NSF CDI Panel

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Ideal Programming Language

• No Silver Bullet Language

• Two types of language
  – Low-level
  – Domain-Specific (finite-element, graph, neural net, etc...)

• Low-level Language (C which knows about big computers)
  – Parallelism
  – Synchronization
  – Locality: Where data lives, and how to get to it
    • Data distribution
    • Thread migration support (Move the computation to the data)

• Domain-Specific (Languages which wish they were MATLAB)
  – May be a library, or thin veneer over low-level
  – Uses the notation best suited to given application
Ideal Machine

- Advanced packaging (3D Stack, Quilt)
  - Interchangeable tiers for customization

- Memory: Close & fast
  - (10-20 ns random access)
  - Single address space
  - Internals exposed to processor
    - “DRAM Aware Processing”

- Processor: Simple & Multithreaded
  - Hardware thread support
  - Support for thread synchronization and migration

- Optical Network
  - Hardware to accelerate message processing (improve injection rate, offload)
  - Scalable!
How can we write Scalable, Portable, Optimal, Correct Code?

• How do we keep up with Moore’s Law?
  – Recognize Moore’s Law has changed – Cores, not clocks
  – Need to exploit new levels of parallelism
• Do we need to rethink compilers/interpreters/OSes?
  – Need Feedback!
  – From Runtime to compiler/programmer: Where are the bottlenecks
  – From programmer to compiler: Generic hints
• Do we need to rethink OSes?
  – Smaller, gets out of the way
  – Modular: Minimal set of services
How do we guarantee reproducible correct computational experiments?

• We Don’t.
  – Real experiments are never completely reproducible or correct
  – Bigger machines will fail frequently

• Need to...
  – ...bound & identify error
  – ...create fault-tolerant algorithms
  – ...learn from mainframes (virtualization, data “evacuation”)

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<tr>
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<th>Red Storm</th>
<th>Petascale</th>
<th>Trans-Peta</th>
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<tbody>
<tr>
<td>“Nodes”</td>
<td>13,000</td>
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<td>Node MTBF</td>
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<td>MTBF (hours)</td>
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<td>8.2</td>
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