

ECE 611 – Assignment 4
(1 week assignment, 100 points)
Due before 11:59 pm 04/05/2017
Electrical and Computer Engineering
George Mason University

1. Objective

Finding the optimum cache size for a given application.

In this assignment, for **three benchmarks of your choice**, you need to vary the cache size and the cache associativity, and then observe how it affects the processor IPC and the cache power dissipation. From these observations, you need to find a sweet spot. A sweet spot would be the configuration at which you get the highest **IPC/Power** value.

Unit(s)configurations	
L1 (I-Cache &D-Cache)16KB, 32KB, L264KB, 128KB, 256KB, 512KB L3 (8way)1MB	64KB, 128KB
Associativity(for both L1 &L2)1way,	2way, 4way, 8way, 16way

*The L1 & L2 cache sizes need to be varied for both I-Cache & D-Cache simultaneously.

**You will have 80 cases for SMTsim simulations.

Once you get the IPC for the above configurations, you need to find the cache power dissipation as well. You should estimate the cache power dissipation using CACTI. CACTI has been developed by HP Lab. You can find it at the following link:

<http://quid.hpl.hp.com:9081/cacti/index.y?new>

The power dissipation calculation can be done in two ways:

1. study all possible cases using CACTI.
2. study a few cases and use regression model to calculate the rest. (Studying the power consumption of large number of cache configurations using CACTI tool could be a time consuming task. Instead, you could simply choose to find the power of few cases using CACTI tool and then use a simple regression model to estimate the power of cache as a function of cache size and cache associativity.)

Based on the IPC results and power results, you need to find the right cache configuration for L1 and L2 cache that gives us the highest Performance/Power (IPC/Watt).

2- Instruction

1. Run the simulations for all the cash configurations to get the processor IPC.
2. Calculate the cache power dissipation for all the configurations. You can do one of the followings:
 - a. Use CACTI for all the configurations.
 - b. Use CACTI for a few configurations and then use the regression model to predict the rest.

*As the memory subsystem has three level of caches, for each configuration, you need to run CACTI up to three times (L1 + L2 + L3). The summation of all three runs will be the total power. Please notice that in each run, you need to gather both the dynamic and the leakage power.

** You will have $6*5 = 30 + 1 = 31$ (30 L1&L2 + L3) cases. (Some L1 and L2 cases overlap).

***If you choose to use regression model, you need to do it for both dynamic and leakage power **separately**.
3. Calculate the target function (IPC/power) for all the configurations.

CACTI

For cacti configuration use the following parameters:

Cache size: all studied cases (make sure to multiply cache size by 1024, instance a cacheso for size of 16KB is going to be 16*1024 byte)

Line size: keep this at 64

Associativity: change this based on what discussed

Nr. of Banks: always keep this at 1

Technology node: keep this at 90

The figure below show and example of cacti output.

Your **total power** is “**Total read dynamic power per read port at max freq (W)**” + “**Total standby leakage power per bank (W)**”

Figure below shows how CACTI look:

Normal Interface	Cache Size (bytes)	<input type="text" value="32768"/>
Detailed Interface	Line Size (bytes)	<input type="text" value="64"/>
Pure RAM Interface	Associativity	<input type="text" value="4"/>
FAQ	Nr. of Banks	<input type="text" value="1"/>
	Technology Node (nm)	<input type="text" value="90"/>
<input type="button" value="Submit"/>		

Cache Parameters:

Number of banks:1
 Total Cache Size (bytes):32768
 Size in bytes of bank:32768
 Number of sets per bank:128
 Associativity:4
 Block Size (bytes):64
 Read/Write Ports per bank:1
 Read Ports per bank:0
 Write Ports per bank:0
 Technology Size (nm):90
 Vdd:1.2

Access time (ns): 1.83589438115
 Random cycle time (ns):1.18028549402
 Multisubbank Interleave cycle time (of data array) (ns):0.553919425074
 Total read dynamic energy per read port(nJ): 0.066153819412
 Total read dynamic power per read port at max freq (W): 0.310224305675
 Total standby leakage power per bank (W): 0.00820833653605
 Refresh power (percentage of standby leakage power): 0.0
 Total area (mm^2): 2.65710023667
 DRAM array refresh interval (microseconds):0.0
 DRAM array availability (percentage):0.0
 Best number of wordline segments (data): 4
 Best number of bitline segments (data): 4
 Best number of sets per wordline (data): 1.0
 Best degree of bitline muxing (data): 2
 Best degree of sense-amp level 1 muxing (data): 4
 Best degree of sense-amp level 2 muxing (data): 1
 Best number of wordline segments (tag): 2
 Best number of bitline segments (tag): 4
 Best number of sets per wordline (tag): 2.0
 Best degree of bitline muxing (tag): 1
 Best degree of sense-amp level 1 muxing (tag): 2
 Best degree of sense-amp level 2 muxing (tag): 2

For this example the power would be 0.3102 Watt

List of Deliverables:

- An XLS file containing all the IPCs, total power numbers and IPC/Power numbers
- A report file in PDF format that includes the followings:
 - 1- For each application: A graph showing the IPC as a function of L1 cache size and associativity when L2 cache size and associativity is 512KB and 4.
 - 2- For each application: A graph showing the IPC as a function of L2 cache size and associativity when L1 cache size and associativity is 32KB and 4.
 - 3- For each application: Find the configuration with the highest IPC among all studied configurations.
 - 4- For each application: Find the configuration with highest IPC/Power among all studied configurations.

- 5- For each application: The regression models (in case you choose to use regression model).
- 6- For each application: Discussion on the trend you observe relating IPC and power to cache size and cache associativity.

Once completed, submit a **ZIPPED** file with the following syntax **assignmentnumber_first_last.zip** where first_last is your first and last name. For instance, file should be named like this → assignment1_Bhoopal_Gunna.zip. Submit the zipped file through the blackboard. Please submit a pdf copy of your report.

WARNING: Points will be taken off if you do not follow the above instructions