

## CS2100 - Tutorial 8 - Set-Associative Cache &amp; Performance

1. SA Cache      block size =  $2^3$  bytes, no. of cache sets =  $16 / 2 / 2 = 2^2$

No.	Memory Address [Dec: Binary]	Cache Hit / Miss
1	4: 00...00 0000 0100	M
2	16: 00...00 0001 0000	M
3	32: 00...00 0010 0000	M
4	20: 00...00 0001 0100	H
5	80: 00...00 0101 0000	M
6	68: 00...00 0100 0100	M
7	76: 00...00 0100 1100	M
8	224: 00...00 1110 0000	M
9	36: 00...00 0010 0100	M
10	44: 00...00 0010 1100	M
11	16: 00...00 0001 0000	H
12	172: 00...00 1010 1100	M
13	20: 00...00 0001 0100	H
14	24: 00...00 0001 1000	M
15	36: 00...00 0010 0100	H
16	68: 00...00 0100 0100	M

Cache set	Valid bit	Tag	Word0	Word1	Valid bit	Tag	Word0	Word1
0	1	1	Mem[32]	Mem[36]	1	2	Mem[64]	Mem[68]
1	1	5	Mem[168]	Mem[172]	1	1	Mem[40]	Mem[44]
2	1	0	Mem[16]	Mem[20]	1	2	Mem[80]	Mem[84]
3	1	0	Mem[24]	Mem[28]	0			

## 2. Performance

$$(a). \text{CPI}_{\text{overall}} = \sum_{k=1} \text{CPI}_k \times F_k$$

$$= 2 \times 0.15 + 2 \times 0.25 + 4 \times 0.15 + 1 \times 0.35 + 1 \times 0.05 + \underline{10 \times 0.05}$$
$$= 2.30$$



$$(b). \text{CPI}_{\text{new}} = 2 \times 0.15 + 2 \times 0.25 + 4 \times 0.15 + 1 \times 0.35 + 1 \times 0.05 + 3 \times 0.05$$
$$= 1.95$$

$$\text{Speedup} = \frac{\text{CPI}_{\text{old}}}{\text{CPI}_{\text{new}}}$$
$$= \frac{2.30}{1.95}$$

$$= 1.1795$$

### 3. The Malleable Truth

$$\begin{aligned} \text{(a). } CPI_{\text{overall}} &= 1 \times 0.20 + 4 \times 0.40 + 4 \times 0.20 + 2 \times 0.20 \\ &= 3.00 \\ \therefore \text{Performance} &= \frac{1 \times 10^9}{3.00} \quad \text{clock rate} \\ &= 3.\bar{3} \times 10^8 \text{ instructions/s} \end{aligned}$$

$$\begin{aligned} \text{(b). } CPI_{\text{new}} &= \frac{1}{4} (1 \times 0.10 + 4 \times 0.20) + 1 \times 0.10 + 4 \times 0.20 + 4 \times 0.20 + 2 \times 0.20 \\ &= 2.325 \\ \text{Performance}_{\text{new}} &= \frac{1 \times 10^9}{2.325} \\ &= 4.301 \times 10^8 \text{ instructions/s} \\ \text{Speedup} &= \frac{3.00}{2.325} \\ &= 1.2903 \end{aligned}$$

$$\begin{aligned} \text{(c). } &100\% \text{ integer arithmetic} \\ CPI_{\text{new}} &= \frac{1}{4} (1 \times 0.50) + 1 \times 0.50 \\ &= 0.625 \\ \text{Performance}_{\text{new}} &= \frac{1 \times 10^9}{0.625} \\ &= 1.6 \times 10^9 \text{ instructions/s} \\ \text{Speedup} &= \frac{3.00}{0.625} \\ &= 4.8 \end{aligned}$$