CM1604
Computer Systems Fundamentals

Operating System
Memory Management

This week …

- Categories of Operating Systems

- Key functions of Operating System

- Memory Management
  - Logical, Physical addressing
  - Partitioning of memory
  - Memory management techniques
  - Paged memory
  - Virtual memory

By the end of this lecture, you will:

- Distinguish among different classifications of OS

- List down the key functions of OS

- Define Memory management

- Explain the relationship between physical and logical address

- Compare and contrast different memory management techniques

A system → Software + Hardware

Software → System Software + Application Software

Operating System (OS) ⇒ A System Software

What is an Operating System

Program that act as a interface between the hardware and the user

Eg: Windows, Linux, Android, RedHat, Mac OS

How the OS is loaded

On pressing 'Power Button' on a computer

- Perform a POST (*Power-On Self Test*)

- Read the BIOS (*Basic Input Output System*)- ROM

- Read Disk Sector Zero

- Read partition Boot Sector

- Loads the OS (OS starts)

Classification of OS

- Hardware on which they run

- Number of active programs

- Type of the interaction

# Classification of OS - Hardware which they run

- Mainframe computer
  - Used for bulk data processing
  - 1000+ concurrent user

- Minicomputer
  - Step down version of mainframe
  - 100+ concurrent users

- Microcomputer
  - Modern personal computers - PC, laptop, mobile devices

Classification of OS - no. of active programs

- Single-programmed OS

    - Only one program/ process operation

    - MS-DOS

- Multi-programmed OS

    - multiple programs in the memory and switches between

    - modern OSs

Classification of OS - interaction provided

- Batch processing systems
  - No interaction between the running program and the user
  - Jobs are submitted in batches
- Interactive systems
  - User can interact with the running program
- Real time systems
  - Time critical systems the response time is crucial
  - Military , air traffic control
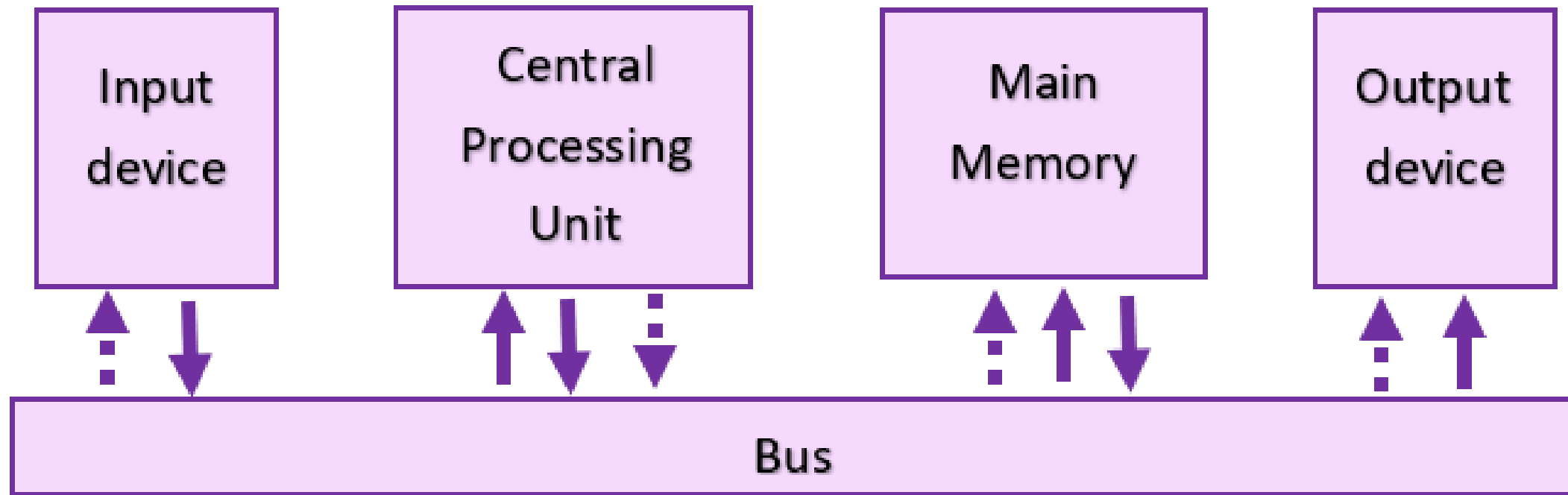
Functions of Operating System

- Process Management

- Memory Management

- Disk management

- File Management

- Security

- Control over system performance

- Error detecting aids

- Coordination between other software and users

Memory Management

What is computer memory

Where the instruction and information about current active process are being stored

- Working memory of CPU
- Transient

- OS should have techniques to keep track of / manage how the memory is utilized

Memory Management

Memory Management

- Allocate memory for process when needed

- Deallocate when no longer needed

- Keep track of the areas of memory which as used

- Enable memory sharing between processes

- Protect the memory allocation of a process from another

- Manage memory swapping between the memory and secondary storage

- Conversion of logical address into physical address
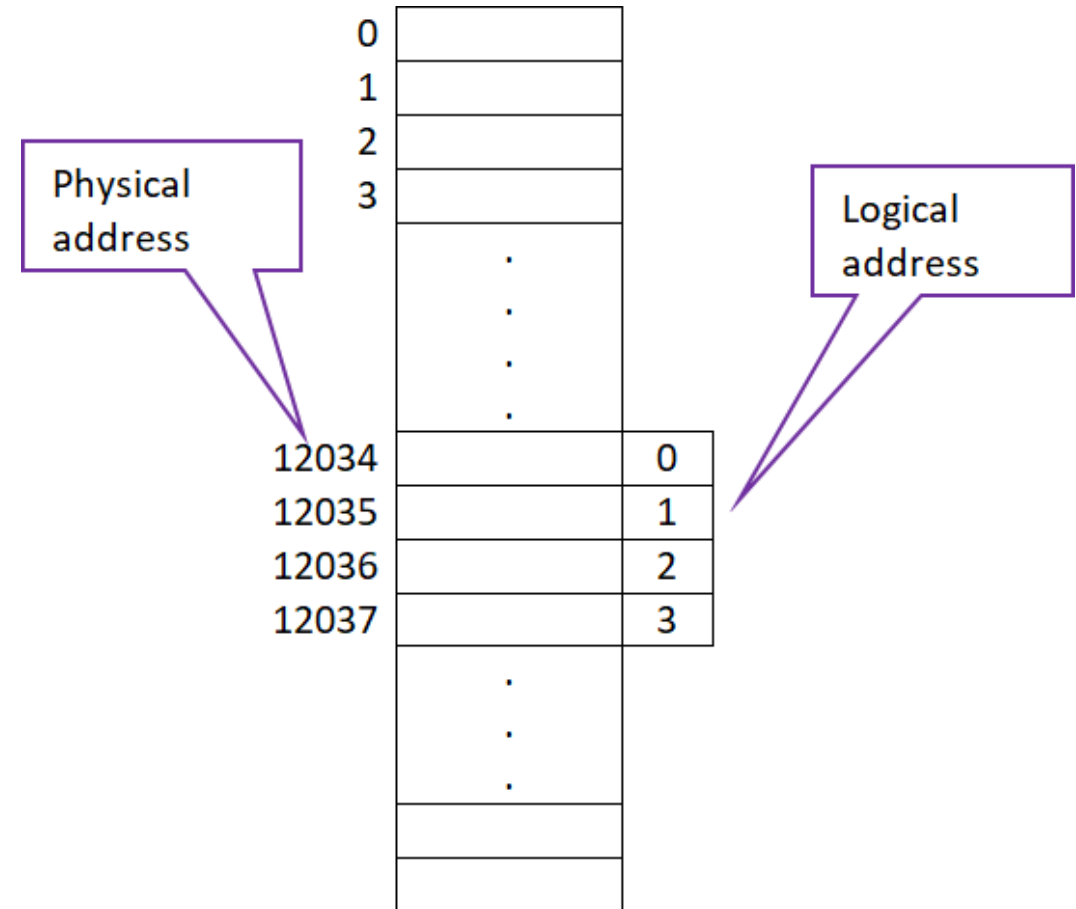
Logical Address vs Physical Address

Memory is a continuous set of bits referenced by specific addresses

Logical Address:

     Location in the memory relative to the program

Physical Address:

     Actual address in the main memory

Single Contigious MM

- Apart from the Operating System, only one application will be in the memory

- Simplest form of memory management

| Operating system |
|---|
| Application program |

Partition MM

- Can accommodate multiple applications in the memory by partitioning the memory

- Two techniques are used

  - Fixed Partition

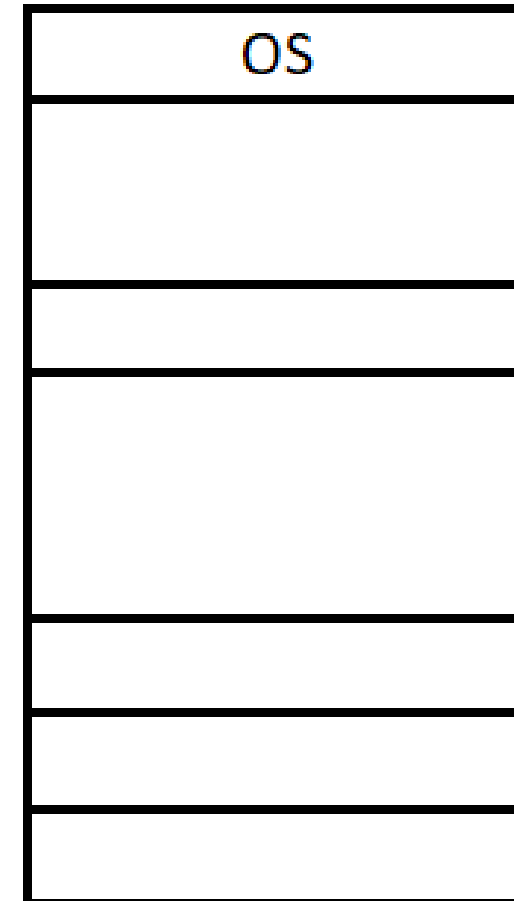 - Variable / Dynamic Partition

Partition MM …
Fixed Partition MM

- Memory is partitioned into equal sized fixed number of partitions

- Memory may wasted- for smaller programs

- Will not have enough memory - for larger programs

OS
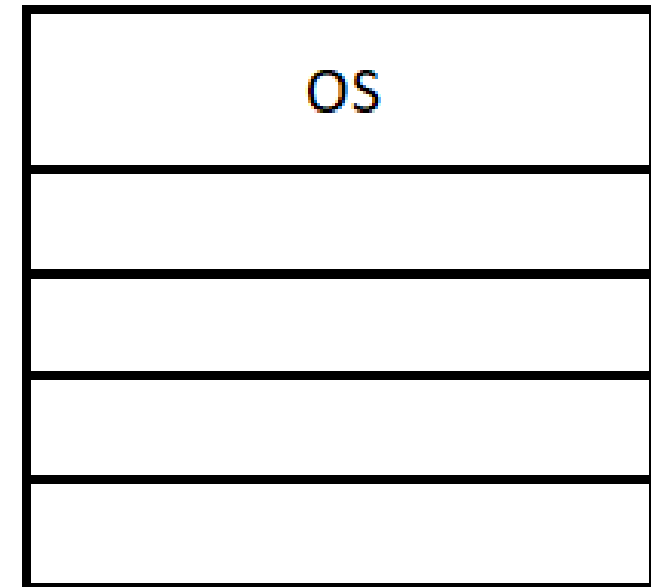
Partition MM …
Variable/Dynamic Partition MM

• Partitions are created

dynamically as per the need

of the program

OS

Partition MM …

- At a given instance, the memory is divided into partitions, some of them are allocated while others are empty
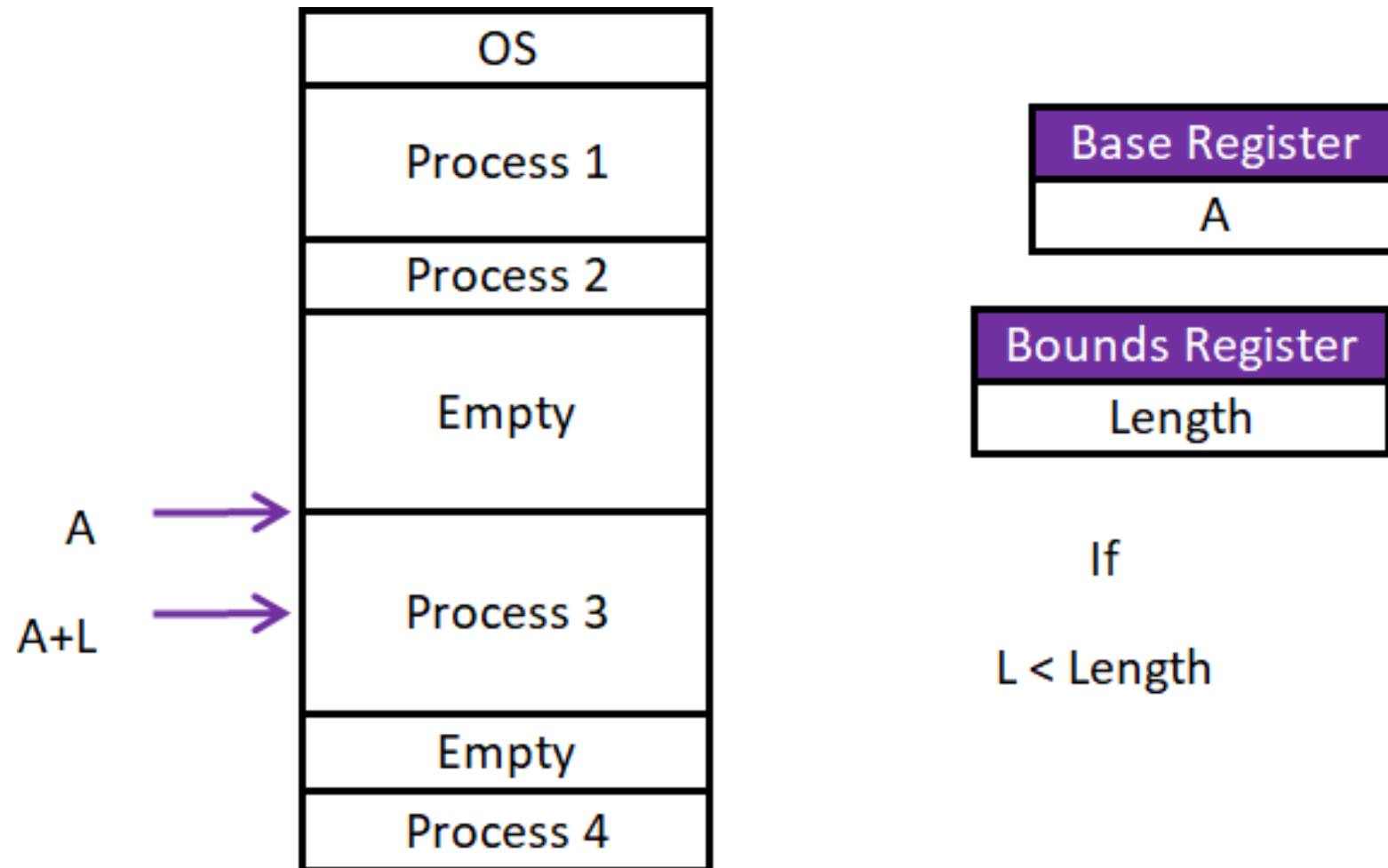- To keep track of individual memory -

Base Register

Register that keeps track of the beginning address of the current partition

Bounce Register

Register that holds the length of the current partition

Partition MM …

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Partition Selection Algoithms

- How to select a partition for a process to accommodate

   First fit

- Allocate the first empty partition that is size enough to hold the process
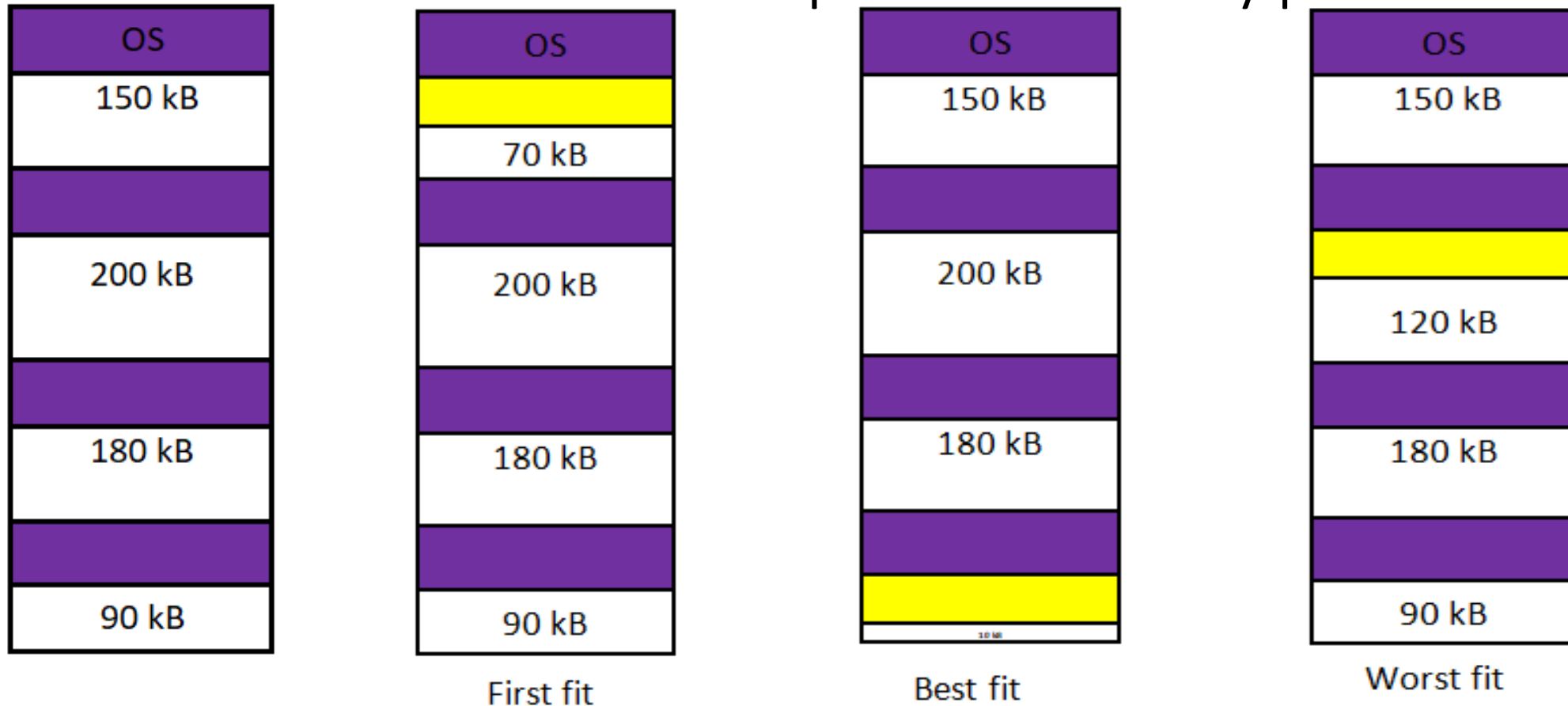 - Fastest

   Best fit

- Allocate the smallest partition that is big enough to hold the process
  - Unused space is minimized

   Worst fit

- Allocate the largest empty partition
  - Leaves larger unused space in the partition

Partition Selection Algoithms …

When a process of 80 kB size request for a memory partition

| | First fit | Best fit | Worst fit |

Paged Memory Management

==**Process** are divided into fixed sized **pages**==
and
==**stored** in memory   when loaded==

Frame
Fixed sized portion of the **main memory** that holds a process page

Page
Fixed sized portion of a **process** that is stored in the main memory

Paged Memory Management …

Demand Paging

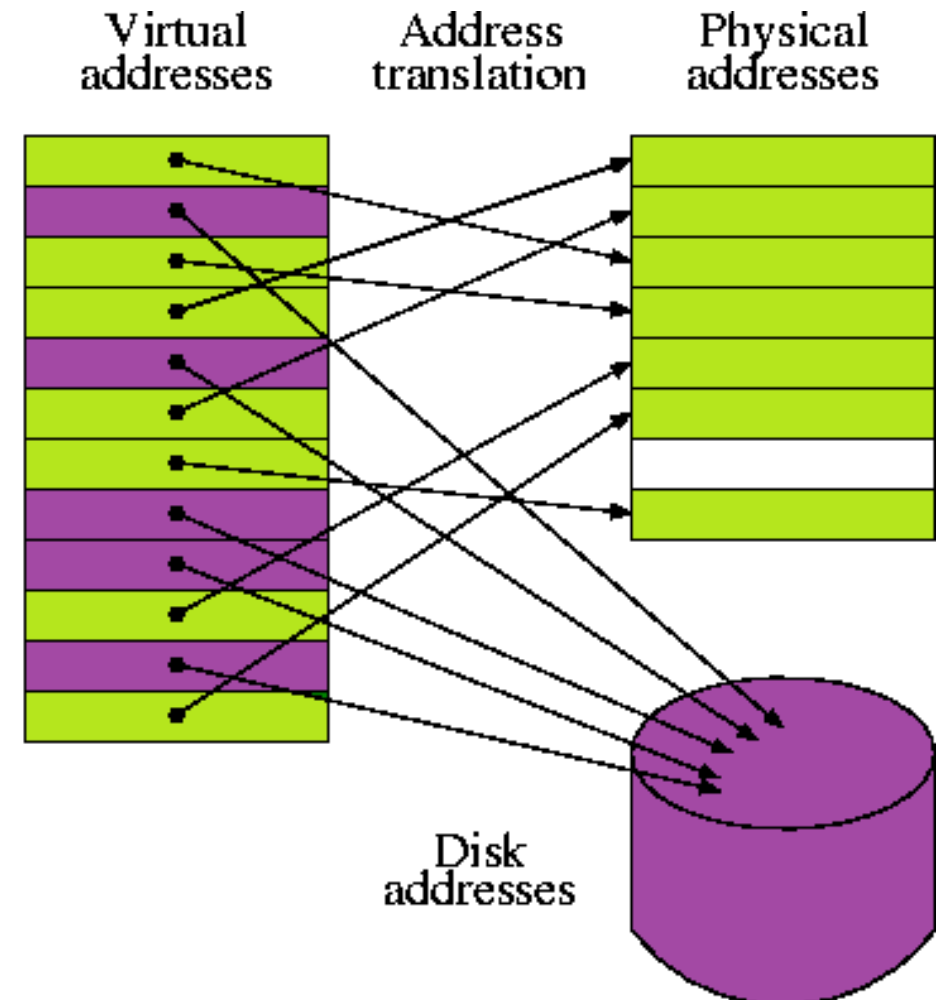Pages are brought to the memory on demand

Page swapping

Brining a page from secondary memory while writing back a page to the secondary memory

Thrashing

Inefficient process caused due to the continuous page swaps

Virtual Memory

- Allocating a part of secondary storage (hard disk) as an extension for main memory

- Disk area is ued as swap space

- Addressing used is called as Virtual Address

Virtual addresses — Address translation — Physical addresses

Disk addresses

http://www.brokenthorn.com/Resources/OSDev18.html

Memory Map Table (MMT)

PAGE TABLE:

Virt Page	Page Frame
0	2
1	not in main memory
2	1
3	3
4	not in main memory
5	not in main memory
6	0
7	not in main memory

MEMORY MAP:

pf Virtual Page	Page frame	Physical
0 0000-1023	2	0 0000-1023
1 1024-2047	-	1 1024-2047
2 2048-3071	1	2 2048-3071
3 3072-4095	3	3 3072-4095
4 4096-5119	-	
5 5120-6143	-	
6 6144-7167	0	
7 7168-8191	-	

Translate: 0000, 5363, 3071, 3072, 3073, 2048, 4196

Result

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Virtual	Physical
0000	2048
5363	page fault
3071	2047
3072	3072
3073	3073
2048	1024
4196	page fault

REFERENCE

- Dale, N.B. and Lewis, J., 2007. Computer science illuminated. Jones & Bartlett Learning.

- http://web.cs.ucla.edu/classes/fall14/cs111/scribe/15e/index.html

READING

Chapter # 10

- Computer science illuminated. Jones & Bartlett Learning.