



# I

## Personal Computer Components— Motherboards and Processors

### CERTIFICATION OBJECTIVES

- 701: 1.2** Explain motherboard components, types, and features
- 701: 1.4** Explain the purpose and characteristics of CPUs and their features
- Two-Minute Drill

Q&A Self Test

This chapter, along with Chapters 2 and 3, introduces you to basic computer concepts, including categorizing, explaining, classifying, and identifying common components. Consider the contents of these first three chapters to be the basic technical knowledge a computer professional working with PCs needs. Familiarity with the components, as well as a good working knowledge of their function, will allow you to work comfortably with most types of computers, in spite of different layouts or new component designs. Once you have a good feeling for how the parts of a computer system work together, you will be on the road to becoming a PC technical professional. This knowledge will aid in all the technical tasks ahead of you and in passing your CompTIA A+ 2009 exams. This chapter's coverage is not intended to be comprehensive, merely a place to begin. Later chapters will give you an opportunity to learn skills for installing and troubleshooting these components.

### CERTIFICATION OBJECTIVE

#### ■ 701: 1.2 *Explain motherboard components, types, and features*

The motherboard is the real estate on which a PC is built; all PC components are directly or indirectly connected to this large printed circuit board. This chapter introduces all of the topics of the CompTIA A+ Essentials (2009 Edition) Exam objective 701: 1.2, including form factors, memory slots, processor sockets, bus architecture, bus slots, PATA, SATA, eSATA, chipsets, and BIOS/CMOS. In later chapters, we will revisit many topics with a different spin, as we look at installing, maintaining, upgrading, and troubleshooting PCs. For instance, we introduce the topic of RAID in this chapter, as it involves a BIOS setting, but we will further explore it in Chapter 2.

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***Safety first! Throughout this book, we will ask you to install and remove components on a PC system. Therefore, you must thoroughly understand two areas before opening the cover of a computer: electrostatic discharge (ESD), which can kill your computer, and high voltage (inside the power supply and any CRT-type display), which can kill you. To make sure you know the complete power protection and safety procedures, read Chapter 18 first.***

## Motherboards

The basic computer system that sits on your desktop may look like Figure 1-1, but it is an extremely complicated piece of equipment that includes a vast array of technologies in its components. As a computer technician, you do not really need to be overly concerned about the actual inner workings of these components, but understanding what they do will be helpful. We will begin with the motherboard, the foundation of every PC. Each internal and external PC component connects, directly or indirectly, to the *motherboard*. The motherboard, also referred to as the *mainboard*, the *system board*, or the *planar board*, is made of fiberglass, typically brown or green, and with a meshwork of copper lines. Power, data, and control signals, also called *traces*, travel to all connected components through these electronic circuits. A group of these wires assigned to a set of functions is collectively called a *bus*. In this section, we focus on types of motherboards, their typical integrated components, and the differences between the motherboard's communication busses and the types of systems they allow you to use.



***If you work with experienced PC technicians, read trade publications, or visit technical Websites, you'll probably see the term *mobo* used in place of motherboard.***

**FIGURE 1-1**

A typical PC



### Form Factors

A motherboard *form factor* defines the type and location of components on the motherboard, the power supply that will work with it, and the corresponding PC case that will accommodate both. There are several motherboard form factors, each with different layouts, components, and specifications. A motherboard will use only certain CPUs and types of memory, based on the type of CPU and memory sockets installed. Therefore, if you decide to build a computer from components, you must ensure that the motherboard, power supply, CPU, memory, and case will all work together. Personal computer motherboards have evolved over the past quarter century, and continue to do so. Although motherboards can vary from manufacturer to manufacturer, Intel Corporation, a major manufacturer, has developed several form factors over the years, including the early AT (not discussed here) and NLX form factors, and the later ATX and BTX form factors. Each of these has size variations, such as the smaller microATX and microBTX form factors. We will discuss their sizes, typical components, and prevalence next.

#### NLX

One step up from the AT form factor of the 1980s, *New Low-profile eXtended (NLX)* was an Intel standard for motherboards targeted to the low-end consumer market.

It was an attempt to answer the need for motherboards with more components built in, including both sound and video, while also saving space and fitting into a smaller case. One method they used to save space was a bus slot called a riser slot, which accepted a card that created an expansion bus perpendicular to the motherboard. This *riser card*, in turn, accepted expansion cards that were oriented horizontal to the motherboard. These motherboards became obsolete very quickly, in part because they used a very old expansion bus, the *industry standard architecture (ISA)* bus, which had some severe limitations that later bus designs overcame.

### exam

#### Watch

**NLX is a very old form factor that you may never encounter on the job. However, it is listed in the exam objectives for the *CompTIA A+ Essentials (2009 Edition)* Exam objective 701: 1.2, so be sure to remember it and its place in the scheme of things.**

#### ATX and MicroATX

The *Advanced Technology eXtended (ATX)* motherboard standard was released by Intel Corporation in 1996 and is the most commonly used form in PCs. The ATX motherboard measures approximately 12" wide by 9.6" from front to back, which keeps

it from interfering with the drive bays, as was a problem with the AT motherboards. The processor socket is located near the power supply, so it will not interfere with full-length expansion boards. Finally, the hard- and floppy-drive connectors are located near the drive bays (see Figure 1-2).

**FIGURE 1-2** An ATX motherboard with the CPU located in the back next to the power supply



When first introduced, the ATX motherboard included integrated parallel and serial ports (I/O ports) and a mini-DIN-6 keyboard connector. ATX boards also have built-in multimedia support accessed through a game port, as well as mini-audio ports for speaker, line-in, and microphone. Manufacturers have modified the ATX standard to support newer technologies, such as USB, IEEE 1394, PCI, and PCIe. A rear panel provides access to the onboard I/O ports.

Depending on the manufacturer and the intended market, an ATX motherboard will contain up to six memory slots for the latest RAM types, support for BIOS-controlled power management, Intel or AMD CPU sockets, both PATA and SATA drive controllers (described later in this chapter), and support for USB and IEEE 1394.

The MicroATX motherboard is a scaled down version, at 9.6" by 9.6". The lightweight ATX motherboard is the Flex ATX, measuring 9" by 7.5" or smaller.

## BTX

Introduced in 2003 by Intel Corporation, the *Balanced Technology eXtended* (BTX) motherboard form factor is the successor to the ATX standard. This standard is a major departure from ATX and offers improved cooling efficiency and a quieter computer through careful placement of the components for better airflow. However, by 2006 manufacturers suspended production of this form factor due to the improved cooling of individual components and BTX's incompatibility with newer chipsets and processors. BTX boards came in three sizes: BTX (or standard BTX), MicroBTX, and PicoBTX. Table 1-1 gives a comparison of these three sizes.

## Motherboard Components

The components built into a motherboard include sockets for various PC components, including the CPU and memory; and built-in components such as video and sound adapters, hard drive controllers (PATA and SATA), support for various port types (parallel, serial, USB, and IEEE 1394), and the chipset.

**TABLE 1-1**

Motherboard Size  
Comparison

Form Factor	Approximate Size
ATX	12" × 9.6"
MicroATX	9.6" × 9.6"
FlexATX	9" × 7.5"
BTX	12.8" × 10.5"
MicroBTX	Up to 10.4" × 10.5"
PicoBTX	8.0" × 10.5"

## SCENARIO & SOLUTION

How does the BTX motherboard form factor differ from ATX?	The BTX design provides better cooling through the positioning of components on the motherboard and quieter operation because it does not require as much fan power.
What other computer components must be matched to a motherboard.	The power supply, CPU, memory, and case must match the motherboard.
Which motherboard form is typically the largest?	The standard BTX motherboard is the largest motherboard form factor.

### Memory Slots

The motherboard has slots or sockets for system memory. Depending on the vintage and the manufacturer of a motherboard, special sockets accept one of the various types of DRAM or SDRAM memory sticks (also called *modules*). These sticks are *Single Inline Memory Module (SIMM)*, *Dual Inline Memory Module (DIMM)*, and *RAMBUS Inline Memory Module (RIMM)*. SIMM is the oldest technology, and you will not see these sockets in new PCs. The current standards are DIMM and RIMM. Both of these physical memory slot types move data 64-bits or 128-bits at a time. DIMM sockets are the most common, and for desktop or tower PCs, they may have 168 pins, 184 pins, or 240 pins. RIMM sockets for nonportable PCs have 184 pins. DIMM and RIMM sockets for portable computers are yet another story. Laptop motherboards have special sockets to accommodate smaller memory sticks, such as SODIMM or SORIMM. Learn more about memory for laptops in Chapter 6.

The number of slots depends on the manufacturer's design, but typical motherboards have up to four slots for one type of memory stick. For instance, we have an ATX motherboard in one of our office computers with six memory slots—four DIMM slots for DDR2 memory sticks and two DIMM slots for DDR3 memory sticks. The slots look similar, but the DIMM slots for DDR2 have 184 pins, whereas the DIMM slots for DDR3 have 240 pins. Learn about RAM technologies in Chapter 2, and learn about installing RAM in Chapter 4.



***Read a good (motherboard) book. How do you find out about using memory slots on a specific motherboard? You read the motherboard user guide. If you cannot find one for your computer, find the manufacturer's name and the model of the motherboard (or computer system) and query your favorite Internet search engine. You will often find the right book in PDF format.***

### Processor/CPU Sockets

The two major CPU manufacturers, Intel and AMD, each offer, at any given time, only a few current processor lines, but numerous, even hundreds, of processor models within each line. One of the many differences among the individual processor models is how the processor attaches to the motherboard, which is referred to as the *socket*. Every motherboard contains at least one CPU socket, and the location varies from one motherboard standard to another. A common CPU socket type is a *zero insertion force (ZIF)* socket, which is square, has a retention lever that holds the CPU securely when it is closed, and makes it easy to put a CPU in the socket when it is open.

For many years both manufacturers used some variation of pin grid array (PGA) CPU packaging, meaning that the processor has a square array of pins (numbered in the many hundreds) that insert into a matching socket on the motherboard. One variation is *PGA2*, which is used with Intel Pentium processors, and later the *SPGA*, or *staggered pin grid array*, came along, in which the pin rows are staggered to allow for a higher pin density than PGA. More recent Intel and AMD processors use the *land-grid array (LGA)* socket. A LGA processor has pads, rather than pins. These pads on the processor come in contact with pins in the socket on the motherboard and permit a higher density than possible with PGA. In many cases, with both PGA and LGA processors, a number that indicates the number of pins or pads in the array follows the word “socket.” For instance, some Intel LGA processors have 1155 pads and are called “Socket 1155.” Read the motherboard and CPU documentation very carefully to be sure the CPU and socket match, because there are many versions of PGA and LGA sockets. Learn how to install a processor on a motherboard in Chapter 4.

### External Cache Memory

The motherboard may have sockets for external cache memory used by the CPU. See the discussion of cache memory later in this chapter in “Processor/CPU.”

### Bus Architecture

The term *bus* refers to pathways that power, data, or control signals use to travel from one component to another in the computer. Standards determine how the wires are used in the various bus designs. There are many types of busses, including the *processor bus*, used by data traveling into and out of the processor. The address and data busses are both part of the processor bus. Another type of bus is the *memory bus*, which is located on the motherboard and used by the processor to access memory. In addition, each PC has an *expansion bus* of one or more types. The most

common types of expansion bus architectures are PCI, PCIe, and AGP, and we discuss these next. Less common types are AMR, ACR, and CNR, which we discuss in Chapter 2.

## Expansion Bus Types and Slots

The bus standards for *input/output (I/O)* devices in PCs have evolved along with the PC over the last quarter century. Input refers to bringing data into a computer for processing, whereas output refers to information that comes out of a computer. Examples of common input devices include the keyboard and any pointing device (mouse, trackball, pen, etc.). Data can also be input from devices that also take output, such as storage devices and network cards. The most common output devices are the display, sound card, and printer. Less common I/O devices include bar code readers, biometric devices, touch screens, and KVM switches—all discussed in Chapter 3. The following bus types are those that you can expect to see in PCs today.



**The terms *bus*, *system bus*, and *expansion bus* are interchangeable. A bus refers to either a system bus or an expansion bus attached to the CPU.**

**PCI** *Peripheral component interconnect (PCI)* is an expansion bus architecture that was released in 1993 but was replaced by newer bus types. The PCI bus transfers data in parallel over a data bus that is either 32- or 64-bits wide. Over the years several variants of the PCI standard have been developed, and data transfer speeds vary, depending on the variant and the bus width. The original 32-bit PCI bus ran at 33.33 MHz (megahertz) with a transfer rate of up to 133 megabytes per second (MBps). PCI is a local bus, meaning that it moves data at speeds nearer the processor speeds.

The variants on the original PCI bus include PCI 2.2, PCI 2.3, PCI 3.0, PCI-X, Mini PCI, Cardbus, Compact PCI, and PC/104-Plus. These substandards vary in signaling speed, voltage requirements, and data transfer speed. Mini PCI and Cardbus brought PCI to laptops, requiring entirely different connectors to save space. Read more on these two busses in Chapter 6.

PCI slots are  $3\frac{3}{8}$  " long and are typically white. PCI cards and slots are not compatible with those of other bus architectures. Although initially developed for video cards, PCI cards are also available for networking, SCSI controllers, and a large variety of peripherals.

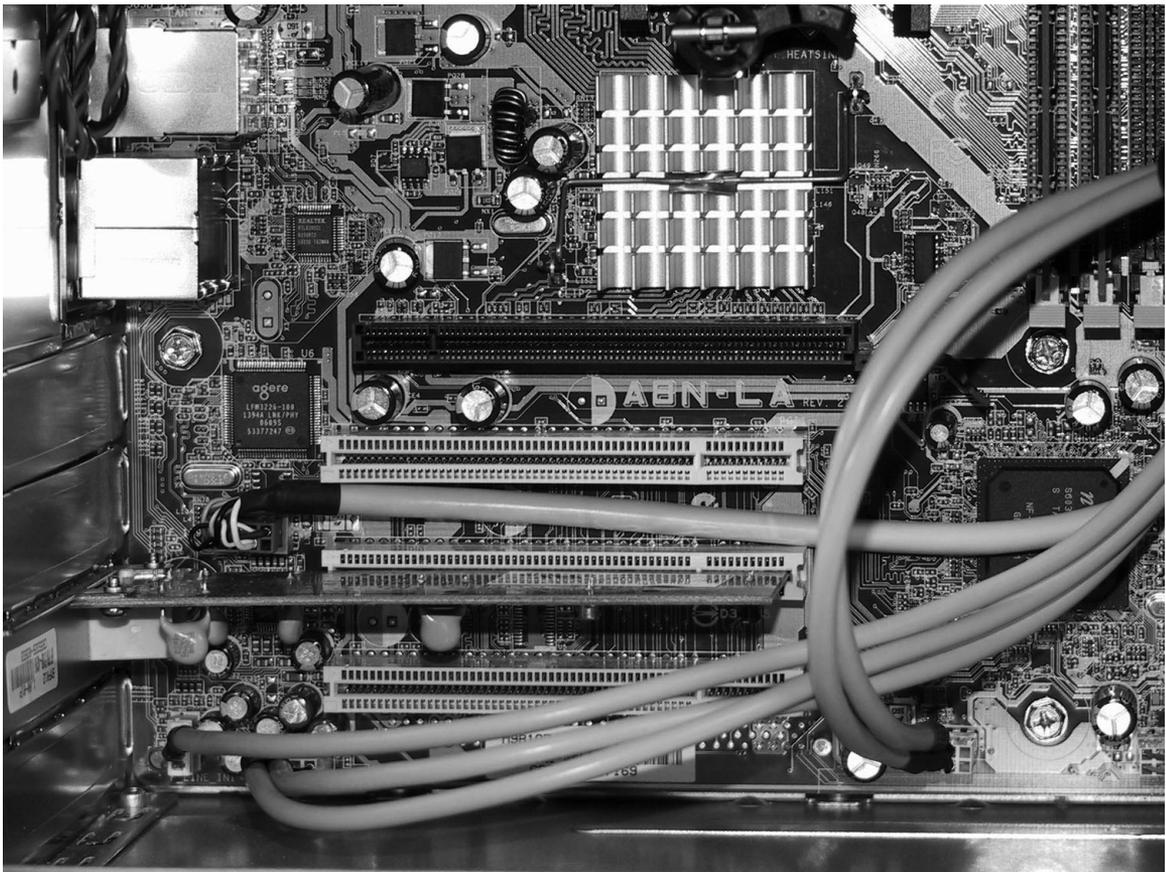
**PCIe** *Peripheral component interconnect express (PCIe)* differs from PCI in that it uses serial communications rather than parallel communications as well as different bus connectors. Also called *PCI Express* and *PCI-E*, it has, for the most part, replaced

PCI and is incompatible with PCI adapter cards. Although PCIe programming is similar to PCI, the newer standard is not a true bus that transfers data in parallel, but a group of serial channels. The PCIe connector's naming scheme describes the number of serial channels each handles, with the designations x1, x4, and x16 indicating one, four, and sixteen channels, respectively. On the motherboard, a PCIe x1 connector is approximately 1½" long, whereas PCIe x4 is about 2" long, and PCIe x16 is close to 4" long. Figure 1-3 shows a black PCIe x16 connector at the top, and three white PCI connectors below it on the motherboard.

The PCIe transfer rate depends on which version of the standard the bus installation supports. For instance, PCIe 1.0 supports data transfers at 250 MBps per channel,

**FIGURE 1-3**

Comparison of PCIe x16 (the dark slot) and the older, light-colored PCI bus connectors



with a maximum of 16 channels. Therefore, the maximum transfer rate for 16-channel PCIe 1.0 is 4 GB per second. PCIe 2.0, released in late 2007, adds a signaling mode that doubles the rate to 500 MBps per channel. At this writing, we are looking forward to the 2010 release of PCIe 3.0, expected to support a signaling mode of 1 GBps per channel.

## exam

### Watch

*For the A+ exams, you don't need to know the full specifications of standards, such as PCI and PCIe, but you should understand the basics of each standard. For instance, know that PCI and*

*PCIe are both expansion bus interfaces; remember that PCIe is the newer of the standards and is serial versus PCI, which was parallel. Be sure you can identify their physical differences on a motherboard.*

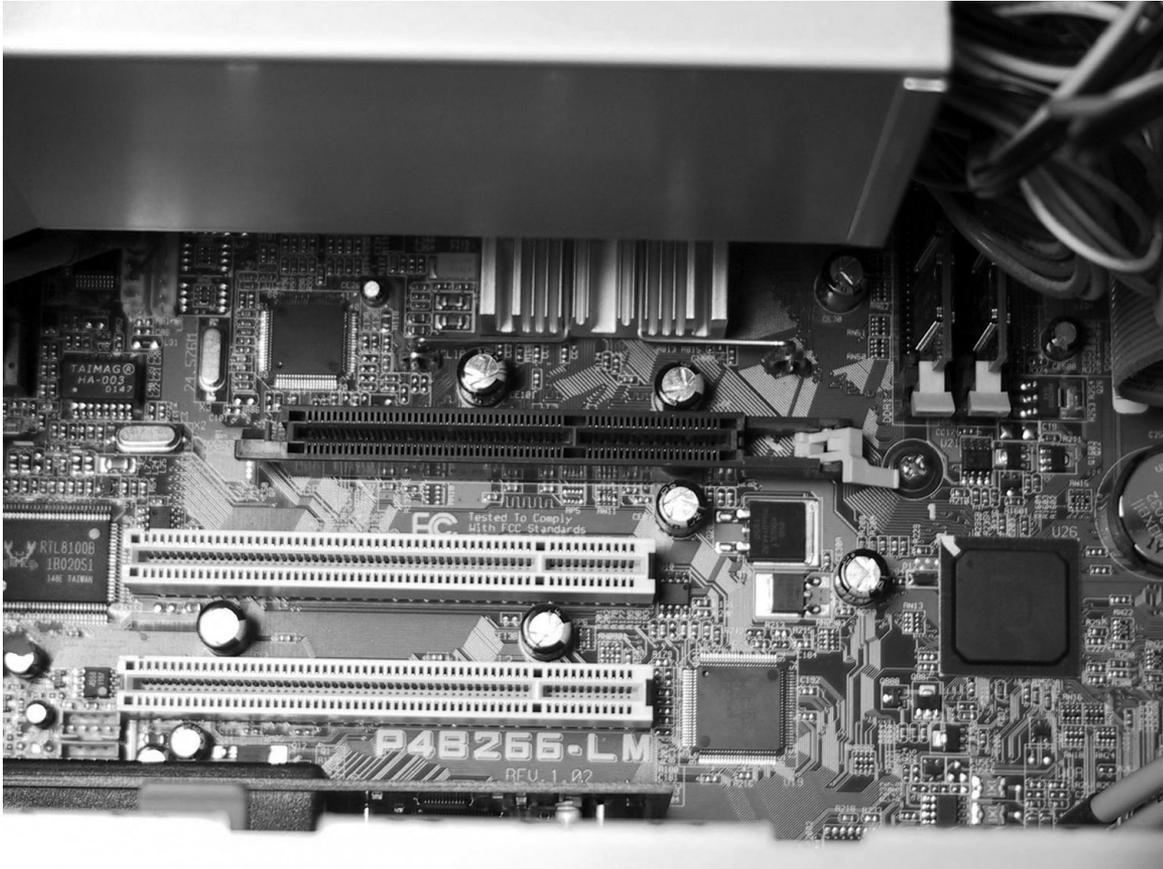
**AGP** *AGP (accelerated graphics port)* is a local bus designed for video only. Because this architecture provides a direct link between the processor and the video card, and gives the graphics adapter direct access to main memory, it is a “port” rather than a bus. It runs at the speed of the processor’s memory bus. AGP is available in 32-bit and 64-bit versions. Figure 1-4 shows a motherboard with a dark AGP connector above two white PCI connectors.

There is normally only one AGP slot on a motherboard, and it looks very similar to a PCI slot, but it is not compatible with PCI cards. To use AGP, the system’s chipset and motherboard must support it. The AGP architecture also includes an AGP controller, which is typically a small, green chip on the motherboard. AGP cards typically run four to eight times faster than PCI and are rated as 2X, 4X, or 8X. A 64-bit 8X AGP transfers data to the display at up to 2GB per second. Fast cards can run in slow AGP slots; however, they will only run at the speed of the AGP port. AGP Pro is a name given to various modified AGP cards with performance enhancements targeted to the very high-performance market. PCIe has, for the most part, replaced AGP.

## ATA Drive Interface Standards

The preceding I/O bus architectures are for attaching video and other expansion cards to the computer. Next, we will look at the types of connectors you will find on a motherboard for installing hard drives and optical drives. The standards for

**FIGURE I-4** An AGP connector (the dark one) above two white PCI connectors



the interface behind these connectors all are descendants of the original *Advanced Technology Attachment (ATA)* standard, developed nearly two decades ago. They include a parallel interface, PATA, and a newer serial interface, SATA. The drive and the interface must comply with the same ATA standard in order to benefit from the features of that version. In Chapter 2, we will discuss SCSI, another interface standard for drives and other devices, which is not usually built into the motherboard. We will clarify where the terms IDE and EIDE fit into this picture, define the PATA and SATA interfaces, and then look at other drive interface technologies that are part of the ATA standards.

**IDE and EIDE** Since the early years of PCs, the terms *Integrated Drive Electronics (IDE)* and, later, *Enhanced IDE (EIDE)* have been used to describe any drive that has the controller circuitry mounted on the drive itself—true of virtually every hard drive and optical drive. Strictly speaking, this is separate from the ATA interface that connects to one of these drives.

**PATA** The first ATA standards defined an interface in which the data signals travelled over a parallel bus. Originally simply called ATA (when it wasn't called IDE or EIDE), this interface is now called *Parallel ATA (PATA)* to distinguish it from the Serial ATA standard introduced in 2003. Versions of the ATA standards were named successively ATA-1, ATA-2, and so forth. Important milestones in the evolution of ATA include ATA-4, which added support for non-hard disks, such as optical drives, tape drives, and some special large-capacity floppy drives via a protocol that allows the ATA interface to carry commands from these devices. This protocol is known as the *ATA Packet Interface (ATAPI)*. In Figure 1-5, you will notice a large ribbon cable on the right. It is connected to (and partially obscuring) the connector labeled IDE 2. In this computer, this cable connects to a DVD drive using the ATAPI standard.

**FIGURE 1-5**

A connector labeled IDE 1 is the long, vertically oriented connector on the right (partially hidden by a ribbon cable), next to four SATA connectors.



When you open a PC and see wide ribbon cables, they usually connect EIDE drives to the PATA interface. Following one of these ribbon cables from a hard or optical drive to the motherboard leads to a connector labeled “EIDE controller 01” or “EIDE controller 02.” Never mind that EIDE is about the drives and PATA is about the interface for these drives. Even in the latest motherboard, you may see these connectors labeled “IDE 1” and “IDE 2,” as Figure 1-5 shows where the long PATA connector on the right, labeled “IDE 1,” sits next to four SATA drive interface connectors that replace PATA. We will discuss SATA shortly.

Technicians have long detested the wide ribbon cabling used for these connectors because it blocks airflow, and it can sometimes be difficult to get unwieldy ribbon connectors tucked into a case without crimping them when closing the case. Space-saving rounded cables are available, but we still see mostly ribbon cables. PATA cables cannot be more than 18 inches in length, and PATA does not support *hot swapping*—the ability to replace a drive without powering down, so to replace a drive you must shut down the computer. While EIDE drives may advertise transfer rates above 80 megabytes per second, in reality, the PATA interface limits the speed due to protocol overhead and because PATA shares the PCI bus with all other PCI devices.

### exam

#### watch

**Are you confused yet? The terms IDE, EIDE, ATA, and PATA are all used interchangeably. IDE and EIDE should refer to the drives, whereas ATA and PATA should refer to the interface. The CompTIA A+ Essentials (2009 Edition) Exam objective**

**701: 1.2 lists IDE and EIDE under PATA. Remember, PATA is the older, slower, parallel technology for interfaces for hard and optical drives. The newer, faster, serial technology is SATA.**

**SATA** The ATA-7 standards introduced *Serial ATA (SATA)*, a faster serial drive interface that has replaced PATA. Although some converters will allow older drives with PATA connectors to connect through this interface, today’s drives are manufactured especially for the SATA interface.

PCs now come with SATA connectors on the motherboard. To the end user, the speed of SATA devices is the most attractive feature, but for the technician, the main advantage of SATA is that it uses thinner cabling. SATA uses slender cables that can be up to 39.4 inches long. Because each SATA device has a direct connection to the SATA controller, it does not have to share a bus with other devices, and therefore it

provides greater throughput. Unlike PATA, SATA also supports hot swapping. Even the first two SATA standards, SATA 1.5 Gbps (150 MBps) and SATA 3 Gbps (300 MBps), far exceeded the PATA speeds. The SATA 3.0 standard, or SATA 6 Gbps, was released in May 2009.

**eSATA** *External Serial ATA* is an extension of the SATA standard for external SATA devices. Its speed (triple that of USB 2.0 and IEEE 1394) positions it to compete with these other external I/O standards. Internal eSATA connectors are included in some newer motherboards, in which case, cabling is required to connect them to an eSATA port on the PC case. Use eSATA adapter cards to add eSATA to motherboards without built-in support. Because it provides the full SATA speed to external devices, expect eSATA to replace FireWire and USB devices that run at much slower speeds.

**Miscellaneous ATA Technologies** Hard drive capacities have increased exponentially since the early PCs, and the various generations of the ATA standards were created to support the growing capacities, as well as the need for increased speeds in moving larger and larger amounts of data. Early on, when computer BIOSs limited drive capacities by defining the geometry of a drive in terms of the number of cylinders (tracks), read/write heads, and sectors (sections within a track), ATA provided a way around those limits using methods to hide the geometry of the drives from the BIOS. One method, called *sector translation*, required that the drive circuitry translate between the computer BIOSs logical view of the hard drive and the actual physical geometry. Both the BIOS and hard drive system must support an additional method, *logical block address (LBA)*, that allows for up to 8.3GB capacity. More recent ATA standards support the huge drives we have today.

In any PC, a hard drive is potentially a bottleneck because it depends on moving parts. Therefore, various schemes have been developed for speeding up the flow of data to and from a hard drive, as well as the actual writing and reading from the hard drive platters. Several methods for speeding up the movement of data between a hard drive system and memory come under the heading of *Ultra DMA (UDMA)*, which uses direct memory accessing (DMA). DMA is explained in Chapter 5. These methods were used with hard drive PATA interfaces and were referred to as *modes*. One of the last modes was Ultra DMA mode 5, introduced with ATA-6, which boosted the data transfer rate to 100 MBps, giving it the popular name of ATA/100. The last of the parallel ATA modes was Ultra DMA mode 6, known as ATA-7 or ATA/133 for the speed (133 MBps), and it was introduced at the same time as SATA, which supports speeds of 150 MBps or 300 MBps, depending on the type of SATA.

## SCENARIO & SOLUTION

What are the most common bus architectures in use today?	PCI and PCIe
What drive interface standard replaced PATA for hard drives?	SATA
What standard, also used by other expansion cards, is replacing AGP for video?	PCIe

### Chipset

A critical component of the motherboard is the *chipset*. When technicians talk about the chipset, they are usually referring to one or more chips designed to work hand in glove with the CPU. One part of this chipset, referred to as the *Northbridge*, controls communications between the CPU and system RAM on motherboards designed for Intel CPUs. In this case, the Northbridge may also be referred to as a *memory controller chip (MCC)*. The Northbridge supports communication between the CPU and the video card on motherboards designed for AMD CPUs that have a memory controller built in. Another portion of the chipset, the *Southbridge*, manages communications between the CPU and such I/O busses as USB, IDE, PS2, SATA, and others. Chipset manufacturers include Intel, AMD, VIA Technologies, and NVIDIA Corporation, among many others.

### Firmware

*Firmware* refers to software instructions, usually stored on ROM chips. Most PC components, such as video adapters, hard drives, network adapters, and printers contain firmware. Because these instructions must always be available, they are not reprogrammed every time the computer is started.

### BIOS

One type of computer firmware is the *basic input/output system (BIOS)*. The BIOS is responsible for informing the processor of the devices present and how to communicate with them. Whenever the processor makes a request of a component, the BIOS steps in and translates the request into instructions that the component can understand.

Older computers contained a true read-only BIOS that was not alterable. This meant that one could not add new types of components to the computer since

the BIOS would not know how to communicate with them. Because this seriously limited users' ability to install a new type of device not recognized by the older BIOS, *flash BIOS* was introduced. Now you can electronically upgrade (or flash) the BIOS so that it can recognize and communicate with a new device type.

Usually you can obtain the flash program from the Website of the motherboard manufacturer. The upgrade process typically requires you to copy the flash program to either a Windows program or a bootable device and follow the detailed instructions included in the download to flash the BIOS.

Further, modern motherboards include a great many more devices and capabilities than older motherboards—often more than can be adequately supported by BIOS-based programs. Therefore, when you purchase a motherboard, you will also have a driver disc. You will learn about installing and configuring motherboards and using the driver disc in Chapter 4. Companies such as Phoenix Technologies and AMI specialize in manufacturing BIOSs for PC manufacturers, and many PC and/or motherboard manufacturers make their own BIOSs.

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***It is very important that you follow the directions given by the manufacturer when performing a flash upgrade. If done incorrectly, the system can become inoperable and require a replacement BIOS chip from the manufacturer.***

## CMOS

Another important type of firmware is *complementary metal-oxide semiconductor* (CMOS). The CMOS chip retains settings such as the time, keyboard settings, and boot sequence. (We describe these settings in more detail in Chapter 4.) CMOS also stores interrupt request line (IRQ) and input/output (I/O) resources that the BIOS uses when communicating with the computer's devices. The CMOS chip is able to keep these settings in the absence of computer power because of a small battery, which usually lasts from two to ten years.

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***If the system repeatedly loses track of time when turned off, you probably need to replace the battery. This is usually a simple process, requiring opening the case and exchanging the old battery for a new one.***

You can view and modify the computer's BIOS settings by entering the computer's Setup program during bootup. When booting up the computer, watch the screen for instructions such as "Press CTRL-S to access Startup Configuration" or "Press DELETE to enter Setup." You will only have about three seconds to enter the appropriate

key combination from the time such a message first displays. You can configure the length of this delay in the CMOS settings, discussed in more detail in Chapter 4, where you will learn about a variety of system settings.

Chapter 4 also describes how to use BIOS-related settings for configuring special hard drive configurations of multiple hard drives called RAID sets. Many motherboard BIOSs support RAID levels 0, 1, and 5, which Chapter 5 will define and describe.

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***Interestingly, the term CMOS settings is a bit of a misnomer. When people talk about the computer's CMOS, or its settings, they are usually referring to the things just described, but CMOS is really simply a type of physical chip. CMOS chips do a variety of things other than retaining BIOS settings. In fact, many processors are actually CMOS chips.***

## **BIOS and CMOS Roles in the Boot Process**

When the computer is started (booted up), the BIOS runs a *power-on self-test* (POST). During the POST, the BIOS checks for the presence and function of each component it is programmed to manage. It first checks the processor, then the RAM, and then system-critical devices such as the floppy drive (if present), hard drive, keyboard, and monitor. It then tests noncritical components such as CD-ROM drives and the sound card.

Next, the BIOS retrieves the resource settings from the CMOS and assigns them to the appropriate devices. Then, it processes the remaining BIOS settings, such as the time or keyboard status (for example, whether the keyboard number lock should be on or off). Finally, it searches for an operating system and hands control of the system over to it. The BIOS settings are no longer required at this point, but the BIOS continues to work, translating communications between the processor and other components.

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***The BIOS contains basic 16-bit drivers for accessing the needed hardware during bootup, such as the keyboard, floppy disk, hard disk, or any other device needed. Drivers loaded with the operating system (32-bit or 64-bit) give access to more advanced features of the basic components, as well as additional components.***

**EXERCISE 1-1****Viewing System Settings in CMOS**

1. Restart your computer, and remain at the keyboard.
2. As the computer starts up, watch for a screen message telling you to press a specific key or key combination in order to enter Setup.
3. Press the key or key combination indicated.
4. Spend time viewing the settings, but *do not* make any changes.
5. When you have finished, use the indicated key combination to exit without saving any changes.

**CERTIFICATION OBJECTIVE**

- **701: 1.4** *Explain the purpose and characteristics of CPUs and their features*

The CompTIA A+ Essentials (2009 Edition) Exam objective 701: 1.4 includes the following subobjectives: Identify CPU types, hyper threading, multi core, on-chip cache, speed, and 32-bit vs. 64-bit. It does not require that you memorize the hundreds, or perhaps thousands, of CPU models you will encounter on the job.

**Processor/CPU**

A personal computer is more than the sum of its parts. However, the most important part, without which it is not a computer, or even a useful tool, is the *central processing unit (CPU)*, also called the *processor*. But a CPU may not be the only processor in a PC. Other components may include a processor for performing the intense work of the component. The most common example of this is the *graphics processing unit (GPU)* found on modern video adapters, used to render the graphics images for the display. This saves the CPU for other system-wide functions and improves system performance. The following is an overview of CPUs, their purposes and characteristics, manufacturers and models, and technologies. You can apply it to both GPUs and CPUs.

## Purposes and Characteristics

In a PC, the central processing unit (CPU) is the primary control device for the entire computer system. The CPU is simply a chip containing a set of components that manages all the activities and does much of the “heavy lifting” in a computer system. The CPU interfaces, or is connected, to all of the components such as memory, storage, and input/output (I/O) through busses. The CPU performs a number of individual or discrete functions that must work in harmony in order for the system to function.

Additionally, the CPU is responsible for managing the activities of the entire system. The CPU takes direction from internal commands stored within the CPU, as well as external commands that come from the operating system and other programs. Figure 1-6 shows a very simplified view of the functions internal to the CPU. It is important to note that these functions occur in all CPUs regardless of manufacturer.

## CPU Technologies

There are a number of technologies employed in a CPU, based on both standards and proprietary designs, which are constantly changing. The following describes common CPU technologies.

### Control Unit

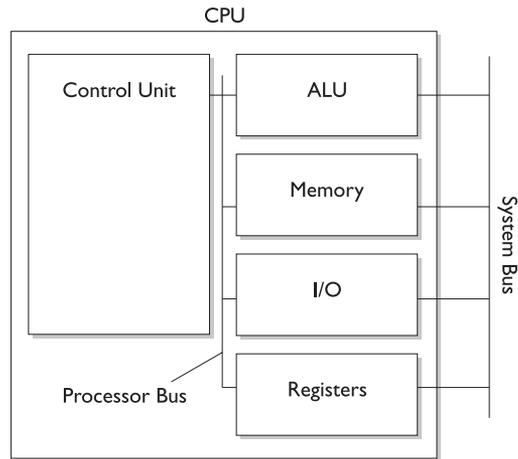
The *control unit* shown in Figure 1-6 is primarily responsible for directing all the activities of the computer. It also manages interactions between the other components in the computer system. In addition, the control unit contains both hardwired instructions and programmed instructions called microcode. See the explanation later in this chapter on microcode.

### Busses

Notice in Figure 1-6 that there are several pathways among components in the CPU. These are busses, used for special purposes such as moving data from internal memory to the control unit. The *internal bus* of the CPU is usually much faster than the external busses. Other busses connect the CPU to the external devices. The *front side bus* connects the processor to system memory and the video adapter. These busses do not usually connect directly to external busses, such as PCI, except through a device called a *controller*.

**FIGURE 1-6**

Simple functional diagram of a CPU



Although certain Intel CPU models have long contained a 36-bit front side or address bus, computer manufacturers generally did not use the additional wires in the address bus to address memory. Therefore, many computers that included these processors supported only 32-bit addressing and could use only up to 4GB of system RAM memory. As the need for more memory grew, so did the address bus. Some implementations used the 36-bit address bus, allowing up to 64GB of addressable memory, and a processor with a 64-bit address bus will address up to one terabyte (1TB) of memory. This also depends on motherboard support, as well as an operating system and application programs that can handle the 64-bit processing. Learn about 32-bit and 64-bit operating systems in Chapter 8.

## ALU

The *arithmetic logic unit (ALU)* is responsible for all logical and mathematical operations in the system. The ALU receives instructions from the control unit. The ALU can take information from memory, perform computations and comparisons, and then store the results in memory locations as directed by the control unit. An additional type of ALU, called a *floating-point unit (FPU)* or *math coprocessor*, is frequently used to perform specialized functions such as division and large decimal number operations. Most modern microprocessors include an FPU processor as part of the microprocessor. This includes both those used as the central processor on PC motherboards, and the GPUs used on modern video adapters.

## Registers

The ALU and control unit communicate with each other and perform operations in memory locations called *registers*. A register is a location, internal to the microprocessor, used as a scratch pad for calculations. There are two types of registers used in modern systems: dedicated registers and general-purpose registers. Dedicated registers are usually for specific functions such as maintaining status or system-controlled counting operations. General-purpose registers are for multiple purposes, typically when mathematical and comparison operations occur.

## Memory

Computer memory provides the primary storage for a computer system. The CPU will typically have internal memory (embedded in the CPU) used for operations, and external memory, which is located on the motherboard. The important consideration about memory is that the control unit is responsible for controlling usage of all memory. You will find a more detailed discussion about memory in Chapter 2.

## Cache

Cache memory in a computer is usually a relatively small amount of expensive, very fast memory used to compensate for speed differences between two components. The cache memory you hear about the most is between the CPU and the main memory. A CPU moves data to and from memory faster than the system RAM can respond. You might think that the solution is to install fast RAM as system RAM, but this would make a PC too expensive. Therefore, main system memory is most often a type of RAM known as DRAM, and cache memory is the faster and more expensive SRAM. Only a relatively small amount of memory is required for cache as compared to system memory. You will learn more about these types of RAM in Chapter 2.

Cache memory runs faster than typical RAM, and the small programs in a component called the *cache controller* have the intelligence to “guess” which instructions the processor is likely to need and retrieve those instructions from RAM or the hard drive in advance. Cache memory can also hold preprocessed data, such as out-of-order processing or data used by a game or an applications program. Typical applications may require frequent processing of the same instructions. For example, a game may have repeatedly called video instructions processed by the video adapter’s GPU. Newer processors can even create a “decision tree” of possible future instructions and store these in the cache, allowing rapid access to information or instructions by the CPU. Even when generating the tree, some instructions are preprocessed and stored in case the specific branch of logic is followed, and those instructions do not have to be reprocessed again. Intel has this down to an art, and the processors are generally correct in the tree they create.

**exam****Watch**

***It is important to remember the locations and general purpose of cache memory, especially L1 and L2, for the exam. In general, you will not be asked the sizes, though the concepts of large and small amounts of memory are important.***

*Internal cache memory*, more commonly called *L1 cache* or *Level 1 cache*, resides within the processor itself. This is one example of “on-chip cache” referenced in the CompTIA A+ Essentials (2009 Edition) Exam objective 701: 1.4. *External cache memory*, called *L2 cache* or *Level 2 cache*, resides external to a CPU’s core. At one time, external cache memory was only on the motherboard, but today’s processors usually have L2 cache installed on the same chip as the processor, but electronically separated

from the inner workings of the process. This is another example of “on-chip cache.” Beginning with the Itanium CPU, Intel offered a new level of external cache memory residing on the motherboard called *L3 cache* (*Level 3 cache*). It measures in megabytes, whereas L1 and L2 cache most often measure in kilobytes. The use of cache memory with CPUs has greatly increased system performance.

## Hyper Threading

A *thread*, or thread of execution, is a portion of a program that can run separately from other portions of the program. A thread can also run concurrently with other threads. *Hyper threading*, also known as *simultaneous multithreading* (SMT), is a CPU technology that allows two threads to execute at the same time within a single execution core. This is considered partially parallel execution. Intel introduced hyper threading in the Pentium 4 Xeon CPU, referring to it as Hyper-Threading Technology (HT Technology).

## Multi-core CPUs

The most visible change in CPUs in recent years has been the introduction of CPUs with more than one core on the same chip. The first of these were *dual-core* CPUs containing two CPU cores. Quad-core CPUs are commonly available, and manufacturers offer six-core, and more. At least one manufacturer has announced a 64-core CPU.

What is the attraction of these multi-core CPUs? Server computers have long been available with multiple CPUs, so why not simply install two or more single-core CPUs on the same motherboard? The answer to both questions is that two cores on the same chip can communicate and cooperate much faster than two single-core processors. A dual-core CPU can simultaneously process two threads in

true parallel execution, and each core has its own L1 cache; triple-core CPUs can simultaneously process three threads, and so on.

### CPU Clock Speed

The *clock speed* of a CPU is the speed at which it can potentially execute instructions. Older CPUs measured this in millions of cycles per second, or megahertz (MHz); more recent CPUs have become so fast that they are measured in billions of cycles per second, or gigahertz (GHz). A CPU of a certain type and model may be available in a range of clock speeds. All other features being equal, the CPU with the faster clock speed will be more expensive.

## exam

### Watch

**The CompTIA A+ Essentials (2009 Edition) Exam objective 701: 1.42 lists “Speed (real vs. actual)” as a subobjective. Since “real” and “actual” are synonyms, it is difficult to determine the distinction between them.**

However, when comparing different models of CPUs, the faster clock speed alone will not determine the fastest CPU. Manufacturers use many technologies to speed up CPUs. For example, the number of clock cycles required for completing the same operation can vary among CPU models. To the end user, the perceived speed of a PC, or lack of it, may involve other aspects of the computer’s total design, such as the cache size, the amount and speed of the RAM, the speed of the busses, and the speed of the hard

drive. Some experts give the “actual” speed of a CPU as the speed determined by the manufacturer through testing each CPU. This speed then becomes part of the rating for that CPU. There are software tools for measuring the speed of the CPU while performing certain operations. This could be considered the “real” speed.

### Overclocking

*Overclocking* is the practice of forcing a CPU or other computer component to run at a higher clock rate than the manufacturer intended. PC hobbyists and gamers often overclock their systems to get more performance out of CPUs, video cards, chipsets, and RAM. The downside to this practice is that overclocking produces more heat and can cause damage to the motherboard, CPU, and other chips, which may explode and/or burst into flames.

### Microcode

*Microcode* (also called a *microprogram*) is one of many low-level instructions built into the CPU’s control unit. An example of an instruction might be the command

to fetch information from memory. People often call microcode “hardwired” because you cannot change it.

## **VRM**

A *voltage regulator module*, or VRM, is a chip or tiny circuit card used to condition the power to the CPU and reduce it from the 5 volts of the motherboard to the lower voltage (3.3 volts or less) of the CPU. Modern CPUs in PCs inform the motherboard of the voltage they require and, therefore, may not require a VRM.

## **Manufacturers and Models**

There are many CPU manufacturers, but the prevailing ones in the personal computer market today are *Intel Corporation* and *Advanced Micro Devices, Inc. (AMD)*. Intel received a huge boost when IBM selected their 8088 processor for the original IBM-PC in 1981. For over a decade, AMD produced “clones” of Intel CPUs under a licensing agreement granted to them at a time when Intel’s manufacturing capacity could not keep up with the demand for CPUs. Since 1995, AMD has designed and produced their own CPUs. Both companies manufacture more than CPUs, but their competition in the CPU market gets more attention in the trade and business press since AMD emerged as Intel’s major competitor. The following discussion includes a sampling of CPU models from both manufacturers and avoids mention of CPU models designed specifically for the laptop market. Learn about those CPUs in Chapter 6.

### **Intel**

Over time, Intel Corporation has released a number of CPU models ranging from the Intel 8086 in 1978 to the latest generation of processors, which come with a variety of model names. Some of these model names carry on the Intel Pentium, Celeron, Xeon, Itanium, and Atom brands. Intel recently changed their branding. Previously, in addition to their CPU brands, they also promoted groups of chips under brand names. For instance, the Centrino brand formerly identified a platform of multiple chips, including the CPU, chipset, and wireless network chips, sold together for use in laptops. With the recent changes, the Centrino brand will only apply to Intel’s wireless network chips. As for CPU branding, the word “Core” is now used in the flagship brand, and Intel is moving away from such terms as “Solo,” “Core 2 Duo,” and “Core 2 Quad.” The newer identifiers for the Core brands are Core i3, Core i5, and Core i7. Further, the old brand names (Pentium, Celeron, and Atom) will be assigned to lower performance CPUs. Of course, all this is subject to change.

What is important for a tech to understand is that each of the CPU brands includes many—even dozens—of individual models, and the various models are categorized by the purposes for which they were designed, such as desktop, server, workstation, notebooks, and Internet devices. Additionally, an entire category of CPUs are designed for the embedded and communication devices markets.

## exam

### Watch

*Any computer professional should understand the differences among the CPU models. However, the CompTIA A+ Essentials (2009 Edition) Exam 701, as well as CompTIA Practical Application*

*(2009 Edition) Exam 702 covered by this Study Guide, do not include specific CPU models or the manufacturers, only the CPU technologies.*

## AMD

Advanced Micro Devices, Inc. (AMD), is Intel's greatest competitor in the CPU arena. They manufacture a large variety of products based on integrated circuits. Like Intel, they categorize their CPUs by the purposes for which they were designed, such as desktop, server, workstation, notebooks, and embedded devices. They also stay competitive with Intel by offering each brand in a variety of multi-core configurations. The AMD Opteron CPU brand is targeted for use in servers, whereas the FireStream brand is intended for use in graphics workstations. The Turion, Athlon, and Sempron brands are found on CPU models designed for laptops, and other Athlon and Sempron CPU models are targeted to desktop computers. As with Intel, this is all subject to change, but look for more simplification in the product lines from both manufacturers, even as they continue to bring out dozens of CPU models each year.

## EXERCISE 1-2

### Identifying Your Processor



1. Right-click the My Computer/Computer icon.
  2. Select Properties.
  3. Read the information in the General tab to determine your processor type.
-

## SCENARIO & SOLUTION

Briefly describe hyper threading.	Hyper threading is a CPU technology that allows two threads to execute at the same time within a single execution core.
Define CPU-based microcode.	Microcode is one of many low-level instructions built into the CPU's control unit. An example of an instruction might be the command to fetch information from memory.
Which companies are the two major manufacturers of CPUs?	The two major manufacturers of CPUs are Intel Corporation and Advanced Micro Devices, Inc., better known as AMD.

## The PC Case

The typical PC user only knows his or her computer by its most visible components—the display (also called the *monitor*), the keyboard, the mouse, and the box that houses the main system, called the *case*. When purchased separately, a typical PC case includes the power supply, cooling system, a slot behind each expansion card position, slot covers over the expansion slots, available external I/O port connectors, and a selection of cables. Figure 1-7 shows the back view of a PC case.

**FIGURE 1-7**

A PC case from the back showing a panel of ports and expansion slots





**Computer case knowledge is not included in the CompTIA A+ 2009 exam objectives for the 220-701 and 220-702 exams. It is included in this book as useful on-the-job information.**

Just as you should not judge a book by its cover, you should not judge a computer by its case. A simple case may hide a very powerful computer, and a well-designed case, built with heavier than usual materials, insulation, and quieter fans, can provide noise reduction, a valuable feature to many of us. Within the computer gaming community, creating highly personalized cases, a practice called case *modding* (modifying), is very popular. These cases may have internal lighting, colorful cable covers, and transparent sides. The components in them may even be liquid cooled. We won't go into these fancy variants because the A+ exams won't test you on case modding. There are many computer case manufacturers.

## Purpose and Features

The purpose of a PC case is to hold all the basic components, to protect those components from dust and dirt, to cool the components, and to provide noise reduction. This last is not a high priority with most common cases, but cases are available that provide noise dampening using heavier materials, insulation, quieter power supplies, and quieter cooling fans.

A case typically comes with a power supply, cable management systems, and mounting locations for the motherboard, drives, and other internal components. A case will also provide connectors on the outside for USB, IEEE 1394, and multimedia ports. (Learn more about the standards for USB and IEEE 1394 in Chapter 3.) A high-quality case comes with premium features such as a large capacity, quiet power supply; easy-to-remove exterior body panels; and easy-to-use hard drive bays with features such as shock absorption. Similarly, better models will have features that make the job of installing a motherboard easier, such as a removable tray to hold it.

## Case Form Factors

PC cases come in form factors to match motherboard form factors, such as ATX, microATX, microBTX, and NLX. A case form factor must take into consideration the location of the motherboard-based components so you can access them. For instance, the case needs to have exterior openings for the adapter cards and port connectors that are built into the motherboard. It must also position drive bays so they will not

interfere with any motherboard components. A case also accommodates the standard power supply formats, described in Chapter 3. A case, motherboard, and power supply must be matched, or the motherboard and power supply may not even fit in the case.

## Case Categories

Most PC cases fall into one of two categories: tower and desktop. A tower is designed to stand on a desk or floor with its largest dimension oriented vertically. A desktop case is designed to sit on a desk with its largest dimension oriented horizontally. In a tower, the motherboard is normally mounted vertically, and in a desktop, the motherboard is mounted horizontally.

## Case Sizes

Case sizes are not standardized, nor are the names manufacturers give the various sizes. Quality and features vary, so bigger is not always better. When quality is comparable, then, as size and features expand, so will the prices for PC cases. Common names used to describe case sizes include (from largest to smallest) full-tower, mid-tower, mini-tower, desktop, and low-profile. Mini-tower is the case size of most brand-name PCs.

## CERTIFICATION SUMMARY

Common computer components include the processor, memory, storage devices, and input and output devices. All of these devices have specific functions, and your familiarity with them will help you to determine when to upgrade or replace a component.

This chapter described general characteristics of motherboards, installed motherboard components and form factors, and CPU technologies. You must use a motherboard that supports the selected CPU and RAM. Motherboards have many integrated functions. This chapter introduced many of the technologies on which you may be tested on the A+ exams. A good knowledge of these concepts is also important when you are repairing or upgrading a computer system. Chapters 2 and 3 will continue with an explanation of other important PC components.



## TWO-MINUTE DRILL

Here are some of the key points covered in Chapter 1.

### Motherboards

- ❑ All components, including external peripherals, connect directly or indirectly to the motherboard.
- ❑ A motherboard form factor defines the type and location of the components on the motherboard, the power supply that will work with that motherboard, and the PC case the components will fit into.
- ❑ A motherboard will use only certain CPUs and types of memory, based on the CPU and memory sockets installed on the motherboard.
- ❑ NLX is a very old form factor that became obsolete very quickly.
- ❑ ATX remains the standard for motherboards, in spite of the introduction of the BTX standard in 2003 by Intel Corporation. The few manufacturers that supported BTX no longer do so.
- ❑ Both the ATX and BTX form factors come in a variety of sizes, including the standard ATX (12" × 9.6") and BTX (12.8" × 10.5"), the smaller MicroATX (9.6" × 9.6"), MicroBTX (up to 10.4" × 10.5"), and smallest FlexATX (9" × 7.5") and PicoBTX (8.0" × 10.5").
- ❑ Motherboard components include sockets for various PC components, including the CPU and memory; built-in components such as video and sound adapters; hard drive controllers (PATA and SATA); support for various port types; and the chipset.
- ❑ Memory sockets can include DIMM or RIMM on motherboards for desktop systems, and SODIMM or SORIMM on laptop motherboards.
- ❑ Every motherboard contains at least one CPU socket, and the location varies, based on the form factor.
- ❑ A motherboard may have sockets for external cache memory used by the CPU.
- ❑ The most common types of bus architectures are PCI (now obsolete), PCIe, and AGP.
- ❑ PCI, PCIe, and AGP bus architectures are “local” because they connect more directly with the processor.

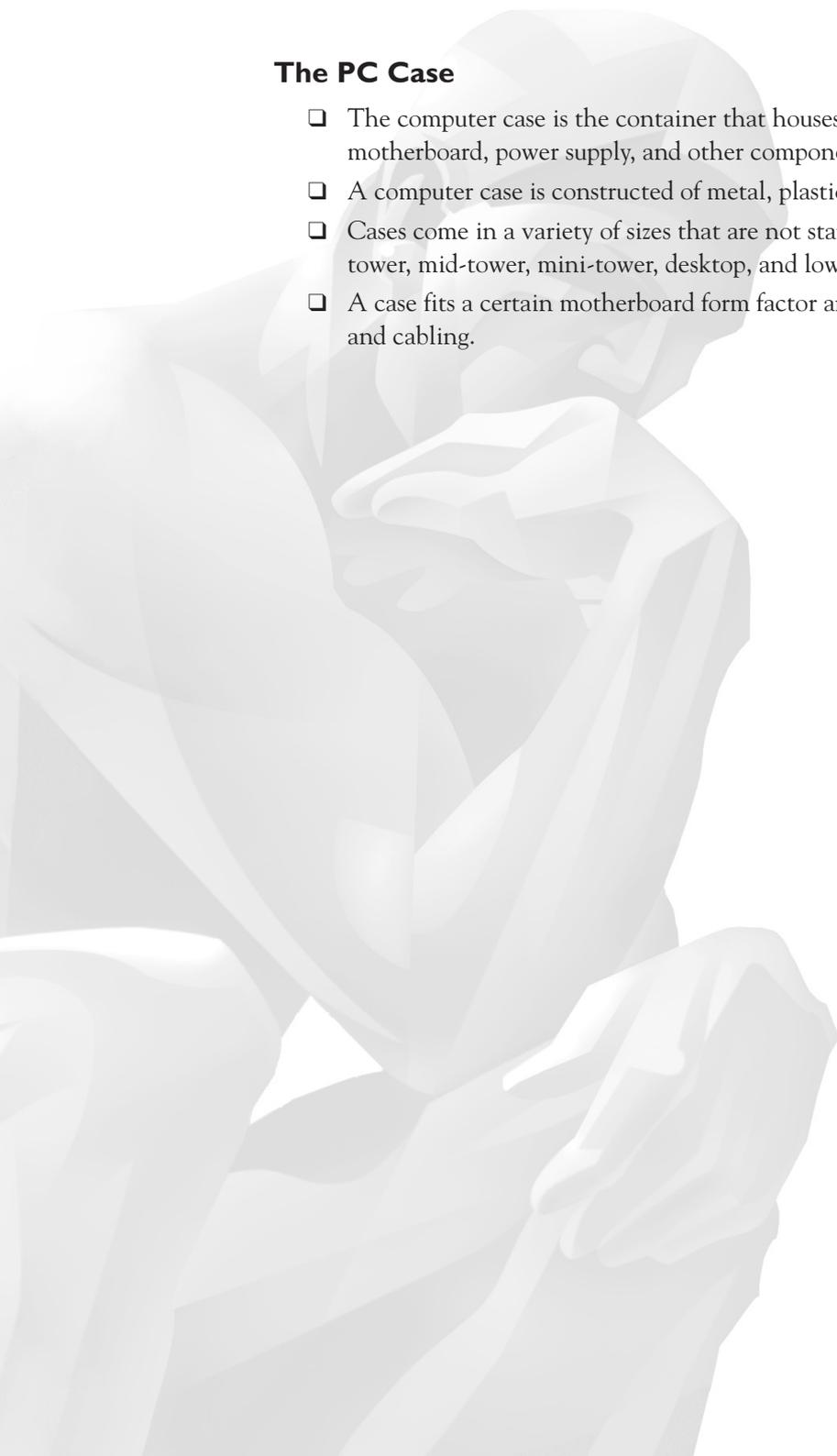
- ❑ The long-reigning drive interface standards based on the EIDE/PATA technology gave way to SATA interface for internal mass storage and eSATA for external devices.
- ❑ The chipset is now one to three separate chips on the motherboard that handle very low-level functions relating to the interactions between the CPU and other components.
- ❑ The basic input/output system, or BIOS, is firmware that informs the processor of the hardware that is present and contains low-level software routines for communicating with and controlling the hardware.
- ❑ The CMOS chip is non-volatile RAM, supported by a battery. CMOS stores basic hardware configuration settings (BIOS settings), such as those for drives, keyboards, boot sequence, and resources used by a particular component.

### **Processor/CPU**

- ❑ The CPU chip is the primary control device for a PC. A GPU is a processor on a video adapter, dedicated to the rendering of display images.
- ❑ The CPU connects to all of the components, such as memory, storage, and input/output through communications channels called busses.
- ❑ CPU (and GPU) components include the control unit, busses, the arithmetic logic unit (ALU), memory, controllers, and cache memory.
- ❑ Hyper threading is a technology that allows a CPU to execute two threads at the same time.
- ❑ A multi-core processor contains two or more processing cores and can process multiple threads simultaneously, performing true parallel execution.
- ❑ Intel Corporation and AMD (Advanced Micro Devices, Inc.) are the two top manufacturers of PC CPUs.
- ❑ Intel has many models under a variety of brand names, such as Pentium, Celeron, Xeon, Itanium, Atom, Centrino, and Core. This last is the latest brand of the newest technology, whereas the older brand names identify lower-end products.
- ❑ AMD CPU lines include the old K5 and K6 lines, followed by the Athlon, Opteron, Turion, Sempron, Duron, and FireStream.

### **The PC Case**

- ❑ The computer case is the container that houses and protects the PC motherboard, power supply, and other components.
- ❑ A computer case is constructed of metal, plastic, and even acrylic.
- ❑ Cases come in a variety of sizes that are not standardized. They include full-tower, mid-tower, mini-tower, desktop, and low-profile.
- ❑ A case fits a certain motherboard form factor and comes with a power supply and cabling.



## SELF TEST

The following questions will help you measure your understanding of the material presented in this chapter. Read all of the choices carefully because there might be more than one correct answer. Choose all correct answers for each question.

### Motherboards

- Which of the following statements is true?
  - The motherboard must always be in a horizontal position.
  - Each internal and external PC component connects to the motherboard, directly or indirectly.
  - The “lines” on the motherboard provide cooling.
  - A system board is an unusual motherboard variant.
- Which of the following describes a motherboard form factor?
  - The size and color of a motherboard
  - The processor the motherboard supports
  - The type and location of components and the power supply that will work with the motherboard, plus the dimensions of the motherboard
  - Mid-tower
- The variants of which motherboard form factor continue to be widely used, in spite of a newer standard from Intel that manufacturers rejected?
  - AT
  - NLX
  - BTX
  - ATX
- How many memory slots does a typical motherboard have?
  - Four to six
  - Three to eight
  - One to six
  - None

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5. Which statement defines Northbridge?
  - A. A chipset component that controls communications between the CPU, the PCI AGP, and PCIe busses, and RAM
  - B. A chipset component that controls communications between the CPU and I/O busses
  - C. A component that saves configuration settings
  - D. The system setup program itself
6. Which statement most accurately describes the relationship between the computer's BIOS and CMOS?
  - A. The CMOS uses information stored in the BIOS to set computer configurations, such as the boot sequence, keyboard status, and hard drive settings.
  - B. The BIOS configuration settings are stored on the battery-supported CMOS chip so they are not lost when you turn off the computer.
  - C. The CMOS uses information stored in the BIOS to communicate with the computer's components.
  - D. They perform the same functions, but the BIOS is found only in newer computers.
7. Which of the following describes a difference between PCI and PCIe?
  - A. PCIe is only used for graphics adapters; PCI is used by a variety of adapters.
  - B. PCI uses parallel data communications; PCIe uses serial communications.
  - C. PCIe uses parallel data communications; PCI uses serial communications.
  - D. PCIe is used by a variety of adapters; PCI is only used by video adapters.
8. This type of bus connector is only used by video adapters, and it is being phased out in favor of PCIe.
  - A. PCI
  - B. NIC
  - C. AGP
  - D. USB

### Processor/CPU

9. Which of the following most accurately describes a function of the CPU's cache memory?
  - A. To store instructions used by currently running applications
  - B. To provide temporary storage of data that is required to complete a task
  - C. To anticipate the CPU's data requests and make that data available for fast retrieval
  - D. To store a device's most basic operating instructions

10. Where would you find a GPU in a PC?
  - A. On the motherboard in place of the CPU
  - B. On the SATA controller
  - C. On the video adapter
  - D. In the chipset
11. What component in a CPU is responsible for all logical and mathematical operations?
  - A. ALU
  - B. Processor
  - C. Control unit
  - D. Bus
12. What CPU component contains microcode?
  - A. ALU
  - B. Processor
  - C. Control unit
  - D. Bus
13. What type of memory is very fast and too expensive to use as system RAM, but is used as cache memory?
  - A. DIMM
  - B. RIMM
  - C. DRAM
  - D. SRAM
14. What is the external data bus width of all Pentium-class processors?
  - A. 32-bit.
  - B. 36-bit.
  - C. 64-bit.
  - D. Each Pentium processor has a different data bus width.
15. Which Intel CPU initiated the fifth generation and began an entire dynasty of Intel processors?
  - A. Athlon
  - B. Opteron
  - C. Pentium
  - D. Celeron

- 16.** The Intel CPU technology that allows two threads to execute at the same time within a single execution core is
- A. Hyper threading
  - B. Throttling
  - C. Overclocking
  - D. Microcode

### **The PC Case**

- 17.** What is the purpose of a PC case?
- A. To block all air flow to the motherboard
  - B. To house the monitor and keyboard
  - C. To hold, protect, and cool the basic PC components
  - D. To process data
- 18.** Which of the following features varies among cases and depends on heavier materials, insulation, and quieter fans?
- A. IEEE 1394
  - B. Easy-to-remove exterior body panels
  - C. Easy-to-use hard drive bays
  - D. Noise reduction
- 19.** Which statement is true?
- A. A case, motherboard, and power supply must match, or the motherboard or power supply will not fit in the case.
  - B. Any power supply will fit into any case.
  - C. Any motherboard will fit into any case.
  - D. The position of drive bays is not a consideration because the motherboard is flat.
- 20.** Which is the case size of most brand-name PCs?
- A. Full-tower
  - B. Mid-tower
  - C. Mini-tower
  - D. Low-profile

## SELF TEST ANSWERS

### Motherboards

- B.** Each internal and external PC component connects to the motherboard, directly or indirectly. This statement is true.

**A** is not true because the motherboard can be oriented in whatever position the case requires. **C** is not true because the lines on the motherboard do not provide cooling but carry signals and are part of various busses installed on the motherboard. **D** is not true; system board is simply another name for motherboard.
- C.** A motherboard form factor is the type and location of components and the power supply that will work with the motherboard, plus the dimensions of the motherboard. This statement is true.

**A** is not correct because, while size may be part of a form factor, color has nothing to do with the form factor. **B** is incorrect because the processor the motherboard supports is not, by itself, a description of a form factor. **D** is incorrect because mid-tower is a case size, not a motherboard form factor.
- D.** ATX. This form factor has had a long run with motherboard manufacturers, even after the introduction of the BTX form factor.

**A** is incorrect because AT is a very old form factor that had too many problems with cooling and the location of components interfering with drive bays. **B**, NLX, is incorrect for the same reasons as AT. **C**, BTX, is incorrect because it is the newest form factor discussed in this chapter, but it has not yet truly replaced the ATX form factor.
- C.** One to six. This is the range of memory slots in a typical motherboard.

**A**, **B**, and **D** are all incorrect because they do not give the correct range of memory slots found on a typical motherboard.
- A.** A chipset component that controls communications among the CPU, the PCI AGP, and PCIe busses, and RAM is the correct answer.

**B** is incorrect because it describes the Southbridge (a chipset component that controls communications between the CPU and I/O busses). **C** is incorrect because it describes CMOS memory. **D**, the system setup program itself, is incorrect because this program is found in the system BIOS.
- B.** The BIOS configuration settings are stored on the battery-supported CMOS chip so they are not lost when you turn the computer off—this is the correct answer.

**A** is incorrect because it is the CMOS, not the BIOS, that stores computer configurations. **C**, that CMOS uses information stored in the BIOS to communicate with the computer's components, is incorrect because this is the opposite of the actual relationship between the BIOS and CMOS. **D** is incorrect. The CMOS and BIOS do not perform the same functions, and both are found in all PCs, old and new.

7.  **B**. PCI uses parallel data communications; PCIe uses serial communications.  
 **A** and **D** are both incorrect because both PCIe and PCI are used by a variety of expansion cards. **C** is incorrect because the very opposite is true. PCIe uses serial data communications, and PCI uses parallel data communications.
8.  **C**. AGP is correct because this video-only bus connector is being replaced by PCIe.  
 **A** is incorrect because, although PCI is also being phased out and replaced by PCIe, it is not only for video adapters. **B**, NIC, is incorrect because this stands for a type of expansion card, a network interface card, not a bus connector. **D**, USB, is incorrect because this is a peripheral bus, not a bus connector on the motherboard in which an expansion card is installed.

## Processor/CPU

9.  **C**. A function of a CPU's cache is to anticipate the processor's data requests and make that data available for fast retrieval.  
 **A**, to store instructions used by currently running applications, and **B**, to provide temporary storage of data that is required to complete a task, are incorrect because these are both functions of RAM memory. **D**, to store a device's most basic operating instructions, is incorrect because this is a function of a device's ROM memory.
10.  **C**. The GPU is located on the video adapter.  
 **A** is incorrect because the GPU does not replace the PC's CPU. **B** is incorrect because the GPU has the processing necessary to produce graphics, not for the SATA controller. **D** is incorrect because a GPU is not part of the motherboard chipset.
11.  **A**. The ALU is the CPU component that is responsible for all logical and mathematical operations.  
 **B**, processor, is incorrect because this is just a synonym for CPU. **C**, control unit is incorrect because this is the component responsible for directing activities in the computer and managing interactions between the other components and the CPU. **D**, bus, is incorrect because a bus is just a pathway among components in the CPU.
12.  **C**. The control unit is correct because it contains microcode.  
 **A**, ALU, is incorrect because it does not contain microcode but receives instructions from the control unit. **B**, processor, is incorrect because this is just another name for CPU. **D**, bus, is incorrect because this is just a group of wires used to carry signals.
13.  **D**. SRAM is correct. Static RAM is fast and expensive. It is used as cache memory because relatively small amounts are required.  
 **A**, DIMM, and **B**, RIMM, are both incorrect because they are each a type of slot and a type of packaging for sticks of DRAM. **C**, DRAM, is incorrect because it is dynamic RAM, which is much slower and cheaper than SRAM.

14.  **C**. All Pentium-class processors have a 64-bit external data bus. This means that 64-bits can enter or leave the processor at a time.  
 **A**, 32-bit, is incorrect because whereas older processors have 32-bit data buses, all Pentiums have 64-bit external data buses. Pentiums, however, do have a 32-bit register (internal bus). **B**, 36-bit, is incorrect. No Intel CPU has a 36-bit data bus, although some Pentium-class processors have a 36-bit memory address bus. **D** is incorrect. Although Pentium CPUs do differ in memory address bus width, they all have the same data bus width: 64-bits.
15.  **C**. Pentium. This CPU marked the beginning of the fifth generation of Intel CPU and spanned several more generations before the name “Pentium” was dropped from CPU model names.  
 **A**, Athlon, and **B**, Opteron, are both incorrect because they are AMD CPUs. **D**, Celeron, is incorrect because it is a consumer-level version CPU line and was not the first fifth-generation CPU.
16.  **A**. Hyper threading is the CPU technology that allows two threads to execute at the same time within a single execution core.  
 **B** is incorrect because throttling is the CPU technology that causes the CPU to lower its speed in order to reduce its temperature. **C**, overclocking, is incorrect because this is the practice of forcing a CPU or other computer component to run at a higher clock rate than the manufacturer intended. **D**, microcode, is incorrect because it is the name for the low-level instructions built into a CPU.

## The PC Case

17.  **C**. The purpose of a PC case is to hold, protect, and cool the basic PC components.  
 **A** is incorrect because the design of a case will allow for proper airflow over the motherboard. **B** is incorrect because the monitor and keyboard are located outside the typical case. **D** is incorrect because processing data is the function of the CPU, one of the components located on the motherboard within a case.
18.  **D**. Noise reduction is a feature that depends on heavier materials, insulation, and quieter fans.  
 **A**, IEEE 1394, is incorrect because it is not a feature of PC cases, although cases will often have exterior ports that connect to circuitry supporting these features on the motherboard. **B** is incorrect because easy-to-remove exterior body panels do not rely on heavier materials, insulation, and quieter fans. **C** is incorrect because easy-to-use hard drive bays do not depend on the items listed.

- 19.**  **A.** A case, motherboard, and power supply must match, or the motherboard or power supply will not fit in the case.
- B** and **C** are both incorrect because each case is designed to fit certain power supplies and motherboards. **D** is incorrect because even though the motherboard itself is flat, the components on the motherboard take up varying amounts of vertical space, and therefore, the position of drive bays is a consideration.
- 20.**  **C.** Mini-tower is the case size on most brand-name PCs.
- A**, full-tower, is incorrect because this very large case is uncommon in the consumer PC market. **B**, mid-tower, is incorrect because it is also uncommon in the consumer PC market. **D**, low-profile, is incorrect; although this is a consumer-oriented case size, it is for low-end systems such as those used in medical environments.