
Information Technology Research: Investing in Our Future (Again)

Revisiting the 1999 PITAC Report

Ken Kennedy
Rice University

<http://www.cs.rice.edu/~ken/Presentations/PITAC2004.pdf>

PITAC Charter

- The Committee shall provide an independent assessment of:
 - Progress made in implementing the High-Performance Computing and Communications (HPCC) Program;
 - Progress in designing and implementing the Next Generation Internet initiative;
 - The need to revise the HPCC Program;
 - Balance among components of the HPCC Program;
 - Whether the research and development undertaken pursuant to the HPCC Program is helping to maintain United States leadership in advanced computing and communications technologies and their applications;
 - Other issues as specified by the Director of the Office of Science and Technology.
 - Review of the entire IT investment strategy — is it meeting the nation's needs

PITAC Membership 97-99

- **Co-Chairs:**

- Bill Joy, Sun Microsystems

- Ken Kennedy, Rice

- **Members:**

- Eric Benhamou, 3Com

- Ching-chih Chen, Simmons

- Steve Dorfman, Hughes

- Bob Ewald, SGI

- Sherri Fuller, U of Washington

- Susan Graham, UC Berkeley

- Danny Hillis, Disney, Inc

- John Miller, Montana State

- Raj Reddy, Carnegie Mellon

- Larry Smarr, UIUC

- Les Vadasz, Intel

- Steve Wallach, Centerpoint

- Vinton Cerf, MCI

- David Cooper, LLNL

- David Dorman, AT&T

- David Farber, Penn

- Hector Garcia-Molina, Stanford

- Jim Gray, Microsoft

- Robert Kahn, CNRI

- David Nagel, AT&T

- Ted Shortliffe, Columbia

- Joe Thompson, Miss. State

- Andy Viterbi, Qualcomm

- Irving Wladawsky-Berger, IBM

Methodology

- Evaluation of Federal Research Investment Portfolio
 - Plans reviewed for each of the major areas:
 - High End Computing and Computation
 - Large Scale Networking
 - Human Centered Computer Systems
 - High Confidence Systems
 - Education, Training, and Human Resources
- Review of Balance in Federal Research Portfolio
 - Fundamental versus Applied
 - Based on our own definition of these terms
 - High-Risk versus Low-Risk
 - Long-Term versus Short-Term

Principal Finding

- **Drift Away from Long-Term Fundamental Research**
 - Agencies pressed by the growth of IT needs
 - IT R&D budgets have grown steadily but not dramatically
 - IT industry has accounted for over 30 percent of the real GDP growth over the past five years, but gets only 1 out of 75 Federal R&D dollars
 - Problems solved by IT are critical to the nation—engineering design, health and medicine, defense
 - Most IT R&D agencies are mission-oriented
 - Natural and correct to favor the short-term needs of the mission
- **This Trend Must Be Reversed**
 - Continue the flow of ideas to fuel the information economy and society

Remedy

- **Increase the Federal IT R&D Investment by 1.4 billion dollars per year**
 - Ramp up over five years
 - Focus on increasing fundamental research
- **Invest in Key Areas Needing Attention**
 - Software
 - Scalable Information Infrastructure
 - High-End Computing
 - Social, Economic, and Workforce Issues
- **Develop a Coherent Management Strategy**
 - Establish clear organizational responsibilities
 - Diversify modes of support

High-End Computing

- Findings:
 - High-end computing is essential for science and engineering research
 - High-end computing is an enabling element of the United States national security program
 - New applications of high-end computing are ripe for exploration
 - Suppliers of high-end systems suffer from difficult market pressures
 - High-end market not large
 - Innovations are required in high-end systems and application-development software, algorithms, programming methods, component technologies, and computer architecture
 - Scalable parallel architectures not ideal for every application
 - High-end computing capability for the civilian science and engineering community is falling dangerously behind the state of the art

High-End Recommendations

- **Research:**
 - Fund research into innovative computing technologies and architectures
 - Fund R&D on software for improving the performance of high-end computing
 - Drive high-end computing research by trying to attain a sustained petaops/petaflops on real applications by 2010 through a balance of hardware and software strategies
- **Facilities**
 - Fund the acquisition of the most powerful high-end computing systems to support science and engineering research
- **Management**
 - Expand the NSTC CIC High End Computing and Computation (HECC) Working Group's coordination process to include all major elements of the government's investment in high-end computing

Management Recommendations

- Program Leadership and Oversight
 - Strongly encourage NSF to assume a leadership role in basic information technology research. Provide NSF the necessary resources to play this role
 - Designate a Senior Policy Official for Information Technology R&D
 - Establish a senior-level policy and coordination committee to provide strategic planning and management
 - Extend the HPCC program coordination model to major Federal information technology R&D activities
 - Establish an annual review of research objectives and funding modes

Management Recommendations

- Modes of Funding
 - Diversify the modes of research support to include more projects of broader scope and longer duration, placing a renewed emphasis on research carried out in teams
 - Fund collaborations with applications to drive information technology research, but take measures to ensure that research remains a primary goal
 - It should be OK for collaborations to produce CS research that does not directly affect the collaborating applications
 - Fund centers for Expeditions into the 21st Century
 - Establish a program of Enabling Technology Centers

Funding Recommendations

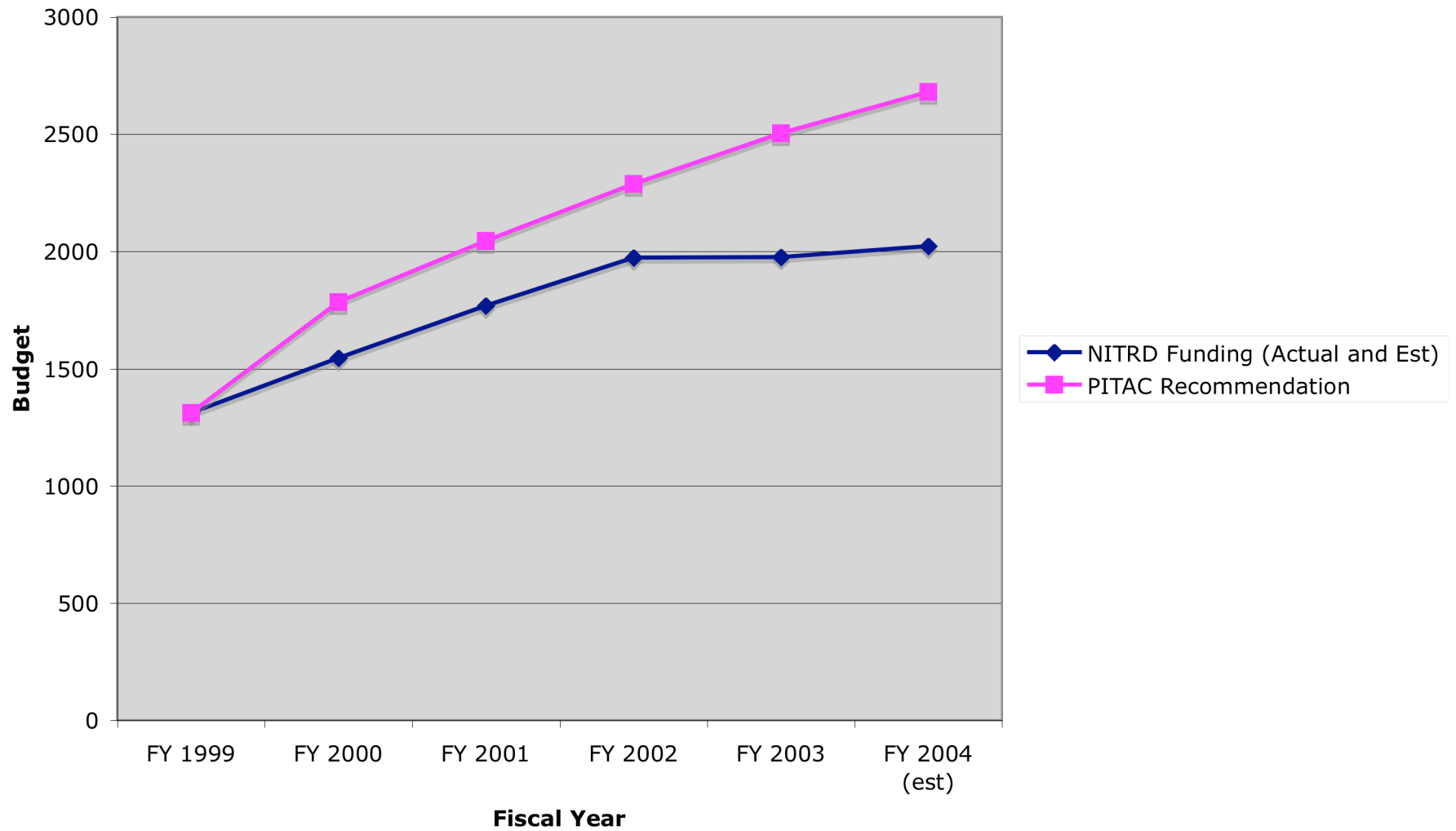
- Increase current funding for IT R&D as follows over the fiscal years 2000-2004

<i>Fiscal Year</i>	<i>2000</i>	<i>2001</i>	<i>2002</i>	<i>2003</i>	<i>2004</i>
<i>Software</i>	112	268	376	472	540
<i>Scalable II</i>	60	120	180	240	300
<i>High End</i>	180	205	240	270	300
<i>HE Facilities</i>	90	100	110	120	130
<i>SEW</i>	30	40	70	90	100
Total	472	733	996	1202	1370

Report Card: Positives

- **Changed Attitudes**
 - Agencies came to understand the value of long-term research
 - NSF initiated programs of 3-5 years
- **Added Funding and Programs**
 - NSF
 - ITR and TeraGrid
 - DARPA HPCS
 - Most exciting new program in architecture in years
 - Emphasis on productivity
 - Company based
 - NIH
 - Not clear whether new funding arrived but new programs in Bioinformatics have begun to appear

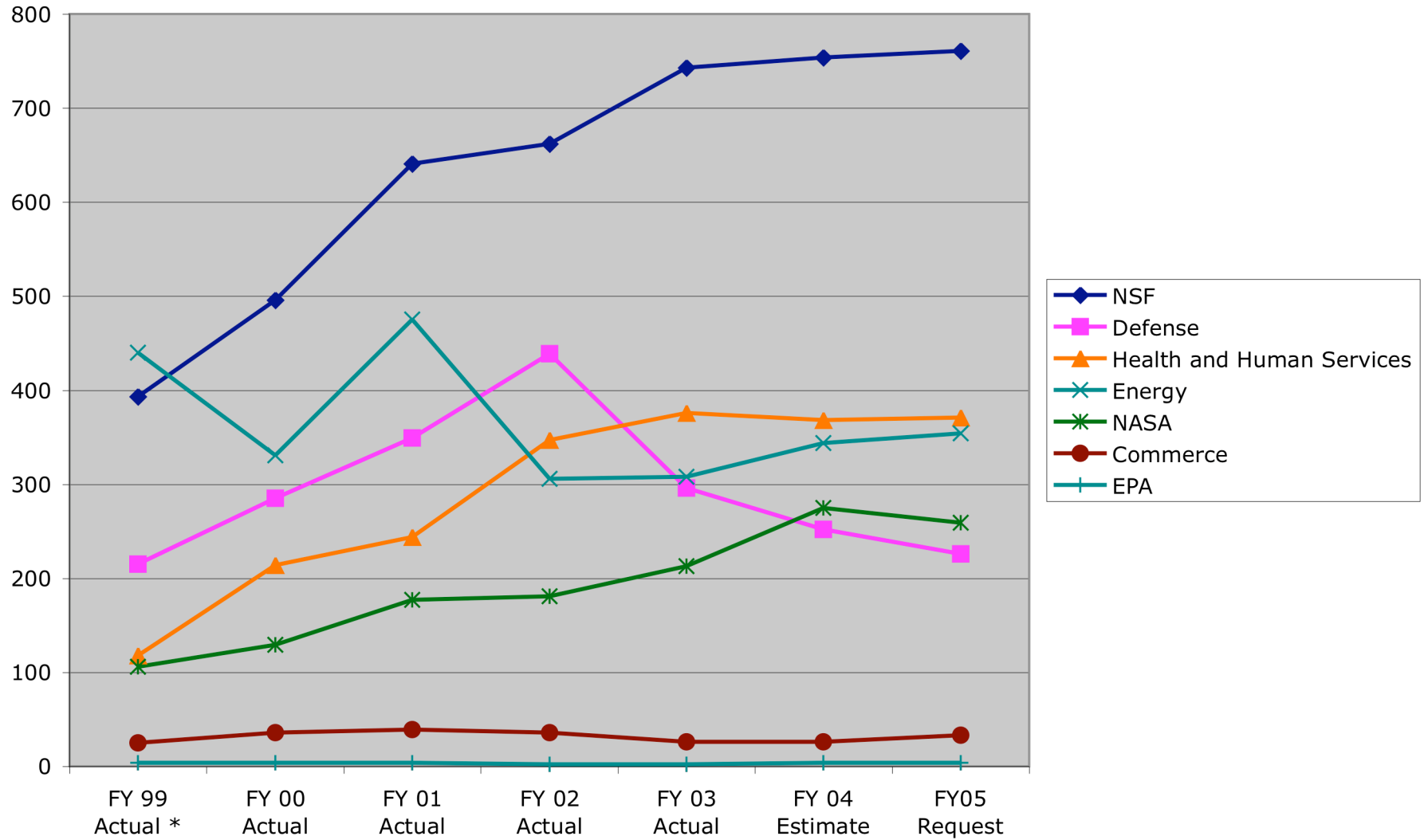
PITAC vs NITRD



Concern: Program Design

- NSF:
 - ITR: Single big program
 - End of PACIs
 - Some funding redirected to science directorates
- DARPA
 - Not clear whether PITAC resulted in additional funds
 - High end scientific computing dropped in spite of DOD Modernization need
 - High Productivity Computing Systems
 - Focus on vendor projects may not have desired effect on software
- Other agencies
 - Unclear if any money arrived

NITRD Funding FY 00 - 05 By Agency



Concerns: NSF

- Is the Centers Program being handled properly?
 - Is the current distributed approach going to provide the services scientists need?
 - Why has the budget been flat?
 - Cannibalization of software for hardware and distributed center operations
- What about software?
 - PACIs eliminated
 - After they developed a good model for collaborative research on CS+application
 - Is there a corresponding increase in the research program?
- Is the Grid middleware initiative succeeding?
 - Globus is there, but there are many problems

Report Card: More Concerns

- **DARPA HPCS**
 - Great program but software funding model is problematic
 - Some software should be the responsibility of independent projects cutting across hardware vendors
 - The latter is essential because application development software must work well on all platforms!
 - Not enough money in ST-HEC to have the desired result
- **NIH**
 - The programs are only now getting into gear
 - Some programs, like the National Centers for Biomedical Computation (NCBC) are focused on development
 - Managers want deliverable artifacts, not research
 - Many good intentions, but money comes through institutes
 - They must be convinced to invest in research

Report Card: More Concerns

- DOE Office of Science
 - Focus on applications and facilities
 - Software research is fairly short-term
- DOE NNSA (Stockpile Stewardship)
 - Not part of original PITAC scope
 - Saved HPC research during a lean period
 - Kept many universities focused on HPC research through center-style and team funding programs
 - Today: Budget pressure driving out long-term research

Conclusions

- PITAC 1999 message: Focus on long-term research
 - Think big and make it possible for researchers to think big
 - Increase the funding and the funding term
 - This is the unique responsibility of the Federal Government
- Positive Result: Funding has increased
 - Most of the measurable growth has gone to NSF
 - Modes of funding diversified
 - New programs initiated
- Concerns
 - HPC software still not getting enough attention
 - Amounts and nature of funding
 - Is the leadership and management adequate?
 - Are we returning to an era of short-term thinking?