Workshop on the Frontiers of Extreme Computing

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Issues

• The 1994 meeting looked to the future
  – 100 Gigaflops × 10,000 → 1 Petaflops
• By contrast, this meeting has no numerical target
  – We have full range of applications represented
    • FLOPS + (some) non-FLOPS
  – We have hardware represented that can run the software, creating a balance
• Drama: we have a “phase change” in the realm at
  – 100 Petaflops for $100M leadership class supercomputer or
  – 1 Petaflops for $1M university class supercomputer
Applications and $100M Supercomputers

System Performance

Plasma Fusion Simulation Jardin Tue 9:30
1 Zettaflops
100 Exaflops
10 Exaflops
1 Exaflops
100 Petaflops
10 Petaflops
1 Petaflops
100 Teraflops

Applications

No schedule provided by source

NASA Computing needs Biswas Wed 9:30
Full Global Climate Bader Mon 9
SCaLeS Keyes Tue 9

Technology

④, ⑤, and ⑥ Quantum Computing on another slide; also Fredkin banquet Tue 7

③ Reversible Logic limits Bennett Mon 10
Frank Mon 1:30, Lent Tue 1:30, Niemier, Tue 2

② Architecture limit Burger Mon 11:30

① Transistorized µP limit Zeitzoff Mon 11

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Emergence of Quantum Computing

- Oskin Wed 2 PM has a paper on how to build a 1 FLOPS QC  
  delivery date unstated
- One would expect an exponential growth rate for quantum computers similar to Moore’s Law, but the rate constant is impossible to predict, so three possibilities have been graphed

Note: I don’t have anything to say about when the first practical QC will be built. This will not affect the argument. Hence “cloud.”

“How to build a 300 bit, 1 Gop quantum computer,” Andrew M. Steane, Clarendon Laboratory, UK, quant-ph/0412165
Quantum Applications

- Consider the classical computer equivalent to a Quantum Computer
- Williams Wed 2:30 will discuss physical simulations with exponential speedup over classical (blue)
- Searching algorithms broadly parallelize loops and can achieve quadratic speedup over a classical computer
Hardware Questions

• Evolutionary Trends
  – What can we expect from transistors, nanotech, & superconducting in current class of computation?

• Drive Current Computing Class to Maturity
  – How can we optimize architectures (mostly for power) in order to get a final $100\times$ performance boost before flat lining?

• Move to the Next Computing Class
  – Should reversible logic and/or quantum computing be considered for the mainstream?
Applications and Software Questions

• Applications
  – How strong is the case for building big computers to solve important problems?
  – Can we better synchronize hardware roadmaps with applications plans

• Software
  – ALL classical (non-quantum) computing options involve dramatic increase in parallelism
  – There is virtually nobody looking into how algorithms and programming
  – Other issues

• Seeks research options for long term continuation of Moore’s Law
• Table created by tallying votes of a committee of industry “experts.”
• Color codes, likely, possible, unacceptable

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Emerging Research Devices (notes 2005)

- Notes from 2005 meeting
- Immediate implication: all devices unacceptable except CNFET
- However CNFET is a short term solution, and belongs on a different table