



STORAGE DEVICES

Storage Devices

- A device unit that holds data without electrical power until purposefully erased. Examples?*
- Magnetic and optical disks, magnetic tape and flash memory devices.
- Storage devices are normally categorised into:
 - **Primary Storage*** e.g. Memory RAM, cache, registers
 - **Secondary Storage*** e.g. Magnetic Hard disks, USB flash drive, floppy disks,
 - **Tertiary Storage*** Tape Drives, CD library changer.
 - **Removable (offline) storage**

Primary Storage

Primary storage (or **main memory** or **internal memory**), often referred to simply as memory, it holds instructions and data for **rapid and direct access** by the computer's central processing unit.

Examples of Primary Storage:

- **Memory RAM:** small-sized, light, volatile, i.e. they lose the information when not powered
- **Processor registers:** located inside the processor. Each register typically holds a word of data (often 32 or 64 bits). CPU instructions instruct the arithmetic and logic unit to perform various calculations or other operations on this data

Primary Storage

- **Processor cache:** to increase performance of the computer. Most actively used information in the main memory RAM is just duplicated in the cache memory, which is faster but lesser capacity e.g. 6MB or 8MB cache. It is located inside the CPU.
- Primary Storage devices (cpu cache, RAM) are generally more expensive, but faster and smaller in size compared to secondary storage devices such as hard disks, USB flash drive.

Secondary Storage

Secondary storage (also known as external memory or auxiliary storage), differs from primary storage in that it is **not directly accessible by the CPU**. The computer usually uses its input/output BUS path to access secondary storage and then transfers the desired data to primary storage.

- Secondary storage does not lose the data when the device is powered down— Secondary storage is **non-volatile**.
- The time taken to access a given byte of information stored on a **Hard disk** is a few thousandths of a second, or milliseconds.
- The time taken to access a given byte of information stored in **Memory RAM** is billionths of a second, or nanoseconds.
- In short most secondary storage devices are typically about a million times slower than primary storage devices.**

Secondary Storage

Types of Secondary Storage:
Examples?

- **Hard Disk:** It is a **non-volatile** magnetic storage device and is capable of storing large amounts of data. Has many moving parts e.g. spindle, motors, magnetic platter, jumper pins, etc.
- **Solid State Disks (also called RAM Disks):** use microchips which retain data in **non-volatile** memory chips and contain **no moving parts**. Data is not lost after device is powered off.



Traditional hard disk drive



Solid state hard drive

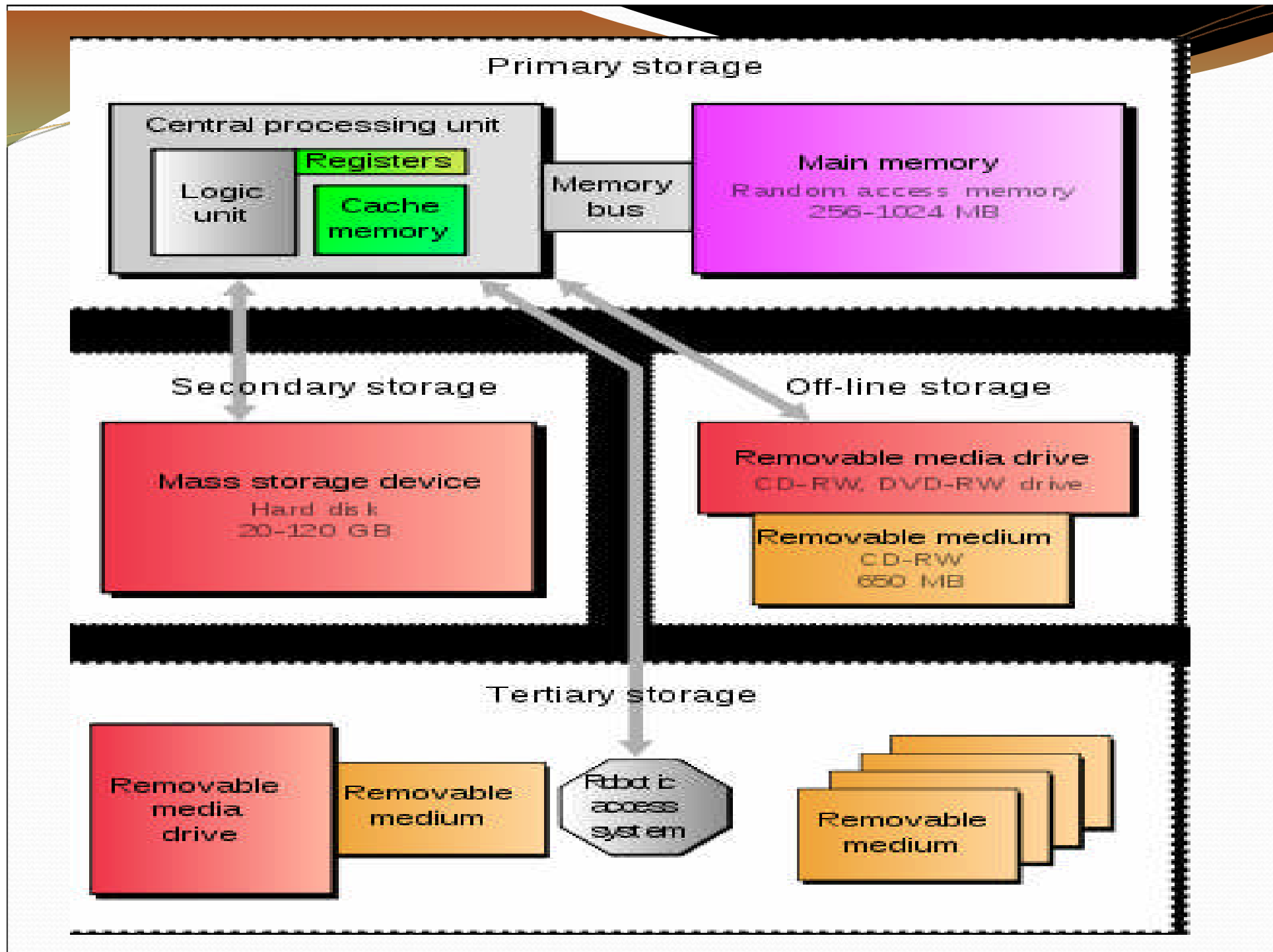
Tertiary Storage

- Its main use is for storing data at a very large-scale.
- This includes Optical Jukeboxes and Server Tape Drives, CD libraries. (Tape drives can store up to over 35 terrabytes)
- Tertiary storage devices require a database to organize the data that are stored in them, and the computer needs to go through the database to access those data.

Removable (Offline) Storage

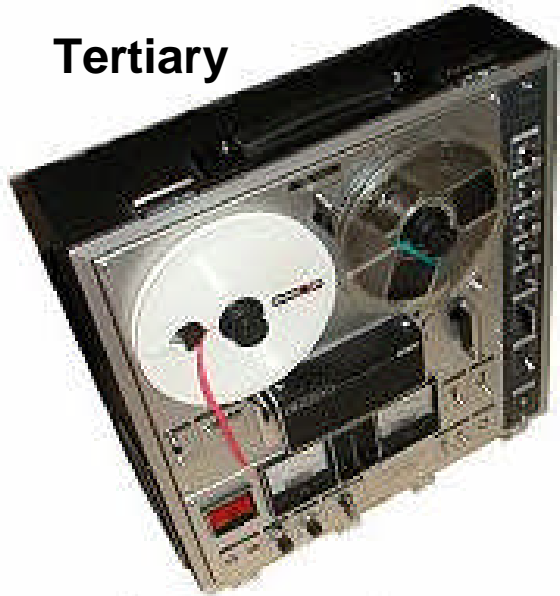
Offline or disconnected storage is not directly connected to the computer and is used as a transfer medium only. Offline storage devices are remotely located and accessed. Example*:

- **Flash memory (Memory cards, SD card, MMC, Memory Stick)**
- **Floppy disks**
- **Magnetic tapes, Zip Drives.**



PRIMARY, SECONDARY, TERTIARY OR OFFLINE?

Tertiary



Secondary



Primary



Offline



Offline



Offline



Tertiary

Hard Disk – Partitioning

- In order for a hard disk to be used it must be divided into multiple logical storage units referred to as *partitions*
- **Primary Partition:** is the active (bootable) partition that is used to start an operating system
- **Extended Partition:** is a partition that can be sub-divided into logical drives.
- **Logical Drives:** A logical drive is created **within an extended partition**. Multiple logical drives can be created from the extended partition.

Hard Disk – File System

- File systems are the **structures behind how your computer stores and organizes data.**
- The file system **manages a folder/directory structure**, which provides an index to the files, and it defines the syntax used to access.
- File systems handles how files are named, the maximum size of a file or volume.
- FAT32 and NTFS are Windows file systems, and HFS is used on Macs. Linux uses ext2, ext3 and FAT32. Unix systems use UFS, ext2, ext3 and ZFS
- After partitioning, the hard disk will be formatted to follow the File System according to the OS installed.

Hard Disk - RAID

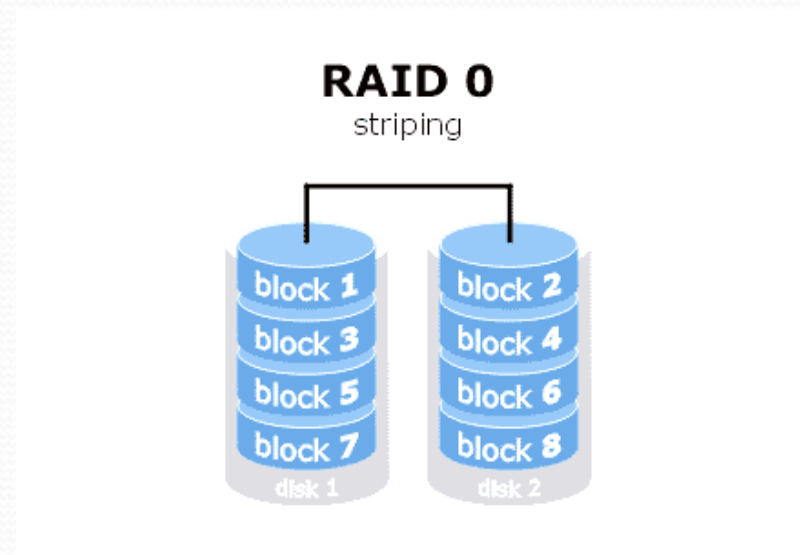
Multiple Hard disk can be combined into one logical unit, where data is distributed across the drives in one of several ways called **RAID** levels.

RAID stands for **Redundant Array of Independent Disks**, and with at least two or more hard disk drives, you can setup them up as a RAID array in order to increase the disk performance. It requires hardware-based RAID controllers, supported by most motherboards or servers.

Hard Disk – Common RAID Systems

RAID 0:

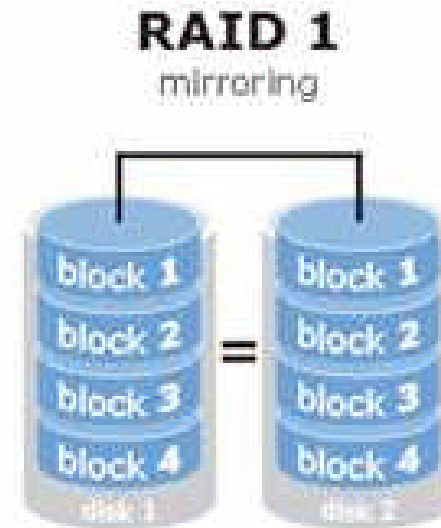
(also known as a **stripe set** or **striped volume**) splits data evenly across two or more disks and offers the **best performance**. However there is no fault tolerance. In a RAID 0 array, if you have 2 disks and 1 fails, the entire array fails.



Hard Disk - Common RAID Systems

RAID 1:

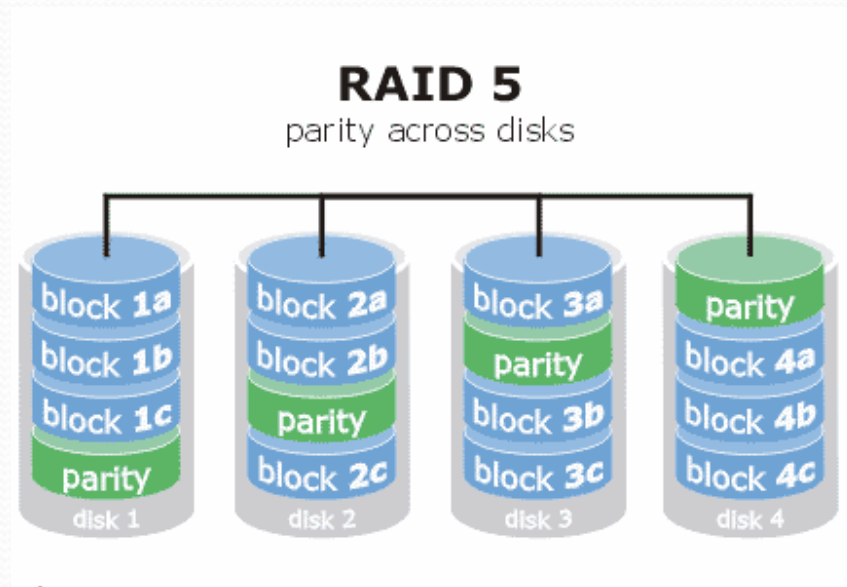
creates an **exact duplicated copy** (or **mirror**) of a set of data on two or more disks. This is useful when read performance or reliability is more important than data storage capacity.



Hard Disk - Common RAID Systems

RAID 5:

Block-level striping with **parity data distributed across all member disks**. But requires at least three and usually five disks for the array. It provides data redundancy and increases speed



Flash Drives

- A flash drive is a storage device that uses **NAND flash memory**, usually with a type-A USB connector. Can also be known as an SSD.
- Flash memory is **non-volatile**. It can be electrically erased and reprogrammed.
- It is a type of Electrically Erasable Programmable Read-Only Memory (**EEPROM**) which is attached on a PCB, a printed circuit board and has no fragile or movable parts.



Flash Drives

- Flash drives have **low power consumption** and **low rate of failures** compared with magnetic floppy disks.
- Earlier USB1.0 flash drives have a speed of 12 Mbit/s. USB2.0 flash drives have a speed of 480Mbits/s. Newer USB3.0 has a speed of 5Gbit/s.



EXERCISE

1. Give 2 reasons how a Flash drive is different to the conventional type of magnetic Hard Disk?
2. I want to partition my hard disk into C: drive and D: drive. What should I do first?
3. I have 2 new hard disks, I want to keep data safe without any chance of failure or data loss. What RAID system should I use? And Why?