General Purpose GPU

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Summary

- SIMD helps increase performance while using less power
  - For some tasks (not everything can use data parallelism).
  - Can use less power since DLP allows use of many more, slower components for similar or better throughput.
- Vector processors were popular for HPC applications once..
- Popularized in a limited way for multimedia applications (SSE, etc).
- Popularized in a more full fledged version with GPUs.
- GPUs increasingly used for things that are unrelated to graphics.

Basic Problem

Maximize processing power while minimizing energy consumption

- NVIDIA: Compared to the latest quad-core CPUs, Tesla C2050 and C2070 Computing Processors deliver equivalent supercomputing performance at 1/10th the cost and 1/20th the power consumption.
- 3 of 5 the top supercomputers as rated by the Top500 project use GPUs for some of their computing.

GPGPU in the Cloud

- Amazon began offering EC2 "Cluster GPU" instances in November
- For $2.00 an hour 2 NVIDIA Fermi M2050s rated at 512 GFlops each
- Amongst other things can run MapReduce jobs on GPUs using EMR
- Many instances used to mine bitcoins but...

EC2 Cluster Uses

- Also used by people in life sciences
  - Directly by a few places.
  - Through intermediaries like CycleComputing in some cases.
- Generally makes HPC application possible for people without much investment

Problems

- The code looks very different from what is written for the CPU, it's hard to reason about code where you need access to both.
  - Lots of libraries and extensions try to fix this by providing better abstractions.
  - Intel is trying to fix this (to an extent) with Larrabee
- For some applications need a lot of traffic between main memory and GPU memory, no I/O support directly to the GPU
- Poor debugging support
  - NVIDIA and AMD are both trying to fix this in different ways
  - Often end up emulating GPU on CPUs to get more information (WARP) or using traces
- GPU virtualization wasn't present until recently, not widespread

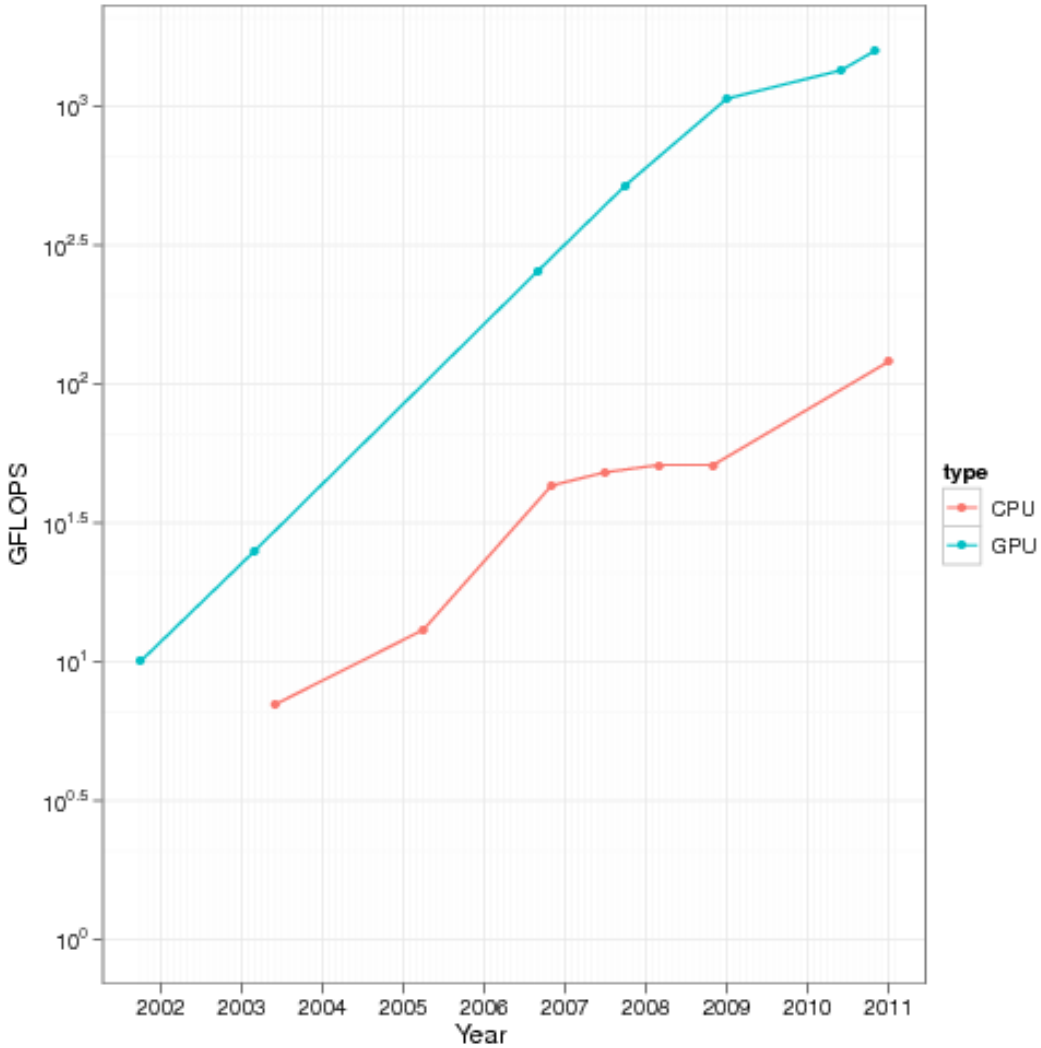
Problems

- In the video Barroso talked about the problems with Wimpy cores, and GPUs do bring up similar questions about heterogeneity, and specialized cores
  - Barroso's point was that small wimpy cores (think a single SIMD lane on a GPU) aren't useful unless programs using them are parallel
  - Easier to do request level parallelism, don't have to design for this parallelism.
  - *Not everything is easily vectorizable*
- On the flip side, GPUs are much better for some tasks.

Trends

- Both NVIDIA and Intel talk about the demise of the separation between CPUs and GPUs
  - NVIDIA envisions a single package with a beefy ARM core and a GPU
  - Beefier than what the Tegra 2 or Tegra 3 have right now
- Lots of work on utilizing GPUs for:
  - Data-mining, analytics, database queries
  - Bio-informatics
  - Automatic trading systems, options pricing, financial risk analysis
  - Numerical analysis
  - Other stuff...

Computing Power



Predictions for the Cloud

- High Probability
  - Greater use for analytics, processing queries, other things
  - More GPGPUs in clusters (perhaps more per machine)
- Somewhat Probable
  - More HPC users move to the "cloud" (DE Shaw Research might not have to build its own supercomputer)
  - Separate clusters for GPU and CPU workloads(?)
- Less Probable
  - CPUs, as they are now, disappear (from clusters and computers)
  - GPUs, as they are now, disappear (from clusters and computers)