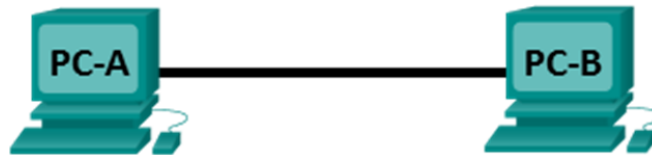


Lab – Understanding Ethernet Cable Standards

Topology



Addressing Table

Device	Interface	IP Address	Subnet Mask	Default Gateway
PC-A	NIC	192.168.10.1	255.255.255.0	N/A
PC-B	NIC	192.168.10.2	255.255.255.0	N/A

Objectives

Part 1: Analyze Ethernet Cabling Standards and Pinouts

Part 2: Build an Ethernet Crossover Cable

Part 3: Test an Ethernet Crossover Cable

Background / Scenario

In this lab, you will build and terminate an Ethernet crossover cable and test it by connecting two PCs together and pinging between them. You will first analyze the Telecommunications Industry Association/Electronic Industries Association (TIA/EIA) 568-A and 568-B standards and how they apply to Ethernet cables. You will then construct an Ethernet crossover cable and test it. Finally, you will use the cable you just constructed to connect two PCs together and test it by pinging between them.

Note: With autosensing capabilities available on many devices, such as the Cisco 1941 Integrated Services Router (ISR) switch, you may see straight-through cables connecting like devices.

Required Resources

- One length of cable, either Category 5 or 5e. Cable length should be 0.6 to 0.9m (2 to 3 ft.)
- 2 RJ-45 connectors
- RJ-45 crimping tool
- Wire cutter
- Wire stripper
- Ethernet cable tester (optional)
- 2 PCs (Windows 7 or 8)

Part 1: Analyze Ethernet Cabling Standards and Pinouts

The TIA/EIA has specified unshielded twisted pair (UTP) cabling standards for use in LAN cabling environments. TIA/EIA 568-A and 568-B stipulates the commercial cabling standards for LAN installations;

Lab - Building an Ethernet Crossover Cable

these are the standards most commonly used in LAN cabling for organizations and they determine which color wire is used on each pin.

With a crossover cable, the second and third pairs on the RJ-45 connector at one end of the cable are reversed at the other end, which reverses the send and receive pairs. The cable pinouts are the 568-A standard on one end and the 568-B standard on the other end. Crossover cables are normally used to connect hubs to hubs or switches to switches, but they can also be used to directly connect two hosts to create a simple network.

Reflection:

Write a research report (Max word count 600) on Cat 5e and 6 Ethernet cable standards.

Please see Appendix A for Report.

Step 1: Analyze diagrams and tables for the TIA/EIA 568-A standard Ethernet cable.

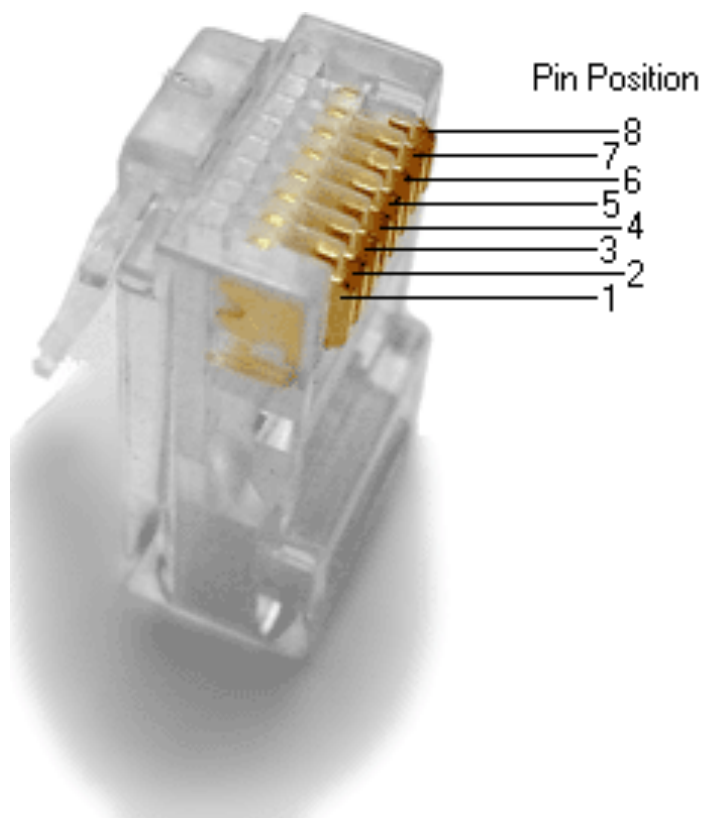
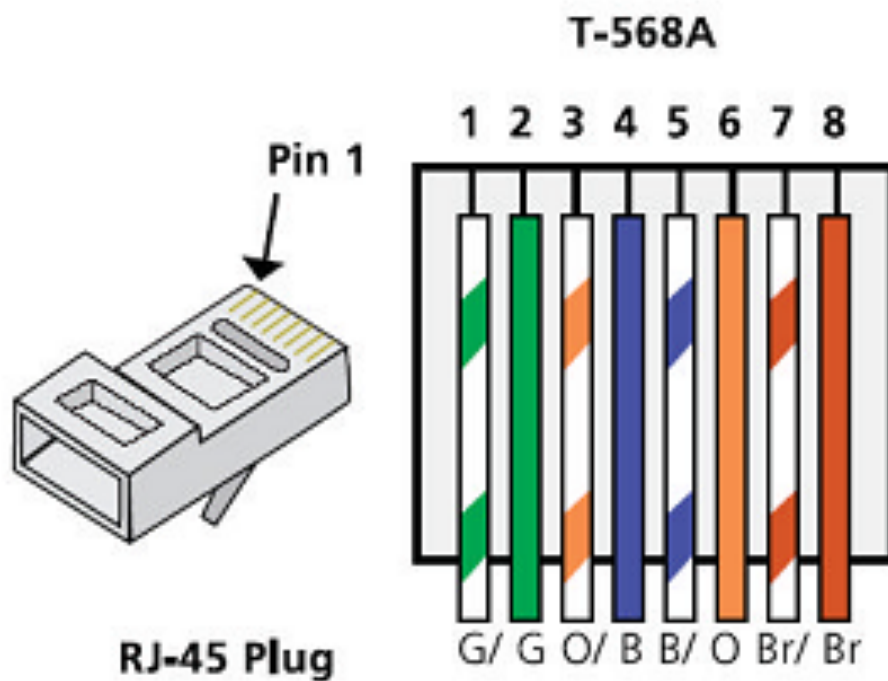
The following table and diagrams display the color scheme and pinouts, as well as the function of the four pairs of wires used for the 568-A standard.

Note: In LAN installations using 100Base-T (100 Mb/s), only two pairs out of the four are used.

568-A 10/100/1000Base-TX Ethernet

Pin Number	Pair Number	Wire Color	10Base-T Signal 100Base-TX Signal	1000Base-T Signal
1	2	White/Green	Transmit	BI_DA+
2	2	Green	Transmit	BI_DA-
3	3	White/Orange	Receive	BI_DB+
4	1	Blue	Not Used	BI_DC+
5	1	White/Blue	Not Used	BI_DC-
6	3	Orange	Receive	BI_DB-
7	4	White/Brown	Not Used	BI_DD+
8	4	Brown	Not Used	BI_DD-

The following diagrams display how the wire color and pinouts align with an RJ-45 jack for the 568-A standard.



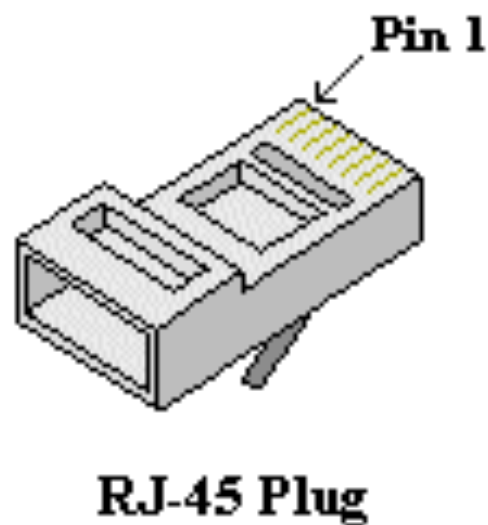
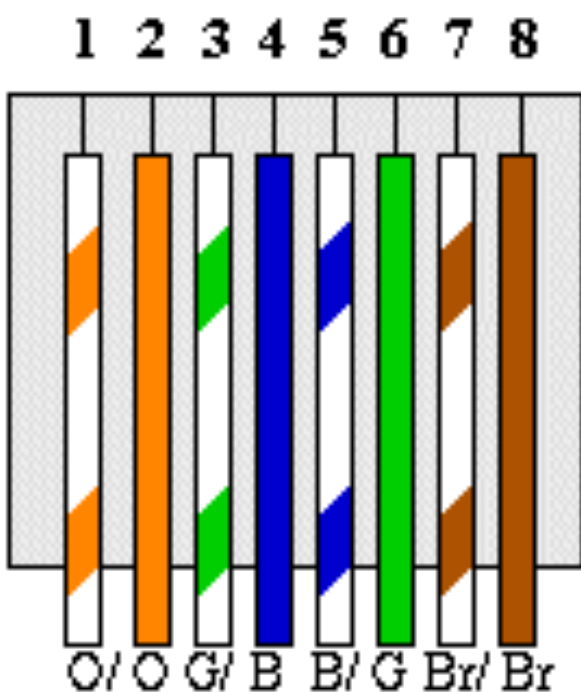
Step 2: Analyze diagrams and tables for the TIA/EIA 568-B standard Ethernet cable.

The following table and diagram display the color scheme and pinouts for the 568-B standard.

568-B 10/100/1000-BaseTX Ethernet

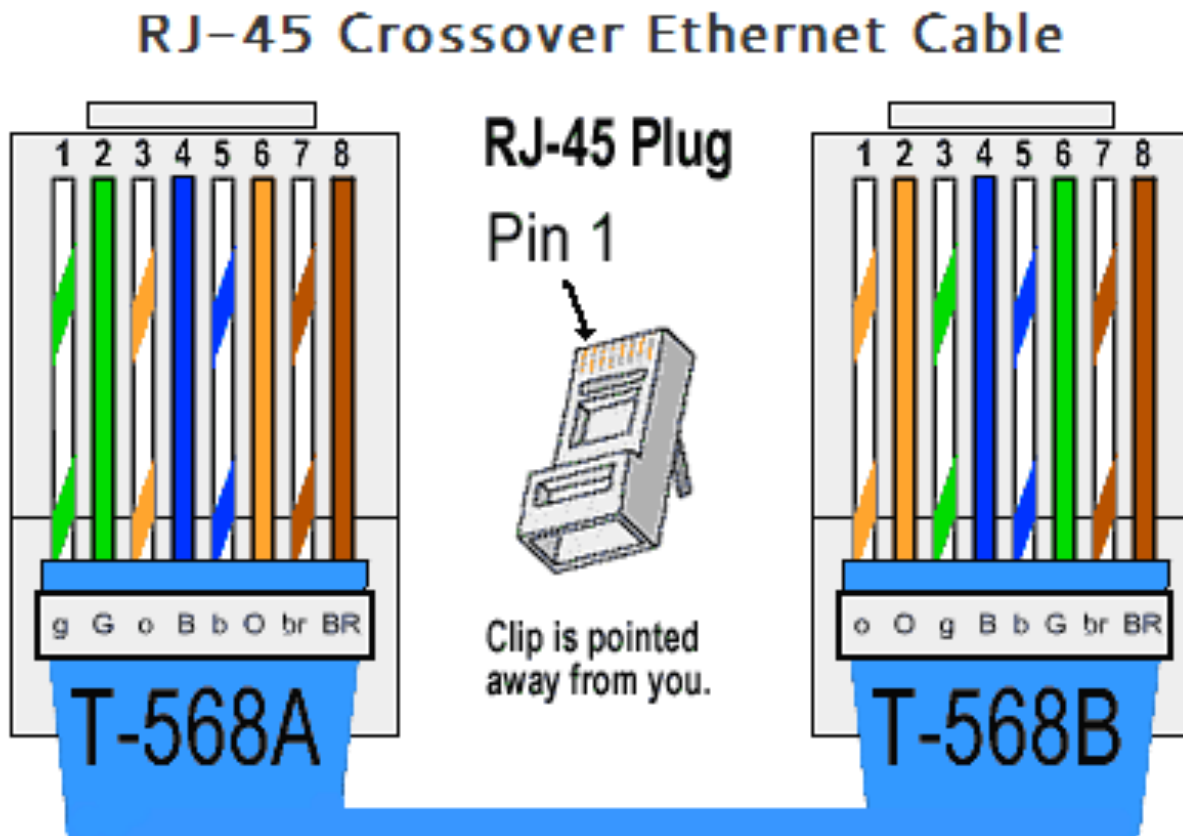
Pin Number	Pair Number	Wire Color	10Base-T Signal 100Base-TX Signal	1000Base-T Signal
1	2	White/Orange	Transmit	BI_DA+
2	2	Orange	Transmit	BI_DA-
3	3	White/Green	Receive	BI_DB+
4	1	Blue	Not Used	BI_DC+
5	1	White/Blue	Not Used	BI_DC-
6	3	Green	Receive	BI_DB-
7	4	White/Brown	Not Used	BI_DD+
8	4	Brown	Not Used	BI_DD-

T-568B



Part 2: Build an Ethernet Crossover Cable

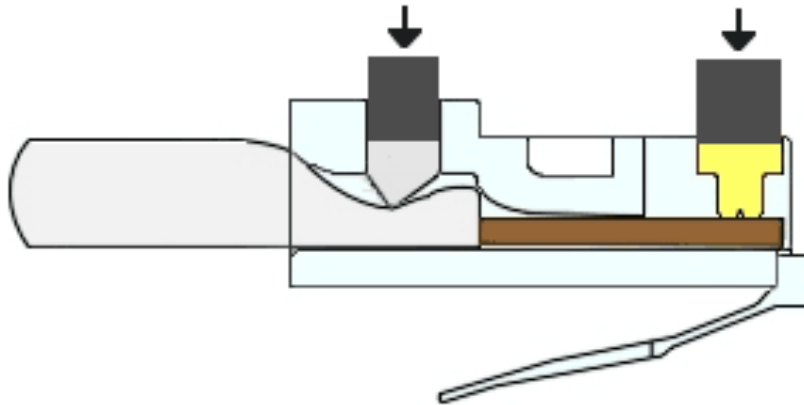
A crossover cable has the second and third pairs on the RJ-45 connector at one end, reversed at the other end (refer to the table in Part 1, Step 2). The cable pinouts are the 568-A standard on one end and the 568-B standard on the other end. The two following diagrams illustrate this concept.



Step 1: Build and terminate a TIA/EIA 568-A cable end.

- Determine the cable length required. (Your instructor will let you know the cable length you should make.)
Note: If you were making a cable in a production environment, the general guideline is to add another 12 in. (30.48 cm) to the length.
- Cut off a piece of cable to the desired length and using your wire stripper, remove 5.08 cm (2 in.) of the cable jacket from both ends.
- Hold the four pairs of twisted cables tightly where the jacket was cut away. Reorganize the cable pairs into the order of the 568-A wiring standard. Refer to the diagrams, if necessary. Take as much care as possible to maintain the twists in the cable; this provides noise cancellation.
- Flatten, straighten, and line up the wires using your thumb and forefinger.
- Ensure that the cable wires are still in the correct order for the 568-A standard. Using your wire cutters, trim the four pairs in a straight line to within 1.25 to 1.9 cm (1/2 to 3/4 in.).
- Place an RJ-45 connector on the end of your cable, with the prong on the underside pointing downward. Firmly insert the wires into the RJ-45 connector. All wires should be seen at the end of the connector in their proper positions. If the wires are not extending to the end of the connector, take the cable out, rearrange the wires as necessary, and reinsert the wires back into the RJ-45 connector.

- g. If everything is correct, insert the RJ-45 connector with cable into the crimper. Crimp down hard enough to force the contacts on the RJ-45 connector through the insulation on the wires, thus completing the conducting path. See the following diagram for an example.



Step 2: Build and terminate a TIA/EIA 568-B cable end.

Repeat steps 1a to 1g using the 568-B color wiring scheme for the other end.

Part 3: Test an Ethernet Crossover Cable

Step 1: Test the cable.

Many cable testers will test for length and mapping of wires. If the cable tester has a wire map feature, it verifies which pins on one end of the cable are connected to which pins on the other end.

If your instructor has a cable tester, test the crossover cable for functionality. If it fails, check with your instructor first as to whether you should re-cable the ends and re-test.

Step 2: Connect two PCs together via NICs using your Ethernet crossover cable.

- Working with a lab partner, set your PC to one of the IP addresses shown in the Addressing Table (see page 1). For example, if your PC is **PC-A**, your IP address should be set to **192.168.10.1** with a **24-bit subnet mask**. Your partner's IP address should be **192.168.10.2**. The default gateway address can be left empty.
- Using the crossover cable you made, connect the two PCs together via their NICs.
- On the PC-A command prompt, ping the PC-B IP address.

Note: The Windows firewall may have to be temporarily disabled for pings to be successful. If the firewall is disabled, make sure you re-enable it at the conclusion of this lab.

- Repeat the process and ping from PC-B to PC-A.

Assuming IP addressing and firewall are not issues, your pings should be successful if the cables were properly made.

Reflection

- Which part of making cables did you find the most difficult?

The cabling exercise was tricky, being sure to not cross the cables from their correct positions when inserting into the RJ-45 connector. I found that when I thought I had inserted them correctly, infact they had twisted and were then in the wrong position.

Once I had inserted them correctly, I proceeded to crimp the connector. I then tested my cable, and found that some of the pins were not making a connection. On closer inspection, I noticed that two of the wires had not been fully inserted into the connector and therefore were not making a connection.

I then re-created my cable but cutting and stripping the end once more, and re-arranging the cable to the correct pattern. This time I took more care to insert the wires and crimp them, and after testing, my cable was working correctly.

Personally, I felt that the most difficult aspect of cabling was the correct insertion of the wires into the RJ-45 connector.

2. Why do you have to learn how to make a cable if you can easily buy pre-made cables?

There may be many circumstances where making a cable would be more suitable, including those where an 'odd' length of cable is required, which is often the case in small home networks. Another reason would be for the repair of existing cables, for example if a cable is of sufficient length but has a damaged connector, the cable can be stripped and a new connector could be fitted.

Appendix A

Report titled "Cat5e and Cat6 Cabling Standards" below.



CAT 5E AND CAT 6 CABLING STANDARDS

University of Wales Trinity Saint David

BSc Computing Portfolio
Computer Architecture and Networks | ACCD4001

Siobhan Stephens
1800709

1. Introduction

Also known as Ethernet cables, Category 5e and Category 6 cables are structured cabling for computer networks. The cable standards have been developed by the Telecommunications Industry Association (TIA) and Electronics Industries Alliance (EIA) along with input from Industry, with the standard covering the cable's construction, performance and testing requirements [1]. The most common form of network cable is an Unshielded Twisted Pair, or UTP, the standard of which is managed by the Institute of Electrical and Electronics Engineers (IEEE) and is referred to as 802.3 [2].

Ethernet cables may be straight through, crossover or rollover, the difference of which vary by the wiring of the connectors on each end. They are produced with eight wires, each protected by a coloured plastic coating, and then twisted together into four twisted pairs using the colours shown in figure 1. The twisted pairs are then covered by an outer plastic jacket.

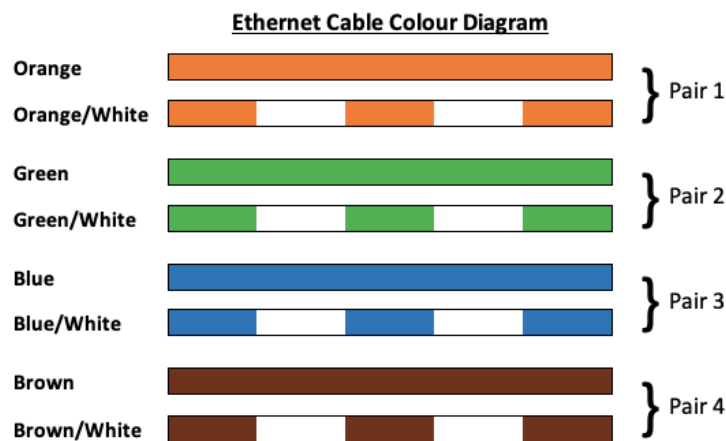


Figure 1. Ethernet Cable Colour Diagram [3]

The standard connectors for Ethernet cables are known widely as RJ-45, however this refers to telephone connectors, and the correct name for the connectors are “modular 8P8C” [4].

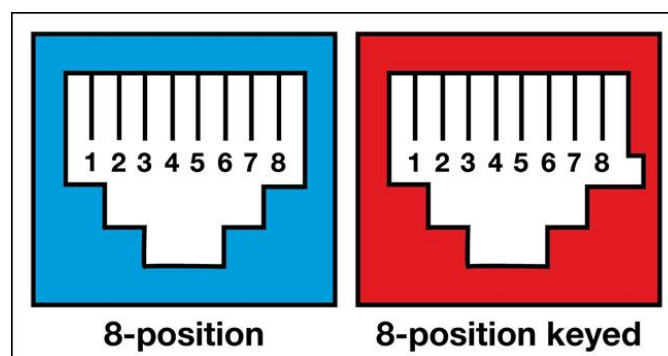


Figure 2. Modular 8P8C vs RJ-45 Connector [4]

2. Category 5e Cable Standard

The standard for Cat5 cables was first defined in TIA/EIA-568-A in 1991, which specified the performance and test requirements for frequencies up to 100MHz. Later, in 1995, the standard was updated to TIA/EIA-568-B for Category 5e cables. Similarly to their predecessor, Cat5e also use a frequency of 100MHz however, Cat5e cables have the capacity to handle greater bandwidth, and are typically used for Ethernet networks of 1000Mbps/1Gbps [5].

Cat5e cables support both half and full-duplex Fast Ethernet communication in conjunction with Carrier Sense Multiple Access with Collision Detection (CSMA/CD) [6]. According to CableK, Cat5e has “stricter specifications for Power Sum Equal-Level Far-End, Near-End Crosstalk, Attenuation, and Return Loss than those for CAT5” [7].

The T568A and T568B wiring schemes specify pin to pair assignments and the cable is connected using modular 8P8C connectors on either end [8].

3. Category 6 and 6a Cable Standards

Category 6 cables and connectors are defined by the TIA/EIA-568-B standard. Cat6 cables, like their predecessors, also use 8P8C connectors however the connectors must be rated for Category 6 performance. Cat6 cables support higher bandwidths than Cat5e, and vary in construction as Cat6 twisted pairs are wound more tightly, and are often fitted with foil or braided shielding (STP) [1]. The added shielding works to prevent electrical interference, referred to as crosstalk [9], and noise interference, both of which were an issue associated with previous cables.

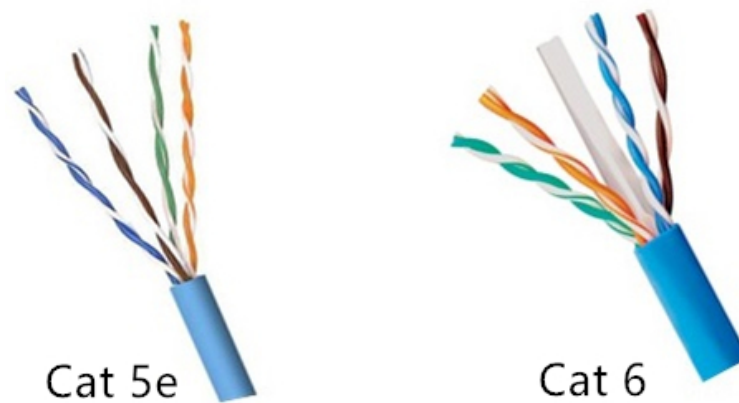


Figure 3. Cat5e vs Cat6 Cable [10].

They operate on a frequency of 250MHz, and can support theoretical speeds of up to 10Gbps, however only over distances up to 55 meters. Category 6 cables are also backwards compatible with other cabling standards and network protocols [11] and therefore are suitable for the following ethernet speeds: 10BASE-T (10Mbit/s); 100BASE-TX Fast Ethernet (100Mbit/s), 1000BASE-T/ 1000BASE-TX Gigabit Ethernet (1Gbit/s) and 10GBase-T (10 Gbit Ethernet) [12].

Comparison of Cat5, Cat5e, Cat6 and Cat6a Cables

	Cat 5	Cat 5e	Cat 6	Cat 6a
Date Introduced	1991	2001	2002	2008
Frequency	Up to 100MHz	100MHz	250MHz min, 500MHz max	Up to 500MHz
Maximum Cable Length	100m	100m or 50m at max rate	100m at 1,000Mbps, 55m max for Gigabit Ethernet	10Gbps over 100m
Theoretical Top Speed	100Mbps	1000Mbps at 50m	10Gbps over 55m	10Gbps over 100m
Attenuation (min at 100MHz)	22dB	22dB	19.8dB	N/A
Shielding	Unshielded Twisted Pair	Unshielded Twisted Pair or Shielded Twisted Pair	Unshielded Twisted Pair or Shielded Twisted Pair	Unshielded Twisted Pair or Shielded Twisted Pair
Connector	8P8C (aka RJ-45)	8P8C (aka RJ-45)	8P8C (aka RJ-45)	8P8C (aka RJ-45)
Reduced Crosstalk	No	Yes, over Cat5	Yes, over Cat5e	Yes, over Cat6
Wiring Scheme	T568A and T568B	T568A and T568B	T568A and T568B	T568A and T568B
Other Features	Isn't widely used (succeeded by Cat5e)	Most commonly used	Has tighter twists than Cat5e. Allows two-way communication on each pair of wires.	Thicker than Cat6

Figure 4. Comparison Table of Cable Standards [13] [14] [15]

The Cat6 standard has been superseded by Cat6a, or Augmented Cat 6 which operates on a frequency of 500MHz and according to Scherer has “improved alien crosstalk characteristics, allowing 10GBASE-T to be run for the same distance as previous protocols” [11]. The IEEE first published the standard (802.3an) in September 2006 [16].

Cat6a offer speeds of up 10Gbit/s (10GBASE-T) over distances up to 100m. The cables differ in construction from most Cat6 cables as they are always shielded [11].

4. Conclusion

Cat5e is currently the most widely used standard in industry, with Cat6 increasing in popularity. According to [17], whilst theoretically Cat6 cables may provide better performance to Cat5e, albeit with a premium price [18], most computers and networking devices are only able to transmit a frequency of 100MHz, therefore, in reality the difference in performance is likely to be negligible.

However, with the fast growth and improvement of technology, it is recommended to use the most up to date standard in order to help future proof a network [19]. As a result, Cat6a cables are likely to become more common due to their higher bandwidth, better distance and reduced crosstalk.

Newer standards including Cat7 and Cat7a have been defined by ISO 11801, which is the international standard for Generic Cabling for Customer Premises [20], however neither have yet been recognised by the TIA/EIA.

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