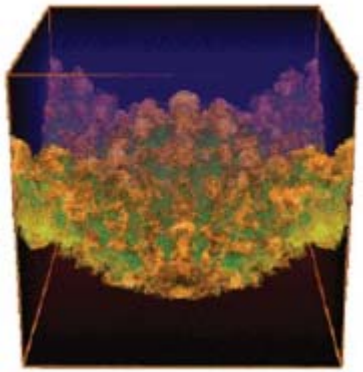
High-End Computing Revitalization Task Force (HECRTF)

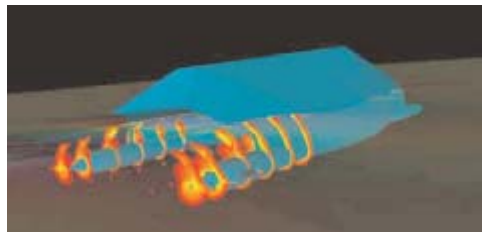
November 21, 2003

Alan Laub (DOE) and John Grosh (DoD)
Co-chairs of the HECRTF

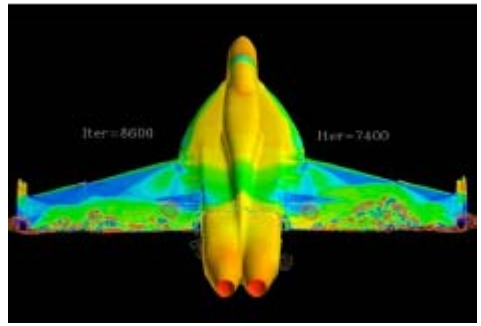
Applications of High-End Computing:
Big Problems with Big Impacts



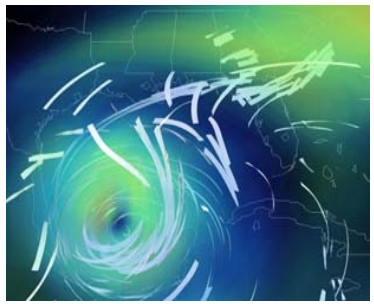
Nuclear Stockpile Stewardship



Ship Design

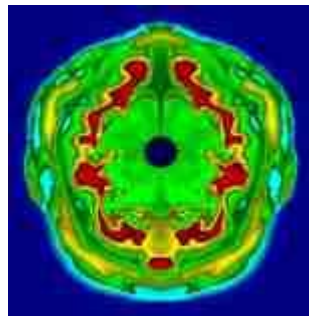


Aeronautics

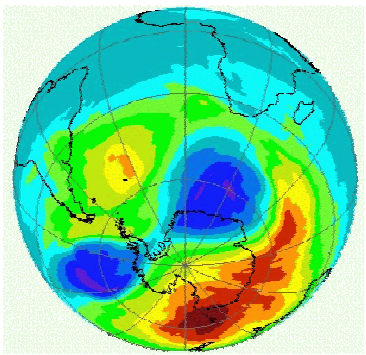


Weather Prediction

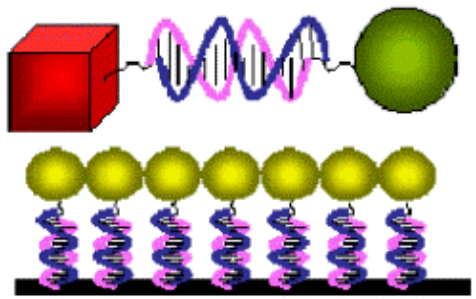
Cryptanalysis



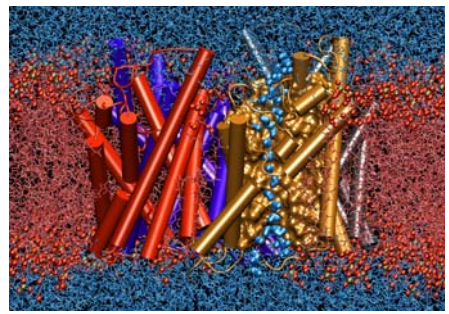
Astrophysical Simulation



Climate Modeling

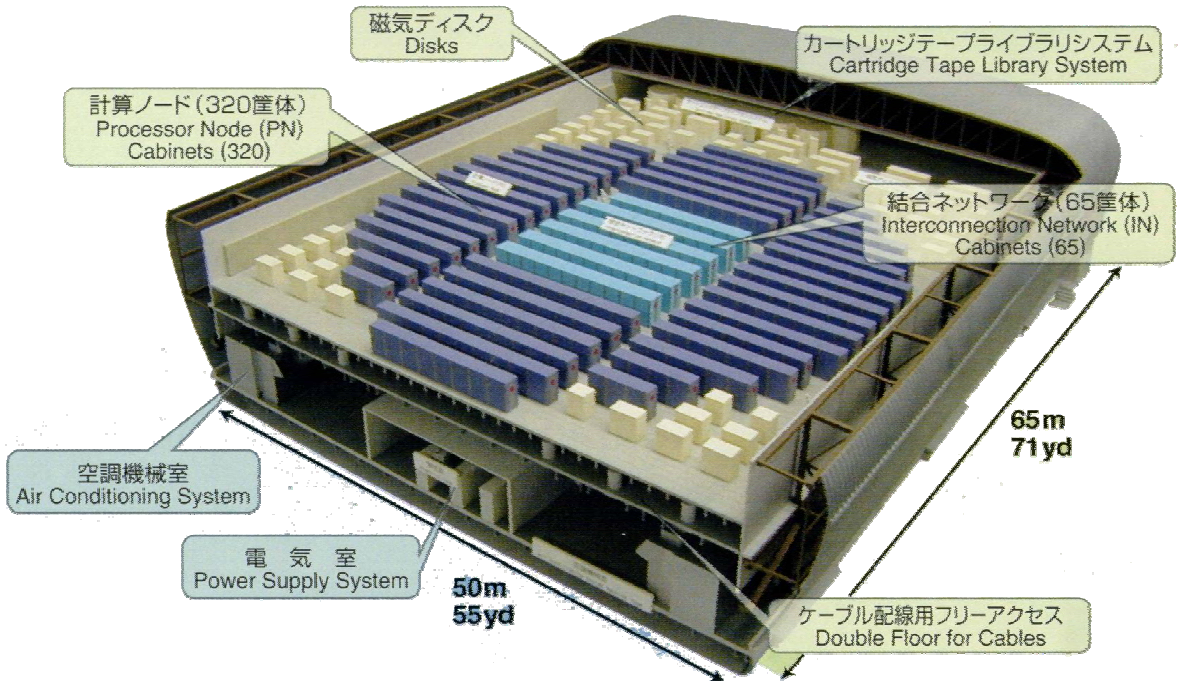


Nano-Science



Biology

Japanese Earth Simulator



OSTP:

- **Neither a revelation nor a demonstration of a loss of U.S. scientific leadership**
- **A challenge to help provide added incentive for action**
- **Federal HEC planning was historically not as well coordinated as it should have been**

User and Agency Views on High-End Computing

- **Research pipeline dry**
- **Industrial base issues**
- **Technology improvement**
  - Radical improvements in time-to-solution;
  - Significant improvements to system bandwidth, reliability, ease of programming
  - Diversity of architectures
- **User demands exceeds available resources for both capacity and capability**

Opportunities

- Move from event-driven investments to one based upon a strategic planning process
- Leverage various Agency strengths, capabilities, and resources via improved cooperation
- Rebuild and sustain critical-mass funding levels to attack national challenges
- Rebuild teaming within government, academia, and industry to address pervasive issues

Schedule

February 28 – Memo announcing HECRTF

March 10 – Kick-off meeting

April 18 – Call for white papers on HECRTF charge

June 16-18 – CRA workshop with academia, industry, and gov't

July 14, 21 – Non-disclosure meetings with industry

August 29 – Plan submitted to OSTP

HEC RTF Chairs

- **Co-Chairs**
  - John Grosh (OSD)
  - Alan Laub (DOE/SC)
- **Task Chairs**
  - **HEC core technologies R&D**
    - Kamal Abdali (NSF)
    - José Muñoz (DOE/NSSA)
  - **Capability, capacity, accessibility**
    - Judy Devaney (NIST)
    - Tom Page (NSA)
  - **Procurement**
    - Bill Turnbull (NOAA)
    - Phil Webster (NASA)

HECRTF Goals

- **Overarching: Revitalize U.S. leadership in high-end computing as a key tool for science and technology.**
  - Make high-end computing easier and more productive to use.
  - Make high-end computing readily available to Federally funded missions that need it.
  - Sustain the development of new generations of high-end computing systems.
  - Effectively manage and coordinate Federal high-end computing.

Scope

- "… focused on activities and technologies that directly sustain a robust technology and industrial base for high-end computing, along with resources required to address agency high-end computing computational requirements."

- **In scope**
  - Large clusters, advanced architectures, programming models/tools, etc.
  - Acquisition of large-scale systems (inc. O&M) to address agency requirements
  - Procurement strategies

- **Out of scope**
  - Applications development, networking, visualization, Grid, small-scale systems, quantum computing

•Yes, these are critical.

• Viewed as requirements drivers for HEC.

Charge for *Core Technologies R&D*

Produce a five-year roadmap, beginning with FY 2005, for core technology development that includes:

- Identification of ***key technologies*** that must be advanced to ***strengthen*** the ***foundation*** for developing ***new generations*** of high-end computing (HEC) systems;
- Coordinated ***multi-agency R&D plans*** that lay out a set of alternative programs, as well as identification of those agencies that are best suited to carry out each part of the program based on expertise, facilities, or technical priority;
- Discussion of ***approaches to planning***, identifying participants, and carrying out the research, development, and engineering in order to enable both revolutionary and evolutionary advances of technology, as well as to enable diffusion of advances in core technologies into commercial industry.

HEC Research, Development, and Engineering (RD&E)

RD&E Strategy

Activity	Purpose	Performers
Basic and Applied Research	*Refill the academic pipeline with new ideas and people*	*Academia and government labs*
Advanced Development	*Develop component and subsystem technologies*	*Mostly industry led, partnering with academia and government labs*
Engineering and Prototype Development	*Integration at system level and development of Serial No. 1*	*Industry*
Test and Evaluation	*Reduce risk for development, engineering, and government procurement*	*Government labs and HEC centers*

RD&E - Key Technologies

Hardware

- ⇨ Microarchitecture
- ⇨ Memory
- ⇨ Interconnect
- ⇨ Power, cooling, and packaging
- ⇨ I/O and storage

Software

- ⇨ Operating systems
- ⇨ Languages, compilers, and libraries
- ⇨ Software tools and development environments
- ⇨ Algorithms

Systems

- ⇨ System architecture
- ⇨ Reliability, availability, and serviceability (RAS)
- ⇨ System modeling and performance analysis
- ⇨ Programming models
- ⇨ System modeling and performance analysis

Charge for
Capability, Capacity, and Accessibility

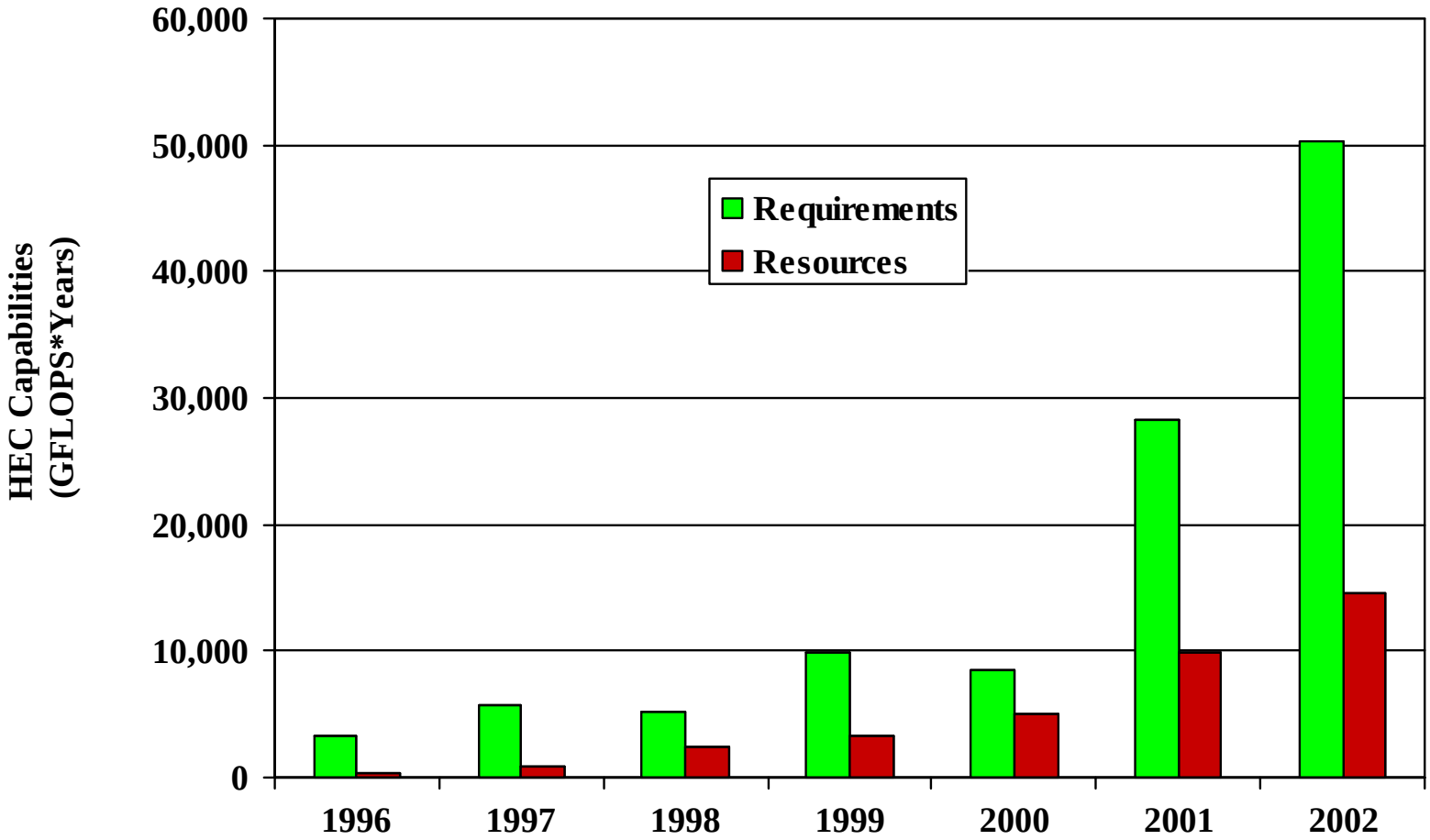
Produce a five-year roadmap, beginning in FY 2005, that includes:

- Sets of ***alternative plans*** for ***HEC resources*** that would help ***reduce the capability or capacity gaps*** in addressing important applications of HEC;
- Performance targets for proposed HEC system alternatives that are linked to application domain requirements for user needs;
- Discussion of types of system design specifications needed to effectively meet various application domain requirements;
- Discussion of resources, tools, and techniques needed to minimize the "***time to solution***" by users of HEC systems;
- ***Accessibility*** approaches to make HEC resources available to Federal and non-Federal user communities, as appropriate, beyond the Federal agency that funds or hosts the resources.

Addressing Agency Needs for HEC Resources

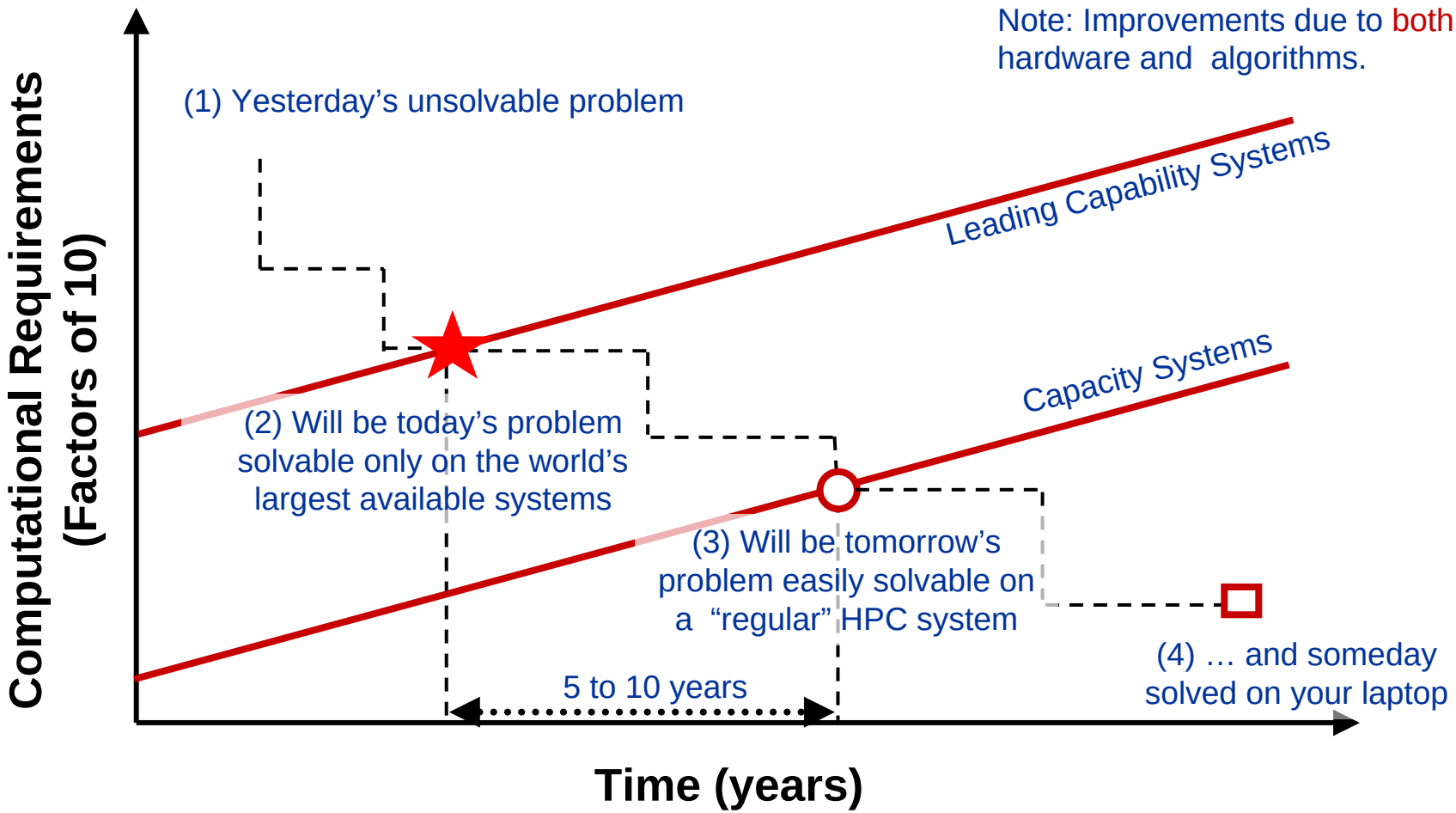
Growing Gap Between Resources and Requirements

Example: DoD HPC Modernization Program



Trend is Consistent with Other Agencies and Studies

Balancing Capability and Capacity



High-end computing enables US to solve "unsolvable" problems first.

Charge for *Federal Procurement of HEC Systems*

Produce findings and recommendations that include:

- Recommendations for ***improving processes*** for ***acquiring HEC systems*** based on the following issues:
  - Identification of practical performance measures for system procurement that correlate well with realized performance of actual applications. These ***performance measures*** should be based on ***sustained*** rather than theoretical or peak ***performance*** and should consider overall system balance in addition to basic computational speed;
  - Recommended ways of deriving system performance targets from actual or projected application requirements or other user needs;
  - Discussion of ***total cost of ownership*** beyond procurement cost, including space, maintenance, utilities, upgradeability, etc.;

Improving HEC Procurement

Lessons learned from the 1990s

Alliant, Cray Computer, Supercomputing Systems, Thinking Machines, Kendall Square Research, …

"In the history of science and technology, it is clear that progress can be strongly correlated with the availability of quantitative data. … The substitution of arm waving and hype has been a major contributor to the tragedies in the field…" p281

***High Performance Computing Challenges for Future Systems* - David J. Kuck (1996)**

Improving HEC Procurement

Multi-Agency Pilot Projects

- **HEC Benchmarking**
- **Models for Total Cost of Ownership**
- **Collaborative Procurement Activities**

Final Observations

- **Important window of opportunity**
- **HECRTF planning has already served as a catalyst for improving planning and coordination**
- **Significant Congressional and Administration interest in HEC**
  - HEC activities are expected to be coordinated
- **Huge opportunity to advance computational science and engineering**
- ✓ **Remember, HEC competes with other priorities/ideas**
  - Information assurance, embedded systems, …