The system unit is a case that contains electronic components of the computer used to process data. System units are available in a variety of shapes and sizes. The case of the system unit, sometimes called the chassis, is made of metal or plastic and protects the internal electronic components from damage. All computers and mobile devices have a system unit. Core components of system unit are processor, memory, adapter cards, drive bays, and the power supply. The processor interprets and carries out the basic instructions that operate a computer. Memory typically holds data waiting to be processed and instructions waiting to be executed. The electronic components and circuitry of the system unit, such as the processor and memory, usually are part of or are connected to a circuit board called the motherboard. Many current motherboards also integrate sound, video, and networking capabilities.

Adapter cards are circuit boards that provide connections and functions not built into the motherboard or expand on the capability of features integrated into the motherboard. For example, a sound card and a video card are two types of adapter cards found in some desktop personal computers today. Devices outside the system unit often attach to ports on the system unit by a connector on a cable. These devices may include a keyboard, mouse, microphone, monitor, printer, scanner, USB flash drive, card reader/writer, Web cam, and speakers. A drive bay holds one or more disk drives. The power supply converts electricity from a power cord plugged in a wall outlet into a form that can be used by the computer.

The Motherboard

The motherboard, sometimes called a system board, is the main circuit board of the system unit. Many electronic components attach to the motherboard; others are built into it. Memory chips are installed on memory cards (modules) that fit in a slot on the motherboard.

A computer chip is a small piece of semi-conducting material, usually silicon, on which integrated circuits are etched. An integrated circuit contains many microscopic pathways capable of carrying electrical current. Each integrated circuit can contain millions of elements such as resistors, capacitors, and transistors. A transistor, for example, can act as an electronic switch that opens or closes the circuit for electrical charges. Today’s computer chips contain millions or billions of transistors. Most chips are no bigger than one-half-inch square. Manufacturers package chips so that the chips can be attached to a circuit board, such as a motherboard or an adapter card.

Processor

The processor, also called the central processing unit (CPU), interprets and carries out the basic instructions that operate a computer. The processor significantly impacts overall computing power and manages most of a computer’s operations. On larger computers, such as mainframes and supercomputers, the various functions performed by the processor extend over many separate chips and often multiple circuit boards. On a personal computer, all functions of the processor usually are on a single chip. Some computer and chip manufacturers use the term microprocessor to refer to a personal computer processor chip. Most processor chip manufacturers now offer multi-core processors. A processor core, or simply core, contains the circuitry necessary to execute instructions. The operating system views each processor core as a separate processor. A multi-core processor is a single chip with two or more separate processor cores. Two common multi-core processors are dual-core and quad-core. A dual-core processor is a chip that contains two separate processor cores. Similarly, a quad-core processor is a chip with four separate processor cores. Each processor core on a multi-core processor generally runs at a slower clock speed than a single-core processor, but multi-core processors typically increase overall performance. For example, although a dual-core processor does not double the processing speed of a single-core processor, it can approach those speeds. The performance increase is especially noticeable when users are running multiple programs simultaneously such as antivirus software, e-mail program, instant messaging, media player, disc burning software, and photo editing software. Multi-core processors also are more energy efficient than separate multiple processors, requiring lower levels of power consumption and emitting less heat in the system unit. Processors contain a control unit and an arithmetic logic unit (ALU). These two components work together to perform processing operations.
Most devices connected to the computer communicate with the processor to carry out a task. When a user starts a program, for example, its instructions transfer from a storage device to memory. Data needed by programs enters memory from either an input device or a storage device. The control unit interprets and executes instructions in memory, and the ALU performs calculation on the data in memory. Resulting information is stored in memory, from which it can be sent to an output device or a storage device for future access, as needed.

The Control Unit
The control unit is the component of the processor that directs and coordinates most of the operations in the computer. The control unit has a role much like a traffic cop: it interprets each instruction issued by a program and then initiates the appropriate action to carry out the instruction. Types of internal components that the control unit directs include the arithmetic/logic unit, registers, and buses.

The Arithmetic Logic Unit
The arithmetic logic unit (ALU), another component of the processor, performs arithmetic, comparison, and other operations. Arithmetic operations include basic calculations such as addition, subtraction, multiplication, and division. Comparison operations involve comparing one data item with another to determine whether the first item is greater than, equal to, or less than the other item. Depending on the result of the comparison, different actions may occur. For example, to determine if an employee should receive overtime pay, software instructs the ALU to compare the number of hours an employee worked during the week with the regular time hours allowed (e.g., 40 hours). If the hours worked exceed 40, for example, software instructs the ALU to perform calculations that compute the overtime wage.

Machine Cycle
For every instruction, a processor repeats a set of four basic operations, which comprise a machine cycle: (1) fetching, (2) decoding, (3) executing, and, if necessary, (4) storing. Fetching is the process of obtaining a program instruction or data item from memory. The term decoding refers to the process of translating the instruction into signals the computer can execute. Executing is the process of carrying out the commands. Storing, in this context, means writing the result to memory (not to storage medium).
Most of today's personal computers support a concept called pipelining. With pipelining, the processor begins fetching a second instruction before it completes the machine cycle for the first instruction. Processors that use pipelining are faster because they do not have to wait for one instruction to complete the machine cycle before fetching the next. Think of a pipeline as an assembly line. By the time the first instruction is in the last stage of the machine cycle, three other instructions could have been fetched and started through the machine cycle (Figure 4-6).

**Registers**
A processor contains small, high-speed storage locations, called registers, which temporarily hold data and instructions. Registers are part of the processor, not part of memory or a permanent storage device. Processors have many different types of registers, each with a specific storage function. Register functions include storing the location from where an instruction was fetched, storing an instruction while the control unit decodes it, storing data while the ALU computes it, and storing the results of a calculation.

**The System Clock**
The processor relies on a small quartz crystal circuit called the system clock to control the timing of all computer operations. Just as your heart beats at a regular rate to keep your body functioning, the system clock generates regular electronic pulses, or ticks, that set the operating pace of components of the system unit. Each tick equates to a clock cycle. In the past, processors used one or more clock cycles to execute each instruction. Processors today often are superscalar, which means they can execute more than one instruction per clock cycle. The pace of the system clock, called the clock speed, is measured by the number of ticks per second. Current personal computer processors have clock speeds in the gigahertz range. Giga is a prefix that stands for billion, and a hertz is one cycle per second. Thus, one gigahertz (GHz) equals one billion ticks of the system clock per second. A computer that operates at 3 GHz has 3 billion (Giga) clock cycles in one second (hertz). The faster the clock speed, the more instructions the processor can execute per second. The speed of the system clock has no effect on devices such as a printer or disk drive. The speed of the system clock is just one factor that influences a computer's performance.

**Data Representation**
Most computers are digital. They recognize only two discrete states: on and off. This is because computers are electronic devices powered by electricity, which also has only two states: on and off. The two digits, 0 and 1, easily can represent these two states. The digit 0 represents the electronic state of off (absence of an electronic charge). The digit 1 represents the electronic state of on (presence of an electronic charge). When people count, they use the digits in the decimal system (0 through 9). The computer, by contrast, uses a binary system because it recognizes only two states. The binary system is a number system that has just two unique digits, 0 and 1, called bits. 

A bit (short for binary digit) is the smallest unit of data the computer can process. By itself, a bit is not very informative. When 8 bits are grouped together as a unit, they form a byte. A byte provides enough different combinations of 0s and 1s to represent 256 individual characters. These characters include numbers, uppercase and lowercase letters of the alphabet, punctuation marks, and others, such as the letters of the Greek alphabet. The combinations of 0s and 1s that represent characters are defined by patterns called a coding scheme. 

ASCII, (A)merican (S)tandard (C)ode for (I)nformation (I)nterchange) is the most widely used coding scheme to represent data (Figure 4-14). The ASCII coding scheme is sufficient for English and Western European languages but is not large enough for Asian and other languages that use different alphabets. Unicode is a 16-bit coding scheme that has the capacity of representing more than 65,000 characters and symbols. The Unicode coding scheme is capable of representing almost all the world’s current written languages, as well as classic and historical languages. To allow for expansion, Unicode reserves 30,000 codes for future use and 6,000 codes for private use. Unicode is implemented in several operating systems, including Windows, MacOS, and Linux. Unicode-enabled programming languages and software include Java, XML, Microsoft Office, and Oracle. Coding schemes make it possible for humans to interact with a digital computer that processes only bits. When you press a key on a key board, a chip in the keyboard converts the key's electronic signal into a special code that is sent to the system unit. Then, the system unit converts the code into a binary form the computer can process and stores it in memory. Every character is converted to its corresponding byte the computer then processes the data as bytes, which actually is a series of on/off electrical states. When processing is finished, software converts the byte into a human-recognizable number, letter of the alphabet, or special character that is displayed on a screen or is printed. All of these conversions take place so quickly that you do not realize they are occurring. Standards, such as those defined by ASCII and Unicode, also make it possible for components in computers to communicate with each other successfully. By following these and other standards, manufacturers can produce a component and be assured that it will operate correctly in a computer.

Memory
Memory consists of electronic components that store instructions waiting to be executed by the processor, data needed by those instructions, and the results of processing the data (information). Memory usually consists of one or more chips on the motherboard or some other circuit board in the computer. Memory stores three basic categories of items: (1) the operating system and other system software that control or maintain the computer and its devices; (2) application programs that carry out a specific task such as word processing; and (3) the data being processed by the application programs and resulting information. This role of memory to store both data and programs is known as the stored program concept.

Types of Memory
The system unit contains two types of memory: volatile and nonvolatile. When the computer’s power is turned off, volatile memory loses its contents. Nonvolatile memory, by contrast, does not lose its contents when power is removed from the computer. Thus, volatile memory is temporary and nonvolatile memory is permanent. RAM is the most common type of volatile memory. Examples of nonvolatile memory include ROM, flash memory, and CMOS (Complementary Metal-Oxide Semiconductor).
Users typically are referring to RAM when discussing computer memory. RAM (Random Access Memory), also called main memory, consists of memory chips that can be read from and written to by the processor and other devices. When you turn on power to a computer, certain operating system files (such as the files that determine how the desktop appears) load into RAM from a storage device such as a hard disk. These files remain in RAM as long as the computer has continuous power. As additional programs and data are requested, they also load into RAM from storage. The processor interprets and executes a program's instructions while the program is in RAM. During this time, the contents of RAM may change. RAM can accommodate multiple programs simultaneously. Most RAM is volatile, which means it loses its contents when the power is removed from the computer. For this reason, you must save any data, instructions, and information you may need in the future. Saving is the process of copying data, instructions, and information from RAM to a storage device such as a hard disk. Three basic types of RAM chips exist: Dynamic RAM, Static RAM, and Magnetoresistive RAM.

- Dynamic RAM (DRAM) chips must be re-energized constantly or they lose their contents. Many variations of DRAM chips exist, most of which are faster than the basic DRAM (Figure 4-19). Most personal computers today use some form of SDRAM chips or RDRAM chips.
- Static RAM (SRAM) chips are faster and more reliable than any variation of DRAM chips. These chips do not have to be re-energized as often as DRAM chips, thus, the term static. SRAM chips, however, are much more expensive than DRAM chips. Special applications such as cache use SRAM chips. A later section in this chapter discusses cache.
- A newer type of RAM, called Magnetoresistive RAM (MRAM), stores data using magnetic charges instead of electrical charges. Manufacturers claim that MRAM has greater storage capacity, consumes less power, and has faster access times than electronic RAM. Also, MRAM retains its contents after power is removed from the computer, which could prevent loss of data for users. As the cost of MRAM declines, experts predict MRAM could replace both DRAM and SRAM. RAM chips usually reside on a memory module, which is a small circuit board. Memory slots on the motherboard hold memory modules. Three types of memory modules are SIMMs, DIMMs, and RIMMs. A SIMM (Single Inline Memory Module) has pins on opposite sides of the circuit board that connect together to form a single set of contacts. With a DIMM (Dual Inline Memory Module), by contrast, the pins on opposite sides of the circuit board do not connect and thus form two sets of contacts. SIMMs and DIMMs typically hold SDRAM chips. A RIMM (Rambus Inline Memory Module) houses RDRAM chips.

Cache

Most of today's computers improve their processing times with cache (pronounced cash). Two types of cache are memory cache and disk cache. Memory cache helps speed the processes of the computer because it stores frequently used instructions and data. Most personal computers today have two types of memory cache: L1 cache and L2 cache. Some also have L3 cache.

- L1 cache is built directly in the processor chip. L1 cache usually has a very small capacity, ranging from 8 KB to 128 KB. The more common sizes for personal computers are 32 KB or 64 KB.
- L2 cache is slightly slower than L1 cache but has a much larger capacity, ranging from 64 KB to 16 MB. When discussing cache, most users are referring to L2 cache. Current processors include advanced transfer cache (ATC), a type of L2 cache built directly on the processor chip. Processors that use ATC perform at much faster rates than those that do not use it. Personal computers today typically have from 512 KB to 12 MB of advanced transfer cache. Servers and workstations have from 12 MB to 16 MB of advanced transfer cache.
- L3 cache is a cache on the motherboard that is separate from the processor chip. L3 cache exists only on computers that use L2 advanced transfer cache. Personal computers often have up to 8 MB of L3 cache; servers and workstations have from 8 MB to 24 MB of L3 cache.

### DRAM Variations

<table>
<thead>
<tr>
<th>Name</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>SDRAM (Synchronous DRAM)</td>
<td>• synchronized to the system clock&lt;br&gt;• much faster than DRAM</td>
</tr>
<tr>
<td>DDR SDRAM (Double Data Rate SDRAM)</td>
<td>• transfers data twice, instead of once, for each clock cycle&lt;br&gt;• faster than SDRAM</td>
</tr>
<tr>
<td>DDR2</td>
<td>• second generation of DDR&lt;br&gt;• faster than DDR</td>
</tr>
<tr>
<td>DDR3</td>
<td>• third generation of DDR&lt;br&gt;• designed for computers with multi-core processors&lt;br&gt;• faster than DDR2</td>
</tr>
<tr>
<td>RDRAM (Rambus DRAM)</td>
<td>• uses pipelining techniques&lt;br&gt;• much faster than SDRAM</td>
</tr>
</tbody>
</table>
Cache speeds up processing time because it stores frequently used instructions and data. When the processor needs an instruction or data, it searches memory in this order: L1 cache, then L2 cache, then L3 cache (if it exists), then RAM — with a greater delay in processing for each level of memory it must search (Figure 4-22). If the instruction or data is not found in memory, then it must search a slower speed storage medium such as a hard disk or optical disc.

**ROM**

Read-only memory (ROM pronounced rahm) refers to memory chips storing permanent data and instructions. The data on most ROM chips cannot be modified — hence, the name read-only. ROM is nonvolatile, which means its contents are not lost when power is removed from the computer. In addition to computers, many devices contain ROM chips. For example, ROM chips in printers contain data for fonts. Manufacturers of ROM chips often record data, instructions, or information on the chips when they manufacture the chips. These ROM chips, called firmware, contain permanently written data, instructions, or information. A PROM (programmable read-only memory) chip is a blank ROM chip on which a programmer can write permanently. Programmers use microcode instructions to program a PROM chip. Once a programmer writes the micro-code on the PROM chip, it functions like a regular ROM chip and cannot be erased or changed. A variation of the PROM chip, called an EEPROM (electrically erasable programmable read-only memory) chip, allows a programmer to erase the microcode with an electric signal.

**Flash Memory**

Flash memory is a type of nonvolatile memory that can be erased electronically and rewritten, similar to EEPROM. Most computers use flash memory to hold their startup instructions because it allows the computer easily to update its contents. For example, when the computer changes from standard time to daylight savings time, the contents of a flash memory chip (and the real-time clock chip) change to reflect the new time. Flash memory cards contain flash memory on a removable device instead of a chip.

**CMOS**

Some RAM chips, flash memory chips, and other memory chips use Complementary Metal-Oxide Semiconductor (CMOS pronounced SEE-moss) technology because it provides high speeds and consumes little power. CMOS technology uses battery power to retain information even when the power to the computer is off. Battery-backed CMOS memory chips, for example, can keep the calendar, date, and time current even when the computer is off. The flash memory chips that store a computer’s startup information often use CMOS technology.

**Memory Access Times**

Access time is the amount of time it takes the processor to read data, instructions, and information from memory. A computer’s access time directly affects how fast the computer processes data. Accessing data in memory can be more than 200,000 times faster than accessing data on a hard disk because of the mechanical motion of the hard disk.

Today’s manufacturers use a variety of terminology to state access times. Some use fractions of a second, which for memory occurs in nanoseconds. A nanosecond (abbreviated ns) is one billionth of a second. A nanosecond is extremely fast. In fact, electricity travels about one foot in a nanosecond. Other manufacturers state access times in MHz; for example, 800 MHz DDR2 SDRAM.

If a manufacturer states access time in megahertz, you can convert it to nanoseconds by dividing 1 billion ns by the megahertz number. For example, 800 MHz equals approximately 1.25 ns (1,000,000,000/800,000,000). The access time (speed) of memory contributes to the overall performance of the computer. Standard SDRAM chips can have access times up to 133 MHz (about 7.5 ns), and access times of the DDR SDRAM chips reach 266 MHz, DDR2 chips reach 800 MHz, and DDR3 chips reach 1600 MHz. The higher the megahertz, the faster the access time; conversely, the lower the nanoseconds, the faster the access time. The faster RDRAM chips can have
access times up to 1600 MHz (about 0.625 ns). ROM access times range from 25 to 250 ns. While access times of memory greatly affect overall computer performance, manufacturers and retailers usually list a computer’s memory in terms of its size, not its access time. Thus, an advertisement might describe a computer as having 2 GB of SDRAM upgradeable to 4 GB.

Lecture 3 Topic 2: Components of System Unit

Expansion Slots and Adapter Cards
An expansion slot is a socket on the motherboard that can hold an adapter card. An adapter card, sometimes called an expansion card, is a circuit board that enhances functions of a component of the system unit and/or provides connections to peripherals. A peripheral is a device that connects to the system unit and is controlled by the processor in the computer. Examples of peripherals are modems, disk drives, printers, scanners, and keyboards. Sometimes, all functionality is built in the adapter card. With others, a cable connects the adapter card to a device, such as a digital video camera, outside the system unit.

Some are a card that you insert in a slot on the computer. Some motherboards include all necessary capabilities and do not require adapter cards. Other motherboards may require adapter cards to provide capabilities such as sound and video. A sound card enhances the sound-generating capabilities of a personal computer by allowing sound to be input through a microphone and output through external speakers or headphones. A video card, also called a graphics card, converts computer output into a video signal that travels through a cable to the monitor, which displays an image on the screen. Today’s computers support Plug and Play, which means the computer automatically can configure adapter cards and other peripherals as you install them. Having Plug and Play support means you can plug in a device, turn on the computer, and then immediately begin using the device.

Ports and Connectors
A port is the point at which a peripheral attaches to or communicates with a system unit so that the peripheral can send data to or receive information from the computer. An external device, such as a keyboard, monitor, printer, mouse, and microphone, often attaches by a cable to a port on the system unit. Instead of port, the term jack sometimes is used to identify audio and video ports. The front and back of a system unit on a desktop personal computer contain many ports. On notebook computers, including net-books and Tablet PCs, the ports are on the back, front, and/or sides.

A connector joins a cable to a port. A connector at one end of a cable attaches to a port on the system unit, and a connector at the other end of the cable attaches to a port on the peripheral. Most connectors and ports are available in one of two genders: male or female. Male connectors and ports have one or more exposed pins, like the end of an electrical cord you plug in the wall. Female connectors and ports have matching holes to accept the pins on a male connector or port, like an electrical wall outlet. Sometimes, you cannot attach a new peripheral to the computer because the port on the system unit is the same gender as the connector on the cable. In this case, purchasing a gender changer solves this problem. A gender changer is a device that enables you to join a port and a connector that are both female or both male. Notice that many are color-coded to help you match the connector to the correct port. Some system units include these ports when you buy the computer.

You add other ports by inserting adapter cards on the motherboard. Certain adapter cards have ports that allow you to attach a peripheral to the adapter card.

USB Ports
A USB port (Universal Serial Bus) port can connect up to 127 different peripherals together with a single connector. Devices that connect to a USB port include the following: mouse, printer, digital camera, scanner, speakers, portable media player, optical disc drive, smart phone, PDA, game console, and removable hard disk. Personal computers typically have six to eight USB ports on the front and/or back of the system unit. USB 2.0, also called Hi-Speed USB, is a more advanced and faster USB, with speeds 40 times higher than that of its predecessor. USB 3.0 is approximately 10 times faster than USB 2.0. Both USB 2.0 and USB 3.0 are backward
compatible, which means they support older USB devices as well as USB 2.0 or USB 3.0 devices. Keep in mind, though, that older USB devices do not run any faster in a newer USB port. To attach multiple peripherals using a single USB port, you can use a USB hub. A USB hub is a device that plugs in a USB port on the system unit and contains multiple USB ports in which you plug cables from USB devices. USB hubs are self-powered or bus-powered. A self-powered USB hub draws power from an electrical outlet, whereas a bus-powered USB hub draws power from the USB bus in the computer. Some devices will work only with a self-powered hub. Some USB hubs are wireless. That is, a receiver plugs into a USB port on the computer and the USB hub communicates wirelessly with the receiver. USB also supports hot plugging and Plug and Play, which means you can attach peripherals while the computer is running.

FireWire Ports
Previously called an IEEE 1394 port, a FireWire port is similar to a USB port in that it can connect multiple types of devices that require faster data transmission speeds, such as digital video cameras, digital VCRs, color printers, scanners, digital cameras, and DVD drives, to a single connector. A FireWire port allows you to connect up to 63 devices together. The three latest versions, FireWire 800, FireWire 1600, and FireWire 3200, have speeds faster than the original FireWire 400. You can use a FireWire hub to attach multiple devices to a single FireWire port. A FireWire hub is a device that plugs in a FireWire port on the system unit and contains multiple FireWire ports in which you plug cables from FireWire devices. The FireWire port supports Plug and Play.

Other Ports
Some ports not included in typical computers but sometimes used are Bluetooth, SCSI, eSATA, IrDA, serial, and MIDI. For a computer to have these ports, you often must customize the computer purchase order.

Bluetooth Port: Bluetooth technology uses radio waves to transmit data between two devices. Bluetooth devices have to be within about 33 feet of each other. Many computers, peripherals, smart phones, PDAs, cars, and other consumer electronics are Bluetooth-enabled, which means they contain a small chip that allows them to communicate with other Bluetooth-enabled computers and devices. Bluetooth headsets allow smart phone users to connect their telephone to a headset wirelessly.

SCSI Port: A special high-speed parallel port, called a SCSI port, allows you to attach SCSI (pronounced skuzzy) peripherals such as disk drives and printers. SAS (Serial-Attached SCSI) is a newer type of SCSI that transmits at much faster speeds than parallel SCSI. Depending on the type of SCSI, which stands for small computer system interface, you can daisy chain up to either 7 or 15 devices together. Some computers include a SCSI port. Others have a slot that supports a SCSI card.

eSATA Port: An eSATA port, or external SATA port, allows you to connect an external SATA (Serial Advanced Technology Attachment) hard disk to a computer. SATA hard disks are popular because of their fast data transmission speeds. eSATA connections provide up to six times faster data transmission speeds than external hard disks attached to a computer’s USB or FireWire port.

IrDA Port: Some devices can transmit data via infrared light waves. For these wireless devices to transmit signals to a computer, both the computer and the device must have an IrDA port. These ports conform to standards developed by the IrDA (Infrared Data Association). To ensure nothing obstructs the path of the infrared light wave, you must align the IrDA port on the device with the IrDA port on the computer, similarly to the way you operate a television remote control. Devices that use IrDA ports include a smart phone, PDA, keyboard, mouse, and printer. Several of these devices use a high-speed IrDA port, sometimes called a fast infrared port.

Serial Ports: A serial port is a type of interface that connects a device to the system unit by transmitting data one bit at a time. Some modems that connect the system unit to a telephone line use a serial port because the telephone line expects the data in a specific frequency.

MIDI Port: A special type of serial port that connects the system unit to a musical instrument, such as an electronic keyboard, is called a MIDI port. Short for Musical Instrument Digital Interface, MIDI (pronounced MID-dee) is the electronic music industry’s standard that defines how devices, such as sound cards and synthesizers, represent sounds electronically. A synthesizer, which can be a peripheral or a chip, creates sound from digital instructions. A system unit with a MIDI port has the capability of recording sounds that have been created by a synthesizer and then processing the sounds (the data) to create new sounds. Nearly every sound card supports the MIDI standard, so that you can play and manipulate on one computer sounds that originally were created on another computer.

Port Replicators and Docking Stations
Instead of connecting peripherals directly to ports on a mobile computer, some mobile users prefer the flexibility of port replicators and docking stations. A port replicator is an external device that provides connections to
peripherals through ports built into the device. The mobile user accesses peripherals by connecting the port replicator to a USB port or a special port on the mobile computer. Port replicators sometimes disable ports on the mobile computer to prevent conflicts among the devices on the computer and port replicator.

A docking station is similar to a port replicator, but it has more functionality. A docking station, which is an external device that attaches to a mobile computer or device, contains a power connection and provides connections to peripherals; it usually also includes slots for memory cards, optical disc drives, and other devices. With the mobile computer or device in the docking station, users can work with a full-sized keyboard, a mouse, and other desktop peripherals from their traditional notebook computer, netbook, or Tablet PC.

Buses

A computer processes and stores data as a series of electronic bits. These bits transfer internally within the circuitry of the computer along electrical channels. Each channel, called a bus, allows the various devices both inside and attached to the system unit to communicate with each other. Just as vehicles travel on a highway to move from one destination to another, bits travel on a bus (Figure 4-36).

Buses are used to transfer bits from input devices to memory, from memory to the processor, from the processor to memory, and from memory to output or storage devices. Buses consist of two parts: a data bus and an address bus. The data bus is used to transfer actual data and the address bus is used to transfer information about where the data should reside in memory. The size of a bus, called the bus width, determines the number of bits that the computer can transmit at one time. For example, a 32-bit bus can transmit 32 bits (4 bytes) at a time. On a 64-bit bus, bits transmit from one location to another 64 bits (8 bytes) at a time. The larger the number of bits handled by the bus, the faster the computer transfers data. Using the highway analogy again, assume that one lane on a highway can carry one bit. A 32-bit bus is like a 32-lane highway. A 64-bit bus is like a 64-lane highway. If a number in memory occupies 8 bytes, or 64 bits, the computer must transmit it in two separate steps when using a 32-bit bus: once for the first 32 bits and once for the second 32 bits. Using a 64-bit bus, the computer can transmit the number in a single step, transferring all 64 bits at once. The wider the bus, the fewer number of transfer steps required and the faster the transfer of data. Most personal computers today use a 64-bit bus. In conjunction with the bus width, many computer professionals refer to a computer’s word size. Word size is the number of bits the processor can interpret and execute at a given time. That is, a 64-bit processor can manipulate 64 bits at a time. Computers with a larger word size can process more data in the same amount of time than computers with a smaller word size. In most computers, the word size is the same as the bus width. Every bus also has a clock speed. Just like the processor, manufacturers state the clock speed for a bus in hertz. Today’s processors usually have a bus clock speed of 400, 533, 667, 800, 1066, 1333, or 1600 MHz. The higher the bus clock speed, the faster the transmission of data, which results in programs running faster.

A computer has these basic types of buses: a system bus, possibly a backside bus, and an expansion bus. A system bus, also called the Front Side Bus (FSB), is part of the motherboard and connects the processor to main memory. A Back Side Bus (BSB) connects the processor to cache. An expansion bus allows the processor to communicate with peripherals. When computer professionals use the term bus by itself, they usually are referring to the system bus.

Expansion Bus

Some peripherals outside the system unit connect to a port on an adapter card, which is inserted in an expansion slot on the motherboard. This expansion slot connects to the expansion bus, which allows the processor to communicate with the peripheral attached to the adapter card. Data transmitted to memory or the processor travels from the expansion slot via the expansion bus and the system bus. The types of expansion buses on a motherboard determine the types of cards you can add to the computer. Thus, you should understand expansion buses commonly found in today’s personal computers: PCI bus, PCI Express bus, AGP bus, USB, FireWire bus, and PC Card bus.

- The PCI bus (Peripheral Component Interconnect bus) is a high-speed expansion bus that connects higher speed devices. Types of cards you can insert in a PCI bus expansion slot include video cards, sound cards, SCSI cards, and high-speed network cards.
The PCI Express (PCIe) bus is an expansion bus that expands on and doubles the speed of the original PCI bus. Nearly all video cards today use the PCI Express bus, as well as many hard disks and network cards. The Express Card technology used in traditional notebook computers and Tablet PCs also works with the PCI Express bus. Experts predict the PCI Express bus eventually will replace the PCI bus completely.

The Accelerated Graphics Port (AGP) is a bus designed by Intel to improve the speed with which 3-D graphics and video transmit. With an AGP video card in an AGP bus slot, the AGP bus provides a faster, dedicated interface between the video card and memory. Newer processors support AGP technology.

The USB (Universal Serial Bus) and FireWire Bus are buses that eliminate the need to install cards in expansion slots. In a computer with a USB, for example, USB devices connect to each other outside the system unit, and then a single cable attaches to the USB port. The USB port then connects to the USB, which connects to the PCI bus on the motherboard. The FireWire bus works in a similar fashion. With these buses, expansion slots are available for devices not compatible with USB or FireWire.

The expansion bus for a PC Card is the PC Card bus. With a PC Card inserted in a PC Card slot, data travels on the PC Card bus to the PCI bus.

Bays

After you purchase a desktop or notebook computer, you may want to install an additional storage device, such as a disk drive, in the system unit. A bay is an opening inside the system unit in which you can install additional equipment. A bay is different from a slot on the motherboard, which is used for the installation of adapter cards. A drive bay is a rectangular opening that typically holds disk drives. Other bays house card readers and widely used ports such as USB, FireWire, and audio ports. An external bay allows a user to access openings in the bay from outside the system unit (Figure 4-37). Optical disc drives are examples of devices installed in external bays. An internal bay is concealed entirely within the system unit. Hard disk drives are installed in internal bays.

Power Supply

Many personal computers plug in standard wall outlets, which supply an alternating current (AC) of 115 to 120 volts (in some countries 230 to 240 volts). This type of power is unsuitable for use with a computer, which requires a direct current (DC) ranging from 5 to more than 15 volts. The power supply is the component of the system unit that converts the wall outlet AC power into DC power. Different motherboards and computers require different wattages on the power supply. Notebook computers, including netbooks and Tablet PCs, can run using either batteries or a power supply. If a power supply is not providing the necessary power, the computer will not function properly. Built into the power supply is a fan that keeps the power supply cool. Some have variable speed fans that change speed or stop running, depending on temperature in the system unit. Many newer computers have additional fans near certain components in the system unit such as the processor, hard disk, and ports.