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DT141G Operating Systems

Theory assignment: Memory

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Contents

1 Aim

The aim of the assignment is, first, to aid your understanding of the treated content by providing questions and problems which inspire reflection. Second, it is to examinate the following:

- That you can explain how different solutions to the problem of memory management work as well as advantages and disadvantages of said solutions.
- That you can analyze performance of different memory management algorithms and how this performance depends on how a process uses its memory.
- That you can explain why most sizes in computer systems are powers of 2.
- That you can analyze the state of a computer system, identify the problem and suggest a solution for the problem.

2 Prerequisites

This assignment covers part three of the book [2; 3], i.e. memory management. Hence, before attempting this assignment you should have read chapters 8 and 9, "Memory-Management Strategies" and "Virtual-Memory Management", respectively. See the study guide for a complete list of reading instructions.

3 Tasks

1. Define the different address spaces
   (a) physical address space, and
   (b) logical 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).
   (a) If a memory reference takes 100 ns, how long does a paged memory reference take?
   (b) If we add an associative register (e.g. a TLB) to keep parts of the page table in, and assume 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 is 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.

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

(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.

4 Examination

Your answers should be handed in using the course platform in a PDF-format. All questions and subquestions must be fully answered. The answers should be well written using correct references including page or section numbers. Use the IEEE Citation Reference[3] and the IEEE format for your references.

References

[1] Abraham Silberschatz, Peter Baer Galvin, and Greg Gagne. *Operating System Concepts*. John Wiley & Sons Inc, Hoboken, N.J., 8 edition, 2009. International Student Version.

[2] Abraham Silberschatz, Peter Baer Galvin, and Greg Gagne. *Operating System Concepts*. John Wiley & Sons Inc, Hoboken, N.J., 9 edition, 2013. International Student Version.

[3] Abraham Silberschatz, Peter Baer Galvin, and Greg Gagne. *Operating System Concepts*. John Wiley & Sons Inc, Hoboken, N.J., 9 edition, 2013.

[2] Or some sort of RAID system.

[3] The IEEE Citation Reference is available at: http://apachepersonal.miun.se/~jimahl/DT141G/ieeecitationref.pdf