Chapter 5
Storage Devices
1. Computer Data Storage
2. Types of Storage
3. Storage Device Features
4. Other Examples of Storage Device
Storage Devices

- A storage device is used in the computers to store the data.
- Provides one of the core functions of the modern computer.
Types of Storage

There are four types of storage:

- Primary Storage
- Secondary Storage
- Tertiary Storage
- Off-line Storage
Primary Storage

- Also known as **main memory**.
- Main memory is directly or indirectly connected to the central processing unit via a memory bus.
- The CPU continuously reads instructions stored there and executes them as required.
- Example:
  - RAM
  - ROM
  - Cache
Primary Storage

RAM

• It is called Random Access Memory because any of the data in RAM can be accessed just as fast as any of the other data.
• There are two types of RAM:
  – DRAM (Dynamic Random Access Memory)
  – SRAM (Static Random Access Memory)
### Primary Storage

**RAM**

<table>
<thead>
<tr>
<th>Static RAM</th>
<th>Dynamic RAM</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Faster</td>
<td>• Slower</td>
</tr>
<tr>
<td>• More expensive</td>
<td>• Less expensive</td>
</tr>
<tr>
<td>• More power consumption</td>
<td>• Less power consumption</td>
</tr>
<tr>
<td>• does not need to be refreshed</td>
<td>• needs to be refreshed thousands of times per second</td>
</tr>
</tbody>
</table>

- [Static RAM Image](#)
- [Dynamic RAM Image](#)
Primary Storage

ROM

• This memory is used as the computer begins to boot up.
• Small programs called firmware are often stored in ROM chips on hardware devices (like a BIOS chip), and they contain instructions the computer can use in performing some of the most basic operations required to operate hardware devices.
• ROM memory cannot be easily or quickly overwritten or modified.
Primary Storage

Cache

- **Cache** is a high-speed access area that can be either a reserved section of main memory or a storage device.
- Most computers today come with L3 cache or L2 cache, while older computers included only L1 cache.
Secondary Storage

- It is not directly accessible by the CPU.
- Computer usually uses its input/output channels to access secondary storage and transfers the desired data using intermediate area in primary storage.
- Example:
  - Hard disk
Secondary Storage

Hard Disk

- The hard disk drive is the main, and usually largest, data storage device in a computer.
- It can store anywhere from 160 gigabytes to 2 terabytes.
- Hard disk speed is the speed at which content can be read and written on a hard disk.
- A hard disk unit comes with a set rotation speed varying from 4500 to 7200 rpm.
- Disk access time is measured in milliseconds.
Secondary Storage

Hard Disk

Internal Hard disk

External Hard disk
# Secondary Storage

## Hard Disk

<table>
<thead>
<tr>
<th></th>
<th>Internal Hard disk</th>
<th>External Hard disk</th>
</tr>
</thead>
<tbody>
<tr>
<td>Portability</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td>Price</td>
<td>Less expensive</td>
<td>More expensive</td>
</tr>
<tr>
<td>Speed</td>
<td>Fast</td>
<td>Slow</td>
</tr>
<tr>
<td>Size</td>
<td>Big</td>
<td>Small</td>
</tr>
</tbody>
</table>
Tertiary Storage

• Typically it involves a robotic mechanism which will mount (insert) and dismount removable mass storage media into a storage device.

• It is a comprehensive computer storage system that is usually very slow, so it is usually used to archive data that is not accessed frequently.

• This is primarily useful for extraordinarily large data stores, accessed without human operators.
Tertiary Storage

- Examples:
  - Magnetic Tape
  - Optical Disc
Tertiary Storage

Magnetic Tape

• A magnetically coated strip of plastic on which data can be encoded.
• Tapes for computers are similar to tapes used to store music.
• Tape is much less expensive than other storage mediums but commonly a much slower solution that is commonly used for backup.
Tertiary Storage

Optical Disc

- **Optical disc** is any storage media that holds content in digital format and is read using a laser assembly and is considered optical media.
- The most common types of optical media are
  - Blu-ray (BD)
  - Compact Disc (CD)
  - Digital Versatile Disc (DVD)
## Tertiary Storage

### Optical Disc

<table>
<thead>
<tr>
<th></th>
<th>CD</th>
<th>DVD</th>
<th>BD</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Capacity</strong></td>
<td>700MB</td>
<td>4.7GB – 17GB</td>
<td>50GB</td>
</tr>
<tr>
<td><strong>Wavelength</strong></td>
<td>780nm</td>
<td>650nm</td>
<td>405nm</td>
</tr>
<tr>
<td><strong>Read/Write Speed</strong></td>
<td>1200KB/s</td>
<td>10.5MB/s</td>
<td>36MB/s</td>
</tr>
<tr>
<td><strong>Example</strong></td>
<td>• CD-ROM,</td>
<td>• DVD-ROM</td>
<td>• BD-R</td>
</tr>
<tr>
<td></td>
<td>• CD-R</td>
<td>• DVD+R/RW</td>
<td>• BD-RE</td>
</tr>
<tr>
<td></td>
<td>• CD-RW</td>
<td>• DVD-R/RW</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>• DVD-RAM</td>
<td></td>
</tr>
</tbody>
</table>
Tertiary Storage

Optical Disc
Off-line Storage

• Also known as **disconnected storage**.
• Is a computer data storage on a medium or a device that is not under the control of a processing unit.
• It must be inserted or connected by a human operator before a computer can access it again.
Off-line Storage

- Also known as disconnected or removable storage.
- Is a computer data storage on a medium or a device that is not under the control of a processing unit.
- It must be inserted or connected by a human operator before a computer can access it again.
Off-line Storage

• Examples:
  – Floppy Disk
  – Zip diskette
  – USB Flash drive
  – Memory card
Off-line Storage

Floppy Disk

- A soft magnetic disk.
- Floppy disks are portable.
- Floppy disks are slower to access than hard disks and have less storage capacity, but they are much less expensive.
- Can store data up to 1.44MB.
- Two common sizes: 5 ¼” and 3 ½”.
Off-line Storage

Floppy Disk

5 ¼ inch Floppy Disk

3 ½ inch Floppy Disk
Off-line Storage

Zip Diskette

• Hardware data storage device developed by Iomega that functions like a Standard 1.44" floppy drive.

• Capable to hold up to 100 MB of data or 250 MB of data on new drives.

• Now it less popular as users needed larger storage capabilities.
Off-line Storage

USB Flash Drive

• A small, portable flash memory card that plugs into a computer’s USB port and functions as a portable hard drive.

• Flash drives are available in sizes such as 256MB, 512MB, 1GB, 5GB, and 16GB and are an easy way to transfer and store information.
Off-line Storage

Memory Card

• An electronic flash memory storage disk commonly used in consumer electronic devices such as digital cameras, MP3 players, mobile phones, and other small portable devices.

• Memory cards are usually read by connecting the device containing the card to your computer, or by using a USB card reader.
Storage Devices

Off-line Storage

Memory Card

- Secure Digital card (SD)
- MiniSD
- Compact Flash
- Memory Stick
- MultiMedia card
- XD-Picture card
- Memory card reader
Storage Device Features

- Volatility
- Accessibility
- Mutability
- Addressability
Volatility

- Two types of volatility:
  - Volatile Memory
  - Non-Volatile Memory
Volatility

Volatile Memory

• Requires constant power to maintain the stored information.
• The fastest memory technologies.
• All contents are erased when the system's power is turned off or interrupted.
• It has been more popularly known as temporary memory.
Volutility

Non-Volatile Memory

• Will retain the stored information even if it is not constantly supplied with electric power.
• Non volatile memory is the device which keeps the data even when the current is off.
• It is suitable for long-term storage of information.
Accessibility

- Refers to reading or writing data records
- Two types of accessibility:
  - Random access
  - Sequential access
Accessibility

Random Access

- Any location in storage can be accessed at any moment in approximately the same amount of time.
- Such characteristic is well suited for primary and secondary storage.
Accessibility

Sequential Access

• The accessing of pieces of information will be in a serial order, one after the other; therefore the time to access a particular piece of information depends upon which piece of information was last accessed.

• Such characteristic is typical of off-line storage.
Mutability

- Allows information to be overwritten at any time.
- A computer without some amount of read/write storage for primary storage purposes would be useless for many tasks.
- Three types of mutability:
  - Read/write storage or mutable storage
  - Read only storage
  - Slow write, fast read storage
Storage Devices

Mutability

Read/Write Storage or Mutable Storage

• Allows information to be overwritten at any time.
• A computer without some amount of read/write storage for primary storage purposes would be useless for many tasks.
Mutability

Read Only Storage

• Retains the information stored at the time of manufacture, and write once storage (WORM) allows the information to be written only once at some point after manufacture.

• These are called immutable storage.
Mutability

Slow Write, Fast Read Storage

• Read/write storage which allows information to be overwritten multiple times, but with the write operation being much slower than the read operation.
Addressability

- Three types of addressability
  - Location-addressable
  - File addressable
  - Content-addressable
Addressability

Location-addressable

- Each individually accessible unit of information in storage is selected with its numerical memory address.
Addressability

File addressable

- Information is divided into files of variable length, and a particular file is selected with human-readable directory and file names.
Addressability

Content-addressable

- Each individually accessible unit of information is selected based on the basis of (part of) the contents stored there.

- Content-addressable storage can be implemented using software (computer program) or hardware (computer device), with hardware being faster but more expensive option.

- Hardware content addressable memory is often used in a computer's CPU cache.
Other Example of Storage Devices

- Punch card
- Cloud storage
- RAID
Other Example of Storage Devices

Punched Card

- Early method of data storage used with early computers
- Punch cards also known as Hollerith cards
- Containing several punched holes that represents data
Other Example of Storage Devices

Cloud Storage

• Cloud storage means "the storage of data online in the cloud," wherein a data is stored in and accessible from multiple distributed and connected resources that comprise a cloud.

• Cloud storage can provide the benefits of greater accessibility and reliability; rapid deployment; strong protection for data backup, archival and disaster recovery purposes.
Other Example of Storage Devices

Cloud Storage

- Examples:
  - Google Drive
  - Flickr
  - Microsoft Sky Drive
Other Example of Storage Devices

RAID

• RAID is short for redundant array of independent (or inexpensive) disks.
• It is a category of disk drives that employ two or more drives in combination for fault tolerance and performance.
• RAID disk drives are used frequently on servers but aren't generally necessary for personal computers.
• RAID allows you to store the same data redundantly (in multiple paces) in a balanced way to improve overall storage performance.