Practical-3

AIM: Prepare and Test Straight UTP Cable and Cross UTP Cable.

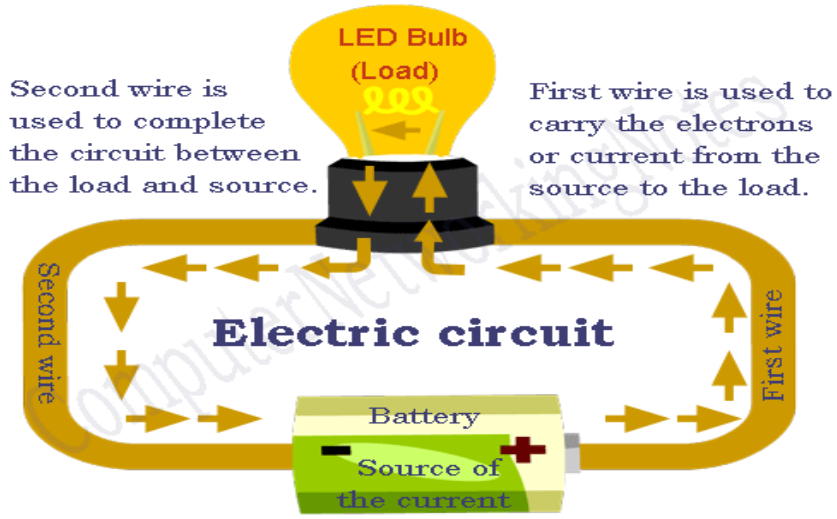
How does the UTP cable work?

In UTP cable, electronic signals are used to transmit and receive the data. A UTP cable connects two nodes. In data transmission, one node sends data and another node receives that data. NIC of the sender node converts data stream into the electronic signals and places them into the copper wire of the UTP cable. NIC of the receiver node reads those signals from the wire and converts back them into the data stream.

Let's understand this process in a little bit more detail.

Electronic signals or electric currents flow in a circuit. In an electric circuit, two wires are used. The first wire is used to carry the electrons or current from the source to the load. The second wire is used to complete the circuit between the load and the source. When electrons or current passes through the load, the load performs its functions.

Suppose we have an LED bulb, two wires, and a battery. To light this bulb, we connect it from the battery using the wires. We connect the positive side and negative side of the battery to the bulb separately. The following image shows this example.

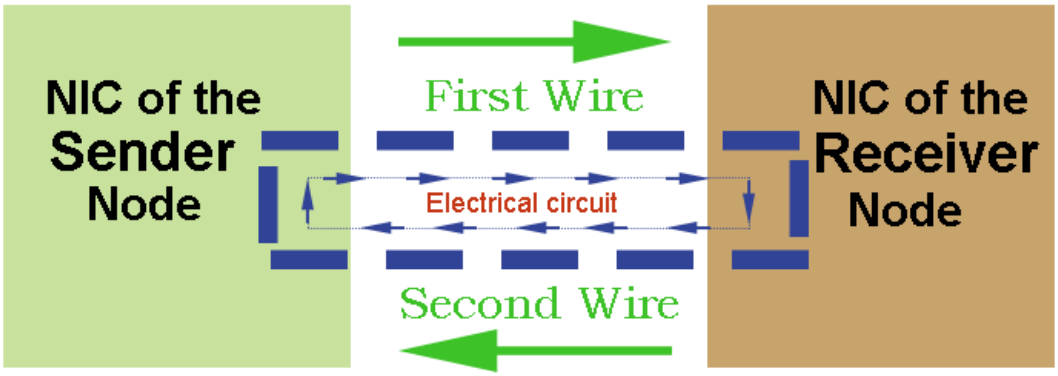


The same mechanism is used in UTP cable to transfer the data. Two wires of a UTP cable create an electric circuit between nodes.

In this circuit:-

- The NIC of the node which sends the data is work as the source.
- The NIC of the node which receives the data is work as the load.
- The first wire carries the current from the sender node to the receiver node.
- The second wire completes the electric circuit.

The following image shows how the electric circuit builds between the sender and receiver nodes.



Once the electric circuit is built, both the sender and receiver nodes use this electric circuit to transfer the data.

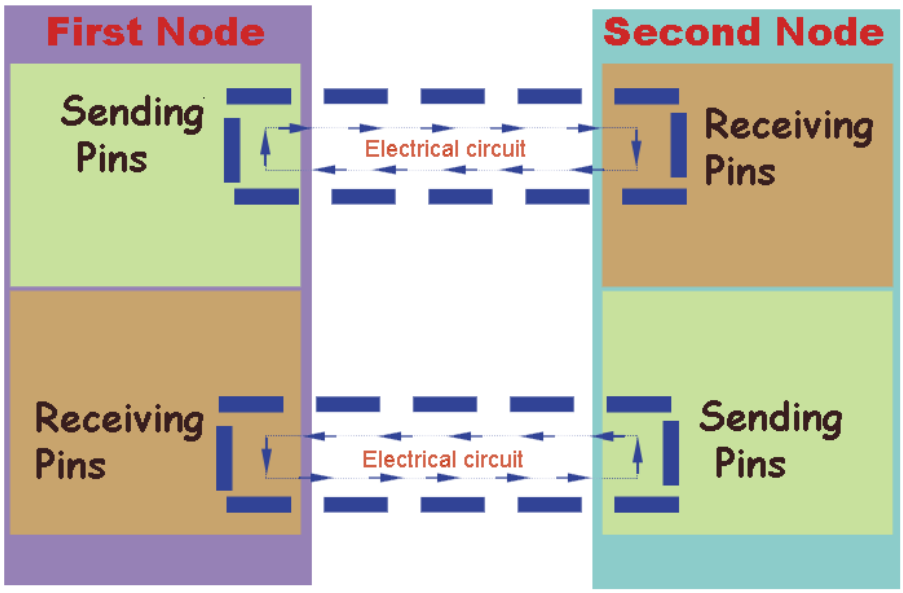
End devices, usually PCs or Server, store and process data in digital or binary format. To transfer binary data through the electric circuit, NICs of both sender and receiver nodes use an encoding scheme.

An encoding scheme is a language that both NICs understand. In the encoding scheme, the sender node changes the electrical signal over time, while the receiver node interprets those changes as binary data.

For example, to transfer a binary digit 0, NIC of the sender node drops the voltage to the lower voltage during the middle of a 1/10,000,000th-of-a-second interval. NIC of the receiver node detects this change and interprets it as a binary digit 0. Just like this, to transfer binary digit 1, NIC of the sender node raises the voltage to the higher voltage.

Current in an electric circuit always flows in one direction; from the source to the load. For this reason, only the sender node (source) can send its data to the receiver node (load). If the receiver node wants to send its data, it must have to create its own circuit.

The following image shows how both nodes create and use their circuits to transfer the data.



UTP cable

A UTP cable contains 8 wires. These wires are grouped in four pairs. Each pair consist of two twisted wires. The first wire has a single color-coded plastic coating while the other wire has that color plus white color striped plastic coating. For example, for the brown wire pair, one wire's coating is all brown, while the other wire's coating is brown-and-white striped.

The following image shows a UTP cable.

Why are the wires twisted?

When electrical current passes through the copper wire, it creates electromagnetic interference (EMI). The EMI interferes with the electrical signals in nearby wires, including the wires in the same cable. It is known as the cross talk. Twisting the wires in pairs removes the effect of cross talk.

RJ-45 (UTP cable) connector

Both NIC and switch port have an eight pins slot. To connect these pins with the wires of a UTP cable, a connector known as the RJ-45 connector is used. The RJ-45 connector has eight physical locations, known as pin positions or simply pins, into which the eight wires of the UTP cable can be inserted. These pins create a place where the ends of the copper wires can touch the pins of NIC or switch port.

The following image shows an RJ-45 connector.

Making a UTP cable

A NIC uses pins 1 and 2 to transmit the data. To receive data, it uses pins 3 and 6. A switch does the opposite of it. It receives data on pins 1 and 2 and transmits data from the pin 3 and 6. Based on the type of end devices, a UTP cable can be made in two ways. The first type of cable, known as the straight-through cable, connects two different types of end devices; such as PC to Switch. The second type of cable, known as the cross-over cable, connects two same type of end devices such as PC to PC or Switch to Switch.

Let's understand how to make both types of cable in detail.

Ethernet straight-through cable

What is Straight Through Cable?

When connecting between two dissimilar devices, for example, from the computer to the router, a straight-through cable will be needed. There are no left or right constrictions on the straight-through cable, as both ends have the same wiring signals, so the wires correspond to the same pins at the other end, too. In such a way, the transceiver protocol can be set up in such a manner that the information is transmitted from one device to another without any need for manual configuration.

Features of Straight-Through Cable

- Direct Connection: Links devices of different categories for instance a computer with a switch or a router, Computer-to-Device connection.
- Standard Ethernet Cable: It is particularly used in Ethernet networks for data transmission purposes.
- Color Code Consistency: The endings of the electrodes have identical sequences in terms of the color codes applied to the wires.
- Common Usage: Sometimes used in home and office networks for sharing devices among the nodes and link points.

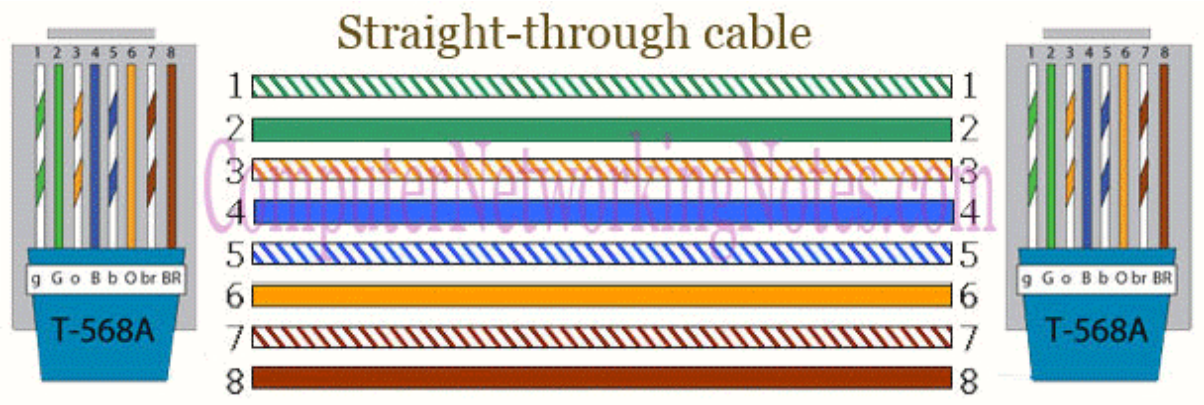
In this cable, wires are placed in the same position at both ends. The wire at pin 1 on one end of the cable connects to pin 1 at the other end of the cable. The wire at pin 2 connects to pin 2 on the other end of the cable; and so on.

Side A	Side B
Green White	Green White
Green	Green
Orange White	Orange White
Blue	Blue

Blue White	Blue White
Orange	Orange
Brown White	Brown White
Brown	Brown

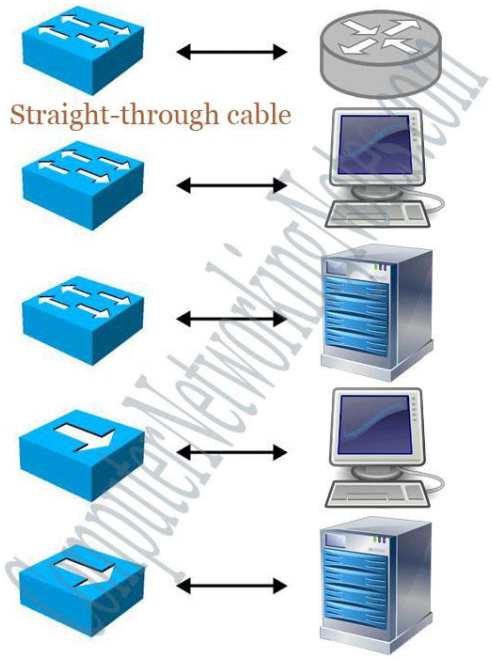
The following table lists the wire positions of the straight-through cable on both sides.

The following image shows the straight-through cable.



A straight-through cable is used to connect the following devices.

- PC to Switch
- PC to Hub
- Router to Switch
- Switch to Server
- Hub to Server



Ethernet cross-over cable

What is a Crossover Cable?

Crossover cables are found primarily on connections between similar devices like two computers or two switches. A difference between straight-through and crossover cables is that the order of the wires differs at each end of the cable. This will allow communication of devices indicating if they are transmitting or receiving by 'crossovering' the 'Tx' and 'Rx' so that data can be obtained by both similar devices.

Features of Crossover Cable

- Device-to-Device Connection: Mostly used in direct connectivity between composites of similar types like two computers or two switches.
- Pin Configuration: Pins connected on two ends with different arrangements for example T568 A on one end and T568B on the other end.
- Transmit/Receive Swapping: Exchange the two ports' T/R signal between the two ends.
- Specific Purpose: Typically employed in scenarios where devices must be able to interface without requiring a hub or switch.
- Colour Code Variation: In a crossover, some wires at each end have colour-coded sequences different from the other end.

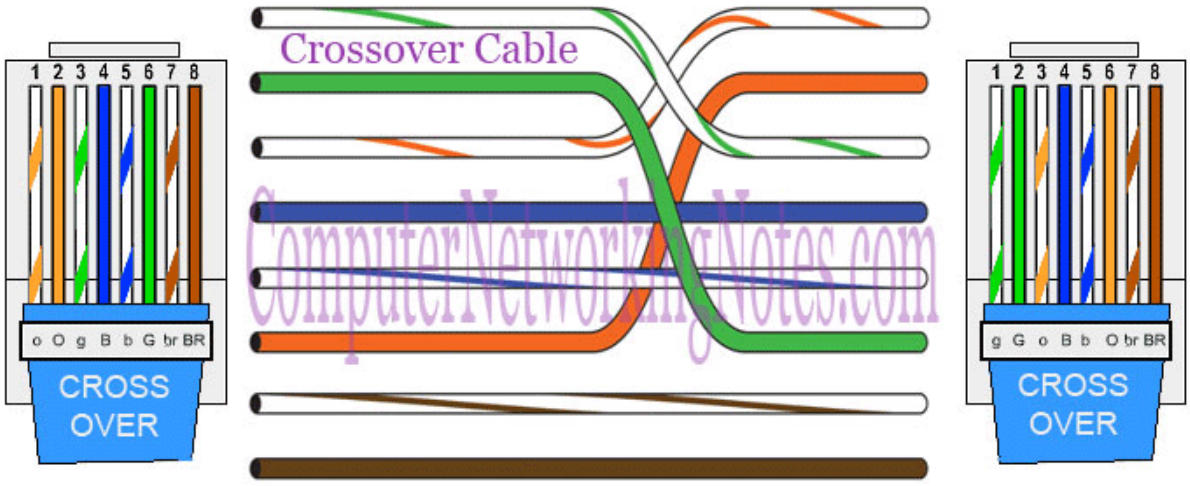
In this cable, transmitting pins of one side connect with the receiving pins of the other side.

The wire at pin 1 on one end of the cable connects to pin 3 at the other end of the cable. The wire at pin 2 connects to pin 6 on the other end of the cable. Remaining wires connect in the same positions at both ends.

The following table lists the wire positions of the cross-over cable on both sides.

Side A	Side B
Green White	Orange White
Green	Orange
Orange White	Green White
Blue	Blue
Blue White	Blue White
Orange	Green
Brown White	Brown White
Brown	Brown

The following image shows the cross-over cable.



The cross-over cable is used to connect the following devices.

- Two computers
- Two hubs
- A hub to a switch
- A cable modem to a router
- Two router interfaces