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Power and Energy Efficiency Analysis of HPC Workloads on Modern CPU Architectures

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The Basics

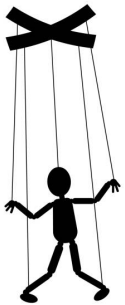
- CPUs are designed to run as fast as possible
- several factors to consider:
  - power consumption
  - frequency
- DVFS takes the control
  - Dynamic Voltage and Frequency Scaling
- DVFS regulates voltage (and therefore power) and frequency according to workload

Taking the control

Power metrics of a CPU can be read out via RAPL. The tool `perf` uses RAPL to get these metrics.

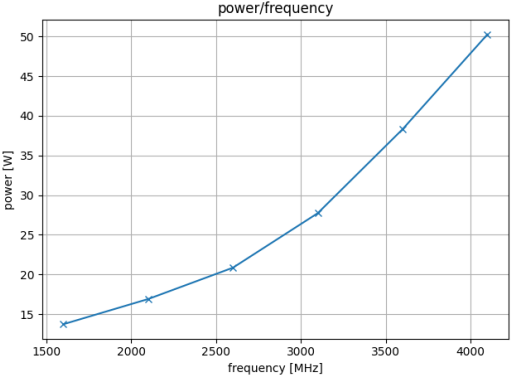
There are CLI tools to set metrics to a fixed value.

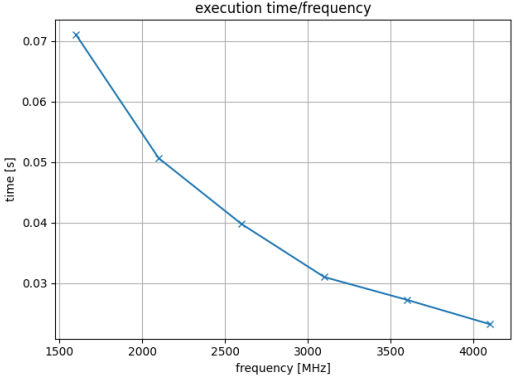
By applying limits, the energy consumption can change for a certain workload.



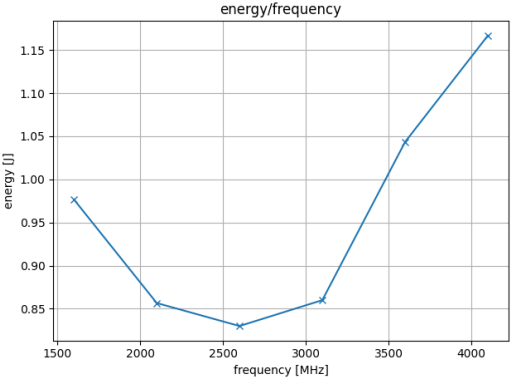
Taking the control

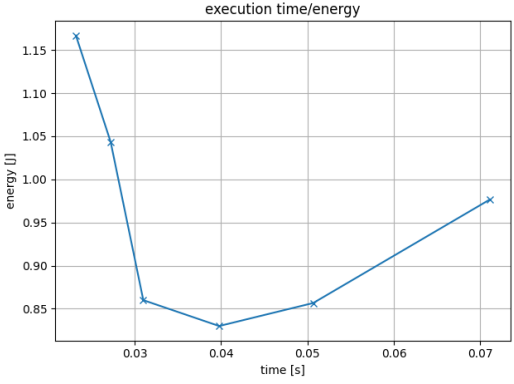
measured with Monte Carlo Pi Approximation with 1e10 points





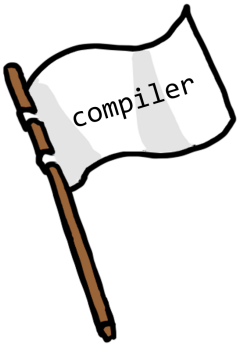
Taking the control





There are many other variables

- vectorization
- thread count
- simultaneous multithreading
- compiler flags
- different architectures (x86, ARM)
- different manufactures (Intel, AMD, Apple)



Using different benchmarks

With different benchmarks different aspects can be analyzed:

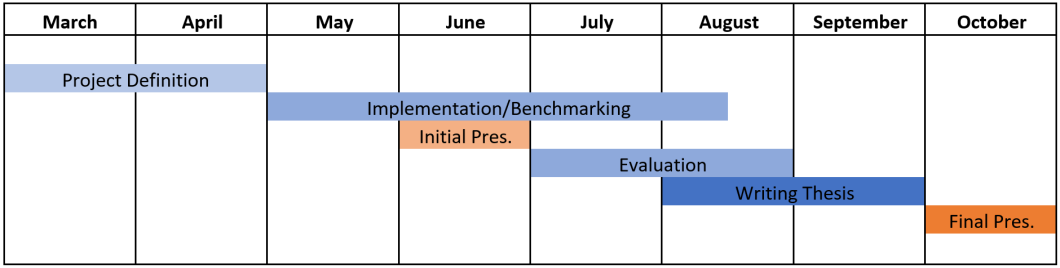
- parallelizable benchmarks
- compute intense benchmarks
- memory intense benchmarks

Benchmarks will be realized using C and OpenMP.

Goals

- find and write suitable benchmarks for different aspects
- analyze under which circumstances CPUs work more energy efficiently
- comparison between different architectures and manufacturers

Timeline


March
April
May
June
July
August
September
October
Project Definition
Implementation/Benchmarking
Initial Pres.
Evaluation
Writing Thesis
Final Pres.