Chapter 7
Types of Storage

Discovering Computers 2012
Your Interactive Guide to the Digital World
Objectives Overview

Differentiate between storage devices and storage media

Describe the characteristics of an internal hard disk including capacity, platters, read/write heads, cylinders, sectors and tracks, revolutions per minute, transfer rate, and access time

Discuss the purpose of network attached storage devices, external and removable hard disks, and hard disk controllers

Describe the various types of flash memory storage

See Page 351 for Detailed Objectives
Objectives Overview

- Describe cloud storage and explain its advantages
- Describe the characteristics of optical discs
- Differentiate among various types of optical discs: CDs, archive discs and Picture CDs, DVDs, and Blu-ray Discs
- Identify the uses of tape, magnetic stripe cards, smart cards, microfilm and microfiche, and enterprise storage

See Page 351 for Detailed Objectives
Storage holds data, instructions, and information for future use.

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

Figure 7-1
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

• A **storage device** is the computer 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

- **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
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

• Characteristics of a hard disk include:

  - Capacity
  - Platters
  - Read/Write Heads
  - Cylinders
  - Sectors and Tracks
  - Revolutions per Minute
  - Transfer Rate
  - Access Time
Hard Disks

- **Formatting** is the process of dividing the disk into tracks and sectors so that the operating system can store and locate data and information on the disk.

<table>
<thead>
<tr>
<th>Sample Hard Disk Characteristics</th>
</tr>
</thead>
<tbody>
<tr>
<td>Advertised capacity</td>
</tr>
<tr>
<td>Platters</td>
</tr>
<tr>
<td>Read/write heads</td>
</tr>
<tr>
<td>Cylinders</td>
</tr>
<tr>
<td>Bytes per sector</td>
</tr>
<tr>
<td>Sectors per track</td>
</tr>
<tr>
<td>Sectors per drive</td>
</tr>
<tr>
<td>Revolutions per minute</td>
</tr>
<tr>
<td>Transfer rate</td>
</tr>
<tr>
<td>Access time</td>
</tr>
</tbody>
</table>

1 TB disk can store any of the following:
- 500,000,000 pages of text
- 285,000 digital photos
- 250,000 songs
- 120 hours of digital video

![Diagram of hard disk properties and storage capacity](image)
Hard Disks

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 a 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

• The hard disk arms move the read/write head, which reads items and writes items in the drive
  – Location often is referred to by its cylinder
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**

**How Disk Cache Works**

**Step 1**
A special-purpose chip on the hard disk, called a controller, receives a request for data, instructions, or information from the processor.

**Step 2a**
The controller first checks disk cache for the requested item.

**Step 2b**
If the controller does not find the requested item in disk cache, it locates the requested item on the hard disk’s platters.

**Step 3**
The controller transfers the requested item to the processor.
Hard Disks

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

• A **network attached storage** (NAS) device is a server connected to a network with the sole purpose of providing storage
Hard Disks

An **external hard disk** is a separate free-standing hard disk that connects to your computer with a cable or wirelessly.

A **removable hard disk** is a hard disk that you insert and remove from a drive.

Internal and external hard disks are available in miniature sizes (miniature hard disks).
Hard Disks

- A disk controller consists of a special-purpose chip and electronic circuits that control the transfer of data, instructions, and information from a disk to and from the system bus and other components of the computer.

  SATA  EIDE
  SCSI  SAS
Flash Memory Storage

- Flash memory chips are a type of solid state media and contain no moving parts
- **Solid state drives (SSDs)** have several advantages over magnetic hard disks:
  - Faster access time
  - Faster transfer rates
  - Generate less heat and consume less power
  - Last longer
Flash Memory Storage

![Flash Memory Storage Image]
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.

- **CompactFlash (CF)**
- **Secure Digital (SD)**
- **Secure Digital High Capacity (SDHC)**
- **microSD**
- **microSDHC**
- **xD Picture Card**
- **Memory Stick**
- **Memory Stick Micro (M2)**
Flash Memory Storage

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### Various Memory Cards

<table>
<thead>
<tr>
<th>Media Type</th>
<th>Storage Capacity</th>
<th>Use</th>
</tr>
</thead>
<tbody>
<tr>
<td>CompactFlash (CF)</td>
<td>512 MB to 100 GB</td>
<td>Digital cameras, smart phones, PDAs, photo printers, portable media players, notebook computers, desktop computers</td>
</tr>
<tr>
<td>Secure Digital (SD)</td>
<td>512 MB to 8 GB</td>
<td>Digital cameras, digital video cameras, smart phones, PDAs, photo printers, portable media players</td>
</tr>
<tr>
<td>SDHC</td>
<td>4 to 32 GB</td>
<td>Digital cameras</td>
</tr>
<tr>
<td>microSD</td>
<td>1 to 2 GB</td>
<td>Smart phones, portable media players, handheld game consoles, handheld navigation devices</td>
</tr>
<tr>
<td>microSDHC</td>
<td>4 to 16 GB</td>
<td>Smart phones, portable media players, handheld game consoles, handheld navigation devices</td>
</tr>
<tr>
<td>xD Picture Card</td>
<td>256 MB to 2 GB</td>
<td>Digital cameras, photo printers</td>
</tr>
<tr>
<td>Memory Stick PRO Duo</td>
<td>1 to 16 GB</td>
<td>Digital cameras, smart phones, handheld game consoles</td>
</tr>
<tr>
<td>Memory Stick Micro (M2)</td>
<td>1 to 16 GB</td>
<td>Smart phones</td>
</tr>
</tbody>
</table>
How One Type of Memory Card Works

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 users 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
Video: Thumb Drive (USB Flash Drive) Encryption

CLICK TO START

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An **ExpressCard module** is a removable device that fits in an ExpressCard slot.

- Developed by the PCMCIA
- Commonly used in notebook computers
Cloud Storage

- **Cloud storage** is an Internet service that provides storage to computer users
# Cloud Storage

## Cloud Storage Providers

<table>
<thead>
<tr>
<th>Web Site Names</th>
<th>Type of Storage Provided</th>
<th>Other Services</th>
</tr>
</thead>
<tbody>
<tr>
<td>Box.net, iDrive, Windows Live SkyDrive</td>
<td>Backup or additional storage for any type of file</td>
<td></td>
</tr>
<tr>
<td>Flickr, Picasa</td>
<td>Digital photos</td>
<td>Photo editing and photo management</td>
</tr>
<tr>
<td>YouTube</td>
<td>Digital videos</td>
<td></td>
</tr>
<tr>
<td>Facebook, MySpace</td>
<td>Digital photos, digital videos, messages, and personal information</td>
<td>Social networking</td>
</tr>
<tr>
<td>Google Docs, Office Web Apps</td>
<td>Documents, spreadsheets, presentations</td>
<td>Productivity suite</td>
</tr>
<tr>
<td>Gmail, Windows Live Hotmail, Yahoo! Mail</td>
<td>E-mail messages</td>
<td></td>
</tr>
<tr>
<td>Amazon EC2, Amazon S3, Nim氰</td>
<td>Enterprise-level storage</td>
<td>Web services, data center services</td>
</tr>
</tbody>
</table>
Cloud Storage

- Users subscribe to cloud storage for a variety of reasons:
  - Access files from any computer
  - Store large files instantaneously
  - Allow others to access their files
  - View time-critical data and images immediately
  - Store offsite backups
  - Provide data center functions
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.
- Typically store software, data, digital photos, movies, and music.
- Read only vs. rewritable.
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.
- Track is divided into evenly sized sectors.
Optical Discs

• Care of optical discs

![Diagram of care instructions for optical discs]

- DO store the disc in a jewel box when not in use.
- DO hold a disc by its edges.
- DO NOT eat, smoke, or drink near a disc.
- DO NOT touch the underside of the disc.
- DO NOT stack discs.
- DO NOT expose the disc to excessive heat or sunlight.
Optical Discs

A **CD-ROM** can be read from but not written to
- Read from a **CD-ROM drive** or CD-ROM player

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

A **CD-RW** is an erasable multisession disc
- Must have a **CD-RW drive**
# Optical Discs

<table>
<thead>
<tr>
<th>Archive disc</th>
<th>Picture CD</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Stores photos from an online photo center</td>
<td>• Single-session CD-ROM that stores digital versions of film</td>
</tr>
<tr>
<td>• Resolution usually is 7200 pixels per photo</td>
<td>• Typically uses a 1024 x 1536 resolution</td>
</tr>
<tr>
<td>• Cost is determined by the number of photos being stored</td>
<td>• Many photo centers offer Picture CD services</td>
</tr>
</tbody>
</table>
Optical Discs

How an Archive Disc Works

Step 1
Upload your digital photos to a photo sharing community for others to view.

Step 2
Select the photos to be stored on the archive disc and then place your order.

Step 3
Pick up your archive disc at a designated store or receive it in the mail. At home, edit and/or print images from the archive disc on your ink-jet or photo printer, or view the images on a monitor or television screen. At a store, edit and/or print images from the archive disc at a kiosk.
A DVD-ROM is a high-capacity optical disc on which users can read but not write or erase

- Requires a DVD-ROM drive

A Blu-ray Disc-ROM (BD-ROM) has a storage capacity of 100 GB

DVD-RW, DVD+RW, and DVD+RAM are high-capacity rewritable DVD formats
Other Types of Storage

- Tape
- Magnetic stripe cards and smart cards
- Microfilm and microfiche
- Enterprise storage
Other Types of 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 a thin microprocessor embedded in the card.
Other Types of Storage

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

<table>
<thead>
<tr>
<th>Media Type</th>
<th>Guaranteed Life Expectancy</th>
<th>Potential Life Expectancy</th>
</tr>
</thead>
<tbody>
<tr>
<td>Magnetic disks</td>
<td>3 to 5 years</td>
<td>20 to 30 years</td>
</tr>
<tr>
<td>Optical discs</td>
<td>5 to 10 years</td>
<td>50 to 100 years</td>
</tr>
<tr>
<td>Solid state drives</td>
<td>50 years</td>
<td>140 years</td>
</tr>
<tr>
<td>Microfilm</td>
<td>100 years</td>
<td>500 years</td>
</tr>
</tbody>
</table>

* according to manufacturers of the media
Other Types of Storage

- Enterprise storage stores huge volumes of data and information for large businesses
  - Uses special hardware for heavy use, maximum availability, and maximum efficiency
Putting It All Together

- **Home user**
  - 500 GB hard disk
  - Cloud storage
  - Optical disc drive
  - Card reader/writer
  - USB flash drive

- **Small Office/Home Office user**
  - 1 TB hard disk
  - Cloud storage
  - Optical disc drive
  - External hard disk for backup
  - USB flash drive

- **Mobile**
  - 250 GB hard disk
  - Cloud storage
  - Optical disc drive
  - Card reader/writer
  - Portable hard disk for backup
  - USB flash drive
Putting It All Together

**Power User**
- 2.5 TB hard disk
- Cloud storage
- Optical disc drive
- Portable hard disk for backup
- USB flash drive

**Enterprise User**
(Based on a desktop computer)
- 1 TB hard disk
- Optical disc drive
- Smart card reader
- Tape drive
- USB flash drive

**Enterprise User**
(Based on a server or mainframe)
- Network storage server
- 40 TB hard disk system
- Optical disc server
- Microfilm or microfiche

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Figure 7-40
Discovering Computers 2012: Chapter 7
Summary

Various storage media and storage devices

Internal hard disks, external and removable hard disks, solid state drives, memory cards, USB flash drives, ExpressCard modules, cloud storage, CDs, DVDs, and Blu-ray Discs, tape, smart cards, and microfilm and microfiche
Chapter 7
Types of Storage

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Chapter 7 Complete