

CS230 DLDC Quiz-4, Fri 08 Nov 2024, 8:30am-9:15am, Max. Marks: 10

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General instructions

- Write only in the space provided. Answer briefly but crisply (not lengthily or loosely).
 - You are allowed to refer to your own hand-written notes only.
 - Write neatly and clearly. Up to +2 **HP** for neat handwriting, neat/crisp answers.
 - Answers generally have to be (briefly) explained. State any necessary assumptions.
1. Consider a machine with a 64-bit virtual address space, 32KB pages, and 64GB of main memory. The L1 cache is of size 512 KB, uses 16-word blocks, and is 4-way set associative. The processor has a 512-entry TLB with 2-way set associativity. The OS uses 32-bit PIDs (Process IDs).
- a) [2 marks] Draw and label the various address fields (virtual and/or physical) during a memory read. Assume that L1 is physically (not virtually) addressed, and that a default page-table scheme is used.

32KB pages ==> 15-bits in VA/PA for address within page

Num sets in TLB = $512/2 = 256$ ==> 8 bits for set num

So, for TLB access, 64-bit VA broken-up as: (show it in drawing)

[41-bit tag]::[8-bit set num]::[15-bit addr-within-page]

64GB MM ==> 36 bit PA which is [21-bit phys page-num]::[15-bit addr-within-page]

TLB access using TLB tag gives 21-bit phys-page-num

L1 is accessed using 36-bit PA

Num sets in L1 = $2^{19}/(2^4 * 2^2 * 2^2) = 2^{11}$

So 36-bit PA broken up as follows for L1 access: (show it in drawing)

[x bit tag]::[11-bit set-num]::[4-bit word-within-block]::00

$x = 36 - (11+4+2) = 19$ here

- b) [2 marks] In the above case, what is the size of the bit comparator in TLB? In L1 cache? Assume that neither the TLB nor the L1 needs to be flushed on a context switch.

TLB needs comparison of PID field too (with PID register), since TLB entries need to be used for multiple processes, without flushing.

So for TLB, comparator size = TLB-tag-size + PID size = $41+32 = 73$ bits

L1 need not have PID comparison, so L1 comparator size = L1 tag size = 19 bits

- c) [1 mark] State one advantage of making the L1 cache virtually addressed.

VA-to-PA translation unnecessary in case of L1 hit ==> no TLB access needed ==> lower hit time

- d) [2 marks] Now suppose that the L1 cache is virtually addressed. Draw and label the various address fields (virtual and/or physical) during a memory read. Assume L1 hit.

No VA-to-PA translation done to access L1; access is using 64-bit VA

Num sets in L1 remains same as earlier, only diff is in tag size, which is now $x = 64 - (11+4+2) = 47$

64-bit VA now broken up as follows for L1 access: (show it in drawing)

[47 bit tag]::[11-bit set-num]::[4-bit word-within-block]::00

- e) [1 mark] In the case of the above virtually addressed L1 cache, and an L1 hit, what is the number of bits compared in the TLB ? Justify your answer briefly.

Trick question; no TLB access during L1 access, in case of virtually addressed L1

Num bits compared in TLB = 0

- f) [2 marks] Continuing along with the virtually addressed cache, give two specific 64-bit virtual addresses and corresponding PIDs, with the aliasing problem. Explain briefly.

Addr1 (in hex): 0x 0000 0000 0000 F000

Addr2 (in hex): 0x 0000 0000 0000 7000 (sample answer)

PID1 (in hex) : 0x 0000 0001

PID2 (in hex) : 0x 0000 0002 (any two different PIDs)

Draw relevant diagram below:

For the addresses, the address within page (last 15 bits) has to be the same, since sharing across processes would be at the granularity of a page. The remaining part should have some (any) difference.

(Diagram needs to show both virtual pages mapped to the same physical page)

2. **Optional, for House Points (up to 5HP):** Starting Mar 2020, for about 2 years, schools and colleges were shut in India. Illiteracy, poverty, child labour, child marriage increased as a result of the lockdown. It was portrayed as though Covid was a danger of unforeseen magnitude for children. What does a data comparison say? There were almost no children/young affected by the virus. In comparison, what is the estimated number of children dying every single day in India, due to poverty, malnutrition, and related illnesses?

Estimated infant (under 1 year) mortality rate: 2000 per day

Children 2-5y: another estimated 2000 per day

Elite “scientists” supporting lockdown were disconnected from science as well as from society, under media-exaggerated fear hallucination