# CS5541 – Computer Systems
# Caches

Suppose we have a system with the following properties:

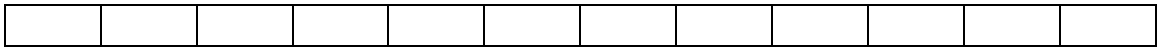
The memory is byte-addressable
Memory accesses are to 1-byte words (not 32-bit or 64-bit)
Addresses are 12 bits wide.
Cache organization: S=4, E=2, B=4

Cache contents (all addresses and tags are in hexadecimal):

| Set index | Tag | Valid | Byte 0 | Byte 1 | Byte 2 | Byte 3 |
|---|---|---|---|---|---|---|
| **0** | 00 | 1 | 40 | 41 | 42 | 43 |
| | 83 | 1 | FE | 97 | CC | D0 |
| **1** | 00 | 1 | 44 | 45 | 46 | 47 |
| | 83 | 0 | - | - | - | - |
| **2** | 00 | 1 | 48 | 49 | 4A | 4B |
| | 40 | 0 | - | - | - | - |
| **3** | FF | 1 | 9A | C0 | 03 | FF |
| | 00 | 0 | - | - | - | - |

Label the following address (1 bit per box) with the following codes:

CI: Cache set index
CO: Cache block offset
CT: Cache tag



11 10 09 08 07 06 05 04 03 02 01 00

For each of the following addresses indicate if it will be a cache hit or miss. Carry out the following accesses in order as listed. Give the value of a read if it can be inferred from the information in the cache.

| Operation | Address | Hit? | Read Value (or Unk) |
|---|---|---|---|
| **Read** | 0x834 | | |
| **Write** | 0x836 | | N/A |
| **Read** | 0xFFD | | |

Suppose we have a system with the following properties:

The memory is byte-addressable
Memory accesses are to 1-byte words (not 32-bit or 64-bit)
Addresses are 13 bits wide.
Cache organization: S=8, E=4, B=4

Consider the following cache state. All tags and values are given in hexadecimal.

| S | T | V | Bytes | T | V | Bytes | T | V | Bytes | T | V | Bytes |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | F0 | 1 | ED 32 0A A2 | 8A | 1 | BF 80 1D FC | 14 | 1 | EF 09 86 2A | BC | 0 | 25 44 6F 1A |
| 1 | BC | 0 | 03 3E CD 38 | A0 | 0 | 16 7B ED 5A | BC | 1 | 8E 4C DF 18 | E4 | 1 | FB B7 12 02 |
| 2 | BC | 1 | 54 9E 1E FA | B6 | 1 | DC 81 B2 14 | 00 | 0 | B6 1F 7B 44 | 74 | 0 | 10 F5 B8 2E |
| 3 | BE | 0 | 2F 7E 3D A8 | C0 | 1 | 27 95 A4 74 | C4 | 0 | 07 11 6B D8 | BC | 0 | C7 B7 AF C2 |
| 4 | 7E | 1 | 32 21 1C 2C | 8A | 1 | 22 C2 DC 34 | BC | 1 | BA DD 37 D8 | DC | 0 | E7 A2 39 BA |
| 5 | 98 | 0 | A9 76 2B EE | 54 | 0 | BC 91 D5 92 | 98 | 1 | 80 BA 9B F6 | BC | 1 | 48 16 81 0A |
| 6 | 38 | 0 | 5D 4D F7 DA | BC | 1 | 69 C2 8C 74 | 8A | 1 | A8 CE 7F DA | 38 | 1 | FA 93 EB 48 |
| 7 | 8A | 1 | 04 2A 32 6A | 9E | 0 | B1 86 56 0E | CC | 1 | 96 30 47 F2 | BC | 1 | F8 1D 42 30 |

What is the size of this cache in bytes?

Label the following address (1 bit per box) with the following codes:

CI: Cache set index
CO: Cache block offset
CT: Cache tag

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | | | |
| 12 | 11 | 10 | 09 | 08 | 07 | 06 | 05 | 04 | 03 | 02 | 01 | 00 |

Suppose that a program references the 1-byte word at address 0x071A. Fill in the following table (if it is a miss, fill in N/A for “Cache byte returned”):

| Parameter | Value |
|---|---|
| Block Offset (CO) | 0x |
| Set Index (CI) | 0x |
| Cache Tag (CT) | 0x |
| Cache hit? (Y/N) | |
| Cache byte returned | 0x |

Suppose that a program references the 1-byte word at address 0x16E8. Fill in the following table (if it is a miss, fill in N/A for “Cache byte returned”):

| Parameter | Value |
|---|---|
| Block Offset (CO) | 0x |
| Set Index (CI) | 0x |
| Cache Tag (CT) | 0x |
| Cache hit? (Y/N) | |
| Cache byte returned | 0x |