CSCI 260 Notes

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https://github.com/rvente/CSCI-260-Notes

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2019 01 30

Every Instruction Set Architecture (ISA) has cross-compatability with processors which implement that ISA.

Measuring Performance

Performance Issues

Latency is the pause between instruction and execution

Throughput is the rate of instruction completion (work per unity time)

- measured in MIPS (**M**illions of **I**nstructions **P**er **S**econd)
- FLOPS (**F**loating **P**oint **O**perations **P**er **S**econd)

NOTE: Memorize all metric prefixes

Bandwidth like throughput, but measured in the context of networks

- bps - bits per second
- Bps - bytes per second (8 bits)
- word - 4 bytes

Response time like latency, but for larger amounts of work

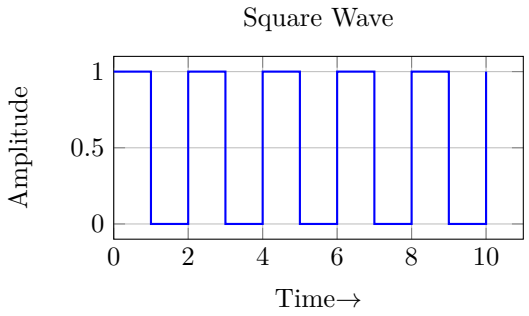
- latency is for a single instruction
- response time for the entire program

Bottleneck something is said to be the bottleneck when it is the limiting factor in execution

Performance Metrics

1. Clock Rate

In a modern computer, there is a clock, which is basically just a square wave. Processing only happens on the rising edge of the square wave.



Peak to peak (or trough to trough) is equivalent to a clock cycle.

- 1Hz = 1 cycle per second
- 2GHz = $2 \cdot 10^9$ cycles per second *or* $1/(2 \cdot 10^9)$ seconds per cycle which is equal to. .5 nanoseconds

This is a bad performance metric because there is a *variable* number of operations per clock across processors.

Complementary Metal Oxide Semiconductor (CMOS)

2. MIPS

Each ISA has different instructions, so MIPS can't be used to compare processors in different ISAs

3. Benchmarks

e.g. SPECMARKS

These benchmarks are the geometric mean of performance across geometric mean of "typical" programs

$$\text{geometric mean} = \left(\prod_{i=1}^{n} \frac{\text{time}_i}{(\text{reference time})_i} \right)^{1/n}$$

Comparing Performance

Unit % improvement

i.e. if $\frac{\text{time}_B}{\text{time}_A} = n$ then A is n times faster than B or $(n-1) \times 100$ percent faster.

Lessons in Evaluating Performance

- Additive v. multiplicative comparison
- Get the units right using dimensional analysis.
- Weighted Averages

instruction type	A	B	C
cycles per instruct.	2	3	4
percentage of time per instruct type	50	20	30

At 36 Hz, ...

For each average, multiply the CPI by the percentage and then sum these components to find the weighted average CPI. Then convert to MIPS using dimensional analysis