Chapter 8
Digital Storage
Objectives Overview

Differentiate between storage and memory
Describe the characteristics of internal hard disks
Identify uses of external hard disks and RAID
Describe the benefits of solid-state drives
Differentiate among various types of memory cards and USB flash drives

See Page 336 for Detailed Objectives
Objectives Overview

- Discuss the benefits and uses of cloud storage
- Describe characteristics of and differentiate among types of optical discs
- Explain types of enterprise storage
- Identify uses of magnetic stripe cards, smart cards, RFID tags, and microfilm and microfiche

See Page 336 for Detailed Objectives
Storage

A storage medium is the physical material on which a computer keeps data, information, programs, and applications.

Cloud storage is another storage option, in which the actual online storage media used is transparent to the user.
Storage

- A **storage device** is the hardware that records and/or retrieves items to and from storage media

**Reading** is the process of transferring items from a storage medium into memory

**Writing** is the process of transferring items from memory to a storage medium
Storage

Figure 8-1
Storage

- **Capacity** is the number of bytes a storage medium can hold

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

- Items on a storage medium remain intact even when you turn off a computer or mobile device

<table>
<thead>
<tr>
<th>An Illustration of Volatility</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>State of Computer</strong></td>
</tr>
<tr>
<td>-------------------------</td>
</tr>
<tr>
<td><strong>ON</strong></td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td><strong>OFF</strong></td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td></td>
</tr>
</tbody>
</table>
Storage

- **Access time** measures:
  - The amount of time it takes a storage device to locate an item on a storage medium
  - The time required to deliver an item from memory to the processor

<table>
<thead>
<tr>
<th>Storage</th>
<th>Stores ...</th>
</tr>
</thead>
<tbody>
<tr>
<td>Memory (most RAM)</td>
<td>Items waiting to be interpreted and executed by the processor</td>
</tr>
<tr>
<td>SSDs</td>
<td>Operating system; applications; user data and information, including photos, music, and videos; backups</td>
</tr>
<tr>
<td>Hard Disks</td>
<td>Digital photos or files to be transported</td>
</tr>
<tr>
<td>USB Flash Drives</td>
<td>Software, movies, music</td>
</tr>
<tr>
<td>Memory Cards</td>
<td></td>
</tr>
<tr>
<td>Optical Discs</td>
<td></td>
</tr>
</tbody>
</table>
Hard Disks

- A **hard disk** contains one or more inflexible, circular platters that use magnetic particles to store data, instructions, and information.
Hard Disks

• Hard disks can store data using longitudinal recording or perpendicular recording
Hard Disks

- **Formatting** is the process of dividing the disk into tracks and sectors.
Hard Disks

• Characteristics of a hard disk include:

- Tracks
- Sectors
- Platters
- Form factor
- Read/write head
- Revolutions per minute
How a Hard Disk Works

Step 1
The circuit board controls the movement of the head actuator and a small motor.

Step 2
A small motor spins the platters while the computer is running.

Step 3
When software requests disk access, the read/write heads determine the current or new location of the data.

Step 4
The head actuator positions the read/write head arms over the correct location on the platters to read or write data.
Hard Disks

- A head crash occurs when a read/write head touches the surface of a platter
- Always keep a backup of your hard disk
Hard Disks

- Disk cache, sometimes called a buffer, consists of a memory chip(s) on a hard disk that stores frequently accessed data, instructions, and information.
- The larger the disk cache, the faster the hard disk.
Hard Disks

- **RAID** (redundant array of independent disks) is a group of two or more integrated hard disks
Hard Disks

- An external hard disk is a separate freestanding storage device that connects with a cable to a USB port or other port on a computer or mobile device.
Flash Memory Storage

- Flash memory chips are a type of solid state media and contain no moving parts.
- An SSD (solid state drive) has several advantages over magnetic hard disks:
  - Higher storage capacities
  - Faster access times
  - Faster transfer rates
  - Quieter operation
  - More durable
  - Lighter weight
  - Less power consumption
  - Less heat generation
  - Longer life
Flash Memory Storage

Figure 8-11
Flash Memory Storage

• A **memory card** is a removable flash memory device that you insert and remove from a slot in a computer, mobile device, or card reader/writer.
Flash Memory Storage
Flash Memory Storage

How SD Cards Work

Step 1
When you insert a memory card in a card reader/writer or card slot, the memory card’s metallic conductors make contact with connectors in the card reader/writer or card slot, allowing the transfer of photos and other items between the card and the reading/writing device.

Step 2
A notch on the side of the memory card prevents the card from accidentally slipping out of the card reader/writer or card slot.

Step 3
Flash memory chips store photos and other types of data and information. When requested, the controller transfers items stored on the flash memory chips to the metallic conductors, using registers for temporary storage, as needed.

Step 4
Some memory cards contain write-protect switches, which prevent you from accidentally erasing photos and other items stored on the flash memory chips.
Flash Memory Storage

- **USB flash drives** plug into a USB port on a computer or mobile device
Cloud Storage

- **Cloud storage** is an Internet service that provides storage to computer or mobile device users
Optical Discs

- An **optical disc** consists of a flat, round, portable disc made of metal, plastic, and lacquer that is written and read by a laser.
Optical Discs

How a Laser Reads Data on an Optical Disc

Step 1
A laser diode shines a light beam toward the disc.

Step 2
If light strikes a pit, it scatters. If light strikes a land, it is reflected back toward the laser diode.

Step 3
Reflected light is deflected to a light-sensing diode, which sends a digital signal of 1 to the computer. Absence of reflected light is read as a digital signal of 0.
Optical Discs

• Optical discs commonly store items in a single track that spirals from the center of the disc to the edge of the disc.
• Track is divided into evenly sized sectors.
Optical Discs

A **CD-ROM** can be read from but not written to

- Single-session disc

A **CD-R** is an optical disc on which users can write once, but not erase

A **CD-RW** is an erasable multisession disc
Optical Discs

A **DVD-ROM** is a high-capacity optical disc on which users can read but not write on or erase.

A **DVD-R** or **DVD+R** are competing DVD-recordable WORM formats, on which users can write once but not erase.

**DVD-RW**, **DVD+RW**, and **DVD+RAM** are high-capacity rewritable DVD formats.
Enterprise Storage

- Enterprise hardware allows large organizations to manage and store data and information using devices intended for heavy use, maximum efficiency, and maximum availability
  - RAID duplicates data, instructions, and information to improve data reliability
Enterprise Storage

- **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.
Enterprise Storage

- A **storage area network (SAN)** is a high-speed network with the sole purpose of providing storage to other attached servers.
Enterprise Storage

- **Tape** is a magnetically coated ribbon of plastic capable of storing large amounts of data and information.
- A tape drive reads and writes data and information on a tape.
Other Types of Storage

- A **magnetic stripe card** contains a magnetic stripe that stores information.
- A **smart card** stores data on an integrated circuit embedded in the card.
Other Types of Storage

- 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 signal and transfers the information to a computer or computing device.
Other Types of Storage

- **Microfilm** and **microfiche** store microscopic images of documents on a roll or sheet film.
Summary

- Variety of storage options
- Storage capacity and storage access times
- Characteristics of hard disks, RAID, and external hard drives
- Various types of flash memory storage
- Advantages and various uses of cloud storage
- Characteristics of optical discs
- Enterprise storage options