Update on High-End Computing Research and Development

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PITAC Recommendations

- **Fund research into innovative computing technologies and architectures.**
- **Fund R&D in software to improve the performance of high-end computing.**
- **Drive high-end computing research by trying to attain sustained petaflops/petaops on real applications by 2010 through a balance of hardware and software strategies.**
- **Fund the acquisition of the most powerful high-end systems to support scientific and engineering research.**
- **Expand the High-End Computing Working Group's coordination process to include all major elements of the government's investment in high-end computing.**
- **Increase funding for high-end computing R&D and acquisitions: Add $270M in FY2000 … Add $430M in Fy2004.**

Recommendation: Fund research into innovative technologies and architectures

- **Funding levels have increased, from 181.3M (FY2000 estimate) to 254.9M (2001 request)**

- **Novel and innovative architectures are being explored**
  - **Beowulf (NASA): Clusters of sovereign workstations to achieve high-performance computing**
  - **MVICH (DOE/NERSC): High-performance communications for cluster computing**
  - **DPSS (DARPA/DOE): Scalable high-end distributed parallel storage systems**

Recommendation: Fund research into innovative technologies and architectures

- **Long-term technological breakthroughs are being funded**
  - **Superconducting materials for computing/storage**
  - **Quantum mechanical & optical computing/storage**
  - **Storage devices based on DNA-like molecules**
  - **Very large scale integration of photonics for intra-chip and inter-chip communications**
  - **Three-dimensional multi-chip modules**
  - **Optical tape: 1 terabyte on a hand-held cartridge**

Recommendation: Fund research into innovative technologies and architectures

Examples of HEC RE&D funding (FY2001 request $M)

NSF	**Computer-Communications Research**	**25.91**
	Revolutionary Computing, *as part of:*	
	Experimental & Integrative Activities	**17.38**
	Information Technology Research	**34.71**
DARPA	**Amorphous & Biological Computing**	**15.50**
	Beyond Silicon	**24.00**
NSA	**Supercomputing Research**	**30.10**
	Superconducting Research	**2.80**
NOAA	**Advanced Scalable Computing**	**1.75**
ODUSD(S&T)	**University Research Initiative**	**2.00**

Recommendation: Fund R&D in software to improve the performance of high-end computing

- **High-end software funding has increased**
  - **System software (operating systems, etc.): Combined NSF, DOE/OS, NASA, DARPA, NIH funding increased by 56.3%, from 86.7M (FY2000 estimate) to 135.4M (FY2001 request)**
  - **Similar increases for software support (e.g., reusable open software libraries) and application algorithm support**
- **These levels attract/retain good researchers**

Recommendation: Drive high-end computing research by trying to attain sustained petaflops/petaops on real applications by 2010 through a balance of hardware and software strategies

- **This will require significant advances at all levels: hardware, software (system, support, application), and process control/monitoring/measurement**

- **Hardware/architecture funding has stayed constant, 62.2M (FY2000 estimate) to 63.6M (FY2001 request), or about one-half the level for software**

Recommendation: Fund the acquisition of of the most powerful high-end systems to support scientific and engineering research

- **NSF is primary funder via PACI**
  - **San Diego Supercomputer Center (1.3 teraflops)**
  - **U Illinois at Urbana-Champaign (800 gigaflops)**
  - **Eight smaller sites**

  Computing power made available to US researchers
- **NSF Distributed Terascale Facility procurement**
- **Significant increases in high-end infrastructure: Combined infrastructure budgets of NSF, NASA, DOE/OS, NIH, NOAA, EPA, NIST are up 74% (FY2000 estimate to FY 2001 request)**

Recommendation: Expand the High-End Computing Working Group's coordination process to include all major elements of the government's investment in high-end computing

- **National Nuclear Security Administration (NNSA) is an active participant in High-End Computing Coordinating Group (HEC/CG)**
- **NNSA HEC budget now included in Blue Book, and is loosely coordinated with the HEC/CG**
- **NNSA official is HEC/CG co-chair**

Recommendation: Increase funding for high-end computing research and development and acquisitions. Add $270M in FY2000 … Add $430M in Fy2004

	FY1999	FY2000	FY2001	FY2002	FY2003	FY2004
Total PITAC HEC Budget Recommendations (Change from FY1999)	--	+270M	+305M	+350M	+390M	+430M
PITAC HEC R&D Budget Recommendation		+180M	+205M	+240M	+270M	+300M
PITAC HEC Infrastructure Budget Recommendation		+90M	+100M	+110M	+120M	+130M
HEC R&D plus HEC Infrastructure Budgets (not including HEC Applications)	389.9M (FY2000 estimate)	504.9 (FY2001 estimate)	705.9 (FY2001 request)	--	--	--
Change from FY 1999		+115M	+316M	--	--	--