Computer Fundamentals

Lecture 4

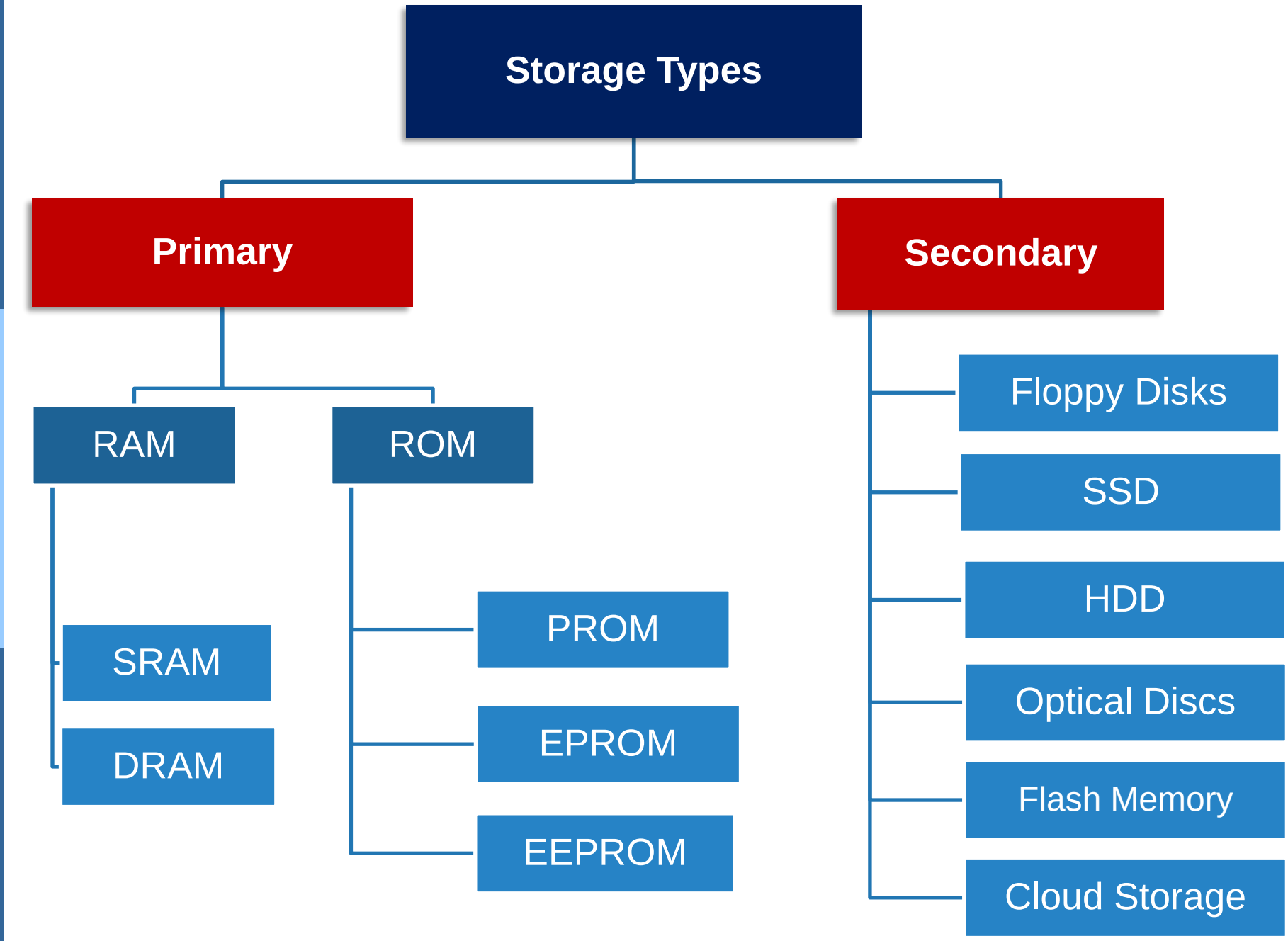
Storage Units

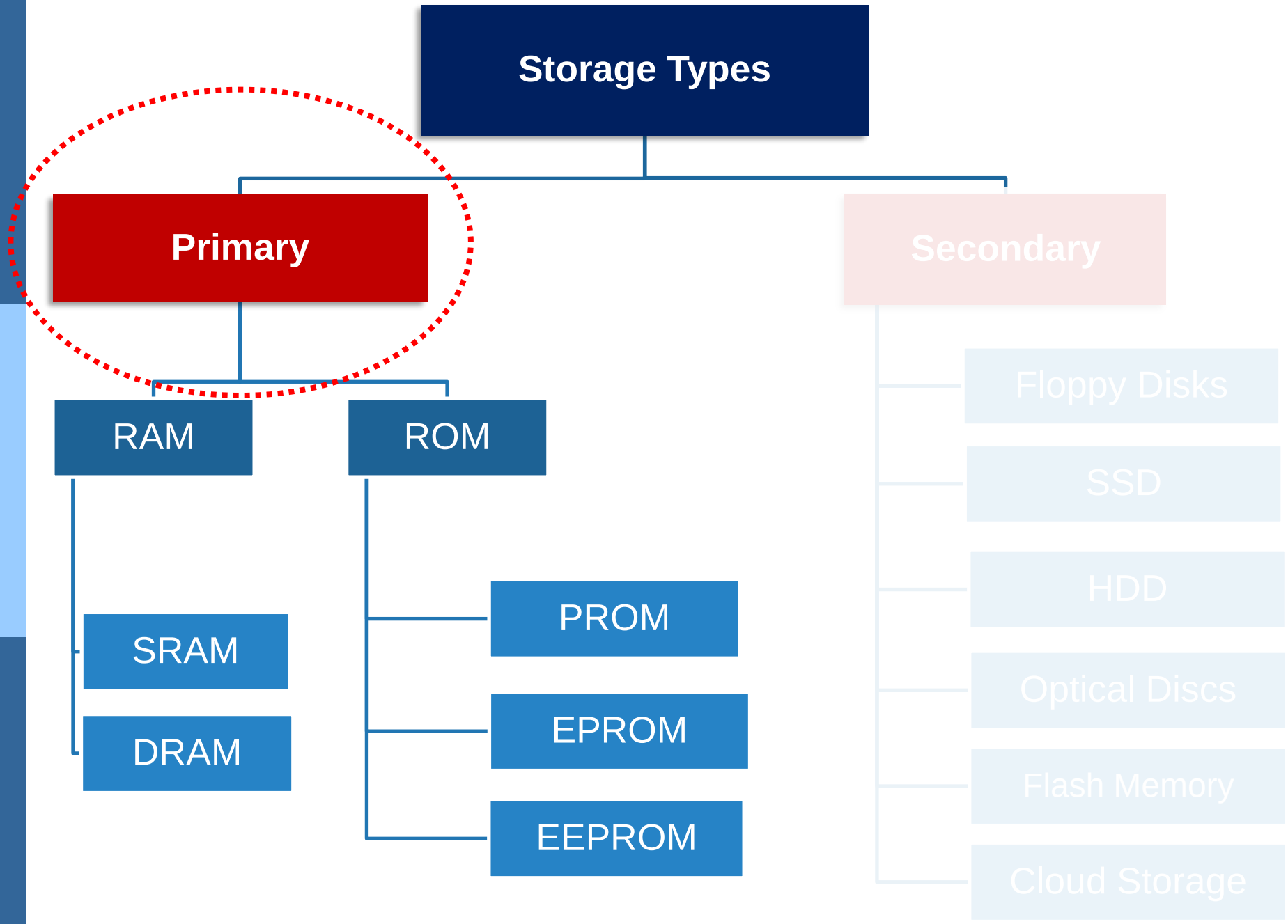
Storage devices

- Storage devices are the computer hardware used to store data.
- The storage hold data either temporarily or permanently.
- Provides one of the core functions of the modern computer.

Storage Types

- Computer storage is of two types:
  - **Primary Storage Devices**
  - **Secondary Storage Devices**


Storage Types
Primary
Secondary
RAM
ROM
SRAM
DRAM
PROM
EPROM
EEPROM
Floppy Disks
SSD
HDD
Optical Discs
Flash Memory
Cloud Storage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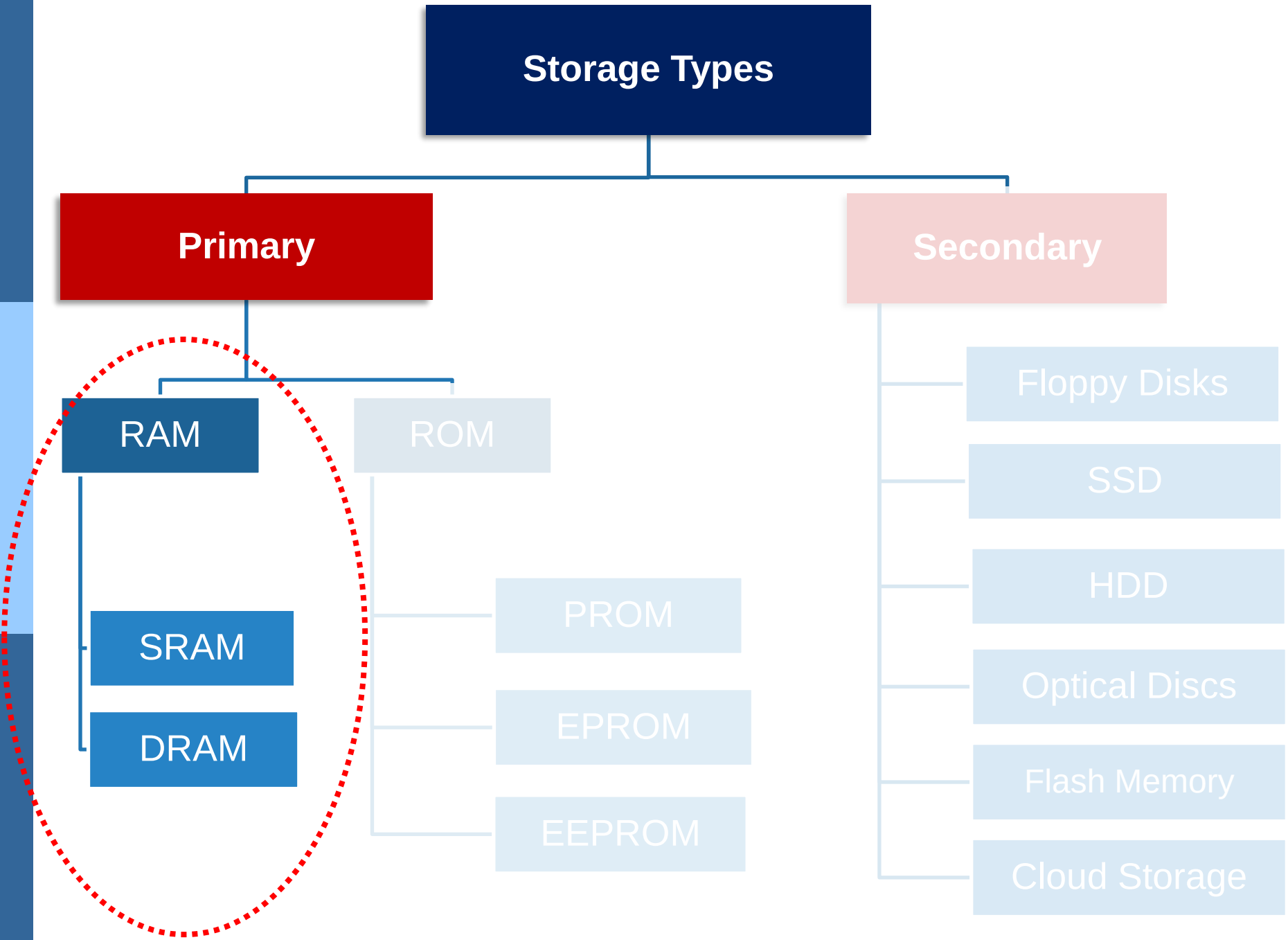
Primary Storage Devices

- It is also known as:
  - "**Internal Memory**" or "**Main Memory**"
- It stores and data, instructions, and information.
- Primary storage devices are located on the motherboard of the computer.
- It is the fastest memory available
- Primary Memory is directly accessed by the processor using data bus.
- It is generally smaller in size.
- **RAM** and **ROM** are examples of primary storage.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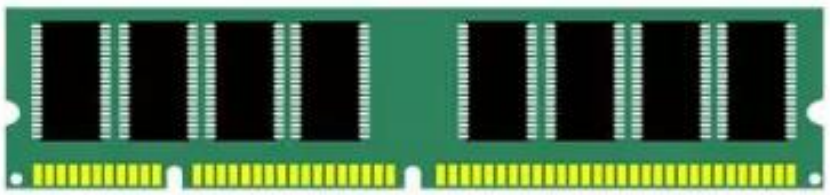
(1) RAM - Random Access Memory

RAM is used to store program/information that needs to be used quickly by CPU

- It is a read/write memory.
- Data in the RAM can be accessed randomly by CPU.
  - Access time in RAM is independent of the address, that is, each storage location inside the memory is as easy to reach as other locations and takes the same amount of time.
- RAM is **volatile**, i.e. data stored in it is lost when we switch off the computer or if there is a power failure.

Picture of SRAM Memory

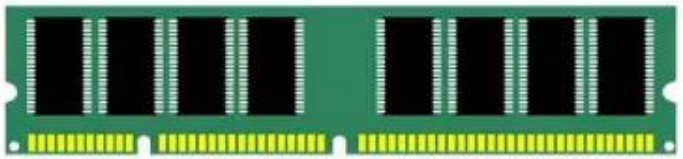


Picture of DRAM

Main Types of RAM

- Two main types of RAM are:
  - **Static RAM (SRAM)**
  - **Dynamic RAM (DRAM)**

Picture of SRAM Memory



Picture of DRAM

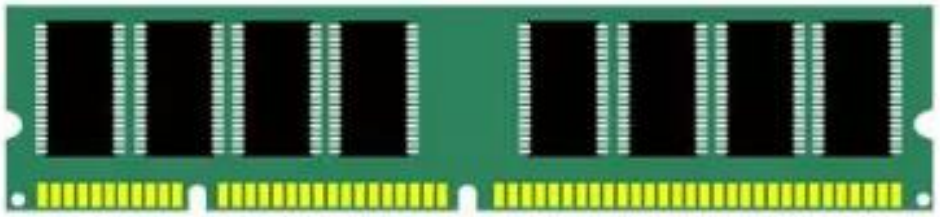
Main Types of RAM

- **Static RAM (SRAM)**
  - SRAM uses more chips than DRAM for the same amount of storage space, making the manufacturing costs higher.
  - Used as **cache** memory
  - It has very fast access.
  - It is volatile

Picture of SRAM Memory

Main Types of RAM

- **Dynamic RAM (DRAM)**
  - Used as the Main RAM for PC's and Laptops.
  - DRAM has high access time, but it is slower than SRAM.
  - DRAM costs less compared to SRAM
  - Can hold more data than an SRAM chip.
  - It is volatile



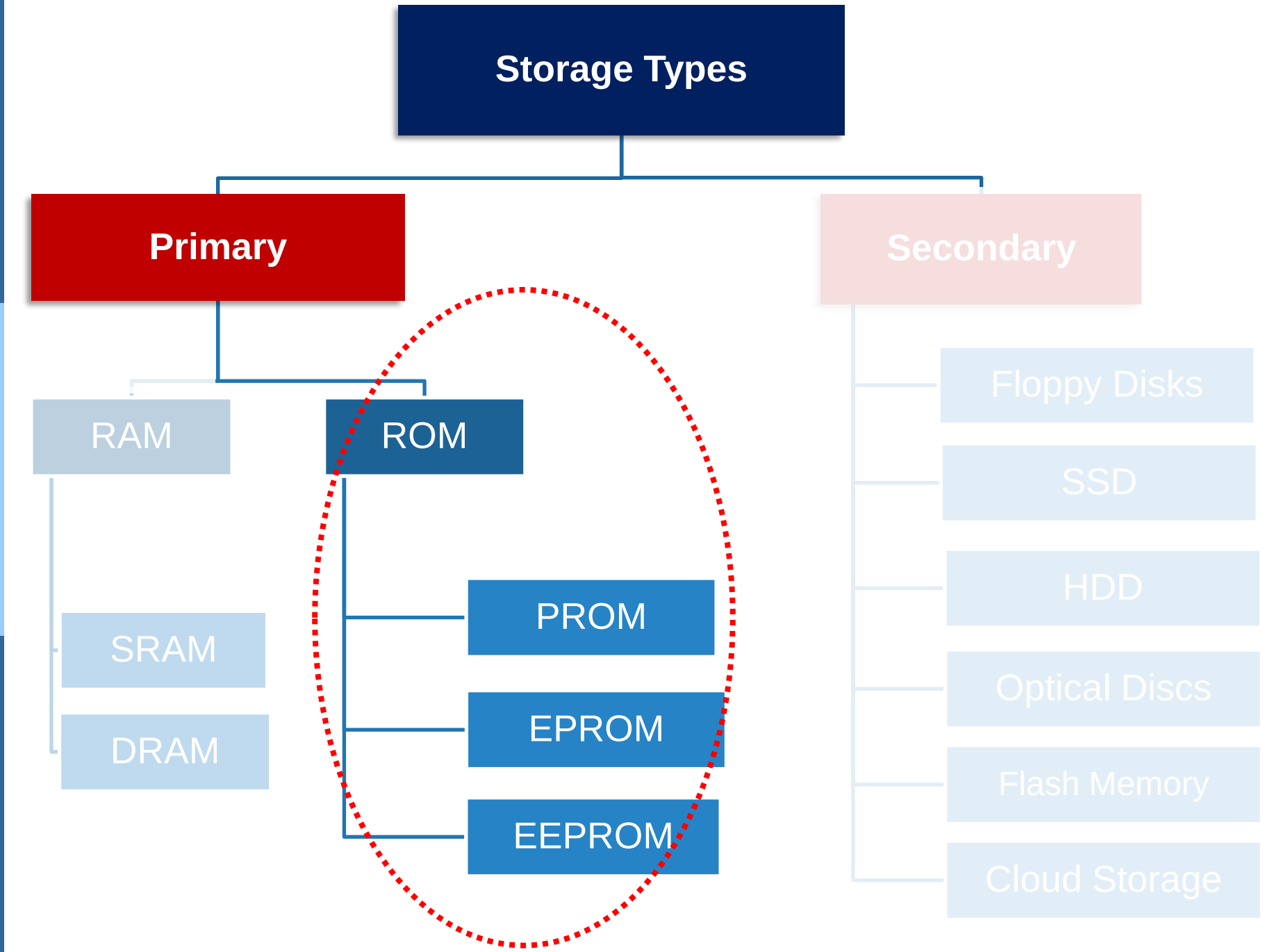
Picture of DRAM

Common Types of **DRAM**

- Today, the most common type of RAM is **DDR-SDRAM**, or Double-Data Rate Synchronous Dynamic Random-Access Memory.
- Basically, it means that they are capable of two reads and two write tasks per clock cycle.

- **Latest Types of RAM Memory**
  - There are various versions, including:
    - DDR1 (2.1 – 3.2 GB/s) **Transfer Rate (GB/s)**
    - DDR2 (4.2 – 6.4 GB/s)
    - DDR3 (8.5 – 14.9 GB/s)
    - DDR4 (17 – 25.6 GB/s)
    - DDR5 (38.4 – 51.2 GB/s)
- Any Other types of DRAM?

DDR5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(2) ROM - Read-only memory

- It stores permanent data and instructions.
  - it is **non-volatile** memory.

- Group of integrated circuits responsible for:
  - Starting computer.
  - Loading operating system.

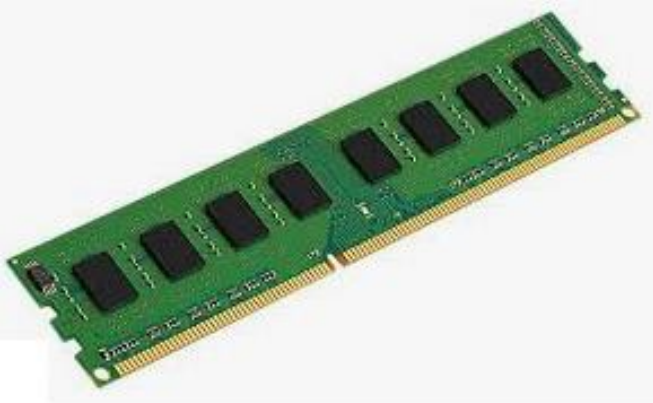
- ROM stores the instructions for the computer to start up (**boot**) when it is turned on.
- The Small program in ROM is called **firmware** (ex: a BIOS chip).

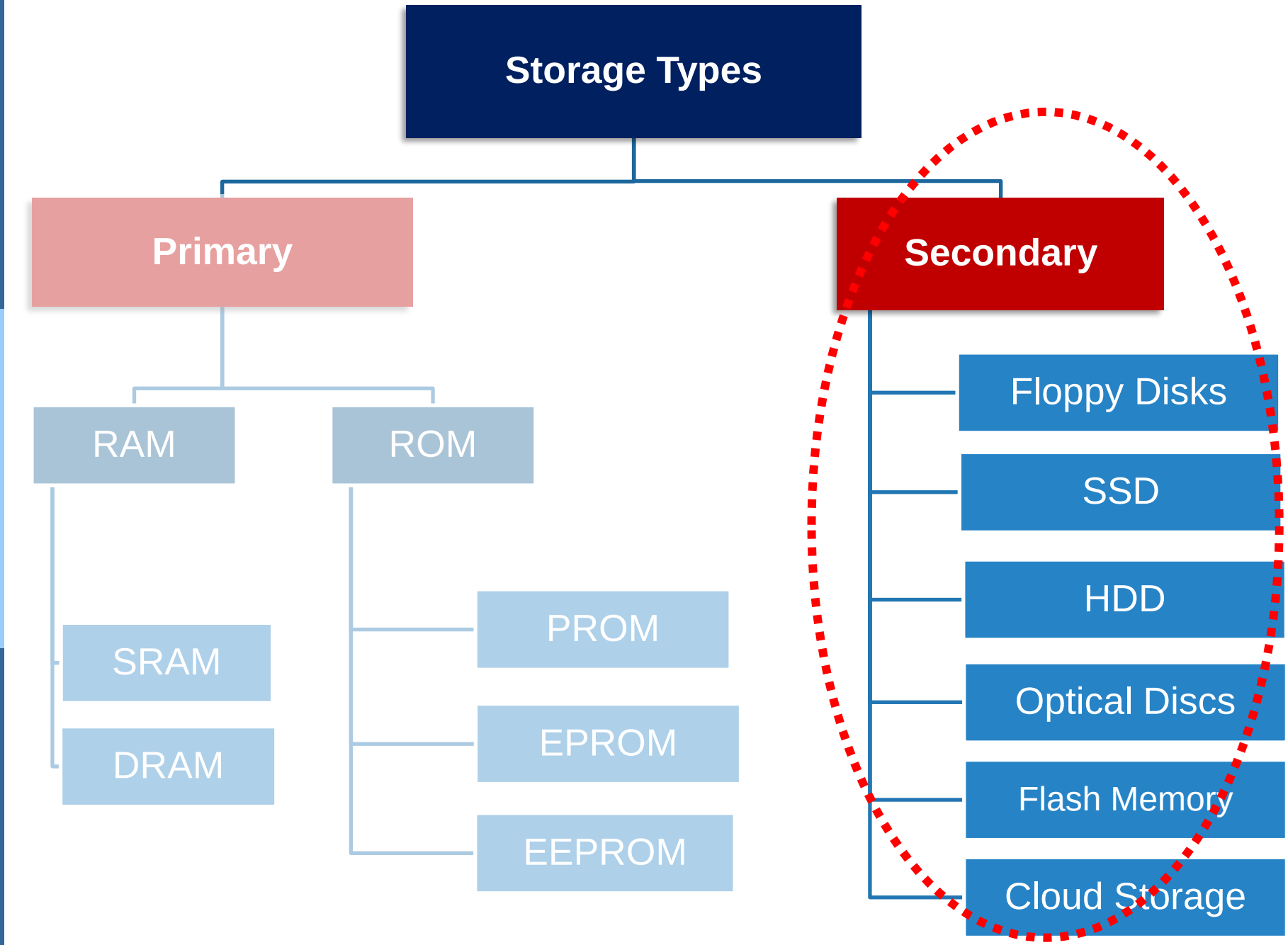
Types of ROM

- There are various types of ROM memory:
  - **PROM**: Programmable Read Only Memory.
  - **EPROM**: Erasable Programmable Read Only Memory.
  - **EEPROM**: Electrically Erasable Programmable Read Only Memory.

Difference between RAM and ROM

RAM	ROM
1. Temporary Storage.	1. Permanent storage.
2. Store data in GBs.	2. Store data in MBs.
3. Volatile.	3. Non-volatile.
4.Used in normal operations.	4. Used for startup process of computer.
5. Writing data is faster.	5. Writing data is slower.

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Secondary Storage

- **Secondary storage** is **non-volatile**, long-term storage. It is used to keep programs and data indefinitely.
- Its speed is **slower** than the primary/main memory.
- It is **cheaper** as compared to primary memory.
- It can store **large** collections of different types, such as audio, video, pictures, text, software, etc.
- Most widely used secondary storage devices are: hard disks, CDs, DVDs and pen drives… etc.

Secondary Storage: Floppy Disks

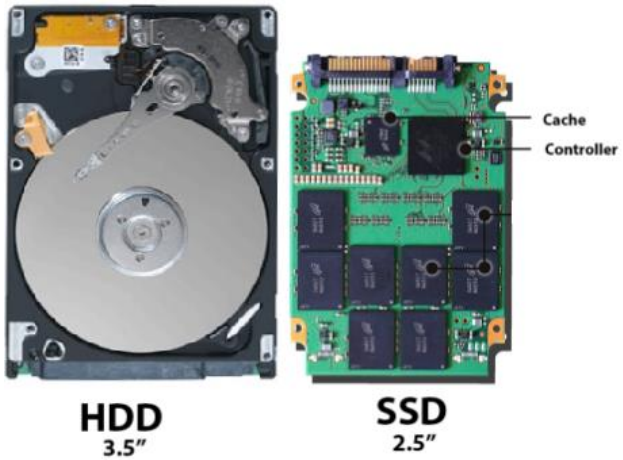
- Floppy Disks is a circular plastic disk with a magnetically sensitive film.
- Floppy disks are design to work with floppy disk drives.
- Floppy size is 1.4MB,
- new floppies size is 2.88MB

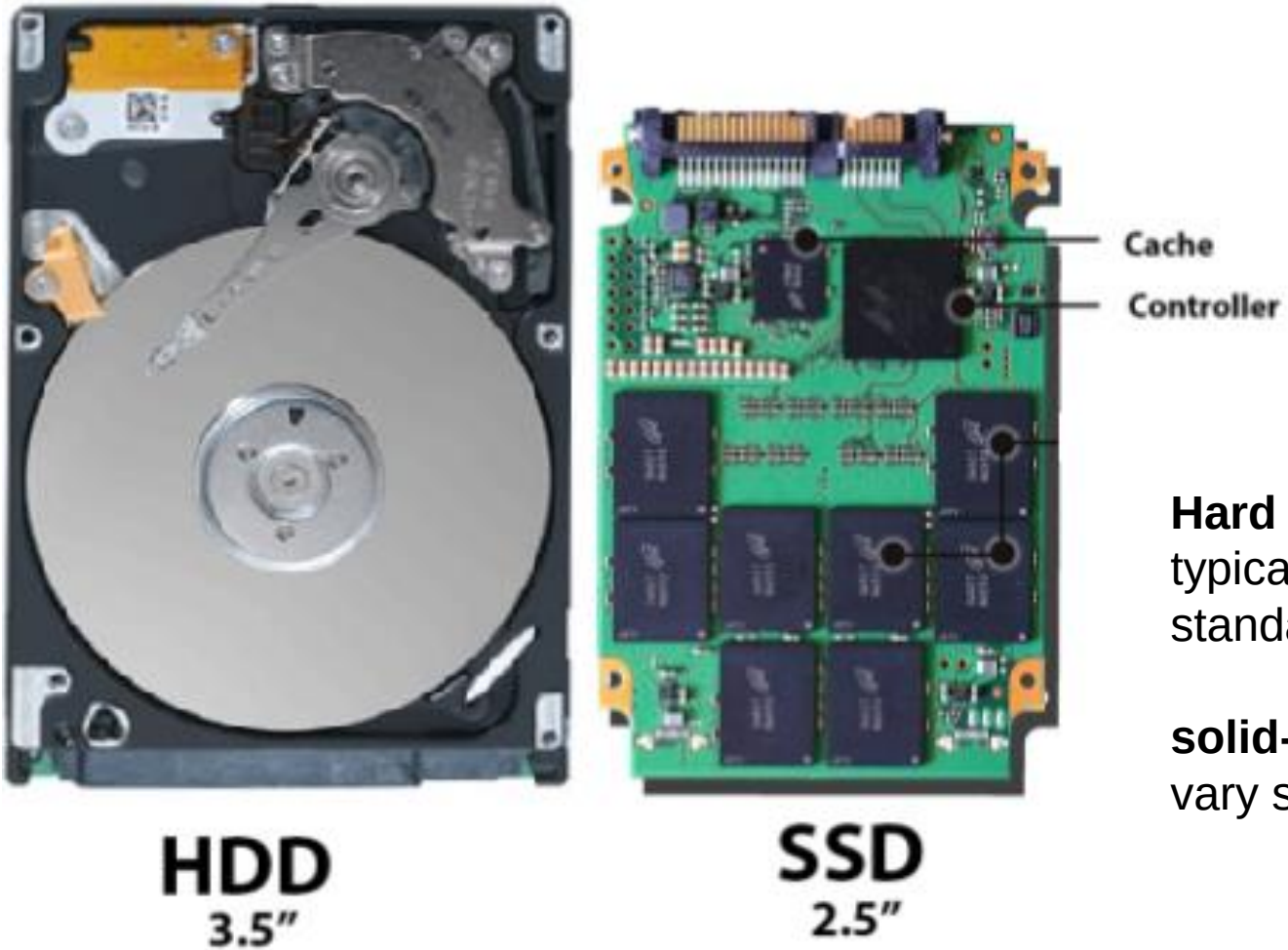
floppy disk drive

floppy disk

Secondary Storage: Hard Drives

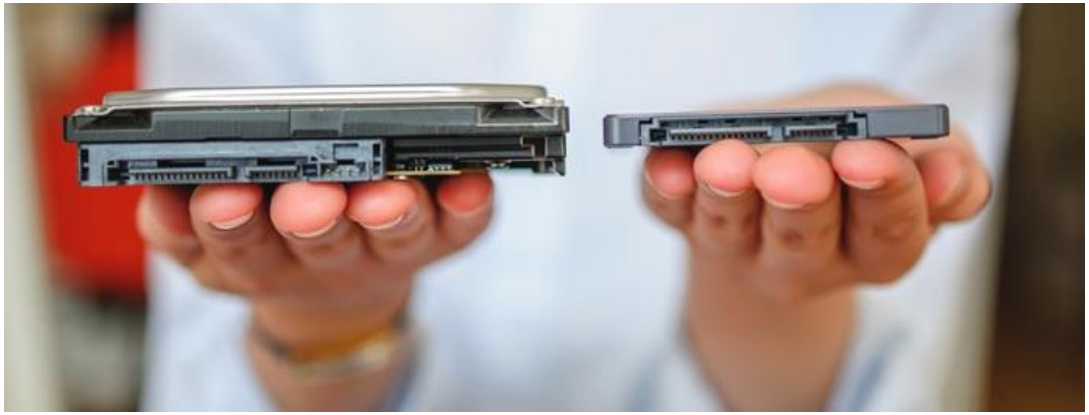
- There are two general **types of hard drives**:
  1) **Hard Disk Drives** (**HDD**), which use one or more rotating discs and rely on magnetic storage
  2) **Solid-State Drives** (**SSD**), which have no moving mechanical parts, but use memory **chips**.





Hard disk drives (left) typically come in standard sizes.

solid-state drives can vary slightly.

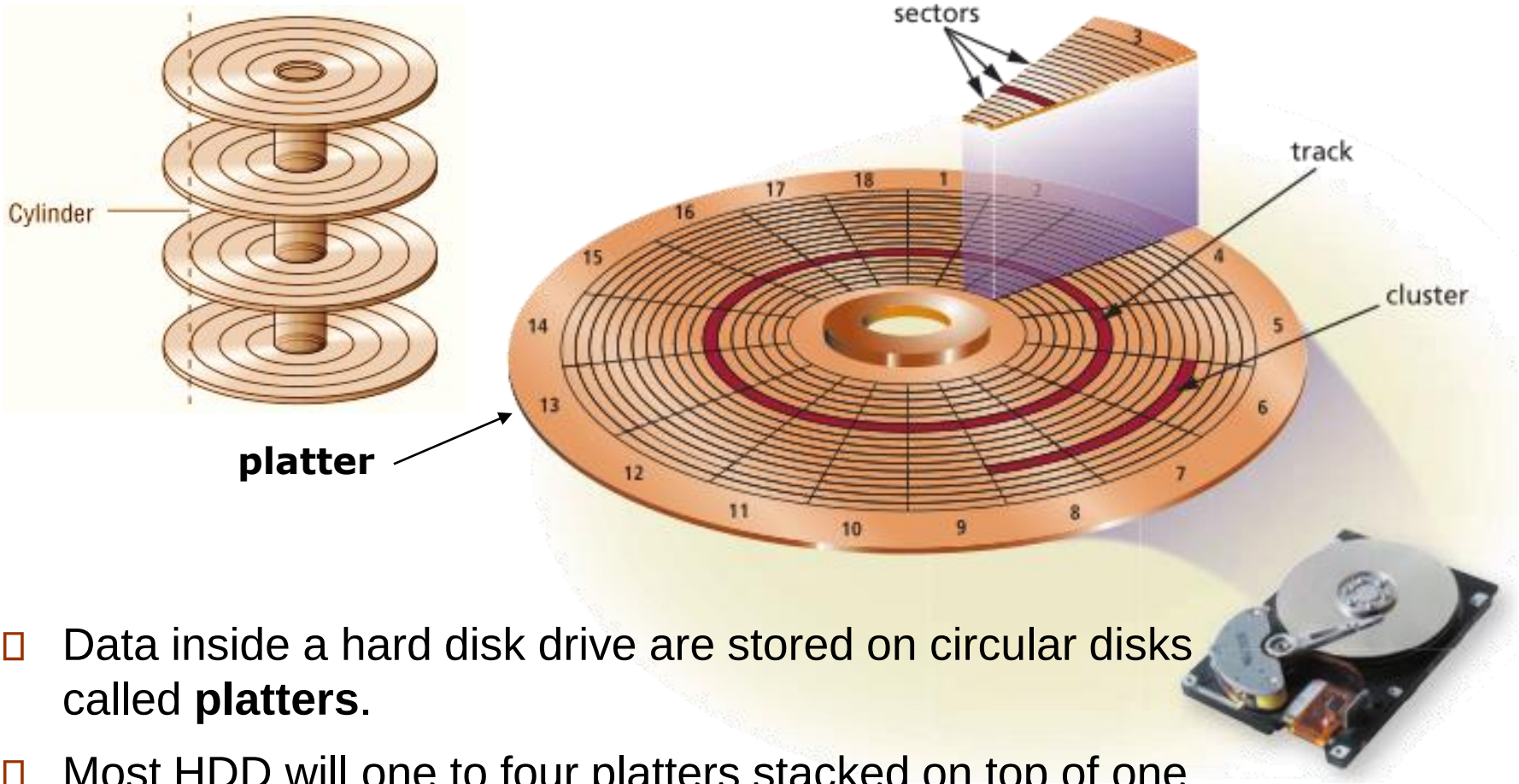


(1) Hard Disk Drives (HDD)

- Magnetic hard drives
- A hard disk is a storage device that contains one or more inflexible, **circular platters** that use **magnetic** particles to store data.
- Hard disks are read/write storage media.

- On desktop computers, platters most often have a size of approximately 3.5 inches in diameter.
- On notebook computers, mobile devices, and some servers, the diameter is 2.5 inches or less.

(1) Hard Disk Drives (HDD)



- Data inside a hard disk drive are stored on circular disks called **platters**.
- Most HDD will one to four platters stacked on top of one another.
- Magnetic disks store data and instructions in tracks and sectors .

(1) Hard Disk Drives - Speed

Speed:

- In HHD, **RPM Revolutions Per Minute**, measures how many revolutions a computer's hard drive platter makes in a single minute.

RPM	Random Performance
5,400 RPM	75 MB/s
7,200 RPM	100 MB/s
10,000 RPM	140 MB/s

Sizes:

- On desktop computers, platters most often have a size of approximately 3.5 inches in diameter.
- On notebook computers, mobile devices, and some servers, the diameter is 2.5 inches or less.

(2) SSD (Solid-State Drive)

- An SSD (solid-state drive) is a **flash memory** storage device.
- SSD are available in a variety of form factors including 3.5 inches, 2.5 inches, and 1.8 inches, .. etc
- SSDs are used in all types of computers, including servers, desktops, laptops, tablets, and a variety of mobile devices, such as portable media players and cameras.

Data is stored in flash memory chips located inside the drive

SSDs (Solid-State Drive)

- SSDs have several advantages over traditional HDD, including the following:
  - Faster access times (can be more than 100 times faster)
  - Less power consumption (leads to longer battery life)
  - Less heat generation

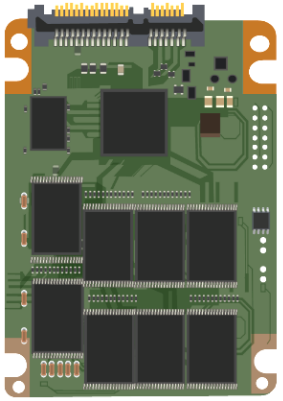
SSDs (solid-state drive)

- Why do SSDs have faster access times than hard disks?
- Access time on a hard disk depends on the location of the data. That is, the data on the platter near the read/write head is accessed faster. The data on an SSD, by contrast, can be accessed almost instantly wherever it is located because the drive contains no moving parts.

Types of SSDs

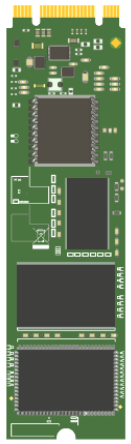
- Types of SSDs (Solid State Drives) and communication interfaces

1) **SATA SSD (SATA I, II, III)**
   - SATA 1.0: 150 MB/s **(Transfer Speed)**
   - SATA 2.0: 300 MB/s
   - SATA 3.0: 600 MB/s



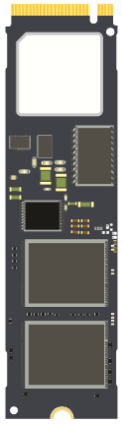
SATA SSD

2) **SATA M.2**
   - M.2, formerly known as the Next Generation Form Factor (NGFF)



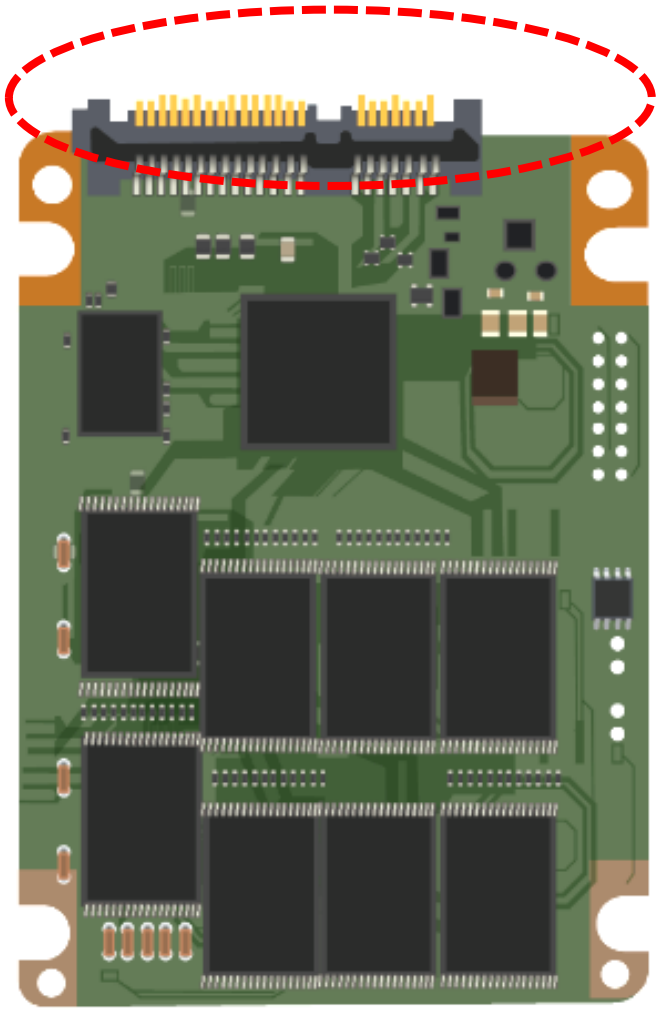
M.2

3) **M.2 NVMe**
   - **N**on-**V**olatile **M**emory **E**xpress (**NVMe**) drives
   - Introduced in 2013
   - It attached to the PCI Express (PCIe) slot on a motherboard OR using SATA bandwidth

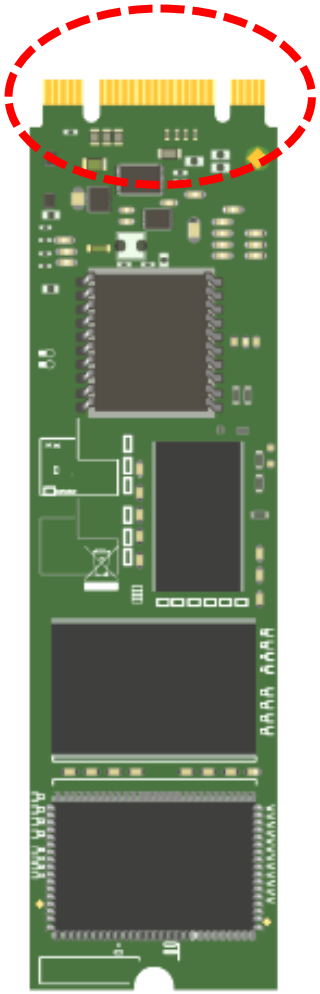


M.2 NVMe

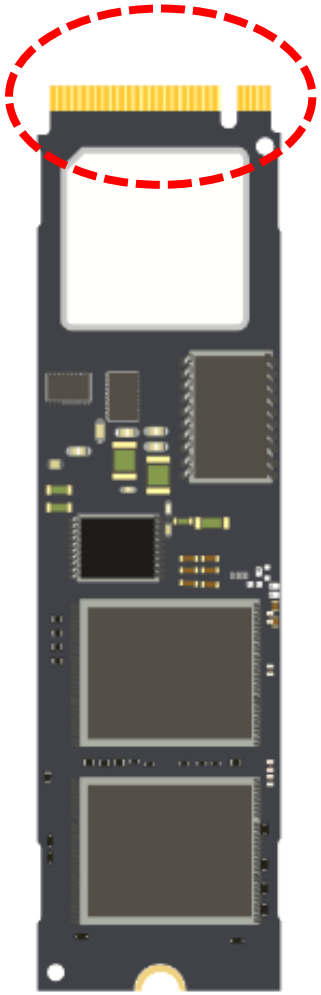
SSD



SATA SSD



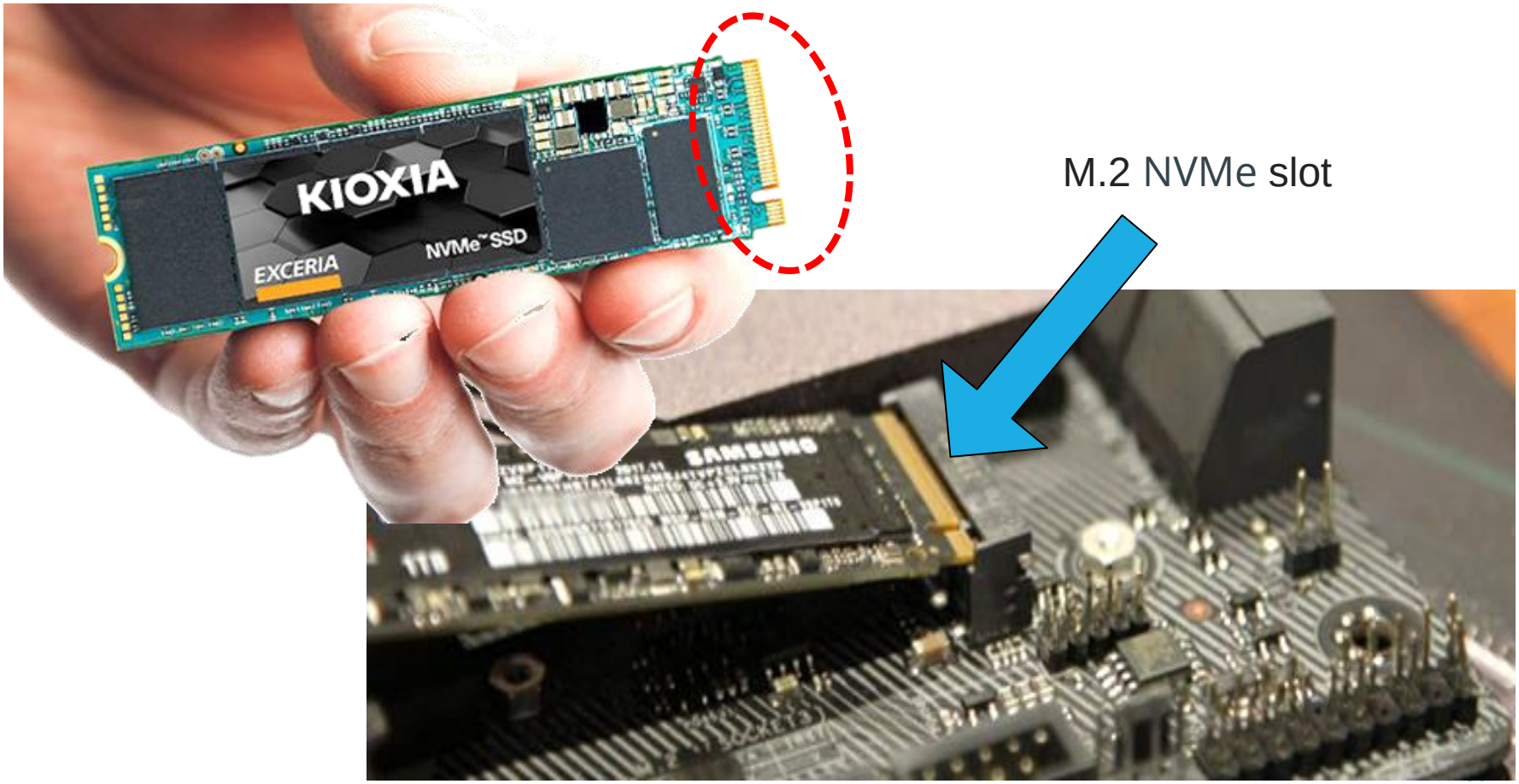
M.2



M.2 NVMe

M.2 NVMe SSD

- ✓ **N**on-**V**olatile **M**emory **E**xpress (**NVMe**) drives
- ✓ Introduced in 2013
- ✓ It attached to the PCI Express (PCIe) slot on a motherboard instead of using SATA bandwidth



SSD vs. HDD Speed

Speed Statistic	**HDD** (Hard Disk Drive)	**SATA SSD** (Solid State Drive)	**NVMe** (Nonvolatile Memory Express)
Read Speed	80 MB/s	200MB/s	5000 to 7300 MB/s
Write Speed	160 MB/s	550 MB/s	5000 to 6350 MB/s

External Hard Drives

- An **external hard** drive is a separate freestanding storage device that connects with a cable to a **USB** port or other port on a computer or mobile device.

- Both hard disks and SSDs are available as external hard drives.

Optical Discs

- An optical disc is a type of storage medium that consists of a flat, round, portable disc made of metal, and plastic that is written and read by a **laser**.
- Three widely used types of optical discs are:
  - **CDs**
  - **DVDs**
  - **Blu-ray Discs**.

Optical Discs

- **CD** (**C**ompact **D**isc)
  - **CD-ROM** (stands for **C**ompact **D**isc **R**ead-**O**nly **M**emory)
    - The manufacturer recorded the data on these CDs, it can't be erased or changed.
  - **CD-R (Compact Disk - Recordable):** The user can write data once on the CD-R. It cannot be deleted or modified later.
  - **CD-RW** (CD-ReWritable)

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- **DVD** (**D**igital **V**ersatile **D**isc) or (**D**igital **V**ideo **D**isc)
  - larger storage capacity than that of CDs.
  - DVDs are available in three basic formats:
    - **DVD-R**
    - **DVD-RW**
    - **DVD-ROM**

Optical Discs

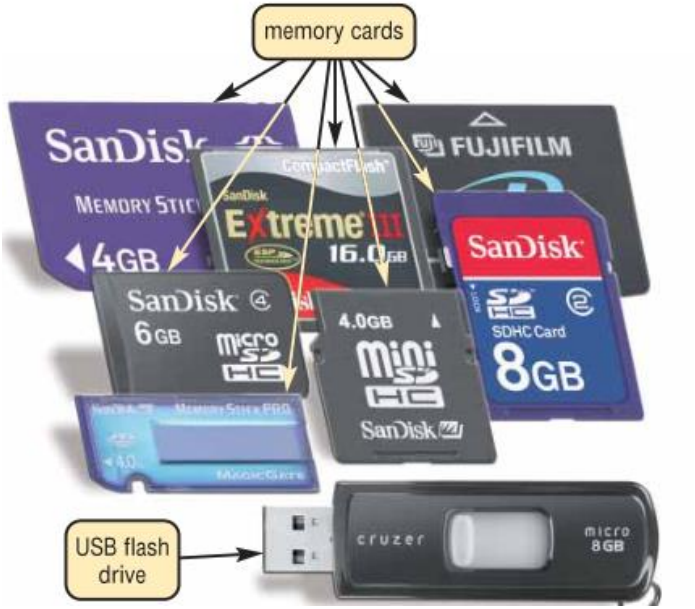
- **Blu-ray Disc** (**BD**)
  - Blu-ray recorders have been available since 2003.
  - **a very high-capacity, high-definition optical disc that stores audio and video media**.
  - has a higher capacity and better quality than standard DVDs,
  - **BD-R** for write-once.
  - **BD-RE** for rewritable media.

Optical Discs capacities

Optical Discs	CD	DVD	Blu-Ray
Capacity	**650MB** to **900 MB**	**4.7GB** to **17GB**	**25GB** to **128GB**

Removable Flash Memory

- Removable flash memory includes these devices: memory cards, USB flash drives, and PC Cards/Express Card modules.
- **SD Card** (Secure Digital Card) is a removable flash memory device, usually no bigger than 1.5" in height or width
  - It is available in different sizes like 2GB, 4GB, 8GB, etc
- A **USB flash drive** is a flash memory storage device that plugs in a USB port on a computer or mobile device



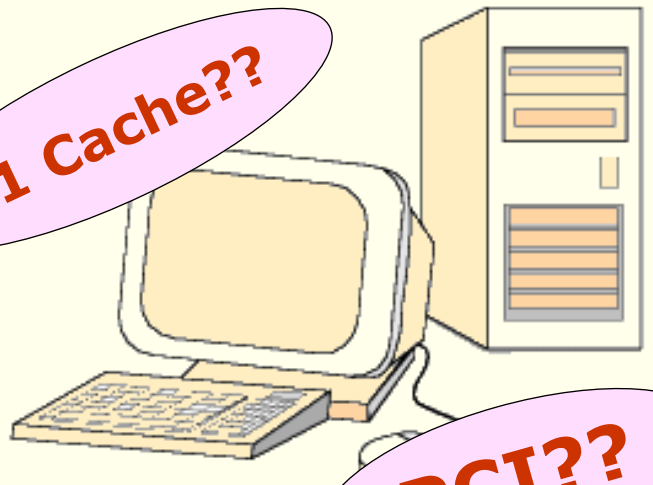
Cloud Storage

- Cloud storage means "the storage of data online in the cloud,"
- Remote storage services accessed via the Internet
- There are also sites whose primary objective is to allow users to store documents online, such as
  - Dropbox
  - Google Drive
  - Microsoft OneDrive

An Example System

Consider this advertisement:

For Sale: Obsolete Computer – Cheap! Cheap! Cheap!



- Pentium 4.20GHz
- 400MHz 256MB DDR SDRAM
- 32KB L1 cache, 256KB L2 cache
- 80GB serial ATA hard drive (7200 RPM)
- 8 USB ports, 1 serial port, 1 parallel port
- Monitor 19" .24mm AG, 1280 x 1024 at 75Hz
- 48x CD-RW drive
- 128MB PCI express video card
- 56K PCI data/fax modem
- 64-bit PCI sound card
- Integrated 10/100 Ethernet card

MHz??

L1 Cache??

MB??

PCI??

USB??

What does it all mean??

Review Questions

- Define the term, motherboard.
- What are the main components of the motherboard?
- What is main components of CPU?
- Why do we need Secondary Storage?

Review Questions

- The _____ is the main circuit board of the computer.
  a. ALU
  b. CPU
  c. motherboard
  d. system chassis
- _____ include basic calculations such as addition, subtraction, multiplication, and division.
  a. Arithmetic operations
  b. Comparison operations
  c. Machine cycles
  d. Transistors

Review Questions

- What type of drive is likely to be a 15,000 rpm drive?
  - NVMe
  - SSD
  - Blu- ray
  - Magnetic
- What type of hard drives are not available in a 3.5″ form factor?
  - SSD
  - mSATA
  - SATA
  - Magnetic