

Algorithm Engineering

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Measurements

Performance Equation

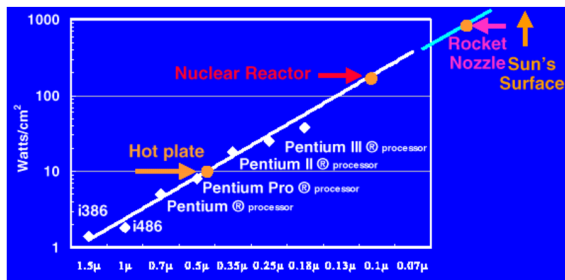
$$s/\text{cycle} \cdot \text{cycle}/\text{Instruction} \cdot \text{Instruction}/\text{Program}$$

The ultimate measure of performance is $s/\text{Program}$.

The Power Wall

Higher power consumption

Power Limits Performance



- Bob says: We're pushing perf & clk rates too hard

[courtesy of Bob Colwell]

from EEC 171 Parallel Architectures [Owe]

The Power Wall (cont.)

Shorter signal propagation

1 GHz, i.e. 1 cycle takes 1 ns

$$1 \text{ ns} \cdot \underbrace{c_0}_{\approx 300 \text{ km/s}} = 0.3 \text{ m}$$

- ▶ Power consumption used to be is neglected (transistors were expensive)
- ▶ These days power is expensive (GFLOP/W) but since Moore's law still in power transistors are getting cheaper

CPU Cycles

- ▶ Independent of clock rate
- ▶ Basis unit in computer architecture
- ▶ Difficult to measure (RDTSC, RDTSCP, CPUID)
- ▶ Instruction set manual Intel 64 and IA-32 Architectures Software Developer's Manual [Int] and Optimization manuals [Fog]

Gabriele Paoloni. How to Benchmark Code Execution Times on Intel IA-32 and IA-64 Instruction Set Architectures. 2010. URL: <http://www.intel.de/content/dam/www/public/us/en/documents/white-papers/ia-32-ia-64-benchmark-code-execution-paper.pdf>

References

- [Fog] Agner Fog. Optimization manuals. URL: <http://agner.org/optimize/#manuals> (cit. on p. 6).
- [Int] Intel 64 and IA-32 Architectures Software Developer's Manual. Instruction Set Reference. 2014. URL: <http://www.intel.com/content/dam/www/public/us/en/documents/manuals/64-ia-32-architectures-software-developer-instruction-set-reference-manual-325383.pdf> (cit. on p. 6).

References (cont.)

- [Owe] John Owens. EEC 171 Parallel Architectures. Introduction / Overview. URL: <http://www.nvidia.com/content/cudazone/cudau/courses/ucdavis/lectures/intro.pdf> (visited on 04/05/2011) (cit. on p. 4).
- [Pao10] Gabriele Paoloni. How to Benchmark Code Execution Times on Intel IA-32 and IA-64 Instruction Set Architectures. 2010. URL: <http://www.intel.de/content/dam/www/public/us/en/documents/white-papers/ia-32-ia-64-benchmark-code-execution-paper.pdf> (cit. on p. 6).