Fundamentals of Computer Engineering

Module II - Unit 6
Operating System.

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Operating Systems

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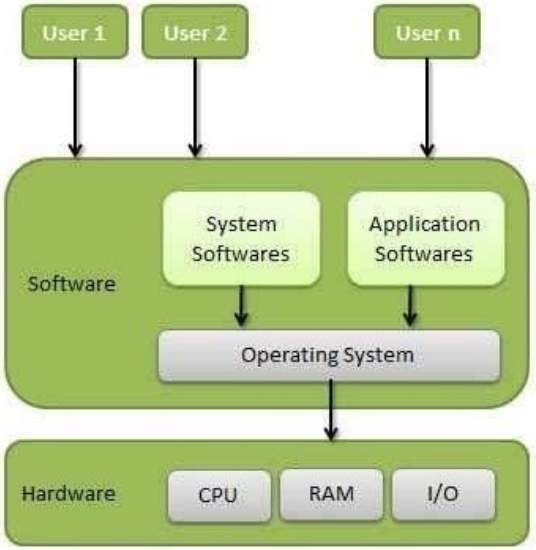
What is an Operating System?

An operating system (OS) is system software that manages computer hardware, software resources, and provides common services for computer programs. This means that is an interface between computer user and computer hardware.

- Resource Manager
  - Manage all the hardware resources.
  - Manage user requests.
- Control program
  - Controls the programs' execution.
  - Manage the life cycle of the application software.
  - Distribute the CPU time between apps.



Types of Operating Systems

Operating system (OS) can be classified using different criteria: users, tasks and processors:

- Batch: A batch OS allow one user do one thing at a time. For example, MS-DOS.
- Multiuser: A multiuser OS allows many different users to take advantage of a computer's resources simultaneously.
- Multitask: A multitask OS allows user to perform more than one computer task (such as the operation of an application program) at a time. Microsoft Windows 10, IBM's OS/390, and mostly Linux are examples of operating systems that can do multitasking (almost all of today's operating systems can).
- Multiprocessing: A multiprocessing OS is one in which two or more central processing units (CPUs) control the functions of the computer. Each CPU contains a copy of the OS, and these copies communicate with one another to coordinate operations.

Types of Operating Systems

Operating system (OS) can be classified using different criteria: users, tasks and processors:

- Distributed: A Distributed OS is a special type of OS that offer an extension of the network operating system that supports higher levels of communication and integration of the machines on the network. This means that the OS uses many processors located in different machines to provide very fast computation to its users.
- Real Time: A Real-Time OS (RTOS) is an operating system (OS) for real-time applications that processes data and events that have critically defined time constraints. These OOSS are divided in 2 groups: (1) Event-driven; and (2) Time-sharing.
- Mobile: A Mobile OS is a special OS designed to work in smartphones, tablets, and wearables devices which have some special features.

OS functions

- Process management: **Process management** helps OS to create and delete processes. It also provides mechanisms for synchronization and communication among processes.
- Memory management: **Memory management** module performs the task of allocation and de-allocation of memory space to programs in need of this resources.
- File management: It manages all the file-related activities such as organization storage, retrieval, naming, sharing, and protection of files.
- Device Management: **Device management** keeps tracks of all devices. This module also responsible for this task is known as the I/O controller.

OS functions

- I/O System Management: One of the main objects of any OS is to hide the peculiarities of that hardware devices from the user.
- Secondary-Storage Management: Systems have **several levels of storage** which includes primary storage, secondary storage, and cache storage. Instructions and data must be stored in primary storage or cache so that a running program can reference it.
- Security: Security module protects the data and information of a computer system against malware threat and authorized access.
- Command interpretation: This module is interpreting commands given by the and acting system resources to process that commands.

OS functions

- Networking: A distributed system is a group of processors which do not share memory, hardware devices, or a clock. The processors communicate with one another through the network.
- Job accounting: Keeping track of time & resource used by various job and users.
- Communication management: Coordination and assignment of compilers, interpreters, and another software resource of the various users of the computer systems.

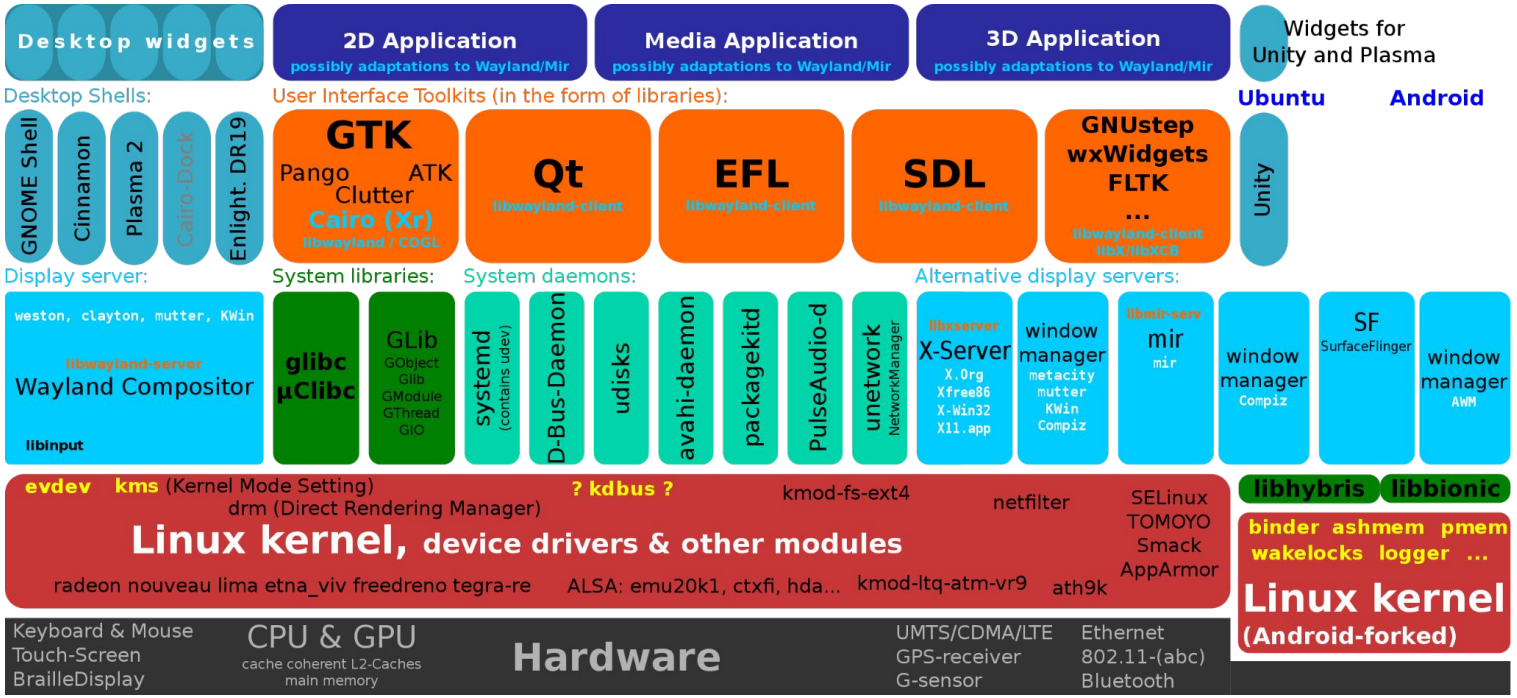
Loading an OS ...

When we start a computer, the process of initialization (more or less the same in all OS) follow the next step:

- Reading: Main code is read from non-volatile storage (ROM). This code detects the boot device and reads (from the boot sector) the code to detect the location (position in the memory) of the OS.
- Loading: The OS kernel is loaded into the computer.
- Starting: The OS take control by starting all services of the system (programs or system daemons) and booting the user interaction interface.

Loading an OS ..... OS is loaded.

A **daemon** is a computer program that runs as a background process, rather than being under the direct control of an interactive user. n a Unix environment, the parent process of a daemon is often, but not always, the init process.



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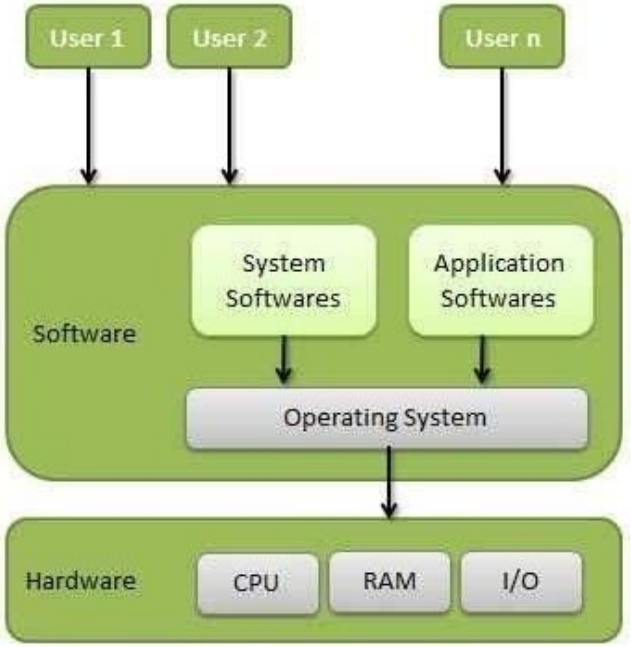
Main Operations

Main operations in a OS.

An operating system (OS) basically performs four main operations:

- Process management.
- Memory management.
- Management of input/output operations on devices.
- Disk storage management.



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Process Management

Process Management

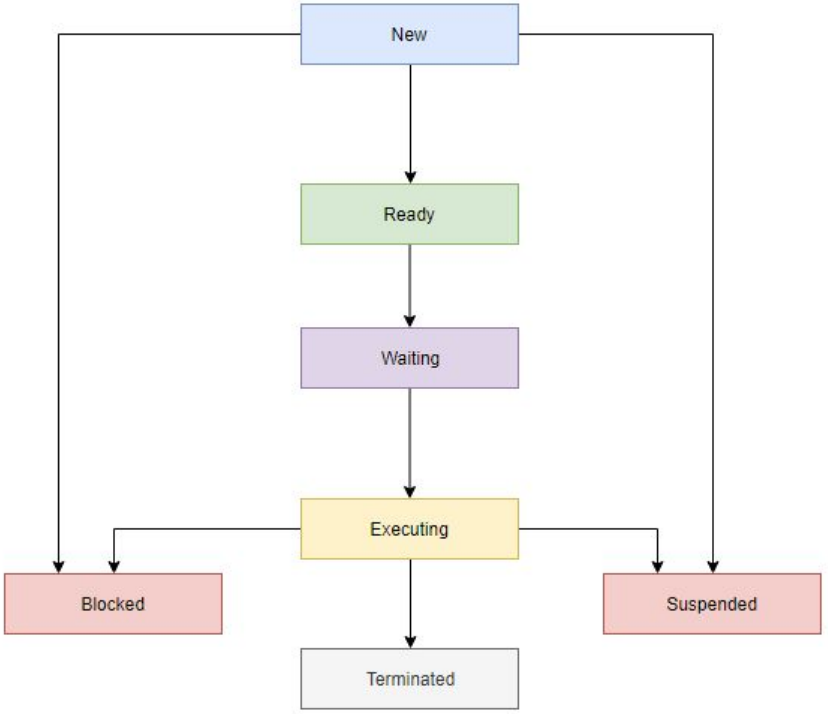
Process management involves various tasks like creation, scheduling, termination of processes, and a dead-lock. Process management allows to “execute multiple process at the same time” (imagine a computer where you cannot open two programs at the same time).

Process is a program that is under execution.

The OS must allocate resources that enable processes to share and exchange information. It also protects the resources of each process from other methods and allows synchronization among processes.

Process Management

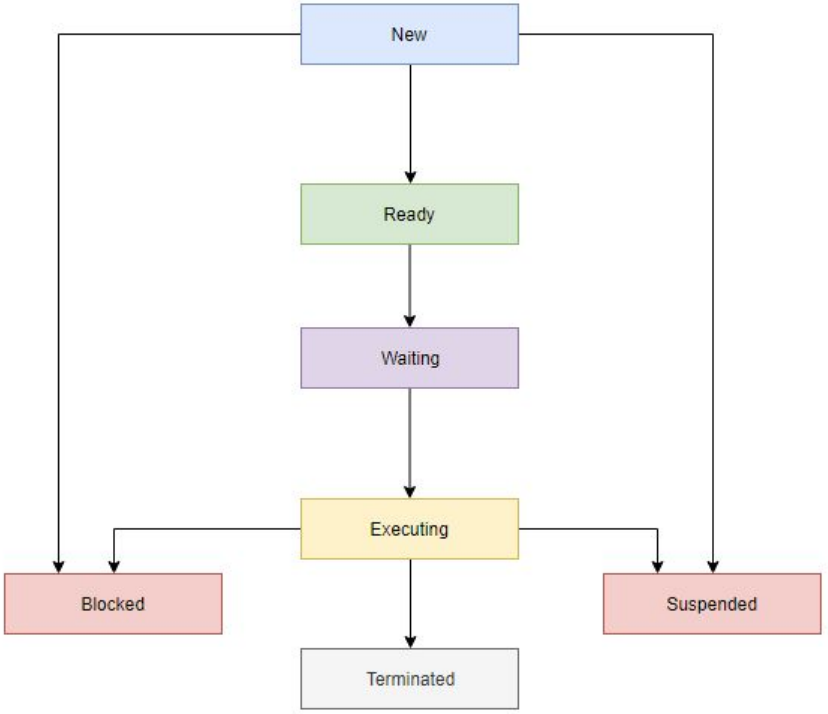
- New: The new process is created when a specific program calls from secondary memory/ hard disk to primary memory/ RAM a
- Ready: In a ready state, the process should be loaded into the primary memory, which is ready for execution.
- Waiting: The process is waiting for the allocation of CPU time and other resources for execution.



After completing every step, all the resources are used by a process, and memory becomes free.

Process Management

- Executing: The process is an execution state.
- Blocked: It is a time interval when a process is waiting for an event like I/O operations to complete.
- Suspended: Suspended state defines the time when a process is ready for execution but has not been placed in the ready queue by OS.
- Terminated: Terminated state specifies the time when a process is terminated



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Process Management

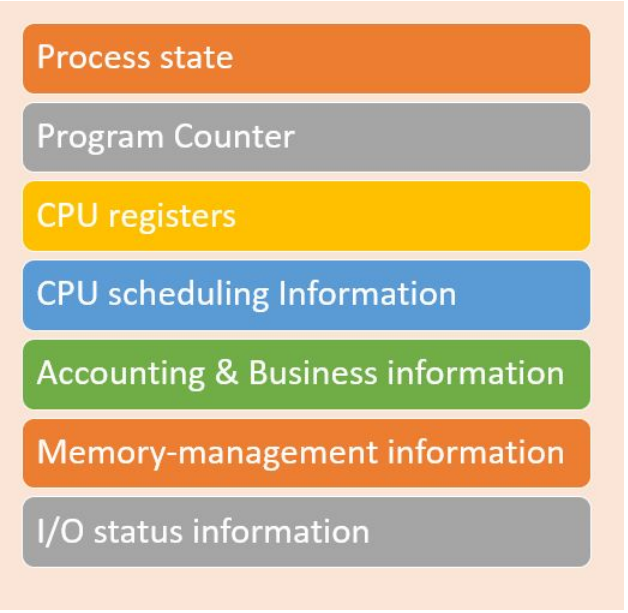
Processes are represented in the operating system by a process control block, which is also called a task control block.

- Process state: A process can be new, ready, running, waiting, etc.
- Program counter: The program counter lets you know the address of the next instruction, which should be executed for that process.
- CPU registers: This component includes accumulators, index and general-purpose registers, and information of condition code.

Process Management

Processes are represented in the operating system by a process control block, which is also called a task control block.

- CPU scheduling information: This component includes a process priority, pointers for scheduling queues, and various other scheduling parameters.
- Accounting and business information: It includes the amount of CPU and time utilities like real time used, job or process numbers, etc.



Process Management

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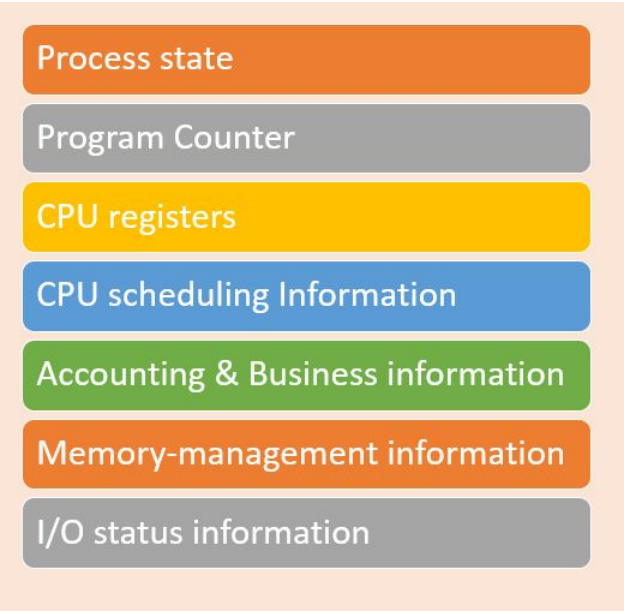
- Memory-management information: This information includes the value of the base and limit registers, the page, or segment tables. This depends on the memory system, which is used by the operating system.
- I/O status information: This block includes a list of open files, the list of I/O devices that are allocated to the process, etc.



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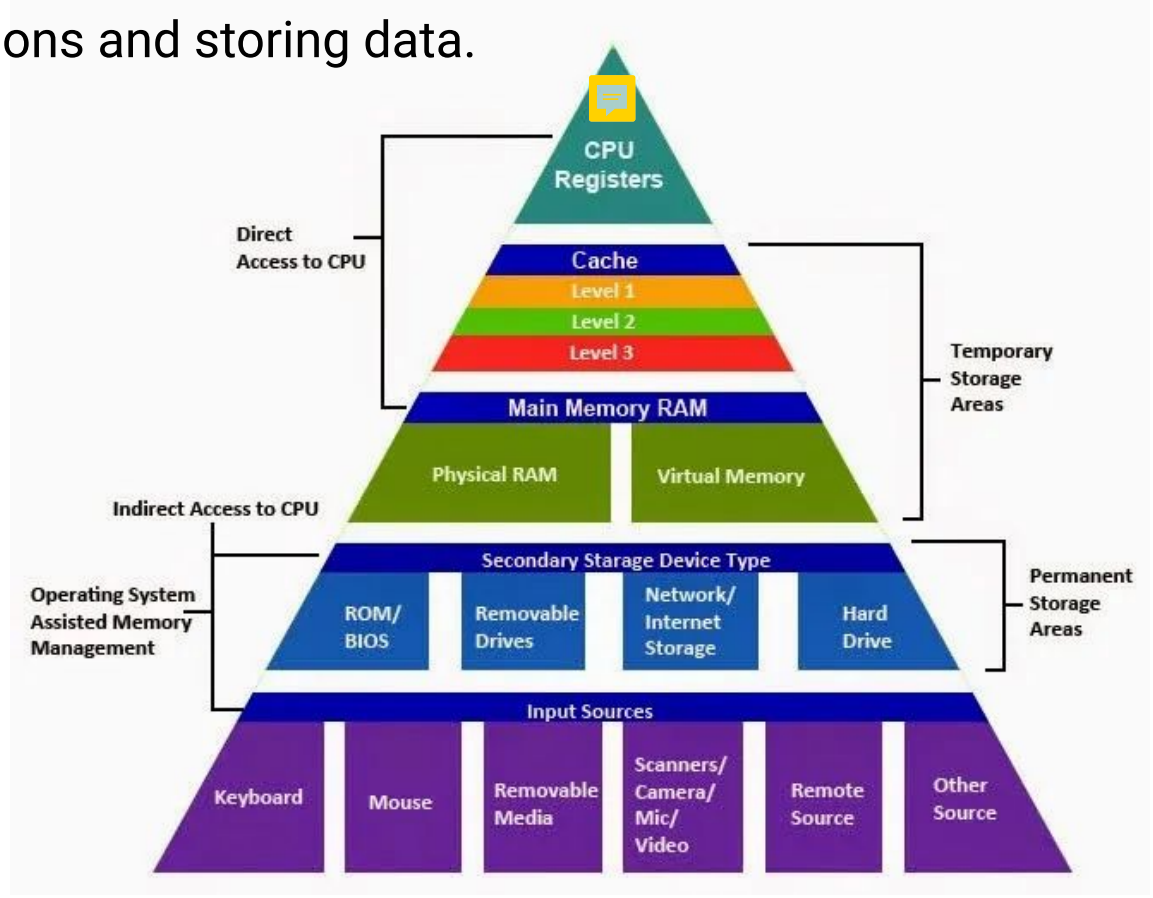
Memory Management

Memory Management

Memory management uses an address space that is the set of virtual addresses available for executing instructions and storing data.



Memory Management

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- Programs are stored on a disk as a binary executable file.
- The program must be brought into memory and placed within a process for it to be executed. Depending on the memory management in use, the process may be moved between disk and memory during its execution.
- The sequence of processes on the disk that is waiting to be brought into memory for execution forms the input queue.

We do not have enough memory to have all program in primary memory.

Memory Management

Memory management uses an address space that is the set of virtual addresses available for executing instructions and storing data. The most common form of memory management is to create **Virtual Memory** using the mass storage devices.

Virtual memory uses both hardware and software to enable a computer to compensate for physical memory shortages, temporarily transferring data from random access memory (RAM) to disk storage. Mapping chunks (blocks) of memory to disk files enables a computer to treat secondary memory as though it were main memory.

Memory Management

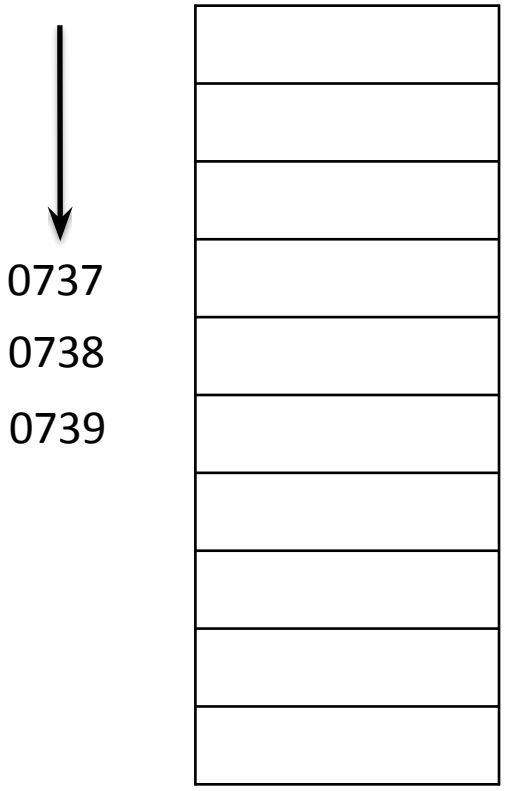
The memory addresses identify a location in the memory where the actual code resides in the system in the operating system. There are two types of addresses used for memory in the operating system:

- Logical address: A logical address is an address that is generated by the CPU during program execution. The logical address is a virtual address as it does not exist physically, and therefore, it is also known as a **Virtual Address**.
- Physical address: A physical address is a real address that identifies the physical location of required data in memory. The user programs generate logical addresses and thinks it is running in it, but the program needs physical memory for its execution.

Memory Management

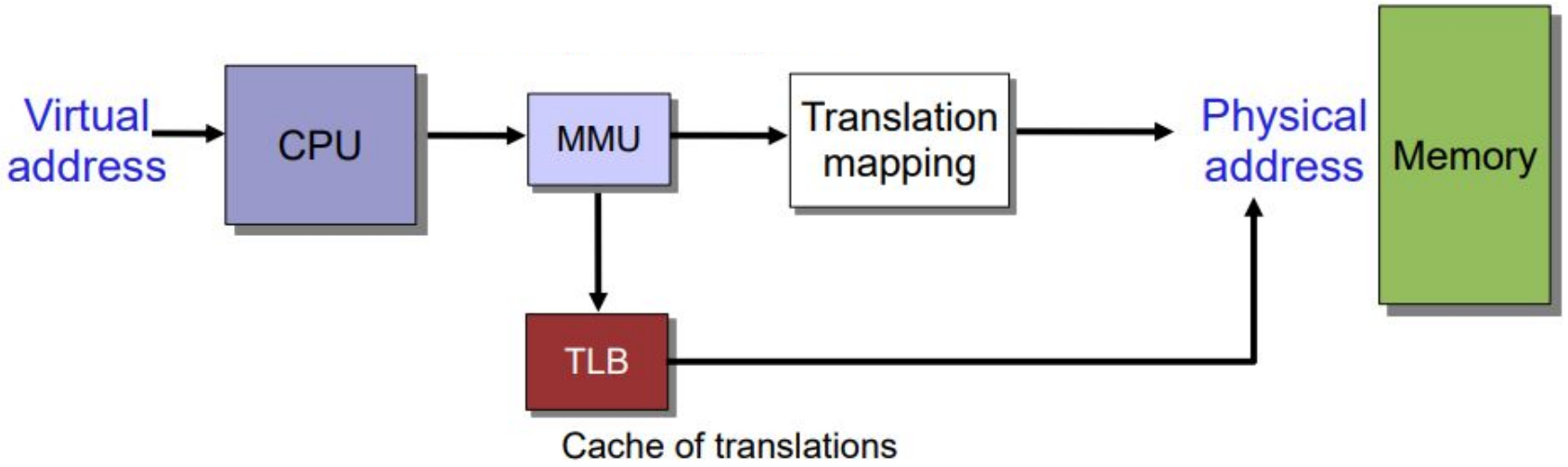
- Virtual memory extends main memory (RAM) for process execution without adding more physical memory in the computer..
- Memory extension is achieved by using the hard disk (or secondary or mass storage system) as an extension of RAM memory.

RAM is a sequence of cells or boxes, each of which can store one byte (8 bits) of information. Each cell is an address.



Memory Management

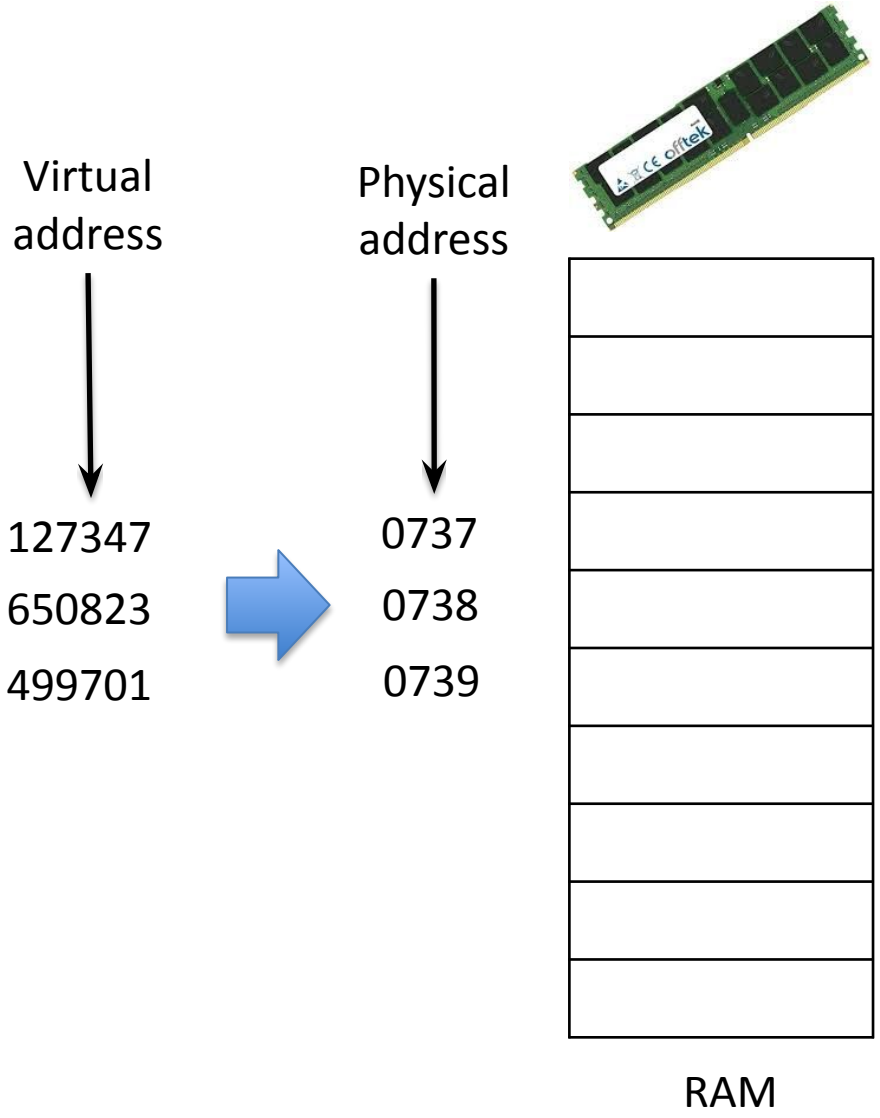
The runtime mapping from virtual to physical address is done by the memory management unit (MMU) which is a hardware device. MMU uses following mechanism to convert virtual address to physical address.



Memory Management

Processes do not use physical addresses to access memory, but logical addresses, which are translated at runtime to physical addresses.

Virtual addresses are usually larger than Physical address, giving access to a larger amount of memory than the real one.



Memory Management

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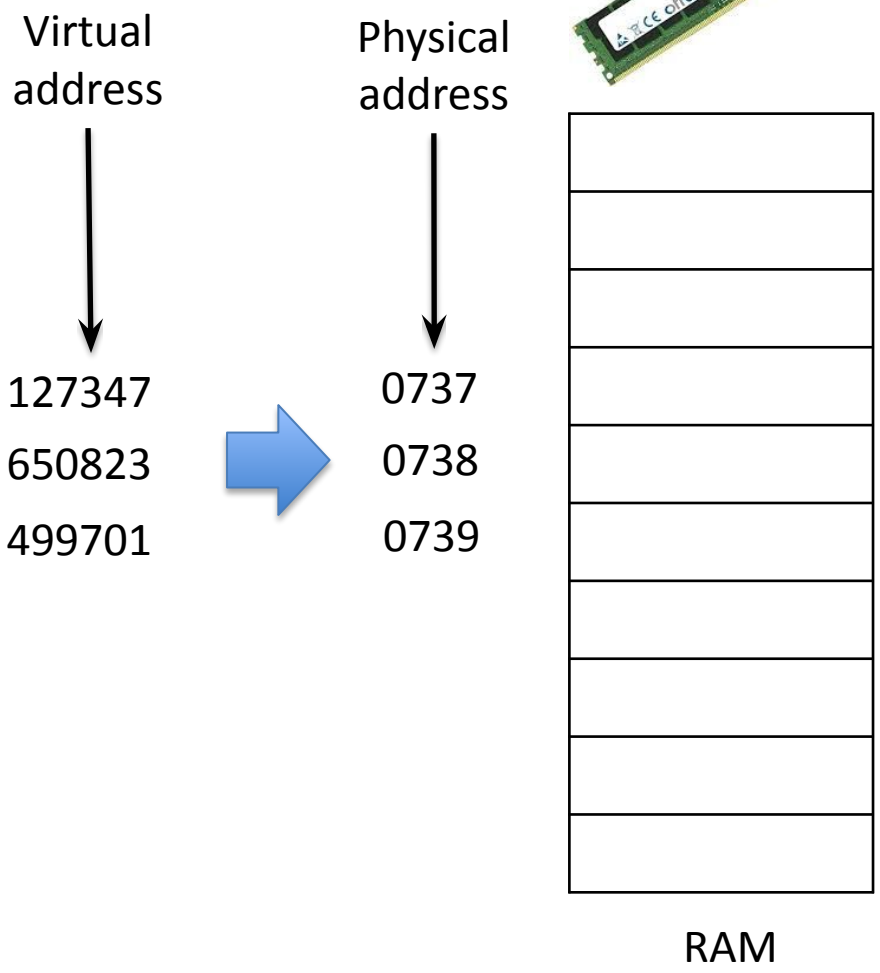
Virtual addresses **are usually larger** than Physical address, giving access to a larger amount of memory than the real one.

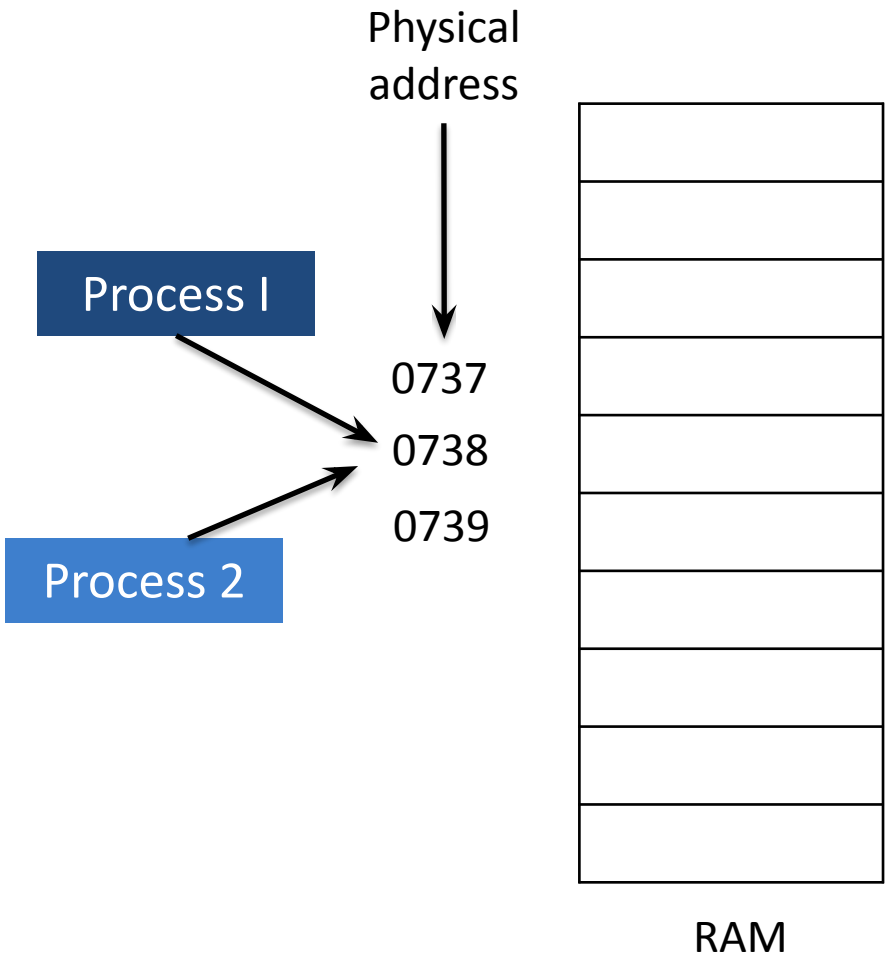
It is an extension of the memory because we need more memory.



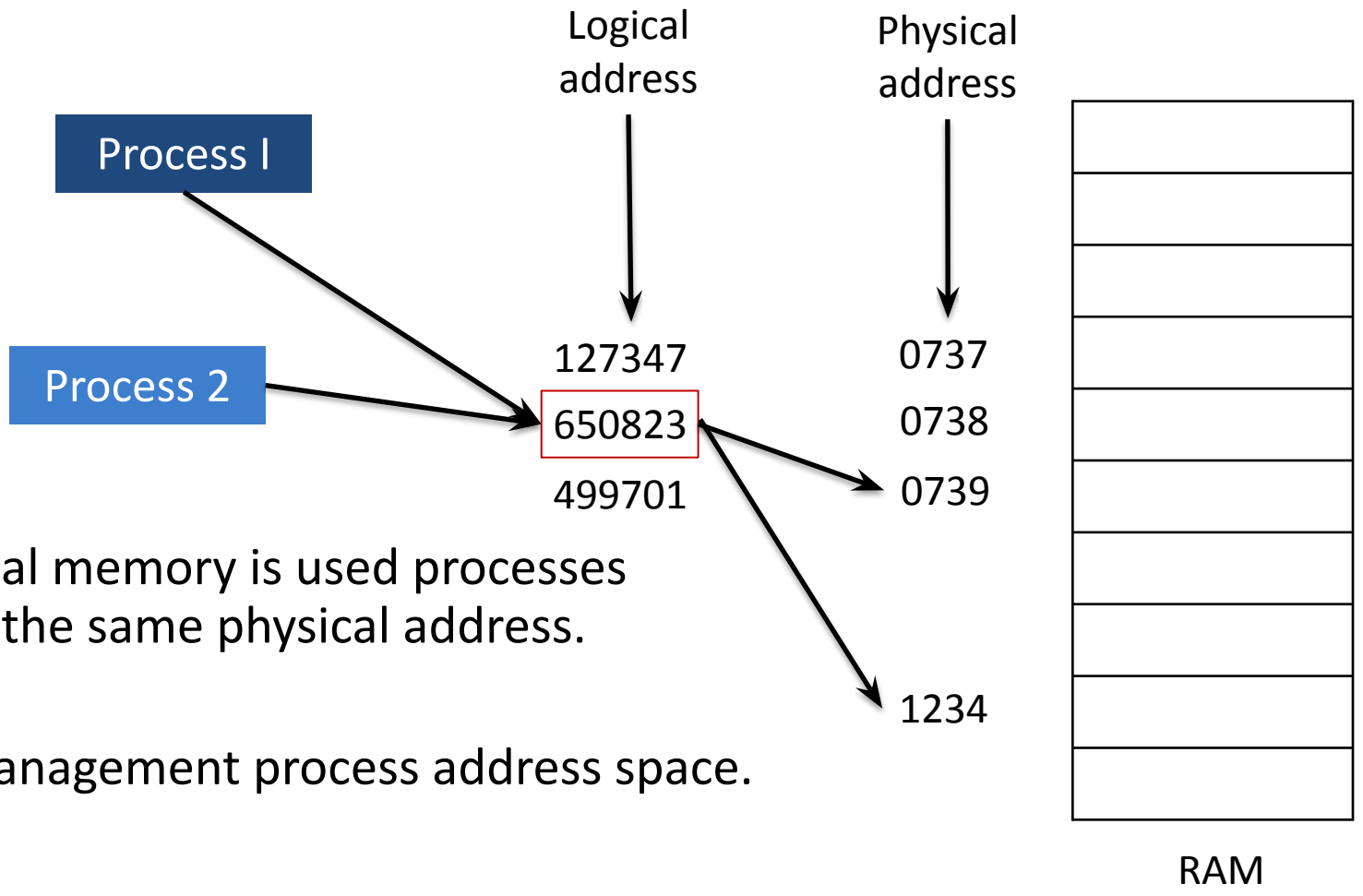
Memory Management

if a program is executed, it uses memory without being aware that it will have to share it with others. **Programs does not care about others!!**

This means that it could be a conflict between two active processes that may be using the same physical locations to store their data.



Memory Management



When Virtual memory is used processes cannot use the same physical address.

Memory management process address space.

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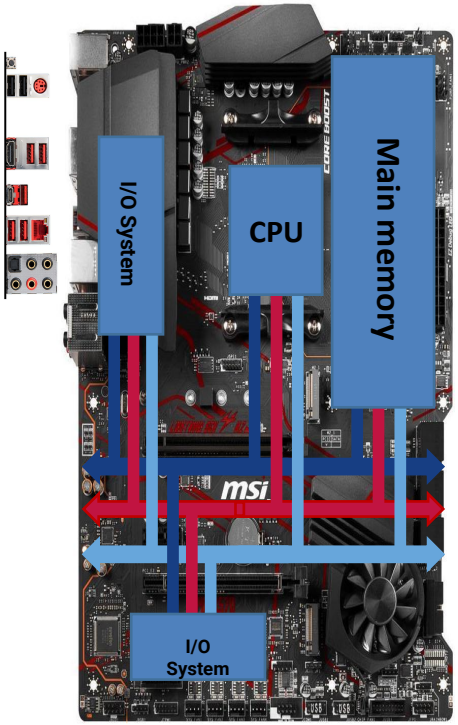
I/O Management

I/O Management

I/O Management is dedicated to managing Input/Output in order to control the access to the different devices.



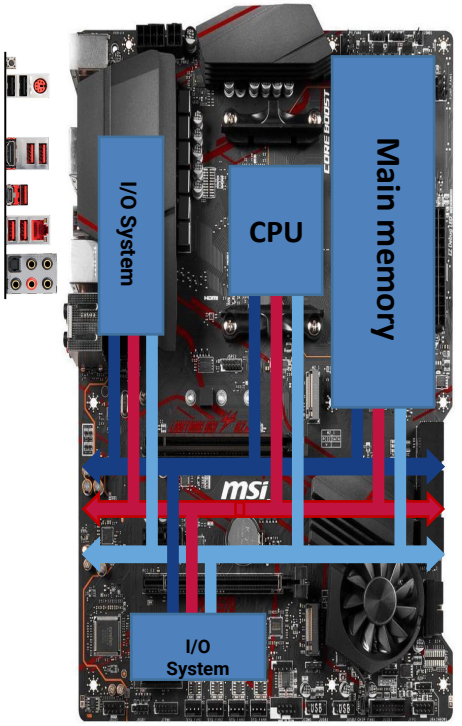
- Computers contains CPUs and more device controllers connected to a common bus channel using a device driver (System Software).

- These device drivers provide an interface to I/O devices for communicating with the system hardware promoting ease of communication providing access to shared memory.

I/O Management

I/O management uses the Device Drivers in collaboration with some system programs inside the I/O device to offer some services:

- I/O Traffic Controller : It keeps track of the status of all devices, control units, and communication channels.
- I/O scheduler : It executes the policies used by OS to allocate and access the device, control units, and communication channels.
- I/O device handler : It serves the device interrupts and heads the transfer of data.



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Disk Storage Management

Disk Storage Management

Secondary storage allows computer to store gigas or teras of bytes (information). The access to the secondary storage devices is managed by the Disk Storage management which allows to create, delete and format disk partitions to store files by means of a **file system** which

- It manages the folder/directory structure and provides an index to the files.
- It defines the syntax used for the "path" to the files. File systems dictate how files are named as well as the maximum size of each file and the total storage capacity it can handle.
- it provide protection which keeps information secure from other users
- It provide Reliability protects information loss due to system crashes

Disk Storage Management

There are some important concepts to understand what is a file system:

- File: A file is a logical unit of information created by processes that processes produce.
- Directory: A location on the storage that stores several files within itself.
- Partition: A part of the storage medium is virtually separate from the rest of the storage.
- Access Mechanism: The process is followed by the OS to grant a user/process access to a file.
- File Extension: A label appended to the name of a file after a dot. Gives information of the purpose of and information in the file.

Disk Storage Management

A file system defines how the contents of a storage medium (hard disk, usb, flash disk, etc) are stored and organized. The file system manages the folder/directory structure and provides an index to the files. It also defines the syntax used for the "path" to the files.

- Files may form arranged or complex structures according to the relationship among them.
- Several files can be grouped together under a directory.
- A directory also referred to as a folder also has attributes similar to those of a file, such as a name, size, location, access permissions, etc.
- A file system also provides several features such as a crash recovery mechanism, data loss/corruption prevention, etc.

Disk Storage Management

There are different types of file systems:

- Windows uses FAT32 (File Allocation Table), exFAT and NTFS.
- Macs use FAT32, exFAT, HFS+ and APFS.
- Linux uses ext2, ext3, ext4, FAT32 and exFAT.
- Unix systems use UFS, ext2, ext3, ext4 and ZFS