Memory Management

Types

- Basic two types of memory management techniques
- Swapping
- Demand Paging

Basic Concept Demand Paging

- Partition physical memory into smaller chunks (pages)
- A process memory is managed in terms of pages
- Kernel only loads frames when needed
- Use a page table to hold referenced frames(pages)

Benefits Of Paging

- Increased utilization of memory
- Reduced I/O for swapping a process in/out of memory
- Faster startup time for processes

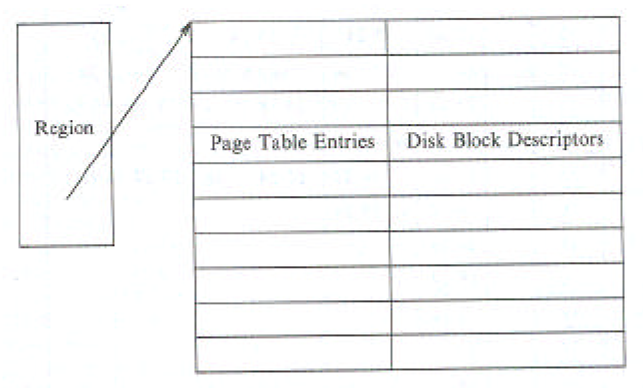
Cons of Page

- Addition kernel structures required for virtual memory management
- Complexity

Data Structures for DP

- Disk block descriptors
- Page frame data table (pfdata)
- Swap use table

Region Structure



Page Table & Disk Block Disp.

Page Table Entry

Page (Physical) Address	Age	Cp/Wrt	Mod	Ref	Val	Prot

Disk Block Descriptor

Swap Dev	Block Num	Type (swap, file, fill 0, demand fill)

Figure 9.13. Page Table Entries and Disk Block Descriptors

Pfdata

- Data contained in Pfdata entry
  - Page state (swap device, executable, currently being copied, etc.)
  - Number of processes that reference the page
  - Logical device and block number
  - Pointers to other pfdata entries

Rel. Data Structures for DP

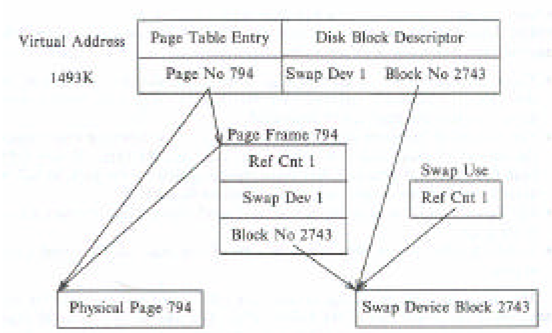


Figure 9.14. Relationship of Data Structures for Demand Paging

Fork in Demand Paging

- Does not copy every region of parent process, instead it manipulates region tables, page table entries and pfdata table entries.
- Incrementing reference counts for shared regions
- Allocates new region tables entries for private.

Fork in Demand Paging

- If page is valid in parent, increment count in pfdata table entry of child processes
- Only when page is modified is a copy of the page made for child/parent process.
- Similar process if page is on swap device.

Exec in Demand Paging

- Entire file may not be read into memory initially
- Instead
  - kernel creates an “Block List” and attaches it to the Inode for the file
  - Disk block descriptor are filled with logical block No. within Block List
  - The block list contains the actual disk block number

Example of Exec (DP)

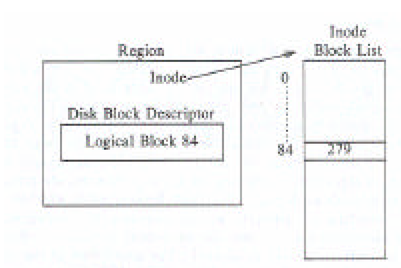


Figure 9.17. Mapping a File into a Region

Running out of Free Pages

- Can the system run out of free pages?
- Page Stealer
  - Kernel Process
  - Swaps out pages not in a process working set
  - Runs periodically

Page Stealer Algorithm

Examine every page
If locked
    skip
Else
Age page
If pageAge > ageLimit
    swap page out
Continue

States for a Swappable Page

- Swap device does not have a copy of the page
- Swap device does have a copy of the page and the page has not been modified
- Swap device has a copy of the page, but the in-core copy of page has been modified.
- Of the identified states which require page be copied out to swap device?

Page Fault

- Occurs when process accesses a page who’s valid bit is not set.
- When is the valid bit of a page table entry not set?
- Validity faults
  - Address that are part of virtual memory, but do not have a physical page assigned
- Protection Faults
  - Address that are out side of the virtual address space of the process

Valid Page Fault Cases

- Basically Five cases
  1. On Swap Device & not in memory
  2. On free page list in memory
  3. In an executable file
  4. Marked “demand zero”
  5. Marked “demand fill”

Valid Fault Example

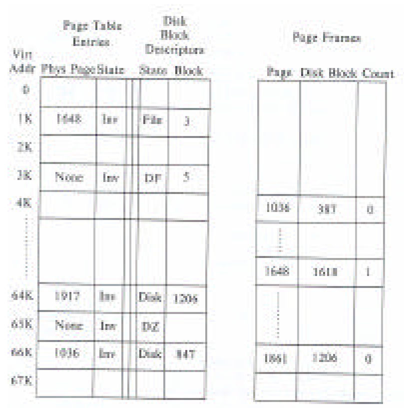


Figure 9.22. Occurrence of a Validity Fault

Valid Fault Example

1. Reference addr. 66K
2. Valid == false
3. Read file from disk block 847.
4. Disk BLK 847 not in page cache.
5. Kernel assigns new page (phy. 1776) to hold contents of virtual addr. 66K

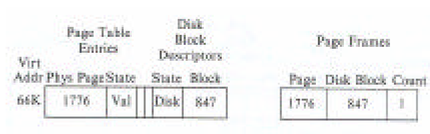
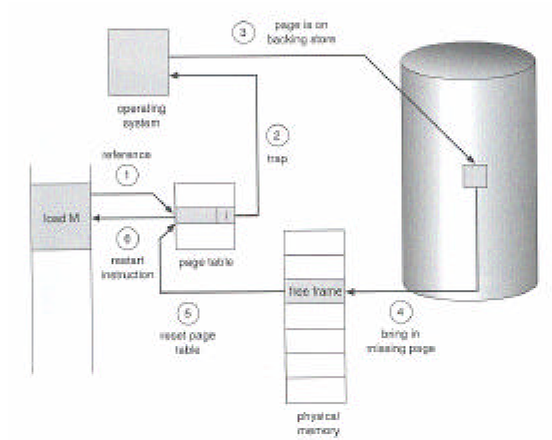
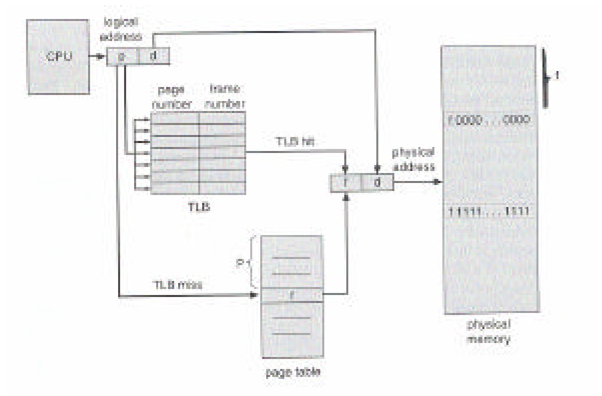


Figure 9.23. After Swapping Page into Memory

Swapping Graph



TLB


CPU
logical address
p
d
page number
frame number
TLB hit
TLB
physical address
f
d
f 0000 . . . 0000
1 1111 . . . 1111
f
p
TLB miss
f
page table
physical memory