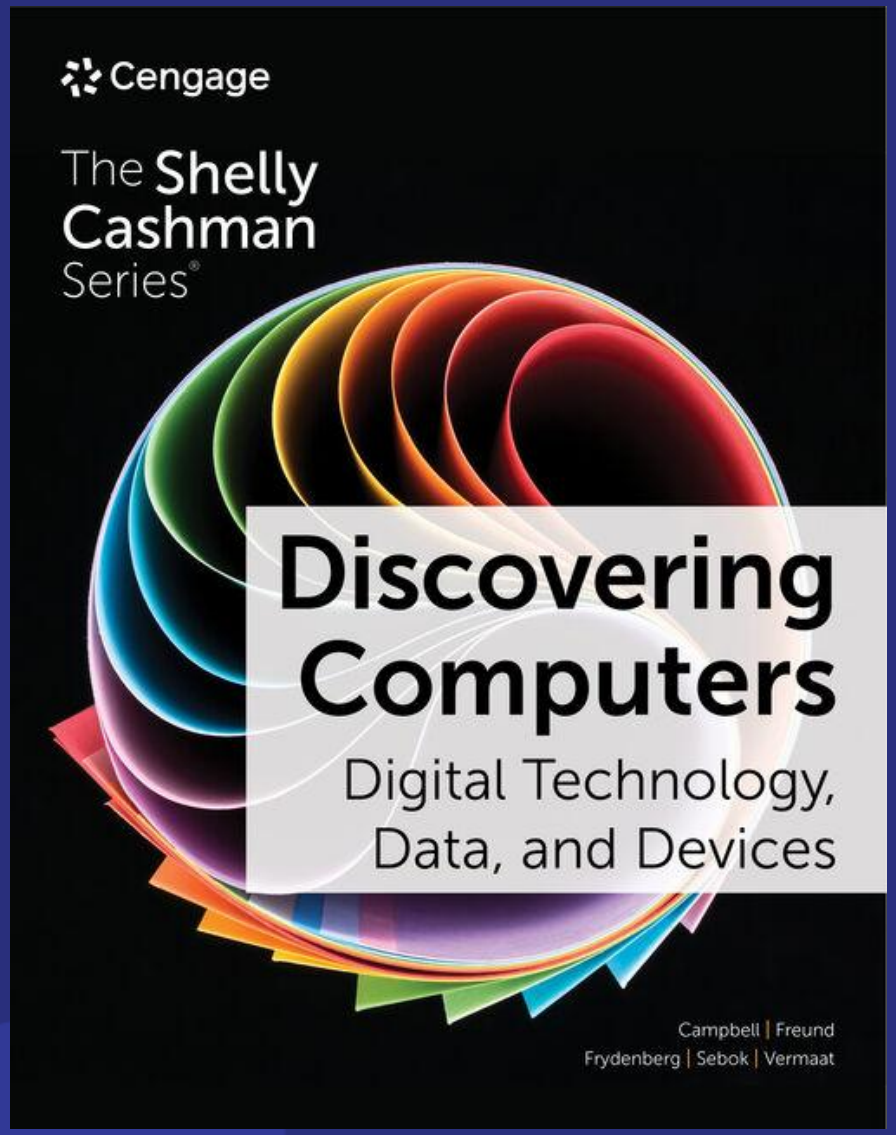

CS 110 – Introduction To Computing

Module 5: Computer Storage

Cengage

Module Objectives

By the end of the module, you should be able to:

- Differentiate between storage and memory
- Identify storage hardware types
- Discuss cloud computing concepts
- Evaluate cloud storage options
- Explain how to secure your cloud data
- Identify enterprise and other storage options
- Explain how memory relates to storage
- Identify risks for the Internet of Things

Storage and Memory Uses (1 of 5)

- Computers and devices use both **storage and memory** to access and save data and information.
- **Memory** consists of electronic components that store instructions waiting to be executed by the processor, data needed by those instructions, and the results of processing the data into information.

Figure 7-1 Storage is similar to a file cabinet for digital content.

Storage and Memory Uses (2 of 5)

- **Storage** refers to long-term, permanent access to data and information.
- A storage medium is **nonvolatile.** Most memory (i.e., RAM), by contrast, holds data and instructions temporarily, thus it is **volatile**.
- A **storage medium**, also called **secondary storage,** is the location where a computer keeps data, information, programs, and applications.
- Examples of **storage media** include digital storage (cloud), and storage hardware, such as hard disks, solid-state drives (internal or external), memory cards, USB flash drives, optical discs, and tags.
- Cloud storage keeps information on servers on the Internet.
- In addition to programs and apps, users store a variety of data and information on storage media on their computers and mobile devices or on cloud storage.

Storage and Memory Uses (3 of 5)

- A **storage device** is the hardware that records and/or retrieves items to and from storage media.
- **Writing** is the process of transferring data, instructions, and information from memory to a storage medium.
- **Reading** is the process of transferring these items from a storage medium into memory.

Figure 7-2 Various storage technologies.

Storage and Memory Uses (4 of 5)

Capacity is the number of bytes (characters) a storage medium can hold. A gigabyte (**GB**) equals approximately 1 billion bytes. A terabyte (**TB**) is equal to approximately 1 trillion bytes.

Table 7-1 Terms used to define storage.

Storage Term	Approximate Number of Bytes	Exact Number of Bytes
Kilobyte (KB)	1 thousand	2^{10} or 1,024
Megabyte (MB)	1 million	2^{20} or 1,048,576
Gigabyte (GB)	1 billion	2^{30} or 1,073,741,824
Terabyte (TB)	1 trillion	2^{40} or 1,099,511,627,776
Petabyte (PB)	1 quadrillion	2^{50} or 1,125,899.,906,842,624
Exabyte (EB)	1 quintillion	2^{60} or 1,152,921,504,606,846,976
Zettabyte (ZB)	1 sextillion	2^{70} or 1,180,591,620,717,411,303,424
Yottabyte (YB)	1 septillion	2^{80} or 1,208,925,819,614,629,174,706,176

Storage and Memory Uses (5 of 5)

- The speed of storage devices and memory is defined by access time.
- **Access time measures**
  - ✓ The amount of time it takes for a storage device to locate an item on a storage medium.
  - ✓ The time required to deliver an item from memory to the processor.
- **Transfer rate** is the speed with which data, instructions, and information transfer to and from a device.
- Transfer rates for storage are stated in KBps, MBps, and GBps.

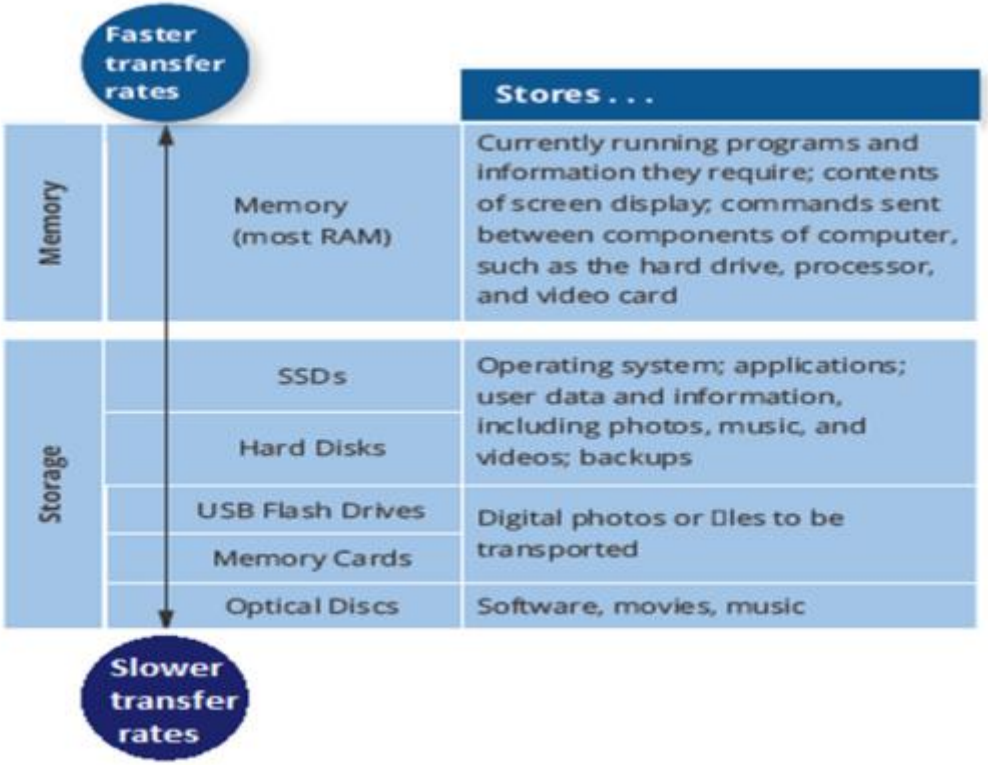

Figure 7-3 Relative speed and uses for storage media.

Storage Hardware (1 of 11)

Hard Drives

- The most common storage medium is the **internal hard drive.**
- **Hard drives** can store data either magnetically or using solid-state storage.
- The files stored on the internal hard drive cannot be accessed on other devices.
- Magnetic hard disk drives (**HDDs**) have greater storage capacity and are less expensive than their solid-state equivalents.
- The term, “hard drive”, refers collectively to hard disks and SSDs.

Storage Hardware (2 of 11)

- A **hard disk,** or **hard disk drive (HDD),** is a storage device that contains one or more inflexible, circular platters that use magnetic particles to store data, instructions, and information.
- Desktops and laptops contain at least one hard disk.
- The **storage capacity of hard disks** is determined by the number of platters that the hard disk contains, the composition of the magnetic coating on the platters, whether it uses longitudinal or perpendicular recording, and its density

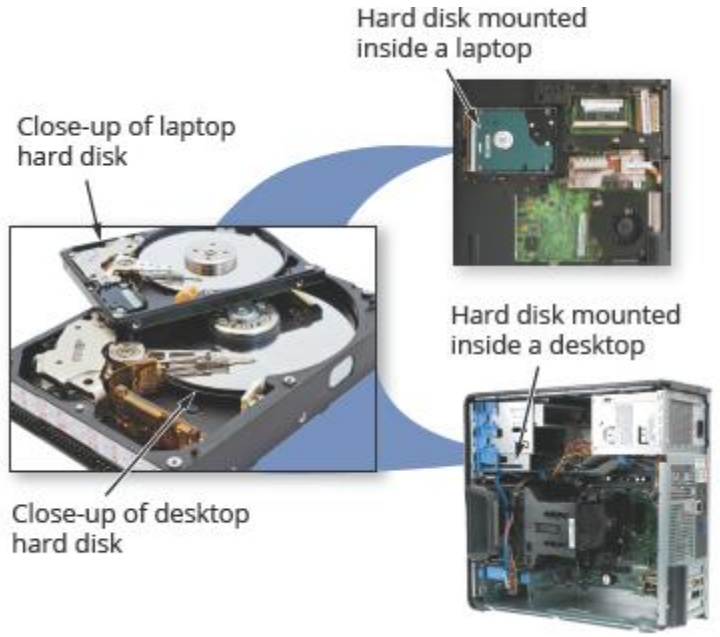

Figure 7-4 Typical hard disk.

Storage Hardware (3 of 11)

- A **platter** is made of aluminum, glass, or ceramic and has a thin coating of alloy material that allows items to be recorded magnetically on its surface.
- **Longitudinal recording** aligns the magnetic particles horizontally around the surface of the disk.
- With **perpendicular recording,** by contrast, hard disks align the magnetic particles vertically or perpendicular to the disk's surface.
- **Density** is the number of bits in an area on a storage medium. A higher density means more storage capacity.

Storage Hardware (4 of 11)

- **Formatting** is the process of dividing the disk into tracks and sectors.
- A **track** is one of the series of concentric circles on one of the surfaces of a magnetic hard disk platter.
- **Tracks** are narrow recording bands that form a full circle on the surface of the disk.
- The disk's storage locations consist of wedge-shaped sections, which break the tracks into small arcs called **sectors.**
- A **sector** is an individual block of data or a segment of a track.

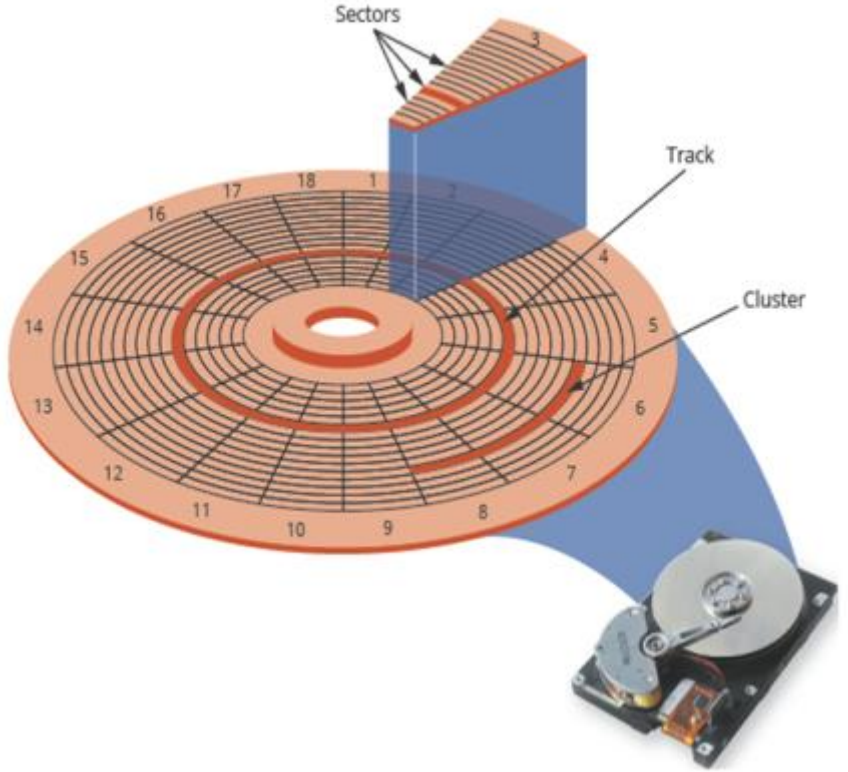

Figure 7-5 Tracks and sectors on a hard disk.

Storage Hardware (5 of 11)

- A typical hard disk has multiple platters. Each platter has two read/write heads, one for each side.
- A **read/write head** is the mechanism that reads items and writes items to the drive.
- A hard disk head actuator connects to arms that move the read/write heads to the correct location on the platter.

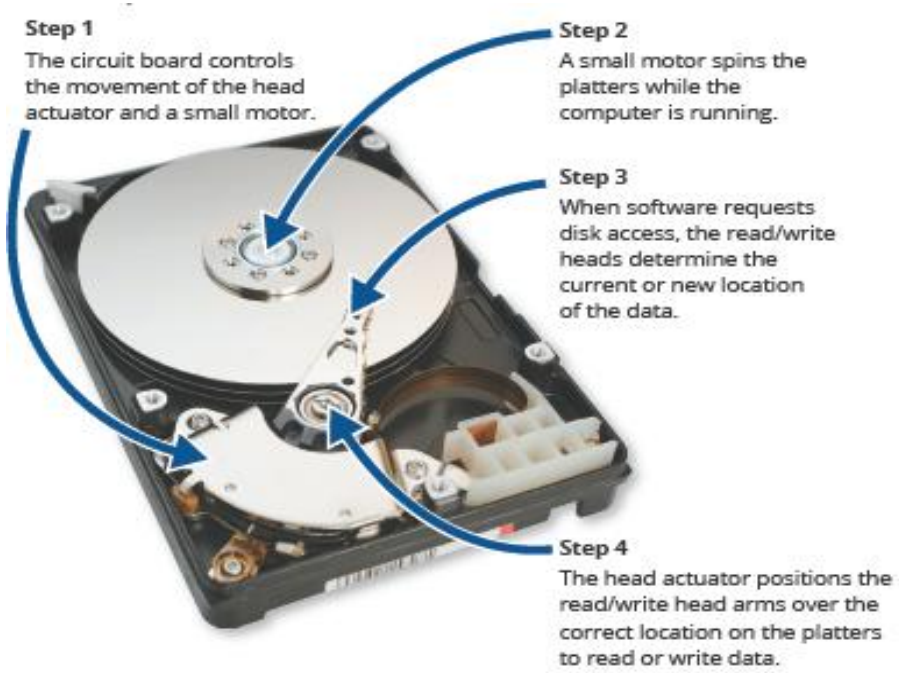

Figure 7-6 How a hard disk works.

Storage Hardware (6 of 11)

- While the computer is running, the **platters** in the hard disk rotate at a high rate of speed.
- This **spinning** allows nearly instant access to all tracks and sectors on the platters.
- The platters continue spinning or slow down after a specified time to save power.
- The **spinning motion** creates a cushion of air between the platter and its read/write head.
- This **cushion** ensures that the read/write head floats above the platter instead of making direct contact with the platter surface.

Storage Hardware (7 of 11)

- An **external hard drive** is a separate, free-standing storage device that connects with a cable to a USB port or other port on any device.
- Sizes and storage capacities of external hard drives vary.
- With an internal hard drive, an entire external hard drive is enclosed in an airtight, sealed case.

Figure 7-7 An external hard disk attached to a laptop.

Storage Hardware (8 of 11)

- An SSD (solid-state drive) is a flash memory storage device.
- Flash memory is a type of nonvolatile memory that can be erased electronically and rewritten.
- Flash memory chips are a type of **solid-state media**, which means they consist entirely electronic components and contain no moving parts.

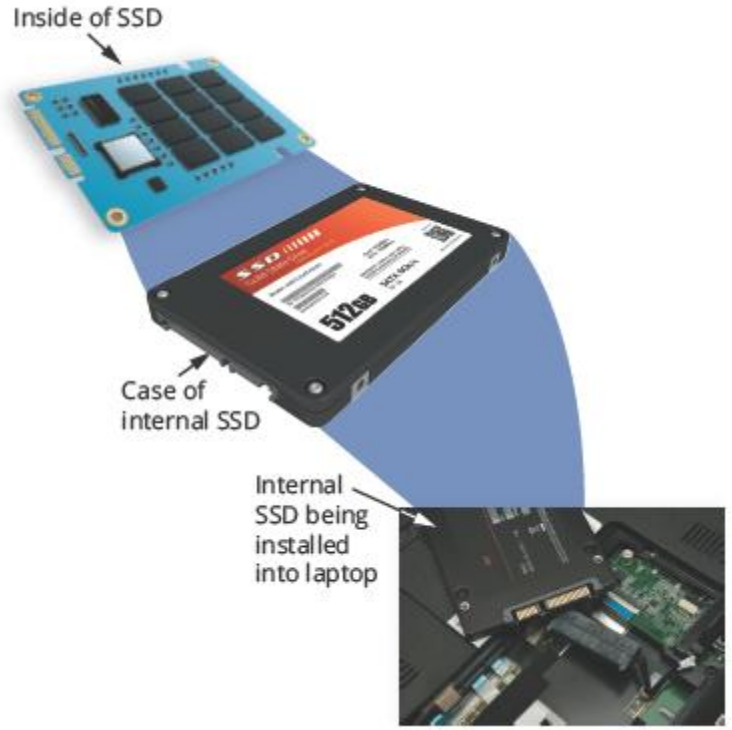

Figure 7-8 An SSD.

Storage Hardware (9 of 11)

Portable Flash Memory Storage

- A **memory card** is a removable flash memory storage device.
- Memory cards enable mobile users to easily transport digital photos, music, videos, or other files to and from mobile devices and computers or other devices.
- A slot on a computer or device accepts multiple types of cards.

Figure 7-9 Memory cards often are used with cameras.

Storage Hardware (10 of 11)

- A **USB flash drive (universal serial bus)** is a removable storage device for folders and files that plug in a USB port on a computer, making it easy to transport folders and files to other computers.
- The Storage capacities of USB flash drives and memory cards vary.

Figure 7-10 USB flash drive.

Storage Hardware (11 of 11)

- **Optical media** include **CDs, DVDs, and Blu-ray discs** (BDs), but their use as storage media is declining.
- An **optical disc** is a type of storage medium that consists of a flat, round, portable disc made of metal, plastic, and lacquer that is written and read by a laser.

Table 7-2 Characteristics of optical disc formats.

Disc Type	Format(s)	Typically Use(s)
CD	• CD-ROM (read-only) • CD-R (recordable) • CD-RW (rewritable)	audio, photo
DVD	• DVD-ROM (read-only) • DVD-R, DVD+R (recordable) • DVD-RW, DVD+RW, and • DVD+RAM (rewritable)	video
Blu-ray	• Higher capacity disc than DVD	video

Cloud Storage (1 of 4)

- Home and business users choose cloud computing for accessibility, cost saving, space saving, and scalability.
- Cloud computing consists of a **front end** and a **back end**, connected to each other through a network.
- The **front end** includes the hardware and software with which a user interacts to access the cloud.
- The **back end** consists of the servers and storage devices that manage and store the resources accessed by users.

Figure 7-11 Cloud storage.

Cloud Storage (2 of 4)

- **Cloud computing** allows companies to outsource, or contract to third-party providers, elements of their information technology infrastructure.
- Cloud storage providers enable you to synchronize files, write documents, **backup files** on your computer or mobile device, share project work, stream music, post photos, and play games online.

Cloud Storage (3 of 4)

- In addition to **SaaS** (software as a service), consumers and organizations rely on cloud computing services to manage:
  - ✓ Infrastructure as a service (**IaaS)**
  - ✓ Storage as service **(STaaS)**
  - ✓ Desktop as a service
  - ✓ Data as a service **(DaaS)**
  - ✓ Platform as a service **(PaaS)**
- Some additional cloud services include:
  - ✓ Synchronize files
  - ✓ Write documents
  - ✓ Backup files
  - ✓ Stream media

Cloud Storage (4 of 4)

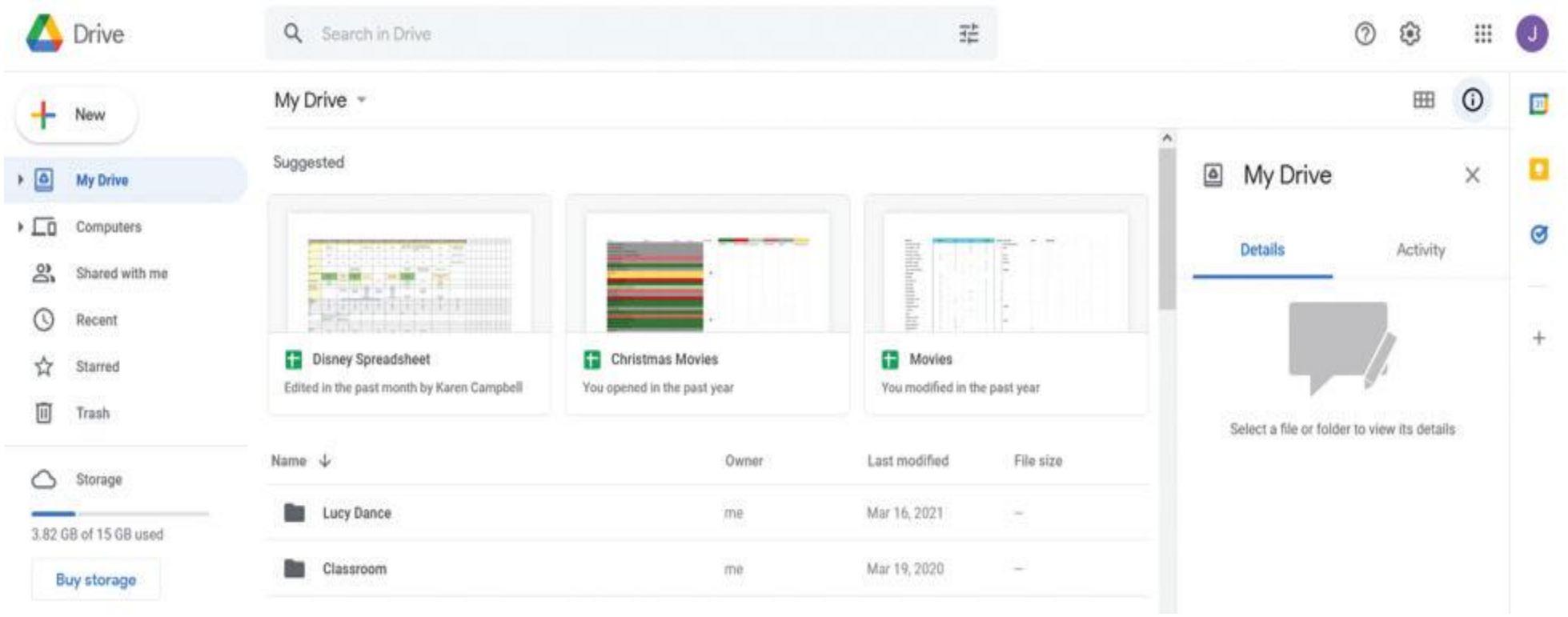

Figure 7-12 Google Drive.

Cloud Storage Options (1 of 3)

- With **Google Drive** or **Microsoft OneDrive**, the files that you save are created by or can be edited or shared using the cloud-based apps that are a part of the service.
- Other cloud storage options, such as **Box**, primarily are storage locations and do not provide corresponding apps.
- The files are protected by security measures, including passwords and identification requirements, or encryption, and are backed up to other servers so that outages in which access is limited or denied are rare.
- One advantage of relying on cloud-based storage is the flexibility of not having to purchase and maintain servers.

Cloud Storage Options (2 of 3)

- Photos, songs, and videos take longer to upload than smaller text or web page files, so it is important to select a **provider** whose servers have sufficient bandwidth to support large file transfers.
- Criteria to consider for providers include the amount of free storage offered, the cost to purchase more storage if needed, and the maximum file size that each service allows you to upload.
- It is also important to read about the cloud storage provider's **privacy policy** and terms of agreement, to which you must consent before using the provider's services.

Cloud Storage Options (3 of 3)

Consider the following guidelines when selecting a cloud storage provider:

- Verify that the company is reputable and has been in business for an extended period of time.
- Choose a provider that encrypts your files.
- Determine whether the provider's service is compatible with your computer(s) and mobile device(s).
- Compare the price of various storage plans and choose a provider that offers competitive pricing.
- Verify that the cloud storage provider will support the types of files you want to back up. If desired, choose a cloud storage provider that allows you to share selected files with others.
- Consider whether the provider offers a mobile app that you can use to access your files using a mobile device.

Secure IT: Secure Your Data on the Cloud

Some steps to protect your cloud-based data include:

- Choose your **cloud provider(s)** carefully, whether you are using a web-based app that also offers storage, such as Google Drive, or using an online backup system.
- Read the **user agreement** for your cloud provider.
- Set the most advanced **privacy settings** that your service allows.
- Use **strong passwords** and two-factor authentication to protect against unauthorized access from hackers.
- Do not store **sensitive data** or other information, without ensuring that they will be encrypted.

Enterprise and Other Storage Options (1 of 9)

- **Enterprise hardware** allows large organizations to manage and store data and information using devices intended for heavy use, maximum efficiency, and maximum availability.
- Highly available hardware is accessible 24 hours a day, 365 days a year.
- To meet the needs, enterprise hardware includes levels of **redundancy,** which means that if one component fails or malfunctions, another can assume its tasks.
- Enterprise storage centers or a **data center** is a secure location with many large computers that act as servers, making files available to users.

Enterprise and Other Storage Options (2 of 9)

- Some organizations manage an enterprise storage system in-house. Others elect to outsource all (or at least the backup) storage management to an outside organization or a cloud storage provider.
- A group of two or more integrated hard drives is called a **RAID** (redundant array of independent disks).
- **RAID** may duplicate data, instructions, and information to improve data reliability.

Figure 7-14 A data center.

Enterprise and Other Storage Options (3 of 9)

- The simplest **RAID storage design** is Level 1, called **mirroring,** which writes data on two drives at the same time to duplicate the data. A Level 1 configuration enhances storage reliability.
- Other RAID levels use a technique called **striping,** which splits data, instructions, and information across multiple drives in the array.
- **Striping** improves drive access times.

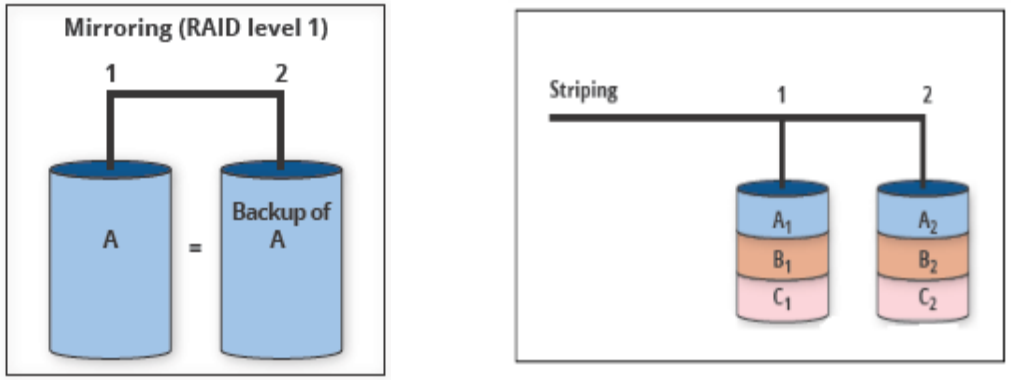

Figure 7-15 Mirroring (a) and striping (b).

Enterprise and Other Storage Options (4 of 9)

- **Network attached storage (NAS)** is a server that is placed on a network with the sole purpose of providing storage to users, computers, and devices attached to the network.
- A **network attached storage** server, often called a storage appliance, has its own IP address, usually does not have a keyboard or display, and contains at least one hard drive, often configured in a RAID.
- **Administrators** can add storage to an existing network quickly by connecting a network-attached storage server to the network.

Enterprise and Other Storage Options (5 of 9)

- A **storage area network (SAN)** is a high-speed network with the sole purpose of providing storage to other attached servers.
- A storage area network includes only storage devices. High-speed fiber-optic cable usually connects other networks and servers to the storage area network, so that the networks and servers have fast access to large storage capacities.
- A storage area network can connect to networks and other servers that are miles away using high-speed network connections.

Enterprise and Other Storage Options (6 of 9)

- **Other Types of Storage** include tape, magnetic stripe cards, smart cards, RFID tags, and NFC chips and tags.
- **Tape** is a magnetically coated ribbon of plastic that is capable of storing large amounts of data and information at a low cost.
- A **magnetic stripe card** is a credit card, entertainment card, bank card, or other similar card with a stripe that contains information identifying you and the card.
- A **smart card,** which is an alternative to a **magnetic stripe card**, stores data on an integrated circuit embedded in the card. Two types of smart cards, also called chip cards, are **contact** and **contactless**.

Enterprise and Other Storage Options (7 of 9)

- The **RFID tag consists of** an antenna and a memory chip that contains the information to be transmitted via radio waves.
- An **RFID reader** reads the radio signals and transfers the information to a computer or computing device.
- **RFID tags** are either active or passive.

Figure 7-16 RFID image on a box.

Enterprise and Other Storage Options (8 of 9)

- **NFC** is a technology (based on RFID) that uses close-range radio signals to transmit data between two NFC-enabled devices or between an NFC-enabled device and an NFC tag.
- **NFC-enabled devices** contain an NFC chip.
- NFC tags are **self-adhesive** so that they can be attached to any location.

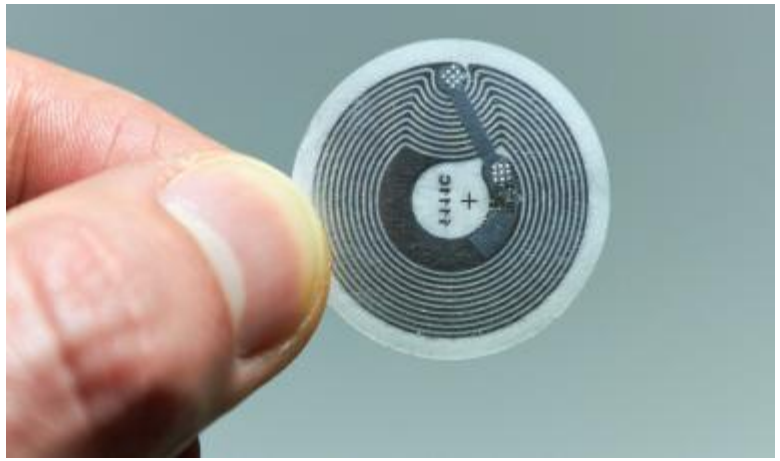

Figure 7-17 Adhesive NFC tag.

Enterprise and Other Storage Options (9 of 9)

- An **NFC tag**, similar to RFID tag, contains a **chip** and **an antenna** that contains information to be transmitted.
- **Uses of NFC communications** include using a mobile device to pay for goods or services, displaying a web page, making a phone call, sending a text message, or exchanging contact information.

How Memory Relates to Storage (1 of 7)

- **Memory** usually consists of one or more chips on the motherboard or some other circuit board on the computer.
- **Memory** stores three basic categories of items:
  - ✓ The **operating system** (a program that manages the complete operation of your computer) and other programs that control or maintain the computer and its devices.
  - ✓ **Applications** that carry out a specific task, such as word processing.
  - ✓ The **data** being processed by the applications and the resulting information.

How Memory Relates to Storage (2 of 7)

- A **byte** (character) is the basic storage unit in memory.
- When an application's instructions and data are transferred to memory from storage devices, the instructions and data exist as bytes.
- Each **byte** resides temporarily in a location in memory that has an address.
- An **address** is a unique number that identifies the location of a byte in memory.
- To access data or instructions in memory, the computer references the addresses that contain bytes of data.

Figure 7-18 Similar to seats in a stadium, one location memory (seat) holds a single byte (person) or can be empty.

How Memory Relates to Storage (3 of 7)

- Memory capacity affects the device's operation speed.
- **RAM** is the most common type of **volatile** memory.
- Examples of **nonvolatile** memory include ROM, flash memory, and CMOS.
- **RAM,** also called **main memory,** consists of memory chips that can be read from and written to by the processor and other devices.
- RAM can accommodate multiple programs and applications simultaneously.
- Saving is the process of copying data, instructions, and information from RAM to a storage device or to the cloud.
- Today's computers improve their processing times with **cache (pronounced cash),** which is a **temporary storage** area.
- **Memory cache** helps speed up the processes of the computer because it stores frequently used instructions and data.

How Memory Relates to Storage (4 of 7)

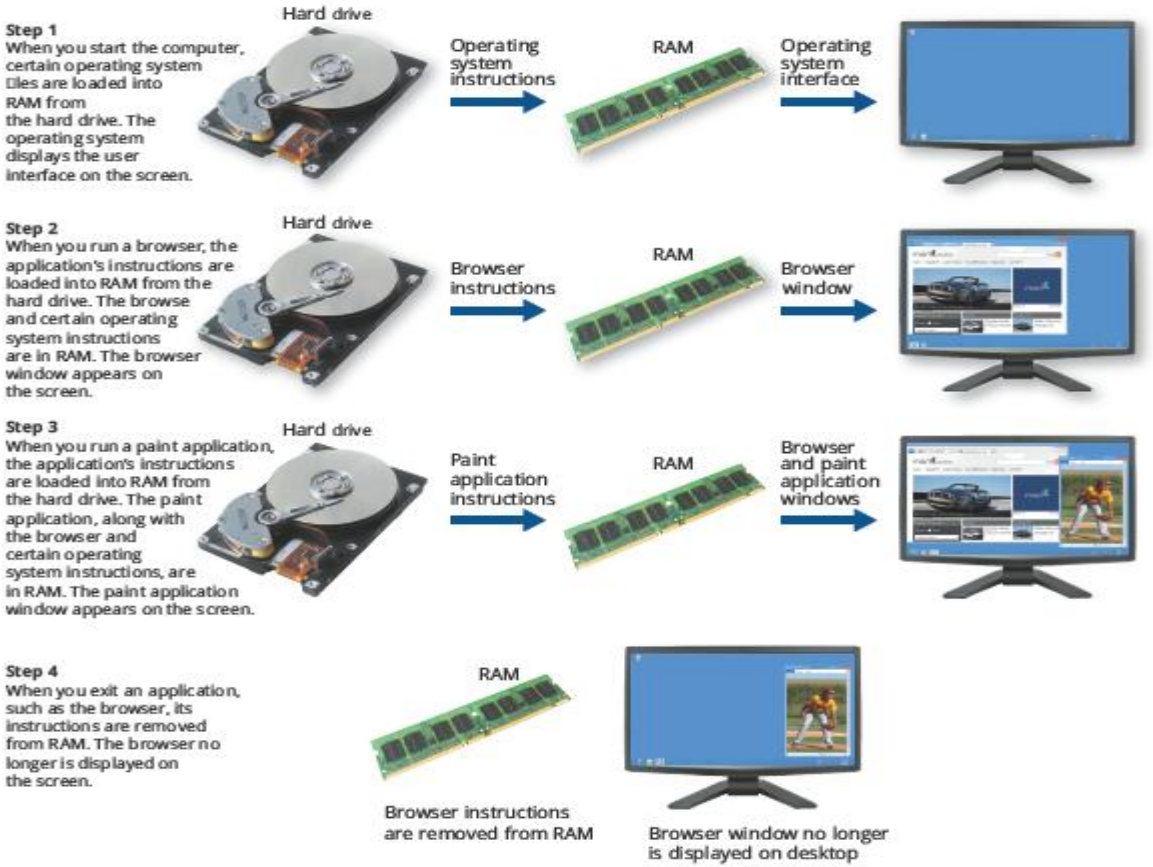

Figure 7-19 How program instructions transfer in and out of RAM.

How Memory Relates to Storage (5 of 7)

- **ROM** (read-only memory) refers to memory chips storing permanent data and instructions.
- The data on most **ROM chips** cannot be modified so it is named as read only.
- Manufacturers of **ROM chips** often record data, instructions, or information on firmware chips when the chips are manufactured.
- These chips contain **permanently written data**, instructions, or information, such as a computer or mobile device's start-up instructions.

How Memory Relates to Storage (6 of 7)

- **Flash memory** is a type of non-volatile memory that can be erased electronically and rewritten.
- Most computers use flash memory to hold their start-up instructions.
- **Flash memory** chips also store data and programs on many mobile devices and peripheral devices, such as smartphones, portable media players, printers, digital cameras, automotive devices, and digital voice recorders.
- Some portable media players store music on **flash memory chips**; others store music on tiny hard drives or memory cards.
- **Memory cards** contain flash memory on a removable device.

How Memory Relates to Storage (7 of 7)

- Some RAM chips, flash memory chips, and other memory chips use **CMOS (complementary metal-oxide semiconductor)** technology as it provides high speeds and consumes little power.
- **CMOS technology** uses battery power to retain information even when the power to the computer is off.
- **Battery-backed CMOS** memory chips.
- The **flash memory chips** that store a computer's **startup** information often use CMOS technology.

Ethics and Issues: Internet of Things and Privacy (1 of 3)

- Every day, smart electric meters, wearable technology, and vehicles' black boxes submit data about us as part of the **IoT**.
- Computers and mobile devices are not the only items that connect to the Internet.
- A thermostat (a temperature sensor that can send and receive data) can be set up that allows you to adjust the temperature of a home from anywhere using an app on your smartphone.
- A wireless chip attached to your medicine bottle can send text messages to remind you to take your medication.

Ethics and Issues: Internet of Things and Privacy (2 of 3)

- Smart trash cans in public places have sensors that monitor the amount of trash deposited and then send a message that notifies owners when the containers need to be emptied.
- Wearable technology, such as smart watches and wristbands, can track your pulse and heart rate, as well as accept calls and display notifications from a smartphone.
- Retailers can use **beacons,** which are devices that send low-energy Bluetooth signals to nearby smartphones, to alert customers who use a payment app, such as PayPal, to personalized offers in their stores.

Ethics and Issues: Internet of Things and Privacy (3 of 3)

- These **devices** could have default settings that prevent the sharing of data until obtaining the consumer's consent.
- **Companies** bear the responsibility of ensuring sensitive data being collected is kept secure and confidential.
- **Privacy and security** concerns abound with the **IoT.**
- **Technology Experts** believe that the security, health, and productivity benefits of this technology outweigh the potential risks.