CS 240 SI Worksheet #21
Valerie Zhao
4/25/17

Virtual Memory

Use the example memory system provided at the end of the "Virtual Memory" lecture slides to find the data mapped to virtual addresses `0x027C`, `0x03A9`, and `0x0040`.

		`0x027C`	`0x03A9`	`0x0040`
Virtual Address (in bits)		**00 0010 0111 1100**	**00 0011 1010 1001**	**00 0000 0100 0000**
Address Translation	VPN	**0x9**	**0xE**	**0x1**
	TLB index	**0x1**	**0x2**	**0x1**
	TLB tag	**0x2**	**0x3**	**0x0**
	TLB hit?	**N**	**N**	**N**
	Page fault?	**N**	**N**	**Y**
	PPN	**0x17**	**0x11**	**n/a**
Physical Address		**0101 1111 1100**	**0100 0110 1001**	**n/a**
Physical Memory Reference	Byte offset	**0x0**	**0x1**	**n/a**
	Cache index	**0xF**	**0xA**	**n/a**
	Cache tag	**0x17**	**0x11**	**n/a**
	Cache hit?	**N**	**N**	**n/a**
	Cache byte returned	**n/a**	**n/a**	**n/a**

(Adapted from CSAPP Practice Problems 9.11-9.13.)

Simple Memory System Example (small)

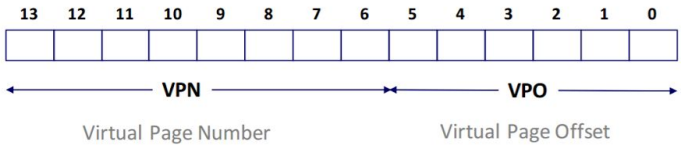
Addressing

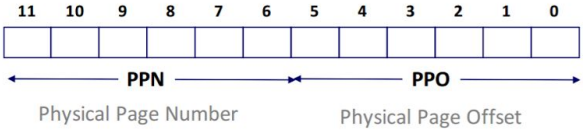
14-bit virtual addresses

12-bit physical address

Page size = 64 bytes

Simulate accessing these virtual addresses on the system: **`0x03D4, 0x0B8F, 0x0020`**

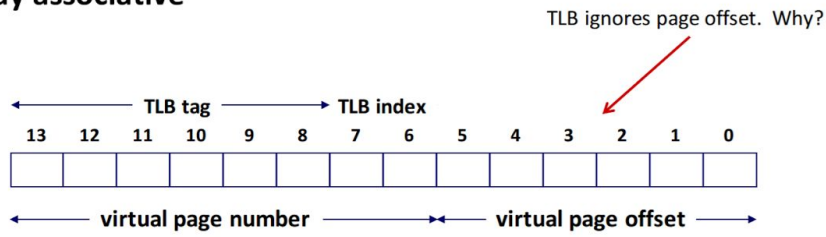




Simple Memory System TLB

16 entries

4-way associative



virtual page #___ TLB index___ TLB tag____ TLB Hit? __ Page Fault? __ physical page #: ____

Set	*Tag*	*PPN*	*Valid*	*Tag*	*PPN*	*Valid*	*Tag*	*PPN*	*Valid*	*Tag*	*PPN*	*Valid*
0	03	–	0	09	0D	1	00	–	0	07	02	1
1	03	2D	1	02	–	0	04	–	0	0A	–	0
2	02	–	0	08	–	0	06	–	0	03	–	0
3	07	–	0	03	0D	1	0A	34	1	02	–	0

Simple Memory System Page Table

Only showing first 16 entries (out of 256 = 2^8)

virtual page #___ TLB index___ TLB tag ____ TLB Hit? __ Page Fault? __ physical page #: ____

VPN	PPN	Valid
00	28	1
01	–	0
02	33	1
03	02	1
04	–	0
05	16	1
06	–	0
07	–	0

VPN	PPN	Valid
08	13	1
09	17	1
0A	09	1
0B	–	0
0C	–	0
0D	2D	1
0E	11	1
0F	0D	1

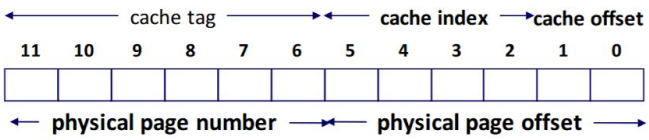
Simple Memory System Cache

16 lines

4-byte block size

Physically addressed

Direct mapped



cache offset___ cache index___ cache tag____ Hit? __ Byte: ____

Idx	Tag	Valid	B0	B1	B2	B3
0	19	1	99	11	23	11
1	15	0	–	–	–	–
2	1B	1	00	02	04	08
3	36	0	–	–	–	–
4	32	1	43	6D	8F	09
5	0D	1	36	72	F0	1D
6	31	0	–	–	–	–
7	16	1	11	C2	DF	03

Idx	Tag	Valid	B0	B1	B2	B3
8	24	1	3A	00	51	89
9	2D	0	–	–	–	–
A	2D	1	93	15	DA	3B
B	0B	0	–	–	–	–
C	12	0	–	–	–	–
D	16	1	04	96	34	15
E	13	1	83	77	1B	D3
F	14	0	–	–	–	–