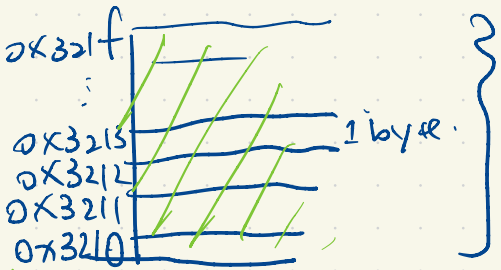


0x3214 miss | 0x31e8 miss | 0x31e8 hit. | 0x3220 miss. | 0x31dc miss | 0x31e0 hit. | 0x320c miss | 0x31d8 hit. | 0x3224 hit | 0x31f8 miss

1 hex digit is 4 bits.

$16 = 2^4$.

System A block size 16 byte. (4 bits)

16 elements., each 1 byte.

① 0x3214 → 0x321f ~ 0x3210

② 0x31e8 → 0x31ef ~ 0x31e0

③

$\Rightarrow \frac{4}{10} = 0.4$

B 256 byte. $\Rightarrow 2^8$. 8 bits.

256 elements

0x3214 0x31e8 0x31e8 0x3220 0x31dc 0x31e0 0x320c 0x31d8 0x3224 0x31f8.

miss miss hit hit hit hit hit hit hit

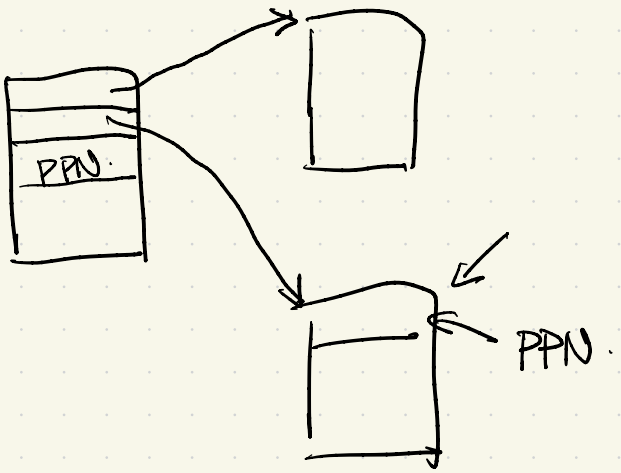
0x32ff] 256 bytes.
0x3200]

$32 \Rightarrow 2^5$.

hit rato $= \frac{8}{10} = 0.8$.

0x3214. $\Rightarrow$ 0x32 | 0001 | 0100 |

0x321f] 32 bytes.
0x3200]



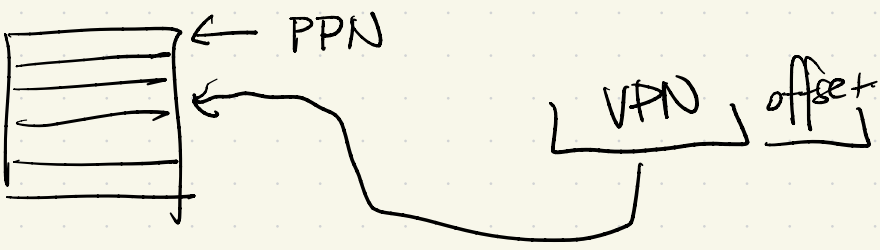
2 level page table.

PTE.

$$\frac{\text{page table size}}{\text{PTE}} = \#\text{ entries}.$$

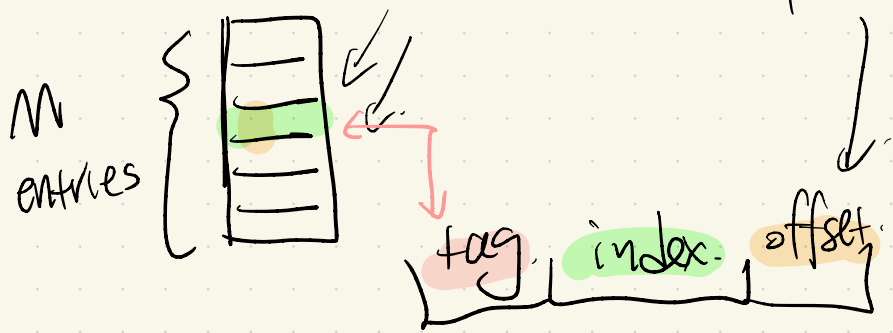
$\log_2(\#\text{ entries}) = \text{len of } VPN_i$.

| VPN_0 | VPN_1 | VPN_2 | ... | offset |

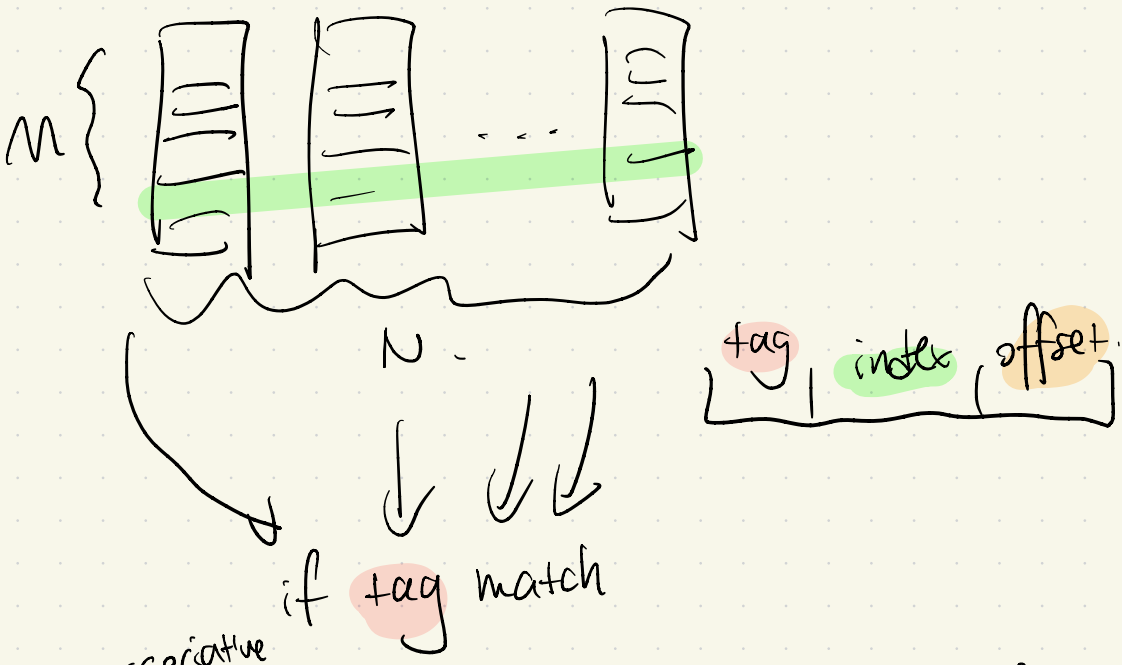


$$\frac{\text{page table size}}{\text{len(PPN)}}.$$

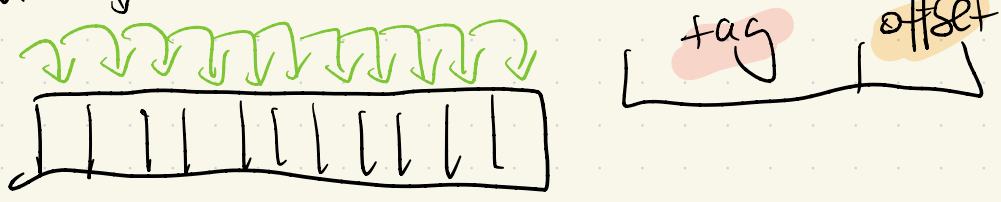
direct-map

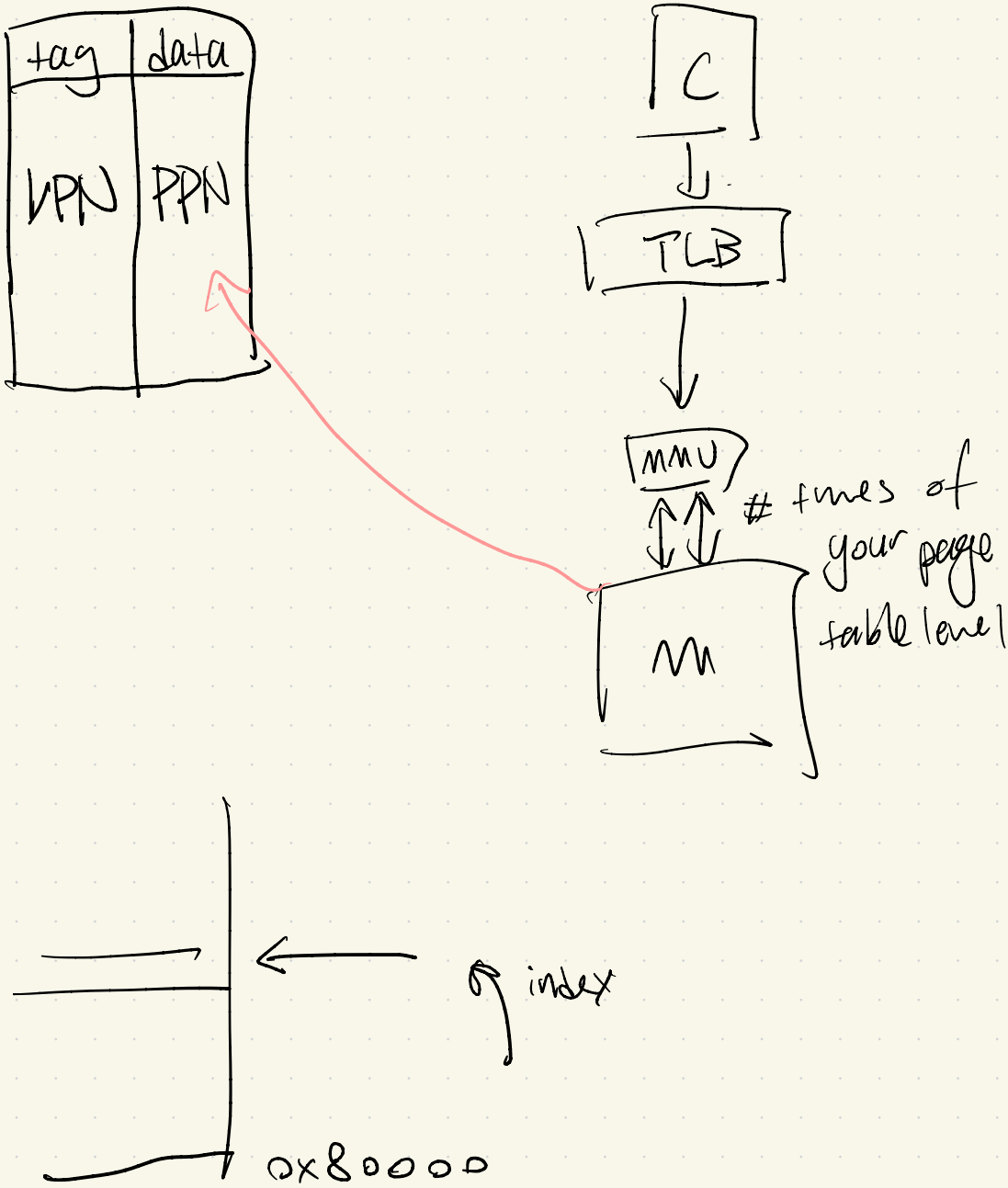


N- way associati



fully associative




tag
data
VPN
PPN
C
TLB
MMU
times of your page table level
M
index
0x80000

- The page size is 64KiB
- The physical address size is 32 bits
- The virtual address size is 26 bits
- There is a two level page table (each level is the same width)
- All PTEs are 32 bits.
- The internal PTEs only contains the address for the next level
- The leaf PTEs only contain the PPN, not the full address

SATP = 0x84816c00.

effective addr.

VPN

0x00f60590 offset.

① calculate the offset for page.

$2^{16} \Rightarrow$ 16 bits.

② find the VPN

len(VAddr) = 26

len(index) = 26 − 16 = 10 bits.

5 bits (VPN0) 5 bits (VPN1).

Physical address 4 bytes of data

0xfe1f87d4	0x94d7edf8
0xfe1f3c70	0x00002e42
0xa1a6f854	0x0000201e
0xa1a6dd20	0xd8d0c54c
0xa06b9904	0xdc72cbd0
0xa06b4868	0x00002558
0x84816c24	0xa1a6f800
③ 0x84816c1c	0x77cc3c00 PTE.
0x84816c18	0xfe1f3c00
0x84816c08	0x54728c00
0x84816c04	0xa06b4800
④ 0x77cc3c58	0x00000a98 PPN
0x77cbf328	0xeb581204
0x64e10590	0xbec813f8
0x5472f62c	0x6da263ec
0x54728c40	0x000039f8
0x44250590	0x805225b4
0x39f80590	0xc7727140
0x2e420590	0xe5af4aa8
0x25580590	0x108e67d4
0x201e0590	0x31094cdc
0x13320590	0xb05fda58
⑤ 0x0a980590	0x04950a20
0x01980590	0x81d2a7e4

0x00f6

VPN0 VPN1

001111 0110

5 bits 5 bits

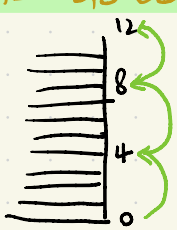
7 22

28 88

11100 1011000

VPN0 = 0x1c VPN1 = 0x58.

★ 4 bytes stored Starts that address.



③ find the first page table entry.

SATP = 0x84816c00

VPN_0 = 0x1c

⇒ 0x84816c1c.

④ find the physical page numbe.

PTE = 0x77cc3c00

VPN_1 = 0x58

⇒ 0x77cc3258.

⑤ find Physical addres.

PPN = 0xa98.

offset = 0x0590

Paddr

⇒ 0xa980590.

⑥ answer = 0x04950a20.

Q4.

$$t = I \times CPI \times \frac{1}{f}$$

$$t_1 = I \times CPI_1 \times \frac{1}{f_1}$$ 1 core

$$t_2 = I \times CPI_2 \times \frac{1}{f_2}$$ 2 cores

$$CPI_2 = CPI_1 \times \left(1 - P + \frac{P}{C}\right)$$

$$\frac{1}{f_2} = \frac{1}{f_1} \times \frac{f_1}{f_2}$$

$$I \times CPI_2 \times \frac{1}{f_2} = I \times CPI_1 \times \left(1 - P + \frac{P}{C}\right) \times \frac{1}{f_1} \times \frac{f_1}{f_2}$$

$$t_2 = t_1 \times \left(1 - P + \frac{P}{C}\right) \times \frac{f_1}{f_2}$$

AMAT = HT + MP.

L1 → 2cycles.

80% hit ratio.

mem → 50 cycles.

80% x 2 cycle. + 20% (2 + 50)

= 80% x 2 + 20% x 2 + 20% x 50.

= 2 + 20% x 50.