

Virtual Memory Examples

Problem 1:

This problem concerns the way virtual addresses are translated into physical addresses. Imagine a system has the following parameters:

- Virtual addresses are 20 bits wide.
- Physical addresses are 18 bits wide.
- The page size is 1024 bytes.
- The TLB is 2-way set associative with 16 total entries.

The contents of the TLB and the first 32 entries of the page table are shown as follows. **All numbers are given in hexadecimal.**

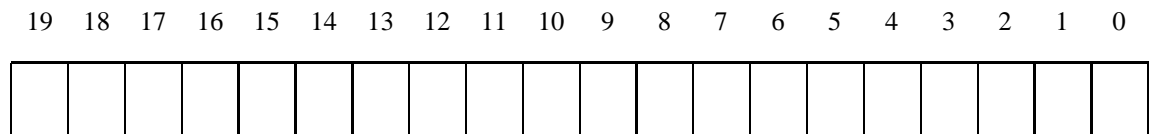
TLB			
Index	Tag	PPN	Valid
0	03	C3	1
	01	71	0
1	00	28	1
	01	35	1
2	02	68	1
	3A	F1	0
3	03	12	1
	02	30	1
4	7F	05	0
	01	A1	0
5	00	53	1
	03	4E	1
6	1B	34	0
	00	1F	1
7	03	38	1
	32	09	0

Page Table					
VPN	PPN	Valid	VPN	PPN	Valid
000	71	1	010	60	0
001	28	1	011	57	0
002	93	1	012	68	1
003	AB	0	013	30	1
004	D6	0	014	0D	0
005	53	1	015	2B	0
006	1F	1	016	9F	0
007	80	1	017	62	0
008	02	0	018	C3	1
009	35	1	019	04	0
00A	41	0	01A	F1	1
00B	86	1	01B	12	1
00C	A1	1	01C	30	0
00D	D5	1	01D	4E	1
00E	8E	0	01E	57	1
00F	D4	0	01F	38	1

Part 1

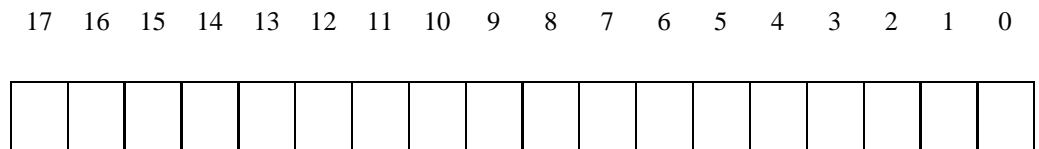
1. The diagram below shows the format of a virtual address. Please indicate the following fields by labeling the diagram: (If a field does not exist, do not draw it on the diagram.)

VPO The virtual page offset
VPN The virtual page number
TLBI The TLB index
TLBT The TLB tag



2. The diagram below shows the format of a physical address. Please indicate the following fields by labeling the diagram: (If a field does not exist, do not draw it on the diagram.)

PPO The physical page offset
PPN The physical page number



Part 2

For the given virtual addresses, please indicate the TLB entry accessed and the physical address. Indicate whether the TLB misses and whether a page fault occurs. If there is a page fault, enter “-” for “PPN” and leave the physical address blank.

Virtual address: 078E6

1. Virtual address (one bit per box)

19 18 17 16 15 14 13 12 11 10 9 8 7 6 5 4 3 2 1 0

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2. Address translation

Parameter	Value	Parameter	Value
VPN	0x	TLB Hit? (Y/N)	
TLB Index	0x	Page Fault? (Y/N)	
TLB Tag	0x	PPN	0x

3. Physical address(one bit per box)

17 16 15 14 13 12 11 10 9 8 7 6 5 4 3 2 1 0

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Virtual address: 04AA4

1. Virtual address (one bit per box)

19 18 17 16 15 14 13 12 11 10 9 8 7 6 5 4 3 2 1 0

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2. Address translation

Parameter	Value	Parameter	Value
VPN	0x	TLB Hit? (Y/N)	
TLB Index	0x	Page Fault? (Y/N)	
TLB Tag	0x	PPN	0x

3. Physical address(one bit per box)

17 16 15 14 13 12 11 10 9 8 7 6 5 4 3 2 1 0

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