ECE 3058

Final Exam Extra Credit

Purpose:

Generate an understanding of performance, energy, and area tradeoffs. The specific context of this assignment is the design of a cache, while the some of the basic lessons do extend to compute logic. There is no code to be written, you will exercise the Cacti tool for this assignment.

(Note: The simulator does not evaluate miss rate! Keep in mind that even if a configuration takes up more resources, it may produce a lower miss rate. Try to combine your knowledge from Assignment 3 - Cache Simulator and this assignment to understand design tradeoffs)

Part I: Downloading and Installing Cacti.

For this assignment, you will use the Cacti tool - an integrated cache access time, cycle time, area, leakage, and dynamic power model for uniform and non-uniform cache architectures. The cacti codebase has been provided to you via Canvas.

1. Execute the following commands

   `cd cacti65`

   `make`

   ***You may need to install the correct dependencies on your host machine**, or a **docker container is provided with instructions to set it up (recommended)**.* Please come to office hours if you are having trouble setting up.
2. Leave all parameters as default expect for the ones identified below.
3. Comment out -cache type "main memory" from the `cache.cfg` file and uncomment -cache type "cache"
4. Comment out -Data array cell type - "comm-dram" from the `cache.cfg` file and uncomment -Data array cell type - "itrs-hp"
5. Have “UCA Bank Count” as 1
6. Technology node 0.032
7. Access mode is set to “sequential”
8. Optimize tag is set to “ED”
9. For future reuse, make a copy of the `cache.cfg` file, this will be your “default” `cache.cfg` file
10. run the executable:

    `./cacti -infile ./cache.cfg` to generate simulation results

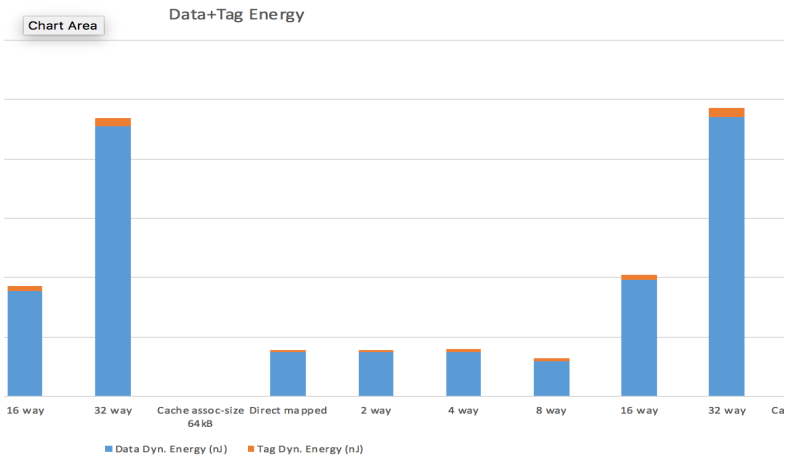
It may be easier to generate a script to execute the configurations required below.

Part II: Analysis (15 pts)

First quantify certain relationships between performance and energy. Then find an optimized cache configuration as described below. Consider the design of a 256 Kbyte data cache. Provide the following.

1. **Energy Analysis:**

    a. [3 points] Provide a bar chart of the dynamic read access energy as a function of associativity (2,4,8,16) with a block size of 64 bytes. See example figure below. Provide a brief explanation in architectural terms, i.e., look at the structure of the cache from the text/class. *What aspect of the cache is responsible for this behavior?*



2. **Performance Analysis:**

    a. [3 points] Provide a bar chart of the access time as a function of associativity (2,4,8,16) with a 64-byte block size. Provide a brief explanation in architectural terms, i.e., look at the structure of the cache from the text/class. *What aspect of the cache is responsible for this behavior?*

3. **Configuration Analysis:**

    [9 points] Find a set associative cache configuration that fits as closely as possible in 1mm^2 (configuration parameters must be a power of 2) and has minimum energy-delay product (product of dynamic read access energy and access time). Provide a brief and clear explanation as to the steps you followed (perhaps influenced by 1 and 2 above) to find this configuration. This is more important than the answer you find.

Grading Guidelines

1. Complete plots and clear explanation of 1 and 2: 6 pts
2. Methodology and explanations for item 3: 9 points.

The overall report is expected to be on the order of 2 pages or so.

Extra Credit Calculation

This assignment will count as **15 points of extra credit** to your finals. In other words you can get up to 115 points in the Finals.

Submissions Instructions

Brevity and precision is valued over volume in your writing. Your submission should be a single PDF file called **Lab-6-cacti.pdf** submitted to Canvas.