Plug IT In 2
Hardware and software

PLUG IT IN OUTLINE

PI2.1 Introduction to hardware

PI2.2 Introduction to software

LEARNING OBJECTIVES

1. Discuss strategic issues that link hardware design to business strategy.
2. Describe different issues associated with the two major types of software.

Introduction

As you begin this Plug IT In, you might be wondering, why do I have to know anything about hardware and software? There are several reasons why it is advantageous to know the basics of hardware and software. First, regardless of your degree (and future functional area in an organisation), you will be using different types of hardware and software throughout your career. Second, you will have input concerning the hardware and software you will use. In this capacity you will be required to answer many questions, such as 'Is my hardware performing adequately for my needs? If not, what types of problems am I experiencing?' 'Does my software help me do my job?' 'Is this software easy to use?' 'Do I need more functionality, and if so, what functionality would be most helpful to me?' Third, you will also have input into decisions when your functional area or organisation upgrades or replaces its hardware, as well as input into decisions about the software you need to do your job. MIS employees will act as advisors, but you will provide important input into such decisions. Finally, in some organisations, the budget for hardware and software is allocated to functional areas or departments. In such cases, you might be making hardware and software decisions (at least locally) yourself.

This Plug IT In will help you better understand the hardware and software decisions your organisation must make as well as your personal computing decisions. Many of the design principles presented here apply to systems of all sizes, from an enterprise wide system to your home computer system. In addition, the dynamics of innovation and cost that you will see can affect personal as well as corporate hardware decisions.

PI2.1 Introduction to hardware

Recall from chapter 1 that the term *hardware* refers to the physical equipment used for the input, processing, output and storage activities of a computer system. Decisions about hardware focus on three interrelated factors: appropriateness for the task, speed and cost. The incredibly rapid rate of innovation in the computer industry complicates hardware decisions because computer technologies become obsolete more quickly than other organisational technologies.

The overall trends in hardware are that it becomes smaller, faster, cheaper and more powerful over time. In fact, these trends are so rapid that they make it difficult to know when to purchase (or upgrade) hardware. This difficulty lies in the fact that companies that delay hardware purchases will, more than likely, be able to buy more powerful hardware for the same amount of money in the future. It is important to note that buying more powerful hardware for the same amount of money in the future is a trade-off. An organisation that delays purchasing computer hardware gives up the benefits of whatever it could buy today until the future purchase date arrives.

Hardware consists of the following.

- *Central processing unit (CPU).* Manipulates the data and controls the tasks performed by the other components.
- *Primary storage.* Temporarily stores data and program instructions during processing.
- *Secondary storage.* Stores data and programs for future use.
- *Input technologies.* Accepts data and instructions and converts them to a form that the computer can understand.
- *Output technologies.* Presents data and information in a form people can understand.
- *Communication technologies.* Provides for the flow of data from external computer networks (e.g. the internet and intranets) to the CPU, and from the CPU to computer networks.

Strategic hardware issues

For most businesspeople the most important issues are what the hardware enables, how it is advancing and how rapidly it is advancing. In many industries, exploiting computer hardware is a key to achieving competitive advantage. Successful hardware exploitation comes from thoughtful consideration of the following questions.

- How do organisations keep up with the rapid price and performance advancements in hardware? For example, how often should an organisation upgrade its computers and storage systems? Will upgrades increase personal and organisational productivity? How can organisations measure such increases?
- How should organisations determine the need for the new hardware infrastructures, such as server farms, virtualisation, grid computing and utility computing? (See Plug IT In 3 for a discussion of these infrastructures.)
- Portable computers and advanced communications technologies have enabled employees to work from home or from anywhere. Will these new work styles benefit employees and the organisation? How do organisations manage such new work styles?

Computer hierarchy

The traditional standard for comparing classes of computers is their processing power. This section presents each class of computers, from the most powerful to the least powerful. It describes both the computers and their roles in modern organisations.

Supercomputers

The term **supercomputer** does not refer to a specific technology. Rather, it indicates the fastest computers available at any given time. At the time of writing (the fastest supercomputer developed in China[1] had speeds exceeding 33[2] petaflop/s (one petaflop is 1000 trillion floating point operations per second). A floating point operation is an arithmetic operation involving decimals.

Because supercomputers are costly as well as very fast, they are generally used by large organisations to execute computationally demanding tasks involving very large data sets. In contrast to mainframes, which specialise in transaction processing and business applications, supercomputers typically run military and scientific applications. Although they cost millions of dollars, they are also being used for commercial applications where huge amounts of data must be analysed. For example, large banks use supercomputers to calculate the risks and returns of various investment strategies and healthcare organisations use them to analyse giant databases of patient data to determine optimal treatments for various diseases.

Mainframe computers

Although mainframe computers are increasingly viewed as just another type of server, albeit at the high end of the performance and reliability scales, they remain a distinct class of systems differentiated by hardware and software features. **Mainframes** remain popular in large enterprises for extensive computing applications that are accessed by thousands of users at one time. Examples of mainframe applications are airline reservation systems, corporate payroll programs, website transaction processing systems (e.g. Amazon and eBay) and student grade calculation and reporting.

Today's mainframes perform at teraflop (trillions of floating point operations per second) speeds and can handle millions of transactions per day. In addition, mainframes provide a secure, robust environment in which to run strategic, mission-critical applications.

Midrange computers

Larger midrange computers, called **minicomputers**, are relatively small, inexpensive and compact computers that perform the same functions as mainframe computers, but to a more limited extent. In fact, the lines between minicomputers and mainframes have blurred in both price and performance. Minicomputers are a type of **server** — that is, a computer that supports computer networks and enables users to share files, software, peripheral devices and other resources. Mainframes are a type of server as well because they provide support for entire enterprise networks.

Microcomputers

Microcomputers — also called micros, personal computers or PCs — are the smallest and least expensive category of general-purpose computers. It is important to point out that people frequently define a PC as a computer that utilises the Microsoft Windows operating system. In fact, there are a variety of PCs available, many of which do not use Windows. One well-known example are the Apple Macs, which use the Mac OS X operating system (discussed later in this Plug IT In). The major categories of microcomputers are desktops, thin clients, notebooks and laptops, netbooks and tablets.

Desktop PCs

The desktop personal computer is the familiar microcomputer system that has become a standard tool for business and the home. (Desktops are being replaced with portable devices such as laptops, netbooks and tablets.) A desktop generally includes a central processing unit (CPU) — which you will learn about later — and a separate but connected monitor and keyboard. Modern desktop computers have gigabytes of primary storage, a rewriteable CD-ROM and a DVD drive, and up to a few terabytes of secondary storage.

Thin-client systems

Before you address thin-client systems, you need to differentiate between clients and servers. Recall that servers are computers that provide a variety of services for clients, including running networks, processing websites, processing email and many other functions. *Clients* are typically computers on which users perform their tasks, such as word processing, spreadsheets and others.

Thin-client systems are desktop computer systems that do not offer the full functionality of a PC. Compared to PCs, or **fat clients**, thin clients are less complex, particularly because they do not have locally installed software. When thin clients need to run an application, they access it from a server over a network instead of from a local disk drive.

For example, a thin client would not have Microsoft Office installed on it. Thus, thin clients are easier and less expensive to operate and support than PCs. The benefits of thin clients include fast application deployment, centralised management, lower cost of ownership and easier installation, management, maintenance and support. The main disadvantage of thin clients is that if the network fails, then users can do very little on their computers. In contrast, if users have fat clients and the network fails, they can still perform some functions because they have software, such as Microsoft Office, installed on their computers.

Laptop and notebook computers

Laptop computers (or **notebook computers**) are small, easily transportable, lightweight microcomputers that fit easily into a briefcase. Notebooks and laptops are designed to be as convenient and easy to transport as possible. Just as important, they also provide users with access to processing power and data outside an office environment. At the same time, they cost more than desktops for similar functionality.

Netbooks

A **netbook** is a small, lightweight, low-cost, energy-efficient, portable computer. Netbooks are generally optimised for internet-based services such as web browsing and emailing.

Tablet computers

A **tablet computer** (or **tablet**) is a complete computer contained entirely in a flat touch screen that users operate via a stylus, digital pen or fingertip instead of a keyboard or mouse (figure PI2.1). Examples of tablets are the Apple iPad Air (**www.apple.com/ipad**), the Microsoft Surface 2,[3] Samsung Galaxy Note 3,[4] and Sony Xperia Z Ultra.[5]

FIGURE PI2.1 Tablet computers are lightweight and easily transportable.

IT'S PERSONAL: PURCHASING A COMPUTER

One day you will purchase a computer for yourself or your job. When that day comes, it will be important for you to know what to look for. Buying a computer can be very confusing if you just read the box. This Plug-IT-In has explained the major components of a computer in terms of both hardware and software. But there are more things you need to consider when you purchase a computer: what you plan to do with it, where do you plan to use it and how long you need service from it. To help answer the first question, consider the following questions.

- What do you plan to do with your computer? Just like buying a vehicle, your plans for using the vehicle determine the type of vehicle you will purchase. It is the same with a computer. You need to consider what you currently do with a computer and what you may do before you replace the one under consideration. Although many people just buy as much as they can afford, they may also overpay because they do not consider what they need the computer for.
- Where do you plan to use your computer? If you only plan to use it at home at your desk, then a desktop model will be fine. In general, you can get more computer for your money in a desktop model. However, if you think you may ever want to take the computer with you, then you will need some type of a laptop or tablet computer. When portability is a requirement, you will want to reconsider what you plan to use the computer for because as computers become more portable (smaller) their functionality changes and you want to make sure it will meet your needs.
- How long do you need service from this computer? Most things we purchase today are bought with the intention of being replaced in a few years. The length of service is really more about warranty and availability of repair services. In some cases, purchase decision should be made based on these issues rather than speed because they can extend the life of your computer.

There are always new tips for purchasing computers that often focus on the specs of a computer rather than some of these more aesthetic issues. Specs and recommendations will change, but the issues mentioned above will remain constant.

Input and output technologies

Input technologies allow people and other technologies to enter data into a computer. The two main types of input devices are human data-entry devices and source-data automation devices. As their name implies, *human data-entry* devices require a certain amount of human effort to input data. Examples are keyboard, mouse, pointing stick, trackball, joystick, touchscreen, stylus and voice recognition.

In contrast, *source-data automation* devices input data with minimal human intervention. These technologies speed up data collection, reduce errors and gather data at the source of a transaction or other event. Barcode readers are an example of source-data automation. Table PI2.1 describes the various input devices.

TABLE PI2.1 Input devices

Input device	Description
Human data-entry devices	
Keyboards	Most common input device (for text and numerical data).
Mouse	Handheld device used to point cursor at point on screen, such as an icon; user clicks button on mouse instructing computer to take some action.
Optical mouse	Mouse is not connected to computer by a cable; mouse uses camera chip to take images of surface it passes over, comparing successive images to determine its position.
Trackball	User rotates a ball built into top of device to move cursor (rather than moving entire device such as a mouse).
Pointing stick	Small button-like device; cursor moves in the direction of the pressure you place on the stick. Located between keys near centre of keyboard.
Touchpad (also called a trackpad)	User moves cursor by sliding finger across a sensitised pad and then can tap pad when cursor is in desired position to instruct computer to take action (also called glide-and-tap pad).
Graphics tablet	A device that can be used in place of, or in conjunction with, a mouse or trackball; has a flat surface for drawing and a pen or stylus that is programmed to work with the tablet.
Joystick	Joystick moves cursor to desired place on screen; commonly used in workstations that display dynamic graphics and in video games.
Touch screen	Users instruct computer to take some action by touching a particular part of the screen; commonly used in information kiosks such as ATMs. Touch screens now have gesture controls for browsing through photographs, moving objects around on a screen, flicking to turn the page of a book and playing video games. For example, see the Apple iPhone.
Stylus	Pen-style device that allows user either to touch parts of a predetermined menu of options or to handwrite information into the computer (as with some PDAs); works with touch-sensitive screens.
Digital pen	Mobile device that digitally captures everything you write; built-in screen confirms that what you write has been saved; also captures sketches, figures and so on with on-board flash memory.
Wii	A video game console by Nintendo. A distinguishing feature of the Wii is its wireless controller, which can be used as a handheld pointing device and can detect movement in three dimensions.
Microsoft Kinect	Enables users to control and interact with the Xbox 360 without the need to touch a game controller, through a natural interface using gestures and spoken commands.
Webcam	A real-time video camera whose images can be accessed via the web or instant messaging.
Voice-recognition	Microphone converts analogue voice sounds into digital input for computer; critical technology for physically challenged people who cannot use other input devices.
Source-data automation input devices	
Automated teller machine	A device that includes source-data automation input in the form of a magnetic stripe reader; human input via a keyboard; and output via a monitor, printer and cash dispenser.

Input device	Description
Magnetic strip reader	A device that reads data from a magnetic strip, usually on the back of a plastic card (e.g. credit or debit cards).
Point-of-sale terminals	Computerised cash registers that may also incorporate touch screen technology and barcode scanners to input data such as item sold and price.
Barcode scanners	Devices scan black-and-white barcode lines printed on merchandise labels.
Optical mark reader	Scanner for detecting presence of dark marks on predetermined grid, such as multiple-choice test answer sheets.
Magnetic ink character reader	Reads magnetic ink printed on cheques that identify the bank, chequing account and cheque number.
Optical character recognition	Software that converts text into digital form for input into computer.
Sensors	Collect data directly from the environment and input data directly into computer; examples include vehicle airbag activation sensors and radio-frequency identification tags.
Cameras	Digital cameras capture images and convert them into digital files.
Radio frequency identification (RFID)	Uses active or passive tags (transmitters) to wirelessly transmit product information to electronic readers.

The output generated by a computer can be transmitted to the user via several output devices and media. These devices include monitors, printers, plotters and voice. Table PI2.2 describes the various output devices.

Multimedia technology is the computer-based integration of text, sound, still images, animation and digitised motion video. It usually represents a collection of various input and output technologies. Multimedia merges the capabilities of computers with televisions, VCRs, CD players, DVD players, video and audio recording equipment, and music and gaming technologies. High-quality multimedia processing requires powerful microprocessors and extensive memory capacity, including both primary and secondary storage.

TABLE PI2.2 Output devices

Output device	Description
Monitors	
Cathode ray tubes	Video screens on which an electron beam illuminates pixels on a display screen.
Liquid crystal display (LCDs)	Flat displays that have liquid crystals between two polarisers to form characters and images on a backlit screen.
Flexible displays	Thin, plastic, bendable computer screens.
Organic light-emitting displays	Displays that are brighter, thinner, lighter, cheaper, faster and take less power diodes (OLEDs) to run than LCDs.
Retinal scanning displays	Project image directly onto a viewer's retina; used in medicine, air traffic control and controlling industrial machines.
Heads-up displays	Any transparent display that presents data without requiring that the user look away from his or her usual viewpoint; for example, see Microvision (www.microvision.com).
Printers	
Laser	Use laser beams to write information on photosensitive drums; produce high-resolution text and graphics.

(continued)

TABLE PI2.2 *(continued)*

Output device	Description
Inkjet	Shoot fine streams of coloured ink onto paper; usually less expensive to buy than laser printers but can be more expensive to operate; can offer resolution quality equal to laser printers.
Thermal	Produces a printed image by selectively heating coated thermal paper; when the paper passes over the thermal print head, the coating turns black in the areas where it is heated, producing an image.
Plotters	Use computer-directed pens for creating high-quality images, blueprints, schematics, drawing of new products and such.
Voice output	A speaker/headset, which can output sounds of any type; voice output is a software function that uses this equipment.
Electronic book reader	A wireless, portable reading device with access to books, blogs, newspapers and magazines. On-board storage holds hundreds of books.
Pocket projector	A projector in a handheld device that provides an alternative display method to alleviate the problem of tiny display screens in handheld devices. Pocket projectors will project digital images onto any viewing surface.
Pico projector	A very small projector incorporated into portable devices, such as the Nikon Coolpix S1000pj camera. Also incorporated into Samsung and LG mobile phones.

The central processing unit

The **central processing unit (CPU)** performs the actual computation or 'number crunching' inside any computer. The CPU is a **microprocessor** (for example, Intel's Core i3, i5 and i7 chips with more to come) made up of millions of microscopic transistors embedded in a circuit on a silicon wafer or *chip*. Hence, microprocessors are commonly referred to as chips.

As shown in figure PI2.2, the microprocessor has different parts, which perform different functions. The **control unit** sequentially accesses program instructions, decodes them and controls the flow of data to and from the arithmetic-logic unit, the registers, the caches, primary storage, secondary storage and various output devices. The **arithmetic-logic unit (ALU)** performs the mathematic calculations and makes logical comparisons. The registers are high-speed storage areas that store very small amounts of data and instructions for short periods.

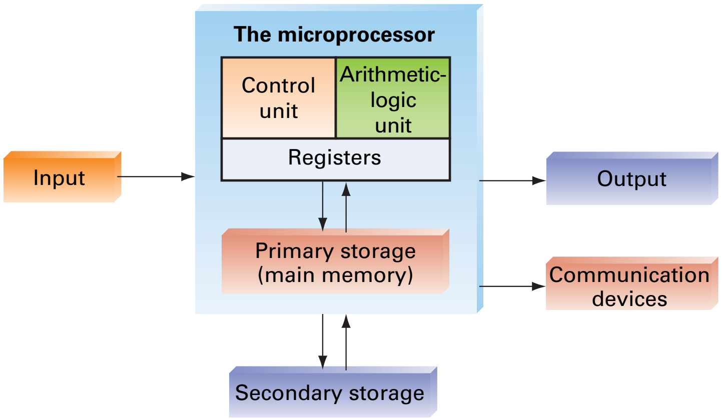

FIGURE PI2.2 Parts of a microprocessor.

How the CPU works

In the CPU, inputs enter and are stored until they are needed. At that point, they are retrieved and processed, and the output is stored and then delivered somewhere. Figure PI2.3 illustrates this process, which works as follows.

- The inputs consist of data and brief instructions about what to do with the data. These instructions come into the CPU from random access memory (RAM). Data might be entered by the user through the keyboard, for example, or read from a data file in another part of the computer. The inputs are stored in registers until they are sent to the next step in the processing.
- Data and instructions travel in the chip via electrical pathways called buses. The size of the bus — analogous to the width of a highway — determines how much information can flow at any time.
- The control unit directs the flow of data and instructions within the chip.
- The ALU receives the data and instructions from the registers and makes the desired computation. These data and instructions have been translated into **binary form** — that is, only 0s and 1s. A '0' or a '1' is called a **bit**. The CPU can process only binary data. All types of data, such as letters, decimal numbers, photographs, music and so on, can be converted to a binary representation, which can then be processed by the CPU.
- The data in their original form and the instructions are sent to storage registers and then are sent back to a storage place outside the chip, such as the computer's hard drive. Meanwhile, the transformed data go to another register and then on to other parts of the computer (e.g. to the monitor for display or to storage).

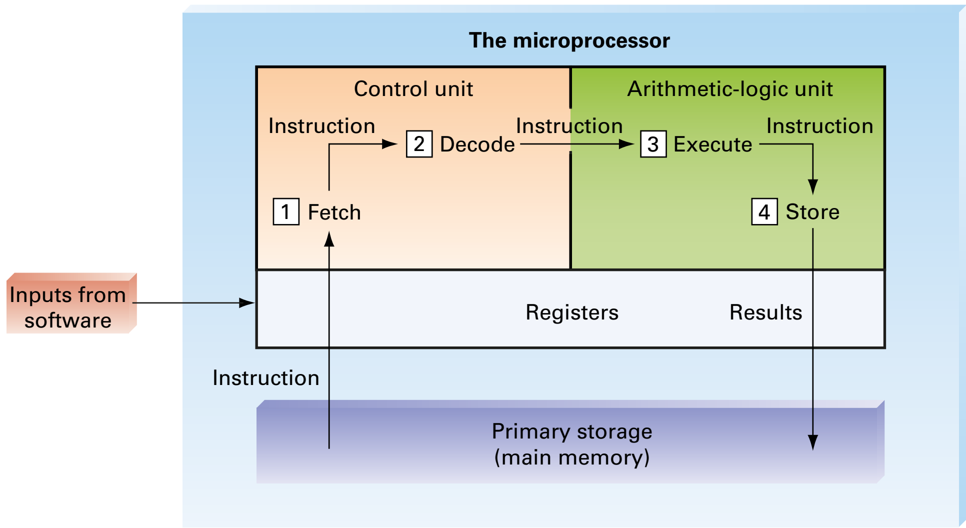

FIGURE PI2.3 How the CPU works.

TABLE PI2.3 Comparison of personal computer components over time

Year	Chip	RAM	Hard drive	Monitor
1997	Pentium II	64 megabytes	4 gigabytes	17-inch
2007	Dual-core	1 gigabyte	250 gigabytes	19-inch
2013	Quad-core	8 gigabytes	2 terabytes	23.5-inch

Intel offers excellent demonstrations of how CPUs work. Search the web for 'Intel' with 'explore the curriculum' to find their demos.

This cycle of processing, known as a *machine instruction cycle*, occurs billions of times per second.

Advances in microprocessor design

Innovations in chip designs are coming at an increasingly faster rate, as described by **Moore's law**. In 1965, Gordon Moore, a cofounder of Intel Corporation, predicted that microprocessor complexity would double approximately every two years. His prediction has been amazingly accurate.

The advances predicted from Moore's law arise mainly from the following changes.

- Producing increasingly miniaturised transistors.
- Placing multiple processors on a single chip. Chips with more than one processor are called *multicore* chips. For example, the Cell chip, produced by a consortium of Sony, Toshiba and IBM, contains nine processors. Computers using the Cell chip display very rich graphics. The chip is also used in TV sets and home theatres that can download and show large numbers of high-definition programs. Intel (**www.intel.com**) and AMD (**www.amd.com**) offer multicore chips.
- In 2013 Intel launched the 4th generation Intel® Core™ processor family. These processors offer responsive, secure and powerful performance for users, enabling them to create and consume content ubiquitously. The 4th generation Intel Core processors can deliver up to 15 per cent better performance than the previous generation, including low power requirements, high performance and superior graphics.[6]

In addition to increased speeds and performance, Moore's law has had an impact on costs, as you can see in Table PI2.3.

Computer memory

The amount and type of memory that a computer possesses has a great deal to do with its general utility. A computer's memory also determines the types of programs that the computer can run, the work it can perform, its speed and its cost. There are two basic categories of computer memory. The first is primary storage. It is called 'primary' because it stores small amounts of data and information that will be used immediately by the CPU. The second category is secondary storage, which stores much larger amounts of data and information (e.g. an entire software program) for extended periods.

Memory capacity

As you have seen, CPUs process only binary units — 0s and 1s — which are translated through computer languages into bits. A particular combination of bits represents a certain alphanumeric character or a simple mathematical operation. Eight bits are needed to represent any one of these characters. This 8-bit string is known as a **byte**. The storage capacity of a computer is measured in bytes. Bits typically are used as units of measure only for telecommunications capacity, as in how many million bits per second can be sent through a particular medium.

The hierarchy of terms used to describe memory capacity is as follows.

- *Kilobyte.* Kilo means 'one thousand', so a kilobyte (KB) is approximately 1000 bytes. In exact terms, a kilobyte is 1024 bytes. Computer designers find it convenient to work with powers of 2: 1024 is 2 to the 10th power, and 1024 is close enough to 1000 that for kilobyte people use the standard prefix *kilo*, which means exactly 1000 in familiar units such as the kilogram or kilometre.
- *Megabyte.* Mega means 'one million', so a megabyte (MB) is approximately 1 million bytes. Most personal computers have hundreds of megabytes of RAM memory.
- *Gigabyte.* Giga means 'one billion', so a gigabyte (GB) is approximately 1 billion bytes.
- *Terabyte.* A terabyte is approximately 1 trillion bytes. The storage capacity of modern personal computers can be several terabytes.
- *Petabyte.* A petabyte is approximately 1000 terabytes.
- *Exabyte.* An exabyte is approximately 1000 petabytes.
- *Zettabyte.* A zettabyte is approximately 1000 exabytes.

To get a feel for these amounts, consider the following example. If your computer has one terabyte of storage capacity on its hard drive (a type of secondary storage), it can store approximately 1 trillion bytes of data. If the average page of text contains about 2000 bytes, then your hard drive could store approximately 10 per cent of all the print collections of the Library of Congress in the United States, the largest library in the world. That same terabyte can store 70 hours of standard-definition compressed video.

Primary storage

Primary storage (or **main memory**, as it is sometimes called), stores three types of information for very brief periods of time: (1) data to be processed by the CPU, (2) instructions for the CPU as to how to process the data and (3) operating system programs that manage various aspects of the computer's operation. Primary storage takes place in chips mounted on the computer's main circuit board, called the *motherboard*, which are located as close as physically possible to the CPU chip. As with the CPU, all the data and instructions in primary storage have been translated into binary code.

The four main types of primary storage are (1) register, (2) cache memory, (3) random access memory (RAM) and (4) read-only memory (ROM).

Registers are part of the CPU. They have the least capacity, storing extremely limited amounts of instructions and data only immediately before and after processing.

Cache memory is a type of high-speed memory that enables the computer to temporarily store blocks of data that are used more often and that a processor can access more rapidly than main memory (RAM). Cache memory is physically located closer to the CPU than RAM. Blocks used less often remain in RAM until they are transferred to cache; blocks used infrequently remain in secondary storage. Cache memory is faster than RAM because the instructions travel a shorter distance to the CPU.

Random access memory (RAM) is the part of primary storage that holds a software program and small amounts of data for processing. When you start most software programs on your computer (such as Microsoft Word), the entire program is brought from secondary storage into RAM. As you use the program, small parts of the program's instructions and data are sent into the registers and then to the CPU. Compared with the registers, RAM stores more information and is located farther away from the CPU. However, compared with secondary storage, RAM stores less information and is much closer to the CPU.

RAM is temporary and, in most cases, volatile — that is, RAM chips lose their contents if the current is lost or turned off, as from a power surge, brownout, or electrical noise generated by lightning or nearby machines.

Most of us have lost data at one time or another due to a computer 'crash' or a power failure. What is usually lost is whatever is in RAM, cache or the registers at the time, because these types of memory are volatile. Therefore, you need greater security when you are storing certain types of critical data or instructions. Cautious computer users frequently save data to nonvolatile memory (secondary storage). In addition, most modern software applications have autosave functions. Programs stored in secondary storage, even though they are temporarily copied into RAM when they are being used, remain intact because only the copy is lost, not the original.

Read-only memory (ROM) is the place — actually, a type of chip — where certain critical instructions are safeguarded. ROM is nonvolatile, so it retains these instructions when the power to the computer is turned off. The read-only designation means that these instructions can only be read by the computer and cannot be changed by the user. An example of ROM is the instructions needed to start or 'boot' the computer after it has been shut off.

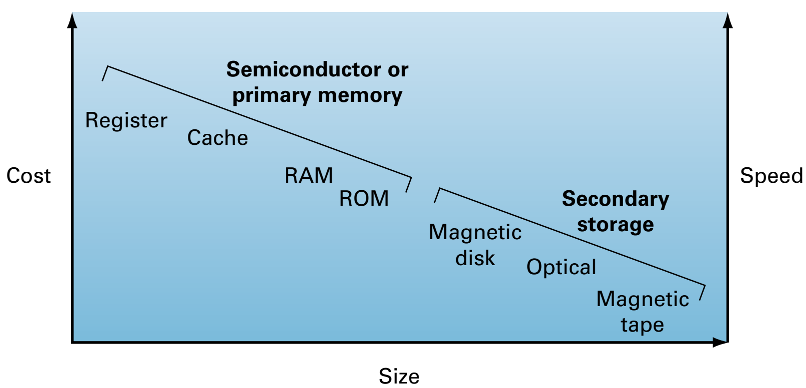

FIGURE PI2.4 Primary memory compared to secondary storage.

Secondary storage

Secondary storage is designed to store very large amounts of data for extended periods. Secondary storage has the following characteristics.

- It is nonvolatile.
- It takes more time to retrieve data from it than from RAM.
- It is cheaper than primary storage (see figure PI2.4).
- It can utilise a variety of media, each with its own technology, as you see next.

One secondary storage medium, **magnetic tape**, is kept on a large open reel or in a smaller cartridge or cassette. Although this is an old technology, it remains popular because it is the cheapest storage medium and it can handle enormous amounts of data. As a result, many organisations use magnetic tape for archival storage. The downside is that it is the slowest method for retrieving data because all the data are placed on the tape sequentially. **Sequential access** means that the system might have to run through the majority of the tape before it comes to the desired piece of data.

Magnetic disks (or **hard drives** or **fixed disk drives**) are the most commonly used mass storage devices because of their low cost, high speed and large storage capacity. Hard disk drives read from, and write to, stacks of rotating (at up to 15 000 rpm) magnetic disk platters mounted in rigid enclosures and sealed against environmental and atmospheric contamination. These disks are permanently mounted in a unit that may be internal or external to the computer.

Solid state drives (SSDs) are data storage devices that serve the same purpose as a hard drive and store data in memory chips. Where hard drives have moving parts, SSDs do not. SSDs use the same interface with the computer's CPU as hard drives and are therefore a seamless replacement for hard drives. SSDs offer many advantages over hard drives. They use less power, are silent and faster, and produce about one-third of the heat of a hard drive. The major disadvantage of SSDs is that they cost more than hard drives.

Unlike magnetic media, optical storage devices do not store data via magnetism. Rather, a laser reads the surface of a reflective plastic platter. Optical disk drives are slower than magnetic hard drives, but they are less susceptible to damage from contamination and are less fragile.

BEFORE YOU GO ON . . .

1. Decisions about hardware focus on what three factors?
2. What are the overall trends in hardware?
3. Define hardware and list the major hardware components.
4. Describe the computer hierarchy from the largest to the smallest computers.
5. Distinguish between human data-input devices and source-data automation.
6. Briefly describe how a microprocessor functions.
7. Distinguish between primary storage and secondary storage.

FIGURE PI2.5 USB flash drives are a popular form of electronic storage device due to their affordability and compact size.

In addition, optical disks can store a great deal of information, both on a routine basis and when combined into storage systems. Types of optical disks include compact disk read-only memory and digital video disk.

Compact disk read-only memory (*CD-ROM*) storage devices feature high capacity, low cost, and high durability. However, because a CD-ROM is a read-only medium, it cannot be written on. CD-R can be written to, but once this is done, what was written on it cannot be changed later. That is, CD-R is writeable, which CD-ROM is not, but is not rewriteable, which CD-RW (compact disk, rewritable) is. There are applications where not being rewriteable is a plus, because it prevents some types of accidental data destruction. CD-RW adds rewriteability to the recordable compact disk market.

The digital video disk (DVD) is a 5-inch disk with the capacity to store about 135 minutes of digital video. DVDs can also perform as computer storage disks, providing storage capabilities of 17 gigabytes. DVD players can read current CD-ROMs, but current CD-ROM players cannot read DVDs. The access speed of a DVD drive is faster than that of a typical CD-ROM drive.

A dual-layer *Blu-ray disc* can store 50 gigabytes, almost three times the capacity of a dual-layer DVD. Development of the Blu-ray technology is ongoing, with 10-layered Blu-ray discs being tested.

Flash memory devices (or memory cards) are nonvolatile electronic storage devices that contain no moving parts and use 30 times less battery power than hard drives. Flash devices are also smaller and more durable than hard drives. The trade-offs are that flash devices store less data than hard drives. Flash devices are used with digital cameras, hand-held and laptop computers, telephones, music players and video game consoles.

One popular flash memory device is the **USB flash drive** (also called memory stick, thumb drive or jump drive). These devices fit into Universal Serial Bus (USB) ports on personal computers and other devices, and they can store many gigabytes. USB drives have replaced magnetic floppy disks for portable storage (see figure PI2.5).

Apply the Concept

Background

Computer hardware components have an interesting relationship with software. The physical size of the processor and memory is decreasing while their performance (speed and capacity) are increasing. Other hardware improvements have opened a whole new possibility for computer software. For example, smart phone hardware has created a market for app developers that did not exist just a few years ago. What will be next as processors and memory continue to improve performance and decrease in size?

Activity

Conduct your own online research about the history of computer hardware. You will notice that we are living in a time where innovation is progressing at an amazing speed.

Look up the year that you were born and see what was going on with technology. Then research every 10th year since then and finish by reading the latest entries. For example, if you were born in 1985 and the year now is 2015, you would look up 1985, 1995, 2005 and 2015. You may need to research international sources to find more information.

Deliverable

Build a table that discusses the progression of technology since the year you were born. Highlight your favourite findings. Finally, predict how technology will have progressed by the end of the following decade (according to the example above, 2025).

Submit your work to your tutorial group.

PI2.2 Introduction to software

Computer hardware is only as effective as the instructions you give it, and those instructions are contained in **software**. The importance of computer software cannot be overestimated. The first software applications of computers in business were developed in the early 1950s. Software was less costly in computer systems then. Today, software comprises a much larger percentage of the cost of modern computer systems because the price of hardware has dramatically decreased, while the complexity and the price of software have dramatically increased.

The increasing complexity of software also leads to the increased potential for errors or *bugs*. Large applications today can contain millions of lines of computer code, written by hundreds of people over the course of several years. The potential for errors is huge, and testing and debugging software is expensive and time-consuming.

Regardless of the overall trends in software — increased complexity, increased cost and increasing numbers of defects — software has become an everyday feature of our business and personal lives.

You begin your examination of software by defining some fundamental concepts. Software consists of **computer programs**, which are sequences of instructions for the computer. The process of writing, or coding, programs is called programming. Individuals who perform this task are called programmers.

Computer programs include **documentation**, which is a written description of the functions of the program. Documentation helps the user operate the computer system, and it helps other programmers understand what the program does and how it accomplishes its purpose. Documentation is vital to the business organisation. Without it, if a key programmer or user leaves, the knowledge of how to use the program or how it is designed may be lost as well.

The computer is able to do nothing until it is instructed by software. Although computer hardware is, by design, general purpose, software enables the user to instruct a computer system to perform specific functions that provide business value. The two major types of software are systems software and application software. The relationship among hardware, systems software and application software is illustrated in figure PI2.6.

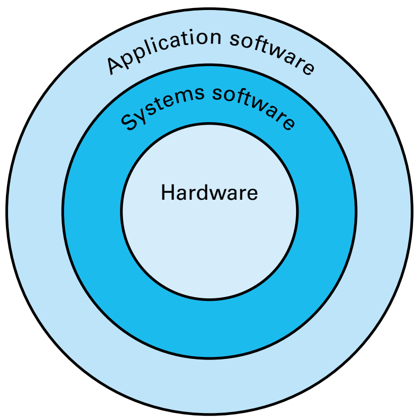

FIGURE PI2.6 Systems software services as intermediary between hardware and functional applications.

Systems software is a set of instructions that serves primarily as an intermediary between computer hardware and application programs. Systems software provides important self-regulatory functions for computer systems, such as loading itself when the computer is first turned on and providing commonly used sets of instructions for all applications. Systems programming refers to both the creation and the maintenance of systems software.

Application software is a set of computer instructions that provide more specific functionality to a user (figure PI2.7). That functionality may be broad, such as general word processing, or narrow, such as an organisation's payroll program. Essentially, an application program applies a computer to a certain need. *Application programming* refers to both the creation and the modification and improvement of application software. Application software may be proprietary or off the shelf. As you shall see, many different software applications are used by organisations today.

FIGURE PI2.7 Application software.

Software issues

The importance of software in computer systems has brought new issues to the forefront for organisational managers. These issues include software defects (bugs), software evaluation and selection, licensing, open systems and open-source software.

Software defects

All too often, computer program code is inefficient, poorly designed and riddled with errors. The Software Engineering Institute (SEI) at US tertiary institution Carnegie Mellon University in Pennsylvania, defines good software as usable, reliable, defect free, cost effective and maintainable. As you become increasingly dependent on computers and networks, the risks associated with software defects are bound to worsen.

The SEI maintains that, on average, professional programmers make between 100 and 150 errors in every 1000 lines of code they write. Fortunately, the software industry recognises this problem. Unfortunately, however, the problem is enormous, and the industry is taking only initial steps to resolve it. One critical step is better design and planning at the beginning of the development process (discussed in chapter 14).

Software licensing

Although many people routinely copy software, making copies without the manufacturer's explicit permission is illegal. The Business Software Alliance (BSA) is a not-for-profit trade association dedicated to promoting a safe and legal digital world. It collects, investigates and acts on software piracy tips. Most tips come from current and past employees of offending companies. The Business Software Alliance (BSA, **www.bsa.org**) has calculated that software piracy costs software vendors around the world billions of dollars annually.

To protect their investment, software vendors must protect their software from being copied and distributed by individuals and other software companies. In Australia, intellectual property (IP), including patents, trademarks and designs, is administered by IP Australia (**www.ipaustralia.gov.au**). Copyright protection, which includes protection of databases and computer programs, is free and automatic in Australia, and is covered by the Attorney-General's Department (**www.ag.gov.au**). According to the BSA, increasing the number of licensed software in Asia-Pacific by 1 per cent could add US$18.7 billion to the regional economy, which represents US$12.7 billion more than the US$6 billion benefit from using pirated software.[7] Results of a global IDC survey published in *The Australian* reveal that 43 per cent of surveyed organisations accept that they lack processes needed for managing their software licences, which puts them at risk of failing licence compliance audits and as a result prone to significant penalties.[8] At least in part this problem is exacerbated by increasing trends of bring-your-own-device (BYOD) and cloud computing. The techniques used to counter problems of this nature include use of network licensing according to which software used is validated against a local licence server. Alternative techniques include using nodelock, where software is locked to a unique identifier on a device.[9]

Open systems

The concept of **open systems** refers to a model of computing products that work together. To achieve this goal, the same operating system with compatible software must be installed on all the different computers that interact with one another within an organisation. A complementary approach is to produce application software that will run across all computer platforms. If hardware, operating systems and application software are designed as open systems, the user will be able to purchase the best software, called 'best of breed', for the job without worrying whether it will run on particular hardware.

Open-source Software. There is a trend within the software industry away from proprietary software towards open-source software. **Proprietary software** is software that has been developed by a company and has restrictions on its use, copying and modification. The company developing such software spends money and time on research and development of its software product and then sells it in the marketplace. The proprietary nature of the software means that the company keeps the source code — the actual computer instructions — private (as Coca-Cola does with its formula).

In contrast, the source code for open-source software is available at no cost to developers and users. Open-source software is copyrighted and distributed with license terms ensuring that the source code will always be available.

Open-source software products have worldwide 'communities' of developers who write and maintain the code. Inside each community, however, only a small group of developers, called core developers, is allowed to modify or submit changes to the code. Other developers submit code to the core developers.

There are advantages and disadvantages to implementing open-source software in an organisation. According to the Open Source Initiative (**www.opensource.org**), open-source development produces high-quality, reliable, low-cost software. This software is also flexible, meaning that the code can be modified to meet the needs of the user. In many cases, open-source software is more reliable than commercial software. Because the code is available to many developers, more bugs are discovered early and they are fixed immediately. Support for open-source software is also available from firms that provide products derived from the software. An example is Red Hat for Linux (**www.redhat.com**). These firms provide education, training and technical support for the software for a fee.

Open-source software also has disadvantages, however. The biggest disadvantage is that companies using open-source software are dependent on the continued goodwill of an army of volunteers for enhancements, bug fixes and so on, even if these companies contract for support. Some companies will not accept this risk, even though as a practical matter the support community for Linux, Apache or Firefox is not likely to disappear. Further, organisations that do not have in-house technical experts will have to buy maintenance-support contracts from a third party. In addition, questions have arisen concerning the ease of use of open-source software, the amount of time and expense needed to train users, and the compatibility with existing systems or with the systems of business partners.

There are many examples of open-source software, including GNU (GNU's Not UNIX) suite of software (**www.gnu.org**) developed by the Free Software Foundation (**www.fsf.org**); Linux operating system (**www.linux.com**); Apache web server (**www.apache.org**); sendmail SMTP (Send Mail Transport Protocol) email server (**www.sendmail.org**); Perl programming language (**www.perl.org**); Firefox browser from Mozilla (**www.mozilla.org**); and the OpenOffice applications suite (**www.openoffice.org**). In fact, there are more than 150 000 open-source projects under way on SourceForge (**www.sourceforge.net**), the popular open-source hosting site.

Linux and Apache are excellent examples of how open-source software is moving to the mainstream. Linux is gaining market share in servers. It now runs on approximately one-quarter of all servers, whereas Microsoft runs on about two-thirds of all servers. Further, almost two-thirds of the world's web servers now run Apache, compared to one-third for Microsoft.

Many organisations use open-source software. For example, recent evidence shows that the open-source Drupal content management system is becoming popular amongst Federal government agencies in Canberra.[10]

Systems software

As noted, systems software is the class of programs that control and support the computer system and its information-processing activities. Systems software also facilitates the programming, testing and debugging of computer programs. Systems software programs support application software by directing the basic functions of the computer. For example, when the computer is turned on, the initialisation program (a systems program) prepares and readies all devices for processing. The major type of systems software with which we are concerned is the operating system.

The **operating system (OS)** is the director of your computer system's operations. It supervises the overall operation of the computer, including monitoring the computer's status, scheduling operations, and managing the input and output processes. The operating system also provides an interface between the user and the hardware.

This user interface hides the complexity of the hardware from the user. That is, you do not have to know how the hardware actually operates. You simply have to know what the hardware will do and what you need to do to obtain desired results.

The ease or difficulty of the interaction between the user and the computer is determined largely by the user interface. The **graphical user interface (GUI)** allows users to exercise direct control of visible objects (such as icons) and actions that replace complex commands.

The next generation of GUI technology will incorporate features such as virtual reality, head-mounted displays, speech input (user commands) and output, pen and gesture recognition, animation, multimedia, artificial intelligence and cellular/wireless communication capabilities. The new interfaces, called natural user interfaces (NUIs), will combine haptic interfaces, social interfaces and touch-enabled gesture-control interfaces.

A **haptic interface** allows the user to feel a sense of touch by applying forces, vibrations and/or motions to the user. A **social interface** is a user interface that guides the user through computer applications by using cartoonlike characters, graphics, animation and voice commands. The cartoonlike characters can be cast as puppets, narrators, guides, inhabitants or avatars (computer-generated humanlike figures). Social interfaces are hard to do without being corny. For example, most users of Microsoft Office 97 found the assistant 'Clippy' so annoying that it was deleted from Office 2003 and later versions.

Motion control gaming consoles are another type of interface. Three major players currently offer this interface: Xbox 360 Kinect, PS3 PlayStation Move and Nintendo Wii.

- Kinect tracks your movements without a physical controller, has voice recognition and accommodates multiple players.
- PlayStation Move uses a physical controller with motion-sensing electronics, making it the technological 'cross' between Kinect and Wii. Move requires each player to use a wand.
- Wii uses a physical controller (see figure PI2.8). Compared to Kinect and Move, Wii has been on the market longer, has the biggest library of motion-sensing games and is the least expensive system. However, Wii has the least accurate motion sensing of the three systems and it is not available in high-definition, whereas Kinect and Move are.

Touch-enabled gesture-control interfaces enable users to browse through photos, 'toss' objects around a screen, 'flick' to turn the pages of a book, play video games and watch movies. Examples of this type of interface are Microsoft Surface and the Apple iPhone.

Microsoft Surface is presently being promoted to Australian corporate users as part of the 'Choose your own device' (CYOD) strategy which is expected to enhance employee productivity through working anytime anywhere.[11]

Well-known desktop operating systems include Microsoft Windows (**www.microsoft.com**), Apple Mac OS X (**www.apple.com**), Linux (linux.com) and Google Chrome OS (**www.google.com/**). As their developers release new versions with new features, they often give the new version a new designation. For example, the latest version of Windows is Windows 7 and the latest version of OS X is Snow Leopard or OS X 10.6.

FIGURE PI2.8 Nintendo Wii controller.

Application software

As noted, application software consists of instructions that direct a computer system to perform specific information-processing activities and that provide functionality for users. Because there are so many different uses for computers, there are a correspondingly large number of application software programs.

Application software may be developed in house by the organisation's information systems personnel, or it may be commissioned from a software vendor. Alternatively, it can be purchased, leased or rented from a vendor that develops programs and sells them to many organisations. This 'off-the-shelf' software may be a standard package, or it may be customisable. Special-purpose programs or 'packages' can be tailored for a specific purpose, such as inventory control or payroll. The term **package** is commonly used for a computer program (or group of programs) that has been developed by a vendor and is available for purchase in a prepackaged form.

TABLE PI2.4 Personal application software

Category of personal application software	Major functions	Examples
Spreadsheets	Use rows and columns to manipulate primarily numerical data; useful for analysing financial information, and for what-if and goal-seeking analyses	Microsoft Excel Corel Quattro Pro Apple iWork Numbers
Word processing	Allows users to manipulate primarily text with many writing and editing features	Microsoft Word Apple iWork Pages
Desktop publishing	Extends word processing software to allow production of finished, camera-ready documents, which may contain photographs, diagrams and other images combined with text in different fonts	Microsoft Publisher QuarkXPress
Data management	Allows users to store, retrieve and manipulate related data	Microsoft Access FileMaker Pro

Category of personal application software	Major functions	Examples
Presentation	Allows users to create and edit graphically rich information to appear on electronic slides	Microsoft PowerPoint Apple iWork Keynote
Graphics	Allow users to create, store and display or print charts, graphs, maps and drawings	Adobe PhotoShop Corel DRAW
Personal information management	Allows users to create and maintain calendars, appointments, to-do lists and business contacts	IBM Lotus Notes Microsoft Outlook
Personal finance	Allows users to maintain cheque books, track investments, monitor credit cards, bank and pay bills electronically	Quicken Microsoft Money
Web authoring	Allows users to design websites and publish them on the web	Microsoft FrontPage Adobe Dreamweaver
Communications	Allows users to communicate with other people over any distance	Microsoft Outlook

General-purpose application programs designed to help individual users increase their productivity are referred to as **personal application software**. Some of the major types of personal application software are listed in Table PI2.4. Software suites combine some of these packages and integrate their functions. Microsoft Office is a well-known example of a software suite.

Speech recognition software is an input technology, rather than strictly an application, that can feed systems software and application software. **Speech recognition software**, or **voice recognition software**, recognises and interprets human speech, either one word at a time (discrete speech) or in a conversational stream (continuous speech).

Advances in processing power, new software algorithms and better microphones have enabled developers to design extremely accurate voice recognition software. Experts predict that, in the near future, voice recognition systems will likely be built into almost every device, appliance and machine that people use. Applications for voice recognition technology abound. Consider the following examples.

- National Australia Bank (NAB) is focusing on voice recognition for customer identification in its call centres. Unlike the fingerprint which has around 40 security points, voice has approximately 120, which makes it a robust approach for ensuring customer security and authentication.[12] Specifically, NAB customers can opt-in to be authenticated[13] by way of voice recognition when they call in to NAB call centres.[14] According to NAB, this technology will save its customers collectively approximately 15 million minutes annually.[15]
- To enhance the security of its mobile banking applications, the ANZ is planning to use voice recognition software that enables customers to authorise large cash transfers to external accounts.[16] Presently, ANZ customers are not allowed to use the 'paying anyone' function to transfer $1000 or more using the ANZ smart phone application. After deployment, ANZ customers can authorise higher-value payments by providing a password and speaking into their phone. The ANZ's application would subsequently compare customer voice to a digital 'voiceprint' already stored in a bank database.[17]
- Siri (Speech Interpretation and Recognition Interface) is an intelligent personal assistant and knowledge navigator that works as an application on a range of Apple products. Siri was first included in iPhone 4S, and subsequently in iPhone 5, iPhone 5C, iPhone 5S, iPod Touch (5th generation), iPad (4th generation), iPad Air and the iPad Mini, to mention a few examples.[18] The application uses a natural language user interface to answer questions, make recommendations (for example, recommendations for a nearby seafood restaurant) and perform other actions such as providing directions.

BEFORE
YOU GO ON . . .

1. What does the following statement mean? 'Hardware is useless without software.'
2. What are the differences between systems software and application software?
3. What is open-source software and what are its advantages? Can you think of any disadvantages?
4. Describe the functions of the operating system.

Apple claims that the software adapts to the user's individual preferences over time and personalises results.

- 3M Australia has recently implemented Speakeasy, an application developed by Wavelink, in its Australian distribution centre in order to improve and streamline picking and increase productivity.[19] Speakeasy is a voice directed warehouse management system. There is evidence to suggest that Speakeasy can deliver 99 per cent accuracy and a 10 per cent improvement in productivity in warehouse functions including data entry, picking and processing.[20] Early reports at 3M Australia indicate that the Wavelink Speakeasy implementation will generate tremendous benefits. In fact, Daniel La Greca, 3M Australia's distribution centre's manager, is quoted as saying that[21] 'Our people love the fact that now they can keep their eyes on the ball by speeding-up the scanning stage. I'm confident that the ability for us to do all of our picking functions without constantly setting down and picking up devices will save a significant amount of time, resulting in savings and new efficiencies, thus extending our leadership position.'
- Presently, the Australian Passport Office (APO) which operates within the Department of Foreign Affairs and Trade (DFAT),[22] is considering enhancing the present facial recognition capability information in Australian passports to include voice recognition, fingerprint and iris metrics.[23]
- Nuance's Dragon NaturallySpeaking (australia.nuance.com) allows for accurate voice-to-text and email dictation.

Apply the Concept

Background

Have a look back at figure PI2.6. You will notice that hardware is the central component and the OS and applications are then installed on the hardware. Imagine that there is another ring called 'input/output hardware' that encircles the entire figure. Given the recent increases in internet bandwidth and hardware capabilities, many software services are being delivered through the web, with minimal hardware requirements. Effectively, this has separated the computer such that the primary hardware and software is receiving inputs from a separate device.

Activity

OnLive is a company that focuses on online gaming and virtual desktops – visit their website to explore their offerings. In the case of this company's online desktop, the software of the desktop is displayed on a mobile device (smart phone or tablet) while the software actually runs on hardware that is kept at a distance. There will be more on this later in Plug IT In 3.

For this activity, consider the pros and cons of your data processing and data storage taking place on remote hardware. In this case, you are strictly working with the software.

Deliverable

Build a table of advantages and disadvantages. Consider scenarios where you may experience physical losses locally (such as fire or theft) — perhaps your internet connection is lost, perhaps the server for the software provider fails. Your table will be similar to the following.

Scenario	Advantage	Disadvantage

WHAT'S IN IT FOR ME?

Hardware

FOR ALL BUSINESS MAJORS

The design of computer hardware has profound impacts for businesspeople. Personal and organisational success can depend on an understanding of hardware design and a commitment to knowing where it is going and what opportunities and challenges hardware innovations will bring. Because these innovations are occurring so rapidly, hardware decisions at both the individual level and at the organisational level are difficult.

At the individual level, most people who have a home or office computer system and want to upgrade it, or people who are contemplating their first computer purchase, are faced with the decision of when to buy as much as what to buy and at what cost. At the organisational level, these same issues plague IS professionals. However, they are more complex and more costly. Most organisations have many different computer systems in place at the same time. Innovations may come to different classes of computers at different times or rates. Therefore, managers must decide when old hardware legacy systems still have a productive role in the organisation and when they should be replaced. A legacy system is an old computer system or application that continues to be used, typically because it still functions for the users' needs, even though newer technology is available.

Software

FOR THE ACCOUNTING MAJOR

Accounting application software performs the organisation's accounting functions, which are repetitive and high volume. Each business transaction (e.g. a person hired, a pay cheque produced, an item sold) produces data that must be captured. After accounting applications capture the data, they manipulate them as necessary. Accounting applications adhere to relatively standardised procedures, handle detailed data and have a historical focus.

FOR THE FINANCE MAJOR

Financial application software provides information about the firm's financial status to persons and groups inside and outside the firm. Financial applications include forecasting, funds management and control applications. Forecasting applications predict and project the firm's future activity in the economic environment. Funds management applications use cash flow models to analyse expected cash flows. Control applications enable managers to monitor their financial performance, typically by providing information about the budgeting process and performance ratios.

FOR THE MARKETING MAJOR

Marketing application software helps management solve problems that involve marketing the firm's products. Marketing software includes marketing research and marketing intelligence applications. Marketing applications provide information about the firm's products and competitors, its distribution system, its advertising and personal selling activities, and its pricing strategies. Overall, marketing applications help managers develop strategies that combine the four major elements of marketing: product, promotion, place and price.

FOR THE PRODUCTION/OPERATIONS MANAGEMENT MAJOR

Managers use production/operations management (POM) applications software for production planning and as part of the physical production system. POM applications include production, inventory, quality and cost software. These applications help management operate manufacturing facilities and logistics. Materials requirements planning (MRP) software is also widely used in manufacturing. This software identifies which materials will be needed, what quantities will be needed and the dates on which they will be needed. This information enables managers to be proactive.

FOR THE HUMAN RESOURCES MANAGEMENT MAJOR

Human resources management application software provides information concerning recruiting and hiring, education and training, maintaining the employee database, termination and administering benefits. HRM applications include workforce planning, recruiting, workforce management, compensation, benefits and environmental reporting subsystems (e.g. equal employment opportunity records and analysis, union enrolment, toxic substances and grievances).

FOR THE MIS MAJOR

If your company decides to develop software itself, the MIS function is responsible for managing this activity. If the company decides to buy software, the MIS function deals with software vendors in analysing their products. The MIS function is also responsible for upgrading software as vendors release new versions.

SUMMARY

1 Discuss strategic issues that link hardware design to business strategy.

Strategic issues linking hardware design to business strategy encompass the following questions. How do organisations keep up with the rapid price/performance advancements in hardware? How often should an organisation upgrade its computers and storage systems? How can organisations measure benefits gained from price/performance improvements in hardware?

2 Differentiate between the two major types of software.

Software consists of computer programs (coded instructions) that control the functions of computer hardware. The two main categories of software are systems software and application software. Systems software manages the hardware resources of the computer system; it functions between the hardware and the application software. Systems software includes the system control programs (operating systems) and system support programs. Application software enables users to perform specific tasks and information-processing activities. Application software may be proprietary or off the shelf.

>>> GLOSSARY

application software The class of computer instructions that directs a computer system to perform specific processing activities and provide functionality for users.

arithmetic-logic unit (ALU) Portion of the CPU that performs the mathematic calculations and makes logical comparisons.

binary form The form in which data and instructions can be read by the CPU — only 0s and 1s.

bit Short for *binary digit* (0s and 1s), the only data that a CPU can process.

byte An 8-bit string of data, needed to represent any one alphanumeric character or simple mathematical operation.

cache memory A type of high-speed memory that enables the computer to temporarily store blocks of data that are used more often and that a processor can access more rapidly than main memory (RAM).

central processing unit (CPU) Hardware that performs the actual computation or 'number crunching' inside any computer.

computer programs The sequences of instructions for the computer, which comprise software.

control unit Portion of the CPU that controls the flow of information.

documentation Written description of the functions of a software program.

fat clients Desktop computer systems that offer full functionality.

flash memory devices Nonvolatile electronic storage devices that are compact, are portable, require little power and contain no moving parts.

graphical user interface (GUI) System software that allows users to have direct control of visible objects (such as icons) and actions, which replace command syntax.

haptic interface Allows the user to feel a sense of touch by applying forces, vibrations and/or motions to the user.

laptop computers (notebook computers) Small, easily transportable, lightweight microcomputers.

magnetic disks (or hard drives or fixed disk drives) A form of secondary storage on a magnetised disk divided into tracks and sectors that provide addresses for various pieces of data.

magnetic tape A secondary storage medium on a large open reel or in a smaller cartridge or cassette.

mainframes Relatively large computers used in large enterprises for extensive computing applications that are accessed by thousands of users.

microcomputers The smallest and least expensive category of general-purpose computers; also called micros, personal computers or PCs.

microprocessor The CPU, made up of millions of transistors embedded in a circuit on a silicon wafer or chip.

minicomputers Relatively small, inexpensive and compact midrange computers that perform the same functions as mainframe computers, but to a more limited extent.

Moore's law Prediction by Gordon Moore, an Intel cofounder, that microprocessor complexity would double approximately every two years.

multimedia technology Computer-based integration of text, sound, still images, animation and digitised full-motion video.

netbook A very small, lightweight, low-cost, energy-efficient, portable computer, typically optimised for internet-based services such as web browsing and emailing.

notebook computer (see laptop computer)

open-source software Software made available in source code form at no cost to developers.

open systems A model of computing products that work together by use of the same operating system with compatible software on all the different computers that would interact with one another in an organisation.

operating system (OS) The main system control program, which supervises the overall operations of the computer, allocates CPU time and main memory to programs, and provides an interface between the user and the hardware.

optical storage devices A form of secondary storage in which a laser reads the surface of a reflective plastic platter.

package Common term for a computer program developed by a vendor and available for purchase in prepackaged form.

personal application software General-purpose application programs that support general types of processing, rather than being linked to any specific business function.

primary storage (also called main memory) High-speed storage located directly on the motherboard that stores data to be processed by the CPU, instructions telling the CPU how to process the data and operating systems programs.

proprietary software Software that has been developed by a company and has restrictions on its use, copying and modification.

random access memory (RAM) The part of primary storage that holds a software program and small amounts of data when they are brought from secondary storage.

read-only memory (ROM) Type of primary storage where certain critical instructions are safeguarded; the storage is nonvolatile and retains the instructions when the power to the computer is turned off.

registers High-speed storage areas in the CPU that store very small amounts of data and instructions for short periods.

secondary storage Technology that can store very large amounts of data for extended periods.

sequential access Data access in which the computer system must run through data in sequence to locate a particular piece.

server Smaller midrange computers that support networks, enabling users to share files, software and other network devices.

social interface A user interface that guides the user through computer applications by using cartoonlike characters, graphics, animation and voice commands.

software A set of computer programs that enable the hardware to process data.

solid state drives (SSDs) Data storage devices that serve the same purpose as a hard drive and store data in memory chips.

speech recognition software (or voice recognition software) Software that recognises and interprets human speech, either one word at a time (discrete speech) or in a stream (continuous speech).

supercomputer Computers with the most processing power available; used primarily in scientific and military work for computationally demanding tasks on very large data sets.

systems software The class of computer instructions that serve primarily as an intermediary between computer hardware and application programs; provides important self-regulatory functions for computer systems.

tablet computer (or tablet) A complete computer contained entirely in a flat touch screen that uses a stylus, digital pen or fingertip as an input device instead of a keyboard or mouse.

thin-client systems Desktop computer systems that do not offer the full functionality of a PC.

USB flash drive Storage device that fits into the USB port of a personal computer and is used for portable storage.

voice recognition software (see speech recognition software)

>>> DISCUSSION QUESTIONS

1 If you were the CIO of a firm, what factors would you consider when selecting secondary storage media for your company's records?

2 Given that Moore's law has proved itself over the past two decades, speculate on what chip capabilities will be in ten years. What might your desktop PC be able to do?

3 If you were the CIO of a firm, how would you explain the workings, benefits and limitations of using thin clients as opposed to fat clients?

4 You are the CIO of your company, and you have to develop an application of strategic importance to your firm. What are the advantages and disadvantages of using open-source software?

5 You have to take a programming course, or maybe more than one, in your MIS program. Which programming language(s) would you choose to study? Why? Should you even have to learn a programming language? Why or why not?

>>> PROBLEM-SOLVING ACTIVITIES

1 Access the websites of the major chip manufacturers — for example, Intel (www.intel.com), Motorola (www.motorola.com) and Advanced Micro Devices (www.amd.com) — and obtain the latest information regarding new and planned chips. Compare performance and costs across these vendors. Be sure to take a close look at the various multicore chips.

2 Access 'The Journey Inside' on Intel's website. Prepare a presentation of each step in the machine instruction cycle.

3 A great deal of software is available for free over the internet. Go to http://wiley.com/go/rainer/problemsolving, and observe all the software that is available for free. Choose one software program and download it to your computer. Prepare a brief discussion about the software for your class.

4 Enter the IBM website (www.ibm.com.au). Click on the drop box for 'Products' and notice how many software products IBM produces. Is IBM only a hardware company?

5 Compare the following proprietary software packages with their open-source software counterparts and prepare your comparison for the class.

Proprietary	Open Source
Microsoft Office	Google Docs, OpenOffice
Adobe Photoshop	Picnik.com, Google Picasa

>>> ENDNOTES

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