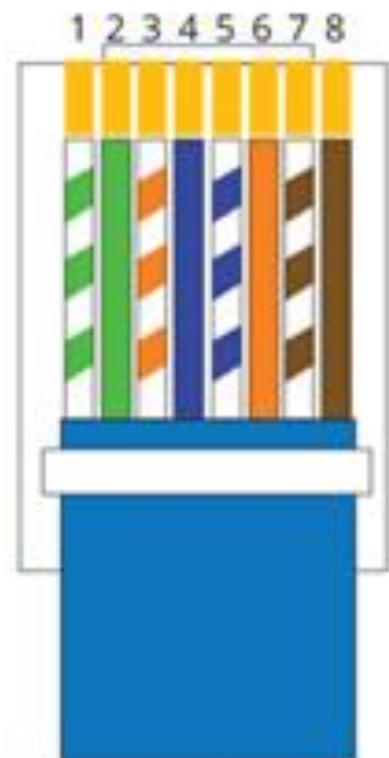
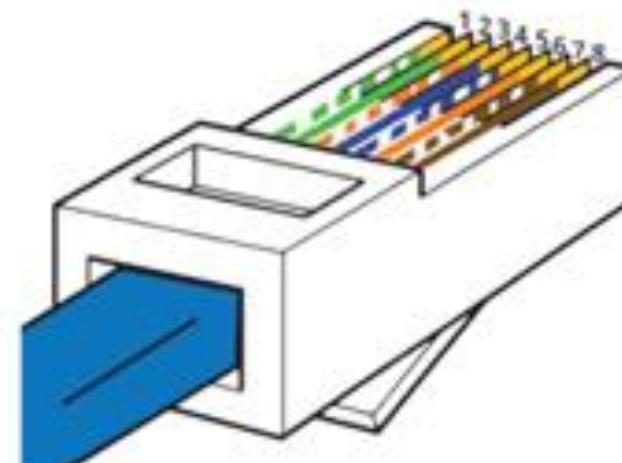
Crossover

SIDE ONE



- | | |
|-----------------|----------------|
| 1. White Orange | 5. White Blue |
| 2. Orange | 6. Green |
| 3. White Green | 7. White Brown |
| 4. Blue | 8. Brown |

SIDE TWO



- | | |
|-----------------|----------------|
| 1. White Green | 5. White Blue |
| 2. Green | 6. Orange |
| 3. White Orange | 7. White Brown |
| 4. Blue | 8. Brown |



568B



568B

For a straight through cable, both ends use the same wiring schematics.

straight through cable



568A



568B

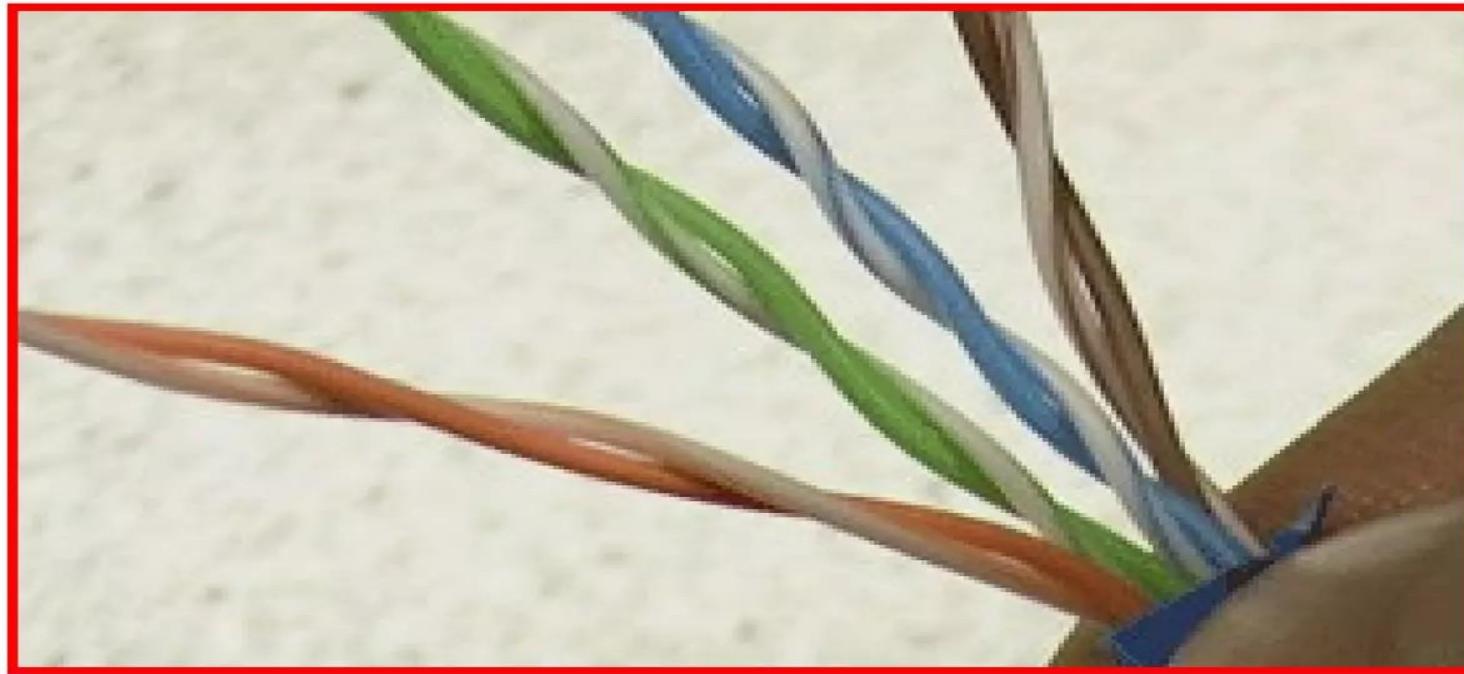
For a crossover cable, both ends use different wiring schematics.

crossover cable

Cables Components

- Connectors: RJ46, BNC, SC, ST, LC
- Patch Panels: Organizing and managing cables
- Cable Management: Trays, ties, and conduits

pair twisted wire



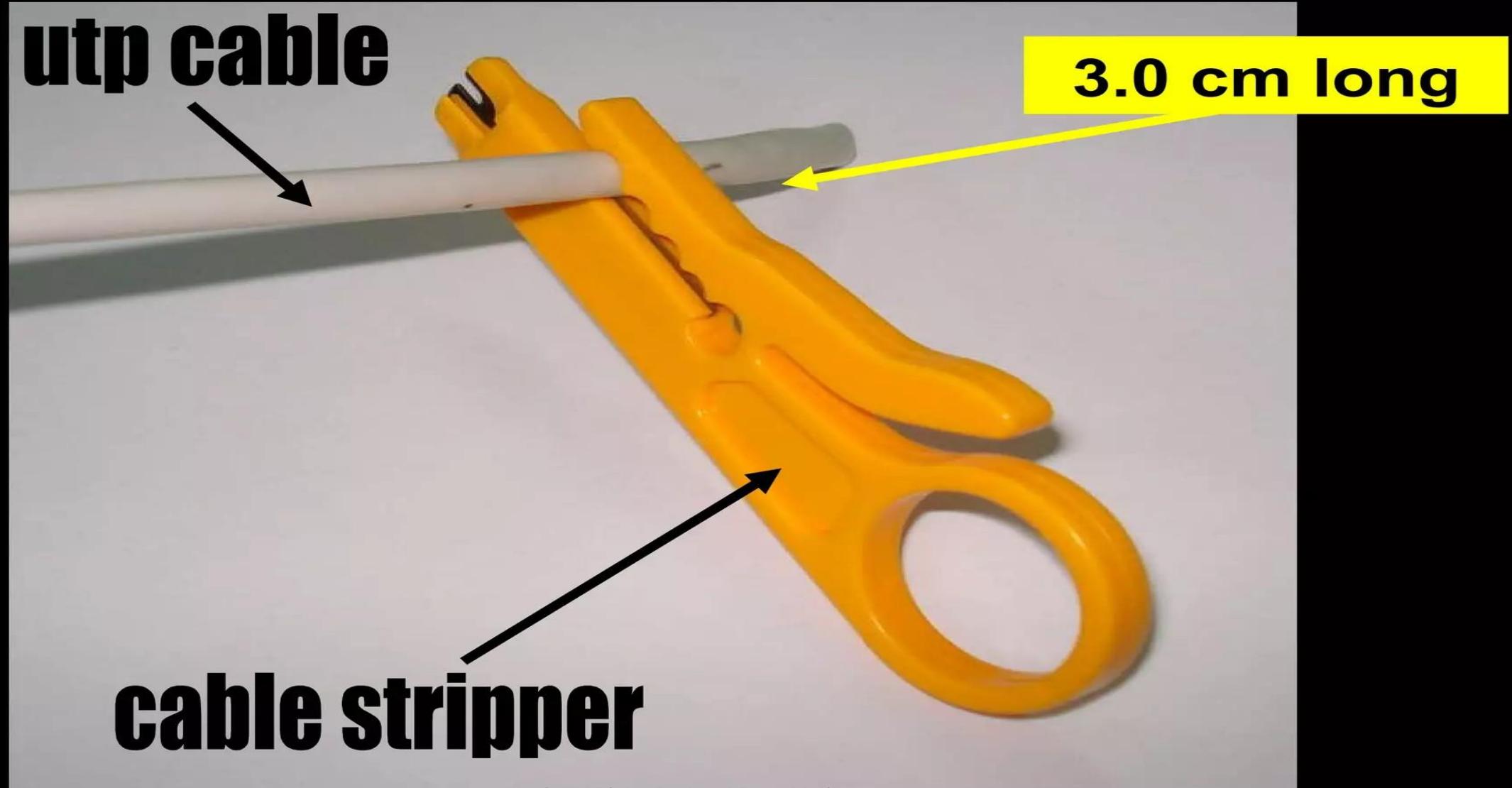
RJ45 connector



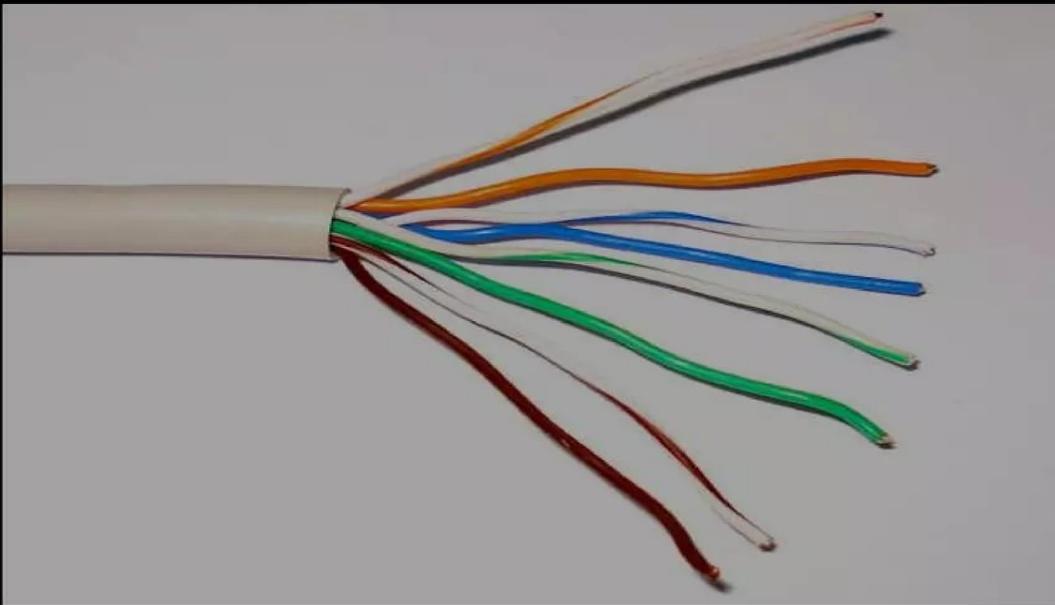
Cable Installation Process

- Cutting and Stripping the cable
- Arranging wire according to standards
- Crimping RJ45 connectors
- Punching down wires into patch panels

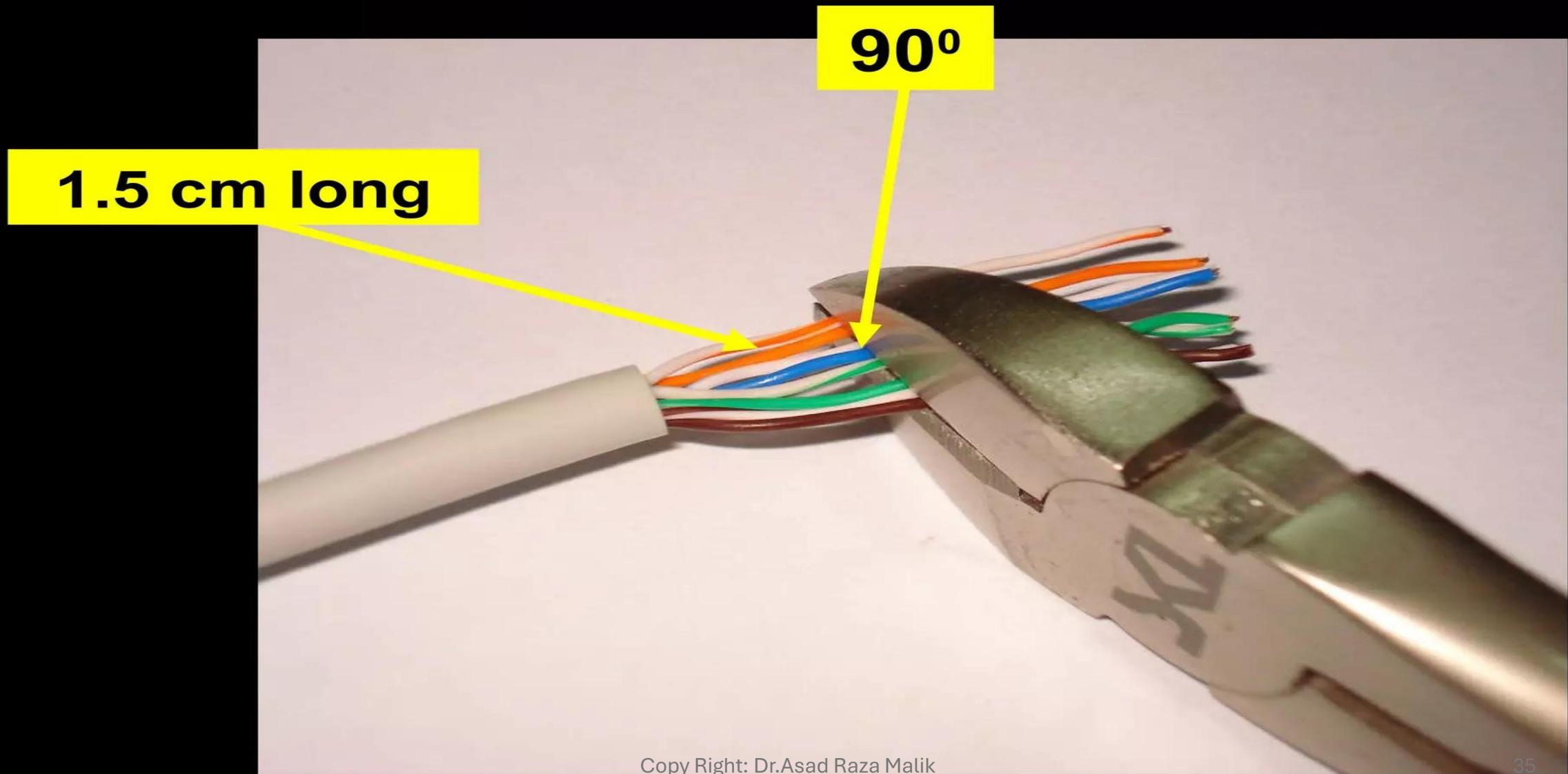
Step 1 : Skin off the cable jacket



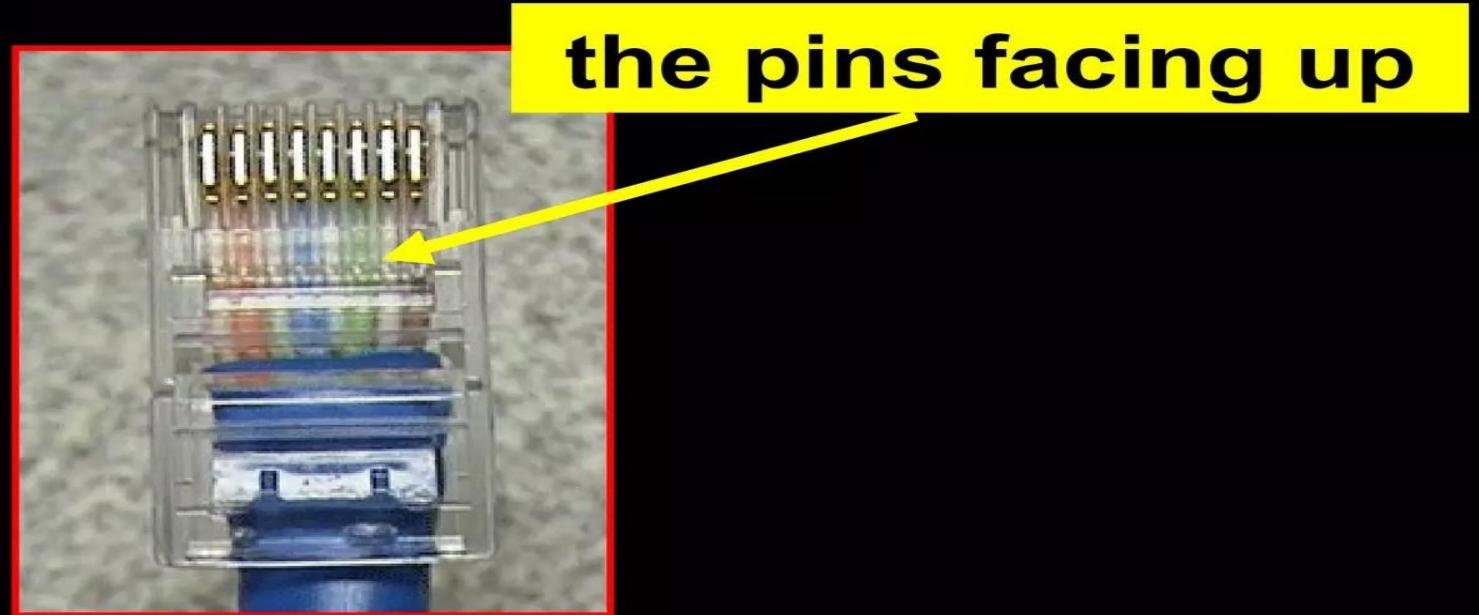
Step 2 : Untwist each pair and straighten each wire



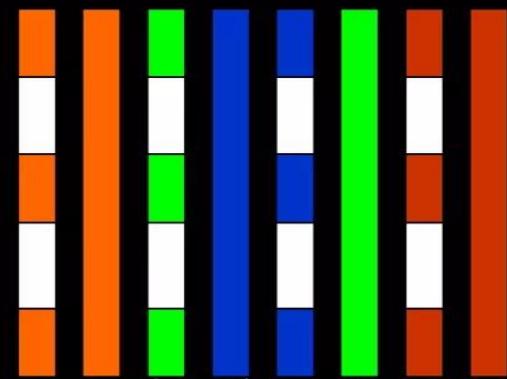
Step 3 : Cut all the wires



Step 4 : Insert the wires into the RJ45 connector



left
white orange



right
brown

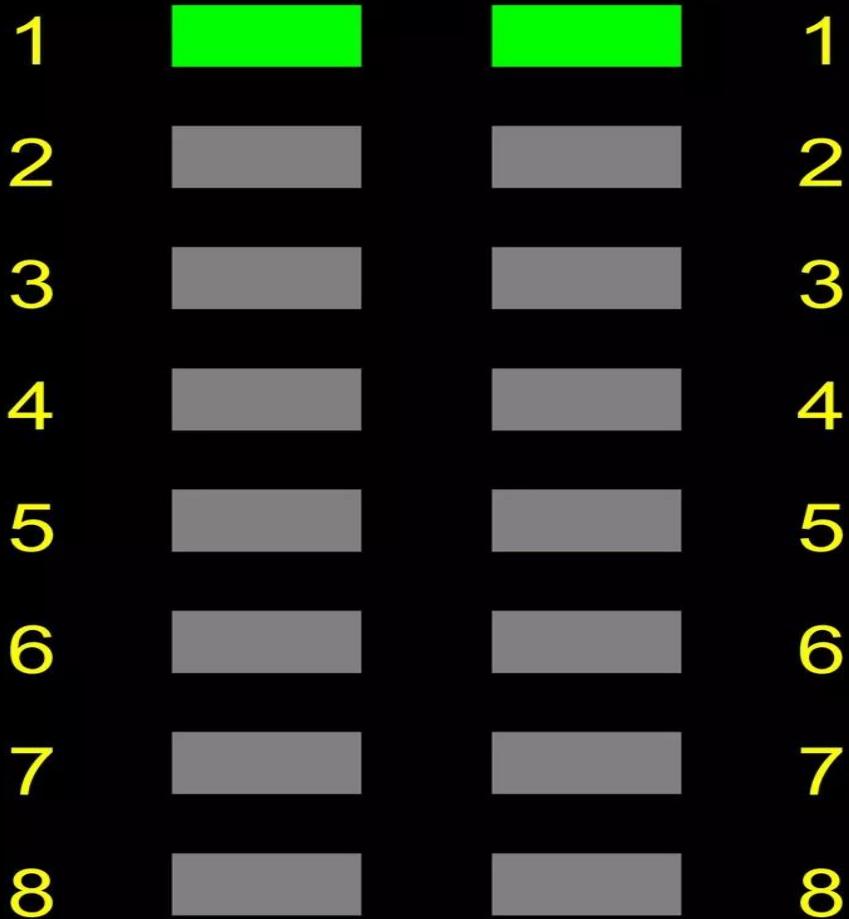
Step 5 : Place the connector into a crimping tool, and squeeze hard so that the handle reaches its full swing.



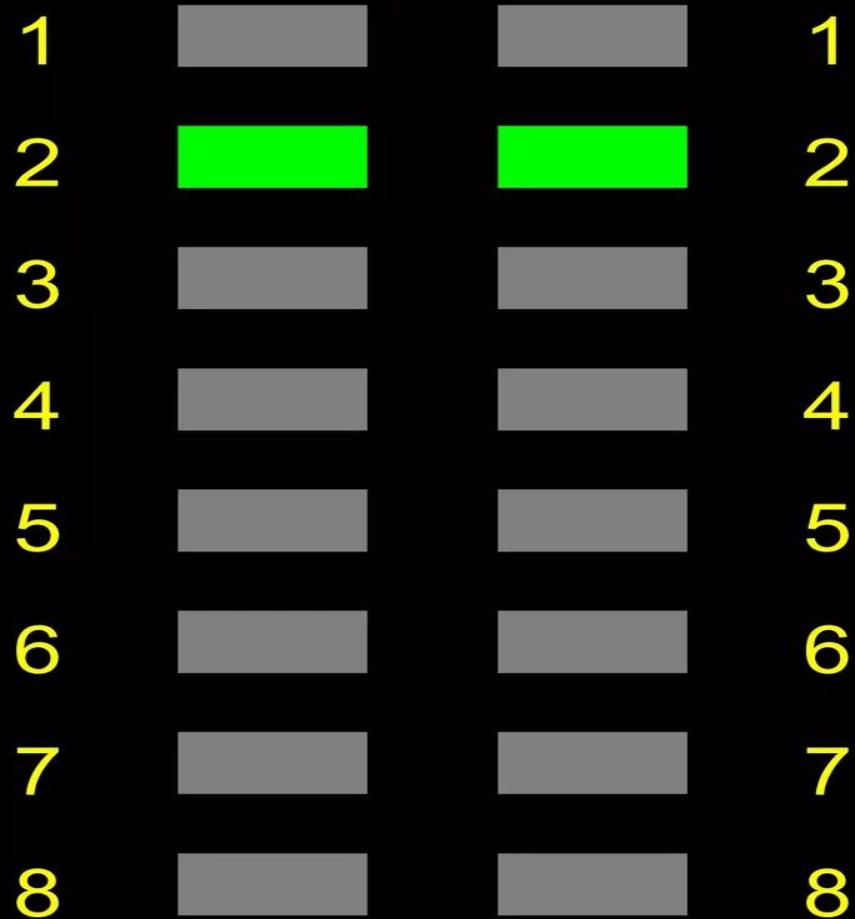
Step 6 : Use a cable tester to test for proper continuity.



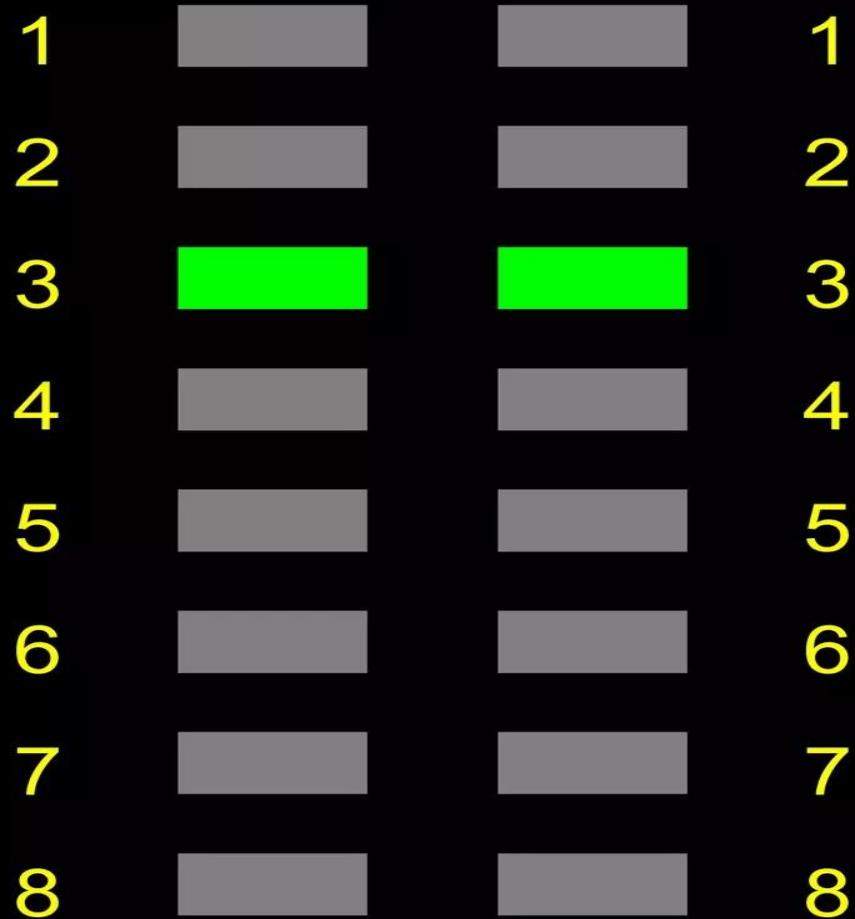
straight cable



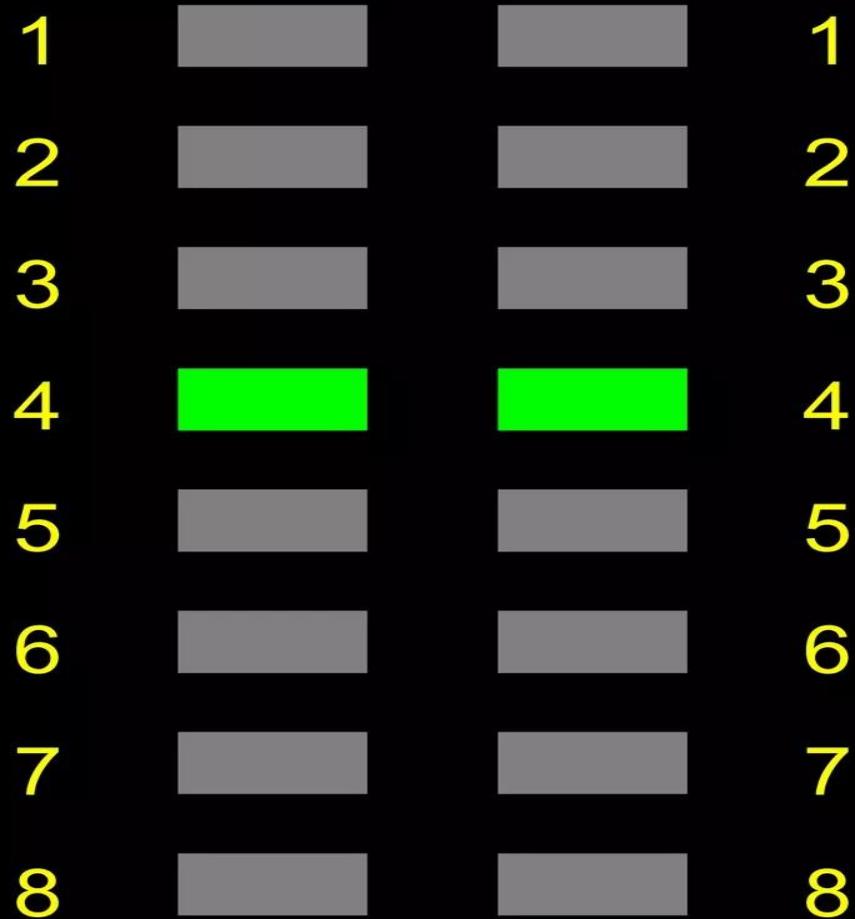
straight cable



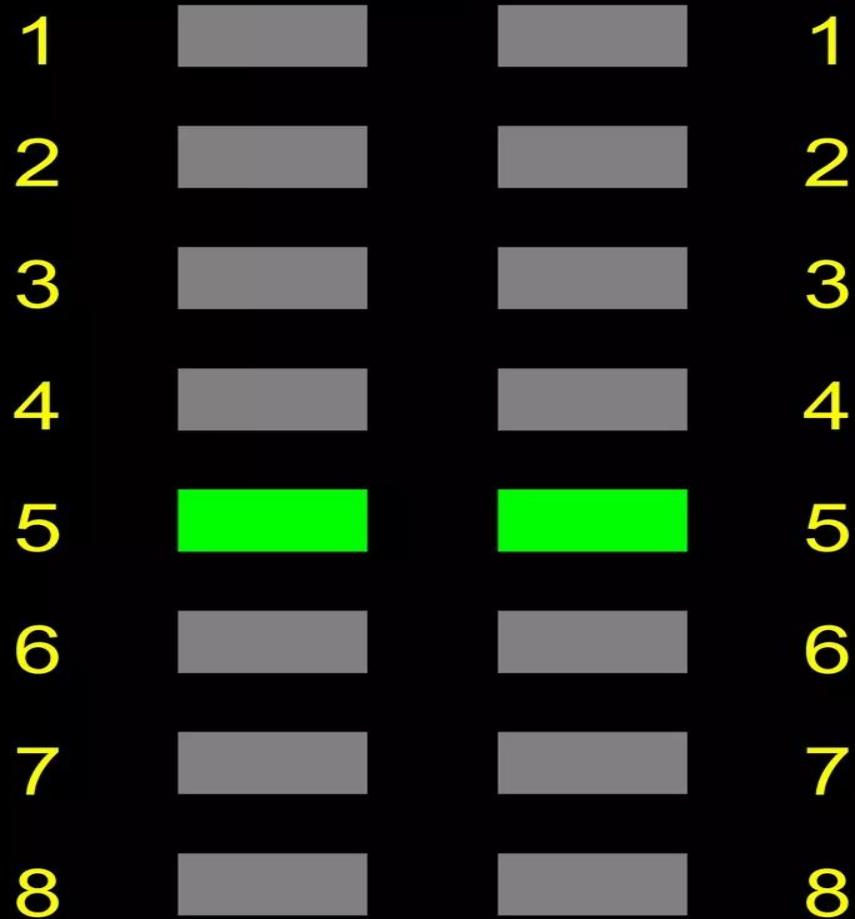
straight cable



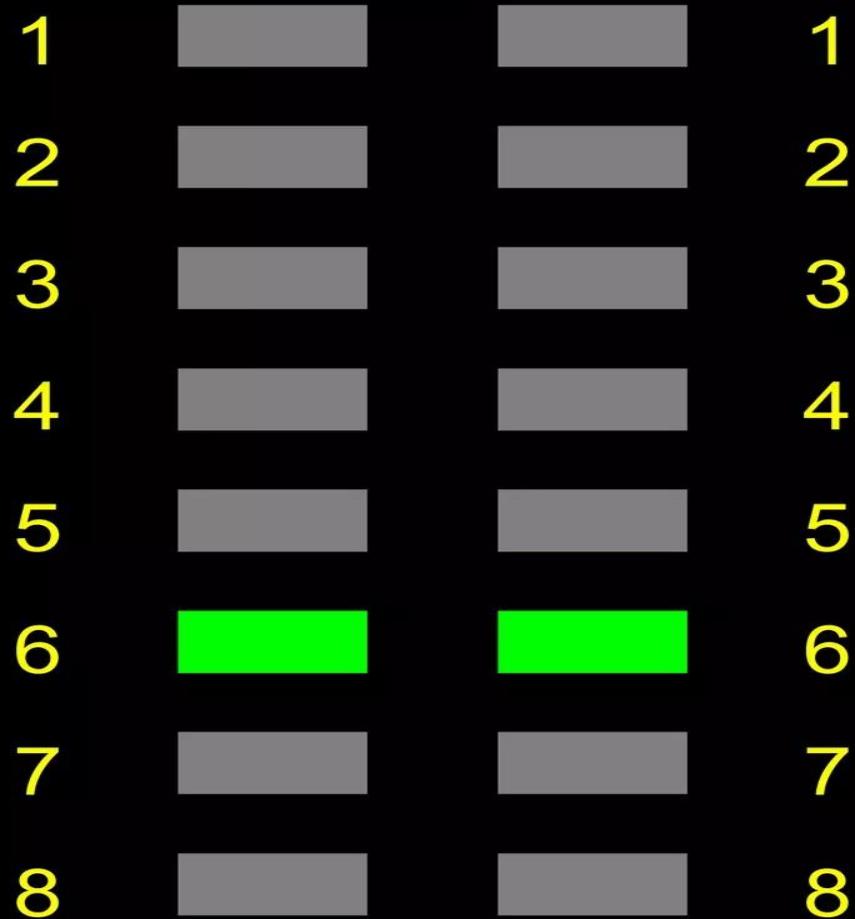
straight cable



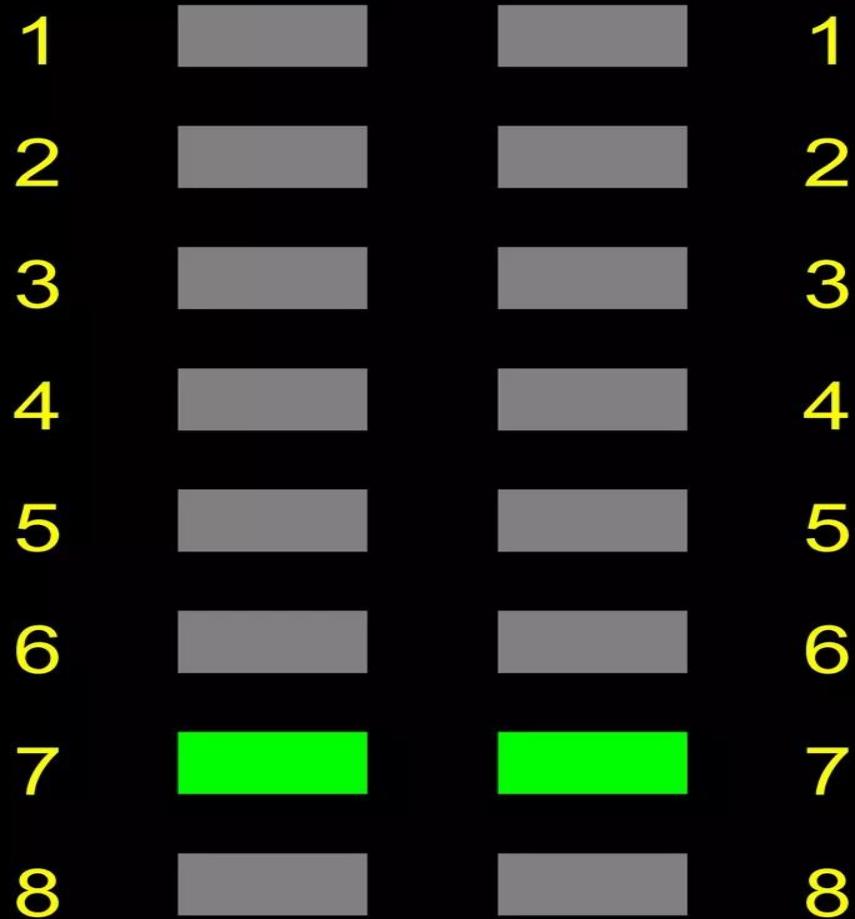
straight cable



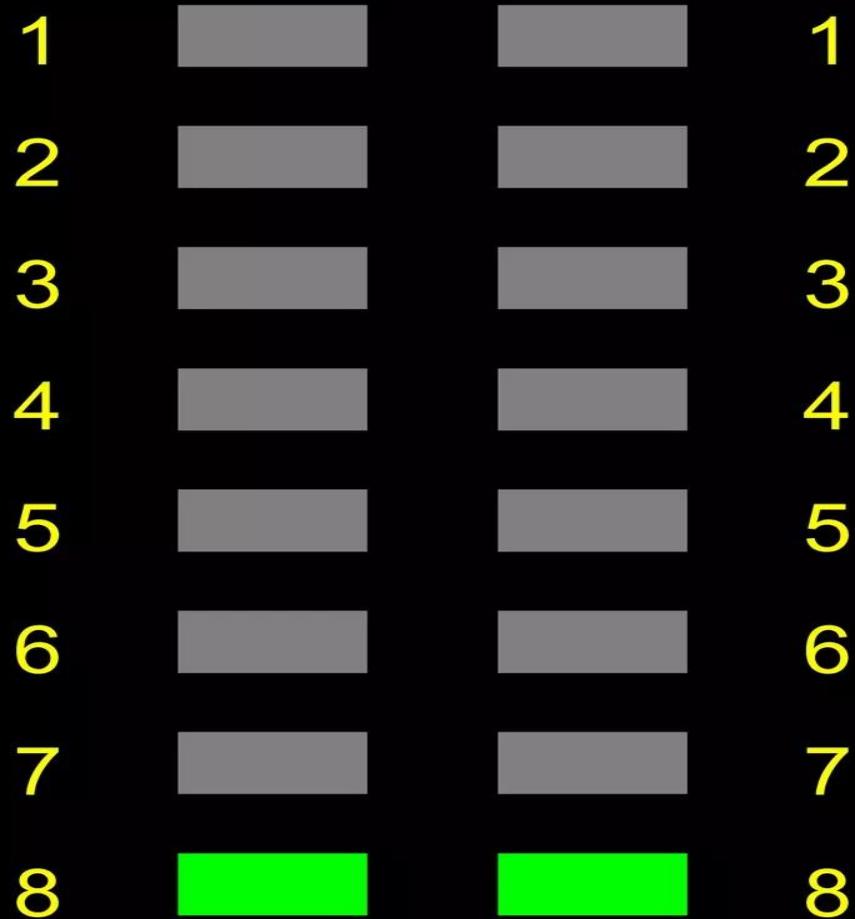
straight cable



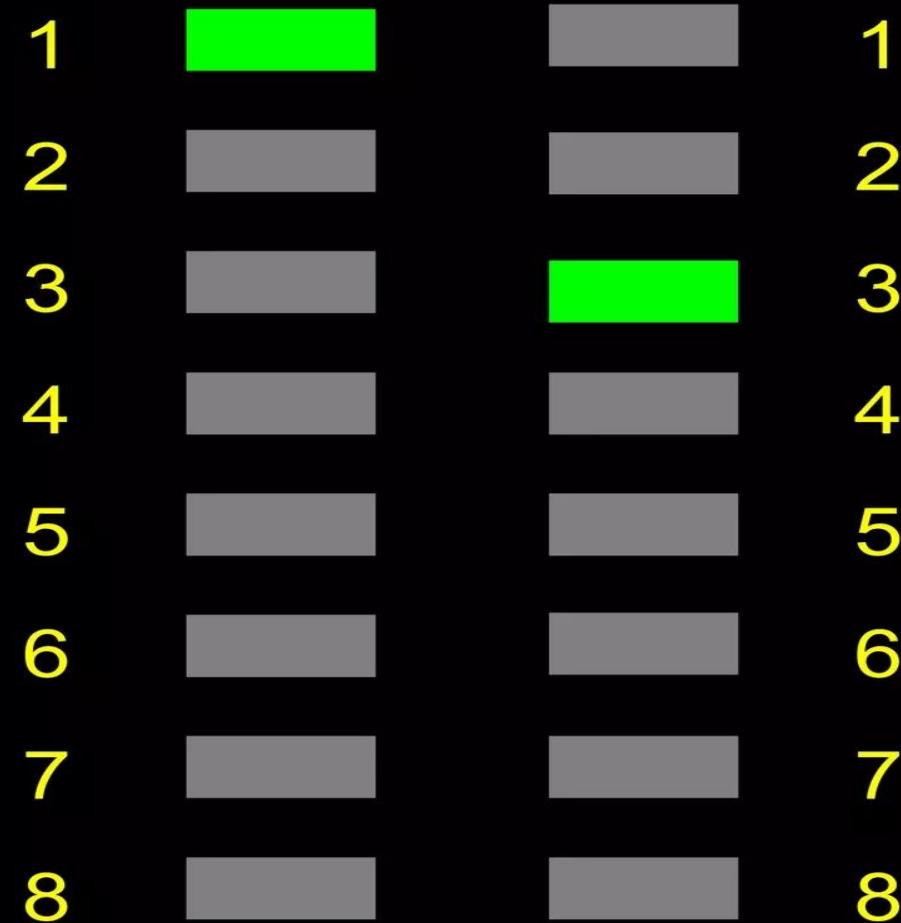
straight cable



straight cable

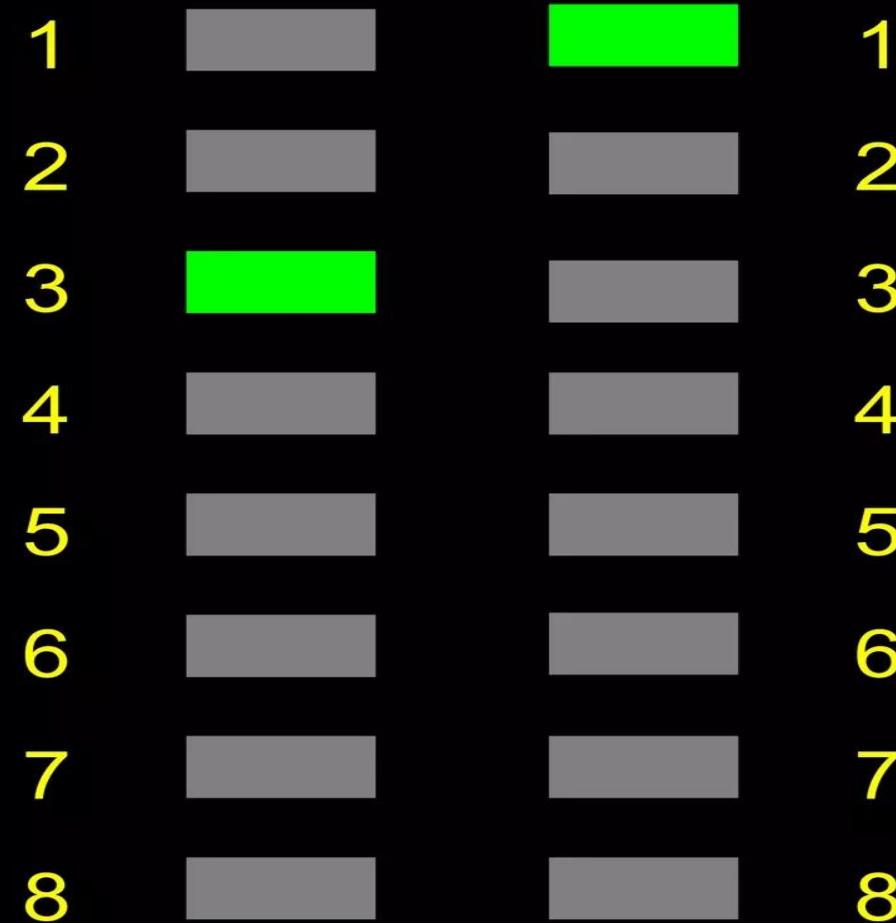


crossover cable



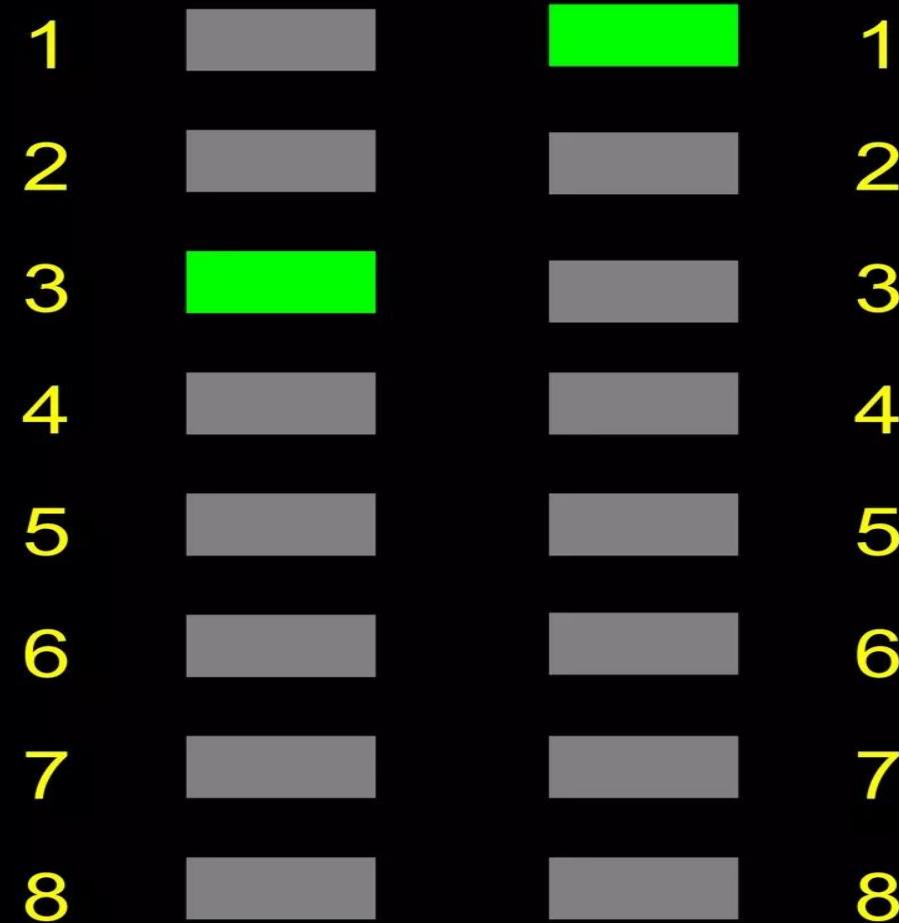
1	3
2	6
3	1
4	4
5	5
6	2
7	7
8	8

crossover cable



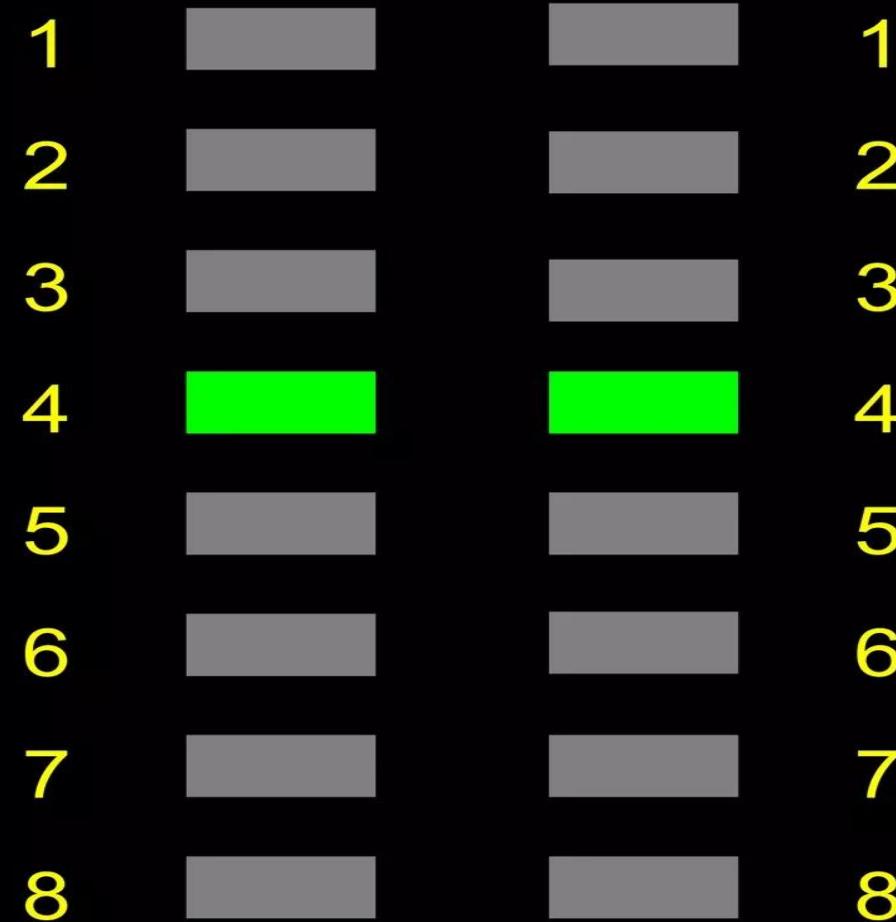
1	3
2	6
3	1
4	4
5	5
6	2
7	7
8	8

crossover cable



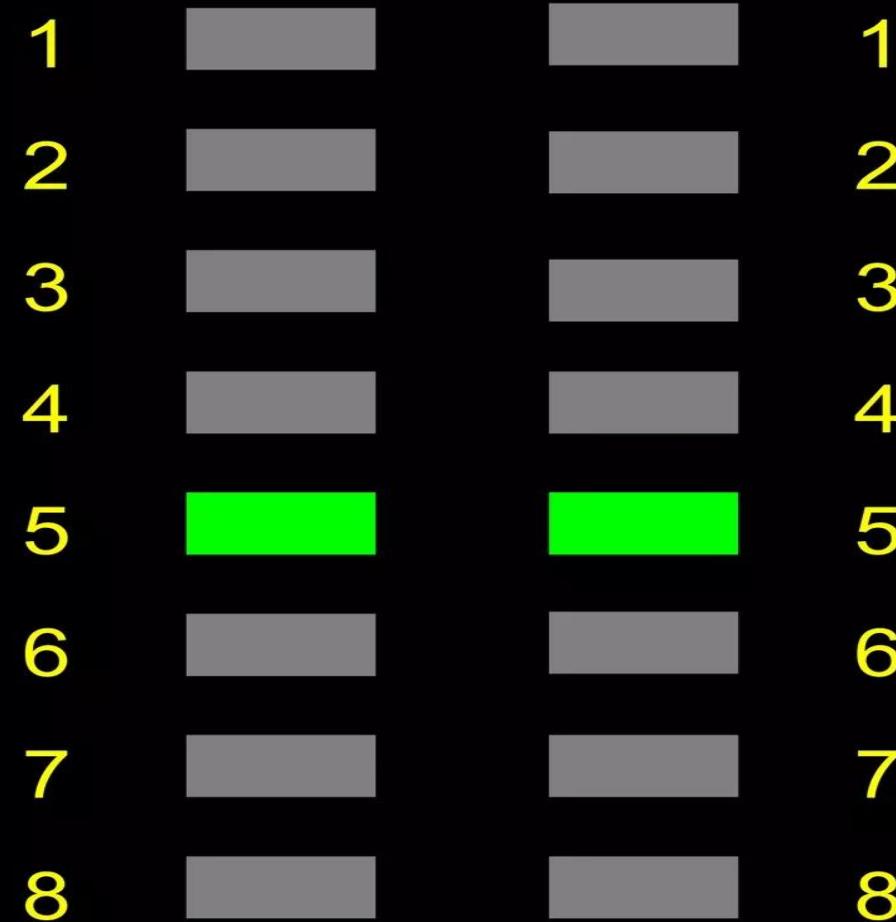
1	3
2	6
3	1
4	4
5	5
6	2
7	7
8	8

crossover cable



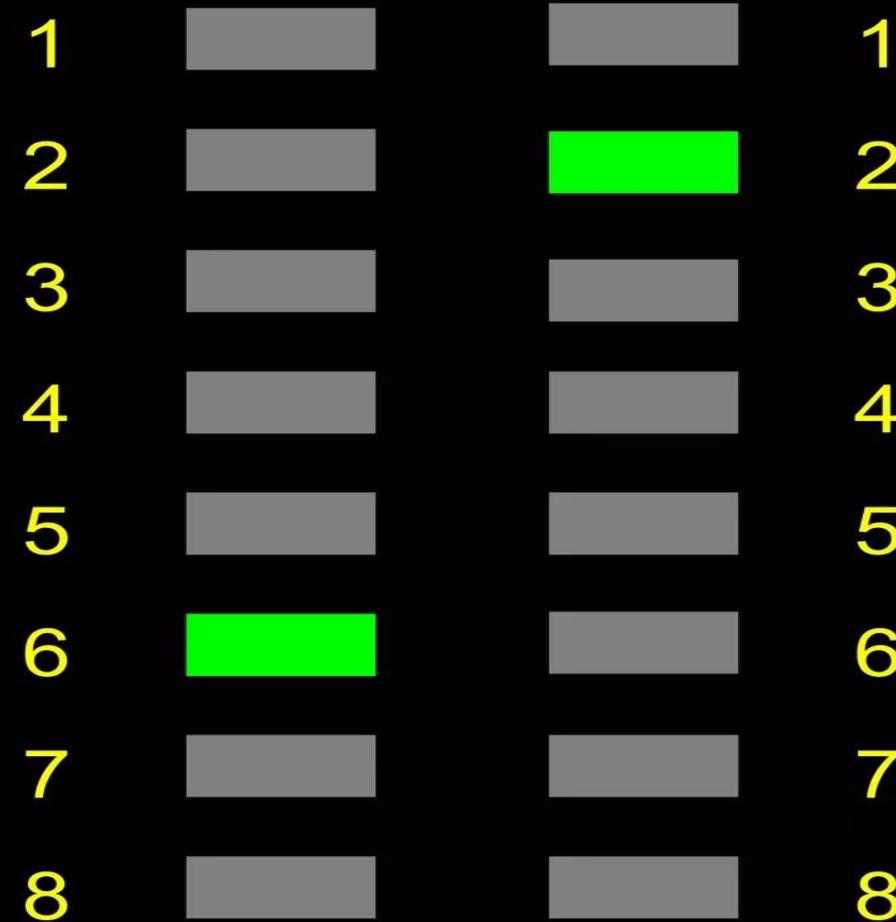
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2	6
3	1
4	4
5	5
6	2
7	7
8	8

crossover cable



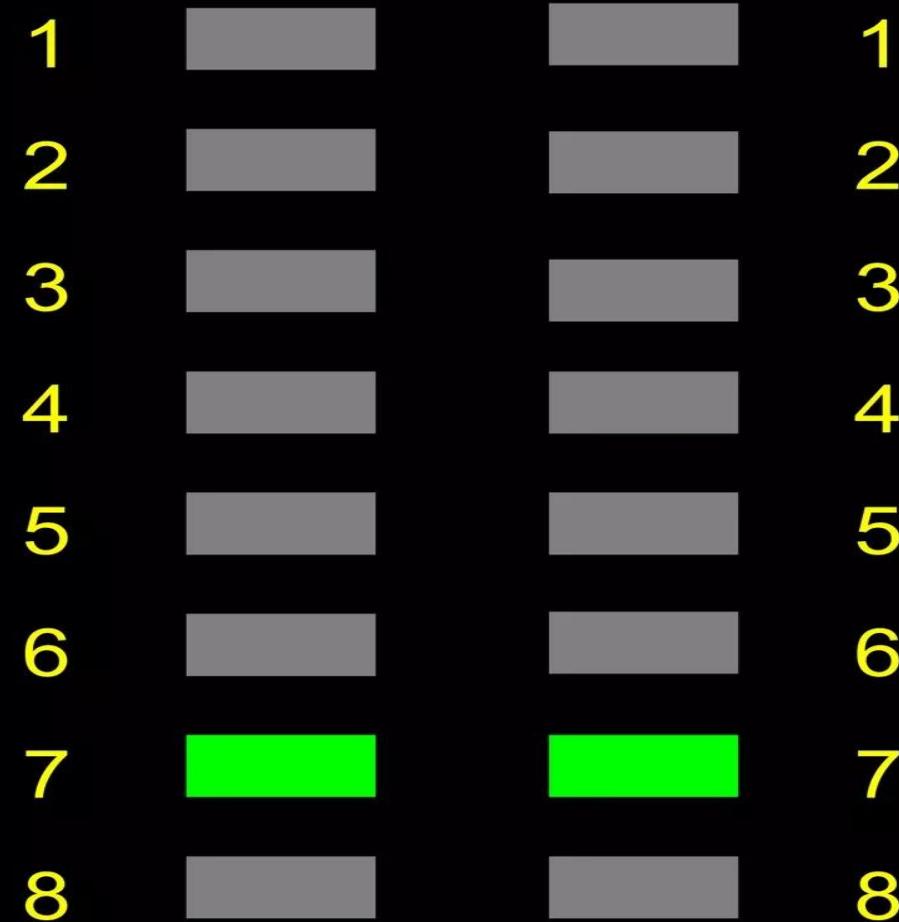
1	3
2	6
3	1
4	4
5	5
6	2
7	7
8	8

crossover cable



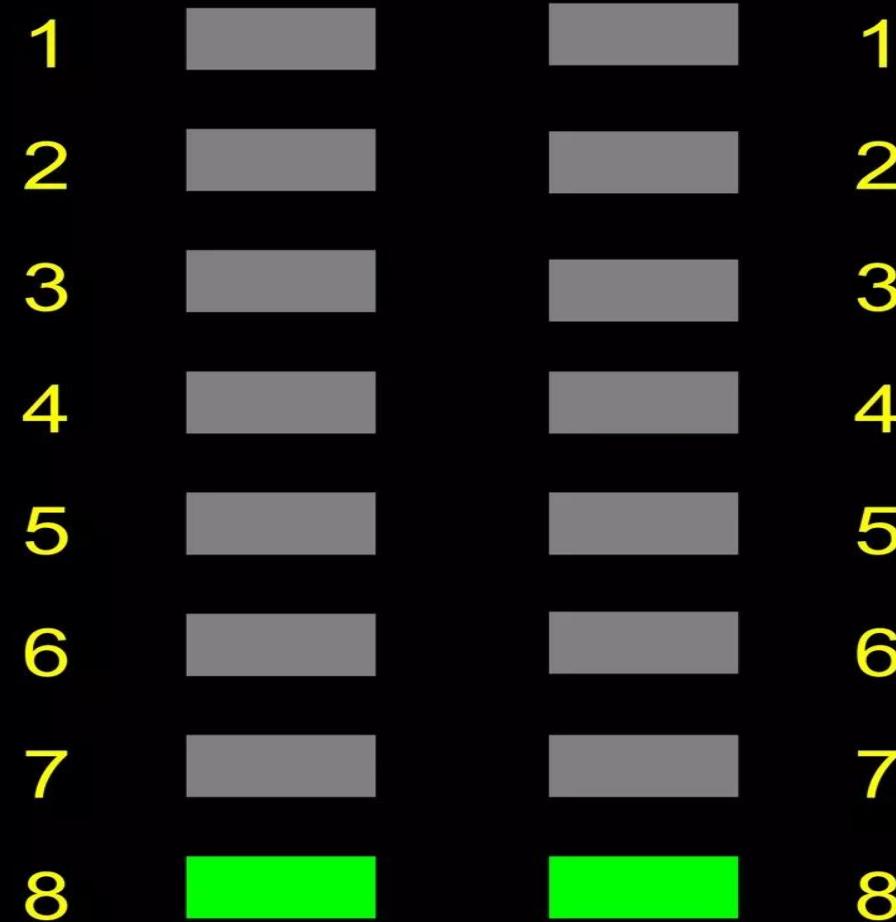
1	3
2	6
3	1
4	4
5	5
6	2
7	7
8	8

crossover cable



1	3
2	6
3	1
4	4
5	5
6	2
7	7
8	8

crossover cable



1	3
2	6
3	1
4	4
5	5
6	2
7	7
8	8



Activity 1: Crimping Ethernet Cables

1. Cut and strip the cable.
2. Arrange wires (T568A or T568b).
3. Insert into RJ45 connector.
4. Crimp and test.

Activity 2: Setting Up a Basic Network

- **Step 1: Connect the Devices**
 - Use the prepared cables to connect PCs or laptops to a network switch or router.
- **Step 2: Configure Network Settings**
 - Assign IP addresses to each device and ensure they are on the same subnet.
- **Step 3: Test Connectivity**
 - Use the ping command to test connectivity between devices.

Activity 4: Troubleshooting Network Cables

- **Step 1: Simulate Common Issues**
 - Create common network issues such as a loose connection, improper pin configuration, or a damaged cable.
- **Step 2: Diagnose the Issues**
 - Use a cable tester to diagnose the problems.
 - Check the network connection status on the PCs.
- **Step 3: Fix the Issues**
 - Re-crimp connectors, and replace damaged cables.