Official Cert Guide

Cisco Certified Support Technician (CCST)

IT Support 100-140

Mark Smith, CCST
David Bayne, CCAI
John Pickard, CCAI

ciscopress.com

Contents

CHAPTER 2

Hardware

This chapter covers the following topics:

- **Safety:** This section explores physical and environmental safety of hardware as well as individual safety.
- **Ports and Interfaces:** The section describes various ports and interfaces used for video as well as data communication.
- **Identifying, Installing, and Upgrading Computer Components:** This section explores key computer components, their functions, as well as basic installation tips and upgrading guidelines.
- **Hardware and Peripheral Issues:** This section details some common troubleshooting tips and issues you might encounter with hardware and peripheral devices.

This chapter covers the basics of computer hardware and topics related to computer hardware. Safety, ports and interfaces, computer components, and common hardware/peripheral issues are all covered in this chapter. While it would take an entire book to cover the breadth of computer hardware, this chapter will help give you an overview as well as prepare you for certification.

The chapter covers information related to the following Cisco Certified Support Technician (CCST) IT Support exam objectives:

- 2.1 Demonstrate how to follow basic safety procedures.
- 2.3 Assist end users in locating, identifying, and understanding the characteristics of various ports and cables.
- 2.4 Identify, install and upgrade various components in a desktop computer.
- 2.5 Investigate commonly encountered hardware issues.
- 3.2 Troubleshoot commonly encountered connectivity issues with peripherals.

“Do I Know This Already?” Quiz

The “Do I Know This Already?” quiz allows you to assess whether you should read this entire chapter thoroughly or jump to the “Exam Preparation Tasks” section. If you are in doubt about your answers to these questions or your own assessment of your knowledge of the topics, read the entire chapter. Table 2-1 lists the major headings in this chapter and their corresponding “Do I Know This Already?” quiz questions. You can find the answers in Appendix A, “Answers to the ‘Do I Know This Already?’ Quizzes.”

Table 2-1 "Do I Know This Already?" Section-to-Question Mapping

Foundation Topics Section	Questions
Safety	1–3
Ports and Interfaces	4–6
Identifying, Installing, and Upgrading Computer Components	7–9
Hardware and Peripheral Issues	10

CAUTION The goal of self-assessment is to gauge your mastery of the topics in this chapter. If you do not know the answer to a question or are only partially sure of the answer, you should mark that question as wrong for purposes of the self-assessment. Giving yourself credit for an answer you correctly guess skews your self-assessment results and might provide you with a false sense of security.

1. What is the minimum number of volts of static electricity that can harm computer components?
   - **a.** 30 volts
   - **b.** 100 volts
   - **c.** 3,000 volts
   - **d.** 5,000 volts
2. What is the acronym to help you remember how to use a fire extinguisher?
   - **a.** P.A.S.T.
   - **b.** A.I.M.M.
   - **c.** P.A.S.S.
   - **d.** C.L.E.A.R.
3. What is the study of engineering and designing of products and systems to help people called?
   - **a.** Kinesiology
   - **b.** Applied biomechanics
   - **c.** Physiology
   - **d.** Ergonomics
4. What video port is not considered high definition and carries only an analog port?
   - **a.** VGA
   - **b.** DVI-D
   - **c.** HDMI
   - **d.** DisplayPort
5. What USB form factor is capable of carrying audio, video, and power?
   - **a.** USB-A
   - **b.** USB-B

c. USB-C

d. Micro-USB

6. What is the most common connector for an Ethernet cable?

a. RJ-11

b. RJ-45

c. BNC

d. LC-ST

7. What computer component is known as the brain of the computer?

a. Processor

b. Chipset

c. Motherboard

d. RAM

8. What storage device doesn't need external power and data cables?

a. Hard drive

b. SSD

c. Optical drive

d. M.2

9. What three computer components must be compatible with each other?

a. CPU, motherboard, storage device

b. CPU, motherboard, RAM

c. Motherboard, power supply, chipset

d. Motherboard, RAM, storage device

10. If a certain piece of software is not installing, what could be a probable cause?

a. The software is 64-bit and trying to be installed on a 32-bit operating system.

b. The software is incompatible with the storage device.

c. The computer has too much RAM for the software to function properly.

d. The computer is lacking an optical drive.

Foundation Topics

Safety

Lots of jobs require safety training and require their employees to be mindful of best safety practices. For instance, a mechanic should know the dangers of working on an engine. Likewise, an electrician should know the dangers of working with electricity. This is true with the IT support technician as well. Safety to the individual as well as safety to the parts you work on is vital to understand.

Electrical Shock

Key Topic

Electrical shock occurs when uncontrolled electricity flows through your body. This electrical flow can range from the tingle of a 9-volt battery on your tongue—an old, not advisable way people would test 9-volt batteries to see if they were still good—to severe injury and even death. There is an adage that states, "amps kill, not volts."

NOTE This is an overly simplistic deduction of Ohm's law because you can't have amps without volts, but it does help answer why touching a plasma globe doesn't instantly kill you (higher volts and lower amps).

As shown in Figure 2-1, **Ohm's law** states W = VA or Watts = Volts × Amps.

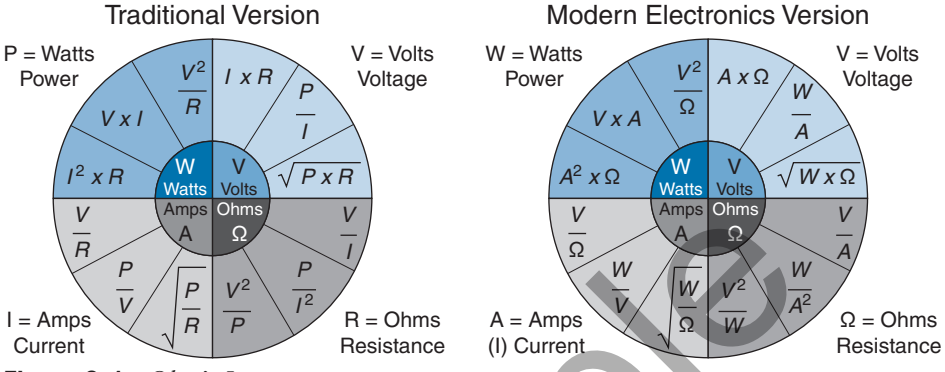

Figure 2-1 *Ohm's Law*

In a reductionist method of describing electricity, the water hose analogy is often used. **Amps**, or current, is often described as the volume of water moving through the water hose, and **volts**, or voltage, is the water pressure. Notice, you can't have one without the other. However, this analogy helps you have a basic understanding that amps are the amount of electricity and consequently what can cause serious harm. You don't need a degree in electrical engineering to be an IT support technician, but it is a good idea to have a basic understanding of electricity so as not to harm yourself.

There is one component that an IT support technician needs to be especially careful around: this is a computer's power supply unit, or **PSU**. Unless specifically trained, you should never open a PSU to fix it. A damaged PSU should be sent back to the factory for repair because they have capacitors in them that hold lethal electrical charge—even after unplugged! This holds true with monitors as well. Never open a monitor for the same reason.

You should be aware of these specific electrical shock hazards when working in IT:

- **Damaged cords and equipment:** Exposed or frayed wires on cords or inside equipment can be a shock hazard.
- **Improperly grounded equipment:** Most surge protectors will help with this, but you should make sure the grounded light is illuminated. Equipment plugged directly into the wall should have the third grounding pin utilized if applicable in your country, as well as the receptacle unless using a two-prong "double insulated" type.
- **Working on live equipment:** For the most part, don't do this unless you know there is zero risk of electrical shock.
- **Liquids:** Water conducts electricity, so keep liquids away from electrical components that are not waterproofed.

Safety tips to minimize electrical shock:

- Do inspect cords and equipment for damage.
- Don't overload power strips/surge protectors and don't daisy-chain them either (plugging one into another one).
- Don't work on electrical equipment while it's plugged in or on.
- Don't eat or drink near electrical equipment.
- Do look around your surroundings to look for potential electrical hazards; be aware.

ESD

Key Topic

Remember shuffling your feet on carpet and touching your friends to give them a shock of static electricity? You were, in fact, giving them electrostatic discharge, or **ESD**. ESD is the releasing of that static electricity. What might seem as harmless fun between two people can be extremely damaging to computer components. Hard drives, solid-state drives, RAM, graphic cards, and motherboards are especially sensitive to static electricity. Basically, any component that has electronic chips and/or memory modules is susceptible to ESD damage. While the results aren't always instantaneous damage, it can be cumulative and ultimately destroy the device.

To go back to the example of "shocking" your friend, it takes over 3,000 volts for a regular person to feel ESD. Ever hear or see the spark of static electricity when, say, touching a doorknob? That's over 5,000+ volts! As previously covered in this chapter, the reason it doesn't kill us is that the amps are very low. Unfortunately, computer components can be damaged with as little as 30 volts. If you're working on sensitive computer components—say, replacing a motherboard—and you feel ESD, there's a good chance you have already done irreversible damage to that part. There are many videos circulating online that try to refute the claim that ESD can cause damage to computer components. It can.

ESD prevention tips:

- Don't work on computer components while standing on carpet (or rugs) unless the carpet/rug has been specifically treated for ESD.
- Don't work on computer components under blowing air from an HVAC system or similar because it can increase static electricity.
- Don't wear wool or synthetic fabrics that can conduct static electricity.
- Don't wear metal jewelry when working on computer components.
- Do adjust the humidity in your room if at all possible—under 40 percent humidity increases static electricity while over 55 percent can cause moisture damage, so try to aim between 45 and 55 percent humidity if at all possible.
- Do store sensitive computer components in antistatic bags (remember the inside of the bag helps reduce static electricity, not the outside; so don't place your motherboard on top of that antistatic bag to work on it).
- Do use an antistatic mat to place your parts on.
- Do wear an antistatic wrist strap.

A note on antistatic wrist straps: these are invaluable tools for the IT support technician. One connects the wrist strap to one hand—usually your nondominant hand so it doesn't cross in front of your work path as often—and the other end, usually with an alligator clip, to the metal chassis of the computer case if you're working on that. There is a misnomer that this process "grounds" you. That is not really the case. Rather, it's important to remember that electricity flows between positive and negative or negative and positive. The antistatic wrist strap equalizes the charge between you and the component you're working on, thus eliminating the flow or discharge of the static electricity. This is why it is important to place the alligator clip to something, ideally metal, near the component you're working on—to help dissipate the electrostatic charge. It is not advisable to clip on to the power supply, because if the alligator clip were to inadvertently touch any of the internal components of the power supply, it could send a dangerous volt to you.

Fire Safety

Fire safety is important in every industry and should be important to every individual as well. Far too many people have had their kitchens burned down from a fire on the stove. Unfortunately, that scenario often goes like this: John heats up a pan of oil to make some fries. The pan catches on fire from the oil heating up too much. Panicked, John sees his kitchen faucet nearby and rushes the flaming pan under the water to put out the fire. Oil and water do not mix. The water displaces the flaming oil and sends shooting, flaming oil all over his kitchen. Don't be John; learn fire types and the proper ways to stop those fire types.

Figure 2-2 depicts the common classes of fires.

Figure 2-2 *Classes of Fire*

Every home and business should have at least one ABC fire extinguisher within easy access—more than one if in a larger area. An ABC fire extinguisher will put out type A, B, and C classes of fires listed in Figure 2-2. If you're working in a specialty industry, such as a restaurant, then a Class K, specifically for grease/oil fires, would be beneficial as well. In IT, you might deal with a wood or paper fire, which a Class A fire extinguisher would work on, but you might also deal with an electrical fire. Again, water is conductive, so you would not want to put out an electrical fire with water. Instead, a typical ABC fire extinguisher, because of the Class C in particular, will be able to put out most electrical fires.

A note on fire extinguishers: fire extinguishers do not last forever. The propellant inside of them dissipates over time. This is why it is critical to have them checked annually (or sooner) or replaced. While most fire extinguishers have a gauge that reads green for good and red for bad, it is not recommended to rely on this gauge alone. Fire extinguishers should be serviced by a reputable company. It is good advice to contact your local fire agency to see if there is an opportunity to learn fire safety and use a fire extinguisher before an emergency.

To use a fire extinguisher, remember the acronym **P.A.S.S.**:

Key Topic

- **P** is for pull the pin on the fire extinguisher. While this might seem obvious, in the heat of the moment, people often forget.
- **A** is for aim. Aim the nozzle to the base of the fire to smother it. It is human nature to aim at the top of the flames because that is what you see. Resist that urge and aim at the base to smother the source/fuel of the fire.
- **S** is for squeeze. Squeeze the trigger slowly and evenly so as to not use all of the extinguishing agents too quickly.
- **S** is for sweep. Whiling aiming at the base of the fire, sweep the nozzle from side to side to make sure to cover as much of the base of the flames as possible.

If applicable, call your local emergency services before the fire is too large for you to put out or after if you are afraid there might still be hot spots.

Prevention of fires is of utmost importance to the IT support technician. The first step is to reduce fire hazards in your workplace. Keep your workplace free of clutter: don't stockpile papers, wires, and other combustible material to reduce the risks of something catching fire. Regularly inspect equipment for damaged cords, overheating components, and overloaded power strips/surge protectors. Have a fire safety plan in your workplace and schedule regular checks of your fire alarms to make sure they are working.

Personal Safety

While the standard IT support technician might not be breathing in dangerous chemicals or working with highly explosive materials in normal working conditions, that doesn't mean there aren't personal safety issues to consider. One major threat to IT technicians is online safety. Often, it is the IT staff who are targeted by **threat actors** to gain access to a network/computer system. However, that topic will be covered in more depth in Chapter 7, "Security."

Key Topic

Another often-overlooked risk to the IT support technician is physical safety. One area of focus in recent decades has been on repetitive strain injuries, or **RSI**s. You will often be working long hours at a desk typing on your keyboard and clicking away with your mouse. Carpal tunnel syndrome is a very real condition that affects many office workers and involves pinching the nerve in your wrist. It is a condition that often causes pain in the hand and wrist. This condition occurs because of the repetitive motion of typing and using your mouse. To help prevent carpal tunnel, take breaks from your computer when at all possible—stand up, stretch, hydrate, and move your body. Another prevention technique is the use of ergonomic devices.

Key Topic

Ergonomics is the study of engineering and designing of products and systems to help people. This can be as simple as chairs to help promote better posture when sitting at a desk, the rise of adjustable desks to allow for standing and working, mouse pads with wrist guards to

help the posturing of your hand, and even keyboards to help your hands be in a more natural position when typing.

Figure 2-3 shows an example of an ergonomic keyboard.

Figure 2-3 *Ergonomic Keyboard*

In addition to RSIs, injuring yourself lifting is also a possible safety risk. You might often be tasked with moving around heavy pieces of equipment. Even lighter equipment can pose a risk of injury if not carried or placed correctly. Use a dolly or moving cart when at all possible. If you must lift an object, use your legs and don't pull up with your back muscles. Ask for help if a piece of equipment needs more than one person to move it.

In addition to injuring yourself physically through moving a heavy object or getting an RSI, you also need to be careful not to be the target of a physical attack. You will often be working alone or late at night. You might be transporting valuable IT equipment from one office to another. This makes you a target for a would-be thief. Be aware of your surroundings and communicate with your colleagues about when and where you're at if it could be a risky situation.

Finally, maintain a healthy lifestyle. Drink plenty of water, eat a balanced diet, take breaks from the computer (in accordance with your company policy), use blue light filters on your monitor to help prevent eyestrain (most operating systems, including phones, have a "night light" feature to help reduce harmful blue light), and get sleep.

"An ounce of prevention is worth a pound of cure."—Benjamin Franklin

Ports and Interfaces

Key Topic

One commonly confused concept in IT is the difference between an interface and a port. You will often hear these terms used interchangeably, but there is a difference. An **interface** is how a device communicates. For example, a mouse is a hardware interface. In particular, it is an input interface. The mouse lets the user send x and y coordinates to the operating

system to move the cursor around the screen. Consequently, the mouse is a hardware interface that is also an input interface. How it connects to the computer is through a port.

NOTE You will often hear terms like an *input* or *output device*. You need to think of it from the perspective of the computer itself. If the information is going into the computer, it is an input device. If the information is going out of the computer, it is an output device. Common input devices are mice, keyboards, scanners, and the like. Common output devices are monitors, speakers, printers, and so forth. If you have an all-in-one printer, then you have an **input/output device**. The printer is an output device, but the scanner is an input device.

The mouse also communicates with a software interface called a driver. The **driver** is software that translates the raw input from the hardware to the operating system. It can also translate output from the operating system to the hardware (think of an image being displayed on your monitor).

Key Topic

A **port** is often the physical connection to the computer. Most mice in the past decade are USB. The USB is the port that the mouse uses to connect to the computer. The physical port is what transfers the electrical signals back and forth. To clarify, the mouse is a hardware input interface that sends x and y coordinates to the operating system through the software interface of a driver so that the operating system can understand the data being fed to it. The mouse itself is plugged into a USB port. The USB port itself is capable of inputting and outputting data—think of a flash drive—but is only inputting data from the mouse.

NOTE When talking about hardware, we usually speak of physical ports—an actual electrical part you can touch. However, there are virtual ports as well. For example, when you go on the Web and search a vital question like what music artist said what to whom, you are often using Hypertext Transfer Protocol Secure, or https, which uses port 443. Port 443 is a virtual port for https communication. You can't physically touch the port.

A wireless card, or wireless NIC, is a physical port, not a virtual port. While you don't plug anything into it, you could touch the actual chip that is sending and receiving radio waves to communicate.

Video Ports

Video ports are just what they sound like—ports that output video. Before we delve into the various video ports every IT technician should know, it is important to know the difference between analog and digital video signals. An analog video signal is presented in a waveform, whereas a digital video signal is discrete binary bits of 0 or 1 (see Figure 2-4).

Binary is how computers function and dates back to early circuits. A circuit was either open, or off (0), or it was closed, or on (1). If you look on a PSU, you will see a switch with a 0 and a 1. Zero means off, and one means on. Early video ports were analog, so if the monitor received analog signals, the computer would have to convert from binary to analog for the monitor to understand it. Today, most monitors are digital, so the move from analog to digital makes sense.

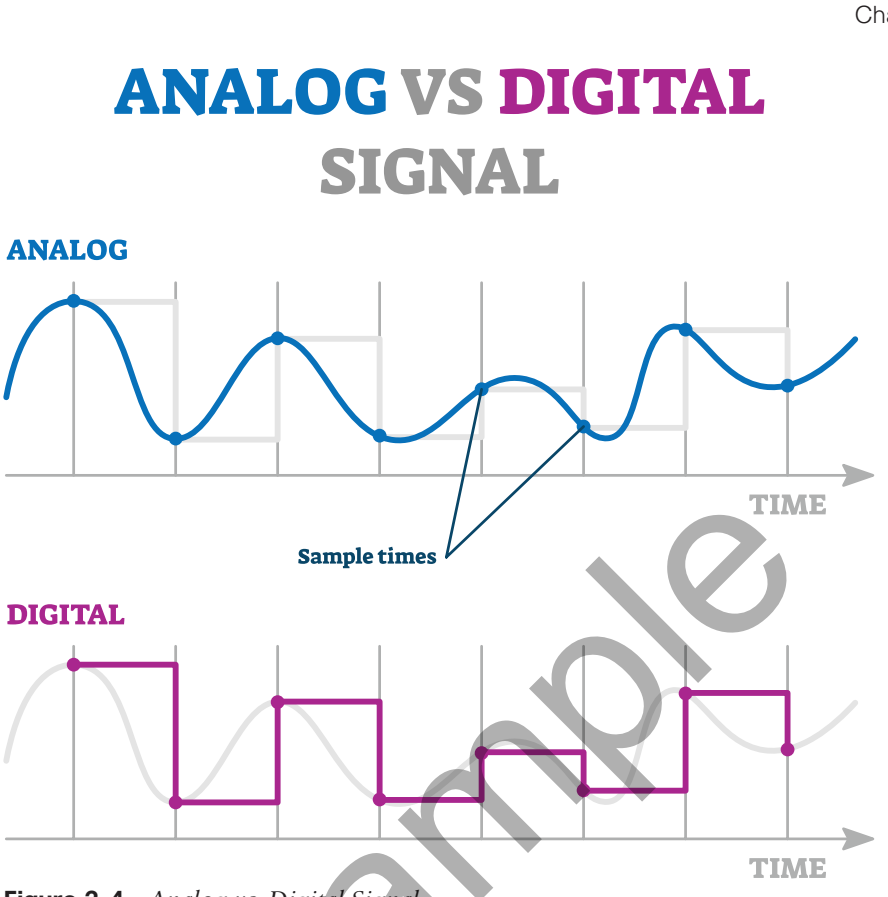

Figure 2-4 *Analog vs. Digital Signal*

NOTE Consumers have been inundated with various technical/marketing terms for their televisions for the past two decades. Terms such as *HD*, *Full HD*, *UHD*, and now *8k*—not to mention *QLED*, *OLED*, and so forth—have saturated the marketplace. While the latter is beyond the scope of this certification, you should know the former. *HD* stands for high definition and is 1280×720 pixels. A **pixel** is merely a single dot of color on a screen. So, HD is 1280 pixels horizontally and 720 pixels vertically. Interestingly, display resolutions for HD and FHD are often referred to as the vertical pixels rather than the horizontal pixels; hence, HD is often called *720(p)*. The *p* stands for progressive because it allows the television to display all lines at once rather than interlaced, which writes odd lines on the first pass and even lines on the second pass. *Full HD* is 1920×1080, 1080(p), or (i); *UHD* is 3840×2160, or 4k; and now we're seeing 7680×4320, or 8k! While these resolutions are more specific to televisions, you will see them marketed in computer monitors as well. One more common monitor resolution that never really came to television is 2k, or 2560×1440, and often called *1440p*. This does not mean all computer monitors follow these resolutions. In fact, many laptops have a 4:3 aspect ratio—making it more square than rectangular—and will have very different resolutions. Today, most of these HD resolutions are digital in port communication, with the one major exception of the aging component port, which is an analog port that is capable of HD resolution.

HDMI

Key Topic

High-Definition Multimedia Interface, or **HDMI**, ports are one of the most common video ports for both televisions and monitors. It is a digital port consisting of 19 pins that can transmit both audio *and* video. With the introduction of the HDMI 2.1 standard, an HDMI 2.1 port can support 4k, 5k, 8k, and 10k at 120 Hz and 48 gigabits per second (Gbps) of bandwidth/data. This is a huge improvement from the previous HDMI standard, which could only support up to 4k at 60 Hz. The two most common HDMI ports are standard (Type A) and Mini (Type C, not to be confused with USB C). See Figure 2-5.

Figure 2-5 *Mini HDMI (on Left) and Standard HDMI (on Right)*

NOTE *Hz* stands for hertz and is the number of times a screen refreshes, or is redrawn, in one second. The official 4k standard for television is 4k at 60 Hz. Gamers will often speak about achieving the maximum frames per second, or fps, when playing video games. This is a direct relation to how often the graphics card can refresh the screen and thereby has a correlation to the hertz of the monitor. For example, if a gamer is receiving stats from the game stating they are playing at 120 fps, but they are using an older HDMI port that is capable of displaying only 60 Hz, then they are only seeing 60 fps on their monitor even if their video card is capable of displaying more. This is why many "gaming" monitors sold use DisplayPorts because it is capable of displaying more hertz.

DisplayPort

Key Topic

DisplayPort is a popular digital, 20-pin, video port that many gamers prefer over HDMI. It supports both video and audio like HDMI. While it has never really gained traction in the television space, it is fairly common on modern video cards and monitors. It can output, on the high end, 8k at 240 Hz with 77.37 Gbps of bandwidth/data! For some, it is easy to confuse a DisplayPort and an HDMI port because one side looks identical to the other. However, a DisplayPort has a flat end on one side. There is also a mini DisplayPort that looks quite different. See Figure 2-6.

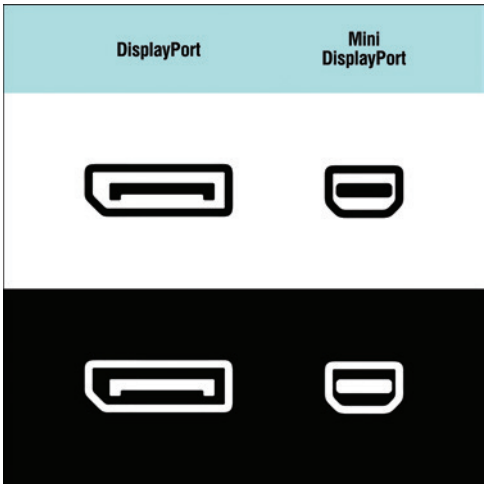

Figure 2-6 *DisplayPort and Mini DisplayPort Illustration*

DVI

Key Topic

A **DVI** is an older 24-pin port that can be both digital and analog and carries only video and *not* audio. Unfortunately, marketing of this port made it more confusing for consumers. There are several variations of DVI: DVI-D Single Link, DVI-D Dual Link, DVI-I Single Link, DVI-I Dual Link, and DVI-A. DVI-A was pure analog and is not used anymore. However, you will still see DVI-D and DVI-I in some older computers. DVI-D is a pure digital connection. It is capable of a max resolution of 3840×2400 at 30 Hz in Dual Link. You will still see people use DVI-D today because it can display 1080p at 144 Hz, but you would have to have a separate audio cable. See Figure 2-7 to see what a DVI-D looks like.

Figure 2-7 *DVI-D Cable*

DVI-I is another port you might still see. It is capable of carrying an analog and a digital signal on separate pins. It does not convert digital to analog signals or vice versa. Rather, it can pass through analog signals on certain pins and digital signals on other pins. This is

important because you can't plug a DVI-A or DVI-I cable into a DVI-D port, but you can plug a DVI-D cable into a DVI-I port. See Figure 2-8 to see a DVI-I port. Notice the cross formation with four dots around it. Those four dots are for analog signals.

Figure 2-8 *DVI-I Port*

VGA

Key Topic

A **VGA** cable is a 15-pin analog port. It does not carry audio signals much like DVI. VGA is one of the original video ports. While it can display up to 2048×1536 at 85 Hz, it is *not* considered a high-definition port. This means you can display 1920×1080 at 60 Hz, but it will be an analog signal and HD is a digital signal. Component ports are the only analog ports that are capable of being called HD because they still carry a digital signal over the analog communication. VGA would have to convert the digital signal to analog and, consequently, is not labeled as true HD. In fact, if you were to compare an HDMI display at 1920×1080 to a VGA display at 1920×1080, you would notice that the VGA display is fuzzier and not as crisp. VGA cables are often blue (see Figure 2-9) but can come in other colors.

Figure 2-9 *Traditional Blue VGA Cable*

USB-C

USB-C can carry audio and video. However, it can do more than that. USB-C, while a port, is also a form factor. This means that it's one of the more complicated concepts for consumers. See the subsection "USB-C" later for more information.

USB

Universal Serial Bus, or **USB**, is a common port type found in most computers today. By design, it can transmit both power and data. The *serial* in its name is an important distinction because it is an evolution of the original 9-pin **serial port**, also called an RS-232 port. While serial ports have all but disappeared from modern computers, they are still in use in industrial control systems and commercial routers and switches. While serial ports are slow in data transfer and do not support power over their wires like USB, they are reliable and easily programmed. Luckily, while most modern computers do not include serial ports anymore, there are many serial-to-USB adapters on the market to communicate with serial port devices. Some people confuse serial ports with VGA ports because of the similar external design, but there are two ways to identify them easily. First, serial ports have only 9 pins, whereas VGA ports have 15 pins. Also, most serial ports are male (pins sticking out), whereas most VGA ports are female (holes for the male pins on the cable to plug in to). In other words, serial ports are male and their cables are female, whereas VGA ports are female and their cables are male. See Figure 2-10 to see a serial port next to a VGA port on the rear input/output panel of a motherboard.

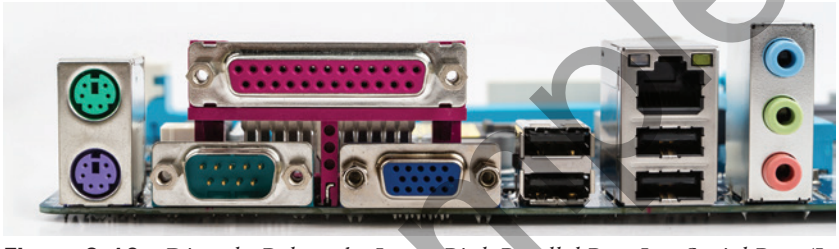

Figure 2-10 *Directly Below the Large Pink Parallel Port Is a Serial Port (Left) and a Blue VGA Port (Right)*

USB speeds have dramatically improved over the years. The first USB version, USB 1.0, was capable of 1.5 megabits per second (Mbps); USB 1.1, 12 Mbps; USB 2.0, 480 Mbps; USB 3.0, 5 gigabits per second (Gbps); USB 3.1, 10 Gbps; USB 3.2, 20 Gbps; USB 4, 40 Gbps; and USB 4 2.0, 80 Gbps.

USB Form Factors

Key Topic

In addition to the different USB versions, which primarily affect speed, there are also different **USB form factors**. Consequently, USBs can look different from each other. Traditionally, when most consumers think USB, they are thinking of USB-A. This is the original rectangular port that has a singular orientation, which means you can only plug it in one way. USB-B is more square and has been traditionally used to connect to printers and is now a popular connection to 3D printers. Mini-USB was a popular standard for phones and portable electronic devices for some time before micro-USB replaced it. Both are singular orientation, and the plug can only be plugged in one way. The newer form factor that has been gaining rapid momentum is USB-C. USB-C is not singular orientation and can be plugged in right side up or upside down. It is now becoming common on most electronic devices, including phones. In addition to the ease of plugging in, there are a multitude of other benefits to USB-C. See the following section for more information. Figure 2-11 helps you visualize the different USB form factors.

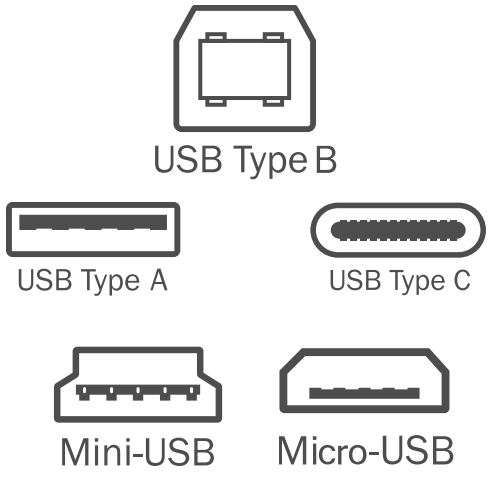

Figure 2-11 *USB Form Factors*

USB-C

Key Topic

USB-C is fast becoming the most ubiquitous of USB form factors. It is also one of the more complicated form factors. By definition, USB-C can carry data and power like the original USB standard. It is now being used as the favored port to power many laptops out there. However, it is also capable of carrying video and audio. Its bidirectional method of plugging in—so you don't have to worry about which side is up—and smaller footprint have made this a prolific form factor. However, the capabilities of USB-C vary wildly and depend on the actual interface technology being used behind the form factor.

USB 3.0, capable of 5 Gbps, can be a USB Type A or USB Type C form factor. USB 3.1, capable of 10 Gbps, can also be Type A or C. However, USB 3.2 is almost exclusively USB Type C, which is capable of 20 Gbps. How do you know which USB type your USB-C port is? Read the documentation for the specific electronic component that has the USB-C connection.

To add to the complexity, USB 4 is often called **Thunderbolt**, but technically Thunderbolt 3/4 is one **proprietary** implementation of USB 3.1/4 capable of 40 Gbps. Non-Thunderbolt USB 4 is only capable of 20 Gbps. Thunderbolt 5 uses USB-C as well and is capable of 80 Gbps. So, all Thunderbolt 3/4/5 interfaces are USB-C ports, but not all USB-C ports are Thunderbolt. Again, how do you know if you have a regular USB-C port or a Thunderbolt USB-C port? Read the documentation or look for the proprietary lightning bolt icon next to the port. See Figure 2-12.

Ethernet Ports

The most common interface for an Ethernet port is an **RJ-45** connector (see Figure 2-13) plugged into a network interface card (NIC). The Ethernet port on the NIC is what you would use to physically connect the Ethernet cable to the Internet or local network. If you connect wirelessly, you use a wireless NIC, and no physical cable is needed. There are also fiber connections to connect to networks, but they are typically not found as direct connections to consumer devices at this time.

Figure 2-12 *Thunderbolt USB-C Port (Look for a Lightning Bolt by the Port)*

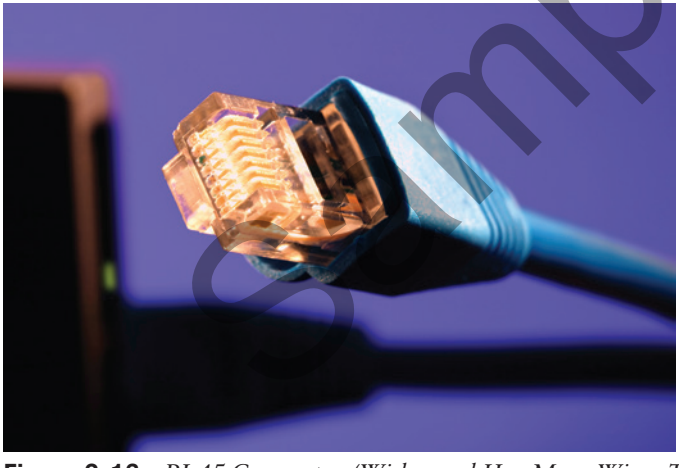

Figure 2-13 *RJ-45 Connector (Wider and Has More Wires Than the Older Telephone Connector, Which Was an RJ-11)*

Key Topic

An Ethernet cable to connect to a network might be called a CAT 5e, UTP, 1000BASE-T cable with an RJ-45 connector. Let's break this down:

- An Ethernet cable is often categorized as a CAT cable, with *CAT* abbreviated from Category. There are currently eight categories of Ethernet cables: CAT 1–5 are rarely used anymore; CAT 5e and 6/6a are commonly used, and CAT 7/8 are used for short runs in data centers. The higher the category, the faster the Ethernet cables can transfer the data. This explanation is a tad oversimplistic but helps in the general overview. CAT 5e is still used in many places and is capable of delivering 1 Gbps of data. CAT 6a can deliver 10 Gbps of data. Both CAT 5e and CAT 6 are capable of sending

data 100 meters before needing a signal repeater. CAT 7/8 can deliver 40 Gbps of data but only between 10 and 30 meters and are typically used only in data centers.

- The *TP* stands for twisted pair. Starting with CAT 3, electrical engineers started twisting the wires together to reduce electrical interference. Now, we have eight wires twisted in four pairs to reduce interference and gain speed (see Figure 2-14). When cutting your own Ethernet wiring, you must untwist the ends of these wires to slide them into an RJ-45 connector. In addition to TP, which all Ethernet cabling uses now, you can also purchase **STP** or **UTP**. Both are twisted pair, but *U* stands for unshielded and *S* stands for shielded.
  - Unshielded is what it sounds like. The cable is unshielded from any sort of electromagnetic interference. The cables are generally cheaper and more flexible than shielded cables. For most smaller runs inside a home or office, UTP is acceptable.
  - Shielded twisted pair means the cable itself is made of a material to help protect against electromagnetic interference. It is often made of PVC or plenum. Plenum is often required if running Ethernet in walls because it has flame-retardant properties. Often the individual wires will also have a foil shielding to protect against interference. STP is often used in commercial projects or for long runs. However, STP is usually more expensive than STP and not as flexible.

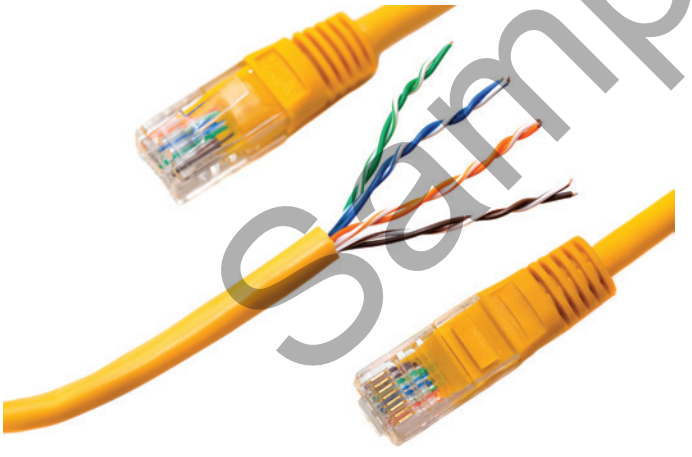

Figure 2-14 *Twisted Pairs in Ethernet*

- *PVC* is polyvinyl chloride, which can produce toxic fumes and should be used in open-air situations.
- Plenum cables have a fire-resistant jacket and should be used inside walls, drop ceilings, or under raised floors.
- The 1000BASE-T part means that there is 1000 Mbps of bandwidth. You will also see this written as 1GBASE as well. The *G* stands for gigabit, which is equal to 1000 megabits. The *BASE* merely refers to baseband signaling, which means only Ethernet signals are carried on it. The *T* stands for twisted pair. Yes, this is redundant because the *T* in UTP and STP also stands for twisted pair.