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# Information Technology Research: Investing in Our Future (Again)

Revisiting the 1999 PITAC Report

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

# PITAC Charter

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- 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

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- **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

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- 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

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- **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

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- 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

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- 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

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- **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

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- 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

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- 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

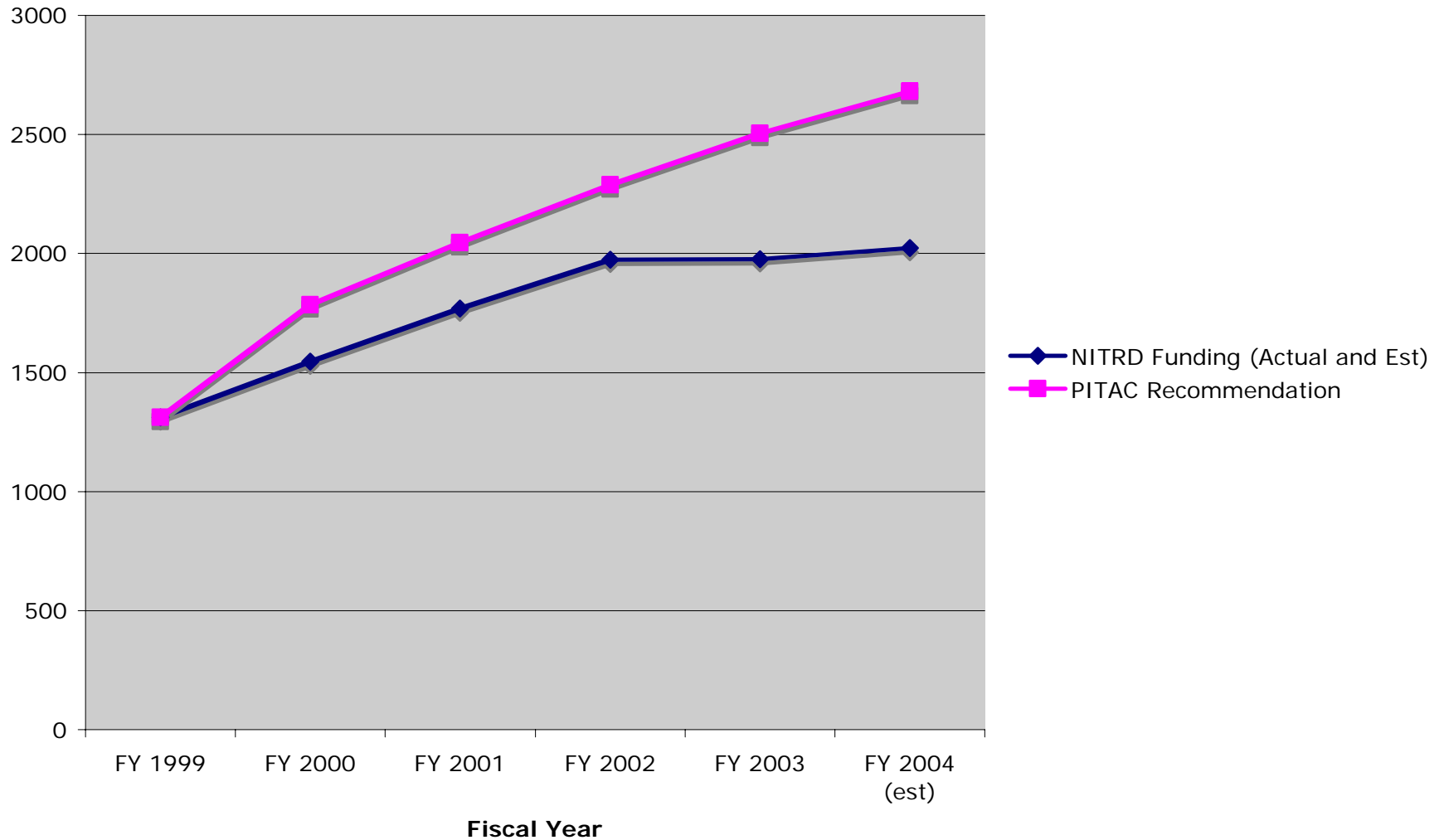
<i>Fiscal Year</i>	<i>2000</i>	<i>2001</i>	<i>2002</i>	<i>2003</i>	<i>2004</i>
<i>Software</i>	112	268	376	472	540
<i>Scalable II</i>	60	120	180	240	300
<i>High End</i>	180	205	240	270	300
<i>HE Facilities</i>	90	100	110	120	130
<i>SEW</i>	30	40	70	90	100
<b>Total</b>	<b>472</b>	<b>733</b>	<b>996</b>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

# Report Card: Positives

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- **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

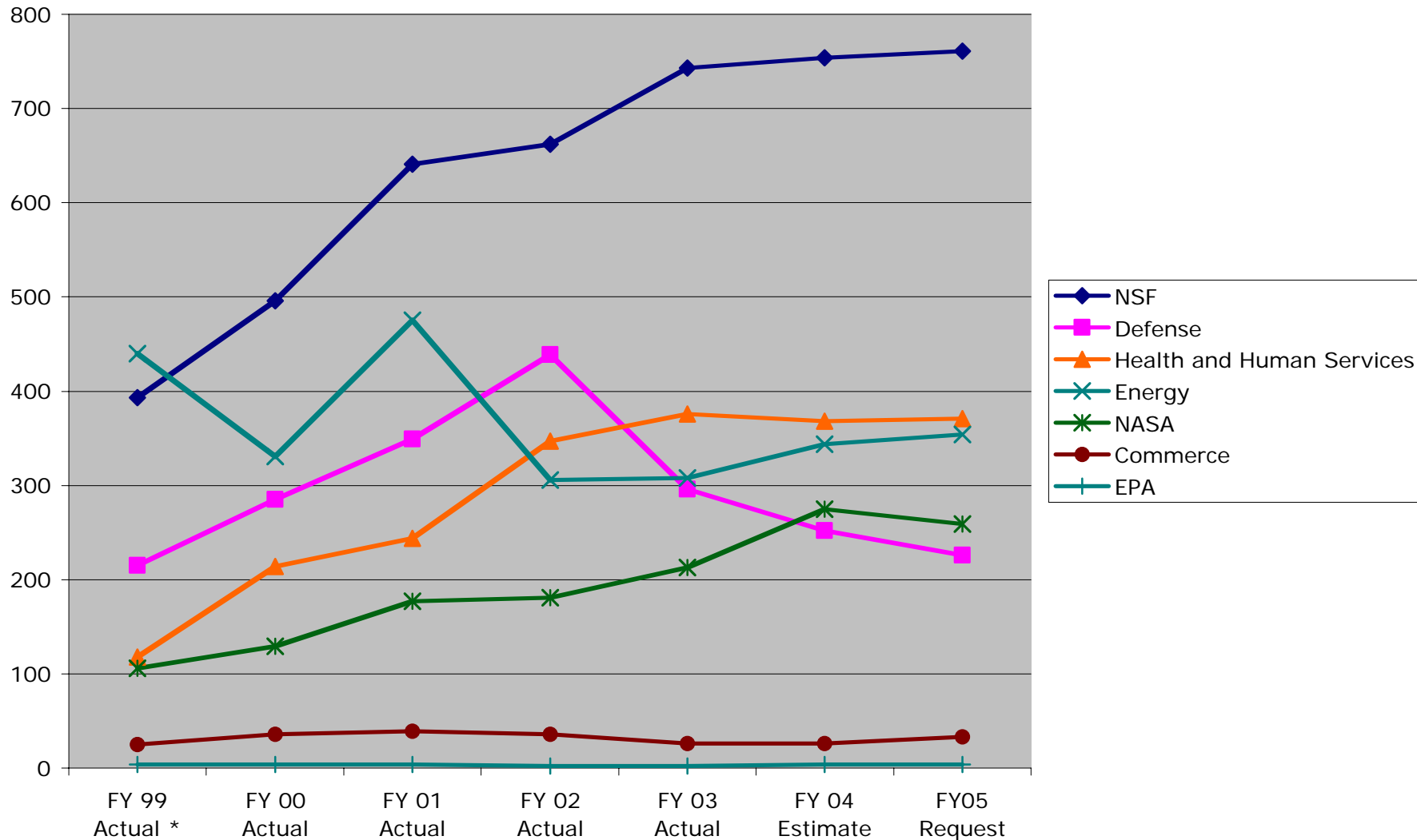


# Concern: Program Design

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- 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

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- 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

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- 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

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- 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

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- 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?