Exposing Thread-level Parallelism

- Previously, we looked at exposing parallelism at the instruction level
  - SIMD: Single Instruction, Multiple Data
- Now, still parallelism, but at the thread-level.
  - What are Multi-Core Processors?
  - Why are they coming now?
  - How can we use them?

AMD dual-core Opteron
What are Multi-Core Processors

- Two (or more) complete processors, fabricated on the same silicon chip
- Execute instructions from two (or more) programs/threads at same time

IBM Power5
Multi-Cores are Everywhere.

It is now hard to buy a computer with 1 core

**XBox360:** 3 PowerPC cores

**Sony Playstation 3:** Cell processor, an asymmetric multi-core with 9 cores (1 general-purpose, 8 special purpose SIMD processors)
Why Multi-cores Now?

- number of transistors we can put on a chip growing exponentially, and
And, performance is scaling up

- But, power is scaling up, also
  - Power has become limiting factor in current chips
Hence, Multi-cores
What happens if we run a program on a multi-core?

```c
void array_add(int A[], int B[], int C[], int length) {
    int i;
    for (i = 0; i < length; ++i) {
        C[i] = A[i] + B[i];
    }
}
```