

# Coaxial and Twisted-Pair Cables

by Sophia



## WHAT'S COVERED

In this lesson, you will learn about the different kinds of copper cabling that is used as a medium of transmission at Layer 1 of wired networks.

Specifically, this lesson will cover the following:

### [1. Physical Media](#)

#### [1a. Coaxial Cable](#)

#### [1b. Twisted-Pair Cable](#)

### [2. Cable Ethernet Descriptions](#)

#### [2a. Category 1](#)

#### [2b. Category 3](#)

#### [2c. Category 5](#)

#### [2d. Category 5e \(Enhanced\)](#)

#### [2e. Category 6](#)

#### [2f. Category 6a \(Augmented\)](#)

#### [2g. Category 7](#)

### [3. Connecting UTP](#)



## BEFORE YOU START

In the previous lesson, you learned about the lower layers of the OSI model, which include Layer 4 (transport), Layer 3 (network), Layer 2 (data link), and Layer 1 (physical). In this lesson, you will learn about the copper-based cables that provide the Layer 1 physical media, enabling data to be transmitted across a network.

The idea of connecting many computers together has not changed a lot since the mid-1980s, but how we go about doing that certainly has. Like everything else, the technologies and devices that we use to create our networks have evolved dramatically and will continue to do so to keep up with the ever-increasing pace of life and the way we do business.

When we connect computers together to form a network, the two goals are to provide error-free and high-speed communication.

# 1. Physical Media

The physical media that carry signals representing data reside at Layer 1 of the OSI model. The most basic physical medium is a cable, also known as a “wire,” that is made of copper or glass. Most data networks are wired, and even wireless networks that work using the radio spectrum typically depend on a cabled infrastructure.



## DID YOU KNOW

The majority of installed LANs today communicate via some kind of cabling.

### 1a. Coaxial Cable

**Coaxial cable**, commonly called “coax” for short, is a legacy cable system that is primarily used today to build cable television networks. It is no longer widely used to build Ethernet LANs, even though the Ethernet protocol was originally designed to work on a coaxial cable bus topology. Coaxial cable is relatively heavy, difficult to install, and expensive when compared to twisted-pair cable, which we will cover later in this lesson. Another reason that we no longer build LANs with coaxial cable is that it utilized a physical bus topology, which you may recall is not as fault tolerant as a star-wired topology.

Coaxial cable contains a center conductor made of copper that is surrounded by a plastic jacket with a braided shield over it. A plastic such as polyvinyl chloride (PVC) or fluoroethylene propylene (FEP) covers this metal shield. The FEP-type covering is frequently referred to as a **plenum-rated coating**.



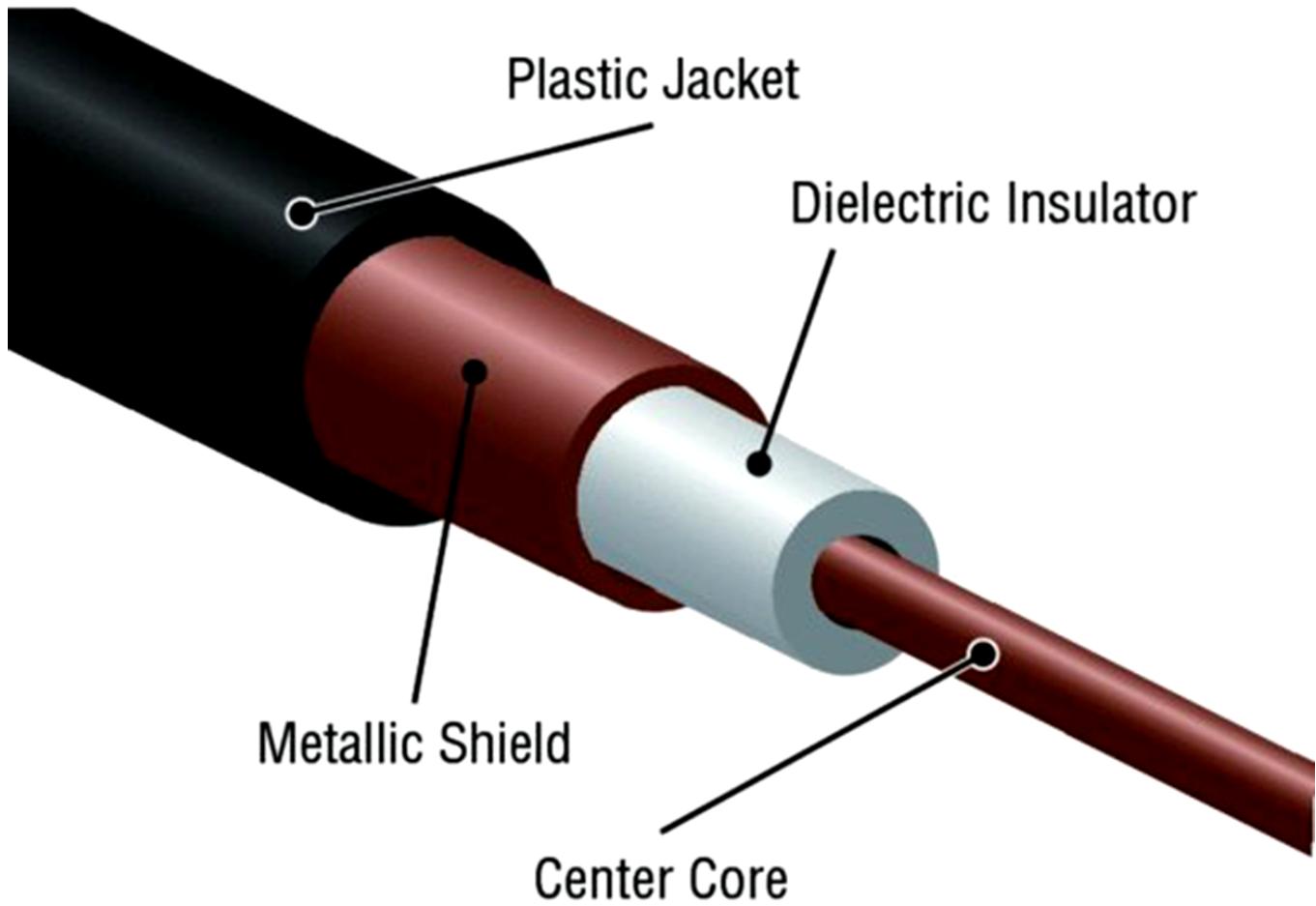
## THINK ABOUT IT

The difference between plenum and non-plenum cable comes down to how each is constructed and where you can use it. Plenum-rated cables for coaxial, unshielded twisted-pair (UTP), and fiber-optic installations are available. Many large multistory buildings are designed to circulate air through the spaces between the ceiling of one story and the floor of the next; this space between floors is referred to as the plenum. The **plenum** includes the space above a false ceiling that is often used to run network cables connecting the computers that are used in the building. In case of a fire, non-plenum cable causes a serious hazard because its sheath gives off poisonous smoke that circulates throughout the whole building. Non-plenum cables can actually act like wicks for the fire, helping it quickly spread from room to room and floor to floor.

To prevent catastrophic fires, the National Fire Protection Association (NFPA) requires that cables run within the plenum be tested and guaranteed to be safe. They must be fire retardant and create little or no smoke and poisonous gas when burned. This means you absolutely cannot use a non-plenum cable in the plenum, but it does not mean you cannot use it in other places where it is safe. And because non-plenum cable is significantly cheaper, you definitely want to use it where you can.

Thin Ethernet, also referred to as **Thinnet** or **10Base2**, is a thin coaxial cable. It is basically the same as thick coaxial cable, except that it is only about 5 mm, or 2/10 in., in diameter. Thin Ethernet coaxial cable is Radio

Grade 58, or just RG-58. The figure below shows an example of Thinnet. This cable's connector is called an **F**-type connector.





You can attach a BNC connector to the cable with a crimper that looks like a specialized pair of pliers and has a die to crimp the connector. A simple squeeze crimps the connector to the cable. You can also use a screw-on connector, but we avoid doing that because it is not as reliable. You can use a BNC coupler to connect two male connectors together or two female connectors together.

The F connector, or F-type connector, is a form of coaxial connector that is used for cable TV. It has an end that screws to tighten the connector to the interface. It resembles the RG-58 mentioned earlier.



## TERMS TO KNOW

### **Coaxial Cable**

A transmission line, consisting of a conducting wire surrounded by an insulated spacer, surrounded by a cylindrical conducting sheath; used to carry high-frequency signals such as TV.

### **Plenum-Rated Cable**

A type of network cabling that satisfies the plenum ratings defined in the National Electrical Code.

### **Plenum**

The space above a false ceiling used for cables, ducts, and so on.

### **Thinnet**

10BASE2, a form of Ethernet using a thin coaxial cable.

### **F-Type Connector**

A coaxial cable connector.

## 1b. Twisted-Pair Cable

Twisted-pair cable is widely popular for building LANs today, because it is relatively lightweight, easy to install, and inexpensive when compared to coaxial cable. Twisted-pair cable supports the star topology, which is more fault tolerant than a coaxial cable bus topology.

Twisted-pair cable consists of multiple individually insulated wires that are twisted together in pairs. Sometimes, a metallic shield is placed around them, hence the name **shielded twisted pair (STP)**, which reduces signal loss caused by **electromagnetic interference (EMI)**. Cable without outer shielding is called **unshielded twisted pair (UTP)**, and it is used in twisted-pair Ethernet.



### BIG IDEA

Twisted-pair cable is widely popular for building Ethernet LANs today, because it is lightweight, is easy to install, and supports the fault-tolerant physical star topology.



### TERMS TO KNOW

#### Shielded Twisted Pair (STP)

A cable with multiple twisted-pair wiring pairs surrounded by a single shield.

#### Electromagnetic Interference (EMI)

Noise generated by an external source that affects signals in an electrical circuit.

#### Unshielded Twisted Pair (UTP)

A type of cable used for computer networking and telecommunications.

## 2. Cable Ethernet Descriptions

Ethernet cable types are described using a code that follows this format:  $N <Signaling> X$ . The  $N$  refers to the signaling rate in megabits per second.  $<Signaling>$  stands for the signaling type—either baseband or broadband—and the  $X$  is a unique identifier for a specific Ethernet cabling standard.

Here is an example of the 1000BaseT standard. The 1000 tells us that the transmission speed is 1,000 Mbps (megabits per second). The word “Base” is short for baseband transmission, which means that the cable has only one communication channel. The “T” is short for “twisted pair.” So, why are the wires in this cable type twisted? When electromagnetic signals are conducted by copper wires in close proximity—like inside a cable—it causes interference called **crosstalk**. Twisting two wires together as a pair minimizes the interference and even protects against interference from outside sources.

UTP cable is rated in the following categories.



### TERM TO KNOW

#### Crosstalk

Undesirable signals from a neighboring transmission circuit; undesired coupling between circuits.

## 2a. Category 1

Two twisted wire pairs (four wires). It is the oldest type and is only voice grade—it is not rated for data communication. People refer to it as **plain old telephone service (POTS)**. Before 1983, this was the standard cable used throughout the North American telephone system. POTS cable still exists in parts of the **Public Switched Telephone Network (PSTN)** and supports signals limited to the 1-MHz frequency range.



### TERMS TO KNOW

#### Plain Old Telephone Service (POTS)

The traditional landline telephone system.

#### Public Switched Telephone Network (PSTN)

Network infrastructure provided by public telecommunications carriers.

## 2b. Category 3

Four twisted wire pairs (eight wires) with three twists per foot. This type can handle transmissions up to 16 MHz. It was popular in the mid-1980s for Ethernet of up to 10 Mbps, but it is now limited to telecommunications equipment and, again, is obsolete for networks.

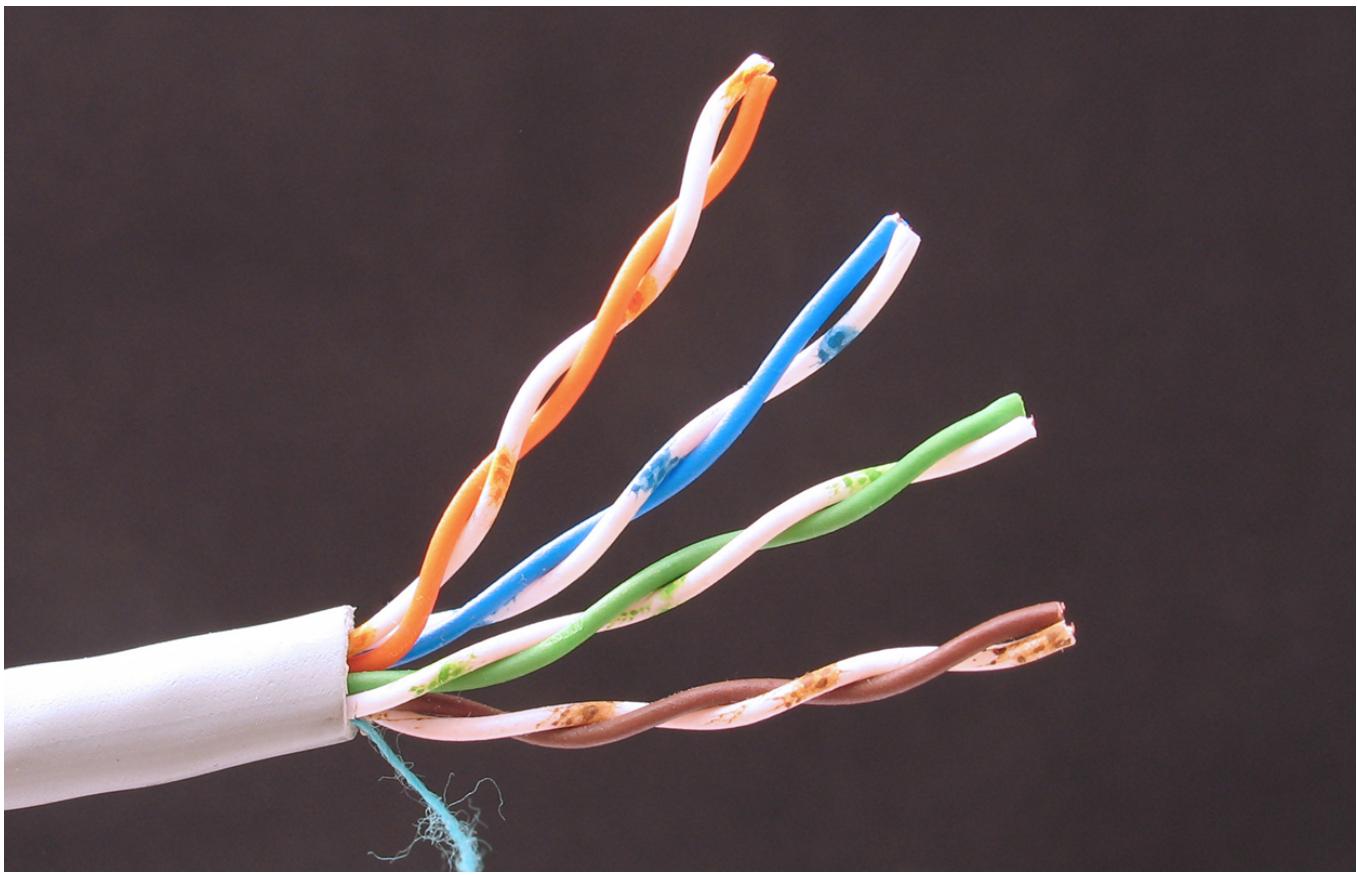
## 2c. Category 5

Four twisted wire pairs (eight wires), used for 100BaseTX (two-pair wiring) and rated at 100 MHz.

## 2d. Category 5e (Enhanced)

Four twisted wire pairs (eight wires), recommended for 1000BaseT (four-pair wiring) and rated for 100 MHz but capable of handling the disturbance on each pair that is caused by transmitting across all four pairs at the same time—a feature that is needed for Gigabit Ethernet. Any category below 5e should not be used in today's network environments.

This picture shows a basic Category 5e cable with the four wire pairs twisted to reduce crosstalk.



## 2e. Category 6

Four twisted wire pairs (eight wires), used for 1000BaseTX (two-pair wiring) and rated at 250 MHz. Category 6 became a standard in June 2002. You would usually use it as a **riser cable** to connect floors to each other. If you are installing a new network in a new building, there is no reason to use anything other than Category 6 UTP cabling as well as running **fiber-optic cable** between floors. You will learn about fiber-optic cable in the next lesson.



### TERMS TO KNOW

#### Riser Cable

A vertical cable that connects the floors of a building.

#### Fiber-Optic Cable

Cable made of flexible fibers with a glass core that carry light signals.

## 2f. Category 6a (Augmented)

A basic Category 6 cable has a reduced maximum length when used for 10GBaseT; however, Category 6a cable, or Augmented Category 6, is rated at 500 MHz and has improved crosstalk characteristics, which allows 10GBaseT to be run for up to 100 m. The most important point is a performance difference between the Electronic Industries Alliance and Telecommunications Industry Association (EIA/TIA) component specifications for the **NEXT** (near-end crosstalk) transmission parameter.



### TERM TO KNOW

## NEXT

Near-end crosstalk.

### 2g. Category 7

Although not recognized by the EIA/TIA, Category 7 cable, or Cat 7, allows 10 Gigabit Ethernet over 100 m of copper cabling. The cable contains four twisted copper wire pairs, just like the earlier standards. Cat 7 cables are double shielded to better mitigate crosstalk and EMI.

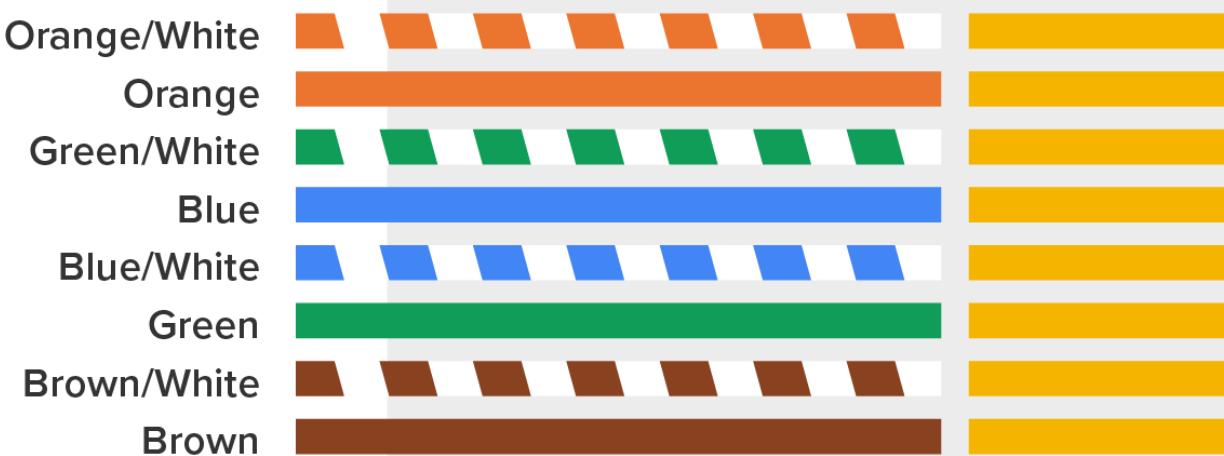
---

## 3. Connecting UTP

BNC connectors will not fit very well to UTP cable, so you need to use a **registered jack (RJ)** connector, which you are familiar with because most telephones are connected with them. The connector used with UTP cable is called RJ-11 for twisted-pair cables that use four wires; RJ-45 has four pairs (eight wires), as shown below.



The diagram below shows the **pin-outs** used in a typical RJ-45 connector. As a reminder of the wiring standard, please see the diagram below:



Most of the time, UTP uses RJ connectors, and you use a crimper to attach them to a cable, just as you would with BNC connectors. The only difference is that the die that holds the connector is a different shape. A crimper is a tool for attaching a network connector to the end of a network cable. Higher-quality crimping tools have interchangeable dies for both types of cables. We do not use RJ-11 for LANs, but we do use them for home landline phones and digital subscriber line (DSL) connections. RJ-45 is mainly used in LANs with short distances, typically up to 100 m, and uses unshielded wiring.



## TERMS TO KNOW

### Registered Jack (RJ)

Standardized telecommunications interface registered by the Federal Communications Commission.

### Pin-Out

The manner in which an electrical connector or device is wired; the list of signals that correspond to each pin or output.



## SUMMARY

In this lesson, you learned about the fundamental ideas of the copper-based **physical media**, both coaxial cables and twisted-pair cables, that exist at Layer 1 (Physical) of the OSI model. You also learned about **Ethernet cables** and **connecting UTP**.

Source: This content and supplemental material has been adapted from CompTIA Network+ Study Guide: Exam N10-007, 4th Edition. Source [Lammle: CompTIA Network+ Study Guide: Exam N10-007, 4th Edition - Instructor Companion Site \(wiley.com\)](#)



## TERMS TO KNOW

**Coaxial Cable**

A transmission line, consisting of a conducting wire surrounded by an insulated spacer, surrounded by a cylindrical conducting sheath; used to carry high-frequency signals such as TV.

**Crosstalk**

Undesirable signals from a neighboring transmission circuit; undesired coupling between circuits.

**Electromagnetic Interference (EMI)**

Noise generated by an external source that affects signals in an electrical circuit.

**F-Type Connector**

A coaxial cable connector.

**Fiber-Optic Cable**

Cable made of flexible fibers with a glass core that carry light signals.

**NEXT**

Near-end crosstalk.

**Pin-Out**

The manner in which an electrical connector or device is wired; the list of signals that correspond to each pin or output.

**Plain Old Telephone Service (POTS)**

The traditional landline telephone system.

**Plenum**

The space above a false ceiling used for cables, ducts, and so on.

**Plenum-Rated Cable**

A type of network cabling that satisfies plenum ratings defined in the National Electrical Code.

**Public Switched Telephone Network (PSTN)**

Network infrastructure provided by public telecommunications carriers.

**Registered Jack (RJ)**

Standardized telecommunications interface registered by the Federal Communications Commission.

**Riser Cable**

A vertical cable that connects the floors of a building.

**Shielded Twisted Pair (STP)**

A cable with multiple twisted-pair wiring pairs surrounded by a single shield.

**Thinnet**

10BASE2, a form of Ethernet using a thin coaxial cable.

**Unshielded Twisted Pair (UTP)**

A type of cable used for computer networking and telecommunications.