COEN-4730 Computer Architecture
HW #5

Dept. of Electrical and Computer Engineering, Marquette University
Cristinel Ababei

OBJECTIVE:

Use gem5 full system simulator and McPAT power estimation tool to conduct design space exploration (DSE) of chip multiprocessors (CMPs) for which the communication between cores is done via the traditional Bus.

1. ASSIGNMENT

In this assignment, you are required to perform **design space exploration (DSE)** for a multicore Alpha platform simulated by GEM5. The goal is to optimize the **Energy-Delay-Area-Product (EDAP)** for a given application.

Step 1: Choose two PARSEC benchmarks
Select **any two** benchmarks (described at: http://www.cs.utexas.edu/~parsec_m5) and generate running .rcS file scripts as discussed in the previous assignment.

Step 2: Build GEM5 for ALPHA FS mode simulation
All your simulations will have to be done for an architecture with four cores; each core must be an Alpha ISA, and the communication between cores should be a traditional Bus in this assignment. So, build a GEM5 target binary as discussed in the previous assignment.

NOTE: Recall that the output of the GEM5 simulation is saved in several files in folder **m5out/**. Remember to save this folder before running new simulations, otherwise these files will be overwritten.

Step 3: Design space exploration using GEM5 simulator
You must perform a search of the **design space formed by three design-parameters as assigned to you by the instructor.** For each parameter select/sweep three different values. **Your assigned parameters are specified on D2L in a separate document.**

For each explored (i.e., simulated) solution in the search space formed by your selected three design-parameters, you must compute the **Energy-Delay-Area-Product (EDAP)**. EDAP combines performance with both power and area. This metric is useful to quantify the cost of new architectural ideas and assess trade-offs of different architectures.

1. **Delay:** this value can be extracted from *sim_seconds*, a simulation statistics from GEM5 output. By default, it is in the **m5out/stats.txt** file. Make sure you use the one that corresponds to the ROI portion of the simulation, as discussed at the end of Section 1.5.
2. **Energy:** to get this value, we first need to extract the runtime-power of the system, which is the top-level *Runtime Dynamic*. You can find this statistics in the McPAT output, under the top-level hierarchy "*Processor*". Note that we ignore leakage power in this assignment. With the power value, we can easily calculate energy using: *Runtime Dynamic * sim_seconds*.
3. **Area:** You can find this statistic in the McPAT output, under the top-level hierarchy "*Processor*".

NOTE: You must find the combination of three parameters that give you the best values (i.e., the lowest value) for EDAP for each of the two selected benchmarks separately. Note that you will have

to **run 27 simulations for each benchmark** because you have 3 parameters with 3 values for each: 3x3x3 = 27. I recommend you write a script to automate your work! And, start as early as you can!

4. DELIVERABLES:

A single-file PDF report which shall include the following sections, with clearly stated section titles:

- Title, your name, and course info.
- Summary Section. Describe what this assignment is about.
- Description of the benchmarks you selected. For example, is it a matrix multiplication algorithm, or some image processing code, etc. It should be a paragraph or so long.
- Listing and description of the three design-parameters you selected to sweep.
- Results of your simulations (all 27x2 of them) and the best architecture(s) for your selected benchmarks; include tables and graphs with plots. Discuss your findings and explain if the results you got are as you expected or not; and why that is so. This discussion is very important in order to get full credit.
- Conclusion