



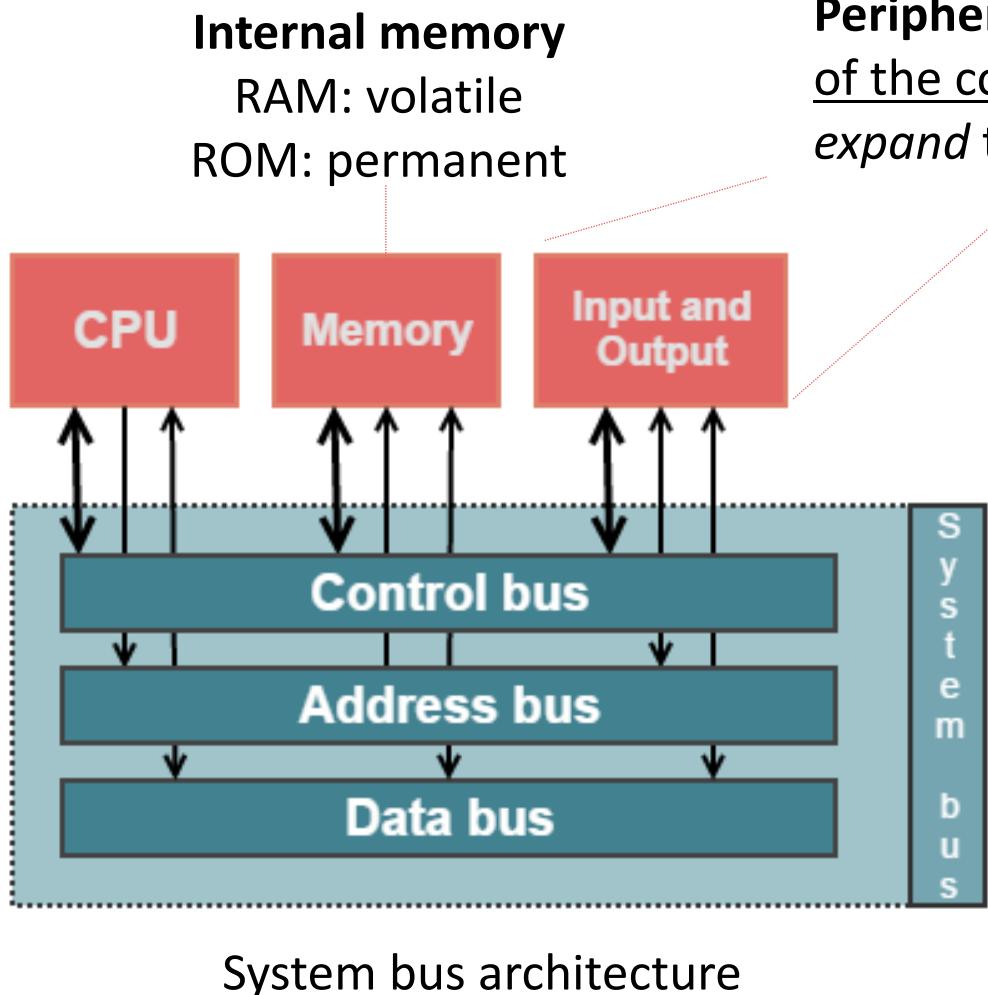
15-110 PRINCIPLES OF COMPUTING – F19

LECTURE 22: FILES I/O 1

TEACHER:
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Files and computer peripherals

- **File:** a sequence of data that is **stored** in some **physical support** either permanently or temporarily



Peripheral devices: parts of a computer system that are not parts of the core computer architecture, they are *optional*, can serve to *expand* the capabilities of the system



I/O storage peripherals:

- ✓ Magnetic storage media
- ✓ Optical storage media
- ✓ Solid state storage media



Data storage and files

Data storage: storing data in a named location (a ‘known’ place, a *file*) that can be accessed (**open**) later on for **read / write / update operations**, and can put aside (**closed**) when done, and it can also be **removed** if stored data are not anymore needed



Create a named file
✓ **Open a new file**



- ✓ **Open** an existing file
- ✓ **Read** existing data
- ✓ **Write** new data
- ✓ **Modify / write** existing data



Temporary shutdown an existing file
✓ **Close existing file**



Delete an existing file from the system
✓ **Remove** an existing file

Modalities for data storage

Data can be stored:

➤ **Temporarily → RAM**

- Volatile: data is erased when computer is switched off
- Use to store data currently in use by running programs
- Very fast I/O operations



➤ **Permanently → Backing storage device**

- Non volatile: data stays stored after powering off the computer / device
- Use to store long-term data
- Slower I/O operations compared to RAM

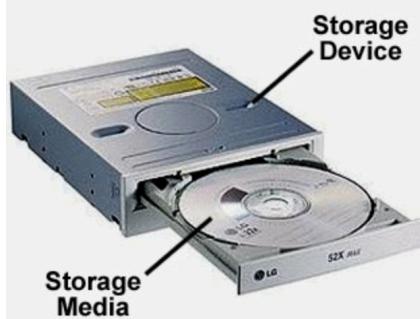


Examples: USB flash drive, solid state drive, hard drive, DVD drive, ROM



Backing storage devices

- A backing storage device consists of:
 - ✓ **Storage media:** the parts / devices that physically hold the data
 - ✓ **Storage device:** the machine / device that reads/writes the data from/to the storage media



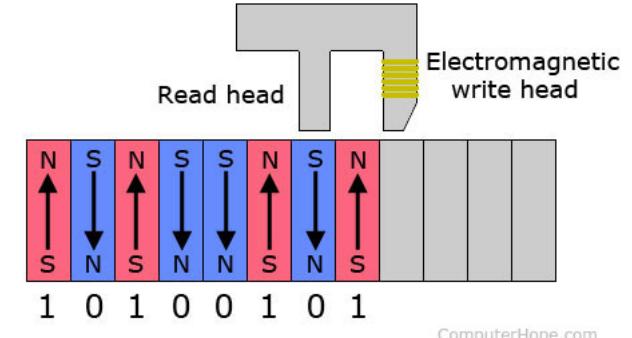
- A backing storage device can be internal or external to the computer system



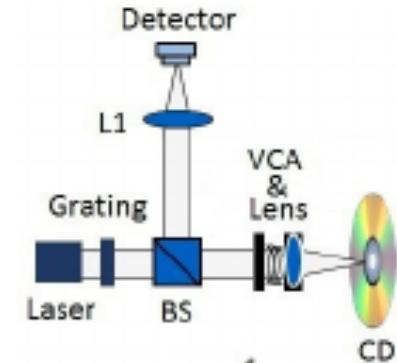
Common storage media

- **Magnetic media** (Hard disk drives, Tapes)
 - Data are written by magnetic polarization. The electromagnetic write head polarizes tiny sections of the ferromagnetic hard drive so they face up or down ("North" or "South") to represent the binary digits 1 or 0 that encode information. The read head can detect the magnetic polarization and then associate 0 or 1 to each section. **R/W head moves**
- **Optical media** (CD, DVD, Blue-ray)
 - Data are written by burning tiny dots on the surface of an optically sensitive medium (e.g., a **rotating disc**) by using a high powered laser. The presence or not of a dot means either 1 or 0. Data is read by shining a low powered laser light over the dots. The presence or not of reflection light is associated to the presence or not of a burned dot.
- **Solid state media** (SSD / Flash memory: SS Hard drives, Memory sticks / Pen drives, Memory cards)
 - Data are stored electronically, using properties of silicon microchips. **No mechanically moving parts**

Hard drive read/write head



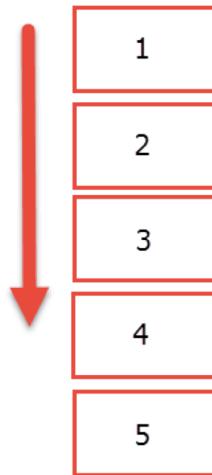
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Accessing the data: Sequential (old style)

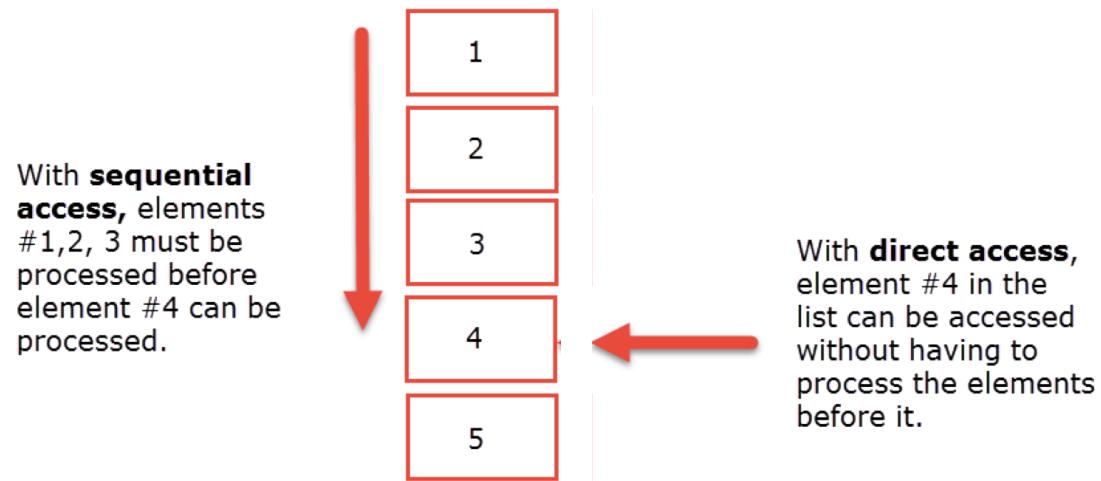
- **Sequential access** (Magnetic data tapes)
 - Data is accessed by starting from the beginning and then moving sequentially, forward and backward, over the medium
 - Slow, very slow, but reliable, cheap, and still in used for backing up very large amount of data

With **sequential access**, elements #1,2, 3 must be processed before element #4 can be processed.



Accessing the data: Direct (most in use)

- **Direct access** (All "modern" media)
 - Information about location of data (e.g., where a file is in the medium) is maintained in a dedicate space on the medium, such as when requested, data can be accessed directly, by "jumping" to the right place rather than moving to the place sequentially from the beginning, as in the case of sequential access
 - Fast, much faster than sequential, especially when there are no moving parts



Files: custom data structures for holding permanent data

- **File:** a *sequence* of data held in a *storage medium*, that can be either *volatile or not*
 - User data are written on the file according to a *custom organization* that reflects user's needs
 - **Data structure:** a collection of data elements organized in some way (e.g., list, dictionary, set)

A file is a *custom, permanent* data structure to hold data

Files: custom data structures for holding permanent data

- A file data structure can be used to hold and represent virtually anything
 - Image, in different formats, such as jpeg, png, svg, gif ...
 - Data of interest: Genome maps, financial data, climate data, traffic logs, medical data....
 - Log about a running program, such as a Web server, or your own python program ...
 - Data collected by sensors during experiments
 - Text of a novel, a poem, a song, ...
 - Specification of a web page, in HTML, CSS, JavaScript, ...
 - Notes about ... anything!
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