Habib University

CE/CS 321/330 Computer Architecture

Homework 4

Hammad Sajid (hs07606)
Muhammad Owais Waheed (ow07611)

Question 1

Caches are important to providing a high-performance memory hierarchy to processors. Below is a list of 64-bit memory address references, given as word addresses. 0x03, 0xb4, 0x2b, 0x02, 0xbf, 0x58, 0xbe, 0x0e, 0xb5, 0x2c, 0xba, 0xfd

a. For each of these references, identify the binary word address, the tag, and the index given a direct-mapped cache with 16 one-word blocks. Also list whether each reference is a hit or a miss, assuming the cache is initially empty. First insertion is already done so that you may get the idea.

Word Address	Binary Address	Tag	Index	Hit/Miss
0x03	0000 0011	0	3	M
0xb4	1011 0100	b	4	M
0x2b	0010 1011	2	b	M
0x02	0000 0010	0	2	M
0xbf	1011 1111	b	f	M
0x58	0101 1000	5	8	M
0xbe	1011 1110	b	e	M
0x0e	0000 1110	0	e	M
0xb5	1011 0101	b	5	M
0x2c	0010 1100	2	c	M
0xba	1011 1010	b	a	M
0xfd	1111 1101	f	d	M

b. For each of these references, identify the binary word address, the tag, the index, and the offset given a direct-mapped cache with two-word blocks and a total size of eight blocks. Also list if each reference is a hit or a miss, assuming the cache is initially empty.

Word Address	Binary Address	Tag	Index	offset	Hit/Miss
0x03	0000 0011	0	1	1	M
0xb4	1011 0100	b	2	0	M
0x2b	0010 1011	2	5	1	M
0x02	0000 0010	0	1	0	H
0xbf	1011 1111	b	7	1	M
0x58	0101 1000	5	4	0	M
0xbe	1011 1110	b	6	0	H
0x0e	0000 1110	0	7	0	M
0xb5	1011 0101	b	2	1	H
0x2c	0010 1100	2	6	0	M
0xba	1011 1010	b	5	0	M
0xfd	1111 1101	f	6	1	M

Question 3

Considering the address size of 64-bits, fill in the data for difference types of caches:

	Blocks	Data per Block	Sets	Associativity-ways	Tag Bits	Index Bits	Offset Bits
Fully Associative Cache	8	8 words	-	8	59	0	5
Direct Mapped Cache	16	8 words	-	1	55	4	5
Associative Cache	32	8 words	4	8	57	2	5
Direct Mapped Cache	64	8 words	-	1	53	6	5
Associative Cache	128	8 words	32	4	54	5	5
Associative Cache	256	8 words	32	8	54	5	5
Fully Associative Cache	512	8 words	-	512	59	0	5
Direct Mapped Cache	1024	8 words	-	1	49	10	5
Associative Cache	2048	8 words	64	32	53	6	5
Direct Mapped Cache	4096	8 words	64	32	53	6	5

Question 5

We are given 4 arrays of size 6. Each element in an array is of 32 bytes i.e., one word. Following is the data stored in the array:
A = (25, 48, 43, 30, 47, 36)
B = (16, 29, 35, 38, 32, 41)
C = (24, 33, 5, 39, 10, 14)
D = (23, 7, 11, 44, 42, 22)
The array data is arranged in main memory as follows:

We are given a direct mapped cache which contains 8 blocks (each block will contain one word). Insert the following elements in cache one by one and also mention whether it was a hit or a miss.

00000	$A[0]$
00001	$A[1]$
00010	$A[2]$
00011	$A[3]$
00100	$A[4]$
00101	$A[5]$
00110	
00111	
01000	$B[0]$
01001	$B[1]$
01010	$B[2]$
01011	$B[3]$
01100	$B[4]$
01101	$B[5]$
01110	
01111	
10000	$C[0]$
10001	$C[1]$
10010	$C[2]$
10011	$C[3]$
10100	$C[4]$
10101	$C[5]$
10110	
10111	
11000	$D[0]$
11001	$D[1]$
11010	$D[2]$
11011	$D[3]$
11100	$D[4]$
11101	$D[5]$
11110	
11111	

Assume that the first block of the cache will be populated by the first element of the array and so on. First insertion is already done so that you may get the idea.

Data to be Inserted	Hit/Miss	Cache Index							
		0	**1**	**2**	**3**	**4**	**5**	**6**	**7**
A[0]	M	A[0]							
A[1]	M	A[0]	A[1]						
A[2]	M	A[0]	A[1]	A[2]					
A[1]	H	A[0]	A[1]	A[2]					
A[5]	M	A[0]	A[1]	A[2]			A[5]		
B[5]	M	A[0]	A[1]	A[2]			B[5]		
B[4]	M	A[0]	A[1]	A[2]		B[4]	B[5]		
B[3]	M	A[0]	A[1]	A[2]	B[3]	B[4]	B[5]		
B[3]	H	A[0]	A[1]	A[2]	B[3]	B[4]	B[5]		
B[4]	H	A[0]	A[1]	A[2]	B[3]	B[4]	B[5]		
D[1]	M	A[0]	D[1]	A[2]	B[3]	B[4]	B[5]		
D[2]	M	A[0]	D[1]	D[2]	B[3]	B[4]	B[5]		
D[3]	M	A[0]	D[1]	D[2]	D[3]	B[4]	B[5]		
D[4]	M	A[0]	D[1]	D[2]	D[3]	D[4]	B[5]		
C[3]	M	A[0]	D[1]	D[2]	C[3]	D[4]	B[5]		
C[2]	M	A[0]	D[1]	C[2]	C[3]	D[4]	B[5]		
C[4]	M	A[0]	D[1]	C[2]	C[3]	C[4]	B[5]		
C[2]	H	A[0]	D[1]	C[2]	C[3]	C[4]	B[5]		

What is the Hit Ratio and the Miss Ratio in the above case?

Solution

Number of hits = 4
Number of misses = 14
Total accesses to the Memory = 18
Hit Ratio = 4/18 = 0.222
Miss Ratio = 14/18 = 0.778