Energy Consumption Analysis of Parallel Haskell Applications

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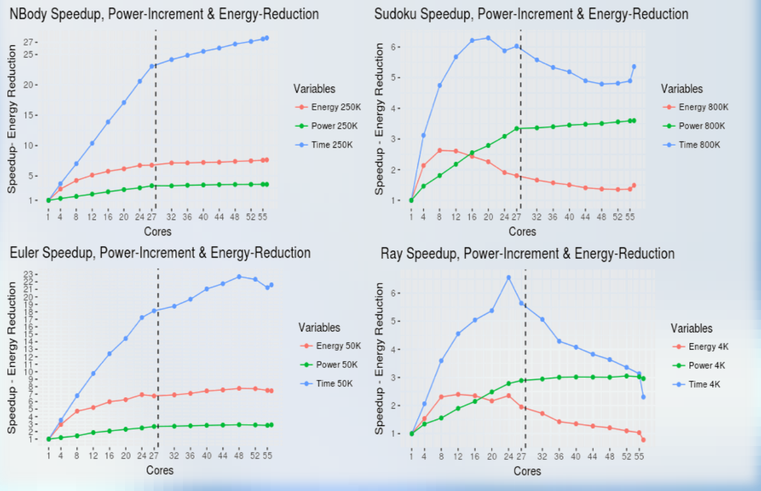
INTRODUCTION

The dissertation investigates the energy behavior of parallel applications. We are focusing on identifying the relationship of the speedup and energy reduction.

Alongside with the main objective, we study the effects of Core affinity which pins a process to a CPU core and of the Hyper-Threading mechanism due to the Nature of the Intel Xeon E-2690 v4 which has 56 by utilizing this technology.

Finally, we try to eradicate the necessity for a distinct analysis of the time and energy by creating a unified model which treats them as one variable.

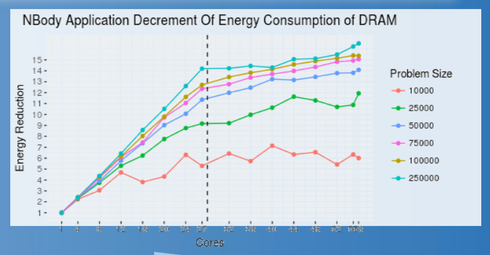
SPEEDUP & ENERGY



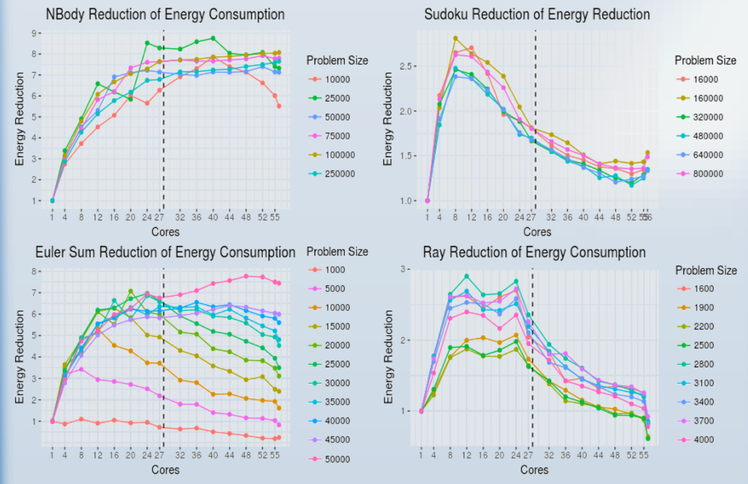
FUTURE WORK

- Analyze in more depth the correlation on the Energy & Time and the impact of the Hyper-Threading mechanism.
- Obtain better energy model by investigating garbage collection overhead on performance.
- Perform similar analyses on different CPU architectures.
- Implement our experiment suggestion about executing the same experimental study on the computer DRAM.

The initial study show similar results on memory and CPU



CPU ENERGY REDUCTION



ENERGY MODEL

The experiment, generated lots of benchmark data. Our goal was to create a generic mechanism that will estimate the CPU power requirements of the application.

R programming language helped us to perform a fifth degree, polynomial multilinear regression for each benchmark to estimate the coefficients, needed by the equation below to calculate the total energy in Joules.

The model works by giving as parameters the number of cores and the problem size.

$$Energy_i(c,s) = E_c(c) + E_s(s) + e^{a_0}$$

$$E_c(c) = e^{a_{c5}\times c^5 + a_{c4}\times c^4 + a_{c3}\times c^3 + a_{c2}\times c^2 + a_{c1}\times c}$$
$$E_s(s) = e^{a_{s5}\times s^5 + a_{s5}\times s^4 + a_{s4}\times s^3 + a_{s3}\times s^2 + a_{s2}\times s}$$

DISCUSSION

- Based on the experiment results, CPU pinning has better results with Hyper-Threading, while on low number of cores worse.
- The thesis confirm our hypothesis, of strong correlation between execution time and energy usage. The main obstacle of the optimum correlation is the overhead of the garbage collection mechanism. In addition, extensive garbage collection can impede energy reduction even when the performance is increased.
- The created model is able to provide reasonably accurate prediction of any out of parallel application on the Intel Xeon E-2690 v4 processor.