Virtual Memory

Vo Hieu Nghia

1)

FIFO											
time	t1	t2	t3	t4	t5	t6	t7	t8	t9	t10	t11
VM page	3	4	6	10	3	5	3	5	4	5	3
Main Page 0	3	3	3	3	3	5	5	5	5	5	5
Main Page 1		4	4	4	4	4	3	3	3	3	3
Main Page 2			6	6	6	6	6	6	4	4	4
Main Page 3				10	10	10	10	10	10	10	10

- First in first out: Which page has been loaded in first will be replaced when there is page fault
- The red marks are page faults, so the number of page fault are 7

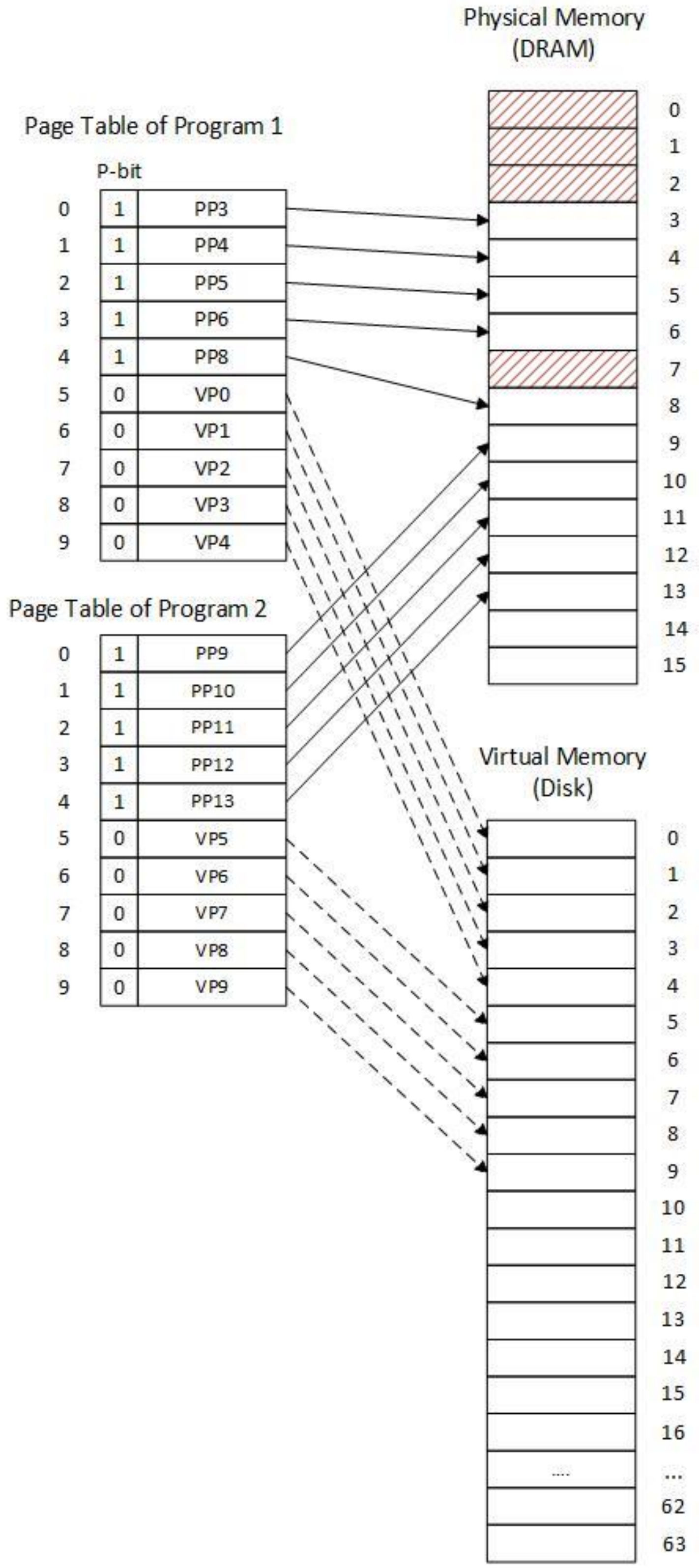
LRU											
time	t1	t2	t3	t4	t5	t6	t7	t8	t9	t10	t11
VM page	3	4	6	10	3	5	3	5	4	5	3
Main Page 0	3 (0)	3 (1)	3 (2)	3 (3)	3(0)	3 (1)	3 (0)	3 (1)	3 (2)	3 (3)	3 (0)
Main Page 1		4 (0)	4 (1)	4 (2)	4(3)	5 (0)	5 (1)	5 (0)	5 (1)	5 (0)	5 (1)
Main Page 2			6 (0)	6 (1)	6(2)	6 (3)	6 (4)	6 (5)	4 (0)	4 (1)	4 (2)
Main Page 3				10 (0)	10(1)	10 (2)	10 (3)	10 (4)	10 (5)	10 (6)	10 (7)

Least recently used:

- The numbers outside the bracket () are the virtual page which is loaded into the memory
- The numbers inside the bracket () are the reference number of Least recently used.

- If the reference of the virtual memory page is called, then the reference of that LRU will be return to 0, else it will be raised by 1
- Therefore, the number of pages fault in this case is 6

2)



Page Table of Program 1

	P-bit	
0	1	PP3
1	1	PP4
2	1	PP5
3	1	PP6
4	1	PP8
5	0	VP0
6	0	VP1
7	0	VP2
8	0	VP3
9	0	VP4

Page Table of Program 2

0	1	PP9
1	1	PP10
2	1	PP11
3	1	PP12
4	1	PP13
5	0	VP5
6	0	VP6
7	0	VP7
8	0	VP8
9	0	VP9

3)The worst case:

- The information that 2 loading instructions is on 2 different pages, which has not been loaded to the main memory

- CPU cannot find the page table entry → Access table page

- MMU cannot find the page which have the information needed to be load in the memory → load from hard disk

- When it loads page from hard disk, the memory is full already → do page replacement

➔ The execution time of program mostly depend on the time access I/O hardware to hard disk (because it has to access hard disk 2 times for 2 loading instructions) and the time to access hard disk is much longer than the time loading from memory