Information Technology
Research: Investing in Our
Future (Again)

Revisiting the 1999 PITAC Report

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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:**
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  - Ching-chih Chen, Simmons
  - Steve Dorfman, Hughes
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  - Danny Hillis, Disney, Inc
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  - David Dorman, AT&T
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  - Hector Garcia-Molina, Stanford
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  - 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

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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
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

Center for High Performance Software Research
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?