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Computing Research in the FY 2006 Budget Request

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HIGHLIGHTS

- Networking and Information Technology Research and Development (NITRD) funding would fall 4.5 percent in FY 2006 to $2.2 billion across twelve federal agencies, under the President's budget request.

- The President's request would increase funding for computing research at the National Science Foundation (NSF), the lead agency in the NITRD initiative, to $803 million in FY 2006, an increase of 1.0 percent (see Table I-9).

- Concerns mount that NSF now bears a disproportionate share of support for computing research as the agency reports that it was responsible for 86 percent of federal obligations for basic computer science research at academic institutions in FY 2004.

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 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 climatic 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, including 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.

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. That effort is now a $2.3 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. The National Science Foundation (NSF) is the lead agency in NITRD.[1]

CURRENT POLICY ENVIRONMENT

The landscape for computing research funding has changed significantly since PITAC began its review of the federal IT R&D effort in 1997. Since the early 1960s, the two federal agencies arguably most responsible for supporting computing research, the development of computer science as a discipline and much of the innovation that has resulted are NSF and DARPA. At the time PITAC began its review, both agencies bore an about equal share of the overall federal investment in IT R&D. In FY 1998, DARPA funding constituted 30 percent of federal IT R&D spending, compared to NSF's 27 percent share. However, as the

[1] Other participating agencies include the Agency for Healthcare Research and Quality (AHRQ), Defense Advanced Research Projects Agency (DARPA), Department of Energy (DOE) National Nuclear Security Administration (NNSA), DOE Office of Science, Environmental Protection Agency (EPA), National Aeronautics and Space Administration (NASA), National Institutes of Health (NIH), National Institute of Standards and Technology (NIST), National Oceanic and Atmospheric Administration (NOAA), National Security Agency (NSA), and the DOD Office of the Secretary of Defense (OSD).

overall investment has increased, DARPA's share of the research – both as a percentage of the overall effort and in absolute dollars – has declined. While NSF's $795 million investment in IT R&D in FY 2005 represents 35 percent of overall federal IT R&D (an increase in its total share since FY 1998), DARPA's $143 million in FY 2005 represents just 6 percent of the overall IT R&D budget, a significant decrease in its share since FY 1998.

There are concerns within the computing research community about the reasons for DARPA's diminished role in supporting computing research and the impact that it will have on the discipline, DARPA's mission, and the nation as a whole. Central to these concerns is the idea that the discipline – and hence, the nation – benefited greatly by having the two different approaches to funding computing research represented by the NSF model and the DARPA model. While NSF has primarily focused on support for individual investigators at a wide range of institutions – and support for computing infrastructure at America's universities – DARPA's approach has varied over the years. DARPA has had a number of "freedoms" that other funding agencies like NSF have not. Historically, DARPA program managers could fund individual researchers, or even "centers of excellence" – typically university research departments – without the requirement for equitable distributions of funding based on geography or any other factor beyond scientific capability. DARPA's requirement for competitive selection did not involve peer review in the same way that competitive grants at NSF were evaluated. DARPA program managers had great flexibility in funding projects they believed to be promising. In this way, DARPA was able to create and nourish communities of researchers to focus on problems of particular interest to the agency and to the Department of Defense, with great success.

The combination of the two different approaches has proven enormously beneficial to the nation, the community argues, and to DARPA's overall mission of assuring that the U.S. maintains "a lead in applying state-of-the-art technology for military capabilities and [preventing] technological surprise from her adversaries." DARPA-supported research in computing over a period of over four decades, beginning in the 1960s, has laid down the foundations for the modern microprocessor, the internet, the graphical user interface, single-user workstations, and a whole host of other innovations that have not only made the U.S. military the lethal and effective fighting force it is today, but have driven

the new economy and enabled a whole range of new scientific disciplines.

However, the computing research community argues that through a series of policy changes, including the use of "go/no-go" decisions applied to critical research at 12 to 18 month intervals and the increasing classification of research sponsored by the agency, DARPA has shifted much of its focus in IT R&D from pushing the leading edge of computing research to "bridging the gap" between basic research and deployable technologies – in essence relying on NSF to fund the basic research needed to advance the field.

These changes at DARPA, the community argues, have discouraged university participation in research, effectively reducing DARPA "mindshare" – the percentage of people working on DARPA problems – at the nation's universities. This fact, combined with an overall growth in the number of researchers in the field and an increase in the breadth of the discipline, has placed a significant burden for funding basic IT R&D on NSF. The agency reports that in FY 2004, NSF supported 86 percent of federal obligations for basic research in computer science at academic institutions – and the agency's Computing and Information Science and Engineering Directorate (CISE) is beginning to show the strain. In FY 2004, the funding rate for competitive awards in CISE fell to a decadal low of 16 percent, lowest of any directorate at NSF and well below the NSF average of 25 percent. Programs in critical areas like information security and assurance are enduring even lower success rates – NSF's CyberTrust program reported an 8.2 percent success rate for FY 2004. Such low success rates, the community argues, are harmful to the discipline and to the nation as a whole.

PITAC began to explore these issues in 2004 as a result of its work on its report on the current state of the federal investment in cyber security R&D, *Cyber Security: A Crisis in Prioritization*, due for release in early 2005. The committee found that DARPA's cyber security efforts were too short-term focused and that its increasing use of classification was limiting the participation of university researchers and likely limiting the benefits of the research. The committee also recommended that the federal budget for fundamental research in civilian cyber security must be dramatically increased or the nation's security and technological edge will be seriously jeopardized. As a first step, the committee agreed to

recommend an immediate increase of $90 million per year to NSF's Cyber Trust program.

Because the cyber security report exposed the PITAC members to concerns about how the changed landscape of funding for computing research has impacted cyber security R&D, it also suggested that the problems likely go beyond cyber security R&D and extend to the overall IT R&D effort. As a result, it is likely that the committee will push forward with some effort to review the overall federal IT R&D program in the coming year. How that effort will move forward is unclear, and there is additional uncertainty whether the committee will be re-appointed when its current charter expires on June 1, 2005.

The committee could get further impetus to undertake an overall review of federal IT R&D from legislation introduced in January 2005, by Rep. Judy Biggert (R-IL), Rep. Lincoln Davis (R-TN), and House Science Committee Chair Sherwood Boehlert (R-NY). The High-Performance Computing Revitalization Act of 2005 (H.R. 28) would require PITAC to review NITRD every two years and report to Congress, in addition to helping assure researchers have access to high-performance computer systems and assuring "balanced progress" in high-performance computing research. The bill is identical to H.R. 4218, introduced by the same Members in the 108th Congress, which passed the House but failed to get consideration in the Senate. Previous efforts to reauthorize NITRD programs in the 106th and 107th Congress also failed to gain the approval of both chambers. Prospects for passage this year are better, given the early start and the uncontroversial nature of the legislation.

In addition to efforts to revitalize high-performance computing, Congress is likely to take an interest in cyber security, though congressional reorganization has made the question of who will take the lead in coordinating cyber security policy difficult to answer. For now, the fact that four House committees share jurisdiction over the issue – Energy and Commerce, Government Reform, Science, and Homeland Security – likely means that prospects for any overarching legislation are slim. However, the release of the PITAC cyber security report will probably generate action in Congress and may lead to oversight hearings for the key agencies involved (NSF, DARPA and DHS).

BUDGET REQUEST

Seven agencies included requests for FY 2006 funding as part of the NITRD activity. Under the President's plan, NSF, as the recipient of the largest amount of NITRD funds, 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 2006, the President has requested $2.2 billion for the NITRD initiative, a decrease of 4.5 percent over the FY 2005 enacted level (see Table I-9). Under the President's plan, NSF, Commerce, Defense, and EPA would see small to moderate increases in FY 2006, while Energy, HHS and NASA would see cuts of 7.8, 3.4 and 54.6 percent respectively.

National Science Foundation (NSF): NSF has requested $803 million in NITRD-related funding, an increase of $8 million or 1.0 percent over FY 2005. The bulk of IT-related funding in the NSF request is contained within the request for the CISE directorate, which would grow 1.1 percent over FY 2005 to $621 million. CISE program funding is detailed in Table II-7. The Foundation's Information Technology Research (ITR) activity ended in FY 2004, so funding included in the ITR line reflects commitments to multi-year grants awarded prior to FY 2004. As with last year, NSF continues to invest the funding "freed up" from the ITR activity as grants end back into the "core" research activities of the directorate.

CISE has also adopted a number of strategies to cope with the low success rate the directorate is currently experiencing (detailed above) due to the significant increase in proposal pressure, an increase in annual award amounts, and budget growth that has not kept pace with demand. In some heavily subscribed programs, CISE plans to delay FY 2005 solicitation deadlines and use FY 2005 money to fund some meritorious FY 2004 solicitations it was unable to fund, and use expected FY 2006 money to fund some FY 2005 solicitations. In addition, CISE will limit the number of proposals that a researcher may submit to some competitions, while enforcing regulations that prohibit sending virtually identical proposals to multiple competitions simultaneously.

NSF remains active in every aspect of the NITRD program component areas and continues in its role as the principal source of federal funding for university-based basic research in computer science, computer

engineering, information science, networking and the computational science disciplines. NSF's request of $803 million is significantly larger than the next largest NITRD participant (HHS, $569 million).

Department of Defense (DOD): The DOD request of $299 million for NITRD-related activities department-wide represents an increase of $21 million from the FY 2005 level. DARPA constitutes the largest share of NITRD-related defense funding at $176 million in the President's request, an increase of $28 million over FY 2005, with the bulk of that effort taking place within the Information Processing Technology Office (IPTO). DARPA efforts in High End Computing would increase by $17 million (to $81 million) to support the High Productivity Computing Systems program, consistent with the recommendations of the Administration's High End Computing Revitalization Task Force released last year. Human-Computer Interaction and Information Management would see a $13 million increase (to $74 million) for research aimed at improving information access and analysis for warfighters.

The DOD request also includes $22 million for research in High Confidence Software and Systems and Software Design and Productivity supported by the Office of the Secretary of Defense (OSD), the same level as in FY 2005. The National Security Agency, also a part of the DOD request, would see its budget drop by $12 million in FY 2006 to $101 million, as it winds down the developmental support for its Black Widow computer system.

Health and Human Services (HHS): NIH constitutes the bulk of funding in IT R&D at HHS. For FY 2006, the President's plan includes $569 million in IT R&D funding at HHS, a decrease of 3.4 percent or $20 million from the FY 2005 level. The bulk of this reduction is due to the completion of testbed projects exploring medical applications of advanced networks.

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 (DOE): IT R&D activities in DOE's Office of Science and NNSA constitute DOE's participation in NITRD. The Office of Science 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 $341 million for FY 2006, a decrease of 7.8 percent or $29 million from the FY 2005 level. According to the request, this reduction reflects the completion of the initial leadership-class computer system acquisition, and consolidation of efforts in networking research and collaboratory tools into an integrated "Distributed Network Environment" focusing on basic research in computer networking and middleware.

National Aeronautics and Space Administration (NASA): Under the President's plan, NASA would see the largest reduction in NITRD funding both on a percentage and an absolute-dollar basis. The President's request includes $74 million for NASA IT R&D in FY 2005, a reduction of $89 million from the FY 2005 level, representing a 54.6 percent decrease. Though NASA will continue operating its 52-teraflop Columbia computer acquired in 2004-2005, funding in all aspects of NASA's IT R&D efforts will be reduced and redirected to support NASA's Vision for Space Exploration and mission needs for returning the Space Shuttle to flight. (See Chapter 10 for details of the NASA budget.)

Department of Commerce (DOC): The DOC request for FY 2006 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 President's request includes $42 million for NIST in FY 2006, an increase of $3 million over FY 2005.

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 $20 million for NOAA in FY 2006, a $1 million increase over FY 2005.

Environmental Protection Agency (EPA): The EPA would receive $6 million in FY 2006 under the President's plan, an increase of $2 million over FY 2005. EPA intends to use that funding 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 (DHS): 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 $17 million in FY 2006 for cyber security research and development, out of a total Science and Technology directorate budget request of $1.3 billion (see Table II-6), a decrease of $1 million compared to FY 2005. In the forthcoming PITAC report on cyber security R&D, the committee is expected to take DHS to task for its inadequate support of long-term cyber security research, given that IT systems constitute the control loop of so much of the nation's critical infrastructure. The report will note that of the $18 million DHS expects to spend in FY 2005 on cyber security R&D, only $1.5 million of that research can truly be described as long-term. (For more on DHS R&D, see Chapter 12.)