Objectives

1. Describe the essential components of computer systems, including both hardware and software.
2. Recognize the rapid evolution of computer systems and the benefit of keeping up-to-date with current trends and developments.
3. Analyze how computer systems function as tools for managing information and generating knowledge.
4. Define the concept of human–technology interfaces.
5. Assess how computers can support collaboration, networking, and information exchange.

Key Terms

- Acquisition
- AMOLED (Active Matrix Organic Light-Emitting Diode)
- Applications
- Arithmetic logic units
- Basic input/output system (BIOS)
- Binary system
- Bit
- Bus
- Byte
- Cache memory
- Central processing unit (CPU)
- Cloud computing
- Cloud storage
- Communication software
- Compact disk read-only memory (CD-ROM)
- Compact disk-recordable (CD-R)
- Compact disk-rewritable (CD-RW)
- Compatibility
- Computer
- Computer science
- Conferencing software
- Creativity software
- Database
- Desktop
- Digital video disk (DVD)
- Digital video disk-recordable (DVD-R)
- Digital video disk-rewritable (DVD-RW)
- Dissemination
- Dots per inch (DPI) switch
- Double data rate synchronous dynamic random-access memory (DDR SDRAM)
- Dynamic random access memory (DRAM)
- E-mail
- E-mail client
- Electronically erasable programmable read-only memory (EEPROM)
- Embedded device
- Exabyte (EB)
- Executes
- Extensibility
- FireWire
- Firmware
- Flash memory
- Gigabyte (GB)
- Gigahertz
- Graphical user interface
- Graphics card
- Haptic
- Hard disk
- Hard drive
- Hardware
- High-definition multimedia interface (HDMI)
- Information
- Information Age
- Infrastructure as a service (IaaS)
- Instant message (IM)
- Integrated drive electronics (IDE)
- Internet browser
- IPS LCD (In-Plane Switching Liquid Crystal Display)
- Keyboard
- Knowledge
- Laptop
- Main memory
- Mainframes
- Megabyte (MB)
- Megahertz
- Memory
- Microprocessor
- Microsoft Surface
- Millions of instructions per second (MIPS)
- Mobile device
- Modem
- Monitor
- Motherboard
- Mouse
- MPEG-1 Audio Layer-3 (MP3)
- Networks
- Office suite
- Open source
- Operating system (OS)
- Parallel port
- Peripheral component interconnection (PCI)
- Personal computer (PC)
- Petabytes (PB)
- Platform as a service (PaaS)
- Plug and play
- Port
- Portability
- Portable operating system interface for UNIX (POSIX)
- Power supply
- Presentation
- Private cloud
- Processing
- Processor
- Productivity software

CHAPTER 3

Computer Science and the Foundation of Knowledge Model

Dee McGonigle, Kathleen Mastrian, and June Kaminski

- » Professional development
- » Programmable read-only memory (PROM)
- » Public cloud
- » Publishing
- » Quantum bits (Qubits)
- » Quantum computing
- » QWERTY
- » Random-access memory (RAM)
- » Read-only memory (ROM)
- » Security
- » Serial port
- » Small Computer System Interface (SCSI)
- » Software
- » Software as a service (SaaS)
- » Sound card
- » Spreadsheet
- » Supercomputers
- » Synchronous dynamic random-access memory (SDRAM)
- » Technology
- » Terabytes (TB)
- » Throughput
- » Touch pad
- » Touch screen
- » Universal serial bus (USB)
- » USB flash drive
- » User friendly
- » User interface
- » Video adapter card
- » Virtual memory
- » Wearable technology
- » Wi-Fi
- » Wisdom
- » Word processing
- » World Wide Web (WWW)
- » Yottabyte (YB)
- » Zettabyte (ZB)

Introduction

In this chapter, the discipline of computer science is introduced through a focus on computers and the hardware and software that make up these evolving systems; computer science is one of the building blocks of nursing informatics (refer to Figure 3-1). **Computer science** offers extremely valuable tools that, if used skillfully, can facilitate the **acquisition** and manipulation of data and **information** by nurses, who can then synthesize these into an evolving knowledge and **wisdom** base. This process can facilitate **professional development** and the ability to apply evidence-based practice decisions within nursing care, and if the results are disseminated and shared, can also advance the professional knowledge base.

This chapter begins with a look at common computer hardware, followed by a brief overview of operating, productivity, creativity, and communication software. It concludes with a glimpse at how computer systems help to shape knowledge and collaboration and an introduction to human–technology interface dynamics.

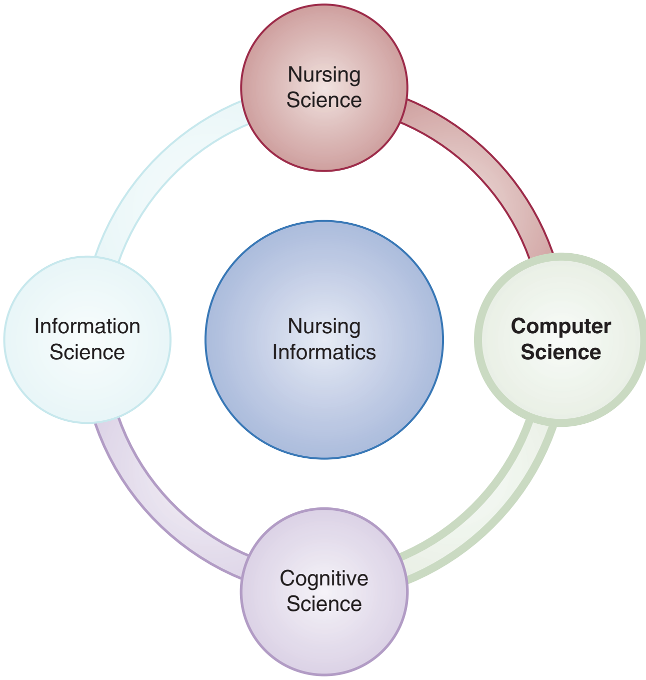

Figure 3-1 Building Blocks of Nursing Informatics

The Computer as a Tool for Managing Information and Generating Knowledge

Throughout history, various milestones have signaled discoveries, inventions, or philosophic shifts that spurred a surge in **knowledge** and understanding within the human race. The advent of the computer is one such milestone, which has sparked an intellectual metamorphosis whose boundaries have yet to be fully understood. Computer **technology** has ushered in what has been called the **Information Age**, an age when data, information, and knowledge are both accessible and able to be manipulated by more people than ever before in history. How can a mere machine lead to such a revolutionary state of knowledge potential? To begin to answer this question, it is best to examine the basic structure and components of computer systems.

Essentially, a **computer** is an electronic information-processing machine that serves as a tool with which to manipulate data and information. The easiest way to begin to understand computers is to realize they are input–output systems. These unique machines accept data input via a variety of devices, process data through logical and arithmetic rendering, store the data in memory components, and output data and information to the user.

Since the advent of the first electronic computer in the mid-1940s, computers have evolved to become essential tools in every walk of life, including the profession of nursing. The complexity of computers has increased dramatically over the years, and will continue to do so. "Computing has changed the world more than any other invention of the past hundred years, and has come to pervade nearly all human endeavors. Yet, we are just at the beginning of the computing revolution; today's computing offers just a glimpse of the potential impact of computers" (Evans, 2010, p. 3). Major computer manufacturers and researchers, such as Intel, have identified the need to design computers to mask this growing complexity. The sophistication of computers is evolving at amazing speed, yet ease of use or **user-friendly** aspects are also increasing accordingly. This is achieved by honing hardware and software capabilities until they work seamlessly together to ensure user-friendly, intuitive tools for users of all levels of expertise. Box 3-1 provides information about **haptic** technology, computing surfaces, and multi-touch interfaces, which are evolving technologies.

BOX 3-1 IMMERSION, MICROSOFT, AND PQ LABS INTERFACES

Dee McGonigle

Do not get too attached to your mouse and keyboard, because they will be outdated soon if Immersion, Microsoft, and PQ Labs have their way. From Immersion's (2016) haptic technology, the **Microsoft Surface** (Microsoft Corporation, 2016), and PQ Labs (2016) multi-touch capabilities, have you ever thought of digital information you can touch and grab? The sense of touch is a powerful sense that we use daily. Haptic technology continues to advance and "brings the sense of touch to digital content" (Immersion, 2016, para. 4). Haptic technology combined with a visual display can be used to prepare users for tasks necessitating hand–eye coordination, such as surgical procedures. Microsoft and PQ Labs are leading us into and evolving the next generation of computing, known as surface or table computing. Surface or table computing consists of a multi-touch, multiuser interface that allows one to "grab" digital information and then collaborate, share, and store that information, without using a mouse or keyboard—just the hands and fingers and devices such as a digital camera or smartphone. These interfaces can actually sense objects, touch, and gestures from many users.

We can enter a restaurant and interact with the menu through the surface of the table where you sit to eat. Once you have completed your order, you can begin computing by using the capabilities built into the surface or using your own device, such as a smartphone. You can set a smartphone on the table's surface and download images, graphics, and text to the surface. You can even communicate with others using full audio and video while waiting for your order. When you have finished eating, you simply set your credit card on the surface and it is automatically charged; you pick up your credit card and leave. This is a different kind of eating experience—but one that will become commonplace for the next generation of users. You can routinely experience this in Las Vegas, as well as in selected casinos, banks, restaurants, and hotels throughout the world.

You should seek to explore this new interface, which will forever change how we interact and compute. Think of the ramifications for health care especially as it relates to the haptic experience and wearables. Explore the Immersion reference provided for you.

REFERENCES

Immersion. (2016). Touch. Feel. Engage. Retrieved from http://www.immersion.com/wearables

Microsoft Corporation. (2016). Designed on Surface: A global art project. Retrieved from https://www.microsoft.com/surface/en-us/art

PQ Labs. (2016). Introducing G5: 4K Touch Fidelity. Retrieved from http://multitouch.com/product.html

As our capabilities evolve, so does the complexity of computer operations. The goal for vendors that provide computer systems and software is to decrease the learning curve for the user while enhancing the user's capacity to manipulate the system to meet their computing needs. Therefore, the complexity of the operation is concealed by the ease of use.

One example of this type of complexity masked in simplicity is the evolution of "**plug and play**" computer add-ons, where a peripheral, such as an iPod or game console, can be simply plugged into a serial or other **port** and instantly used.

Computers are universal machines, because they are general-purpose, symbol-manipulating devices that can perform any task represented in specific programs. For instance, they can be used to draw an image, calculate statistics, write an essay, or record nursing care data. In a nutshell, computers can be used for data and information storage, retrieval, analysis, generation, and transformation.

Most computers are based on scientist John Von Neumann's model of a processor–memory–input–output architecture. In this model, the logic unit and control unit are parts of the processor, the **memory** is the storage region, and the input and output segments are provided by the various computer devices, such as the keyboard, mouse, monitor, and printer. Recent developments have provided alternative configurations to the Von Neumann model—for example, the parallel computing model, where multiple processors are set up to work together. Nevertheless, today's computer systems share the same basic configurations and components inherent in the earliest computers.

Components

Hardware

Computer **hardware** refers to the actual physical body of the computer and its components. Several key components in the average computer work together to shape a complex yet highly usable machine that serves as a tool for knowledge management, communication, and creativity.

Protection: The Casing

The most noticeable component of any computer is the outer case. **Desktop** personal computers have either a desktop case, which lies horizontally (flat) on a desk, often with the computer monitor positioned on top of it; or a tower case, which stands vertically, and usually sits beside the monitor or on a lower shelf or the floor. Most cases come equipped with a case fan, which is extremely critical for keeping the computer components cool when in use. **Laptop** and surface computers combine the components into a flat rectangular casing that is attached to the hinged or foldable monitor. Smartphones also have a protective outer plastic or metal case with a display screen.

Central Processing Unit (CPU)/Processor

The **central processing unit (CPU)** is an older term for the **processor** and **microprocessor**. Sometimes conceptualized as the "brain" of the computer, the processor is the computer component that actually **executes**, calculates, and processes the binary computer code (which consists of various configurations of 0s and 1s), instigated by the **operating system (OS)** and other **applications** on the computer. The processor and microprocessor serve as the command center that directs the actions of all other computer components, and they manage both incoming and outgoing data that are processed across components. Some of the best processors include the AMD FX-9590, AMD FX-8320, AMD FX-6300, Intel Core i7-5820K, Intel Core i7- 4930K, Intel Core i7-5960X, Intel Core i5-6600K, and Intel Xeon processor (Futuremark, 2016).

The processor contains specific mechanical units, including registers, **arithmetic logic units**, a floating point unit, control circuitry, and cache memory. Together, these inner components form the computer's central processor. Registers consist of data-storing circuits whose contents are processed by the adjacent arithmetic and logic units or the floating point unit. **Cache memory** is extremely quick memory that holds whatever data and code are being used at any one time. The processor uses the cache to store in-process data so that it can be quickly retrieved as needed. The processor is protected by a heat sink, a copper or aluminum metal block that cools the processor (often with the help of a fan) to prevent overheating (refer to **Figure 3-2**).

In the past, the speed and power of a processor were measured in units of **megahertz** and was written as a value in MHz (e.g., 400 MHz, meaning the microprocessor ran at 400 MHz, executing 400 million cycles per second). Today, it is more common to see the speed measured in **gigahertz** (1 GHz is equal to 1,000 MHz); thus a processor that operates at 4 GHz is 1,000 times faster than an older one that operated at 4 MHz. The more cycles a processor can complete per second, the faster computer programs can run. However, according to Anderson (2016),

> *Intel has said that new technologies in chip manufacturing will favour better energy consumption over faster execution times—effectively calling an end to "Moore's Law," which successfully predicted the doubling of density in integrated circuits, and therefore speed, every two years. (para. 1)*

For example, the Intel Xeon processor E5-2699 v4 has a speed of 2.20 Ghz with 55 MB cache (Intel Corporation, 2016), making it more efficient at a lower speed.

In recent years, processor manufacturers, such as Intel, have moved to multicore microprocessors, which are chips that combine two or more processors. In fact, multiple microprocessors have become a standard in both personal and professional-level computers. Minicomputers were replaced by servers using microprocessors and multiprocessors have replaced most **mainframes**.

As **mobile devices** and **embedded devices** are being integrated into our daily routines, mainframes can create secure transactions with the analytics necessary for organizations

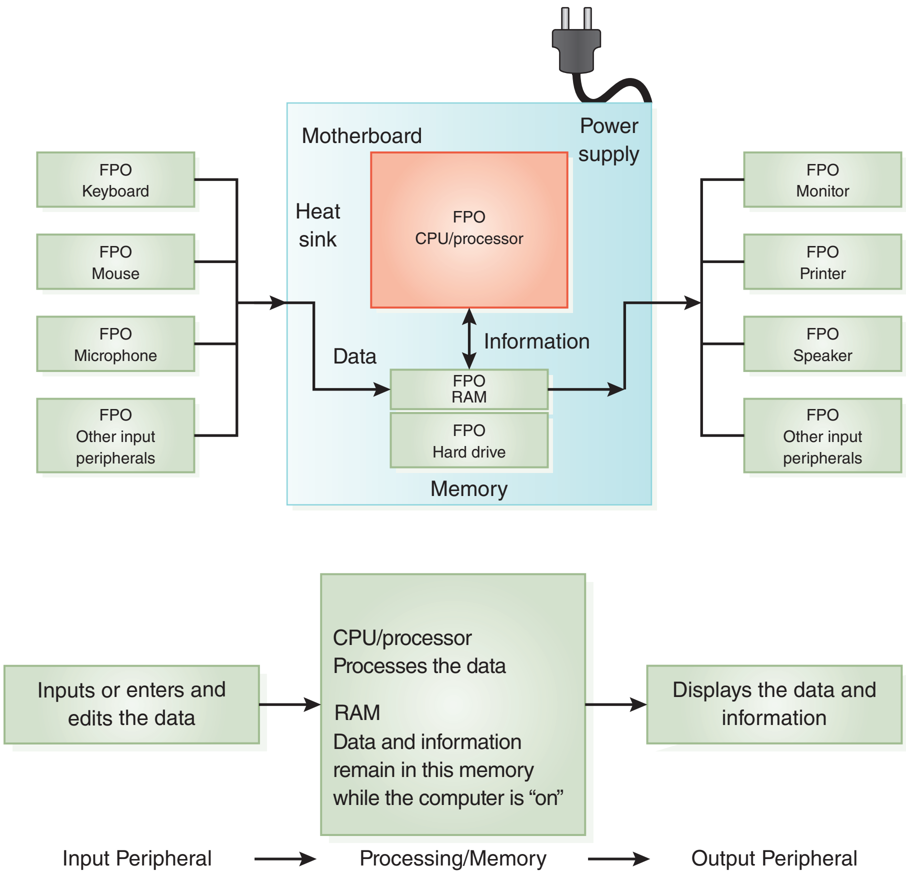

Figure 3-2 Computer Components

to improve their business processes. IBM has found its niche and continues to build mainframes. According to Alba (2015),

> *The concept of a "mobile transaction" is a bit of marketing-speak. Tons of transactions take place via mobile devices, and the mainframe is good at transaction processing. Put them together, and voilà: a computer the size of a backyard shed becomes a mobile product. (para. 6)*

Powerful **supercomputers** are also using collections of microprocessors.

Motherboard

The **motherboard** has been called the "central nervous system" of the computer because it facilitates communication among all of the different computer components. This makes it a key foundational component because all other components are connected to it in some way (either directly via local sockets, attached directly to it, or connected via cables). This includes **universal serial bus (USB)** controllers, Ethernet network controllers, integrated graphics controllers, and so forth. The essential structures of the motherboard include the major chipset, Super Input/Output chip, basic input/output system read-only memory, **bus** communications pathways, and a variety of sockets that allow components to plug into the board. The chipset (often a pair of chips) determines the computer's CPU type and memory. It also houses the north bridge and south bridge controllers that allow the buses to transfer data from one to another.

Power Supply

The **power supply** is a critical component of any computer, because it provides the essential electrical energy needed to allow a computer to operate. The power supply unit converts the 120-volt AC main power (provided via the power cable from the wall socket into which the computer is plugged) into low-voltage DC power. Computers depend on a reliable, steady supply of DC power to function properly. The more devices and programs used on a computer, the larger the power supply should be to avoid damage and malfunctioning. Power supplies normally range from 160 to 700 watts, with an average of 300 to 400 watts. Most contemporary power supply units come equipped with at least one fan to cool the unit under heavy use. The power supply is controlled by pressing the on and off switch, as well as the reset switch (which restarts the system) of a computer.

Laptop and other portable computing machines, such as electronic readers and tablet computers, are equipped with a both rechargeable battery power supply and the standard plug-in variety.

Hard Disk

This component is so named because of the rigid hard disks that reside in it, which are mounted to a spindle that is spun by a motor when in use. Drive heads (most computers have two or more heads) produce a magnetic field through their transducers that magnetizes the disk surface as a voltage is applied to the disk. The **hard disk** acts as a permanent data storage area that holds gigabytes (GB) or even terabytes (TB) worth of data, information, documents, and programs saved on the computer, even when the computer is shut off. Disk drives are not infallible, however, so backing up important data is imperative.

The computer writes binary data to the hard drive by magnetizing small areas of its surface. Each drive head is connected to an actuator that moves along the disk to hover over any point on the disk surface as it spins. The parts of the hard disk are encased in a sealed unit. The hard drive is managed by a disk controller, which is a circuit board that controls the motor and actuator arm assembly. The **hard drive** produces the voltage waveform that contacts the heads to write and read data, and handles communications with the motherboard. It is usually located within the computer's hard outer casing. Some people also attach a second hard drive externally, to increase available memory or to back up data.

Main Memory or Random-Access Memory

Random-access memory (RAM) is considered to be volatile memory because it is a temporary storage system that allows the processor to access program codes and data while working on a task. The contents of RAM are lost once the system is rebooted, is shut off, or loses power.

The memory is actually situated on small chip boards, which sport rows of pins along the bottom edge and are plugged into the motherboard of the computer. These memory chips contain complex arrays of tiny memory circuits that can be either set by the processor during write operations (puts them into storage) or read during data retrieval. The circuits store the data in binary form as either a low (on) voltage stage, expressed as a 0, or a high (off) voltage stage, expressed as a 1. All of the work being done on a computer resides in RAM until it is saved onto the hard drive or other storage drive. Computers generally come with 2 GB of RAM or more, and some offer more RAM via **graphics cards** and other expansion cards.

A certain portion of the RAM, called the **main memory**, serves the hard disk and facilitates interactions between the hard disk and central processor. Main memory is provided by **dynamic random access memory (DRAM)** and is attached to the processor using specific addresses and data buses.

Synchronous dynamic random-access memory (SDRAM) (also known as static dynamic RAM) protects its data bits. The newer chip is **double data rate synchronous dynamic random-access memory (DDR SDRAM)** that allows for greater bandwidth and twice the transfers per the computer's internal clock's unit of time.

Read-Only Memory

Read-only memory (ROM) is essential permanent or semipermanent nonvolatile memory that stores saved data and is critical in the working of the computer's OS and other activities. ROM is stored primarily in the motherboard, but it may also be available through the graphics card, other expansion cards, and peripherals. In recent years, rewritable ROM chips that may include other forms of ROM, such as **programmable read-only memory (PROM)**, erasable ROM, **electronically erasable programmable read-only memory (EEPROM)**, and **flash memory** (a variation of electronically erasable programmable ROM), have become available.

Basic Input/Output System

The **basic input/output system (BIOS)** is a specific type of ROM used by the computer when it first boots up to establish basic communication between the processor, motherboard, and other components. Often called boot firmware, it controls the computer from the time the machine is switched on until the primary OS (e.g., Windows, Mac OS X, or Linux) takes over. The **firmware** initializes the hardware and boots (loads and executes) the primary OS.

Virtual Memory

Virtual memory is a special type of memory that is stored on the hard disk to provide temporary data storage so data can be swapped in and out of the RAM as needed. This capability is particularly handy when working with large data-intensive programs, such as games and multimedia.

Integrated Drive Electronics Controller

The **integrated drive electronics (IDE)** controller component is the primary interface for the hard drive, **compact disk read-only memory (CD-ROM)**, **digital video disk (DVD)** drive, and the floppy disk drive (found largely on pre-2010 computers).

Peripheral Component Interconnection Bus

This component is important for connecting additional plug-in components to the computer. It uses a series of slots on the motherboard to allow **peripheral component interconnection (PCI)** card plug-in.

Small Computer System Interface

The **Small Computer System Interface (SCSI)** component provides the means to attach additional devices, such as scanners and extra hard drives, to the computer.

DVD/CD Drive

The CD-ROM drive reads and records data to portable CDs, using a laser diode to emit an infrared light beam that reflects onto a track on the CD using a mirror positioned by a motor. The light reflected on the disk is directed by a system of lenses to a photodetector that converts the light pulses into an electrical signal; this signal is then decoded by the drive electronics to the motherboard. There are **compact disk-recordable (CD-R)** and **compact disk-rewritable (CD-RW)**, **digital video disk-recordable (DVD-R)**, and **digital video disk-rewritable (DVD-RW)** drives. A DVD drive can do everything a CD drive can do, plus it can play the content of disks and, if it is a recordable unit, can record data on blank DVDs.

Flash or USB Flash Drive

This portable memory device uses electronically erasable programmable ROM to provide fast permanent memory. The **USB flash drive** is typically a removable and rewritable device that includes flash memory and an integrated USB interface. They are easily portable due to their small size and are durable and dependable, and obtain their power from the device they are connected to via the USB port.

Modem

A **modem** is a component that can be situated either externally (external modem) or internally (internal modem) relative to the computer and enables Internet connectivity via a cable connection through network adapters situated within the computer apparatus.

Connection Ports

All computers have connection ports made to fit different types of plug-in devices. These ports include a monitor cable port, keyboard and mouse ports, a network cable port, microphone/speaker/auxiliary input ports, USB ports, and printer ports (SCSI or parallel). These ports allow data to move to and from the computer via peripheral or storage devices. Specific ports include the following:

- **Parallel port**: Connects to a printer
- **Serial port**: Connects to an external modem
- USB: Connects to a myriad of plug-in devices, such as portable flash drives, digital cameras, **MPEG-1 Audio Layer-3 (MP3)** players, graphics tablets, and light pens, using a plug-and-play connection (the ability to add devices automatically). The development of the USB Type-C–to–**high definition multimedia interface (HDMI)** adapter (Sexton, 2016) has expanded connectivity and transfer. HDMI is replacing analog video standards as an audio/video interface that can transfer

compressed and uncompressed video and digital audio data from any device that is HDMI-compliant to compatible monitors, televisions, video projectors, and audio devices.
- **FireWire** (IEEE 1394): Often used to connect digital-video devices to the computer
- Ethernet: Connects networking apparatus, such as Internet and modem cables

Graphics Card

Most computers come equipped with a graphics accelerator card slotted in the microprocessor of a computer to process image data and output those data to the monitor. These in situ graphic cards provide satisfactory graphics quality for two-dimensional art and general text and numerical data. However, if a user intends to create or view three-dimensional images or is an active game user, one or more graphics enhancement cards are often installed.

Video Adapter Cards

Video adapter cards provide video memory, a video processor, and a digital-to-analog converter that works with the processor to output higher quality video images to the monitor.

Sound Card

The **sound card** converts digital data into an analog signal that is then output to the computer's speakers or headphones. The reverse is also accomplished by inputting a signal from a microphone or other audio recording equipment, which then converts the analog signal to a digital signal.

Bit

A **bit** is the smallest possible chunk of data memory used in computer processing and is depicted as either a 1 or a 0. Bits make up the **binary system** of the computer.

Byte

A **byte** is a chunk of memory that consists of 8 bits; it is considered to be the best way to indicate computer memory or storage capacity. In modern computers, bytes are described in units of **megabytes (MB)**; **gigabytes (GB)**, where 1 GB equals 1,000 MB; or **terabytes (TB)**, where 1 TB equals 1 trillion bytes or 1,000 GB. Box 3-2 discusses storage capacities.

BOX 3-2 STORAGE CAPACITIES

Dee McGonigle and Kathleen Mastrian

Storage and memory capacities are evolving. In the past few decades, there have been great leaps in data storage. It all begins with the bit, the basic unit of data storage, composed of 0s and 1s, also known as binary digits. A byte is generally considered to be equal to 8 bits. The files on a computer are stored as binary files. The software that is used translates these binary files into words, numbers, pictures, images, or video. Using this binary code in the binary numbering system, measurement is counted by factors of 2, such as 1, 2, 4, 8, 16, 32, 64, and 128. These multiples of the binary system in computer usage are also prefixed based on the metric system. Therefore, a kilobyte (KB) is actually 2 to the 10th power (210) or 1,024 bytes, but is typically considered to be 1,000 bytes. This is why one sees 1,024 or multiples of that number instead of an even 1,000 mentioned at times in relation to kilobytes.

In the early 1980s, kilobytes were the norm as far as computer capacity went, and 128 KB machines were launched for personal use. Subsequent decades, however, have seen advanced computing power and storage capacity. As capabilities soared, so did the ability to save and store what was used and created. Megabytes (MB) emerged as a common unit of measure; 1 megabyte is 1,048,576 bytes but is considered to be roughly equivalent to 1 million bytes. The next leap in computer capacity was one that some people could not even imagine: gigabytes (GB). A gigabyte is 1,073,741,824 bytes but is generally rounded to 1 billion bytes. Some computing experts are very concerned that valuable bytes are lost when these measurements are rounded, whereas hard drive manufacturers use the decimal system so their capacity is expressed as an even 1 billion bytes per gigabyte.

Computer capacity has moved into and beyond the range of terabytes, with capacities moving into the range of **petabytes (PB)**, **exabytes (EB)**, **zettabytes (ZB)**, and **yottabytes (YB)**. These terms for storage capacity are defined as follows:

1 TB = 1,000 GB
1 PB = 1,000,000 GB
1 EB = 1,000 PB
1 ZB = 1,000 EB
1 YB = 1,000 ZB

To put all of this in perspective, Lyman and Varian describe the data powers of 10:

2 KB: A typewritten page
2 MB: A high-resolution photograph
10 MB: A minute of high-fidelity sound *or* a digital chest X-ray
50 MB: A digital mammogram
1 GB: A symphony in high-fidelity sound *or* a movie at TV quality
1 TB: All the X-ray films in a large, technologically advanced hospital
2 PB: The contents of all U.S. academic research libraries
5 EB: All words ever spoken by human beings

We have not even addressed ZB and YB. Stay tuned . . .

REFERENCE

Lyman, P., & Varian, H. R. (2003). How much information? Retrieved from http://groups.ischool.berkeley.edu/archive/how-much-info-2003/

Software

Software comprises the application programs developed to facilitate various user functions, such as writing, artwork, organizing meetings, surfing the Internet, communicating with others, and so forth. For the purposes of this overview, the various types of software have been divided into four categories: (1) OS software, (2) productivity software, (3) **creativity software**, and (4) communication software.

User friendliness is a critical condition for effective software adoption. The easier and more intuitive a software package seems to be to a user influences that user's perception of how clear the package is to understand and to use. The rapid evolution of hardware mentioned previously has been equally matched by the phenomenal development in software over the past three or four decades.

Commercial Software

Several large commercial software companies, such as Apple, Microsoft, IBM, and Adobe, dominate the market for software, and have done so since the advent of the **personal computer (PC)**. Licensed software has evolved over time; hence, most products have a long version history. Many software packages, such as office suites, are expensive to purchase; in turn, there is a "digital divide" as far as access and affordability go across societal spheres, especially when viewed from a global perspective.

Open Source Software

The **open source** initiative began in the late 1990s and has become a powerful movement that is changing the software production and consumer market. In addition to commercially available software, a growing number of open source software packages are being developed in all four of the categories addressed in this chapter. The open source movement was begun by developers who wished to offer their creations to others for the good of the community and encouraged them to do the same. Users who modify or contribute to the evolution of open source software are obligated to share their new code, but essentially the software is free to all. Apache OpenOffice, Google Docs, and NeoOffice are examples of open source productivity software (refer to Figure 3-3).

OS Software

The OS is the most important software on any computer. It is the very first program to load on computer start-up and is fundamental for the operation of all other software and the computer hardware. Examples of commonly used OSs include the Microsoft Windows family, Linux, and Mac OS X. The OS manages both the hardware and the software and provides a reliable, consistent interface for the software applications to work with the computer's hardware. An OS must be both powerful and flexible to adapt to the myriad of types of software available, which are made by a variety of development companies. New versions of the major OSs are equipped to deal with multiple users and handle multitasking with ease. For example, a user can work on a word processing document while listening for an "e-mail received" signal, have an **Internet browser** window open to look for references on the Internet as needed, listen to music in the CD drive, and download a file—all at the same time.

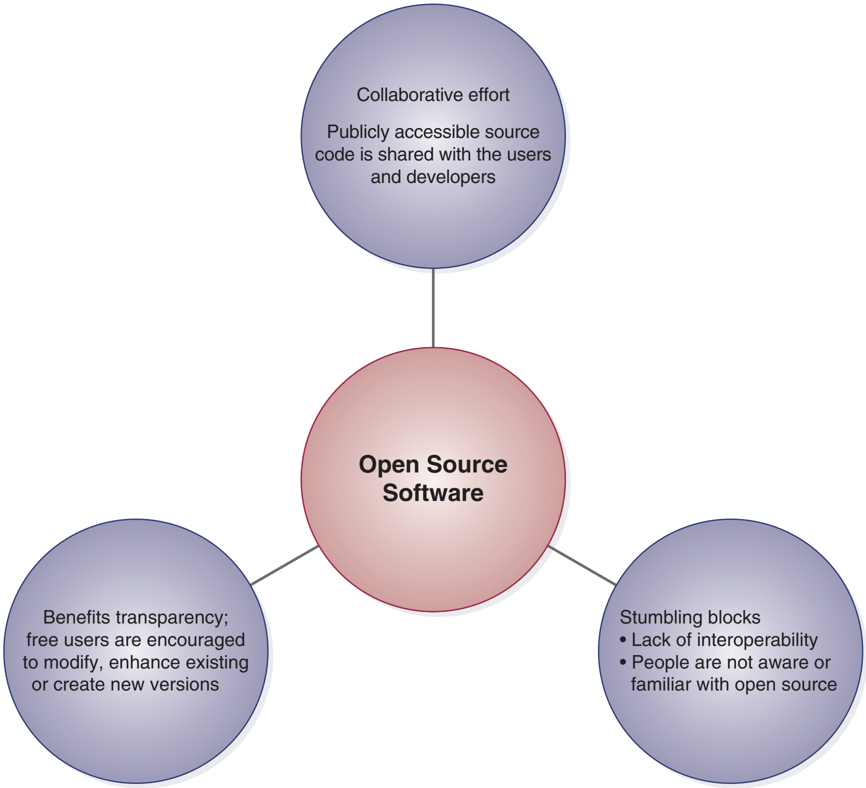

Figure 3-3 Open Source Software

OS tasks can be described in terms of six basic processes:

- Memory management
- Device management
- Processor management
- Storage management
- Application interface
- **User interface** (usually a **graphical user interface** [GUI])

A GUI (pronounced "gooey") is used by OSs to display a combination of graphics and text such as icons, drop-down menus, and buttons; it allows you to use input and output devices as well as icons that represent files, programs, actions, and processes.

OSs should be convenient to use, easy to learn, reliable, safe, and fast. They should also be easy to design, implement, and maintain and should be flexible, reliable, error free, and efficient. For example, Silbershatz, Baer Galvin, and Gagne (2013) described how "Microsoft's design goals for Windows included security, reliability, Windows and POSIX application compatibility, high performance, extensibility, portability, and international support" (p. 831). The following goals were established by Microsoft:

- **Portability**: The OS can be moved from one hardware architecture to another with few changes needed.
- **Security**: The OS incorporates hardware protection for virtual memory and software protection mechanisms for OS resources, including encryption and digital signature capabilities.
- **Portable operating system interface for Unix (POSIX)** compliance: Applications designed to follow the POSIX (IEEE 1003.1) standard can be compiled to run on Windows without changing the source code. Windows OSs have varying levels of compatibility with the applications that ran on earlier versions of Windows OSs.
- Multiprocessor support: The OS is designed for symmetrical multiprocessing.
- **Extensibility**: This capability is provided by using a layered architecture with a protected executive layer for basic system services, several server subsystems that operate in user mode, and a modular structure that allows additional environmental subsystems to be added without affecting the executive layer.
- International support: The Windows OS supports different locales via the national language support application programming interface (API).
- **Compatibility** with MS-DOS and MS-Windows applications.

Productivity Software

Productivity software, such as an **office suite**, is the type of software most commonly used both in the workplace and on personal computers. Several software companies produce this type of multiple-program software, which usually bundles together **word processing**, **spreadsheet**, **database**, **presentation**, Web development, and **e-mail** programs.

The intent of office suites is generally to provide all of the basic programs that office or knowledge workers need to do their work. The bundled programs within the suite are organized to be compatible with one another, are designed to look similar to one another for ease of use, and provide a powerful array of tools for data manipulation, information gathering, and knowledge generation. Some office suites add other programs, such as database creation software, mathematical editors, drawing, and desktop **publishing** programs. Table 3-1 summarizes the application of programs included in some of the popular office suites: Microsoft Office, Apache OpenOffice, NeoOffice, Corel WordPerfect Suite, and Apple iWork.

Creative Software

Creative software includes programs that allow users to draw, paint, render, record music and sound, and incorporate digital video and other multimedia in professional aesthetic ways to share and convey information and knowledge (Table 3-2).

Communication Software

Networking and **communication software** enable users to dialogue, share, and network with other users via the exchange of e-mail or **instant message (IM)**, by accessing the World Wide Web, or by engaging in virtual meetings using **conferencing** software (Table 3-3)

Table 3-1 Office Suite Software Features and Examples

Office Suite Software		
Program	**Application**	**Examples**
Word processing	Composition, editing, formatting, and producing text documents	Microsoft Word, Open Office Writer, KOffice KWord, Corel WordPerfect or Corel Write, Apple Pages
Spreadsheets	Grid-based documents in ledger format; organizes numbers and text; calculates statistical formulae	Microsoft Excel, Open Office Calc, KOffice KSpread, Corel Quattro Pro, Apple Numbers
Presentations	Slideshow software, usually used for business or classroom presentations using text, images, graphs, media	Microsoft PowerPoint, Open Office Impress, KOffice KPresenter, Corel Show, Apple Keynote
Databases	Database creation for text and numbers	Microsoft Access (in elite packages), Open Office Base, KOffice Kexi, Corel Calculate, Corel Paradox
Email	Integrated email program to send and receive electronic mail	Microsoft Outlook, Corel WordPerfect Mail, Mozilla Thunderbird
Drawing	Graphics and diagram drawing	Open Office Draw, Corel Presentation Graphics, KOffice Kivio, Karbon, Krita
Math formulas	Inserts math equations in word processing and presentation work	Open Office Math, KOffice KFormula
Desktop publishing	Page layouts and publication-ready documents	Microsoft Publisher (in elite packages), Apple Pages

Acquisition of Data and Information: Input Components

Input devices include the keyboard; mouse; joysticks (typically used for playing computer games); game controllers or pads; Web cameras (webcams); stylus (often used with tablets or personal digital assistants); image scanners for copying a digital image of a document or picture; touch pads; or other plug-and-play input devices, such as digital cameras, digital video recorders (camcorders), MP3 players, electronic musical instruments, and physiologic monitors. These devices are the origin or medium used to input text, visual, audio, or multimedia data into the computer system for viewing, listening, manipulating, creating, or editing. The primary input devices on a computer are the keyboard, mouse, touch pad, and touch screen.

Keyboard

A computer **keyboard** is very similar to the typewriter keyboards of earlier days and usually serve as the prime input device that enables the user to type words, numbers, and commands into the computer's programs. Standard computer keyboards have 110 keys and are organized to facilitate Latin-based languages using a **QWERTY** layout (so named because these letters appear on the first six keys in the first row of letters).

Table 3-2 Creative Software Features and Examples

Creative Software	
Program and Application	**Software Examples**
Raster graphics programs	
Draw, paint, render, manipulate, and edit images, fonts, and photographs to create pixel-based (dot points) digital art and graphics.	Adobe Photoshop and Fireworks, Ulead PhotoImpact, Corel Draw, Painter, and Paint Shop Pro, GIMP (open source), KOffice Krita (open source)
Vector graphics programs	
Mathematically rendered, geometric modeling is applied through shapes, curves, lines, and points and manipulated for shape, color, and size. Ideal for printing and three-dimensional (3D) modeling.	Adobe Flash, Freehand, and Illustrator; CorelDraw and Designer, Open Office Draw (open source), Mirosoft Visio, Xara Xtreme, KOffice Karbon14 (open source)
Desktop publishing programs	
Page layout and publishing preparation for printed and Web documents, such as magazines, journals, books, newsletters, and brochures.	Adobe InDesign, Corel PageMaker, Microsoft Publisher, Scribus (open source), QuarkXPress, Apple Pages (note that many of the graphics programs can also be used for DTP)
Web design programs	
Create, edit, and update webpages using specific codes, such as XML, CSS, HTML, and Java.	Adobe Dreamweaver, Coffee Cup, Microsoft FrontPage, Nvu (open source), W3C's Amaya (open source)
Multimedia programs	
Combines text, audio, images, animation, and video into interactive content for electronic presentation.	Adobe Flash, Microsoft Movie Maker, Apple QuickTime and FinalCut Studio, Corel VideoStudio, Ulead VideoStudio, Real Studio, CamStudio (open source), Audacity (open source)

Certain keys are used as command keys, particularly the control (CTRL), alternate (Alt), delete (Del), and shift keys, which can all be used to activate useful commands. The escape (ESC) key allows the user instantly to exit a process or program. The F keys, numbered F1 through F12, are function keys. They are used in different ways by particular programs. If a program instructs users to press the "F8" key, they would do so by pressing F8. The print screen (PrtSc) key sends a graphical picture or screen shot of a computer screen to the clipboard. This copied screen shot can then be pasted in any graphic program that can work with bitmap files.

Some keyboards have a wire and plug in, while others are wireless or cordless. Touch screen or virtual keyboards are those being incorporated into the touch screens of phones, gaming machines, and tablets, and they are also available through ease-of-access tools on laptops.

Table 3-3 Communication Software Features and Examples

Communication Software	
E-mail client	
Allows user to read, edit, forward, and send email messages to other users via an Internet connection. The software can be resident on the computer or accessed via the World Wide Web.	**Resident programs** Microsoft Outlook and Outlook Express, Eudora, Pegasus, Mozilla Thunderbird, Lotus Notes **Web-based programs** Gmail, Yahoo Mail, Hotmail
Internet browsers	
Enables user to access, browse, download, upload, and interact with text, audio, video, and other Web-based documents.	Mozilla Firefox, Microsoft Internet Explorer, Google Chrome, Apple Safari, Opera, Microbrowser (for mobile access)
Instant messaging (IM)	
Real-time text messaging between users, can attach images, videos, and other documents via personal computer, cell phone, handheld devices.	MSN Instant Messenger, Microsoft Live Messenger, Yahoo Messenger, Apple iChat
Conferencing	
Enables user to communicate in a virtual meeting room setting to share work, discussions, planning, using an intranet or Internet environment; can exhibit files, video, and screenshots of content.	Adobe Acrobat Connect, Microsoft Live Meeting or Meeting Space, GoToMeeting, Meeting Bridge, Free Conference, RainDance, WebEx

Mouse

The **mouse** is the second-most-commonly used input device. It is manipulated by the user's hand to point, click, and move objects around on the computer screen. A mouse can come in a number of different configurations, including a standard mechanical trackball serial mouse, bus mouse, PS/2 mouse, USB-connected mouse, optical lens mouse, cordless mouse, and optomechanical mouse. Even though "the mouse may be a simple device in concept," it has evolved and increased in complexity and capability over time (Bagaza & Westover, 2016, para. 2). For example, "[g]aming mice take the basic mouse concept and amplify every element to extremes" (Bagaza & Westover, para. 4). Some manufacturers offer specialized features, but there is a common "combination of high-performance parts—laser sensors, light-click buttons, and gold-plated USB connectors—and customization, like adjustable weight, programmable macro commands, and on-the-fly DPI switching. For non-gamers, these features are overkill; for dedicated gamers, they provide a competitive edge" (Bagaza & Westover, para. 4). The **dots per inch (DPI) switch** is an actual switch on a computer mouse that allows you to adjust the mouse's sensitivity to movement, as in faster or slower mouse pointer speeds. Having the ability to do this on the fly or as needed without pausing could enhance the computing or gaming experience.

Touch Pad

The **touch pad** is a device that senses the pressure of the user's finger along with the movement of the finger on the touch pad to control input positioning. It is an alternative to using a mouse.

Touch Screen

The **touch screen** is a display used as an input device for interacting with or relating to the display's materials or content. The user can touch or press on the designated display area to respond, execute, or request information or output.

Processing of Data and Information: Throughput/Processing Components

All of the hardware discussed earlier in this chapter is involved in the **throughput** or **processing** of input data and in the preparation of output data and information. Specific software is used, depending on the application and data involved. One key hardware component, the computer monitor, is a unique example of a visible throughput component—it is the part of the computer that users focus on the most when they are working on a computer. Input data can be visualized and accessed by manipulating the mouse and keyboard input devices, but it is the monitor that receives the user's attention. The monitor is critical for the efficient rendering during this part of the cycle, because it facilitates user access and control of the data and information.

Monitor

The **monitor** is the visual display that serves as the landscape for all interactions between user and machine. It typically resembles a television screen, and comes in various sizes (usually ranging from 15 to 21 inches) and configurations. Monitors either are based on cathode ray tubes (the conventional monitor with a large section behind the screen) or are thinner, flat-screen liquid crystal display devices. Some computer monitors also have a touch screen that can serve as an input device when the user touches specific areas of the screen.

Monitors vary in their refresh rate (usually measured in megahertz) and dot pitch. Both of these characteristics are important for user comfort. The faster the refresh rate, the cleaner and clearer the image on the screen, because the monitor refreshes the screen contents more frequently. For example, a monitor with a 100 MHz refresh rate refreshes the screen contents 100 times per second. Similarly, the larger the dot pitch factor, the smaller the dots that make up the screen image, which provides a more detailed display on the monitor and also facilitates clarity and ease of viewing.

If equipped with a touch screen, a monitor can also serve as an input device when activated by a stylus or finger pressure. Some users might also consider the monitor to be an output device, because access to input and stored documents is often performed via the screen (e.g., reading a document that is stored on the computer or viewable from the Internet). As we advance to more engaged computing, larger screens and ultra-wide monitors are evolving to provide immersive experiences.

Smartphone displays can be a form of **AMOLED (Active Matrix Organic Light-Emitting Diode)** or **IPS LCD (In-Plane Switching Liquid Crystal Display)** . In the AMOLED type, the individual pixels are lit separately (active matrix); the next-generation super AMOLED type includes touch sensors. The IPS LCD–type uses polarized light passing through a color filter and all of the pixels are backlit. The liquid crystals control the brightness and which pixels are on or off. With the active matrix, you have crisp, vivid colors and darker blacks.

Dissemination: Output Components

Output devices carry data in a usable form through exit devices in or attached to a computer. Common forms of output include printed documents, audio or video files, physiologic summaries, scan results, and saved files on portable disk drives, such as a CD, DVD, flash drive, or external hard drive. Output devices literally put data and information at the user's fingertips, which can then be used to develop knowledge and even wisdom. The most commonly used output devices include printers, speakers, and portable disk drives.

Printer

Printers are external components that can be attached to a computer using a printer cord that is secured into the computer's printer port. Printers enable users to print a hard paper copy of documents that are housed on the computer.

The most common printer types are the inkjet and laser printers. Inkjet printers are more economical to use and offer good quality print; they apply ink to paper using a jet-spray mechanism. Laser printers produce publisher-ready quality printing if combined with good-quality paper, but cost more in terms of printing supplies. Both types of printers can print in black and white or in color. Printers can be single function (print only), but typically they are all-in-one machines or multifunction printers that can also scan, fax, and copy. There are printers that can be accessed via the Internet using **Wi-Fi**. There are also three-dimensional (3D) printers that can create a 3D solid object produced layer by layer from a 3D software digital file.

Speakers

All computers have some sort of speaker setup, usually small speakers embedded in the monitor, in the case, or, if a laptop, close to the keyboard. Often, external speakers are added to a computer system using speaker connectors; these devices provide enhanced sound and a more enjoyable listening experience.

What Is the Relationship of Computer Science to Knowledge?

Scholars and researchers are beginning to understand the effects that computer systems, architecture, applications, and processes have on the potential for knowledge acquisition and development. Users who have access to contemporary computers equipped with full Internet access have resources at their fingertips that were only dreamed of before the 21st century. Entire library collections are accessible, with many documents available in full printable form. Users are also able to contribute to the development of knowledge through the use of productivity, creativity, and communication software. In addition, using the **World Wide Web (WWW)** interface, users are able to disseminate knowledge on a grand scale with other users. This deluge of information available via computers must be mastered and organized by the user if knowledge is to emerge. Discernment and the ability to critique and filter this information must also be present to facilitate the further development of wisdom.

The development of an understanding of computer science principles as they apply to technology used in nursing can facilitate optimal usage of the technology for knowledge development in the profession. The maxim that "knowledge is power" and that the skillful use of computers lies at the heart of this power is a presumption. Once nurses become comfortable with the various technologies, they can shape them, refine them, and apply them in new and different ways, just as they have always adapted earlier equipment and technologies. Nurses must harness the power of data and information through the use of computer technologies to build knowledge and gain wisdom.

How Does the Computer Support Collaboration and Information Exchange?

Computers can be linked to other computers through networking software and hardware to promote communication, information exchange, work sharing, and collaboration. Such **networks** can be local or organizationally based, with computers joined together into a local area network; organized on a wider area scope (e.g., a city or district) using a metropolitan area network; or encompassing computers at an even greater distance (e.g., a whole country or continent, or the Internet itself) using a wide area network configuration (Sarkar, 2006). Network interface cards are used to connect a computer and its modem to a network.

Networks within health care can manifest in several different configurations, including client-focused networks, such as in telenursing, e-health, and client support networks; work-related networks, including virtual work and virtual social networks; and learning and research networks, as in communities of practice. These trends are still evolving in most nursing work environments (and most nurses' personal lives), but they are predicted to continue to grow dramatically. We are experiencing one of the greatest upsurges in shared information and our ability to access, exchange, and utilize this information to enhance knowledge.

Virtual social networks are another form of professional network that have expanded phenomenally since the advent of the Internet and other computer software and hardware. Nursing-related virtual social networks provide a cyberspace for nurses to make contacts, share information and ideas, and build a sense of community.

Social communication software is used to provide a dynamic virtual environment, and often virtual social networks provide communicative capabilities through posting tools, such as blogs, forums, and wikis; e-mail for sharing ideas on a smaller scale; collaborative areas for interaction, creating, and building digital artifacts or planning projects; navigation tools for moving through the virtual network landscape; and profiles to provide a space for each member to disclose personal information with others. Nurses who have to engage in shift work often find that virtual social networks can provide a sense of connection with other professionals that is available around the clock. Because time is often a factor in any social interchange, virtual communication offers an alternative for practicing nurses, who can access information and engage in interchanges at any time of day. With active participation, the interchanges and shared information and ideas of the network can culminate in valuable social and cultural capital, available to all members of that network. Often, nursing virtual social networks are created for the purpose of exchanging ideas on practice issues and best practices; to become more knowledgeable about new trends, research, and innovations in health care; or to participate in advocacy, activist, and educational initiatives.

Through the use of portable disk devices, such as flash drives, CDs, and DVDs, as well as Web-based and cloud spaces, people can share information, documents, and communications by exchanging files. Since the advent of the Internet in the mid-1980s, the World Wide Web has evolved to become a viable and user-friendly way for people to collaborate and exchange information, projects, and other knowledge-based files, such as websites, e-mail, social networking applications, and webinar logs. Box 3-3 provides information on Web 2.0, the latest iteration of the World Wide Web, and beyond.

BOX 3-3 WEB 2.0 AND BEYOND TOOLS

Dee McGonigle, Kathleen Mastrian, and Wendy Mahan

Web 2.0—the name given to the new World Wide Web tools—enables users to collaborate, network socially, and disseminate knowledge with other users on a scale that was once not even comprehensible. These programs promote data and information exchange, feedback, and knowledge development and **dissemination**.

To facilitate a selective review of the Web 2.0 tools available, they have been categorized into three areas here: (1) tools for creating and sharing information, (2) tools for collaborating, and (3) tools for communicating. Examples of tools for creating and sharing information include blogs, podcasts, Flickr, YouTube, Hellodeo, Jing, Screencast-o-matic, Facebook, MySpace, Box, Samepage, Wrike, Snapchat, and MakeBeliefsComix. Examples of tools for collaborating with others include Google Docs, Zoho, wikis, Del.icio.us, and Gliffy. Finally, some tools for communicating with others include Adobe Connect, GoToMeeting, BlueJeans, WebEx Meeting Center, Vyew, Skype, Twitter, and instant messaging.

The application of the creating and sharing information tools has led to an explosion of social networking on the Web. YouTube has promoted the "broadcast yourself" proliferation. Anyone can post a video onto YouTube that is shared with others over the Web. Similarly, Flickr allows users to upload and tag personal photos to share either privately or publicly. Facebook and MySpace both promote socializing on the Web. Facebook is a social utility and MySpace is a place for friends, according to the descriptions found on these websites. Other tools let users create and share recorded messages, diagrams, screen captures, and even custom comic strips.

Collaborating over the Web has become easier. Indeed, it is a way of life for many people. Google Docs and Zoho allow users to create online and share and collaborate in real time. Wikis are server-based software programs that enable users to generate and edit webpage content using any browser. Del.icio.us is a social bookmarking manager that uses tags to identify or describe the bookmarks that can be shared with others.

Communicating with others includes audio- and videoconferencing in real time. Adobe Connect is a comprehensive Web communications solution. Although a fee-based service, it does provide a free trial. Users should read all of the documentation on Adobe's site before downloading, installing, and using this software. Vyew is free, always-on collaboration plus live webinars. Skype allows users to make calls in audio only or with video. Users can download Skype for free but depending on the type of calls made, fees or charges could be assessed. Individuals should read through all of the information before downloading, installing, and using this software. Twitter allows participants to answer the question "What are you doing?" with messages containing 140 or fewer characters. Although Twitter can be used to keep the friends in a person's network updated on daily activities, it can also be used for other purposes, such as asking questions or expressing thoughts. In addition, Twitter can be accessed by cell phones, so users can stay in touch on the go.

Along with all of the advantages and intellectual harvesting capabilities from the use of these tools come serious security issues. Wagner (2007) warned the user to "bear in mind before you jump in that you're giving information to a third-party company to store" (para. 5). He also states that "you should talk to your company's legal and compliance offices to be sure you're obeying the law and regulations with regard to managing company's information" (para. 5). One suggestion that Wagner offers is that if you do not want to involve a third party, "Wikis provide a good alternative for organizations looking to maintain control of their own software. Organizations can install wiki software on their own, internal servers" (para. 6).

This new wave of Web-based tools facilitates the ability to interact, exchange, collaborate, communicate, and share in ways that have only begun to be realized. As the tools and their innovative uses continue to expand, users need to stay vigilant to handle the associated security challenges. These Web 2.0 and beyond tools are providing a new cyber-playground that is limited only by users' own imaginations and intelligence. We encourage you to explore these tools.

REFERENCE

Wagner, M. (2007). Nine easy Web-based collaborative tools. *Forbes*. Retrieved from http://www.forbes.com/2007/02/26/google-microsoft-bluetie-enttech-cx_mw_0226smallbizresource.html

Cloud Computing

Cloud computing has Web browser–based login-accessible data, software, and hardware that you can access and use. Using the cloud, you could link systems together and reduce costs (Figure 3-4). According to Griffith (2016), "cloud computing means storing and accessing data and programs over the Internet instead of [on] your computer's hard drive. The cloud is just a metaphor for the Internet" (para. 2). IBM (2016) stated that cloud computing, "referred to as simply 'the cloud,' is the delivery of on-demand computing resources—everything from applications to data centers—over the Internet on a pay-for-use basis" (para. 1). IBM described services as elastic resources, either metered or self-service. Elastic resources refer to those that are able to be scaled up or down to meet the consumer's needs. Metered services allow you to pay only for what you use, and self-service refers to having self-service access to all of the IT resources the consumer needs. Woodford (2016) stated that cloud computing is different because it is managed; on-demand; and can be public, private, or a hybrid of both. The **public cloud** is owned and operated by companies offering public access to computing resources. It is believed to be more affordable and economically sound because the user does not need to purchase the hardware, software, or supporting infrastructure, as these are managed and owned by the cloud provider (IBM, 2016). The **private cloud** is operated for a single organization with the infrastructure being managed and/or hosted internally or outsourced to a third party; it provides added control and avoids multi-tenancy (IBM).

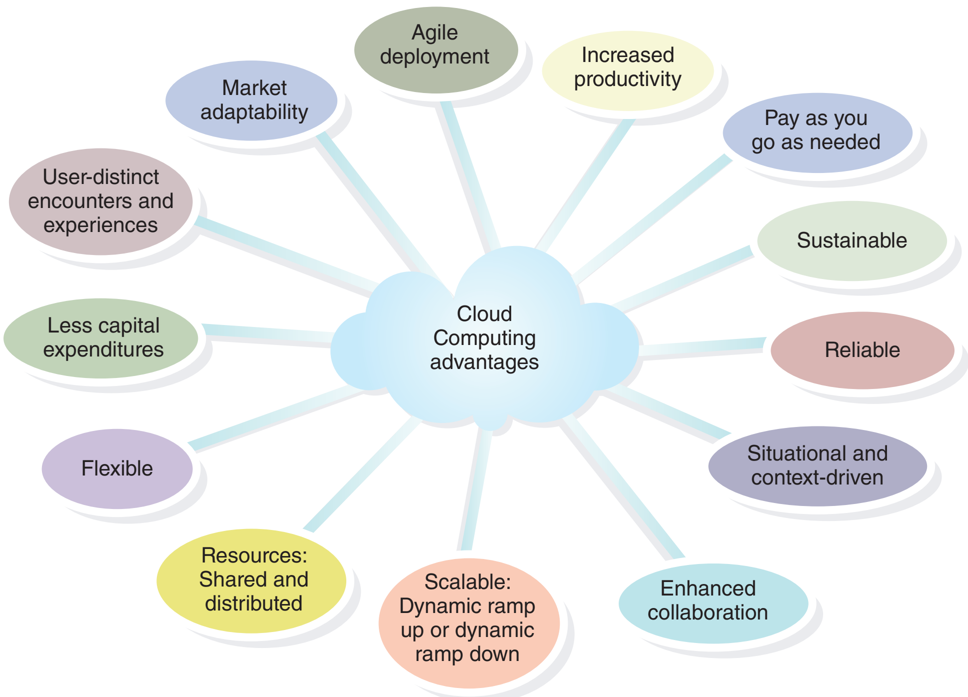

Figure 3-4 Cloud Computing

As we explore Web-based apps and computing over the Internet, we are cloud computing. Griffith (2016) described some common major examples of cloud computing that you might be using right now: Google Drive, Microsoft Office Online, Microsoft OneDrive, Apple iCloud, Amazon Cloud Drive, Box, Dropbox, and SugarSync. There is also cloud hardware; the primary example of a device that is completely cloud-centric is the Chromebook, a laptop that has just enough local storage and power to run the Chrome OS, which essentially turns the Google Chrome Web browser into an operating system. "With a Chromebook, most everything you do is online: apps, media, and storage are all in the cloud" (Griffith, 2016, para. 16).

Cloud storage is data storage provided by networked online servers that are typically outside of the institution whose data are being housed.

There are also additional services based in the cloud that are mainly business related: **software as a service (SaaS)**, **platform as a service (PaaS)**, and **infrastructure as a service (IaaS)** (Figure 3-5). SaaS, such as Salesforce.com refers to cloud-based applications with the following benefits: quickly start using innovative or specific business apps that are scalable to your needs, any connected computer can access the apps and data, and data is not lost if your hard drive crashes because the data is stored in the cloud (Griffith, 2016; IBM, 2016). PaaS provides everything needed to support the cloud application's building and delivery, enabling users to develop and launch custom Web applications rapidly to the cloud (Griffith, 2016; IBM, 2016). IaaS such as Amazon, Microsoft, Google, and Rackspace provide a rentable backbone to companies, enabling the scalable, on-demand infrastructure they need to support their dynamic

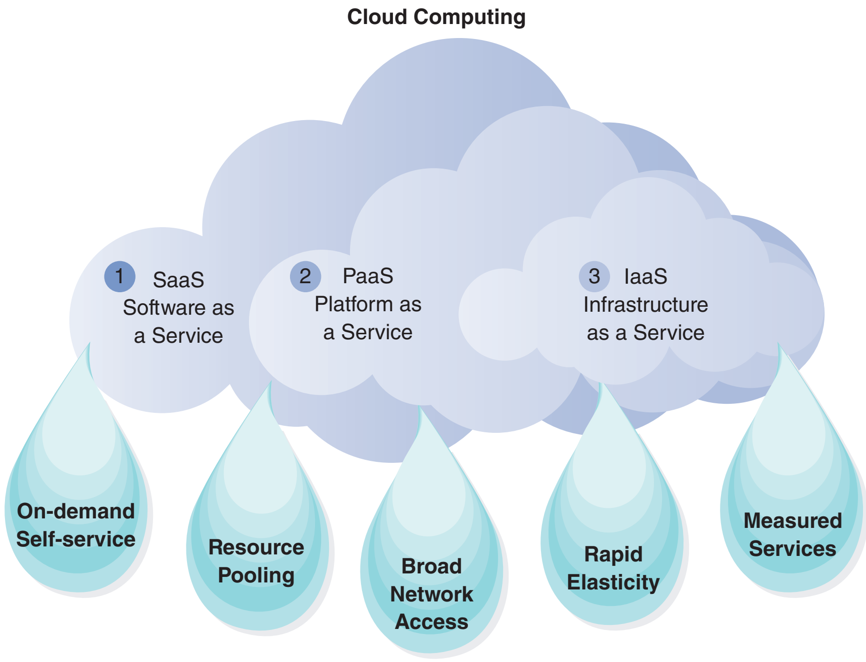

Figure 3-5 Software as a Service (SaaS), Platform as a Service (PaaS), and Infrastructure as a Service (IaaS)

workloads; the user pays only for what they use and he or she does not have to invest in hardware such as networks, storage, and data center space (Griffith, 2016; IBM, 2016). You can access and receive services from Netflix and Pinterest because they are customers of Amazon's cloud services. According to Griffith (2016), cloud computing is truly big business and could generate 500 billion dollars within the next 5 years.

Cloud computing is Internet computing, and it has the same pitfalls and benefits as using the Internet. Some are not sold on the claims that it is totally reliable, safe, and/or secure. Others believe it is a more environmentally friendly option because it uses fewer resources and less energy, and yet many people can share efficiently managed, centralized cloud-based systems (Woodford, 2016). One of the driving forces behind the initiation of cloud computing was the need for scalable resources that are affordable. As with anything on the Internet, these resources can be shared or privately held. Cloud computing will continue to grow as long as there is demand and it can meet the scalability requirements while maintaining secure, reliable spaces.

In an ideal world, nurses would be able to use and interact with computer technologies effectively to enhance patient care. They would understand computer science and know how to harness its capabilities to benefit the profession and ultimately their patients.

Looking to the Future

The use of the cloud will continue to expand. The market for **wearable technology**, which is comprised of smaller and faster handheld and portable computer systems, and high-quality voice-activated inventions will further facilitate the use of computers in nursing practice and professional development. The field of computer science will continue to contribute to the evolving art and science of nursing informatics. New trends promise to bring wide-sweeping and (it is hoped) positive changes to the practice of nursing. Computers and other technologies have the potential to support a more client-oriented healthcare system in which clients truly become active participants in their own healthcare planning and decisions. Mobile health technology, telenursing, sophisticated electronic health records, and next-generation technology are predicted to contribute to high-quality nursing care and consultation within healthcare settings, including patients' homes and communities.

Computers are becoming more powerful, yet more compact, which will contribute to the development of several technologic initiatives that are currently still in their infancy, such as **quantum computing**. Some of these initiatives are described here. These predicted innovations are only some of the many computer and technologic applications being developed. As nurses gain proficiency in capitalizing on the creative, timesaving, and interactive capabilities emerging from information technology research, the field of nursing informatics will grow in similar proportions.

Quantum Computing

Quantum bits (qubits) are three-dimensional arrays of atoms in quantum states. A quantum computer is a proposed machine that is not based on the binary system, but instead performs calculations based on the behavior of subatomic particles or qubits. It is estimated that if quantum computing, the act of using a quantum computer, is ever realized, we will be able to execute **millions of instructions per second (MIPS)** due to the qubits existing in more than one state at a time or having the ability to simultaneously execute and process. According to Kennedy (2016), "the era of quantum computers is one step closer" (para. 1) due to the creation of qubits by David Weiss's research team.

Voice-Activated Communicators

Voice-activated communicators are already on the market, with new iterations being developed by a variety of companies, including Vocera Communications. Vocera (2015) developed the Vocera B3000n Communication Badge, which

> *is a lightweight, voice-controlled, wearable device that enables instant two-way or one to many conversations using intuitive and simple commands. The Vocera Badge is widely used by mobile workers who need wearable devices that provide the convenience and expedience of being able to respond to calls without pressing a button (i.e. sterile operating rooms, nuclear power plants, hotel staff, security personnel). (para. 1)*

These new technologies will permit nurses to use wireless, hands-free devices to communicate with one another and to record data. This technology is becoming a user-friendly and cost-effective way to increase clinical productivity.

Game and Simulation Technology

Game and simulation technology is offering realistic, innovative ways to teach content in general, including healthcare informatics concepts and skills. The same technology that powers video games is being used to create dynamic educational interfaces to help students learn about pathophysiology, care guidelines, and a host of other topics. Such applications are also very valuable for client education and health promotion materials. The "serious games" industry is growing now that video game producers are looking beyond mere entertainment to address public and private policy, management, and leadership issues and topics, including those related to health care. For example, the Games for Health Project, initiated by the Robert Wood Johnson Foundation (2015), is working on developing best practices to support innovation in healthcare training, messaging, and illness management. The Serious Games & VE Arcade & Showcase is presented at the annual meetings of the Society for Simulation in Healthcare and is continuing to flourish with numerous products available to demonstrate.

Virtual Reality

Virtual reality is another technological breakthrough that is and will continue to influence healthcare education and professional development. Virtual reality is a three-dimensional, computer-generated "world" where a person (with the right equipment) can move about and interact as if he or she was actually in the visualized location. The person's senses are immersed in this virtual reality world using special gadgetry, such as head-mounted displays, data gloves, joysticks, and other hand tools. The equipment and special technology provide a sense of presence that is lacking in multimedia and other complex programs. According to Smith (2015), "It's crazy but true: Virtual reality will be a real thing in people's homes by this time next year" (para. 1). There are numerous products available. Virtual Realities (2015) stated that they provide "head mounted displays, head trackers, motion trackers, data gloves, 3D controllers, haptic devices, stereoscopic 3D displays, VR domes and virtual reality software. Virtual Realities' products are used by government, educational, industrial, medical and entertainment markets worldwide" (para. 1). Oculus VR (2015) developed Rift, which is the next generation of virtual reality products, and they are currently distributing the developer kits. HTC (2015) manufactures consumer electronics and developed the Vive headset. The Morpheus headset is used with PlayStation 4.

Mobile Devices

Mobile devices will be used more by nurses both at the point of care and in planning, documenting, interacting with the interprofessional healthcare team, and research. Nurses also will be using such powerful wearable technologies as nano-based diagnostic sensors in their personal lives, and will be generating their own data streams and receiving data from the wearable and mobile devices their patients use. Silbershatz et al. (2013) stated that Apple iOS and Google Android are "currently dominating mobile computing" (p. 37). Perry (2015) stated that it is "estimated more than 177 million wearable devices will be in use by 2018" (para. 5). Cisco (2014) reported that "by the year 2020, the majority of Generation X and Y professionals believe that smartphones and wearable devices will be the workforce's most important 'connected' device—while the laptop remains the workplace device of choice" (para. 1). Data are truly at our fingertips.

Summary

The field of computer science is one of the fastest-growing disciplines. Astonishing innovations in computer hardware, software, and architecture have occurred over the past few decades, and there are no indications that this trend will come to a halt anytime soon. Computers have increased in speed, accuracy, and efficiency, yet now cost less and have reduced physical size compared to their forebears. These trends are predicted to continue. Current computer hardware and software serve as vital and valuable tools for both nurses and patients to engage in on-screen and online activities that provide rich access to data and information. Productivity, creativity, and communication software tools also enable nurses to work with computers to further foster knowledge acquisition and development. Wide access to vast stores of information and knowledge shared by others facilitates the emergence of wisdom in users, which can then be applied to nursing in meaningful and creative ways. It is imperative that nurses become discerning, yet skillful users of computer technology to apply the principles of nursing informatics to practice to improve patient care and to contribute to the profession's ever-growing body of knowledge.

Working Wisdom

Since the beginning of the profession, nurses have applied their ingenuity, resourcefulness, and professional awareness of what works to adapt technology and objects to support nursing care, usually with the intention of promoting efficiency but also in support of client comfort and healing. This resourcefulness could also be applied effectively to the adaptation of information technology within the care environment, to ensure that the technology truly does serve clients and nurses and the rest of the interprofessional team.

Consider this question: "How can you develop competency in using the various computer hardware and software not only to promote efficient, high-quality nursing care and to develop yourself professionally, but also to further the development of the profession's body of knowledge?"

Application Scenario

Dan P. is a first-year student in graduate studies in nursing. In the past, he has learned to use his family's personal computer to surf the World Wide Web, exchange e-mail with friends, and play some computer games. Now, however, Dan realizes that the computer is a vital tool for his academic success. He has saved up enough money to purchase a laptop computer. He has decided on an Intel processor with 1 TB of storage and 8 GB of RAM. Dan also wishes to choose appropriate software for his system. He is on a limited budget but wants to make the most of his investment.

1. Dan still wants to learn more about computers. *You recommend that he review the following information: Domingo (2016), Knapp (2016), and PCMag Digital Group (2016).*
2. Which of the four categories of software discussed in this chapter would benefit Dan the most in his studies (OS, productivity, creativity, or communication)? *Dan definitely needs an OS—this is critical. He would also directly benefit from productivity software and at least connective e-mail and web browser software from the communication group so he can access the Internet for research, to collaborate with peers, and to communicate with his teachers.*
3. How could Dan afford to install software from all four groups on his new laptop? *If Dan accessed some open source software (e.g., Apache OpenOffice for his productivity software), he could save money to put toward creativity software.*

THOUGHT-PROVOKING QUESTIONS

1. How can knowledge of computer hardware and software help nurses to participate in information technology adoption decisions in the practice area?
2. How can new computer software help nurses engage in professional development, collaboration, and knowledge dissemination activities at their own pace and leisure?

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