Chapter 2

Information Technology and AISs

After reading this chapter, you will:

1. *Be able to describe* why information technology is important to accounting information systems, and why accountants should know about this technology.
2. *Understand* why computer processor speeds are not particularly important to most accounting information systems.
3. *Be familiar with* source documents and why they are important to AISs.
4. *Know* some common AIS uses for POS input, MICR media, and OCR.
5. *Be able to explain* in general terms the value of secondary storage devices to AISs.
6. *Understand* why data communications are important to AISs.
7. *Be able to describe* some advantages of client/server computing.
8. *Be able to explain* the advantages and disadvantages of cloud computing.

Business does not operate independently of technology. It never did . . . Business analysis cannot operate without considering the impact of technology. It never could . . .

Robert Scott, ''Knowing the Tech Talk'' *Accounting Technology* Vol. 20, No. 3 (April 2004), p. 4.

INTRODUCTION

In automated accounting systems, **information technology (IT)** serves as a platform upon which other system components rely. The purpose of this chapter is to discuss IT subjects in detail, especially as they relate to AISs. Because most students in AIS courses have already taken a survey computer class, the discussions here are brief. This chapter may nonetheless be useful as a review of computer hardware and software concepts, or as a study of how IT helps organizations accomplish strategic accounting goals.

It is helpful to view an accounting information system as a set of five interacting components: (1) hardware, (2) software, (3) data, (4) people, and (5) procedures. Computer hardware is probably the most tangible element in this set, but ''hardware'' is only one piece of the pie—and not necessarily the most important piece. For example, most organizations spend more money on people (in wages and salaries) than they do on computer hardware and software combined. Similarly, computer hardware must work together with the other system components to accomplish data processing tasks. Without computer software, for example, the hardware would stand idle. Without data to process, both the hardware and the software would be useless. Without procedures, accounting data could not be gathered accurately or distributed properly. And finally, without people, it is doubtful that the rest of the system could operate for long or be of much use.

What all this means is that ''information technology'' is a fuzzy term that includes more than computer hardware. In this chapter, we concentrate on computer hardware (in the next three sections of the chapter) and software (in the final section). But you should remember that these items must interact with all the other system components to create successful AISs.

Case-in-Point 2.1 CPA Crossings is a small consulting company in Rochester, Minnesota, that provides IT services to both CPA firms and the organizations they serve. In helping companies install document management systems, general partner John Higgins notes that such matters as (1) defining work flow policies and procedures, and (2) understanding the difference between document management systems and electronic documents themselves are the keys to successful implementations—not "technology."[1]

THE IMPORTANCE OF INFORMATION TECHNOLOGY TO ACCOUNTANTS

Although it may be tempting to dismiss ''information technology'' as more important to computer people than accountants, this would be a mistake. In fact, most of the references at the end of this chapter make clear that ''IT'' and ''accounting systems'' are intimately related. Here are six reasons why IT is important to accountants.

[1]Source: John H. Higgins, ''Street Talk: Reader Views'' *Accounting Technology* Vol. 22, No. 3 (April 2006), p. 7.

Six Reasons

One reason for IT's importance is because information technology must be compatible with, and support, the other components of an AIS. For example, to automate the accounting system of a dry-cleaning business, the owners will have to consider what tasks they'll want their system to accomplish, identify what software package or packages can perform these tasks, and perhaps evaluate several different computer hardware configurations that might support these packages. These concerns are the subject of ''systems analysis''—the topic covered in Chapter 13.

A second reason why information technology is important is because accounting professionals often help clients make hardware and software purchases. For example, large expenditures on computer systems must be cost-justified—a task usually performed with accounting expertise and assistance. For this reason, many consulting firms now specialize in, or have departments for, management advisory services to perform these consulting tasks. Understanding IT is critical to these efforts.

A third reason why information technology is important to accountants is because auditors must evaluate computerized systems. Today, it is no longer possible for auditors to treat a computer as a ''black box'' and audit around it. Rather, auditors now commonly audit through or with a computer. This means that auditors must understand automation and automated controls, and also be able to identify a computerized system's strengths and weaknesses. We discuss these matters in Chapter 14.

A fourth reason why IT is important to accountants is because they are often asked to evaluate the efficiency (for example, costliness and timeliness) and effectiveness (usually strategic value) of an existing system. This is a daunting task, requiring a familiarity with the strengths and weaknesses of the current system, as well as an understanding of what alternate technologies might work better.

A fifth reason why information technology is important to accountants is because IT profoundly affects the way they now work, and how they will work in the future. This includes new ways of gathering and recording information, new types of systems that accountants will use (both to perform personal tasks and to communicate their work to others), new types of hardware, software, and computer networks upon which these systems will run, and even new ways to audit these systems.

Case-in-Point 2.2 Target is a retailer with 1,591 stores in the United States (in 2008) and over $65 billion in retail sales. Many of its suppliers claim that the chain's sophisticated technology is "the best in the business," enabling managers to make fast, accurate decisions on its many merchandising operations. Attention to detail is also important, including color-coding department areas within the store and automating operations at checkout stands. Says Target president Kenneth Woodrow, "If people have to wait in line, it means we don't respect their time."[2]

A final reason why information technology is important to accountants is because understanding how IT affects accounting systems is vital to passing most accounting certification examinations. For example, sections of both the CPA and CMA examinations contain questions about information technology.

[2]Source: Jim Frederick, ''Target Adheres to Core Strategy in Midst of Tough Economy'' *Drug Store News* Vol. 30, No. 5 (April 21, 2008), p. 130.

The Top Ten Information Technologies

Annually, the AICPA conducts a voluntary annual survey of its members to identify the ''top 10 information system technologies'' affecting the study and practice of accounting. Figure 2-1 provides the set for 2008. For the fifth year in a row, ''information security'' tops the list, although the general topic of ''security'' involves almost all the other items in the list as well.

Because of their importance, we discuss many of the items in Figure 2-1 in various chapters of the text itself. For example, Chapters 10, 11, 12, and 15 discuss the topic of ''information security'' (item 1 on the list). Similarly, we discuss ''assurance and compliance standards'' in Chapter 14, ''identity and access management'' in Chapter 12, ''mobile and remote computing'' here, and ''disaster recovery'' in Chapter 12.

INPUT, PROCESSING, AND OUTPUT DEVICES

Figure 2-2 suggests that the hardware of a computer system includes the computer itself—for example, a microcomputer—as well as the keyboards, printers, hard disks, and similar devices that help the computer perform input and output tasks. These devices are commonly called **peripheral equipment** because they typically surround the computer and help it process data.

One way to classify peripheral equipment is by the tasks they perform. Thus, *input equipment* (such as computer mice and keyboards) enable users to enter data into a computer system, *output equipment* (such as monitors and printers) enable users to see processed results, *secondary storage devices* (such as hard disks) enable users to store data for future reference, and *communications equipment* (such as internal networking cards) enable users to transmit data over data networks. Like any other system, these distinct pieces of computer equipment must work together to accomplish data processing tasks.

Most accounting transactions are processed in a three-phase operation called the **input-processing-output cycle**. For convenience, we shall look at technologies that assist AISs in each of these areas in this order.

Input Devices

The starting point of the input-processing-output cycle—especially when processing accounting data—is input. Thus, even where the amount of data is small, most AISs require input methods and procedures that ensure complete, accurate, authentic, timely, and cost-effective ways of gathering and inputting accounting data. Usually, there are several ways of capturing accounting data, so system designers must pick those input procedures and devices that best meet these system objectives.

Source Documents and Data Transcription. The starting point for collecting accounting data in most AISs is a **source document**. Manual examples include time cards, packing slips, survey forms, employee application forms, patient intake forms, purchase

Rank	Item	Explanation
1	Information Security	The ability to protect the components of an AIS from such threats as viruses, password intrusions, and physical harm.
2	Identity and Access Management	The hardware, software, and procedural tools that enable organizations to identify and authenticate individuals uniquely. Examples include passwords, digital certificates, and biometrics.
3	Conforming to Assurance and Compliance Standards	Software tools that enable organizations to create, document, monitor, assess, test, and report on their compliance with specified controls. This encompasses risk management, risk assessment, and continuous auditing.
4	Privacy Management	Protecting the rights and meeting the responsibilities of collecting, storing, using, and disclosing personal information—especially information in digital formats.
5	Disaster Planning and Recovery	The ability to continue business operations in the event that a disaster (such as an earthquake) occurs.
6	IT Governance	Relationships and processes that help organizations achieve strategic goals while balancing risks and returns in IT operations.
7	Securing and Controlling Information Distribution	Protecting and securing the transmission and distribution of digital data—for example, using encryption systems.
8	Digital Identity and Authentication Technologies	Methods that verify users are who they say they are, and also non-repudiation techniques.
9	Wireless Technology	The ability to transmit voice and data via airwaves, thus avoiding the need for physical connectivity.
10	Mobile and Remote Computing	Hardware, software, and procedures that enable users to connect securely to computer systems remotely, using such technologies as wireless PDAs, Bluetooth, WiFi, and WiMax.
11	Electronic Archiving and Data Retention	Technologies that enable organizations to archive and retrieve digital information efficiently and securely—for example, using Direct Attached Storage (DAS), Network Attached Storage (NAS), and Storage Area Networks (SANs), or optical devices such as DVDs, CDs, and Blu-Ray. This includes policies for both the backup and destruction of archived data.
12	Document, Content, and Knowledge Management	Methodologies for capturing, storing, indexing, retrieving, searching, and managing digital information, including database information and video files. The term ''knowledge management'' means organizing this information so that employees can use it intelligently.

FIGURE 2-1 The AICPA's Top 10 Information Technologies for 2008. Source: www.AICPA.org

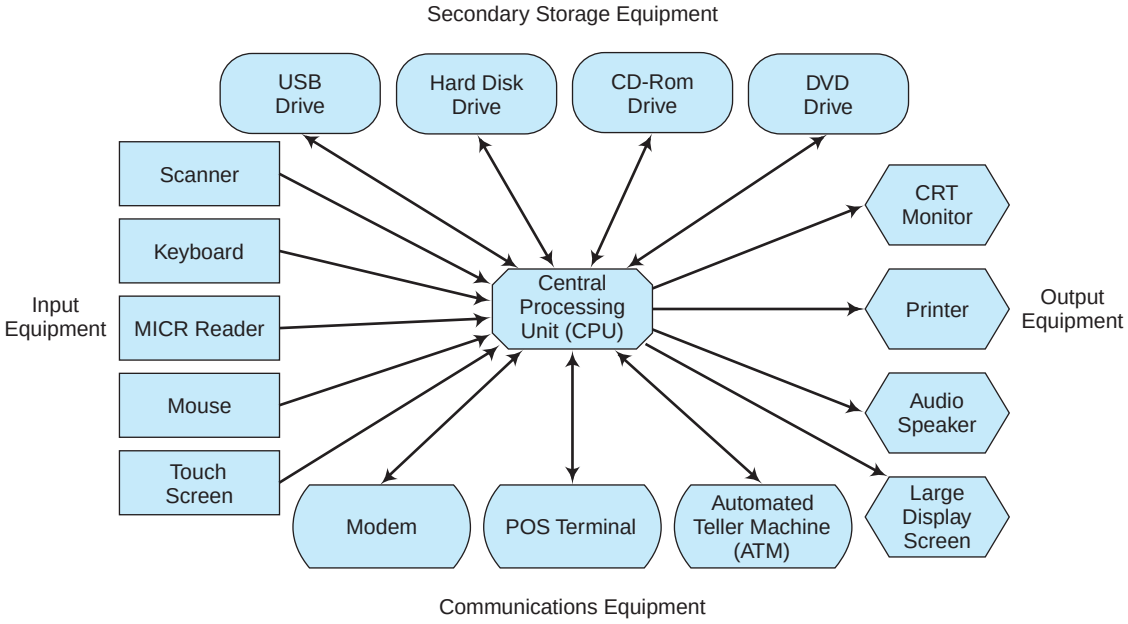

FIGURE 2-2 A central processing unit and examples of peripheral equipment.

invoices, sales invoices, cash disbursement vouchers, and travel reimbursement forms. Computerized examples include airline reservation screens, bank deposit screens, and web-based customer-order forms.

Source documents are important to AISs because (1) they are human readable, and (2) they can be completed by the user. Source documents also important because they provide evidence of a transaction's authenticity (e.g., a signed cash disbursement voucher authorizes a cash disbursement), are the starting point of an audit trail, and (in emergencies) can serve as backup in the event that the computer files created from them are damaged or destroyed.

The greatest disadvantage of manually-prepared source documents is that they are not machine-readable. Thus, in order to process source-document data electronically, the data must first be transcribed into machine-readable media. This **data transcription** is mostly an inefficient, labor-intensive, time-consuming, costly, and non-productive process that has the potential to bottleneck data at the transcription site, embed errors in the transcribed data, and provide opportunities for fraud, embezzlement, or sabotage. Is it any wonder, then, that most AISs capture data that are already in machine-readable formats? The paragraphs that follow describe some devices that overcome these problems.

POS Devices. Because most of the information required by retailers can be captured at the point at which a sale is made, retail businesses now commonly use automated **point-of-sale (POS) devices** to gather and record pertinent data electronically at that time. One example is the ''smart cash registers'' that are connected to offsite computers. Another example is the **bar code readers** that interpret the *universal product code (UPC)* commonly printed on supermarket and variety store items (Figure 2-3). Non-UPC bar codes are used extensively in transportation and inventory applications to track shipments (e.g., Federal Express), by warehouse employees to log received merchandise, by universities

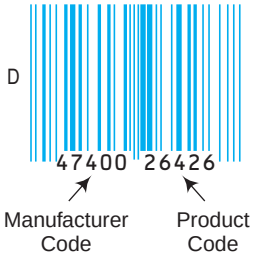

FIGURE 2-3 An example of the universal product code (UPC), which is often preprinted on the labels of retail products for merchandise identification and computerized checkout.

to identify equipment, by the U.S. Post Office to route mail, and by publishers to identify books using ISBN numbers (see the bar code on the back of this book for an example).

POS systems allow retailers to centralize price information in online computers, avoid the task of affixing price stickers to individual items on retail store shelves, and update prices easily when required. With such systems, for example, the sales data obtained at the checkout-station of a convenience store can be transmitted directly to a computer where they can be verified for accuracy, reasonableness, and completeness, and also stored for later uses—for example, preparing sales reports. Figure 2-4 lists other advantages of POS data collection systems, which are actually growing in use despite the maturity of the technology.

Case-in-Point 2.3 Independent dealers operate the 1,370 Mac's Convenience Stores in Canada, but the company provides the accounting and systems support. Saddled with extra steps required to consolidate information using its old system and a need for tighter inventory control, corporate managers decided to install a new Catapult POS system. The new system fully integrates debit/credit card purchases, uses touch screen technology that is "10 times faster" than the old system, and enables store owners to identify supplier problems more quickly.[3]

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1. Clerical errors, such as a salesperson's incorrect reading of a price tag, are detectable, and even potentially correctable, automatically.
2. Such standard procedures as the computation of a sales tax, the multiplication of prices times quantities sold, or the calculation of a discount can be performed using the register-terminal as a calculator.
3. Processing errors caused by illegible sales slips can be reduced.
4. Credit checks and answers to questions about customers' account balances are routinely handled by using the cash register as an inquiry terminal.
5. The inventory-disbursements data required for inventory control are collected as a natural part of the sales transaction.
6. A breakdown listing by the computer of sales by type of inventory item, dollar volume, sales clerk, or store location is possible because the data required for such reports are collected automatically with the sales transaction and may be stored for such use.
7. Sales and inventory personnel levels can be reduced because the manual data processing functions required of such personnel have largely been eliminated.

FIGURE 2-4 Advantages of POS systems.

[3]Source: Tammy Mastroberte, "A Perfect Connection" *Convenience Store News* Vol. 39, No 13 (October 12, 2003), pp. 216–218.

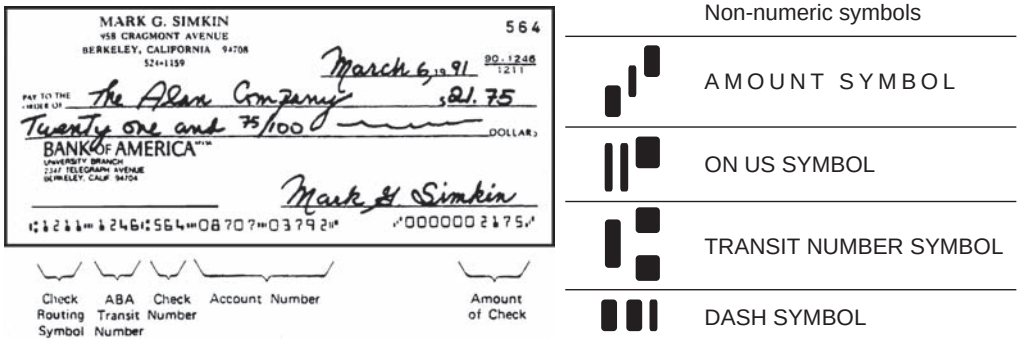


FIGURE 2-5 The MICR symbols of the American Banking Association (ABA).

Magnetic Ink Character Recognition. The banking industry pioneered the development of magnetically-encoded paper, commonly called **magnetic ink character recognition (MICR)**. You are probably familiar with MICR characters—the odd-looking numbers printed on the bottom of your checks (Figure 2-5). This type font has been standardized for the entire country by the American National Standards Institute (ANSI). Thus, a check you write anywhere in the United States or Canada is machine-readable by any bank.

One advantage of MICR coding is that it is both machine readable and human readable. Another advantage is that MICR coding is quite flexible: documents of varying sizes, thicknesses, or widths may be used. The chief disadvantage of MICR is that the magnetic strength (called the ''magnetic flux'') of the characters diminishes over time. This makes MICR documents unreliable when they must be input repeatedly.

Optical Character Recognition. **Optical character recognition (OCR)** uses optical, rather than magnetic, readers to interpret the data found on source documents. Typical OCR devices use light-sensing mechanisms and laser technology to perform the character-recognition function required to interpret recorded data. **Mark-sense media** (such as the type used in computerized exams) use simple rectangles or ovals as ''characters'' that you blacken with a pencil. More sophisticated versions of OCR can read complete character sets of numbers and letters (Figure 2-6), and are therefore more versatile as input.

Accounting uses of OCR include the billing statements of public utility companies, credit card issuers, and insurance companies, mortgage payment coupons, telephone bills, subscription renewal forms, and airline tickets. Most of these forms are **turnaround documents**—i. e., documents that are initially prepared by a company, then sent to individuals, and finally returned to the organization for further data processing. Like MICR encoding, the chief advantage of OCR is a source document that is both human-readable and machine-readable.

Plastic Cards with Magnetic Strips. Many plastic cards have a magnetic strip attached to one side of them that can store permanent information and therefore provide input data when required. Typically, the ''mag strip'' stores information about the user—for example, a checking account number, credit-card number, room number, or security-clearance code. In the United States, the magnetic strip on these cards has been divided into distinct physical areas and, by agreement, each major industry using these

FIGURE 2-6 This versatile optical character reader from Scan Corporation can read OCR characters, barcodes, and magnetic stripes.

cards has its own assigned space. Thus, the International Airline Transport Association (IATA), the American Banking Association (ABA), and the savings and loan industry each encode information pertinent to their individual needs on such plastic cards without fear that, by accident, these cards will be misused in another application.

AISs use mag-strip cards to capture data at the time these cards are used. For example, credit cards can include passwords that ATM machines can examine every time someone uses the card. This also facilitates data gathering because reliable electronic equipment reads the strip, thus eliminating human error.

> ***Case-in-Point 2.4*** In the United States, many gambling casinos issue mag-strip "club cards" to their customers, who use them as internal credit cards for playing slot machines, poker machines, and so forth. These cards free customers from the task of cashing checks or getting change. But these same cards also enable casinos to gather data on player activities—information that managers can subsequently use to make better decisions about extending credit limits or providing complimentary meals and hotel rooms.[4]

Microcomputer Input Devices. Many specialized devices now help users input data to their microcomputers. *Keyboards* are perhaps the most common input device. *Computer mice, touch pads, joy sticks* and similar devices enable users to control a screen cursor, create graphic images, reposition screen objects, or select items from display menus. *Touch screens* enable users to make menu choices simply by touching a display screen with a finger or stick. *Web cams* provide live video input to a computer. *Computer pens or styluses* permit users to enter data on video screens and are especially popular with **PDA (personal data assistant) devices** such as Blackberries. These PDAs enable their users to make phone calls as well as maintain such personal data as address books, appointment calendars, and check registers. Most models also incorporate

[4]Source: From the authors.

wireless technology that provide access to the Internet—a practical feature for email users.

Digital Cameras. Although many people only use digital cameras in recreational settings, accountants also use them for documenting (1) inventories of large assets such as trucks, cranes, and buildings, (2) damage to vehicles or offices due to accidents, vandalism, or natural disasters for insurance purposes, and (3) new or existing employees for identification and security purposes. As suggested by the following case-in-point, the benefits of digital photographs—i.e., the ability to store, display, reproduce, and transmit them electronically—must be weighed against their potential social costs.

Case-in-Point 2.5 Red-light cameras automate the process of ticketing motorists who drive through red traffic lights (Figure 2-7). Such cameras enable municipalities to enforce driving laws at important traffic intersections and often substantially increase revenues from traffic violations. Proponents of red-light cameras argue that red-light cameras reduce accidents and that the funds they generate can be used to pay for other important police work. Critics counter that the cameras are *only* revenue generators and that they pose an important threat to an individual's right to privacy.[5]

FIGURE 2-7 An example of a red-light camera (*Source*: istockphoto).

[5]Source: no author, ''California City to Transform Red Light Cameras into Spy Cameras'' *The* Newspaper.com*: A Journal of the Politics of Driving*, accessed at www.thenewspaper.com/news/18/1886.asp, November 23, 2008.

(a) fingerprint scanner

(b) iris scanner

FIGURE 2-8 (a) An inexpensive USB fingerprint scanner, courtesy of BioEnable, and (b) an inexpensive iris scanner, courtesy of LG Electronics.

Biometric Scanners. Many accounting applications must verify that a user has legitimate access to a system—for example, can view corporate personnel files. Authentication systems based on *what you know* require you to input codes, account numbers, passwords, or similar values. These are low-security systems because users can easily forget, lose, or guess such information, making such systems vulnerable to attack and misuse. Systems based on *what you have* require physical keys, magnetic cards, or similar physical media—but suffer many of the same problems as password-based authenticating systems.

Biometric scanners authenticate users based on *who they are. Behavioral systems* recognize signatures, voices, or keystroke dynamics. *Physiological systems* recognize fingerprints, irises, retinas, faces, and even ears. Most of these devices connect directly to computer USB ports or are integrated in computer keyboards, mice, or web cams. The two most reliable biometric systems use fingerprint or iris scanners to authenticate users (Figure 2-8). Fingerprints are unique, and experts have yet to discover two people with the same minute details since 1892 when records were kept. Iris scans record vein patterns in the colored portion of the eye, and are even more accurate than fingerprints because of the wider variability in vein patterns and the fact that even the right and left eye of the same person are not identical.

Biometric authentication begins with *enrollment*—the process of creating digital templates for legitimate users. Template files are small, requiring about 256 bytes for a fingerprint and 512 bytes for an iris scan. To authenticate a user, the scanner takes a new sample from the individual and compares it to known templates. Unlike passwords, the new samples will not perfectly match the template. The *hamming distance* measures how close the two match.

Case-in-Point 2.6 One interesting use of biometric scanning was recently mandated by the Maritime Transportation Security Act. Workers, such as longshoremen and truck drivers who need access to secure U.S. ports or marine vessels, must now apply for a Transportation Worker Identification Credential (TWIC) card. Over 1.1 million port workers already have such smart cards, each of which includes a picture, a magnetic stripe, and a bar code. The information in the card includes the cardholder's fingerprints to establish a secure biometric connection between the cardholder and the card.[6]

[6]Source: www.tsa.gov/what_we_do/layers/twic.

Central Processing Units

Once data have been captured (and perhaps transcribed into machine-readable formats), they usually must be processed to be valuable to decision-makers. These processing tasks are performed by the **central processing unit (CPU)** of a computer system (Figure 2-9). In the computer industry, the terms *computer* and *CPU* are often used interchangeably.

The processing power of CPUs starts with the most limited microcomputers (aka ''personal computers'' or ''PCs'') and increases in such capabilities as speed, multi-user support, and peripheral equipment with **minicomputers, mainframe computers**, and **supercomputers**. A growing segment of the microcomputer market is the portable systems—i.e., *laptop computers, netbook computers*, and the even more-compact *personal digital assistants (PDAs)* and cell phones. The accounting systems of the smallest businesses—for example, that of a bicycle-repair shop—can often be implemented entirely on a desktop microcomputer. In contrast, the inventory control systems of the nation's largest vendors—for example, Wal-Mart—require multi-user systems that may employ several centralized mainframes working in tandem.

One of the biggest challenges facing businesses today is identifying the right combination of computing technologies—i.e., computers of various sizes, networks, and related software—that best meet their IT needs. Dollar for dollar, organizations usually get the most processing power and the cheapest software with microcomputers, which helps explain why modern organizations buy so many of them. Reasons to retain older mainframe systems include (1) the need to support multi-user processing capabilities that work best on such systems, (2) the advantages of centralized processing—for example, simplified control over hardware, software, and user accesses to databases, and (3) the huge costs that organizations typically incur when replacing these **legacy systems**.

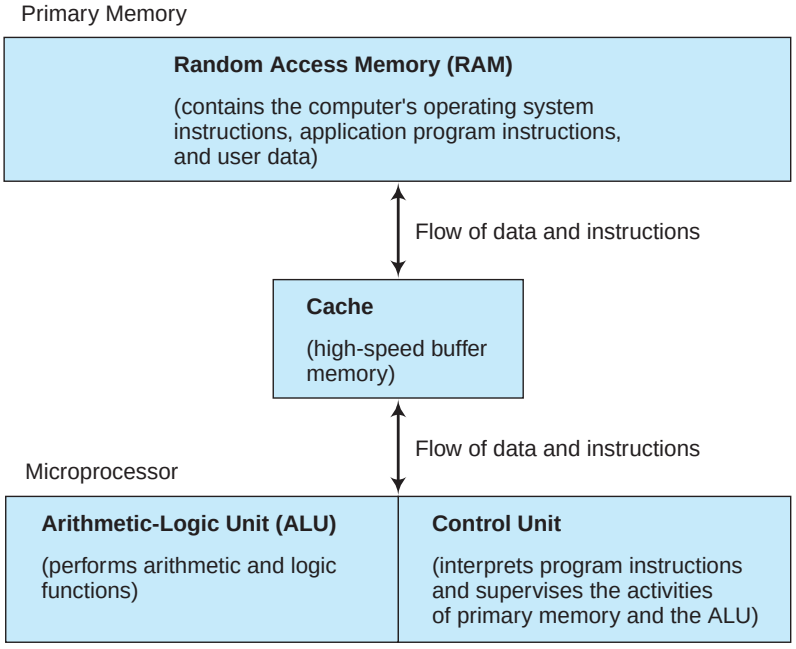


FIGURE 2-9 A schematic of a central processing unit. In some computers, the ''Level 2'' (high-speed buffer) cache is part of the microprocessor unit.

Primary Memory. Figure 2-9 indicates that the two main components of a CPU are its primary memory and its microprocessor, with *cache*, or buffer, memory serving as the interface between these components. The purpose of **primary memory** is to store data and program instructions temporarily for immediate processing and execution. In microcomputers, this primary or *random access memory* (*RAM)* consists of individual *bytes*, each capable of storing a single character of data—e.g., a letter or punctuation mark. RAM capacities are typically measured in *gigabytes* (billions of bytes). Most accounting software requires minimum amounts of primary memory to operate properly, so ''RAM size'' is often a key concern when matching computer hardware to software requirements for smaller AIS applications.

Microprocessors. Computers cannot manipulate data or execute instructions directly in primary memory. Rather, these tasks are performed by the CPU's **microprocessor**. Examples include Intel Corporation's Atom or Core 2 Quad chips. The *arithmetic-logic unit (ALU)* portion of these microprocessor chips performs arithmetic tasks (such as addition and multiplication), as well as logic tasks (such as comparisons). In contrast, the *control unit* of the processor supervises the actual data processing—for example, transferring data from primary memory to the ALU, performing the required task (e.g., adding two numbers together), and transferring the answer back to primary memory.

Computers, Processor Speeds, and AISs. The most important thing to know about processor speeds is that they are rarely important in accounting applications. This is because the input-processing-output cycle characteristic of most accounting tasks requires input and output operations as well as processing procedures in order to perform specific tasks. An example is a payroll application, which must input, process, and output the data from each time card. The speeds of the input/output (I/O) operations involved in this application are orders of magnitude slower than the internal speeds of the processor, thus explaining why most computers are **I/O bound**, not process bound. What this means to accounting applications is that designers must typically look elsewhere for ways to speed computer *throughput*—i.e., the time it takes to process business transactions such as payroll time cards—for example, by employing faster data transmissions.

Output Devices

Accounting data are meaningless if they cannot be output in forms that are useful and convenient to end users. Printed, **hard-copy output** is one possibility, but video or **soft-copy output** on monitor screens, audio output, and file output to secondary storage devices such as hard disks are other possibilities that we explore here. Outputs are especially important to AISs because the information in these outputs is usually the basis of managerial decision making, and therefore the goal of the entire system.

Printers. The hope for a *paperless office* has yet to be realized and most AISs still produce many types of printed outputs—for example, transaction summaries, financial statements, exception reports, spreadsheet-based budget reports, word processing documents, and graphs. Many printers now also perform the functions of fax machines, copiers, and scanners, enabling these devices to serve as input devices, transmission devices, and standalone copying devices.

Printers fall into three general categories: (1) dot-matrix, (2) ink-jet, and (3) laser. **Dot-matrix printers** are impact printers that employ tiny wires in a print head to strike

an inked ribbon and create tiny dots on a print page. These printers are popular with small-business users because they are inexpensive and can print multipart (''carbon'') paper—an important feature commonly used in commercial cash registers to print multiple copies of credit-card receipts.

Ink-jet printers create characters by distributing tiny bubbles or dots of ink onto print pages. The print resolutions of these printers (commonly measured in *dots per inch* or *dpi*) tend to be higher than dot-matrix printers, while printing speeds (commonly measured in *pages per minute* or *ppm*) tend to be lower than laser printers. But most ink-jet printers can print in colors—a capability lacking in many dot-matrix and laser printers—enabling them to print graphics and colored pictures as well as text documents.

Laser printers create printed output in much the same way as duplicating machines. The costs of laser printers are higher than dot-matrix or ink-jet printers, but print quality is usually superior and output speeds are much faster. Laser printers are often the printer of choice for commercial users because of this speed advantage. Many laser printers can now also print in color.

Video Output. Because hard-copy outputs clutter offices with paper and take time to print, many AISs use fast, *soft-copy* video screen displays instead. Computer monitors are perhaps the most common type of video output, but the airport display screens showing arrivals and departures, stadium scoreboards, highway billboards, and the signage of many private stores are also forms of computerized video outputs.

The monitors of most laptop and desktop computers use flat-panel, *liquid crystal display (LCD) screens* to create video outputs the same way that televisions do. The **picture elements (pixels)** in both types of screens are tiny, discrete dots arranged in a matrix. SVGA (for super video graphics adapter) refers to a pixel matrix of about 1200 by 800 pixels (the exact dimensions are not standardized and vary with the manufacturer).

Multimedia. Multimedia combines video, text, graphics, animation, and sound to produce multidimensional output. By definition, multimedia presentations also require advanced processor chips, sound cards, and fast video cards to work properly. One accounting use of multimedia is storing the pictures of employees in personnel files. Another is recording verbal interviews with audit clients. A third is preparing instructional disks for tax accountants. Accounting uses of multimedia are likely to grow as the cost of producing multimedia applications becomes cheaper and new applications are found for this stimulating form of output. Multimedia applications are now also becoming common on the Internet.

SECONDARY STORAGE DEVICES

Primary memory is **volatile memory**, meaning memory that loses its contents when electrical power is lost. In contrast, AISs must store data on permanent media that maintain their accuracy and integrity, yet permit these systems to access and modify information quickly and easily. This is the purpose of **secondary storage** (also called *mass storage* or *auxiliary storage*). Like primary memory, the basic unit otf secondary storage is a *byte*, and secondary storage capacities are measured in *kilobytes* (1,024 bytes), *megabytes* (1,024 kilobytes), *gigabytes* (1,024 megabytes), or *terabytes* (1,024 gigabytes).

In this section, we examine several types of secondary storage: magnetic (hard) disks, CD-ROMs, DVD disks, and USB flash disks. Common to all these media is the concept of

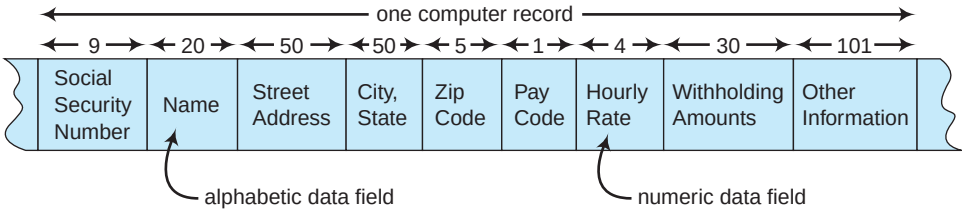


FIGURE 2-10 The format for the computer record of an employee on a payroll file.

a computer record. Like manual systems, computerized AISs must maintain information about payroll activities, warehouse inventories, and accounts receivable data in permanent files. In each such file, a **computer record** is a collection of information about one file entity—for example, one employee on a payroll file (Figure 2-10).

Magnetic (Hard) Disks

A **magnetic (hard) disk** (Figure 2-11) consists of one or more spinning platters, each surface of which has an iron oxide coating that can be magnetized to record information. The smallest hard disks use only a single, double-sided platter, whereas larger-capacity hard disks use multiple platters. The disk system can access (or write) records from any portion of the platter by moving its read/write heads in toward the center of the disk platters, or outward to their outer edges. To avoid contamination from dust or smoke particles, most hard disks are permanently sealed in their boxes.

To further guard against disk failures as well as increase storage capacities, manufacturers now also offer **redundant arrays of inexpensive disks (RAIDs)**—see Figure 2-12. In effect, these are stacks of hard disks, each similar to the disk system shown in Figure 2-11.

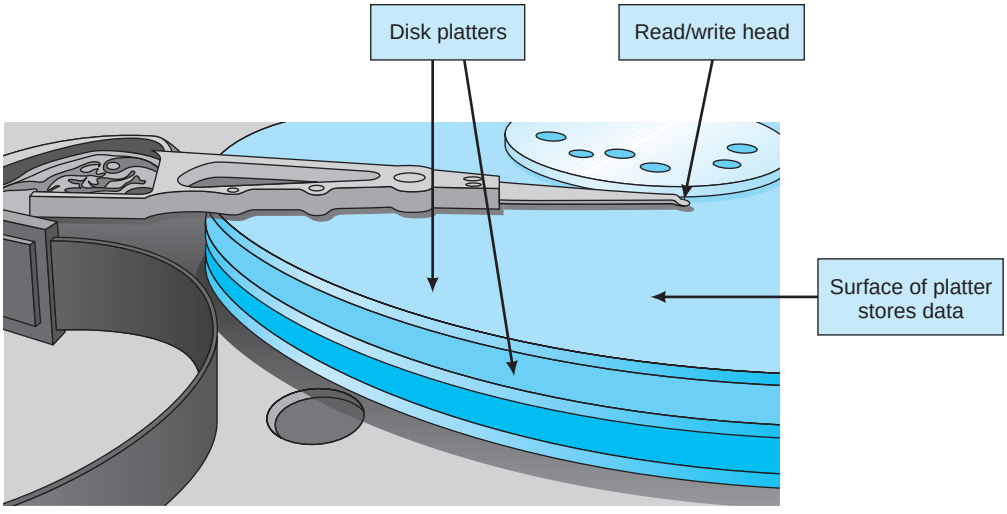


FIGURE 2-11 A schematic of a multiplatter hard disk. The read/write head assembly moves the read/write heads inward (toward the central spindle) or outward as needed, allowing the system to access the data on any portion of any platter.

FIGURE 2-12 A redundant array of inexpensive disks (RAID).
Source: OrbitMicro at www.orbitmicro.com

RAIDs are also commonly used for archiving functions—and therefore critical to AISs in the event of an unforeseen disaster.

One advantage of magnetic disk media is their large storage capacities—now commonly measured in *gigabytes* for microcomputers and *terabytes* for commercial AISs. Another advantage is their fast data transfer rates, which now can exceed 100 million characters per second. Finally, perhaps their most important advantage is their ability to directly access any specific record without sequential searching—a capability made possible by the fact that disk data are assigned individual addresses (like postal addresses). This accessing capability is useful for such online applications as airline reservations or bank account inquiries, when users require immediate access to specific records, and explains why magnetic disks are also called *direct access storage devices (DASDs)*.

CD-ROMs and DVDs

Two types of secondary storage devices currently popular with microcomputer users are CD-ROMS and DVDs. Both media store data digitally and are read optically.

CD-ROMs. The term **CD-ROM** is an acronym for ''compact disk-read only memory.'' The name is appropriate because CD-ROMs are the same size and appearance as audio CDs. CD-ROMs contain microscopic pits that are etched along a spiraling track in their substrate surfaces. Laser beams interpret the presence or absence of a pit as the ''one'' or ''zero'' of binary codes.

CD-ROMs come in three types. The oldest, prerecorded versions are similar to those on which music or software is distributed. Newer, ''CD-r'' media are blank CD-ROMs that can be recorded (only once) with inexpensive CD encoding devices. These are **worm (write-once, read-many) media**. Finally, the newest ''CD-rw'' media are rewritable, allowing AISs to use them as low-capacity hard disks.

One advantage of CD-ROMs is the fact that they are a removable medium with storage capacities in excess of 650 megabytes per disk—the equivalent of 300,000 pages of text! This makes CD-ROMs ideal for storing large amounts of accounting data or reference materials. Because CD-ROMs are read with laser beams, data transfer rates are also very fast, and wear and tear is minimal, even with continuous usage. Finally, the worm characteristic

of CD-ROMs and CD-r's make them useful for archiving files securely (i.e., storing files on a medium that cannot be changed). But CD-ROMs suffer from at least one drawback—the fact that that worm media cannot be updated (because new information cannot be written on them once they have been encoded).

DVDs. A digital video disk or **DVD** closely resembles a CD-ROM in that it too is a 5-inch plastic disk that uses a laser to encode microscopic pits in its substrate surface. But the pits on a DVD are much smaller and encoded much closer together than those on a CD-ROM. Also, a DVD can have as many as two layers on each of its two sides (compared to the single-layered, single-sided CD-ROM). The end result is a medium that can hold as much as 17 gigabytes of data—over 25 times the capacity of a standard CD-ROM disk. The two greatest advantages of DVDs are therefore (1) a huge storage capacity that enables users to archive large amounts of data, and (2) a single, light-weight, reliable, easily-transportable medium. Newer DVDs are writeable and even re-writeable.

Flash Memory

Flash memory is solid state memory that comes in various forms. Examples include the flash drives that use the USB ports of microcomputers (Figure 2-13), the PCMCIA memory cards used with laptops, the memory sticks used in digital cameras, and the memory cards used with video games. The term ''solid state'' means that there are no moving parts (unlike the hard disk in Figure 2-11)—everything is electronic rather than mechanical.

USB drives can store gigabytes of data in an erasable format. Because data transfer rates are high and the devices themselves compact, they are particularly useful to accountants for creating backups of important files and transporting them offsite. Costs are low—under $20 for smaller-capacity USB drives.

Image Processing and Record Management Systems

The life cycle of business documents begins with their creation, continues with their storage and use, and ends with their destruction. Two important tools that can help managers with such tasks are image-processing systems and record management systems.

FIGURE 2-13 This Flash memory from San Disk plugs into a standard USB microcomputer connector. It can write data at 13 mb per second, read data at 15 mb per second, and store up to 4 gigabytes of data.

Image Processing. **Image processing** allows users to store graphic images in digital formats on secondary storage media (e.g., the images now taken by digital cameras). Thus, image processing systems are able to capture almost any type of document electronically, including photographs, flowcharts, drawings, and pages containing hand-written signatures. Commercial users of image processing include: (1) insurance companies that use image processing to store claims forms and accident reports, (2) banks that use image processing to store check images, (3) hospitals that use image processing to store medical-diagnostic scans, and (4) the Internal Revenue Service, which uses image processing to capture and store tax return data.

Case-in-Point 2.7 Lloyd's of London is the world's largest insurer. It processes over 90,000 new claims annually and handles over 1.5 million paper documents each year. To speed claims processing as well as reduce the costs associated with all this paper handling, the company is developing an £11m system to store new claims information digitally as well as process the transactions associated with them. Estimated annual savings: £50 million.[7]

Image processing offers several advantages. One is the fast speeds at which images can be captured—a benefit of special importance to high-volume users such as banks. Another advantage is the reduced amount of physical storage space required (compared to paper storage). A third advantage is the convenience of storing images in computer records, which can then be sorted, classified, retrieved, or otherwise manipulated as needs require. A final advantage is the ability to store images in central files, thus making copies available to many users at once, even at the same time. (This last advantage is an important benefit to business and medical offices, where personnel no longer have to ask ''who's got the file?'' This is the topic of the AIS at Work at the end of Chapter 8.)

Record Management Systems. Simple record management systems enable businesses to systematically capture and store documents. Newer **electronic document and record management systems (EDRMs)** extend such capabilities by helping organizations manage the workflow of electronic documents during document development, provide collaborative tools that enable several users to work on the same document, and allow organizations to create and store multiple versions of documents.

It is easy to understand why business and government organizations use EDRM tools. For legal reasons, for example, businesses may need to retain both current and old policy manuals, contracts, or employment records. Similarly, it is convenient to automate the termination of documents when contracts expire, employees quit, or new policies replace them.

DATA COMMUNICATIONS AND NETWORKS

Data communications refers to transmitting data to and from different locations. Many accounting applications use data communications in normal business operations. For example, banking systems enable individual offices to transmit deposit and withdrawal information to centralized computer locations, airline reservation systems enable travel agents to book flights from remote locations, and stock brokerage systems enable brokers

[7]Source: Nick Huber, ''Lloyd's Moves to End Paper-Based Transactions'' *Computer Weekly* (February 17, 2004), p. 5.

to transmit buy and sell orders for their customers. Accountants must understand data communication concepts because so many AISs use them and also because so many clients acquire AISs that depend upon them. In addition, auditors must sometimes audit the capabilities of a network—for example, evaluate its ability to transmit information accurately and to safeguard the integrity of the data during such transmissions.

Communication Channels and Protocols

A *communication channel* is the physical path that data take in data transmissions. Examples include: (1) the twisted-pair wires of telephone lines, (2) coaxial cables, (3) optical fibers, (4) microwaves, and (5) radio (satellite) waves. Local area networking applications (discussed shortly) typically use the first three of these, while Internet applications often use all five of them.

To transmit data over these communications channels, the digital pulses of the sending computer must be translated into the sound patterns, light pulses, or radio waves of the communications channel. Over voice-grade telephone lines, this translation is performed by a **modem** (an acronym for ''modulator-demodulator''). The transmission rates are commonly measured in *bits per second (bps)*.

ISDN (integrated services digital network) is an international data communications standard that transmits data, voice message, or images at a standard rate of 128k bps over the Internet. A similar data transmission service is a **digital subscriber line (DSL)**, which supports data communications rates up to 9 megabits per second. Finally, large data communications installations using fiber optic cables and similar wide-band channels can currently transmit data up to 266 million bps. Future optic fiber transmission rates will transmit data at speeds up to 2.2 billion bps—speeds high enough to transmit motion-picture images in real time.

In all data communications applications, the sending and receiving stations must use a compatible transmission format. A **data communications protocol** refers to the settings that provide this format. Two common protocols are *TCP (transmission control protocol)*, which networks commonly use for emails, and *HTTP (hypertext transmission protocol)*, which networks commonly use for web pages.

Local and Wide Area Networks

One important use of data communications is in **local area networks (LANs)**. Figure 2-14 shows that a LAN consists of microcomputers, printers, terminals, and similar devices that are connected together for communications purposes. Most LANs use **file servers** to store centralized software and data files, and also to coordinate data transmissions among the other LAN devices and users. Most local area networks occupy a single building, although LANs covering several buildings are also common. In the past, installers hard-wired LAN devices together. Today, many LANs are wireless—a convenience to users, who no longer need to worry about where to place computer equipment in their offices, but an added security hazard to network administrators.

LANs provide several users access to common hardware, software, and computer files, as well as to each other. Some advantages of LANs are:

1. **Facilitating communications:** The number one reason why businesses install LANs today is to support email and/or provide access to the Internet.

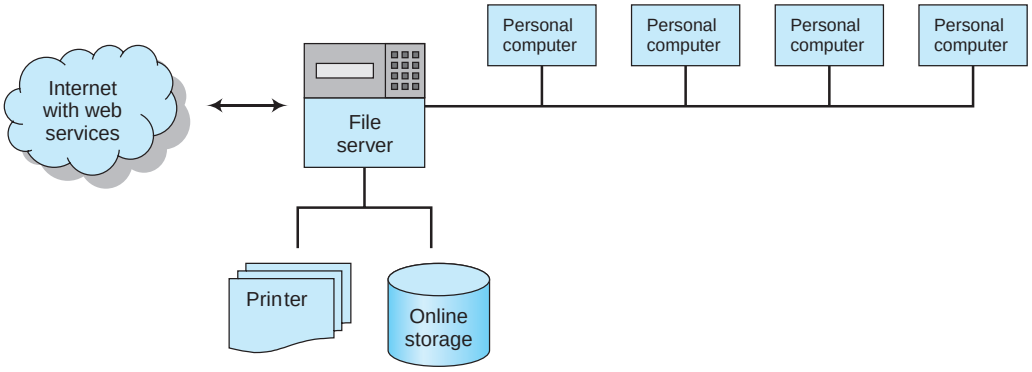


FIGURE 2-14 A local area network with representative devices.

2. **Sharing computer equipment:** For example, a LAN can provide users access to the same printers or Internet servers.
3. **Sharing computer files:** LANs enable several users to input or output data to or from the same accounting files.
4. **Saving software costs:** It is often cheaper to buy a single software package for a local area network than to buy individual packages for each of several workstations.
5. **Enabling unlike computer equipment to communicate with one another:** Not all computers use the same operating system or application software. LANs enable different computers using different software to communicate with one another.

Wide area networks (WANs) are computer networks spanning regional, national, or even global areas. For example, a WAN enables a national manufacturing company to connect several manufacturing, distribution, and regional centers to national headquarters, and therefore to each other, for communications purposes (see Figure 2-15). WANs typically

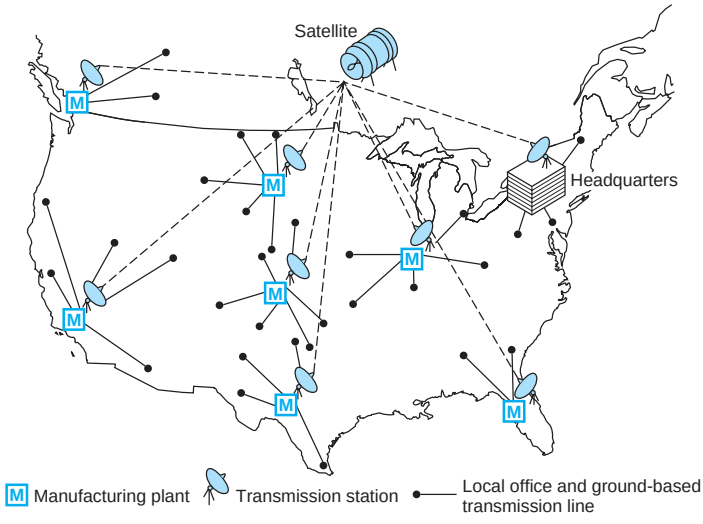


FIGURE 2-15 A wide area network that a large organization might use to connect regional users and computers.

use a multitude of communications channels for this purpose, including leased phone lines, microwave transmitters, and perhaps even satellite transmissions. Rather than developing and maintaining their own WANs, many organizations employ public carriers, the Internet, or third-party network vendors to transmit data electronically.

Case-in-Point 2.8 IGT is the world's largest slot machine manufacturer, but nearly half its profits derive from another product—its Megabucks ® system. Megabucks is, in effect, a WAN of progressive slot machines that are located on the floors of participating casinos in the state of Nevada. The company links the machines together over private communications lines, enabling the company to both monitor its slot machines and display the growing jackpots in real time as customers play. (You can view the current jackpot: www.igtonline.com/megajackpots/nevada/systems/flash9_99. html). To date, Megabucks has created more than 1,000 millionaires and paid more than $3.8 billion in major jackpots. On March 21, 2003, it set a new jackpot record: $39 million. Only one lucky player has ever won the Megabucks jackpot twice—once for $4.6 million in 1989 and again for $21.1 million in 2005 (when he was 92).[8]

AISs use WANs to gather financial data from remote sites, distribute accounting information to and from headquarters, and support email communications among users. WANs are therefore typically complex, multifaceted systems that serve many users for many purposes. For example, the wide area networks of large *Internet service providers (ISPs)* such as America Online allow subscribers to access centralized databases through local phone lines. Similarly, regional supermarket chains use WANs to gather inventory data, cash receipts data, and sales information from the many stores in their chains. WANs can also be dedicated to specific tasks. For example, most bank ATM machines are connected to WANs for the purpose of centralizing account information.

Many WANs are organized in a hierarchy, in which the individual microcomputers of a specific branch office are connected to a file server on a local area network, the file servers of several LANs are connected to a regional computer, and several regional computers are connected to a corporate mainframe. This hierarchical approach allows a large company to gather, store, and distribute financial and non-financial information at the appropriate geographic level of the company.

Client/Server Computing

Client/server computing is an alternate technology to mainframe and/or hierarchical networks. Depending on the type of client/server system, the data processing can be performed by any computer on the network. The software application, such as a spreadsheet program, resides on the client computer—typically, a microcomputer. The database and related software are stored on networked file servers. Although mainframe systems normally centralize everything (including the control of the system), client/server applications distribute data and software among the server and client computers of the system. As a result, client/server computing is a way to achieve the overall objective of an **enterprise network**. In so doing, more computing power resides in user desktops, yet all organizational computers are linked together.

[8]Source: The IGT website at www.igt.com/Content (2006).

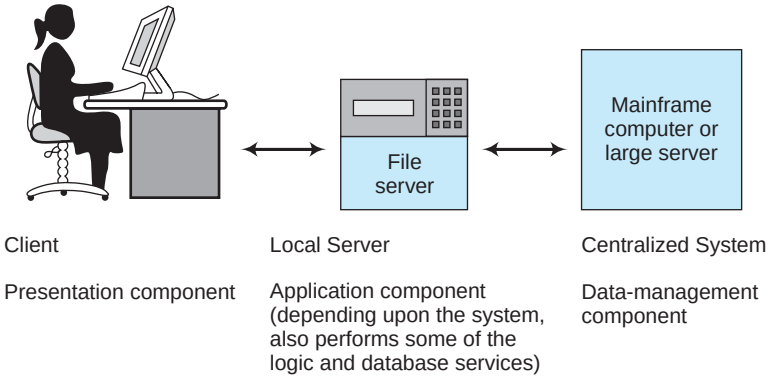


FIGURE 2-16 Components of a client/server system.

Components of Client/Server Systems. Figure 2-16 shows that a client/server system may be viewed as a set of three interacting components: (1) a presentation component, (2) an application-logic component, and (3) a data-management component. The *presentation component* of a client/server system is the user's view of the system—i.e., what the user sees onscreen. This view may resemble the familiar screens of the user's home computer, or may differ considerably from them. Simple client/server systems that focus on this presentation task are called *distributed presentation systems*. Most Internet applications illustrate this category.

The *application-logic component* of a client/server system refers to the processing logic of a specific application—for example, the logic involved in preparing payroll checks. Thus, client/server computing differs from simple ''host/terminal computing'' in the user's new ability to (1) query or manipulate the warehoused data on the server, (2) ask what-if questions of the server's data, (3) process a transaction that may affect data stored on both client and server computers, or (4) alter data stored elsewhere on the network. Some systems enable users to write their own data queries (that ask for specific information from the server database), and also to store such queries on local files for later uses.

The processing tasks involved in each application are typically shared unequally between the client computer and the server, with the division of labor depending upon the particular application. For example, in a payroll application, the client's contribution may be limited to validating the data entered into the system, while in a word-processing application the client computer might perform nearly all the processing tasks required.

Finally, the *data-management component* of a client/server system refers to its databases and data-storage systems. Some applications rely on a centralized mainframe for this task. More typically, however, multiple copies of the databases reside on large, regional file servers, thereby speeding user access to the data they contain. These systems are also the most complex, and therefore pose the greatest challenges to accountants for control and audit tasks.

Advantages and Disadvantages. The advantages of client/server computing include the flexibility of distributing hardware, software, data, and processing capabilities throughout a computer network. A further advantage can be reduced telecommunications costs—an advantage that enabled Avis Rent-a-Car to save a half-minute on each of its 23 million annual customer calls, and therefore $1 million. A third advantage is the ability to install *thin-client systems*, which use inexpensive or diskless microcomputers, instead of more expensive models, to save money on system acquisition and maintenance costs. The managers of

Mr. Gatti's, a Texas chain of 300 pizza restaurants, for example, estimate that it will save about 45% on its maintenance costs using such a system.

One disadvantage of a large client/server system is that it must maintain multiple copies of the same databases, which it then stores on its various regional servers. This makes backup and recovery procedures more difficult because multiple copies of the same file (or several parts of a single file) now exist on several different computers. This multiple-copy problem also causes difficulties in data synchronization (i.e., the need to update all copies of the same file when a change is made to any one of them).

Changing from one version of an application program to another is also more difficult in client/server systems because the system usually requires consistency in these programs across all servers. User access and security are also more difficult because access privileges may vary widely among employees or applications. Finally, the need for user training is often greater in client/server systems because employees must not only know how to use the data and application programs required by the jobs, but also understand the system software that enables them to access these databases and programs from local workstations.

Wireless Data Communications

A recent survey by Intuit revealed that over 70% of the small businesses in the U.S. have mobile employees, and by all accounts that number is growing. The term **wireless communications**, also called **Wi-Fi** (for ''wireless fidelity''), means transmitting voice-grade signals or digital data over wireless communication channels. Wi-Fi creates a wireless Ethernet network using access hubs and receiver cards in PCs, cell phones, and PDAs, thereby turning cell phones and similar wireless devices into cordless, multi-function ''web appliances.''

Wireless devices have become important tools for business professionals, helping accountants in particular stay in touch with fellow employees, clients, and corporate networks. Early, emailing uses of wireless communications have now been joined by such job-dependent financial functions as recording sales orders, entering time and billing information, and—as suggested by the following case-in-point—even preparing the payroll.

Case-in-Point 2.9 It wasn't until the middle of his son's little league game that Eddie Elizando realized he hadn't prepared the payroll for the employees at his small CPA company. Mr. Elizando was nowhere near his corporate office, but this wasn't a problem. Using his new iPhone, Mr. Elizando called his payroll service, entered data by clicking through the appropriate payroll program, and accomplished the task remotely between innings of the game. An added bonus: one of Mr. Elizando's employees was his wife, who still wanted to be paid![9]

The two key dimensions of Wi-Fi applications are ''connectivity'' and ''mobility.'' The connectivity advantage means the ability to connect to the Internet, LAN, or WAN without physical wires or cables. To accomplish this, Wi-Fi devices use **wireless application protocol (WAP)**, a set of communications standards and *wireless markup language* (a subset of XML optimized for the small display screens typical of wireless, Internet-enabled appliances). Two important types of wireless communications are RFID applications and NFC communications.

[9]Source: Alexandra Defelice, ''Working in a Wireless World'' *Accounting Technology* Vol. 23, No. 10 (November 2007), pp. 30–34.

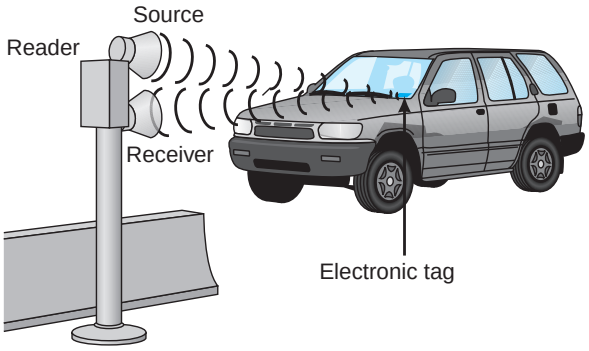


FIGURE 2-17 Reading an RFID at a toll both.

RFID. **Radio frequency identification (RFID)** enables businesses to identify pallets and even individual items without unpacking them from shipping crates. *Passive RFID tags* have no power source (and therefore cannot wear out), but can nonetheless ''answer'' inquiries from energized sources. *Active RFID tags* are actually chips with antennas, have their own power source, enjoy ranges of more than 100 meters, and are generally more reliable than passive tags.

Perhaps the most noticeable use of RFID tags is as user identifiers in transportation systems (Figure 2-17). For example, the subway systems of New York City, Moscow, and Hong Kong use them, as do some of the toll roads and parking lots in the states of New York, New Jersey, Pennsylvania, Massachusetts, Georgia, Florida, and Illinois. Similar systems may be found in Paris, the Philippines, Israel, Australia, Chile, and Portugal. To toll-road travelers, RFID systems represent a convenient way of paying user fees and reducing wait times in tollbooth lines. To their operators, these systems are a convenient way of gathering accounting data and updating customer accounts.

Case-in-Point 2.10 Recent RFID applications include employee ID badges, library books, credit cards, and even tire-tread sensors. Similarly, many retailers now require their suppliers to include tags that identify merchandise. Wal-Mart, Target, and Albertsons are three of a growing list of large retailers that now require their largest suppliers to include RFID tags in the cases and pallets sent to their various distribution centers. The tags are superior to bar codes, which require a line of sight for reading, must appear on the outside of cartons, and can be lost or defaced.[10]

NFC. **Near field communication (NFC)** enables mobile devices such as cell phones, PDAs, and laptop computers to communicate with similar devices containing NFC chips (Figure 2-18). With NFC devices, for example, you can make travel reservations on your PC, download airline tickets to your mobile phone or PDA, and check in at a departure gate kiosk with a swipe of your mobile device—all with no paper or printing.

In effect, NFCs represents RFID communications for the masses. But the operating range of NFC devices is limited to 20 cm or about 8 inches—a limitation that helps avoid unintentional uses. The transit systems in China, Singapore, and Japan now use NFC

[10]Doug Desjardins, ''Implementation Easier as No. 2'' *DSN Retailing Today* Vol. 44, No. 7 (March 11, 2005), p. 34.

FIGURE 2-18 Near field communication devices.

systems, as do Visa International's credit card system and chip-enabled posters of the Atlanta Hawk's basketball team.

NFC technology is a joint product development of Sony, Philips, and Nokia. Three possible communication modes are (1) *active* (bidirectional), (2) *passive* (one way), and (3) *transponder* (battery-less and therefore only powered by an external communication source). Current NFC standardized communication speeds are between 106k and 424k bps—considerably less than the 1–7 mbps speeds of Bluetooth or Wi-Fi data transmissions. But passive NFC chips cost as little as 20 cents and are currently considerably cheaper than these alternate communications devices.

Cloud Computing

The term **cloud computing** refers to a range of computing services on the Internet—for example, access to computer software programs, backup and recovery file services, and even web-page development and hosting. The term gets its name from the common use of a cloud symbol to represent the Internet itself—refer back to Figure 2-14. Most commercial applications of cloud computing are types of outsourcing—i.e., situations in which one company hires another to perform a vital service. An accounting application is the use of tax preparation software, which the customer accesses over the Internet from the vendor for a fee. Many cloud service vendors have familiar names, including Amazon, Google, Yahoo, IBM, Intel, Sun Microsystems, and Microsoft. The first cloud computing conference took place in May 2008, and attracted over 1,000 attendees.

Cloud computing offers several advantages. One is that it gives even the smallest customer access to supercomputing capabilities. Another is that it enables organizations of any size to avoid investing in the technology required to perform the outsourced tasks in-house. A third is that customers only pay for services actually used. A fourth is the ability to avoid preparing for peak loading—e.g., times when transaction volumes are high. Finally, when companies purchase archiving services, backup files can be created automatically and by definition, are stored offsite for security. This last advantage might also be of particular interest to students, who can subscribe to one of several services at nominal costs, or even for free—see Figure 2-19.

Cloud computing also has several drawbacks. One is that cloud subscription fees can be high and may not always be cost effective. Another is that many cloud services require customers to trust their service providers with sensitive data and to stay operational at all times—uncomfortable risks to some. Finally, backup service providers typically require large bandwidths, and the timing of automatic backups is not always convenient to individual subscribers.

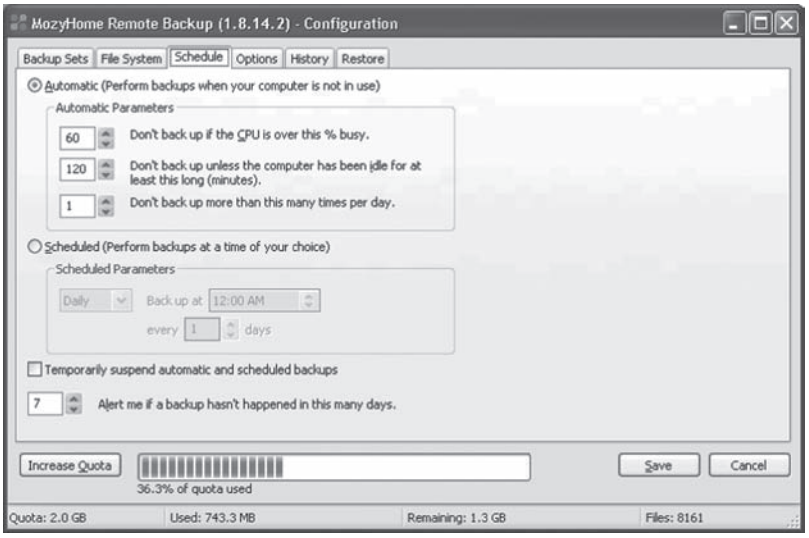


FIGURE 2-19 Mozy is a cloud service provider of backups for both individual and corporate users. This configurations screen allows a user to schedule backups.

COMPUTER SOFTWARE

As noted in the introduction to this chapter, it is impossible to discuss information technology without also recognizing the importance of **computer software**. Computer hardware serves as a base, or platform, upon which two types of computer software typically reside: (1) operating systems, and (2) application software. This chapter concludes by briefly discussing each of these types of software.

It is difficult to overstate the importance of software to AISs. Both in industry and in private homes, computer software performs such tasks as computing spreadsheets, paying corporate bills, routing parcels on conveyor belts, answering telephones, and reserving airline seats. Automated AISs depend on software to function properly. But this dependency also presents important challenges to accountants. For example, every system that influences cash accounts or affects other corporate resources must also contain automated controls to ensure the reliability, completeness, and authenticity of computer inputs, processing, and outputs. Similarly, all AIS software must initially be designed, acquired, and installed by someone. These facts help explain why accountants are often such an integral part of the teams that shop for, test, and audit such systems.

Operating Systems

An **operating system (OS)** is a set of software programs that helps a computer, file server, or network run itself and also the application programs designed for it. Examples of operating systems for microcomputers include MacOS, Windows Vista, and Linux. Operating systems for larger computers include UNIX, Windows.Net server, and OS2. Some of these operating systems are designed as single-user operating systems (e.g., Windows XP), while others are designed as multi-user operating systems for LANs (e.g., Windows NT Server and Novell Netware). Operating systems for very small systems such as PDAs and cell phones include Windows Mobile, Blackberry, Bluetooth, Palm OS, and Symbian OS. Most of these operating systems combine many convenient software tools

in one package and use **graphical user interfaces (GUIs)** with menus, icons, and other graphics elements (instead of instruction commands) to identify system components and launch processing programs.

On computers of any size, the operating system is typically the first piece of software loaded (booted) into primary memory when the computer powers up. System tasks for single-user OS's include testing critical components on boot-up, allocating primary memory among competing applications (i.e., managing the multitasking demands of several Windows sessions), managing system files (such as directory files), maintaining system security, and (in larger computers) gathering system performance statistics. The system tasks for multi-user OS's are even more complicated than for single-user systems because more users are involved and more coordination of system resources is required. These multi-user OS's maintain job queues of programs awaiting execution, create and check password files, allocate primary memory to several online users, apportion computer time in time-sharing (**multiprocessing**) environments, and accumulate charges for resource usage.

Application (end-user) programs are designed to work with (''run under'') a particular operating system. An operating system helps run application programs by coordinating those programs' input and output tasks, by managing the pieces of a large application program that is too large to fit entirely in RAM, and by monitoring their execution.

The **utility programs** that come with operating systems help users perform such tasks as copying files, converting files from one format to another, compressing files, performing system diagnostics, and building disk directories. Another task is to manage **virtual storage—** i.e., disk memory that a computer system uses to augment its limited primary memory. Finally, today's operating systems also run **antivirus software**. As explained more fully in Chapter 12, a **virus** is a destructive program that, when active, damages or destroys computer files or programs. Today's operating systems include antivirus software routines that guard against the virus programs a user might accidentally introduce into his or her computer system from external sources. However, because new viruses continue to appear, users should update this software at least monthly.

Application Software

The term **application software** refers to computer programs that help end users such as accountants perform the tasks specific to their jobs or relevant to their personal needs. One category of application software is the **personal productivity software** familiar to most accountants—i.e., word processing software (for creating documents and reports), spreadsheet software (for creating worksheets of rows and columns and also for graphing the data), database software (for creating files and databases of personal information), and personal finance software (for paying bills, creating personal budgets, and maintaining investment portfolio data).

Another category of application software is the personal productivity software designed for commercial uses. Examples include *project management software* (for coordinating and tracking the events, resources, and costs of large projects such as construction projects or office moves), *computer-aided design (CAD) software* (for designing consumer products, fashion clothing, automobiles, or machinery), and *presentation graphics software* (for creating slides and other presentations).

A third category of application software is the accounting software that performs such familiar tasks as preparing payrolls, maintaining accounts receivable files, executing accounts payable tasks, controlling inventory, and producing financial statements. Often, developers integrate these tasks in complete accounting packages. Because of the particular relevance of such software to AISs, Chapter 9 discusses such packages in greater detail.

Yet a fourth type of application software is *communications software* that allows separate computers to transmit data to one another. Microcomputer examples include communications packages (for simple data transmissions between computers), web browsers (for accessing and displaying graphics information on the Internet), backend software (that enables web servers to communicate with large, commercial databases of customer and product information), and email software (for creating, transmitting, displaying, and deleting email messages).

Finally, a fifth type of application software is the relatively-new **enterprise resource planning (ERP) software** that enables businesses and government agencies to transmit and manipulate financial data on an organization-wide basis. An example is SAP. These systems are particularly important to electronic commerce (e-commerce) applications—for example, because a simple sale over the Internet simultaneously affects accounts receivable, inventory, and marketing subsystems.

Programming Languages

To develop application software, developers must write detailed instructions in **programming languages** that computers can understand and execute. FORTRAN, COBOL, and RPG are examples of older programming languages that developers used to create minicomputer and mainframe AISs (i.e., the older but still-viable legacy systems). Newer computer languages include C++ (favored for its ability to manipulate data at the bit level), Visual Basic (favored for creating Windows-like user interfaces), HTML (an editing language favored for creating web pages), and Java (favored for its ability to run on many different types of computers).

Most of the newer programming languages are **object-oriented**, meaning that they encourage programmers to develop code in reusable modules called *objects*, which are easier to develop, debug, and modify. Both Visual Basic and C++ are **event-driven programming languages—** i.e., programming languages where code responds to events such as a user clicking on a menu item with a mouse.

Figure 2-20 illustrates how developers create application programs using these programming languages. The process begins when computer programmers write instructions in a *source* programming language such as Visual Basic. In a second step, the developers use another program called a **compiler to** translate this *source code* into the machine language (*object code*) that a computer understands. This translation process is called a *compilation*. The output from the compilation is the object code that a computer can then load and execute in a third step. When end users buy application software packages, they buy compiled programs in machine language that are ready to execute on their specific computers.

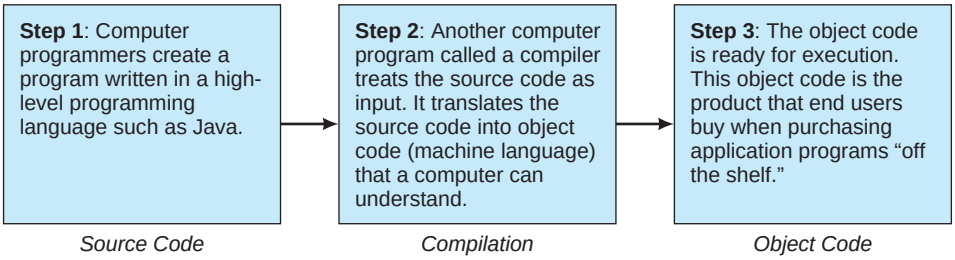


FIGURE 2-20 How computer programmers create application software.

AIS AT WORK
Delivering Packages is High-Tech at UPS

Most people recognize UPS as the company that picks up or delivers packages with brown delivery trucks—not exactly a high-tech business. But UPS has gone high-tech. The company's annual spending on IT is now about $1 billion—one of the largest in the world—and the company's IT division alone employs 4,700 employees, maintains 8,700 web servers and 15 large mainframe computers, and helps the company deliver about 15 million packages each day to customers around the world.

Why does a company in a ''low-tech business'' spend all that money on IT resources? One of its newest initiatives is its automated delivery system. That system starts with a ''smart label'' that customers can create for themselves on UPS's website for each of their packages. Even before a driver picks up the package, the company forwards a copy of the label to the distribution center closest to the final delivery point, where special software begins building a delivery schedule for each of 66,000 UPS drivers. When the package finally arrives at the center, the system creates a separate label with delivery instructions that also indicate where to place the package in the truck and when to drop it off. (Express deliveries go in the front, afternoon deliveries go in the back.) The system also creates a customized route for each driver each day.

The gains from all this automation are also impressive. In one month, for example, the new routing system reduced almost 2 million miles in delivery and pickup travel, and enabled drivers to make an additional seven to nine pickups or drop-offs per day. The new system also interfaces with a global positioning system (GPS), enabling managers to precisely locate the position of any truck and, perhaps estimate more precisely pickup times for customers waiting with packages.

UPS executives note that the most important problem they've had with their new systems has been a lack of familiarity with the new software and an unanticipated need for more employee training. This reminds us that, like any large information system, ''people'' play an important role in high-tech applications.

Source: Corey Dade ''Moving Ahead: How UPS Went from Low-Tech to an IT Power'' *Wall Street Journal* (July 24, 2006), pp. R4, R7.

SUMMARY

- It is useful to view an AIS as a collection of hardware, software, data, people, and procedures that must all work together to accomplish processing tasks.
- Information technology will become even more important to accountants as AISs continue to incorporate technological advances in their designs, and also as this technology becomes more important to their daily professional and personal tasks.
- To achieve their objectives, computerized AISs must input, process, store, and output information, and often, utilize data communications.
- The starting point for most AIS data processing is either an electronic or a manual source document. Electronic source documents eliminate many errors that are introduced by human input. POS devices, MIRC readers, OCR readers, and magnetic strip readers enable AISs to capture data that are already in machine-readable formats.
- Biometric scanners help AISs limit access to legitimate users. Two of the most reliable types of scanners read fingerprints or irises.

- The central processing unit (CPU) of a computer system performs the data-manipulating tasks required of the system. In order of increasing power, these units are micro- or personal computers, minicomputers, mainframe computers, and supercomputers. All CPUs have primary memories and microprocessors. However, most AISs are I/O bound, not process bound.
- Two major output devices are printers and video monitors. Three important types of printers are dot matrix printers, ink-jet printers, and laser printers. Businesses usually prefer laser printers because they are the fastest and have the highest print resolutions.
- Secondary storage devices enable AISs to store and archive data on permanent media. Magnetic disks, CD-ROMs, DVDs, and flash memories are the most common secondary storage devices.
- Image processing allows users to capture and store visual graphs, charts, and pictures in digital formats on such media.
- Data communications enable AISs to transmit data over local and wide area networks. Many AISs now use LANs or WANs for email, sharing computer resources, saving software costs, gathering input data, or distributing outputs. Wi-Fi technology such as RFID and NFC applications significantly increases our ability to access information accurately as well as communicate efficiently with others.
- Cloud computing refers to the use of service providers over the Internet. Applications include access to computer software programs, backup and recovery file services, and web-page development and hosting.
- The software of an AIS performs the specific data processing tasks required. Operating systems enable computers to run themselves, and also to execute the application programs designed for them.
- Application software enables end users to perform work-related tasks. Categories of such software include personal productivity software, integrated accounting packages, and communication packages. Programming languages enable IT professionals to translate processing logic into instructions that computers can execute.

KEY TERMS YOU SHOULD KNOW

antivirus software
application software
audio input
bar code reader
CD-ROM
central processing unit (CPU)
client/server computing
cloud computing
compiler
computer record
computer software
data communications
data communications protocol
data transcription
digital subscriber line (DSL)
dot-matrix printer
electronic data interchange (EDI)
enterprise network
enterprise resource planning (ERP) software
event-driven programming language
extranet
file server
graphical user interface (GUI)
hard-copy output
I/O-bound computer
image processing
information technology (IT)
ink-jet printer
input-processing-output cycle
ISDN line
laser printer
legacy system
local area network (LAN)
magnetic (hard) disk
magnetic ink character recognition (MICR)
mainframe computer
mark-sense media
microprocessor
minicomputer
modem (modulator/demodulator)
multimedia

near field communications (NFC)
object-oriented programming language
operating system
optical character recognition (OCR)
peripheral equipment
personal data assistant (PDA) devices
personal productivity software
picture elements (pixels)
point-of-sale (POS) device
primary memory
programming language
radio frequency identification (RFID)
redundant array of independent disks (RAIDs)
secondary storage
soft-copy output
source document
supercomputer
turnaround document
utility program
virtual storage
virus
voice recognition system
volatile memory
wireless application protocol (WAP)
wide-area network (WAN)
wireless communications
Wi-Fi (wireless fidelity)
worm (write-once, read many)

TEST YOURSELF

Q2-1. All of the following are reasons why IT is important to accountants *except:*

a. Accountants often help clients make IT decisions
b. Auditors must evaluate computerized systems
c. IT questions often appear on professional certification examinations
d. The costs of IT are skyrocketing

Q2-2. Data transcription is best described as:

a. An efficient process
b. Always necessary in AISs
c. Labor-intensive and time-consuming
d. An important way to limit fraud and embezzlement

Q2-3. The acronyms POS, MIC, and OCR are most closely associated with:

a. Input devices
b. Processing devices
c. Output devices
d. Communication devices

Q2-4. Purchasing backup services from an Internet vendor is an example of:

a. OCR
b. Modem services
c. Virtual storage
d. Cloud computing

Q2-5. The term ''enrollment'' is most closely associated with:

a. PDAs
b. Biometric scanners
c. Printers
d. Modems

Q2-6. The RAM of a computer is associated with:

a. Primary memory

b. Secondary storage
c. Arithmetic-logic unit
d. Modem

Q2-7. The term ''I/O bound'' means that:
a. Computers must input and output data when executing accounting applications
b. AISs are headed for the land of I/O
c. Computers can ''think'' faster than they can read or write
d. Computers are obligated to make inferences and oversights

Q2-8. Video output can also be called:
a. Hard-copy output
b. Soft-copy output
c. Image output
d. Pixilated output

Q2-9. Which of these devices is capable of storing the most data?
a. CD-ROM disk
b. DVD disk
c. USB (flash memory) drive
d. Magnetic (hard) disk

Q2-10. All of these are components, or layers, of a client/server computing system *except:*
a. Presentation layer
b. Application/logic layer
c. Client layer
d. Data management layer

Q2-11. All of these are terms associated with programming languages *except:*
a. Object-oriented
b. Event-driven
c. Compiler
d. Server

DISCUSSION QUESTIONS

2-1. Why is it important to view an AIS as a combination of hardware, software, people, data, and procedures?

2-2. Why is information technology important to accountants?

2-3. Why do most AISs try to avoid data transcription?

2-4. Name several types of computer input devices, and explain in general terms how each one functions.

2-5. How do you feel about red light cameras? Should cities be allowed to use them? Why or why not?

2-6. Identify the three sections of a CPU, and describe the functions of each component. How are microprocessor speeds measured? Why are such speeds rarely important to AISs?

2-7. Identify several types of printers. What are the advantages and disadvantages of each type?

2-8. What is the function of secondary storage? Describe three types of secondary storage media, and describe the advantages and disadvantages of each type.

2-9. What is image processing? How is image processing used in AISs?

2-10. What are data communication protocols? Why are they important?

2-11. What are local area networks? What advantages do LANs offer accounting applications?

2-12. What is client/server computing? How does it differ from host/mainframe computing? What are some of the advantages and disadvantages of client/server systems?

2-13. What are the names of some current cloud computing vendors other than those discussed in the text? Do you think that all firms should use cloud vendors, or are there some reasons why they should be avoided?

2-14. What are windowing operating systems, multitasking operating systems, and graphical user interfaces? Why are they useful to AISs?

2-15. Name some general classes of application software. What tasks do each of the software classes perform?

2-16. What are computer programming languages? Name some specific languages and describe briefly an advantage of each.

PROBLEMS

2-17. Are the following input equipment, output equipment, CPU components, secondary storage devices, or data-communications related?
(a) CRT screen, (b) ALU, (c) CD-ROM, (d) keyboard, (e) modem, (f) dot-matrix printer, (g) audio speaker, (h) POS device, (i) MICR reader, (j) laser printer, (k) magnetic tape, (l) flash memory, (m) OCR reader, (n) magnetic (hard) disk, (o) ATM, (p) primary memory, (q) ALU.

2-18. All of the following are acronyms discussed in this chapter. What words were used to form each one and what does each term mean?
(a) POS, (b) CPU, (c) OCR, (d) MICR, (e) ATM, (f) RAM, (g) ALU, (h) MIPS, (i) OS, (j) MHz, (k) pixel, (l) RGB, (m) CD-ROM, (n) worm, (o) modem, (p) LAN, (q) WAN, (r) ERP, (s) WAP, (t) Wi-Fi, (u) ppm, (v) dpi, (w) NFC, (x) RFID.

2-19. Which of the following holds the most data?
(a) One DVD disk (b) One hard disk (capacity: 160 gigabytes), or (c) Ten CD-ROMs

2-20. Brian Fry Products manufactures a variety of machine tools and parts used primarily in industrial tasks. To control production, the company requires the information listed below. Design an efficient record format for Brian Fry Products. (Hint: see Figure 2-10.)

a. Order number (4 digits)

b. Part number to be manufactured (5 digits)

c. Part description (10 characters)

d. Manufacturing department (3 digits)

e. Number of pieces started (always less than 10,000)

f. Number of pieces finished

g. Machine number (2 digits)

h. Date work started

i. Hour work started (use 24-hour system)

j. Date work completed

k. Hour work completed

l. Work standard per hour (3 digits)

m. Worker number (5 digits)

n. Foreman number (5 digits)

2-21. Go to the AICPA website at www.aicpa.org. What are the top ten information technologies for the current year? How do these items compare with the list in Figure 2-1? Is it common for new items to appear, or do you think this list is ''stable'' from year to year?

2-22. Your state has recently decided to install an RFID system for its toll roads. The current plan is to sell non-refundable transponders for $20 and allow users to deposit up to $1,000 in their accounts. To assist the IT personnel, the system's planners want to develop a list of possible accounting transactions and system responses. Using your skills from earlier accounting classes, what debit and credit entries would you make for each of the following activities? (Feel free to develop your own accounts for this problem.)

a. A user buys a new transponder for $20.

b. A user adds $100 to his account.

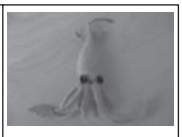
c. A user discovers that a data entry clerk charges his credit card $1,000 instead of $100 when adding $100 to his account.

d. An individual leaves the state, turns in his transponder, and wants a cash refund for the $25.75 remaining in his account.

e. A good Samaritan turns in a transponder that he finds on the side of the road. There is a $10 reward for this act, taken from the owner's account.

2-23. Select a type of computer hardware that interests you and write a one-page report on three possible choices of it. Examples include monitors, USB drives, external hard drives, or even new laptops. Your report should include a table similar to the one shown here that includes: (1) embedded pictures of your choices, (2) major specifications (e.g., storage capacities, pixel sizes, data transfer rates, etc.), (3) the suggested retail price of each item, (4) the likely ''street price'' of the item, and (5) the name of the vendor that sells the item at the street price.

The major deliverable is a one-page report that includes (1) the table identified above, (2) an explanation of why you chose to examine the hardware you did, and (3) an indication of which particular item you would buy of your three choices.

		
Sushi USB	Cruzer USB	Squid USB
spec	spec	spec
spec	spec	spec

CASE ANALYSES

2-24. Savage Motors (Software Training)

Savage Motors sells and leases commercial automobiles, vans, and trucks to customers in southern California. Most of the company's administrative staff works in the main office. The company has been in business for 35 years, but only in the last 10 years has the company begun to recognize the benefits of computer training for its employees.

The company president, Arline Savage, is thinking about hiring a training company to give onsite classes. To pursue this option, the company would set up a temporary ''computer laboratory'' in one of the meeting rooms, and the trainers would spend all day teaching one or more particular types of software. You have been hired as a consultant to recommend what type of training would best meet the firm's needs.

You begin your task by surveying the three primary corporate departments: sales, operations, and accounting. You find that most employees use their personal computers for only five types of software: (1) word processing, (2) spreadsheets, (3) database, (4) presentations, and (5) accounting. The accompanying table shows your estimates of the total number of hours per week used by each department on each type of software.

Department (number of employees)	Hours per week				
	Word Processing	Spreadsheet	Database	Presentation	Accounting
Sales (112)	1,150	750	900	500	700
Operations (82)	320	2,450	650	100	500
Accounting (55)	750	3,600	820	250	2,500

Requirements

1. Create a spreadsheet illustrating each department's average use of each application per employee, rounding all averages to one decimal point. For example, the average hours of word processing for the Sales department is 1,150/112 = 10.3 hours.
2. Suppose there were only enough training funds for each department to train employees on only one type of application. What training would you recommend for each department?
3. What is the average number of hours of use of each application for all the employees in the company? What training would you recommend if funds were limited to only training one type of application for the entire company?
4. Using spreadsheet tools, create graphs that illustrate your findings in parts 1 and 2. Do you think that your graphs or your numbers better ''tell your story?''
5. What alternatives are there to onsite training? Suggest at least two alternatives and discuss which of your three possibilities you prefer.

2-25. Backwater University (Automating a Data Gathering Task)

Backwater University is a small technical college that is located miles from the nearest town. As a result, most of the students who attend classes there also live in the resident dormitories and purchase one of three types of meal plans. The ''Full Plan'' entitles a student to eat three meals a day, seven days a week, at any one of the campus's three dining facilities. The ''Weekday Plan'' is the same as the Full Plan, but entitles students to eat meals only on weekdays—not weekends. Finally, the ''50-Meal'' plan entitles students to eat any 50 meals during a given month. Of course, students and visitors can always purchase any given meal for cash.

Because the school administration is anxious to attract and retain students, it allows them to change their meal plans from month to month. This, in fact, is common, as students pick plans that best serve their needs each month. But this flexibility has also created a nightmare at lunch times, when large numbers of students attempt to eat at the dining facilities simultaneously.

In response to repeated student complaints about the long lines that form at lunchtime, Barbara Wright, the Dean of Students, decides to look into the matter and see for herself what is going on. At lunch the next day, she observes that each cashier at the entrance to

the dining facilities requires each student to present an ID card, verifies that the picture on the card matches the student presenting it, and then consults a long, hard-copy list of students to determine whether the student is eligible for the current meal. A cashier later informs Barbara that these tasks are regrettable, but also mentions that they have become necessary because many students attempt to eat meals that their plans do not allow.

The cashier also mentions that, at present, the current system provides no way of keeping a student from eating *two of the same meals* at two different dining facilities. Although Barbara thinks that this idea is far-fetched, the cashier says that this problem is surprisingly common. Some students do it just as a prank or on a dare, but other students do it to smuggle out food for their friends.

Barbara Wright realizes that one solution to the long-lines problem is to simply hire more cashiers. She also recognizes that a computerized system might be an even more cost-effective solution. In particular, she realizes that if the current cashiers had some way of identifying each student quickly, the computer system could immediately identify a given student as eligible, or ineligible, for any given meal.

Requirements

1. Suggest two or more ''technology solutions'' for this problem.
2. What hardware would be required for each solution you named in part 1?
3. What software would be required for each solution you named in part 1? What would this software do?
4. How would you go about showing that your solutions would be more cost effective than simply hiring more cashiers? (You do not have to perform any calculations to answer this question, merely outline your method.)

2-26. Bennet National Bank (Centralized versus Decentralized Data Processing)

Bennet National Bank's credit-card department issues a special credit card that permits credit-card holders to withdraw funds from the bank's automated teller machines (ATMs) at any time of the day or night. These machines are actually smart terminals connected to the bank's central computer. To use them, a bank customer inserts the magnetically-encoded card in the automated teller's slot and types in a unique password on the teller keyboard. If the password matches the authorized code, the customer goes on to indicate, for example, (1) whether a withdrawal from a savings account or a withdrawal from a checking account is desired and (2) the amount of the withdrawal (in multiples of $10). The teller terminal communicates this information to the bank's central computer and then gives the customer the desired cash. In addition, the automated terminal prints out a hard copy of the transaction for the customer.

To guard against irregularities in the automated cash transaction described, the credit-card department has imposed the following restrictions on the use of the credit cards when customers make cash withdrawals at ATMs.

1. The correct password must be keyed into the teller keyboard before the cash withdrawal is processed.
2. The credit card must be one issued by Bennet National Bank. For this purpose, a special bank code has been encoded as part of the magnetic strip information.

3. The credit card must be current. If the expiration date on the card has already passed at the time the card is used, the card is rejected.
4. The credit card must not be a stolen one. The bank keeps a computerized list of these stolen cards and requires that this list be checked electronically before the withdrawal transaction can proceed.
5. For the purposes of making withdrawals, each credit card can only be used twice on any given day. This restriction is intended to hold no matter what branch bank(s) are visited by the customers.
6. The amount of the withdrawal must not exceed the customer's account balance.

Requirements

1. What information must be encoded on the magnetic-card strip on each Bennet National Bank credit card to permit the computerized testing of these policy restrictions?
2. What tests of these restrictions could be performed at the teller window by a smart terminal and what tests would have to be performed by the bank's central processing unit and other equipment?

2-27. Prado Roberts Manufacturing (What Type of Computer System to Implement?)

Prado Roberts Manufacturing is a medium-sized company with regional offices in several western states and manufacturing facilities in both California and Nevada. The company performs most of its important data processing tasks, such as payroll, accounting, marketing, and inventory control, on a mainframe computer at corporate headquarters. However, almost all the managers at this company also have microcomputers, which they use for such personal productivity tasks as word processing, analyzing budgets (using spreadsheets), and managing the data in small databases.

The IT manager, Tonya Fisher, realizes that there are both advantages and disadvantages of using different types of systems to meet the processing needs of her company. Although she acknowledges that many companies are racing ahead to install microcomputers and client/server systems, she also knows that the corporate mainframe system has provided her company with some advantages that smaller systems cannot match. Tonya knows that American companies annually purchase over $5 billion in used computers, primarily mainframes.

Requirements

1. Identify several advantages and disadvantages of operating a mainframe computer system that is likely to be present at Prado Roberts Manufacturing. Are these advantages and disadvantages likely to parallel those at other manufacturing companies?
2. Identify at least two factors or actions that companies experience or do to prolong the lives of their legacy systems. Are these factors or actions likely to apply to Prado Roberts Manufacturing?

3. Identify several advantages and disadvantages of microcomputer/client server systems. Would these advantages apply to Prado Roberts Manufacturing? (CMA Adapted)

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ANSWERS TO TEST YOURSELF

1. **d** 2. **c** 3. **a** 4. **d** 5. **b** 6. **a** 7. **c** 8. **b** 9. **d** 10. **c** 11. **d**