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UNIT-1

→ OS is an interface b/w hardware and user
→ It is a System program.
→ Manages System resources
→ Provides platform for other applications
→ Core part of OS is Kernel

Primary Goals : To make ~~make~~ User Sys. friendly

Secondary Goal : Make Sys. efficient

Functions :

→ Process Management
- Scheduling Processes & threads on CPU
- Creating & deleting both user & Sys. process
- Process Synch.
- Process Communication

→ Memory Management
- keeping track of memory usage
- Deciding which process & data move in/out of memory.
- Allocating / De-allocating memory space

→ Disk Management
- Free space mgmt. in disk
- Disk Scheduling
- Storage alloc.

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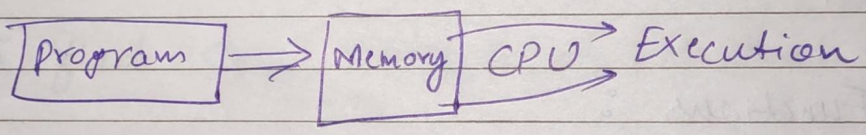
→ File Mgmt.
- Create/Delete files
- Backing up files on stable storage media
- Create/Delete Directories

→ I/O Device Mgmt.
→ Network Mgmt.
→ Security and mgmt.

Services :

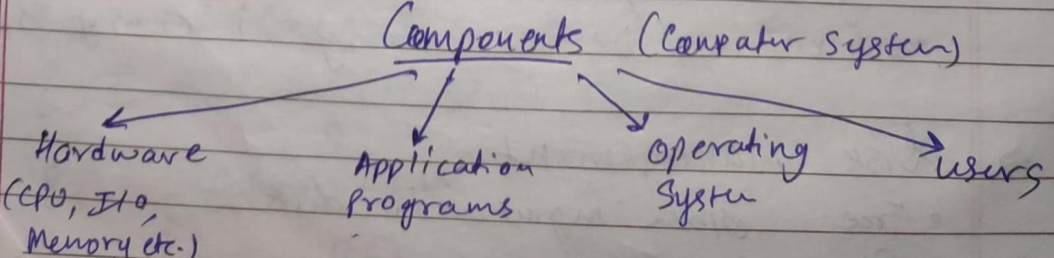
→ User Interface
→ Program Execution



→ Access I/O Devices
→ File system access
- Read/write files & directories
- Search for a file in it
- Access control to files

→ Error Detection & Response
- Troubleshooting
- Error codes

→ Communication



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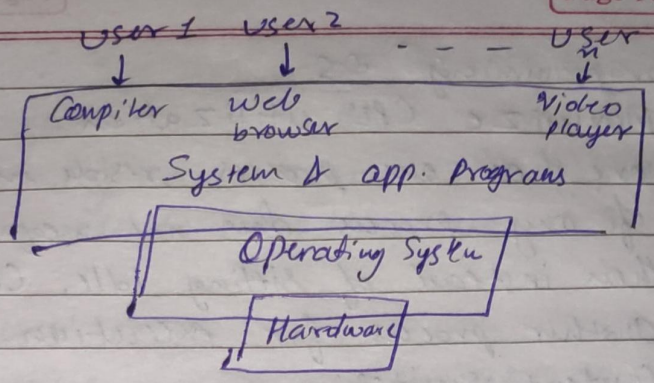
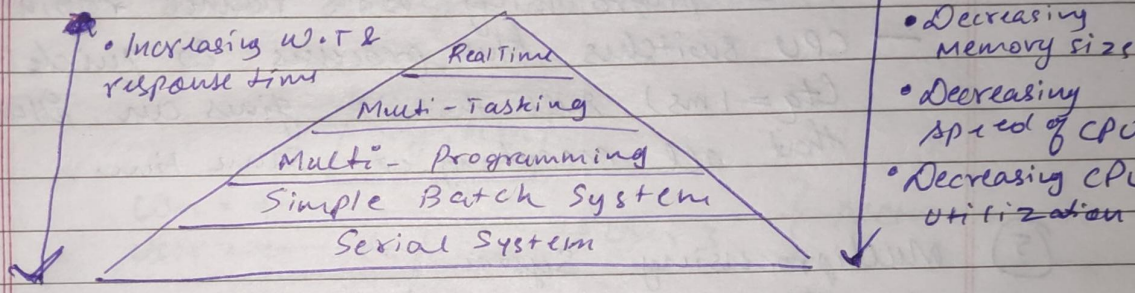


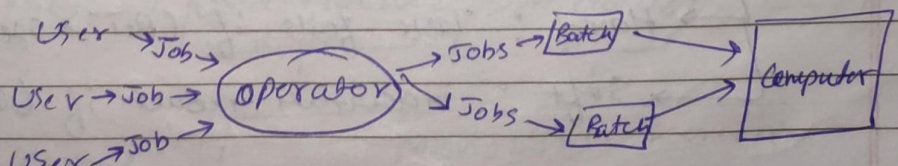
Classification of OS :



(1) Serial System
- No O.S needed
- Direct interaction of programs with hardware

(2) Batch System
- Set of JOBS with similar need.
  - Program
  - Input Data
  - Control Instructions

- Similar types of jobs batch together



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(3) Multiprogramming OS
- Maximize CPU utilization
- More than one process reside in M/M
- If any process does not require CPU then instead of sitting idle, CPU picks another process for execution.
- Context switching

(4) Time sharing / Multi-Tasking
- Multi-programming with round robin system.
- CPU switches b/w processes so quickly (tq = 1 ms) such that it gives an illusion that all executing at same time.

(5) Multiprocessing System
- Two or more CPU within a single comp. share system bus and I/O devices.
- True parallel execution of processes.
- Two types
  - Asymmetric : Master-slave
  - Symmetric : No master-slave

(6) Real Time System
- Well-defined fixed time constraints.
- Used when we require quick response against input.
- Two Types
  - Hard : Task fails if (R.T > specified time)
  - Soft : inaccurate result if (RT > specified time)

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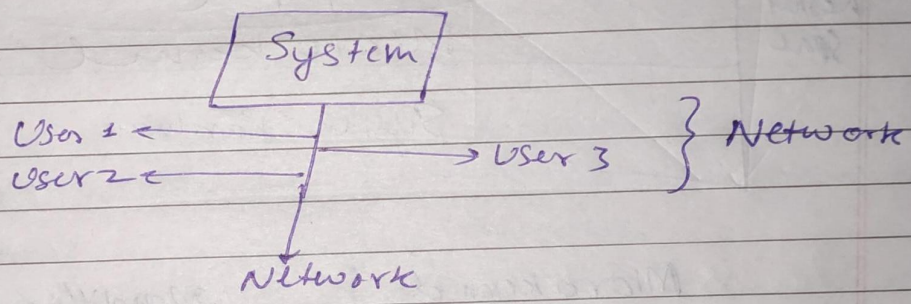
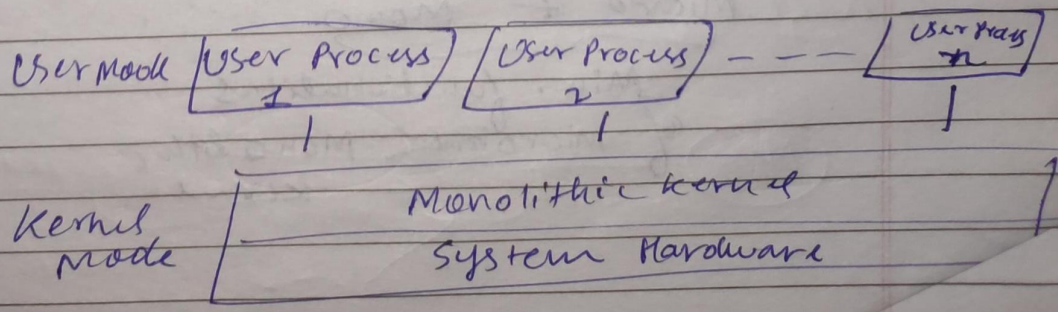
(7) Interactive System
- Direct comm. btw user & system.
- user gives ins. to OS or program (Input)
- Immediate results (output)

(8) Multi-user O.S
- Multiple users on different computers to access a single system with one OS on it.
- Access through a network



Kernels : Set of necessary software/programs modules which drives the hardware.
Types →

(1) Monolithic
- Literally means all in one place.
- User and kernel services under same address space.



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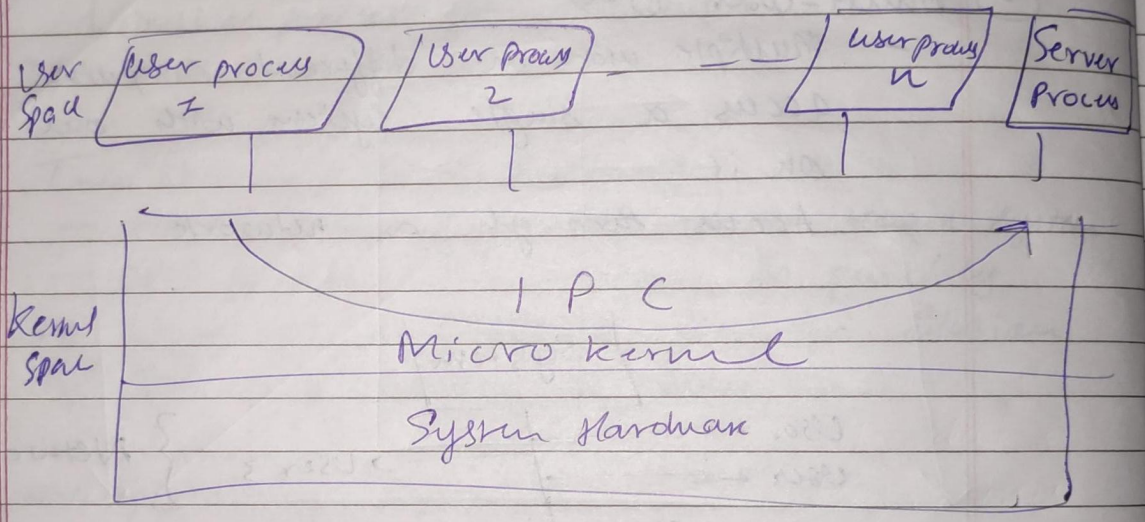
(2) Micro kernel

- Different address space for user and kernel services implementation
- Only most imp. services present in kernel



	Microkernel	Monolithic kernel
Size	Small	Large
Speed	Faster	Slower
Extendibility	Easy	Hard
Error prone	Less	More

(3) Hybrid kernel

Micro + Mono

Mix functionalities of microkernel & Monolithic kernel

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(4) Reentrant kernel

- Executable code stored in memory such that several processes can use this code at same time without hindering the working of other processes.
- Multiple processes executed in kernel mode at same time.
- Example : UNIX.

Program	Process
- Set of instructions to do specific task	- Instance of an executing program
- Passive entity	- Active entity
- Resides in secondary memory	- Resides in primary memory.
- continues to exist until deleted	- Limited span of time until completion of time.

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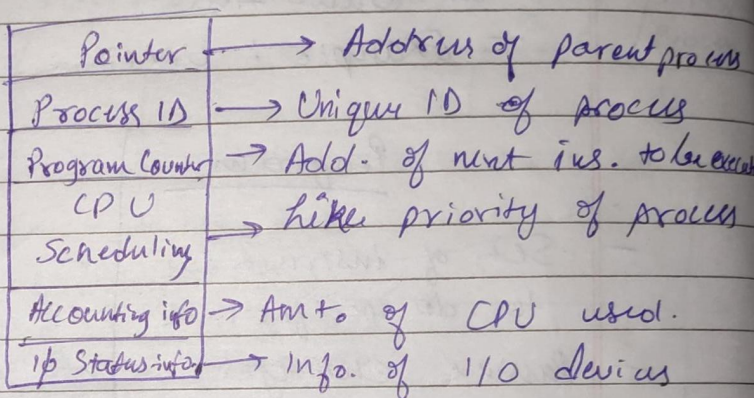
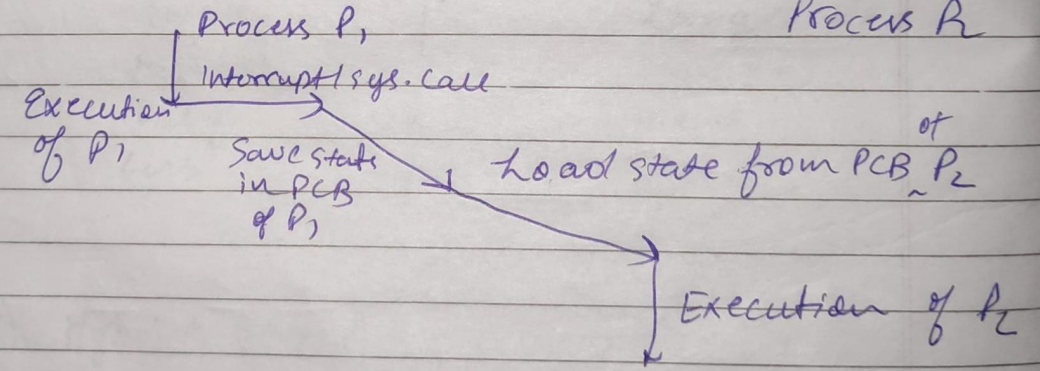
UNIT-3

Process Control Block :

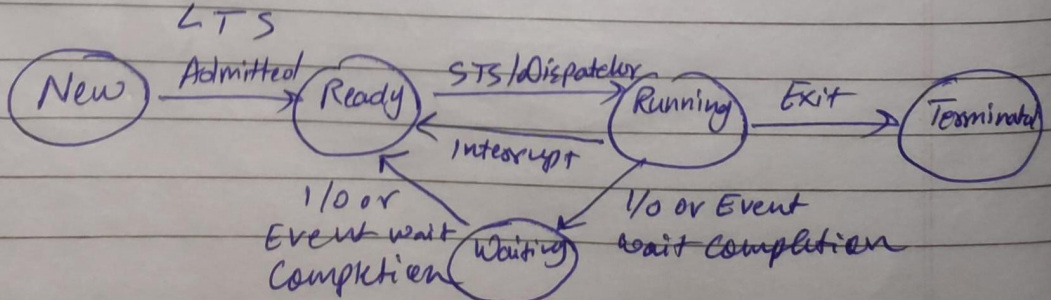
- Holds all info necessary to keep track of process
- OS creates PCB for every process



Process State Switching :



Life Cycle of Process :



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- New state: Process is created (Job queue)
- Ready state: Resides in Ready queue (Primary Memory)
- Running state: ~~Assigned~~ CPU is assigned to a process
- Terminated state: Process has completed its execution successfully
- Waiting state: Resides in waiting queue (Primary Memory) → I/O burst.

Schedulers:

- LTS
  - Selects process from Job Queue → Ready Queue
  - New state → Ready state
- STS
  - Selects process Ready Queue → CPU
  - Ready State → Running state
  - Dispatcher Saves content of PCB and loads content of another process. (Content Switching)
- MTS
  - Removes processes from MM.
  - ★ Reduces degree of multiprogramming

Multilevel Queue Scheduling:

- Partitions ready queue into separate queue
- Each queue has its own scheduling algorithm.

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* Aging :

Gradually increasing the priority of the process that wait in the System for long time

Multilevel Feedback Queue Scheduling :

- Allows a process to move between queues.
- If process uses too much CPU time it will be moved towards lower priority queue
- If it stayed too long in lower priority queue, it may be moved to higher priority queue.

Fork() System call :

→ used to create new process (child process)
→ If we call fork() n-times, $2^{(n-1)}$ child process will be generated.

Deadlock :

Def→ Sit Situation where two or more than 2 processes are waiting for each other to complete the execution and release the resource so that requesting processes will get resources for successful execution.

But, none of processes get executed.

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→ Mutual Exclusion
→ Hold & Wait
→ No Preemption
→ Circular Wait

Deadlock Recovery :

→ Abort all processes involved in deadlock
→ Abort processes one by one to make system deadlock free.

8.

Process	Allocated R_1 R_2 R_3	MAX R_1 R_2 R_3	AVAILABLE R_1 R_2 R_3	NEED R_1 R_2 R_3
P1	2 2 3	3 6 8	7 7 10	1 4 5
P2	2 0 3	4 3 3	9 9 13	2 3 0
P3	1 2 4	3 4 4	11 9 16	2 2 0
			12 11 20	

$[P_1 \longrightarrow P_2 \longrightarrow P_3]$

SAFE SEQUENCE ✓✓ Safe state

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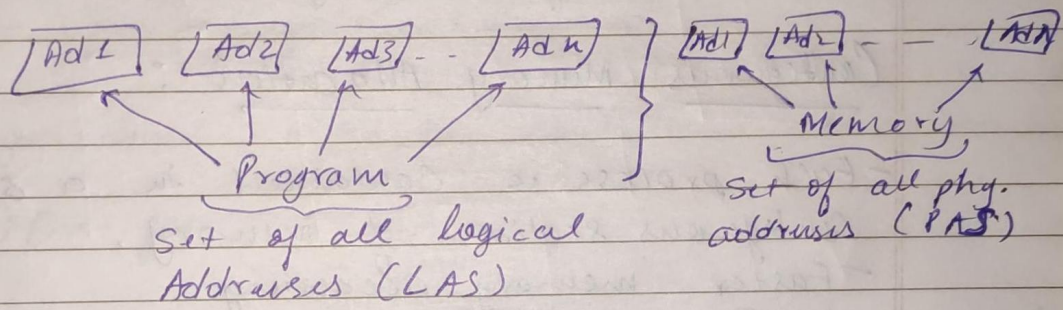
UNIT - 4

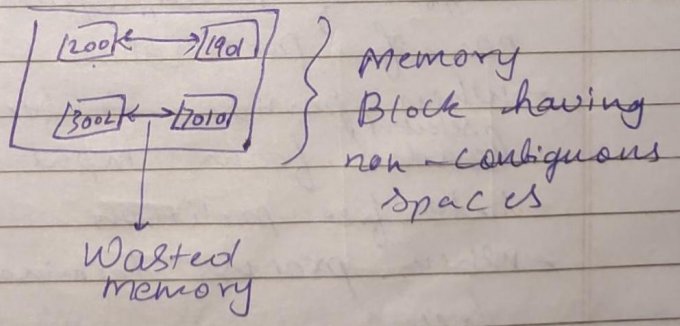
LAS V/s PAS :

→ Logical Address is generated by CPU
→ Physical Address is generated by Memory Unit.



Fragmentation :

① External
- Enough total memory to satisfy a req. but available spaces are not contiguous.



② Internal
- Memory allocated to a process may be larger than req. memory.
- Difference b/w these 2 nos. is Internal frag.

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Compaction →

Shuffle ~~all~~ Memory contents to place all free memory together in one large block.

↳ To solve external fragmentation

↳ we can move all holes to one side/ one end of memory.

Contiguous Memory Allocation :

- Each process is contained in a single contiguous section of memory.
- Faster memory accessing
- Two Categories :

① Multiprogramming with fixed no. of tasks

- Fixed sized partitions
- Each partition may contain one process
- Degree of multiprogramming is bound by no. of partitions
- when partion is free, a process is ~~loaded~~ selected from input queue and loaded into free partition.
- when process terminates, partition becomes free.
- Prone to Internal, External fragmentation.

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(2) Multiprogramming with variable no. of tasks

- OS keeps a table indicating which parts of memory are available / occupied.
- Initially all memory is one large hole
- As process enter, put into input queue and OS checks memory requirements of each process and allocates memory.
- Ext. fragmentation occur.

Algorithms used in Contigious memory --

(1) First fit

Allocate the first hole that is big enough

(2) Best fit

Allocate the ~~Smallest~~ smallest hole big enough

(3) Worst fit

Allocate the largest hole.

Memory Protection :

- We are allocating separate memory spaces to each process
- Obviously there should be a range for these addresses of memory spaces
- Base register → smallest phy. memory address
  Limit register → size of range

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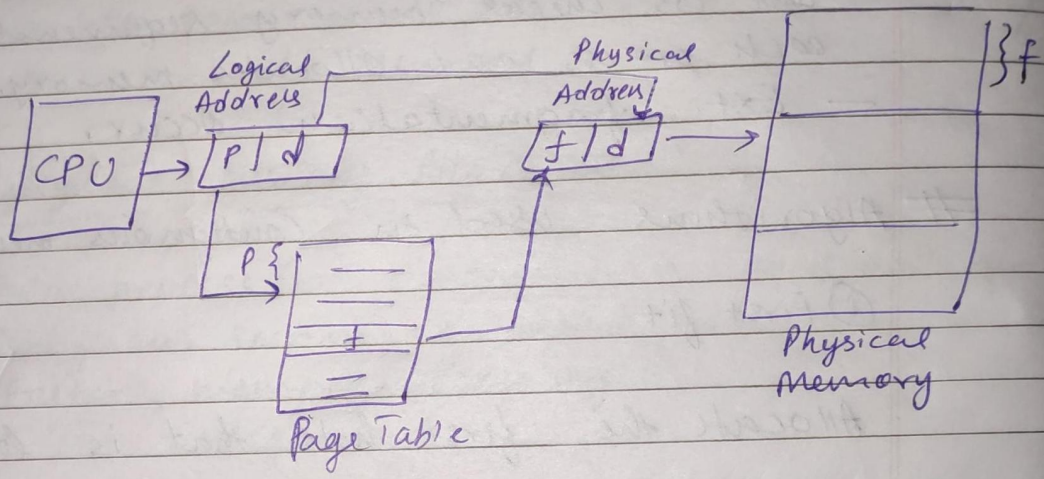
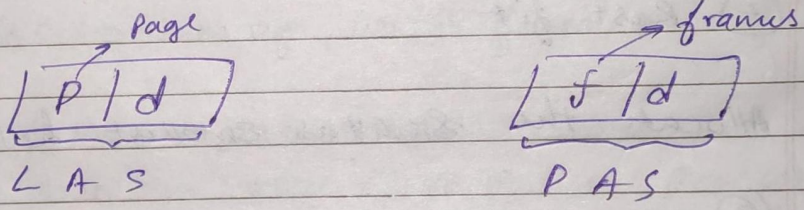
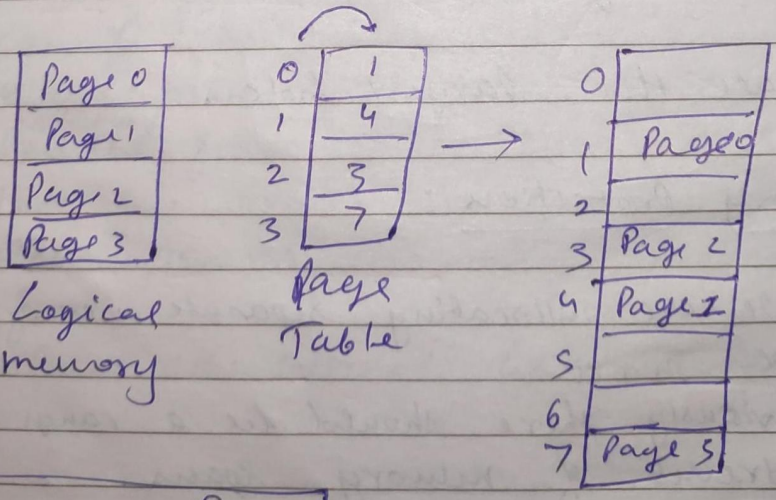
Paging :

- a scheme that permits phy. addrss space a process to be non-contiguous.
- Prone to internal fragmentation.





Example:



Frame no.	Page no.

Page table

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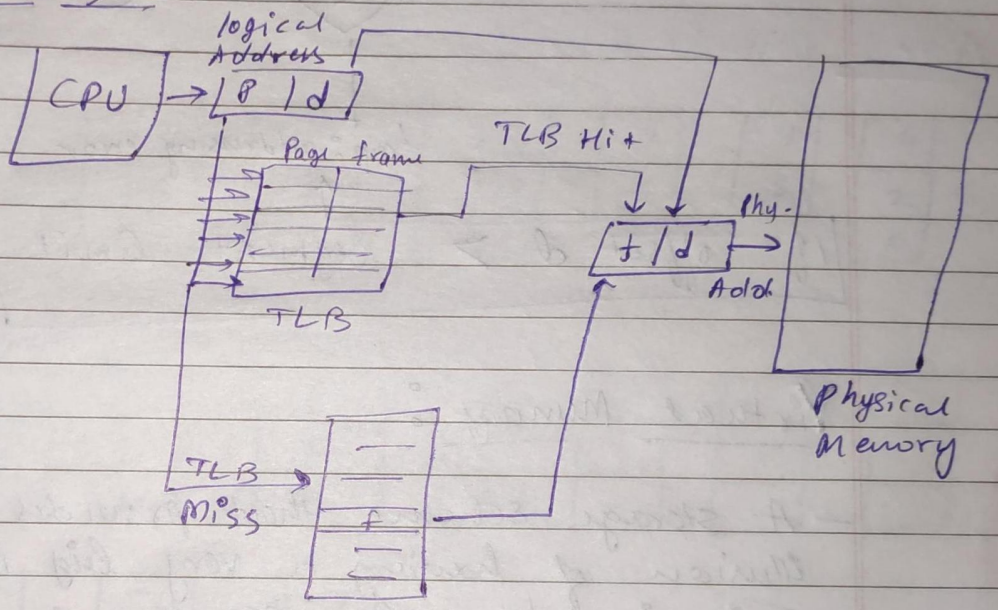
Paging with TLB :

- To increase speed of memory accss, TLB is used with page table.
- Small, fast
- Fixed sized blocks



$$\text{Hit Ratio} = \frac{N_{Hit}}{(N_{Hit} + N_{miss})}$$

- Valid bit → 1 → Page is in LAS
  0 → Page is not in LAS

Segmentation :

- LAS has variable sized segments. Each segment has a name and a length
- Avoids both ext. and int. frag.
- Takes lesser space in phy. memory.

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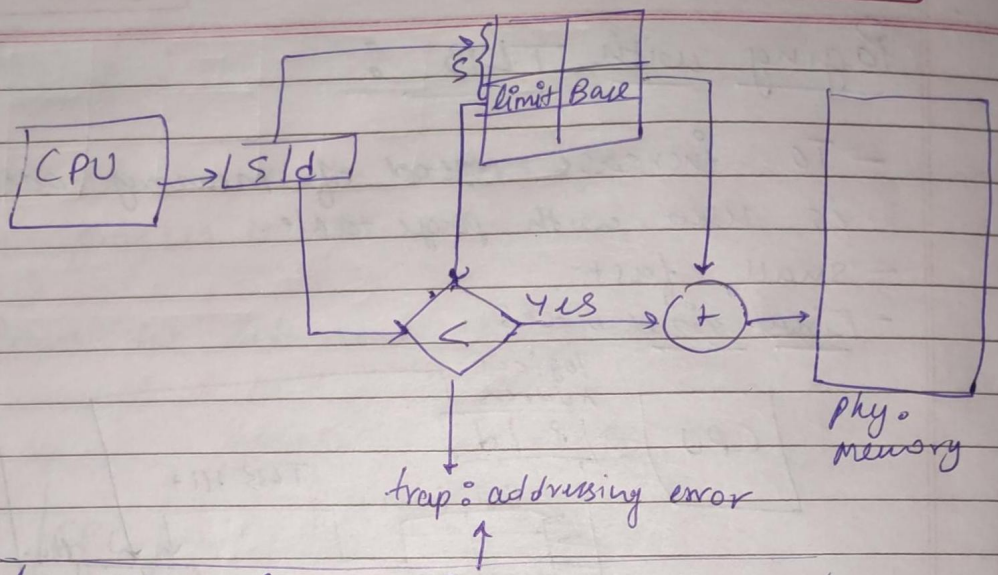

If offset d > Segment limit

Virtual Memory :

- A storage scheme that provides user an illusion of having a very big main memory.
- This is done by treating a part of secondary memory as main memory.

Demand Paging :

- only ~~those~~ pages are loaded when they are demanded.
- Lazy swapper is used, it never swaps a page into memory unless that page will be needed.

Effective Access Time = (1-p) * ma + p * page fault time

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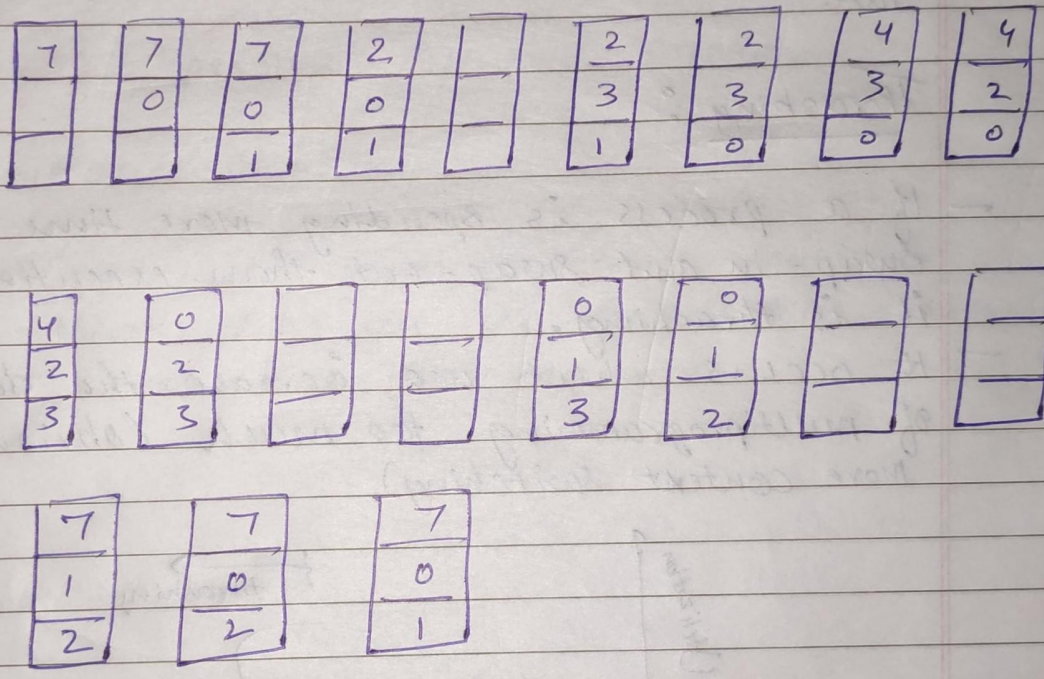
Q. 7, 0, 1, 2, 0, 3, 0, 4, 2, 3, 0, 3, 2, 1, 2, 0, 1, 7, 0, 1

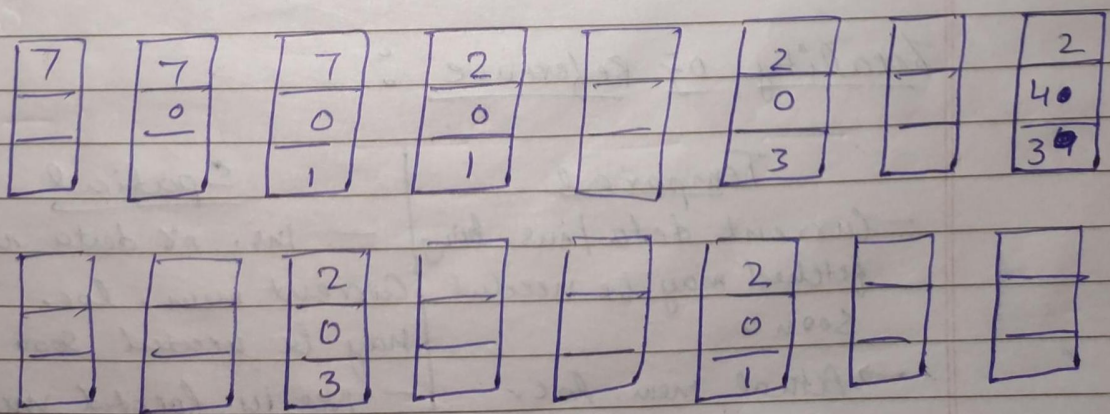
Apply : (3 frames)

(1) FIFO



Page Faults = 15

(2) Optimal Page Replacement



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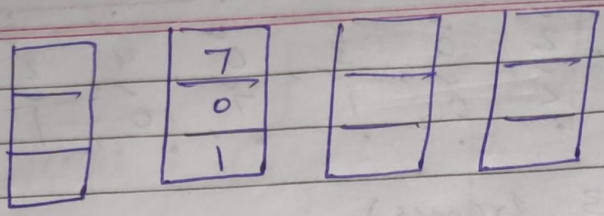
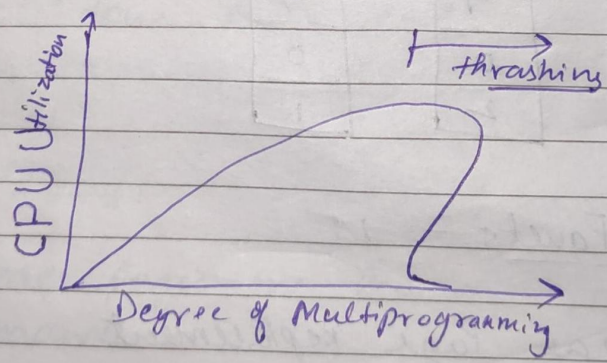


Page Faults = 9

Note :- Optimal Page Replacement has lowest page-fault rate.

Thrashing :

- If a process is spending more time in swap-in and swap-out than executing then it is thrashing.
- It occurs when we increase the degree of multiprogramming too much (obviously, more context switching).



Locality of Reference :

Temporal	Spatial
- Current data/ins. being fetched may be needed soon. → Actual mem. loc.	- Ins. or data near to current mem. loc. being fetched may be needed soon in future. - Nearly located mem. loc.

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Other useless Machines :

① Bare Machine

- Comp. with no OS
- Ins. directly on logical HW.
- uses machine language.
- Fast code
- Expensive Software creation

② Resident Monitor

- Code that runs on Bare Machine
- Works like an OS that controls instructions
- Works like job sequencer

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UNIT - 5

Disk Scheduling Algorithms :

1. FCFS
   - Scheduled in the order they arrive in disk queue

2. Shortest Seek Time First (SSTF)
   - Request is calculated in advance in the queue
   - Request near disk arm gets executed first.

3. SCAN
   - ELEVATOR Algorithm
   - Disk moves into a particular direction
   - Then reverses its direction and again services the request arriving in its path.
   - Touches the first limit of disk (upper or lower)

4. LOOK
   - Improved version of SCAN Algorithm.
   - Head does not touch limit, just goes to last request and reverses its direction

5. CSCAN
   - Direction is preserved
   - Both limits are touched.

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(6) CLOOK

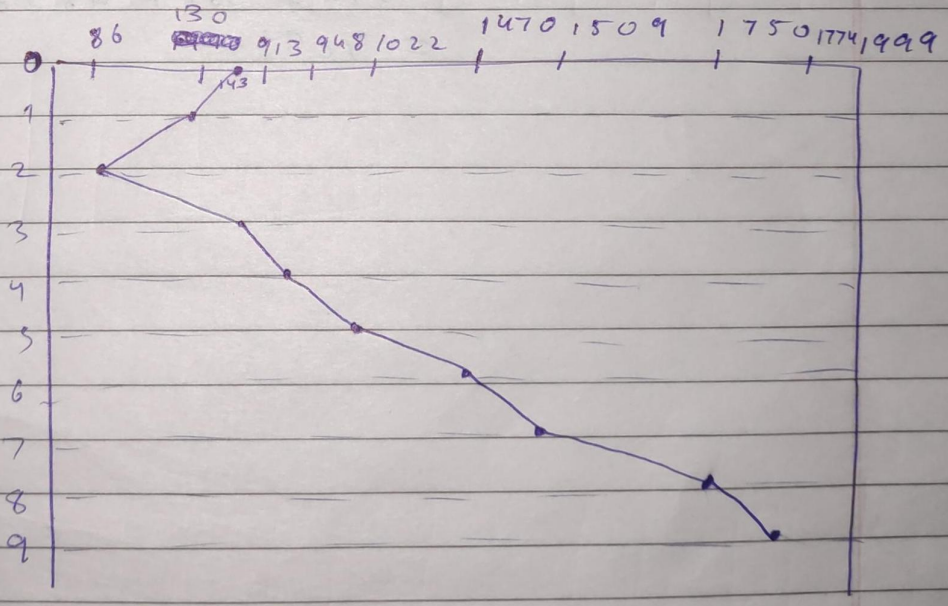
- Same as CSCAN
- No limits are touched
- Only first and last requests are touched to preserve direction

8. 86, 1470, 913, 1774, 948, 1509, 1022, 1750, 130

Initial Head = 143
Range = 0 to 1999

Apply :

(1) ~~FCFS~~ SSTF



Total Seek Time = 13 + 44 + 827 + 35 + 74 + 448 + 39 + 241 + 24
= 1745

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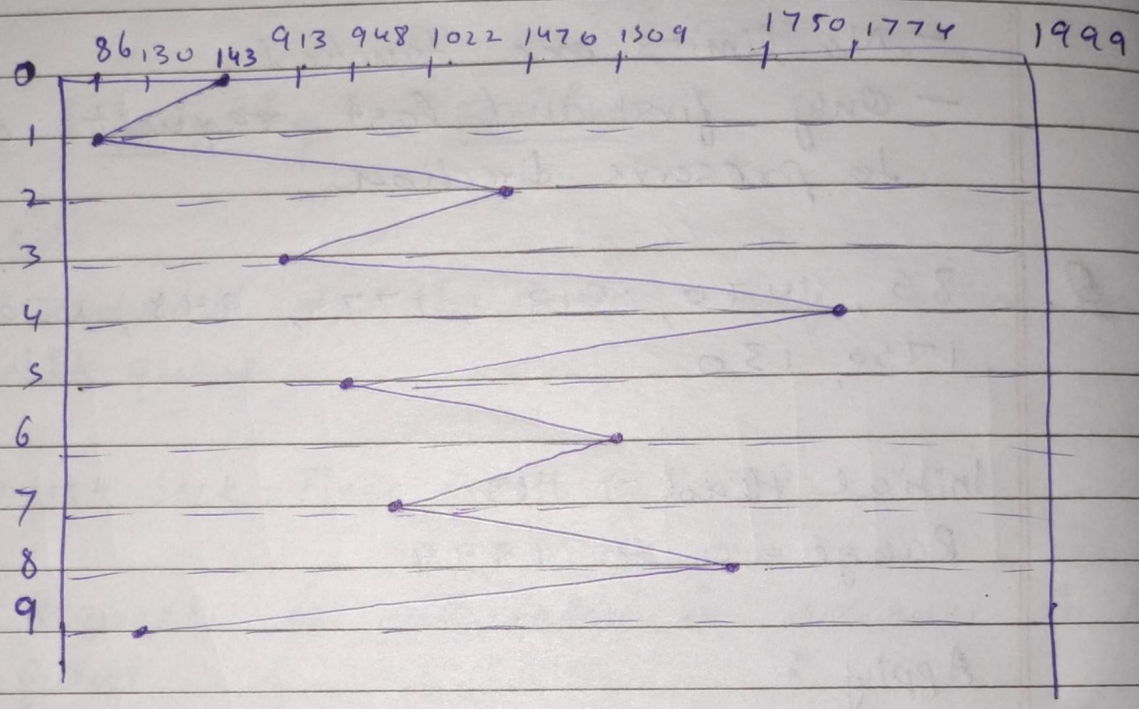
(2) FCFS



Total Seek Time = 57 + 1384 + 557 + 861 +
826 + 561 + 487 + 728 + 1620
= 7081