Mittuniversitetet
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DT011G Introduction to Operating Systems

Theory assignment: Memory

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1 Prerequisites

This assignment covers part four of the book [**Silberschatz2009osc**], i.e. memory management. Hence, before attempting this assignment you should have read part four, i.e. chapters 8 and 9, *Memory-management strategies* and *Virtual memory management*, respectively.

2 Tasks

1. Define the different address spaces
   (a) physical address space,
   (b) logical address space, and
   (c) virtual address space.
2. Describe the differences and similarities of paging and segmentation, also describe how they can be combined to complete each other.
3. Consider a paging system where the page table is stored in memory (e.g. in a process' PCB).

*This work is licensed under the Creative Commons Attribution-ShareAlike 3.0 Unported license. To view a copy of this license, visit `http://creativecommons.org/licenses/by-sa/3.0/`. Some of the questions are derived from the work of **Silberschatz2009osc**

(a) If a memory reference takes 100 ns, how long does a paged memory reference take?

(b) If we add an associative register to keep parts of the page table in, 80 percent of all page references are found in this table, what is the effective access time if a lookup in this register takes 10 ns.

4. Explain why page sizes are always a power of 2. (Note that this explanation can be directly mapped to why the number of host addresses in a subnet is a power of 2, it makes subnet masking that much easier.)

5. Describe the chain of events which takes place when a page fault occurs. Start with the process executing the instruction referencing the logical address and end with the process moving on to the next instruction.

6. Imagine a computer providing a 32-bit virtual-memory space, i.e. 2^{32} bytes. The computer has a page size of 4096 bytes. A user process generates the virtual address $deadbeef_{16}$. What is the page number and what offset in that page i referenced? (You must explain how you come to this conclusion.)

7. On one of your servers you find these, quite disturbing, statistics:

   - The CPU utilization is at 20 percent,
   - the paging disk utilization is at 98 percent[1], and
   - utilization of other I/O devices is at 5 percent.

   As this system is part of one of the heavily used compute clusters the CPU utilization should be above 70 percent at all times. First answer what the problem with the system is and then explain how the following actions will affect the statistics above.

   (a) Installing a faster CPU.

   (b) Installing a bigger paging disk.

   (c) Installing more main memory.

   (d) Installing a faster hard disk drive[2] as the paging disk.

   (e) Increasing the page size.

   (f) Add prepaging to the page fetch algorithms.

   (g) Increasing the level of multiprogramming.

   (h) Decreasing the level of multiprogramming.

8. Describe Belady's anomaly.

3 Examination

Your answers should be handed in using the course platform. They should be well-written using correct references including page or section numbers[3].

[1] This does not mean it is 98 percent full but that it is constantly read from and written to.

[2] Or some sort of RAID system.

[3] This is also to better prepare you for the exam, then you can use your assignment to quickly find information in the book.