Virtual Memory and Paging (2) (Practice)

ICS332

Operating Systems

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(q1) Hierarchical Page Table

- Consider a system that supports address spaces up to 2 GiB, uses a 2 KiB page size, and uses 2 bytes per page table entry
- Could we use a single-level page table?
- Say we use a 2-level page table, how is a logical address split into outer (p1), inner (p2), and offset?

(q1) Answer

- Consider a system that supports address spaces up to 2 GiB, uses a 2 KiB page size, and uses 2 bytes per page table entry
- Could we use a single-level page table?
  - NO: A process can have up to $2^{31} / 2^{11} = 2^{20}$ pages, so a single-level page table would be $2^{20} \times 2 = 2^{21}$ bytes, which is (way) bigger than the page size
- Say we use a 2-level page table, how is a logical address split into outer (p1), inner (p2), and offset?
  - Offset: 11 bits (# bytes per page = 2^{11})
  - p2: 10 bits (#entries per page = $2^{11} / 2 = 2^{10}$)
  - p1 = 31 - 11 - 10 = 10

(q2) Hierarchical Page Table

- Consider a system that supports address spaces up to 1 GiB, uses a 16 KiB page size, and uses 8 bytes per page table entry
- Say we use a 2-level page table
- What fraction of the outer page table page is utilized?

(q2) Answer

- Consider a system that supports address spaces up to 1 GiB, uses a 16 KiB page size, and uses 8 bytes per page table entry
- Say we use a 2-level page table
- What fraction of the outer page table page is utilized?

- There can be up to $2^{30} / 2^{14} = 2^{16}$ pages
- A page can hold $2^{14} / 2^{3} = 2^{11}$ page table entries
- So we need $2^{16} / 2^{11} = 2^{5}$ entries in the outer page table page (out of the 2^{11} possible)
- So the utilized fraction is $2^{5} / 2^{11} = 2^{-6} = 1 / 64$