

ECE574: Cluster Computing – Homework 10
HPC Power / Energy

Due: Thursday 18 April 2019, 11:00am

1. Background

- We will measure the energy/energy-delay tradeoffs of some of our past homework assignments.

2. Setup

- For this assignment you will need to log into the Haswell-EP machine. As a reminder, use the username handed out in class and ssh in like this

```
ssh -p 2131 username@weaver-lab.eece.maine.edu
```
- Create a document that contains the results from the questions asked below. A .pdf or .txt file is preferred but I can accept MS Office format if necessary.

3. RAPL: OpenMP varying threads (5 pts)

- You can measure the estimated power of the CPU and RAM on the Haswell-EP machines using the Intel RAPL interface as discussed in class.
- You can use the “perf” tool to do this. There are three counters available.
 - power/energy-pkg/ – estimated energy used by package (socket)
 - power/energy-cores/ – estimated energy used by the cores in the package (not counting uncore)
 - power/energy-ram/ – estimated energy used by DRAM
- The Haswell-EP has two packages (sockets) but perf measures both and totals them for you.
- Measure the total package power using your OpenMP `sobel_fine` code from HW#5 for various cores using the space station image. The command will look something like this:

```
env OMP_NUM_THREADS=1 perf stat -e power/energy-pkg/ \
./sobel_fine ./space_station_hires.jpg
```
- Fill in the table below and answer the following questions. Remember that Energy delay is just Energy times time, and that Energy delay squared is Energy times time times time.

Cores	Energy	time	Energy Delay	Energy Delay Squared
1				
2				
4				
8				
16				
32				

- (a) Which number of threads used the least Energy?
- (b) Which was the fastest?
- (c) Lower Energy Delay and Energy Delay squared is better. Does the optimal number of threads to use change if you use those metrics instead?

4. RAPL: OpenMP vs OpenCL (2 pts)

- This time we are going to compare your best OpenMP result from the last question to the result using the Intel optimized OpenCL results from HW#9.
- Be sure to run OpenCL using the Intel CPU backend as we can't measure GPU power on the P400 GPU.

```
perf stat -e power/energy-pkg/ ./sobel_fine ./space_station_hires.jpg 1
```

Method	Energy	time	Energy Delay	Energy Delay Squared
OpenMP				
OpenCL				

(a) Which did better on the Energy related metrics, OpenMP or OpenCL?

5. RAPL: OpenCL backends (3 pts)

- I gathered these results for you on a different machine which has a Quadro K2220 GPU. The K2220 can provide power measurements (the P400 on haswell-ep cannot).
- I have filled in the values for my OpenCL implementation. RAPL was used to measure CPU and DRAM energy, and the `nvidia-smi` tool was used to measure GPU energy.
- A larger 10848x10824 image was used as an input for this test.
- Fill in the empty parts of the table.

Method	CPU Energy	GPU Energy	DRAM Energy	Total Energy	time	Energy Delay	Energy Delay Squared
NVIDIA	49.1	9.9	4.46	63.5	2.07		
Intel	83.1	1.8	6.86	91.7	2.54		
POCL	112.2	2.2	7.57	122	3.00		

(a) If you were doing a large number of sobel runs, given the data above, which OpenCL backend would you choose when running them? Why?

6. Submitting your work.

- Send me a document (pdf, txt, docx) including your name/names, data asked for, and answers to the questions. Please e-mail your document to me.