Operating Systems

Virtual Memory

Background

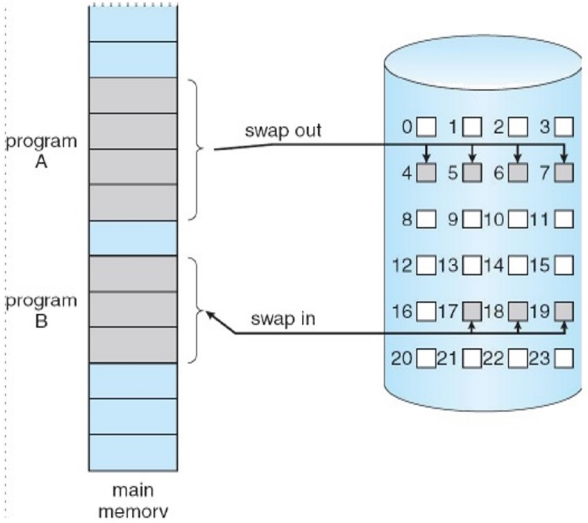
- The term “virtual memory” refers to something which appears to be present but actually it is not.
- The virtual memory technique allows users to use more memory for a program than the real memory of a computer.
- Virtual memory is a **concept** that we use when we have processes that exceed the main memory.
- When computer runs out of physical memory, it writes its requirement to the hard disc in a swap file as “virtual memory”.

Demand Paging

- ❑ Bring a page into memory only when it is needed
- Less I/O needed
- Less memory needed
- Faster response
- More users

- ❑ Disadvantage: Page fault interrupt

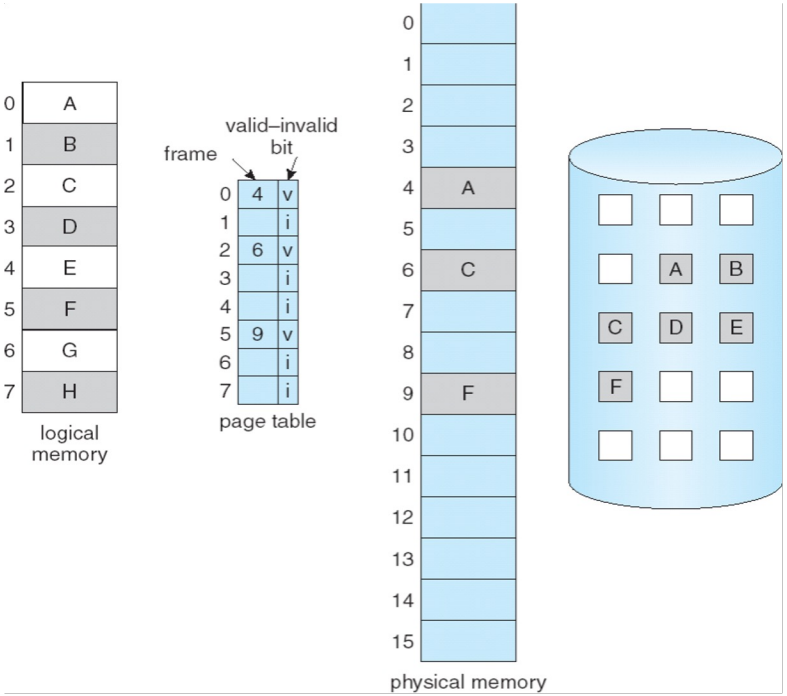
- ❑ Required hardware support:
- Page Table with valid-invalid bit
- Secondary memory



Demand Paging in OS

Valid-Invalid Bit

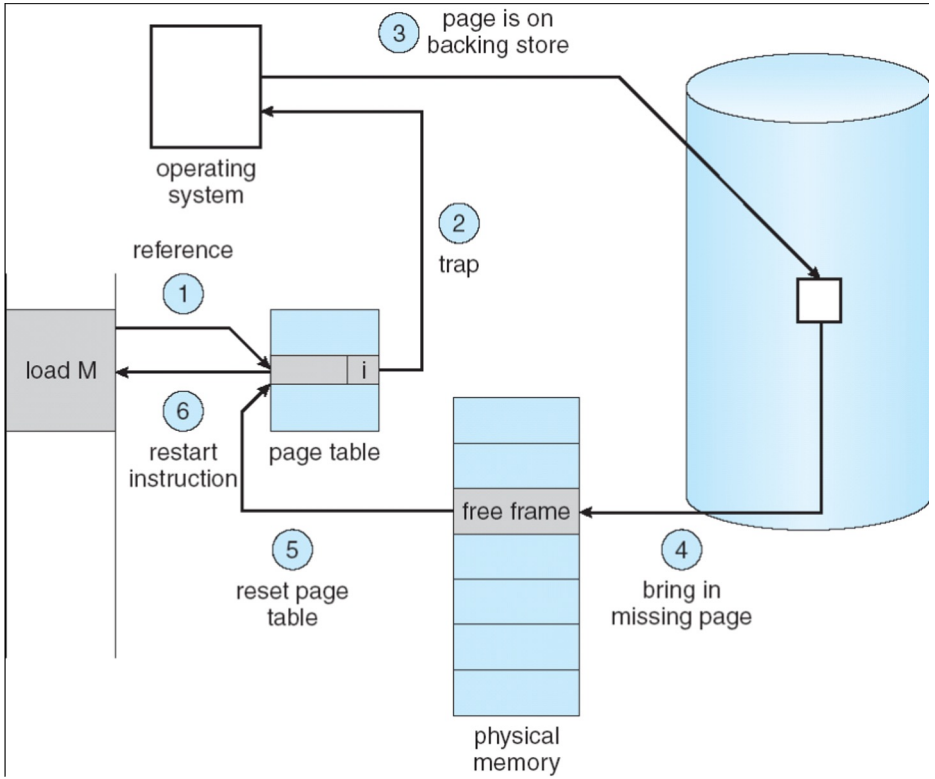
- ❑ An extra bit in the page table which indicates the existence of the page in the main memory.
- ❑ Attempt to access page
- ❑ If page is valid (in memory) then continue processing instruction as normal.
- ❑ If page is invalid then a page-fault trap / page-fault interrupt occurs.
- ❑ Page is needed ⇒ reference to it
- Invalid reference ⇒ abort
- Not-in-memory ⇒ bring to memory



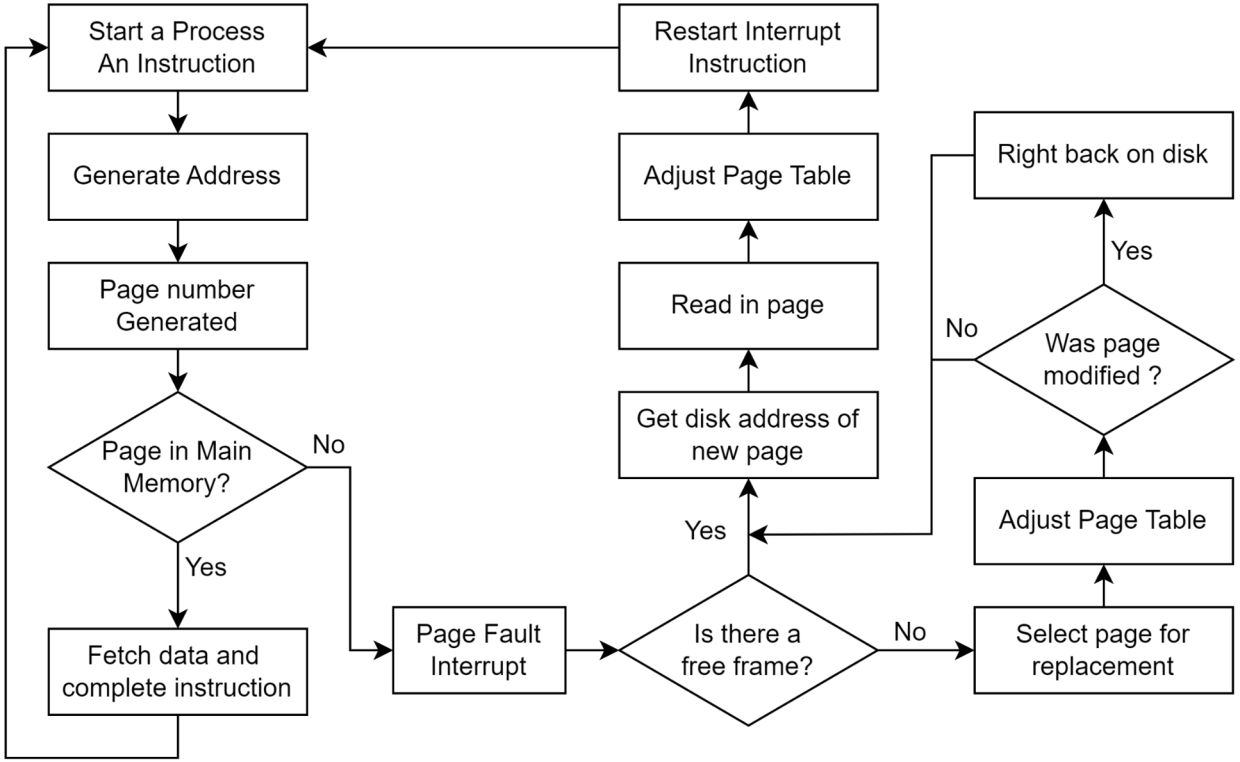
Page Fault

If there is ever a reference to a page, first reference trap to OS ⇒ **page fault**

1. OS looks at another table to decide:
   - Invalid reference ⇒ abort.
   - Just not in memory.
2. Find empty/ free frame.
3. Load page from disk into frame.
4. Reset tables, validation bit = 1.
5. Restart instruction that caused page fault



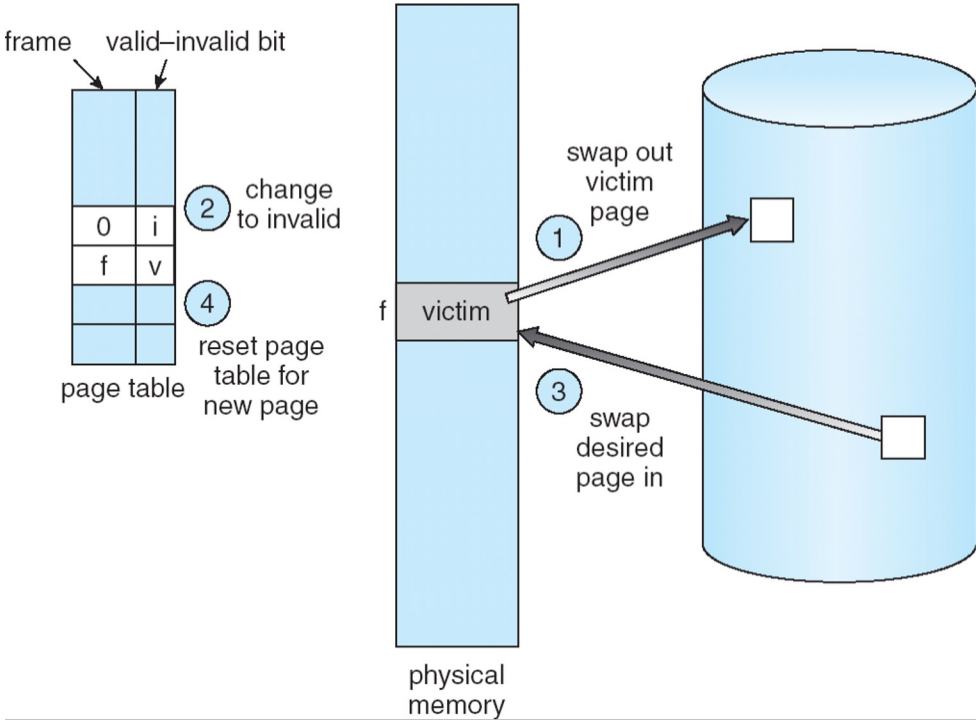
Demand Paging Flowchart



Page Replacement

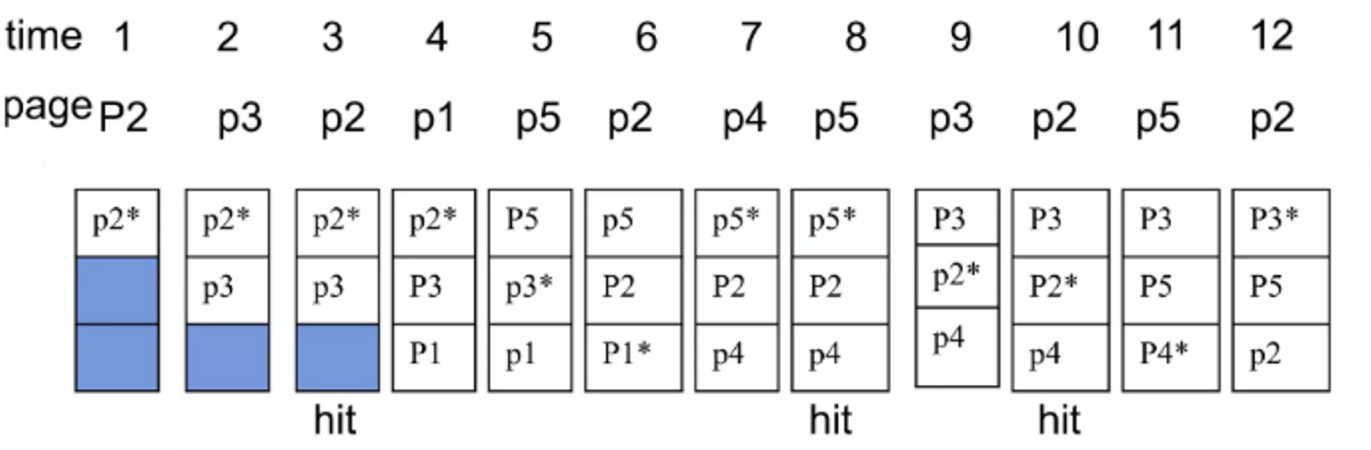
Page Replacement Algorithms:

- FIFO (First In First Out)
- LRU (Least Recently Used)
- OPT (Optimal)



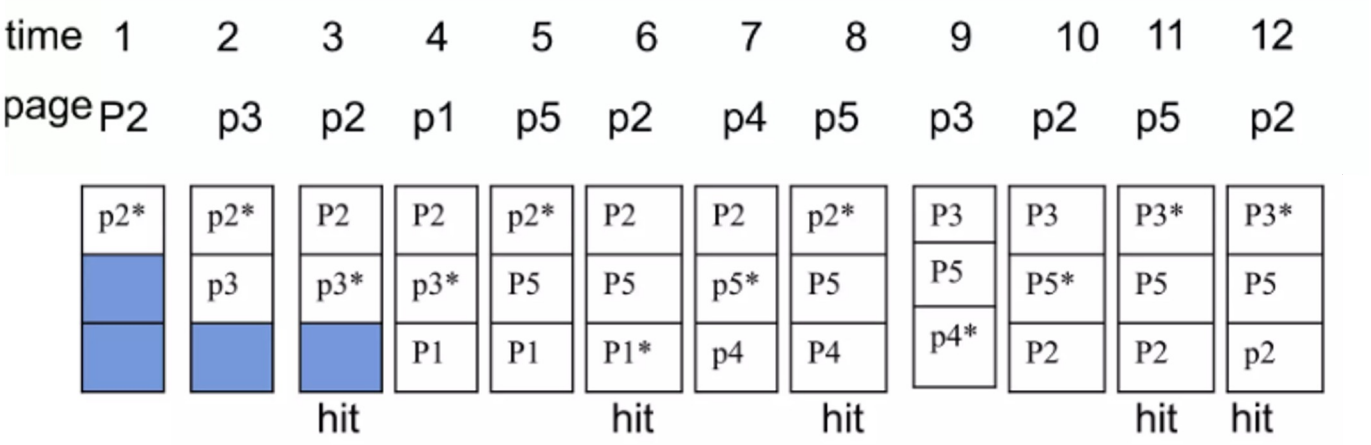
FIFO (First In First Out)

- Selects the page for replacement that has been in the memory for the longest amount of time



LRU (Least Recently Used)

- Replace the least recently used page in the past
- Can be implemented by associating a counter with every page that is in main memory



Optimal

- Replace the page which is not used in longest dimension of time in future