WE14.1

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Video explanation of solution is provided below the problem.

Cache Benefits

5/5 points (ungraded)
After his geek hit single *I Hit the Line*, renegade singer Johnny Cache has decided he'd better actually learn how a cache works. He bought three Beta processors, identical except for their cache architectures:

- **Beta1** has a 64-line direct-mapped cache
- **Beta2** has a 2-way set associative cache, LRU, with a total of 64 lines
- **Beta3** has a 4-way set associative cache, LRU, with a total of 64 lines

Note that each cache has the same total capacity: 64 lines, each holding a single 32-bit **word** of data or instruction. All three machines use the same cache for data and instructions fetched from main memory.

Johnny has written a simple test program:

```
// Try a little cache benchmark
J = 0x1000                // where program lives
A = 0x2000                // data region 1
B = 0x3000                // data region 2
N = 16                    // size of data regions (BYTES!)

.=J                       // start program here
P:    CMOVE(1000, R6)     // outer loop count
Q:    CMOVE(N, R0)        // Loop index I (array offset)
R:    SUBC(R0, 4, R0)     // I = I-1
      LD(R0, A, R1)       // read A[I]
      LD(R0, B, R2)       // read B[I]
      BNE(R0, R)
      SUBC(R6,1, R6)      // repeat many times
      BNE(R6, Q)
```

Johnny runs his program on each Beta, and finds that one Beta model outperforms the other two.

1. Which Beta gets the highest hit ratio on the above benchmark?
   Beta3 ✔
2. Johnny changes the value of **B** in his program to 0×2000 (same as A), and finds a substantial improvement in the hit rate attained by one of the Beta models (approaching 100%). Which model shows this marked improvement?
   Beta2 ✔
3. Finally, Johnny sets **J**, **A**, and **B** each to **0×0**, and sets **N** to **64**. What is the TOTAL number of cache misses that will occur executing this version of the program on each of the Beta models?

   Total cache misses running on Beta1: 16 ✔

   Total cache misses running on Beta2: 16 ✔

   Total cache misses running on Beta3: 16 ✔

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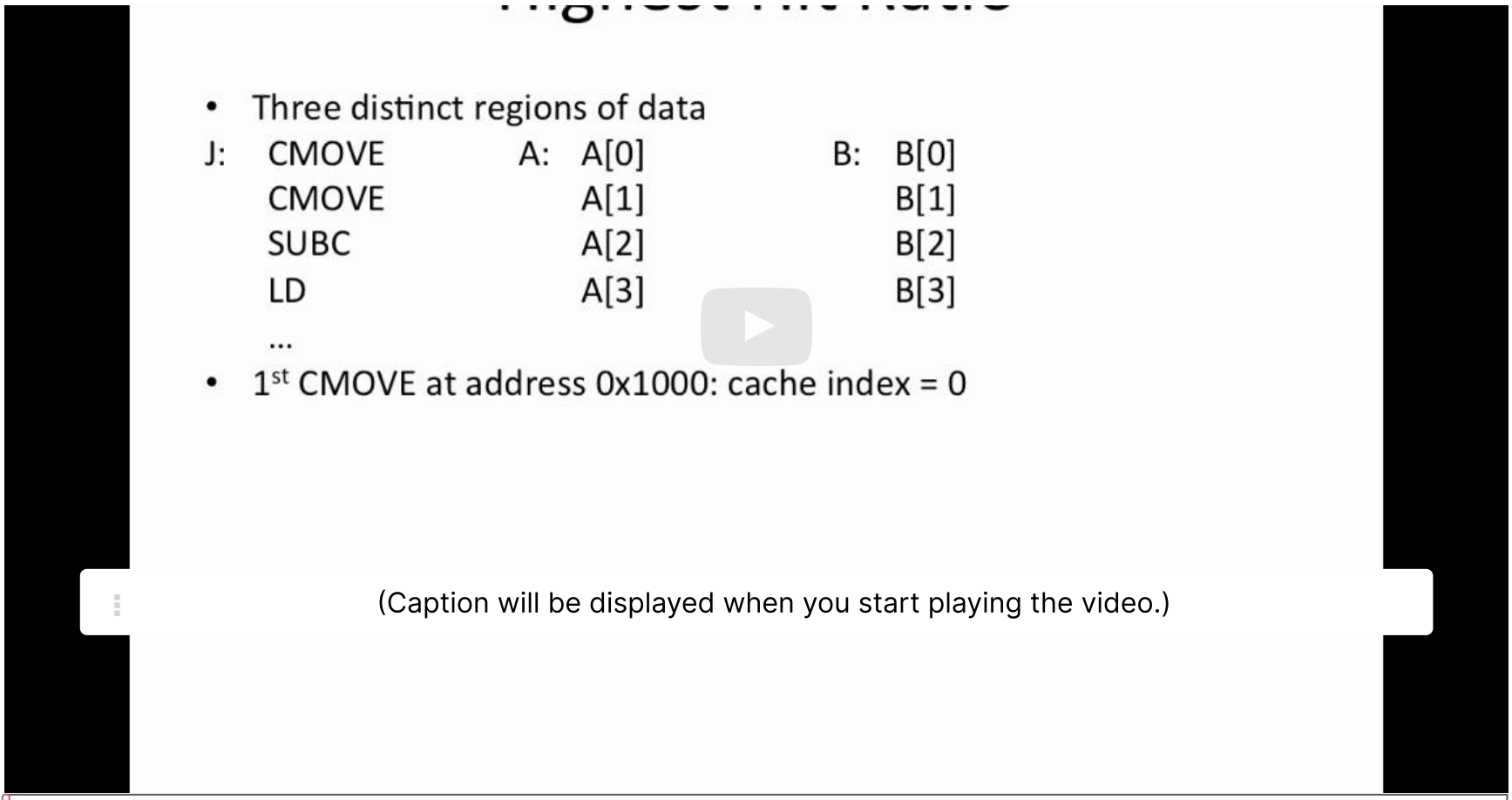
Cache Benefits

Calculator



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