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CS 219-1802: Computer Organization

5 April 2021

CS 219 - Assignment #8

Purpose: Become familiar with basic cache implementation and operation

Points: 60

Reading/References:

Chapter 5

Assignment:

Answer the following questions:

1-4) A series of address references generated in order (0-7) by the microprocessor are provided. The table shows the address references (in binary) and the data stored at that address (in decimal).

The cache uses 4 bytes per block. All data items shown are word sized values. Assume a 2way set associative cache design that uses the LRU algorithm (with a cache that can hold a total of 4 blocks). Assume that the cache is initially empty.

- a) Determine the tag, line/set, and offset fields and fill in the appropriate table (first table).
 (2 pts)
- b) In the provided table (second table), insert for each access the tag (in binary), valid bit (0/1), least recently used (0/1), and data (in decimal) for each access. Use the provided tables (next page). Assume any unprovided data items are all set to 0. (10 pts)
- c) What is the hit ratio for this access sequence (hits/accesses) as a percentage? (3 pts)

Hit!		Hit!
7 8 de 10 de		PILE!

	0	1	2	3	4	5	6	7
address	10001100	10110010	10111110	10001100	10011100	11101000	11111110	11101000
data	3	32	98	3	51	48	42	48
tag	10001	10110	10111	10001	10011	11101	11111	11101
line/set	1	0	1	1	. 1	8	1	9
offset	99	10	10	89	88	66	10	88

access 0	Blo	ck 0						
	v	lru	tag	data				
line/set 0	0	-	-					
line/set 1	1	1	10001	3				
access 1	Block 0							
	v	lru	tag	data				
line/set 0	1	1	10110	32				
line/set 1	1	1	10001	3				
access 2	Blo	ck 0						
	v	lru	tag	data				
line/set 0	1	1	18118	32				
line/set 1	1	9	18881	3				
access 3	Block 0							
	٧	lru	tag	data				
line/set 0	1	1	18118	32				
line/set 1	1	1	18881	3				
access 4	Block 0							
	v	lru	tag	data				
line/set 0	1	1	10110	32				
line/set 1	1	0	10001	3				
access 5	Block 0							
	٧	iru	tag	data				
line/set 0	1	Ð	10110	32				
line/set 1	. 1	0	18881	3				
access 6	Blo	ck 0						
	v	lru	tag	data				
line/set 0	1	0	10110	32				
line/set 1	1	1	11111	42				
access 7	Blo	ck 0						
	٧	lru	tag	data				
line/set 0	1	9	10110	32				
line/set 1	1	1.	11111	42				

Blo	ck 1		
v	lru	tag	data
8	+	-	1 2
9		-	-
Blo	ck l		
v	tru	tag	data
8	-		1 (30
8	-	-	1 2
Blo	ck l		
v	lru	tag	data
9	-	+1	-
1	1	10111	98
Blo	ck 1		
v	lru	tag	data
8	-		-
1	8	10111	98
Blo	ck 1		
v	lru	tag	data
8	+	-	-
1	1	10011	51
Blo	ck 1		
v	lru	tag	data
1	1	11181	48
1	1	10011	51
Blo	ck 1		-
v	Iru	tag	data
1	1	11181	48
1	9	10011	51
Blo	ck 1		
٧	Iru	tag	data
1	1	11101	48
1	0	10011	51

Hit Ratio: 2 / 8 = 25%

	0	1	2	3	4	5	6	7
address	11000000	11111110	11000100	11001000	10011100	11001100	11010000	11010100
data	25	24	35	45	28	55	65	75
tag	11000	11111	11000	11001	10011	11001	11010	11010
line/set	0	1	1	0	1	1	9	1
offset	99	10	89	88	88	89	88	88

access 0	Blo	ck 0						
	v	lru	tag	data				
line/set 0	1	1	11000	25				
line/set 1	Ð			+				
access 1	Block 0							
	v	iru	tag	data				
line/set 0	1	1	11000	25				
line/set 1	1	1	11111	24				
access 2	Blo	ck 0						
	v	lru	tag	data				
line/set 0	1	1	11000	25				
line/set 1	1	a	11111	24				
access 3	Block 0							
	٧	ìru	tag	data				
ine/set 0	1	е	11000	25				
ine/set 1	1	0	11111	24				
access 4	Block 0							
	v	lru	tag	data				
line/set 0	1	θ	11000	25				
ine/set 1	1	1	10011	28				
access 5	Block 0							
	٧	lru	tag	data				
line/set 0	1	θ	11000	25				
line/set 1	1	0	18811	28				
access 6	Blo	ck 0						
	v	lru	tag	data				
line set 0	1	1	11010	65				
ine/set 1	1	0	18811	28				
access 7	Blo	ck 0						
	٧	lru	tag	data				
line/set 0	1	0	11010	65				
line/set 1	1	0	10011	28				

	ck l					
v	lru	tag	data			
9	-	+	-			
0	-	*	-			
Blo	ck 1					
v	lru	tag	data			
0	-	+	-			
8	-	-	-			
Blo	ck 1					
v	lru	tag	data			
9	*	-	=			
1	1	11000	35			
Blo	ck 1					
v	lru	tag	data			
1	1	11001	45			
1	1	11000	35			
Blo	ck 1	100				
v	lru	tag	data			
1	1	11001	45			
1	9	11000	35			
Blo	ck 1					
v	lru	tag	data			
1	1	11001	45			
1	1	11001	55			
Blo	ck 1					
v	Iru	tag	data			
1	9	11001	45			
1	1	11001	55			
Blo	ck I					
v	Iru	tag	data			
1	1	11010	75			
1	1	11001	55			

Hit Ratio: θ / 8 = 8%

- H- H- D			Hitl		Hit!	Hit!	Hit!	Hit!
	0	1	2	3	4	5	6	7
address	10001100	11101010	10001100	11101110	11101010	10001100	11101010	11101110
data	51	21	51	91	21	51	21	91
tag	10001	11101	10001	11101	11101	10001	11101	11181
line/set	1	0	1	1	9	1	0	1
offset	99	18	88	10	10	99	10	18

access 0	Blo	ck 0							
	v	lru	tag	data					
line/set 0	Ð	-	-	+					
line/set 1	7	1	10001	51					
access 1	Blo	Block 0							
	٧	lru	tag	data					
line/set 0	1	1	11101	21					
line/set 1	1	1	10001	51					
access 2	Blo	ck 0							
	v	lru	tag	data					
line/set 0	1	1	11101	21					
line/set 1	1	1	10001	51					
access 3	Block 0								
	٧	lru	tag	data					
line/set 0	1	1	11101	21					
line/set 1	1	0	18881	51					
access 4	Block 0								
	٧	lru	tag	data					
line/set 0	1	1	11191	21					
line/set 1	1	0	18881	51					
access 5	Block 0								
	v	lru	tag	data					
line/set 0	1	1	11101	21					
line/set 1	1	1	10001	51					
access 6	Blo	ck 0							
	٧	lru	tag	data					
line/set 0	1	1	11101	21					
line/set 1	1	1	10001	51					
access 7	Block 0								
	٧	lru	tag	data					
line/set 0	1	1	11101	21					
line/set 1	1	0	10001	51					

Blo	ck 1						
v	lru	tag	data				
9	-	+ 4					
9	-	-					
Blo	ck 1						
v	iru	tag	data				
8	-	2	1				
9	-	70					
Blo	ck 1						
v	lru	tag	data				
0	4	+					
9	-	+	+				
Blo	ck 1						
v	lru	tag	data				
8	-		+				
1	1	11181	91				
Blo	ck 1						
v	lru	tag	data				
8	-						
1	1	11101	91				
Blo	ck 1						
v	lru	tag	data				
8	-		1 2				
1	9	11181	91				
Bto	ck 1						
v	lru	tag	data				
9	-	-					
1	0	11101	91				
Blo	ck 1						
v	lru	tag	data				
8	1	-	-				
1	1	11101	91				

Hit Ratio: 5 / 8 = 62.5%

Hit!

	0	1	2	3	4	5	6	7
address	10101000	10111110	11101000	10011100	10001100	10111100	10110010	10001100
data	71	21	91	92	31	10	43	31
tag	10101	10111	11101	10011	10001	18111	10110	10001
line/set	9	1	9	1	1	1	0	1
offset	99	10	88	88	99	99	10	99

access 0	Block 0							
	v	lru	tag	data				
line/set 0	1	1	10101	71				
line/set 1	e		-)					
access 1	Block 0							
	v	Iru	tag	data				
line/set 0	1	1	10101	71				
line/set 1	1	1	18111	21				
access 2	Blo	ck 0						
	v	Iru	tag	data				
line/set 0	1	8	10101	71				
line/set 1	1	1	10111	21				
access 3	Block 0							
	v	Iru	tag	data				
line/set 0	1	8	10101	71				
line/set 1	1	Ð	10111	21				
access 4	Block 0							
	v	Iru	tng	data				
line/set 0	1	0	10101	71				
line/set 1	1	1	10001	31				
access 5	Block 0							
	v	lru	tag	data				
line/set 0	1	0	10101	71				
line/set 1	1	0	10001	31				
access 6	Blo	ck 0						
	v	lru	tag	data				
line/set 0	1	1	10110	43				
line/set 1	1	9	10001	31				
access 7	Blo	ck 0						
	٧	Iru	tag	data				
line/set 0	1	1	10110	43				
line/set 1	1	1	18881	31				

Blo	ck I		
v	lru	tag	data
Ð	-	-	4
0	+:	+	to
Blo	ek 1		
v	lru	tag	data
8		4	2
0	+,	8	7.0
Blo	ck I		
٧	lru	tag	data
1	1	11101	91
0	*	+	*
Blo	ck I		
٧	lru	tag	data
1	1	11101	91
1	1	10011	92
Blo	ck I		
٧	lru	tag	data
1	1	11101	91
1	8	10011	92
Ho	ck 1		
v.	lru	tag	data
1	1	11101	91
1	1	18111	10
Blo	ck 1		
v	lru	tag	data
1	8	11101	91
1	1	18111	10
Blo	ek 1		
v	lru	tag	data
1	9	11101	91
1	8	10111	10

Hit Ratio: 1 / 8 = 12.5%