

Computing Research in the FY 2007 Budget Request

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HIGHLIGHTS

- Funding for the Networking and Information Technology Research and Development (NITRD) program would increase 7.7 percent in the President's FY 2007 request versus FY 2006 (see Table I-9).
- The National Science Foundation (NSF), Defense Advanced Research Projects Agency (DARPA), National Institute of Standards and Technology (NIST), and Department of Energy Office of Science (DOE SC) would all see significant increases to their computing research efforts under the President's plan.
- The President's Information Technology Advisory Committee (PITAC) has been dissolved as a free-standing committee and its responsibilities have been folded into the President's Council of Advisors for Science and Technology (PCAST), which has had its membership expanded to take on this new role.

INTRODUCTION AND BACKGROUND

The importance of computing research in enabling the new economy is well documented. The resulting advances in information technology have led to significant improvements in product design, development and distribution for American industry, provided instant communications for people worldwide, and enabled new scientific disciplines like bioinformatics and nanotechnology that show great promise in improving a whole range of health, security, and communications technologies. Federal Reserve Board Chairman Alan Greenspan has said that the growing use of information technology has been the distinguishing feature of this "pivotal period in American economic history." Recent analysis suggests that the remarkable growth the U.S. experienced between 1995 and 2000 was spurred by an increase in productivity

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enabled almost completely by factors related to IT. “IT drove the U.S. productivity revival [from 1995-2000],” according to Harvard economist Dale Jorgenson.

Information technology has also changed the conduct of research. Innovations in computing and networking technologies are enabling scientific discovery across every scientific discipline—from mapping the human brain to modeling climate change. Researchers, faced with research problems that are ever more complex and interdisciplinary in nature, are using IT to collaborate across the globe, simulate experiments, visualize large and complex datasets, and collect and manage massive amounts of data.

According to a 1995 report by the National Research Council, a significant reason for this dramatic advance in computing technology and the subsequent increase in innovation and productivity is the “extraordinarily productive interplay of federally funded university research, federally and privately funded industrial research, and entrepreneurial companies founded and staffed by people who moved back and forth between universities and industry.” That report, and a subsequent 1999 report by the President’s Information Technology Advisory Committee (PITAC), emphasized the “spectacular” return on the federal investment in long-term IT research and development.

However, in that 1999 report PITAC—a congressionally-chartered, presidentially-appointed committee charged with assessing the overall federal investment in IT R&D—also determined that federal support for IT R&D was inadequate and too focused on near-term problems; long-term fundamental IT research was not sufficiently supported relative to the importance of IT to the United States’ economic, health, scientific and other aspirations; critical problems in computing were going unsolved; and the rate of introduction of new ideas was dangerously low. The PITAC report included a series of recommendations, a set of research priorities and an affirmation of the committee’s unanimous opinion that the federal government has an “essential” role in supporting long-term, high-risk IT R&D. This opinion was buttressed by the inclusion of a recommendation for specific increases in funding levels for federal IT R&D programs beginning in FY 2000 and continuing through FY 2004—an increase of \$1.3 billion in additional funding over those five years.

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Though the funding levels actually appropriated to federal IT R&D programs have never approached the level of the PITAC recommendations—federal agencies received \$2.2 billion in FY 2004 for IT R&D, \$476 million short of the PITAC recommendation—the PITAC report has done much to shape the current federal IT R&D effort. As of FY 2006, that effort is now a \$2.9 billion, multi-agency enterprise called the Networking and Information Technology Research and Development (NITRD) program and coordinated by the Interagency Working Group (IWG) on Information Technology Research and Development of the National Science and Technology Council (NSTC). NITRD is the successor of the High Performance Computing and Communications Program established by Congress in 1991. NITRD agencies coordinate research in seven Program Component Areas (PCAs): High End Computing Infrastructure and Applications; High End Computing Research and Development; Human Computer Interaction and Information Management; Large Scale Networking; Software Design and Productivity; High Confidence Software and Systems; and Social, Economic, and Workforce Implications of IT and IT Workforce Development. NSF is the lead agency in NITRD; other participating agencies include the Agency for Healthcare Research and Quality (AHRQ), Department of Energy (DOE) National Nuclear Security Administration (NNSA) and the Office of Science, Environmental Protection Agency (EPA), National Aeronautics and Space Administration (NASA), National Institutes of Health (NIH), NIST, National Oceanic and Atmospheric Administration (NOAA), National Security Agency (NSA), and the Department of Defense Office of the Secretary of Defense (OSD) and DARPA.

CURRENT POLICY ENVIRONMENT

Concerns about the state of federal support for computing research generated a surprising amount of attention in both the national press and from Congress in 2005. Long-standing concerns from the computing research community about the impact of what its members saw as a changing landscape for federal support of computing research—a move away from the support of long-term research, especially at agencies like DARPA that had been historically strong supporters of long-term research, in favor of shorter-term, more development-oriented research—gained currency when DARPA confirmed to the Senate Armed Services Committee (SASC) that its support for university-led computer science research had dropped nearly in half in the years since FY 2001. DARPA

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noted that while its overall investment in computer science research had increased from \$546 million in FY 2001 to \$583 million in FY 2004, the amount directed towards universities dropped from \$214 million in FY 2001 to \$123 million in FY 2004.

The acknowledgement from DARPA that it had decreased its investment in university-led research caught the attention of Congress and the national media. At a time when many in the science advocacy community were arguing that the current Administration's investments in research were too narrowly focused on short-term, defense-oriented research and not the longer-payoff, fundamental research usually performed in U.S. universities, the DARPA computer science story became one of the prime examples of this trend. The irony that DARPA, which had been instrumental in funding the long-term research that led to information technologies like the Internet and personal computing that were driving the new economy, was now in the process of deemphasizing that research proved particularly newsworthy. In April 2005, the *New York Times* covered the issue in a piece by John Markoff headlined "Pentagon Redirects Its Research Dollars." That piece spawned subsequent news coverage and editorials in the *Times*, *The Washington Post*, the *San Jose Mercury News*, *Roll Call*, *Science*, the *Los Angeles Times*, *Business Week*, *U.S. News and World Report*, *The Wall Street Journal*, and *Time*, among others—all mentioning the DARPA computer science story as an example, or even the sole example, of this trend.¹

In addition to the media coverage, two federal advisory boards issued findings that echoed the computing research community's concern. In its February 2005 report on the DOD's high-performance microchip supply, the DOD's Defense Science Board found that changes in emphasis at DARPA—particularly its de-emphasis of university-led, long-term research—had already impacted DOD-related research long-term:

Historically, the rapid rate of growth in U.S. microchip capability resulted from a robust national portfolio of long-term research that incorporated both incremental and revolutionary components. Industry excelled in evolutionary technology developments that resulted in reduced costs, higher quality and reliability and vastly improved performance. DOD now is no longer perceived as being seriously involved in -- or even taking steps to ensure that others are conducting -- research to enable the embedded

¹ For links to all the news articles mentioned, see <http://cra.org/research>

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processing proficiency on which its strategic advantage depends. This withdrawal has created a vacuum where no part of the U.S. government is able to exert leadership, especially with respect to the revolutionary component of the research portfolio. -*High Performance Microchip Supply*, Defense Science Board, February 2005, Appendix D, p. 87-88

The following month, PITAC issued its report on the state of the federal cyber security R&D program, "Cyber Security: A Crisis of Prioritization," which noted similar concerns with DARPA's handling of its cyber security research portfolio. The committee found that DARPA's efforts were too short-term focused and its increased use of classification was limiting the participation of university researchers and likely limiting the benefits of the research.

Responding to the concerns, the House Science Committee held a hearing of the full committee on May 12, 2005, to discuss the issue. The hearing, titled "The Future of Computer Science Research in the U.S.," brought together John Marburger, III, Director of the White House Office of Science and Technology Policy; Anthony Tether, Director of DARPA; William Wulf, a computer scientist and President of the National Academy of Engineering; and Tom Leighton, co-Founder of Akamai Industries and Chair of the PITAC Committee on Cyber Security, to discuss the issue with the committee. The sometimes-contentious hearing convinced Science Committee Chair Sherwood Boehlert (R-NY) that the community's concerns appeared to have merit and he pledged to continue working to address them. "We had a vigorous discussion today that I want to see continue," Boehlert said. "I want the Science Committee to be an honest broker that can bring together DARPA and its critics to help Congress and the Administration create a computer science funding policy that will address the nation's future and current needs. We will continue to pursue this issue."

The SASC also weighed in to support the research community position in the Senate version of the FY 2006 Defense Authorization bill (S. 1042). In report language accompanying the bill, the committee wrote that it was "concerned that the Department of Defense is reducing its investment in long-term computer science research, without due consideration of the potential negative ramifications of such reductions on the development of next generation networking, information technology, and information assurance systems on which our military will depend in the future." In addition, the committee directed the DOD Undersecretary of Defense for Acquisitions, Logistics and Technology to

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“carefully examine the long-term practical and policy implications of the Department’s investment strategy for computing research.” That report should be available in early 2006.

In addition, an amendment to S. 1042 introduced by Sen. Susan Collins (R-ME) and Sen. Edward Kennedy (D-MA) included a provision specifically aimed at addressing some of the computing research community’s concerns by authorizing \$5 million in additional funding for “fundamental research in computer science and cyber security” at DARPA. The amendment passed and the funding was included in the final bill signed by the President.

However, a cut to a requested increase for DARPA’s Cognitive Computing program by the Senate Appropriations Committee in the FY 2006 Defense Appropriations bill (H.R. 2863) muted the impact of the Collins-Kennedy amendment. Senate appropriators reduced the President’s requested budget for the \$113 million “Learning, Reasoning and Cognitive Systems” account at DARPA by \$35 million in FY 2006, because they believed DARPA’s justification for the program failed to demonstrate the military utility of the research. It is likely the Cognitive Computing program will face similar scrutiny in the coming year.

Also expected in the coming year is the start of a new review of the overall federal IT R&D portfolio by the President’s Council of Advisors for Science and Technology (PCAST), which has assumed the oversight role of NITRD formerly the responsibility of PITAC. In June 2005, the President let the most recent incarnation of PITAC expire after the committee released its report on “Computational Science: Ensuring America’s Competitiveness”—the last of three reports prepared by that committee on narrow aspects of the federal IT R&D effort (the other two reports were on information technology and health, and cyber security R&D). Though the committee had expressed an interest in following up the three narrow reports with a broader look at the overall IT R&D effort, the committee members’ appointments expired before they had a chance to begin and were not renewed by the President. On September 30, 2005, the President announced that he was terminating the free-standing PITAC and folding its responsibilities into PCAST. The President also announced that he was expanding the membership of PCAST to allow for the inclusion of additional members with some expertise in information technology issues. The newly empowered PCAST met in early January (though the new members had not yet been named) and

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discussed beginning a report on the NITRD program similar in scope to the 1999 PITAC report, “Investing in Our Future,” that had proved so influential on the federal IT R&D program and investment. It is not known how long PCAST will take to generate the new report.

BUDGET REQUEST

Seven agencies included requests for FY 2007 funding as part of the NITRD activity. Under the President’s plan, NSF would once again be designated as the lead agency for the initiative, with NSF Computing and Information Systems and Engineering (CISE) directorate head Dr. Peter Freeman serving as the head of the NITRD Interagency Working Group. For FY 2007, the President has requested \$3.1 billion for the NITRD initiative, an increase of 7.7 percent over FY 2006 (see Table I-9). NITRD is an important component of the President’s American Competitiveness Initiative, as evidenced by the fact that under the President’s budget, every major NITRD participating agency with the exception of NIH would see its funding for NITRD-related research increase, in some cases significantly.

National Science Foundation: Because a recharacterization of IT R&D funded by the Department of Defense increased DOD’s apparent share of the NITRD budget to nearly \$1.1 billion in the President’s plan, NSF is no longer the largest contributor to the NITRD program.² Yet NSF remains the largest supporter of fundamental computer science in U.S. universities, supporting 86 percent of federal obligations in basic computer science research. NSF’s overall share of the NITRD program would grow to \$904 million in FY 2007 under the President’s plan, an increase of 11.4 percent over FY 2006. NSF’s Computer and Information Science and Engineering directorate (CISE) would continue to be home of the largest share of that investment with a budget of request of \$527 million, an increase of 6.1 percent over FY 2006. The CISE investment is spread relatively equally between its Computing and Communication Foundations activity (\$123 million in the request, an increase of 16.5 percent over FY 2006), Computer and Network Systems (\$163 million,

² Included in the DOD budget for the first time is funding for the DOD service research organizations (Air Force, Army, Navy) as well as DOD’s High Performance Computing Modernization Office. Total funding for these programs is \$466 million in FY 2007, which increases DOD NITRD baseline funding but does not represent “new money” at DOD. FY 2006 and FY 2005 NITRD funding amounts have been adjusted to reflect this change.

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an increase of 15.2 percent), and Information and Intelligent Systems (\$119 million, an increase of 15.1 percent). The double-digit increases to these programs are made possible by both the 6.1 percent overall increase for the directorate and funding freed up as grants under the old Information Technology Research (ITR) program—which officially ended in FY 2004—continue to expire. ITR expenditures in FY 2007 would decline by 17 percent to \$122 million under the current plan.

The overall NSF contribution to Cybersecurity and Information Assurance would also grow significantly under the President's plan. The budget request boosts NSF's Cyber Trust program \$10 million to \$35 million in FY 2007, bringing NSF's total contribution to information assurance research to \$97 million (an increase of 26 percent).

Proposed investments in NSF's new Office of Cyberinfrastructure (to be headed by University of Michigan professor and computer scientist Daniel Atkins) account for \$182 million of NSF's NITRD share in FY 2007, an increase of \$55 million, or 44 percent, over FY 2006. The great bulk of that increase (\$50 million) would begin the acquisition of a new "petascale" computing system.

The remainder of NSF's investments in NITRD programs would come from the other research directorates, which on average would receive about the same increase as CISE (about 6 percent vs. FY 2006).

Department of Defense: Despite concerns about DARPA's lack of support for university-led research computer science research, computing research at DARPA would grow significantly under the President's plan, gaining back lost ground in FY 2006 appropriations when \$35 million was cut from the agency's Cognitive Computing program. DARPA's two main computing research efforts, the Information and Communications Technology (ICT) account and the Cognitive Computing Systems account, are both slated for substantial gains in the President's budget. ICT would grow \$47 million to \$243 million in FY 2007, an increase of 24 percent. Cognitive Computing Systems would grow \$57 million to \$220 million in FY 2007, an increase of 35 percent.

Computing research in the DOD service labs would see a slight decline in FY 2007, falling 8.5 percent or \$46 million to \$498 million. Much of this decrease is attributable to reductions to the High Performance Computing Modernization Program Office and a decrease in large scale

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networking research in the Army Research Lab. The National Security Agency would also see a 16.3 percent or \$23 million cut in its FY 2007 budget, largely due to accelerated investments in FY 2006 for the Black Widow computing system, which will be largely complete by FY 2007.

Health and Human Services (HHS): NIH constitutes the bulk of funding in IT R&D at HHS. For FY 2007, the President's plan includes \$548 million in IT R&D funding at HHS, a decrease of 2.7 percent, or \$15 million less than the FY 2006 level, mirroring the overall NIH decrease found in the President's budget.

Within HHS, NIH participates in NITRD by supporting research that advances its mission of developing the basic knowledge for the understanding, diagnosis, treatment, and prevention of human disease. IT research in this area includes applying the power of computing to manage and analyze biomedical data and to model biological processes. AHRQ focuses on research into state-of-the-art IT for use in health care applications such as computer-based patient records, clinical decision support systems, and standards for patient care data.

Department of Energy: IT R&D activities in the Office of Science and NNSA constitute DOE's participation in NITRD. The Office of Science (SC) focuses on computational and networking tools that enable researchers to model, simulate, analyze, and predict complex physical, chemical and biological phenomena important to the department's overall mission. NNSA supports research developing new means of assessing the performance, safety, and reliability of nuclear weapons systems through high-fidelity computer models and simulations. Under the President's plan DOE NITRD funding would be \$387 million for FY 2007, an increase of 33.0 percent or \$96 million from the FY 2006 level.

The budget increase includes a \$31 million increase to DOE SC's High End Computing Infrastructure and Applications efforts to enhance partnerships to deliver applications for petascale computing systems, as well as investments to expand high-performance computing capacity at DOE Labs. The budget also includes a \$51 million increase in high-end computing R&D for enhancements to the Leadership Computing Facility, including investments at Oak Ridge National Laboratory and Argonne National Lab.

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National Aeronautics and Space Administration: Under the President's plan, NASA would see a 5.1 percent or \$4 million increase to its NITRD programs. The President's request includes \$82 million for NASA IT R&D in FY 2007, up from \$78 million. Within its NITRD-related efforts, NASA has reduced funding for research in Human-Computer Interaction and Information Management, Large Scale Networking, and High Confidence Software and Systems, in order to focus on R&D aimed at implementing its Vision for Space Exploration.

Department of Commerce (DOC): The DOC request for FY 2007 contains NITRD-related funding requests from two agencies: NOAA and NIST. NIST IT R&D efforts include working with industry, educational, and government organizations to make IT systems more useable, secure, scalable, and interoperable. In addition, NIST works to apply IT to specialized areas like biotechnology and manufacturing, and to encourage industry to accelerate development of IT innovations. The request includes \$43 million for NIST in 2007, an increase of \$4 million.

NOAA supports IT research in emerging computer technologies for improved climate modeling and weather forecasting, and for improved communications technologies to disseminate weather products and warnings to emergency responders, policymakers, and the general public. The President's request includes \$23 million for NOAA in FY 2007, a \$7 million increase over FY 2006. The President's requested increase would restore funding to programs cut by Congressional action in FY 2006.

Environmental Protection Agency: The EPA would receive \$6 million in FY 2007 under the President's plan. EPA intends to support IT technologies that facilitate ecosystem modeling, risk assessment, and environmental decision making at the federal, state, and local levels.

Department of Homeland Security: Because the Department of Homeland Security, established in 2003, was created well after the original passage of the legislation creating the current NITRD structure (the High Performance Computing and Communications Act of 1991), the agency is not officially a member of the NITRD Interagency Working Group. However, the agency has requested \$23 million in FY 2007 for cyber security research and development, out of a total Science and Technology directorate budget request of \$1.2 billion (see Table II-6), an increase of \$6 million.