CS250 HW #5

① Write-back caches are usually also write-allocate because in a write-back cache, writes will only change the block in cache. However, on a write-miss, if the cache was write-no-allocate, there would be no block moved to cache, so no change will happen. If the cache were write-allocate, the write miss will bring a block from memory to the cache, and then that block can be modified in the cache according to the write-back policy.

②
L1 access = 1ns   ~~90%~~ 90% L1 hit   ~~every~~ L1 miss 10%
L2 access = 10ns   100% L2 hit

$$t_{avg} = t_{L1} + \%_{L1 miss} \cdot t_{L2} = 1 + (0.1)(10) = 2\ ns$$

③g) Cont. A multi-level page table is a page table that splits up the existing page tables into multiple partitions (n partitions). We ~~then store n bits that indicate whether the partition has data~~ ~~each of the n partitions has data (allow 1 = 0, data 1)~~. We then store n bits that indicate whether the partition has data (1 bit for every n partitions). If we need to use a page table, we then ~~create~~ initialize the partition with values corresponding to that section of the page table. Since in general, we are not actually using all ~~of~~ of the page entries in a page table, we are able to save a large amount of space by never initializing those values that are null for values that we don't use.

③ 8GB Physical Mem $= 2^3 \times 2^{30} = 2^{33}$ physical mem
   256KB Page Size $= 2^8 \times 2^{10} = 2^{18}$ page size
   64-bit machine $= 2^{64}$ virtual mem

a) $\dfrac{2^{64}}{2^{18}} = 2^{46}$ ~~for~~ virtual pages

b) $\log_2 2^{46} = 46$ bits for VPN

c) $\dfrac{2^{33}}{2^{18}} = 2^{15}$ ~~for~~ physical pages

d) $\log_2 2^{15} = 15$ bits for PPN

e) $15 + 1 = 16$ bits = 2 bytes

f) Page table maps VPNs → PPNs $(2^{46}\ \text{entries})(2\ \text{bytes})$
   $= 2^{47}$ bytes

g) $2^{47} > 2^{33}$ so the flat page table is much larger than the physical memory. Thus, we need a data structure like a multi-level page table.

h) No. A TLB miss means that the page number is not in the TLB. If this happens, then we look for the PPN in the page table, which is stored in physical memory. If the PPN exists in the page table, it will not page fault. Otherwise, it will page fault.

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