Visions for Application Development on Hybrid Computing Systems

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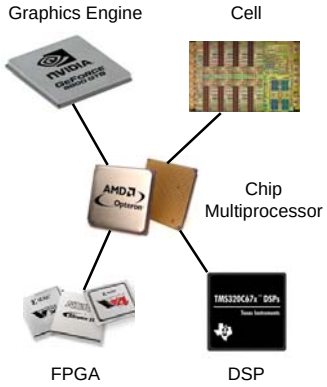
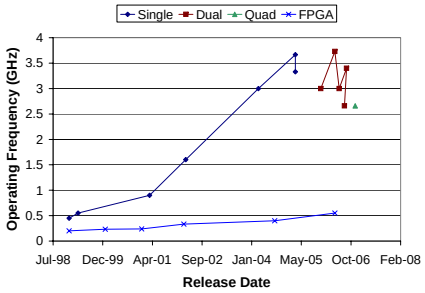
Hybrid Systems



- Hybrid systems have diverse architectures, usually with distributed memory subsystems

- Individual processor core performance isn't increasing much any more
- Clock rate gap is decreasing



- Application acceleration has been demonstrated many times [1,2]
- Power savings can be substantial

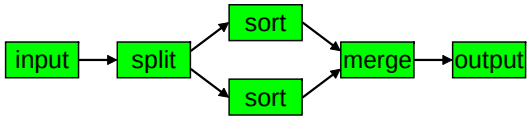
Authoring Applications

- Memory is a critical resource

Chip	Process	Memory
Intel Xeon (Tulsa)	65 nm	16 MB
Xilinx Virtex-5	65 nm	1.4 MB
TI TMS320C DSP	90 nm	2 MB

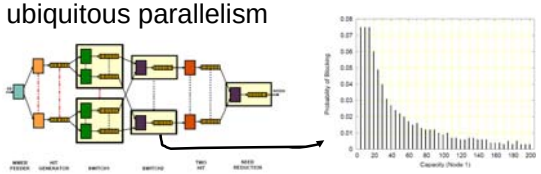
- Applications often have large memory footprint
- Dataflow programming models nudge programmers in the right direction

- Language choices are important
- Use familiar languages to express kernel computations, e.g.,
  - C/C++/Java/etc. for processors
  - Verilog/VHDL for FPGAs
  - Brook/CUDA for graphics engines
- Use coordination language to express communications between kernels [3,4]



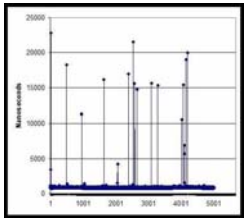
Debugging and Understanding the Performance of Applications

- Significant challenges
  - Diversity leads to incoherent system
  - Components have limited observability and ubiquitous parallelism



- Need hardware resources throughout system enabling monitoring
  - Dedicate resources for observing and processing system data
  - Reconfigurable monitoring elements allow data reduction and flexibility [5]

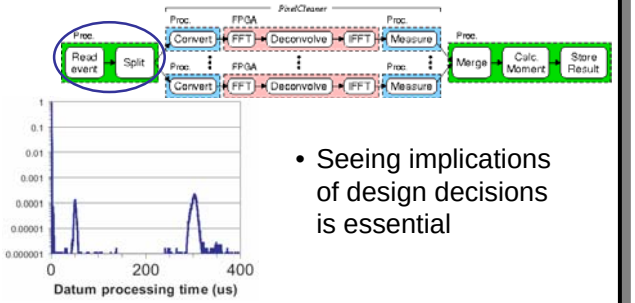
- Deploy monitors at the communication arcs
  - Use results to develop and validate system performance models
  - Unobtrusive monitoring allows for detection of rare events



- Provide "gdb-like" debugging environment with performance visualization programmers need

Putting it all Together

- Easing the deployment task is key



- Seeing implications of design decisions is essential

- A development environment can do all this [6]

[1] Z. Guo et al. A quantitative analysis of the speedup factors of FPGAs over processors. In *Proc. of Symp. on Field Programmable Gate Arrays*, Feb. 2004.
[2] I. Buck et al. Brook for GPUs: Stream computing on graphics hardware. *ACM Trans. on Graphics*, 23(3):777-786, Aug. 2004.
[3] E. Lee. The problem with threads. *IEEE Computer*, 39(5):33-42, 2006.
[4] M. Franklin et al. Auto-pipe and the X language: A pipeline design tool and description language. In *Proc. of IPDPS*, April 2006.
[5] M. Schulz et al. Owl: Next Generation System Monitoring. In *Proc. of Computing Frontiers*, May 2005.
[6] R. Chamberlain et al. Application Development on Hybrid Systems. To appear in *Proc. of Supercomputing*, Nov. 2007.