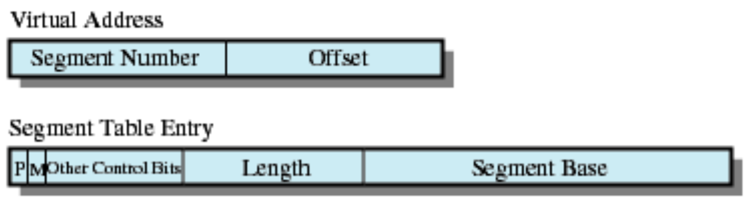
Segmentation

- May be unequal, dynamic size
- Simplifies handling of growing data structures
- Allows programs to be altered and recompiled independently
- Lends itself to sharing data among processes
- Lends itself to protection

Segment Tables

- Corresponding segment in main memory
- Each entry contains the length of the segment
- A bit is needed to determine if segment is already in main memory
- Another bit is needed to determine if the segment has been modified since it was loaded in main memory

Segment Table Entries



(b) Segmentation only

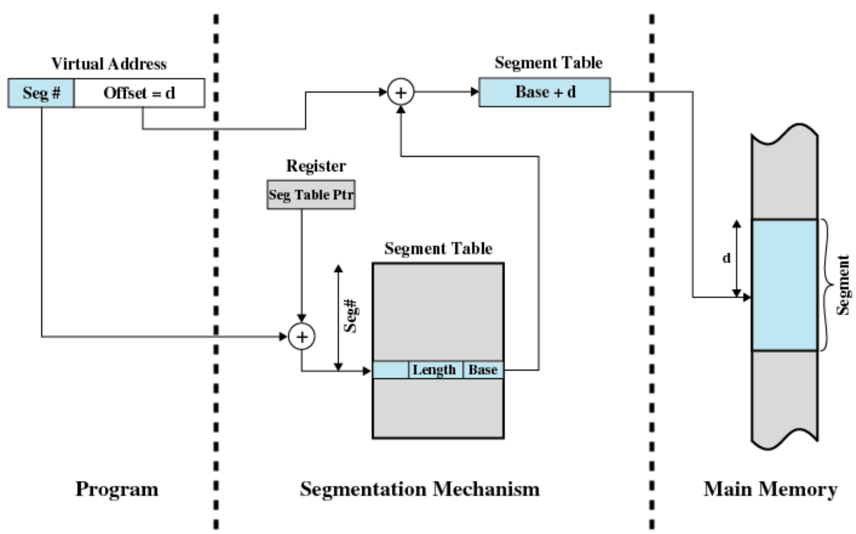
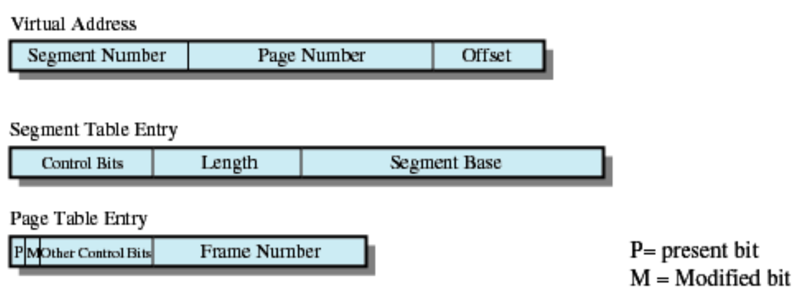


Figure 8.12 Address Translation in a Segmentation System

Combined Paging and Segmentation

- Paging is transparent to the programmer
- Segmentation is visible to the programmer
- Each segment is broken into fixed-size pages

Combined Segmentation and Paging



(c) Combined segmentation and paging

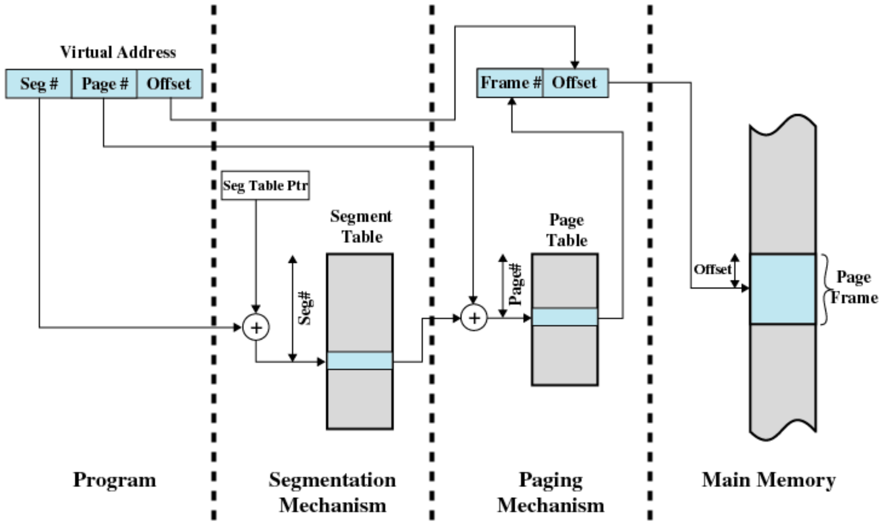


Figure 8.13 Address Translation in a Segmentation/Paging System

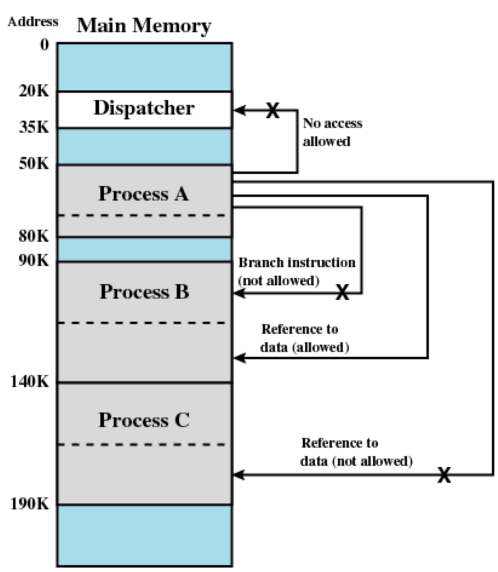


Figure 8.14 Protection Relationships Between Segments

Fetch Policy

- Fetch Policy
  - Determines when a page should be brought into memory
  - **Demand paging** only brings pages into main memory when a reference is made to a location on the page
    - Many page faults when process first started
  - **Prepaging** brings in more pages than needed
    - More efficient to bring in pages that reside contiguously on the disk

Placement Policy

- Determines where in real memory a process piece is to reside
- Important in a segmentation system
- Paging or combined paging with segmentation hardware performs address translation

Replacement Policy

- Placement Policy
  - Which page is to be replaced?
  - Page removed should be the page least likely to be referenced in the near future
  - Most policies predict the future behavior on the basis of past behavior

Replacement Policy

- Frame Locking
  - If frame is locked, it may not be replaced
  - Kernel of the operating system
  - Control structures
  - I/O buffers
  - Associate a lock bit with each frame

Basic Replacement Algorithms

- Optimal policy
  - Selects for replacement that page for which the time to the next reference is the longest
  - Impossible to have perfect knowledge of future events
  - This policy is "wishful thinking", but can serve as a base-line when post-evaluating different policies

Basic Replacement Algorithms

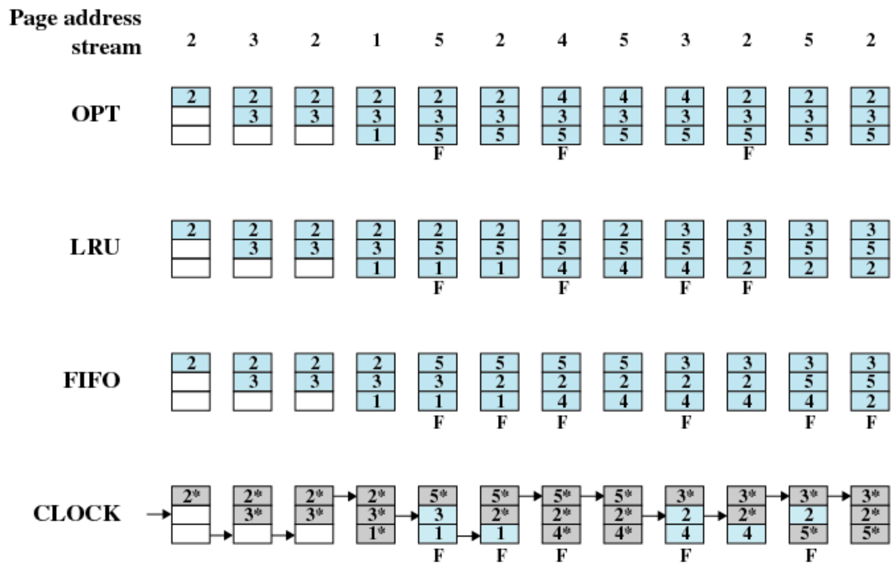
- Least Recently Used (LRU)
  - Replaces the page that has not been referenced for the longest time
  - By the principle of locality, this should be the page least likely to be referenced in the near future
  - Each page could be tagged with the time of last reference. This would require a great deal of overhead.

Basic Replacement Algorithms

- First-in, first-out (FIFO)
  - Treats page frames allocated to a process as a circular buffer
  - Pages are removed in round-robin style
  - Simplest replacement policy to implement
  - Page that has been in memory the longest is replaced
  - These pages may be needed again very soon
  - Performs relatively poorly

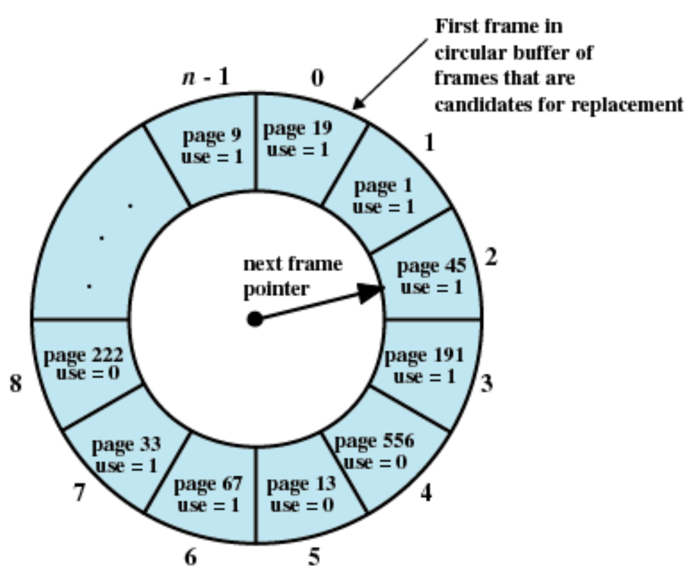
Basic Replacement Algorithms

- Clock Policy
  - Additional bit called a *use* bit
  - When a page is first loaded in memory, the *use* bit is set to 1
  - When the page is referenced, the use bit is set to 1
  - When it is time to replace a page, the first frame encountered with the *use* bit set to 0 is replaced.
  - During the search for replacement, each *use* bit set to 1 is changed to 0

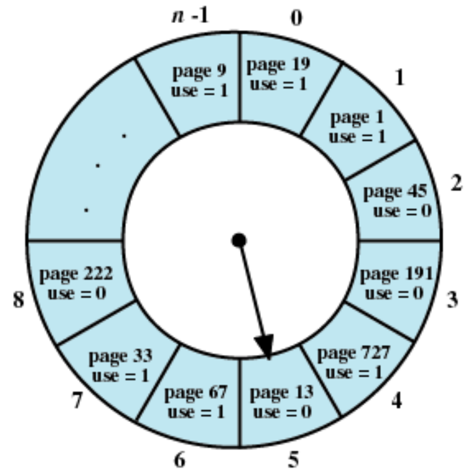


F = page fault occurring after the frame allocation is initially filled

Figure 8.15 Behavior of Four Page-Replacement Algorithms



(a) State of buffer just prior to a page replacement



(b) State of buffer just after the next page replacement

Figure 8.16 Example of Clock Policy Operation

Comparison of Placement Algorithms

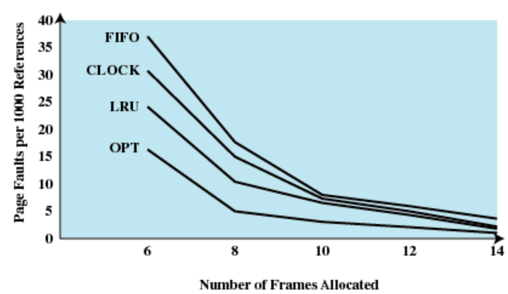


Figure 8.17 Comparison of Fixed-Allocation, Local Page Replacement Algorithms

case study: page size = 256 words