

# **Introduction to Computer Engineering (E114)**

Harris

Spring 1999

## **Problem Set 10**

**Due: Friday, April 23**

**Reading:** Chapter 8

### **1) I/O Systems**

Do Exercises 8.4, 8.5, and 8.11.

### **2) Cache Construction**

One day after lunch, Bert Simpson, uncle of famous TV star Bart Simpson, was called into his boss's office at computer giant, MBI Corporation (or Big Purple, as they are sometimes called). It seems that Bert's performance had been slipping in recent months and his boss wanted to get him back on track. At the meeting the boss said, "Bert, we need someone to design a cache for our new Cower-PC computer system. Here are the specifications. Oh, and Bert, I don't have to tell you that your job is on the line. Say hi to Marge for me, will you, and lay off the doughnuts." "Urgh," Bert grumbled as he walked back to his cube. Looking at the specifications he noticed the following requirements for the cache:

- two-way set-associative structure
- 32 bit data word size. Eight bytes per block.
- Total cache size = 128 KB data
- 32 bit addresses used
- Only word addresses need to be considered
- Only building blocks in Figure 1 and a small number (less than 5) of two-input logic gates may be used to create the cache.

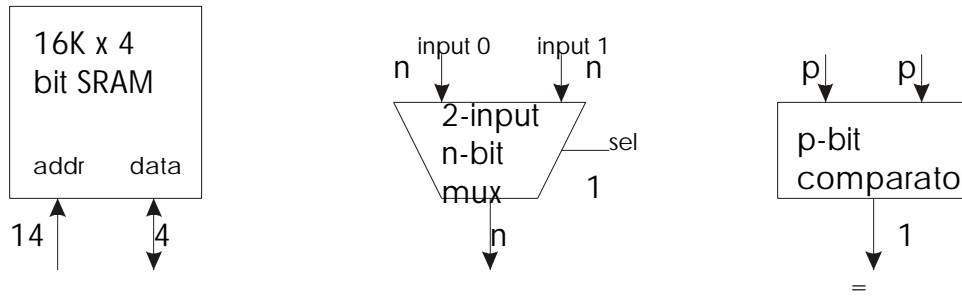


Figure 1: Cache Building blocks

Note that the multiplexer and comparator blocks may be any size ( $n$  or  $p$  bits wide, respectively), but that the RAM blocks must be 16K by 4 bits.

Several weeks have gone by since Bert met with the boss and frankly he's having trouble. Let's give him a hand and save his job.

- What is the size of the cache tags in bits?
- How many SRAM building blocks will Bert need in order to build the cache? (this includes data and tag storage).
- Show which portions of the address will be used to select a block inside the cache. Which address bits will select the word?
- Design a cache that will fit the specifications presented on the previous page. The cache design must include tag storage, data storage, address comparison, data output selection, and any other parts you feel are relevant. Remember that you may only use the building blocks identified in the problem specification. Be sure to include a neatly labeled block diagram.

### 3) Time

Please indicate how many hours you spent on this problem set. This will not affect your grade, but will be helpful for calibrating the workload for next semester's class.

Some of these problems are courtesy old MIT 6.004 (Computation Structures) problem sets.