

# Virtual Memory

## Chapter 8

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## Hardware and Control Structures

- Memory references are dynamically translated into physical addresses at run time
  - A process may be swapped in and out of main memory such that it occupies different regions
- A process may be broken up into pieces that do not need to be located contiguously in main memory
- All pieces of a process do not need to be loaded in main memory during execution

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## Execution of a Program

- Operating system brings into main memory a few pieces of the program
- Resident set - portion of process that is in main memory
- An interrupt is generated when an address is needed that is not in main memory
- Operating system places the process in a blocking state

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## Execution of a Program

- Piece of process that contains the logical address is brought into main memory
  - Operating system issues a disk I/O Read request
  - Another process is dispatched to run while the disk I/O takes place
  - An interrupt is issued when disk I/O complete which causes the operating system to place the affected process in the Ready state

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## Advantages of Breaking up a Process

- More processes may be maintained in main memory
  - Only load in some of the pieces of each process
  - With so many processes in main memory, it is very likely a process will be in the Ready state at any particular time
- A process may be larger than all of main memory

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## Types of Memory

- Real memory
  - Main memory
- Virtual memory
  - Memory on disk
  - Allows for effective multiprogramming and relieves the user of tight constraints of main memory
  - Programming convenience

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# Thrashing

- Swapping out a piece of a process just before that piece is needed
- The processor spends most of its time swapping pieces rather than executing user instructions

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# Principle of Locality

- Program and data references within a process tend to cluster
- Only a few pieces of a process will be needed over a short period of time
- Possible to make intelligent guesses about which pieces will be needed in the future
- This suggests that virtual memory may work efficiently

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## Support Needed for Virtual Memory

- Hardware must support paging and segmentation
- Operating system must be able to management the movement of pages and/or segments between secondary memory and main memory

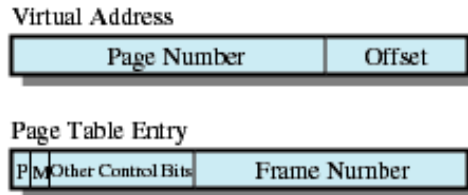
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## Paging

- Each process has its own page table
- Each page table entry contains the frame number of the corresponding page in main memory
- A bit is needed to indicate whether the page is in main memory or not

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# Paging



(a) Paging only

P : present  
M: modified

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## Modify Bit in Page Table

- Modify bit is needed to indicate if the page has been altered since it was last loaded into main memory
- If no change has been made, the page does not have to be written to the disk when it needs to be swapped out

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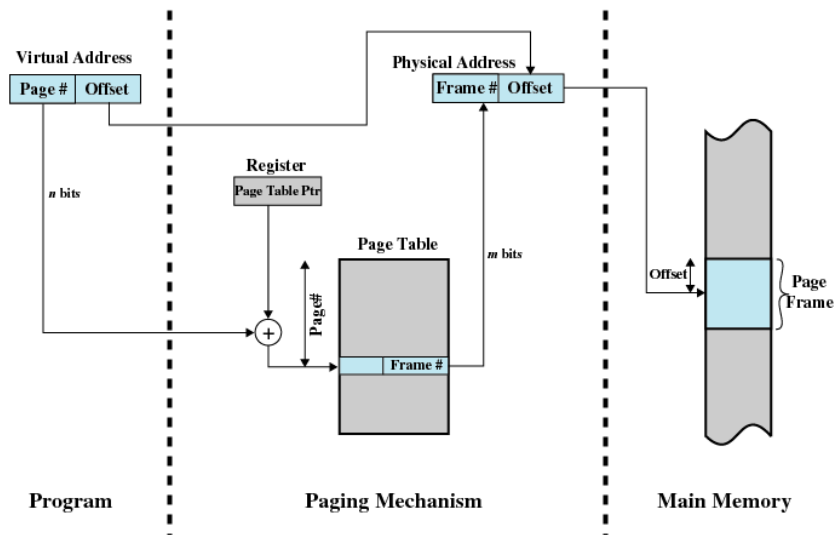


Figure 8.3 Address Translation in a Paging System