IA Operating Systems:
Protection, Memory Management

Lent 2024
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1 Suppose we have a system with three users a, b and c and ten files $f_0, f_1, \ldots f_9$.

Further suppose we have four operations for which we wish to control access: *read, append, replace* and *modify*.

(a) Do we require all of these or can some be described by combinations of others?

(b) Create a nontrivial example set of access tuples of the the form (user, file, permission) and show how it might be represented as:

(i) an access matrix,

(ii) access control lists,

(iii) capability sets

2 Indicate if the follow statement is true or false, and explain why:

"A paged virtual memory is smaller than a segmented one."

3 (a) What is the *address binding* problem?

(b) The address binding problem can be solved at compile time, load time or run time. For *each* case, explain what form the solution takes, and give one advantage and one disadvantage.

4 Most operating systems provide each process with its own *address space* by providing a level of indirection between virtual and physical addresses.

(*a*) Give *three* benefits of this approach.

(*b*) Are there any drawbacks? Justify your answer.

5 A processor may support a *paged* or a *segmented* virtual address space.

(*a*) Sketch the format of a virtual address in each of these cases, and explain using a diagram how this address is translated to a physical one.

(*b*) In which case is physical memory allocation easier? Justify your answer.

(*c*) Give *two* benefits of the segmented approach.

6 (*a*) In the context of memory management, under which circumstances do *external* and *internal* fragmentation occur? How can each be handled?

(*b*) What is the purpose of a page table? What sort of information might it contain? How does it interact with a TLB?

(*c*) Describe with the aid of a diagram a two-level page table. Explain the motivation behind the structure and how it operates.

7 Past paper questions

- y2015p2q4 [not the last part of (c) about segment faults]

- y2013p2q4

- y2009p2q3 [not (b)]

- y2009p2q4

- y2011p2q4 (a)