Parallel Programming: Moore's Law and Multicore

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Moore's Law

- Fabrication process sizes ("gate pitch") have fallen from 65 nm, to 45 nm, to 32 nm, to 22 nm, to 16 nm, to 11 nm. This translates to more transistors on the same size die.
- From 1986 to 2002, processor performance increased an average of 52%/year, but then virtually plateaued.

Increasing Transistor Density -- Moore's Law

"Transistor density doubles every 1.5 years." Note: Log scale!

Increasing Clock Speed?

Source: Intel

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Von Neumann Architecture: Basically the fundamental pieces of a CPU have not changed since the 1960s

Other elements:
- Clock
- Registers
- Program counter
- Stack pointer

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Clock Speed and Power Consumption

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PowerConsumption \propto ClockSpeed²

Yikes!

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What Kind of Power Density Would it Have Taken to Keep up with Clock Speed Trends?

Recently, AMD set the world record for clock speed (8.429 GHz) using a Liquid Nitrogen-cooled CPU

MultiCore – Multiprocessing on a Single Chip

So, to summarize:
Moore’s Law of transistor density is still going strong, but the “Moore’s Law” of clock speed has hit a wall. Now what do we do?

MultiCore and Multithreading

Multicore is a very hot topic these days. It would be hard to buy a CPU that doesn’t have more than one core. We, as programmers, get to take advantage of that. However, Multithreading, even without multicore too, is still a good thing. Threads can make it easier to logically have many things going on in your program at a time, and can absorb the dead-time of other threads.

But, the big gain in performance is to use both to speed up a single program. For this, we need a combination of both multicore and multithreading.

Intel’s Approach to Multicore and Multithreading

"HT" stands for "HyperThreading"