High End Computing Research & Development

SC2002 HEC BOF
19 November 2002

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NSA's High End Computing R&D Program

HEC Architectures and Systems

Collaboration with DARPA on HPCS

High Speed Switches and Interconnects

Superconducting Electronics

Thermal Management

Programming Environments

Quantum Information Sciences

The Pervasive Architectural Issue

Type T Systems*	*Type C Systems**
Commodity Components, Sub-systems	*Highly Customized*
Performance: Degrades with Scaling	*Performance: Better Sustained*
Server Architectures (SMP)	*Various Architectures (MPP, PVP…)*
4-128 Processor	*8-128 Processors/Node*
Relatively High Latency	*Accelerators: Vector, Multithreading Registers, Special Functions*
Distributed Memories (Shared in Node)	*Distributed, Shared Memories*
Memory BW: Poorer	*Memory BW: Better*
Programming Model: Usually MPI	*Programming Model: Shmem, MPI*
Programmability: Harder	*Programmability: Easier*
Initial Cost: Less	*Initial Cost: More*

*Burton Smith, CAS2001

CRAY X1

CRAY X1

- *Multi-year Joint Development Effort in Scalable Vector Architecture*

- *Technology Transfer - NSA Developed Technology*

- *Aug-Sept '02: Prototypes delivered*

- *Production Model Delivery by Year's End*

- *Collaboration with DoD/DDRE*

- *Joint Development Program Continues on X1e and Next Generation System*

HAC Task on HEC R&D Program

- ***Multi-agency Study Resulted in Development and Acquisition Plan for HEC R&D Program***

- ***Participants:***
  - *Executive panel: NSA, DUSD S&T, DoE*
  - *Agencies conducting R&D in HEC for national security applications: NSA, DARPA, NNSA, NASA*
  - *National Security users of HEC: NSA, NNSA, NASA, DoD High Performance Computing Modernization Program, ASD C3I, Naval Oceanographic (Fleet Numerical), NIMA, NRO, military high end computing laboratories*

- ***Status: Study in DoD; Coordination & Funding***

HEC Needs for National Security

- *Comprehensive Aerospace Vehicle Design*
- *Operational Weather/Ocean Forecasting*
- *Stealthy Ship Design*
- *Nuclear Weapons Stockpile Stewardship*
- *Army Future Combat Systems*
- *Weapons Development*
- *Intelligence Support*
    - *Imagery & Geospatial Intelligence*
    - *Signals Intelligence*
    - *Threat Weapons Systems Characterization*

HEC Improvements Needed

- *Sustained Performance: 4-100X*
- *Scalable, Balanced Architectures*
    - *Interconnects (Processor, Memory, Board, Node)*
    - *Larger, Global Shared Memories*
    - *Scalable I/O*
    - *Processor Designs*
    - *Systems Software*
- *Reduction in Power & Size*
- *Improved Cooling*
- *Programming Paradigms*
- *Ease of Use (Tools, Tools, Tools)*
- *Time to Solution*