Memory Management (2)

VIRTUAL MEMORY

- Problem: programs were too big to fit in the available memory
- Solution:
  1. overlay (split the program into pieces)
     - Swapping overlay done by system, however splitting the program has to done by the programmer
  2. Virtual memory
     - Basic idea: programs may exceed the amount of physical memory available for it
     - Most virtual memory system use a technique called paging,

Paging

- Virtual addresses: program-generated addresses, it form Virtual address space.
- Memory Management Unit (MMU): maps the virtual addresses onto the physical memory addresses

![Diagram of Memory Management System]

- Virtual address space is divided up into units called pages
- The corresponding units in the physical memory are called page frames
- Page fault / fault = happened if program tries to use an unmapped page.
  - The operating system picks a little-used page frame and writes its contents back to the disk.
  - It then fetches the page just referenced into the page frame just freed, changes the map, and restarts the trapped instruction.
MOV REG,0
0 (virtual address)
Page 0
Frame 2
Physical address is 8192

MOV REG,20500
20 bytes from the start of virtual page 5 (virtual addresses 20480)
Frame 3
Physical address = 12288+20 = 12308

MOV REG, 33000 – PAGE FAULT

Paging
- Virtual address consist of 2 part:
  - page number p
  - offset page d

Page table = table for all processes in the memory

Page Replacement Algorithm
- When a page fault occurs, the operating system has to choose a page to remove from memory to make room for the page that has to be brought in.
- Objective: Minimum page fault
Page Replacement Algorithm

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

FIFO (First In First Out)

- Replace the oldest page
- Number of faults: 15

Optimal

- Replace the page that will not be used in the near future
- Impossible to implement because the operating system has no way of knowing when each of the pages will be referenced next.

LRU (Least Recently Used)

- Replace the page that is not recently used