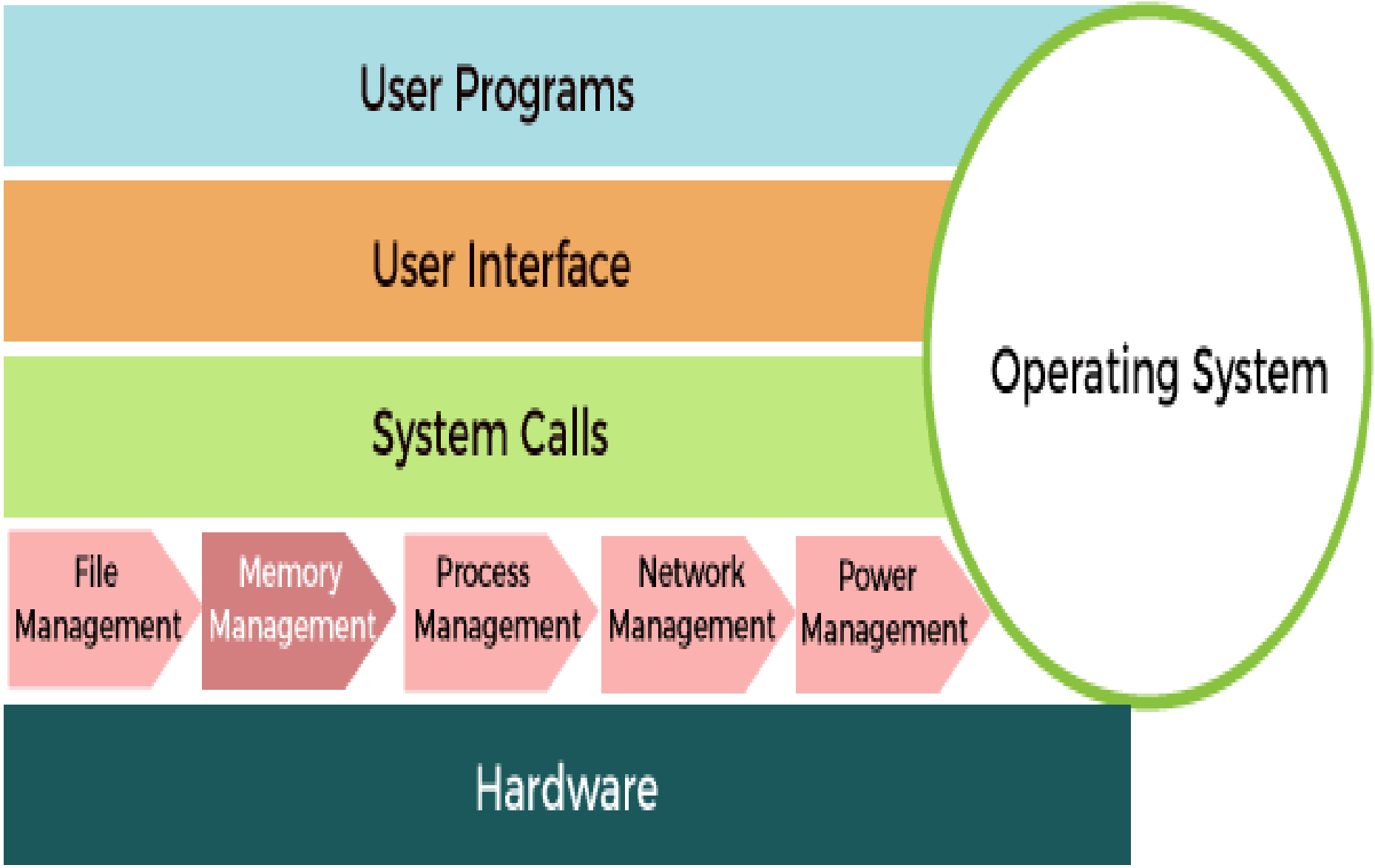
UNIT-2(PART-2)
CONCURRENCY

MEMORY MANAGEMENT

- Memory is the important part of the computer that is used to store the data. Its management is critical to the computer system because the amount of main memory available in a computer system is very limited.
- At any time, many processes are competing for it. Moreover, to increase performance, several processes are executed simultaneously. For this, we must keep several processes in the main memory, so it is even more important to manage them effectively.

Memory Management in OS



Memory management plays several roles in a computer system

- Memory manager is used to keep track of the status of memory locations, whether it is free or allocated. It addresses primary memory by providing abstractions so that software perceives a large memory is allocated to it.
- Memory manager permits computers with a small amount of main memory to execute programs larger than the size or amount of available memory. It does this by moving information back and forth between primary memory and secondary memory by using the concept of swapping.
- The memory manager is responsible for protecting the memory allocated to each process from being corrupted by another process. If this is not ensured, then the system may exhibit unpredictable behavior.
- Memory managers should enable sharing of memory space between processes. Thus, two programs can reside at the same memory location although at different time

Swapping:

- Swapping is a memory management scheme in which any process can be temporarily swapped from main memory to secondary memory so that the main memory can be made available for other processes.
- It is used to improve main memory utilization. In secondary memory, the place where the swapped-out process is stored is called swap space.

The concept of swapping has divided into two more concepts: Swap-in and Swap-out.

- Swap-out is a method of removing a process from RAM and adding it to the hard disk.
- Swap-in is a method of removing a program from a hard disk and putting it back into the main memory or RAM.

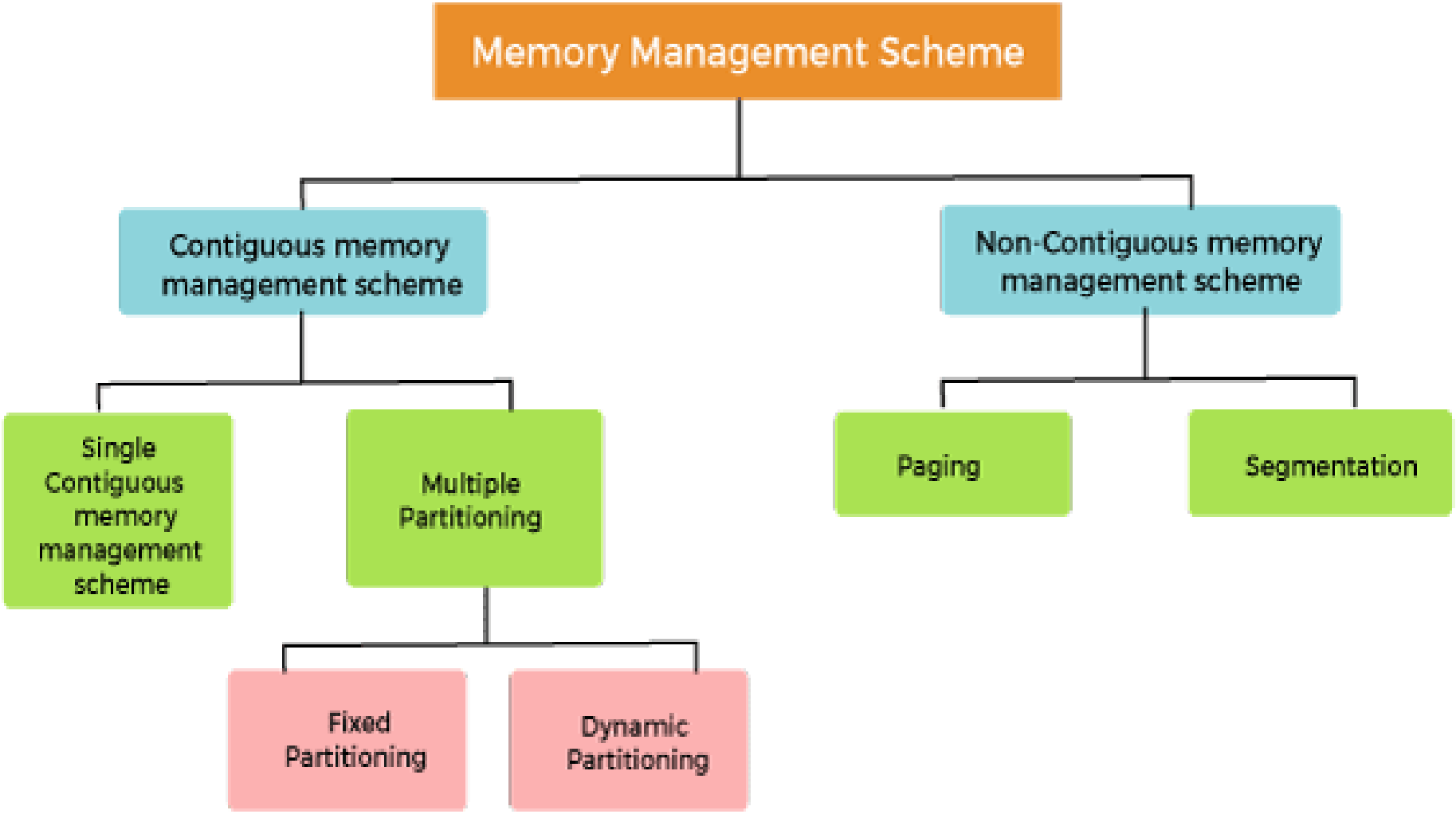
Advantages of Swapping:

- It helps the CPU to manage multiple processes within a single main memory.
- It helps to create and use virtual memory.
- Swapping allows the CPU to perform multiple tasks simultaneously. Therefore, processes do not have to wait very long before they are executed.
- It improves the main memory utilization.

Disadvantages of Swapping:

- If the computer system loses power, the user may lose all information related to the program in case of substantial swapping activity.
- If the swapping algorithm is not good, the composite method can increase the number of Page Fault and decrease the overall processing performance.

Memory management Techniques:



Classification of memory management schemes

Contiguous memory management:

- Contiguous memory management scheme, each program occupies a single contiguous block of storage locations, i.e., a set of memory locations with consecutive addresses.

Single contiguous memory management:

- Single contiguous memory management scheme is the simplest memory management scheme used in the earliest generation of computer systems. In this scheme, the main memory is divided into two contiguous areas or partitions.
- The operating systems reside permanently in one partition, generally at the lower memory, and the user process is loaded into the other partition.

Multiple Partitioning:

- The single Contiguous memory management scheme is inefficient as it limits computers to execute only one program at a time resulting in wastage in memory space and CPU time.
- The problem of inefficient CPU use can be overcome using multiprogramming that allows more than one program to run concurrently. To switch between two processes, the operating systems need to load both processes into the main memory.
- The operating system needs to divide the available main memory into multiple parts to load multiple processes into the main memory. Thus multiple processes can reside in the main memory simultaneously.

The multiple partitioning schemes can be of two types:

- **Fixed Partitioning**
- **Dynamic Partitioning**

- The main memory is divided into several fixed-sized partitions in a fixed partition memory management scheme or static partitioning. These partitions can be of the same size or different sizes. Each partition can hold a single process.
- The number of partitions determines the degree of multiprogramming, i.e., the maximum number of processes in memory. These partitions are made at the time of system generation and remain fixed after that.

Dynamic Partitioning

- The dynamic partitioning was designed to overcome the problems of a fixed partitioning scheme. In a dynamic partitioning scheme, each process occupies only as much memory as they require when loaded for processing.
- Requested processes are allocated memory until the entire physical memory is exhausted or the remaining space is insufficient to hold the requesting process. In this scheme the partitions used are of variable size, and the number of partitions is not defined at the system generation time.

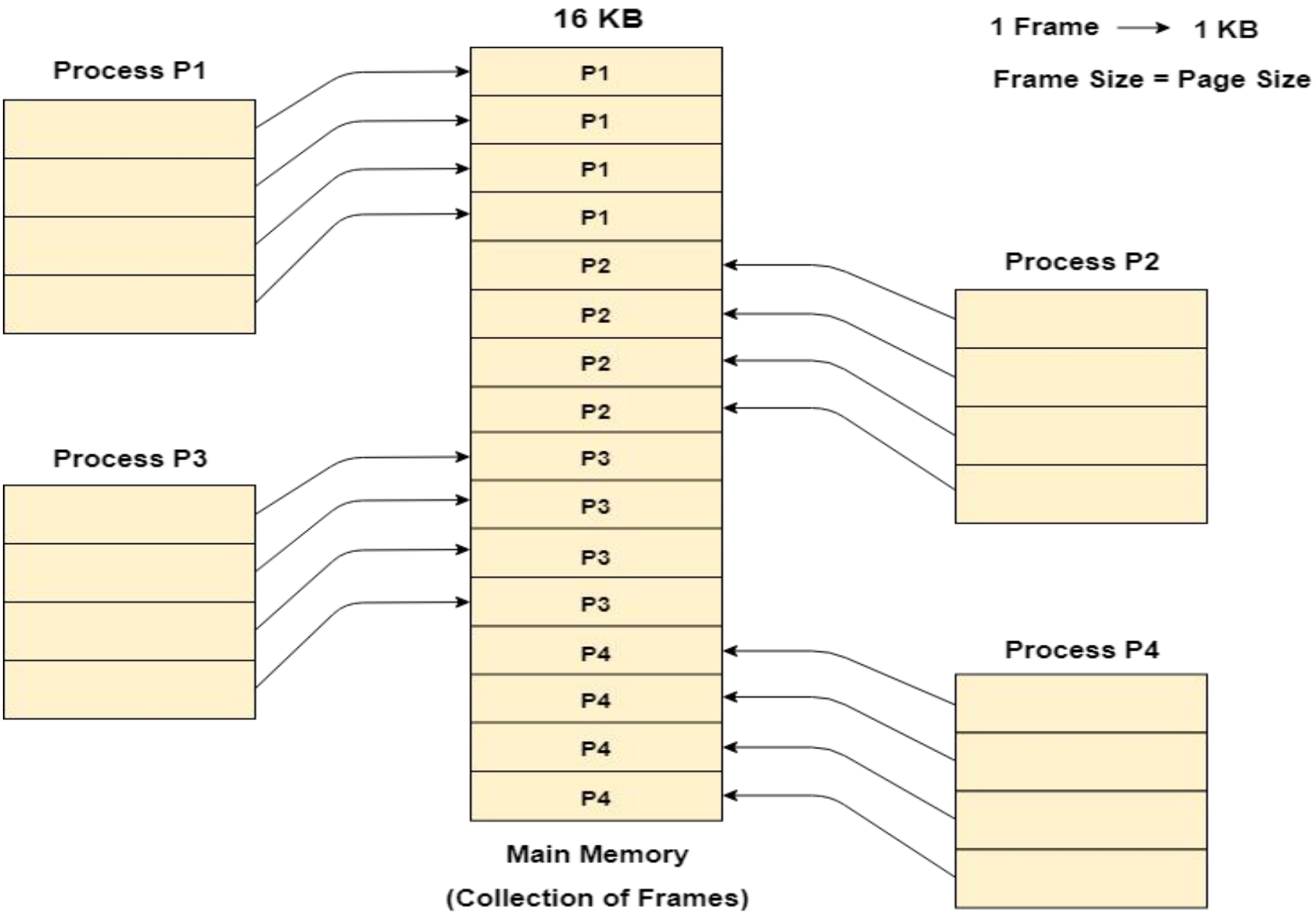
Non-Contiguous memory management

- Non-Contiguous memory management scheme, the program is divided into different blocks and loaded at different portions of the memory that need not necessarily be adjacent to one another.
- This scheme can be classified depending upon the size of blocks and whether the blocks reside in the main memory or not.

What is paging?

- Paging is a storage mechanism used to retrieve processes from the secondary storage into the main memory in the form of pages.
- The main idea behind the paging is to divide each process in the form of pages. The main memory will also be divided in the form of frames.
- One page of the process is to be stored in one of the frames of the memory. The pages can be stored at the different locations of the memory but the priority is always to find the contiguous frames or holes.
- Pages of the process are brought into the main memory only when they are required otherwise they reside in the secondary storage.

- Paging is a technique that eliminates the requirements of contiguous allocation of main memory. In this, the main memory is divided into fixed-size blocks of physical memory called frames.
- The size of a frame should be kept the same as that of a page to maximize the main memory and avoid external fragmentation.
- **Advantages of paging:**
- Pages reduce external fragmentation.
- Simple to implement.
- Memory efficient.
- Due to the equal size of frames, swapping becomes very easy.
- It is used for faster access of data.

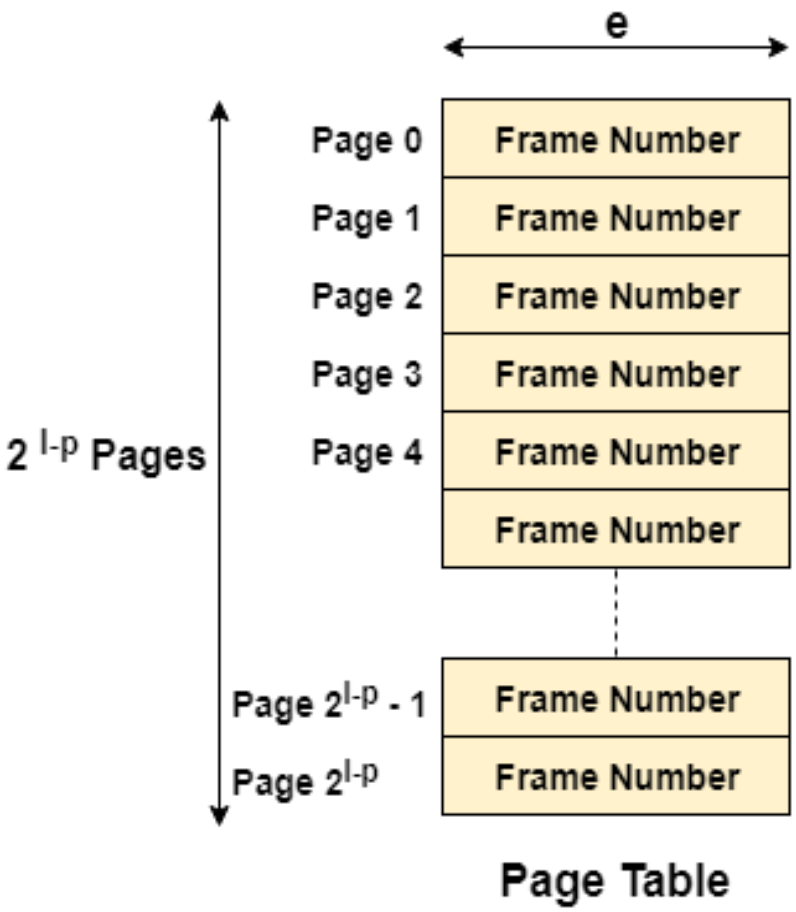

16 KB
1 Frame → 1 KB
Frame Size = Page Size
Process P1
Process P2
Process P3
Process P4
P1
P1
P1
P1
P2
P2
P2
P2
P3
P3
P3
P3
P4
P4
P4
P4
Main Memory
(Collection of Frames)

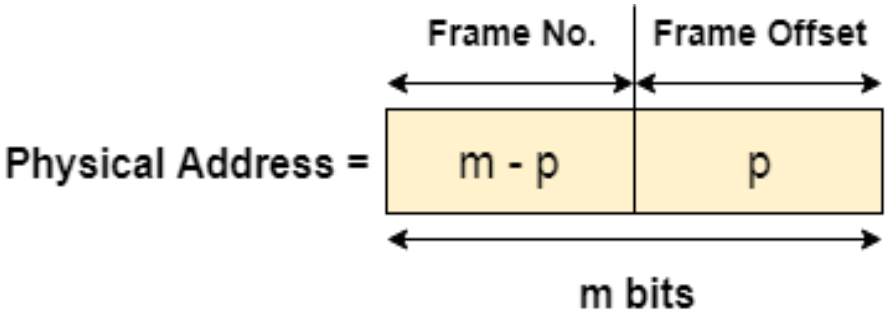
Paging

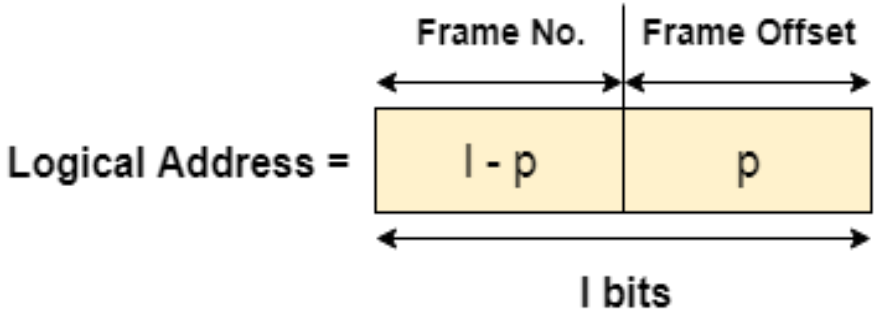
Page Table

- Page Table is a data structure used by the virtual memory system to store the mapping between logical addresses and physical addresses.
- Logical addresses are generated by the CPU for the pages of the processes therefore they are generally used by the processes.
- Physical addresses are the actual frame address of the memory. They are generally used by the hardware or more specifically by RAM subsystems.
- The image given below considers,

structure of the page table







No. of entries in Page Table = No. of the pages in the process

Page Table Size = 2^{l-p} X e bytes

e = m-p (Frame Size) bits

What is Segmentation?

- Segmentation is a technique that eliminates the requirements of contiguous allocation of main memory. In this, the main memory is divided into variable-size blocks of physical memory called segments.
- It is based on the way the programmer follows to structure their programs. With segmented memory allocation, each job is divided into several segments of different sizes, one for each module. Functions, subroutines, stack, array, etc., are examples of such modules.