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The Federal Networking and Information Technology Research and Development Program: Background, Funding, and Activities

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Summary

In the early 1990s, Congress recognized that several federal agencies had ongoing high-performance computing programs, but no central coordinating body existed to ensure long-term coordination and planning. To provide such a framework, Congress passed the High-Performance Computing and Communications Program Act of 1991 (P.L. 102-194) to enhance the effectiveness of the various programs. In conjunction with the passage of the act, the White House Office of Science and Technology Policy (OSTP) released *Grand Challenges: High-Performance Computing and Communications*. That document outlined a research and development (R&D) strategy for high-performance computing and a framework for a multi-agency program, the High-Performance Computing and Communications (HPCC) Program. The HPCC Program has evolved over time and is now called the Networking and Information Technology Research and Development (NITRD) Program to better reflect its expanded mission.

Current concerns are the role of the federal government in supporting information technology (IT) R&D and the level of funding to allot to it. Proponents of federal support of IT R&D assert that it has produced positive outcomes for the country and played a crucial role in supporting long-term research into fundamental aspects of computing. Such fundamentals provide broad practical benefits but generally take years to realize. Additionally, the unanticipated results of research are often as important as the anticipated results. Another aspect of government-funded IT research is that it often leads to open standards, something that many perceive as beneficial, encouraging deployment and further investment. Industry, on the other hand, is more inclined to invest in proprietary products and will diverge from a common standard when there is a potential competitive or financial advantage to do so. Proponents of government support believe that the outcomes achieved through the various funding programs create a synergistic environment in which both fundamental and application-driven research are conducted, benefitting government, industry, academia, and the public. Supporters also believe that such outcomes justify government's role in funding IT R&D as well as the growing budget for the NITRD Program. Critics assert that the government, through its funding mechanisms, may be picking "winners and losers" in technological development, a role more properly residing with the private sector. For example, the size of the NITRD Program may encourage industry to follow the government's lead on research directions rather than selecting those directions itself.

The President's FY2016 budget request for the NITRD Program is $4.1 billion and the estimated FY2015 spending totaled $4.0 billion. Estimated spending for FY2016 and the budget request for FY2017 are not yet available.

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The Federal NITRD Program

The federal government has long played a key role in the country's information technology (IT) research and development (R&D) activities. The government's support of IT R&D began because it had an important interest in creating computers and software that would be capable of addressing the problems and issues the government needed to solve and study. One of the first such problems was calculating the trajectories of artillery and bombs; more recently, such problems include simulations of nuclear testing, cryptanalysis, and weather modeling. That interest continues today. These complex issues have led to calls for coordination to ensure that the government's evolving needs (e.g., homeland security) will continue to be met in the most effective manner possible.

Structure

Established by the High-Performance Computing Act of 1991 (P.L. 102-194), the Networking and Information Technology Research and Development (NITRD) Program is the primary mechanism by which the federal government coordinates its unclassified networking and information technology (NIT) R&D investments. Eighteen federal agencies, including all of the large science and technology agencies, are formal members of the NITRD Program,[1] with many other federal entities participating in NITRD activities. The program aims to ensure that the nation effectively leverages its strengths, avoids duplication, and increases interoperability in such critical areas as supercomputing, high-speed networking, cybersecurity, software engineering, and information management. **Figure 1** illustrates the organizational structure of the NITRD Program.

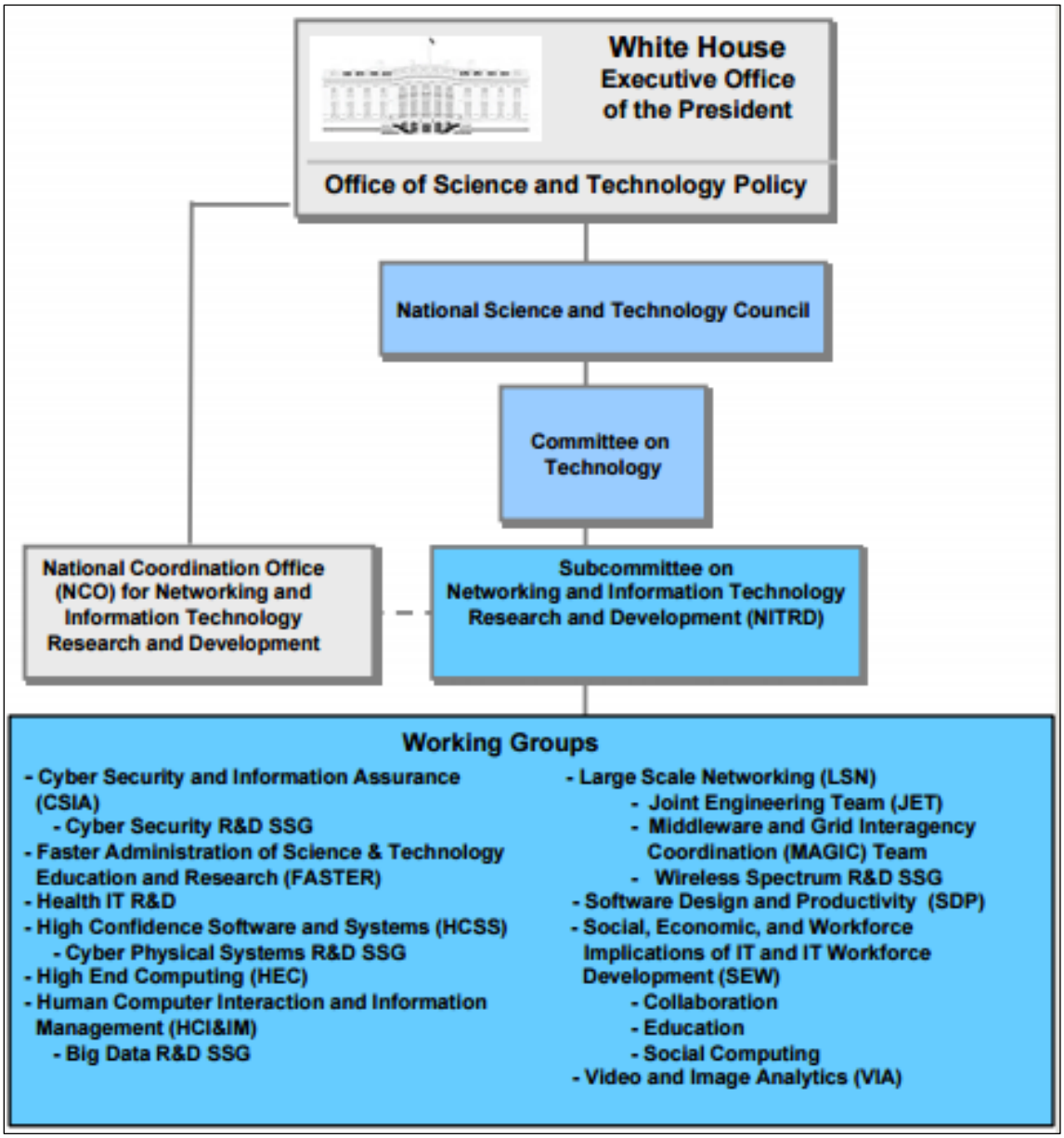
The National Coordinating Office (NCO) coordinates the activities of the NITRD Program. The NCO was established in September 1992 and was initially called the National Coordination Office for High Performance Computing and Communications (NCO/HPCC). Its name has changed several times over the years; since July 2005, it has been called the National Coordination Office for Networking and Information Technology Research and Development (NCO/NITRD). The NCO/NITRD supports the planning, coordination, budget, and assessment activities of the program. The NCO's role in the NITRD enterprise is recognized in the National Science and Technology Council (NSTC) charters, authorizing NITRD Program structures as well as in legislation and congressional hearings. The director of the White House Office of Science Technology and Policy (OSTP) appoints a director for the NCO. The director of the NCO reports to the director of the White House Office on Science and Technology Policy (OSTP). The NCO supports the National Science and Technology Council's Subcommittee on NITRD (also called the NITRD Subcommittee).[2] The NITRD Subcommittee provides policy, program, and budget planning for the NITRD Program and is composed of representatives from each of the participating agencies, OSTP, Office of Management and Budget (OMB), and the NCO.

[1] Department of Commerce (DOC): National Institute of Standards and Technology (NIST), National Oceanic and Atmospheric Administration (NOAA); Department of Defense (DOD): Defense Advanced Research Projects Agency (DARPA), National Security Agency (NSA), Office of the Secretary of Defense (OSD) and Service Research Organizations (Air Force Office of Scientific Research (AFOSR), Air Force Research Laboratory (AFRL), Army Research Laboratory (ARL), Office of Naval Research (ONR); Department of Energy (DOE): National Nuclear Security Administration (DOE/NNSA), Office of Science (DOE/SC); Department of Homeland Security (DHS); Department of Health and Human Services (HHS): Agency for Healthcare Research and Quality (AHRQ), National Institutes of Health (NIH), Office of the National Coordinator for Health Information Technology (ONC); Environmental Protection Agency (EPA); National Aeronautics and Space Administration (NASA); National Archives and Records Administration (NARA); National Science Foundation (NSF).

[2] The NITRD Subcommittee was previously called the Interagency Working Group for IT R&D (IWG/IT R&D).

NITRD Program activities are described under a set of seven Program Component Areas (PCAs),[3] 10 working groups (see **Figure 1**), and a number of Interagency Working Groups, Coordinating Groups, Senior Steering Committees, and Communities of Practice (see **Figure 2**).

Figure 1. Management Structure of the NITRD Program



Source: NITRD Program website, http://www.nitrd.gov.

[3] Cyber Security Information Assurance (CSIA); High End Computing (HEC); Human Computer Interaction and Information Management (HCI & IM); High Confidence Software and Systems (HCSS); Large Scale Networking (LSN); Software Design and Productivity (SDP); and Social, Economic, and Workforce Implications of IT and IT Workforce Development (SEW).

Figure 2. NITRD Groups

Source: NITRD Program website, http://www.nitrd.gov.

Budget, Funding, and Spending

The President's FY2017 budget request for the NITRD Program is $4.54 billion, an increase of $0.05 billion, or approximately 1.11%, compared to the $4.49 billion FY2016 estimate. The overall change is due to both increases and decreases in individual agency NITRD budgets.[4]

The NITRD budget is an aggregation of the IT R&D components of the individual budgets of NITRD participating agencies and is reported in the annual release of the *Networking and Information Technology Research and Development Program Supplement to the President's Budget*. The NITRD budget is not a single, centralized source of funds that is allocated to individual agencies. In fact, the agency IT R&D budgets are developed internally as part of each agency's overall budget development process. These budgets are subjected to review, revision, and approval by the OMB and become part of the President's annual budget submission to Congress. The NITRD budget is then calculated by aggregating the IT R&D components of the appropriations provided by Congress to each federal agency. An interactive history of NITRD

[4] NITRD FY2017 Supplement to the President's Budget, April 2016, https://www.nitrd.gov/pubs/2017supplement/FY2017NITRDSupplement.pdf.

Program funding, dating back to 1991, is available online at http://www.nitrd.gov/open/index.aspx.

Federal Technology Funding: Background and Context

In the early 1990s, Congress recognized that several federal agencies had ongoing high-performance computing programs,[5] but no central coordinating body existed to ensure long-term coordination and planning. To provide such a framework, Congress passed the High-Performance Computing Program Act of 1991 to improve the interagency coordination, cooperation, and planning of agencies with high-performance computing programs.

In conjunction with the passage of the act, OSTP released *Grand Challenges: High-Performance Computing and Communications*. That document outlined an R&D strategy for high-performance computing and communications and a framework for a multi-agency program, the HPCC Program.

The NITRD Program is part of the larger federal effort to promote fundamental and applied IT R&D. The government sponsors such research through a number of channels, including

- federally funded research and development laboratories, such as Lawrence Livermore National Laboratory;
- single-agency programs;
- multi-agency programs, including the NITRD Program, but also programs focusing on nanotechnology R&D and combating terrorism;
- funding grants to academic institutions; and
- funding grants to industry.

In general, supporters of federal funding of IT R&D contend that it has produced positive results. In 2003, the Computer Science and Telecommunications Board (CSTB) of the National Research Council released a "synthesis report" based on eight previously released reports that examined "how innovation occurs in IT, what the most promising research directions are, and what impacts such innovation might have on society."[6] The CSTB's observation was that the unanticipated results of research are often as important as the anticipated results. For example, electronic mail and instant messaging were byproducts of (government-funded) research in the 1960s that was aimed at making it possible to share expensive computing resources among multiple simultaneous interactive users. Additionally, the report noted that federally funded programs have played a crucial role in supporting long-term research into fundamental aspects of computing. Such "fundamentals" provide broad practical benefits but generally take years to realize. Furthermore, supporters state that the nature and underlying importance of fundamental research makes it less

[5] "High-performance" computing is a term that encompasses both "supercomputing" and "grid computing." In general, high-performance computers are defined as stand-alone or networked computers that can perform "very complex computations very quickly." Supercomputing involves a single, stand-alone computer located in a single location. Grid computing involves a group of computers, in either the same location or spread over a number of locations, that are networked together (e.g., via the Internet or a local network). U.S. Congress, House Committee on Science, *Supercomputing: Is the United States on the Right Path*, hearing, 108th Cong.,1st sess., July 16, 2003, http://commdocs.house.gov/committees/science/hsy88231.000/hsy88231_0f.htm, 2003, pp. 5-6.

[6] National Research Council, *Innovation in Information Technology*, 2003, p. 1. This report discusses all federal funding for R&D, not only the NITRD Program.

likely that industry would invest in and conduct more fundamental research on its own. As noted by the CSTB, "companies have little incentive to invest significantly in activities whose benefits will spread quickly to their rivals."[7] Further, in the board's opinion:

> Government sponsorship of research, especially in universities, helps develop the IT talent used by industry, universities, and other parts of the economy. When companies create products using the ideas and workforce that result from Federally-sponsored research, they repay the nation in jobs, tax revenues, productivity increases, and world leadership.[8]

Another aspect of government-funded IT R&D is that it often leads to open standards, something that many perceive as beneficial, encouraging deployment and further investment. Industry, on the other hand, is more likely to invest in proprietary products and will typically diverge from a common standard if it sees a potential competitive or financial advantage; this happened, for example, with standards for instant messaging.[9]

Finally, proponents of government R&D support believe that the outcomes achieved through the various funding programs create a synergistic environment in which both fundamental and application-driven research are conducted, benefitting government, industry, academia, and the public. Supporters also believe that such outcomes justify government's role in funding IT R&D as well as the growing budget for the NITRD Program.

Critics have asserted that the government, through its funding mechanisms, may set itself up to pick "winners and losers" in technological development, a role more properly residing with the private sector.[10] For example, the size of the NITRD Program could encourage industry to follow the government's lead on research directions rather than selecting those directions itself.

Overall, the CSTB stated that government funding appears to have allowed research on a larger scale and with greater diversity, vision, and flexibility than would have been possible without government involvement.[11]

Legislative Activity in the 114th Congress

On October 28, 2015, the House Committee on Science, Space, and Technology Subcommittee on Research and Technology held a hearing, "A Review of the NITRD Program." Witnesses testifying were—

- Dr. Keith Marzullo
  Director, NCO, NITRD;
- Dr. Gregory D. Hager
  Mandell Bellmore Professor, Department of Computer Science, Johns Hopkins University; Co-Chair, NITRD Working Group, President's Council of Advisors on Science and Technology (PCAST); and

[7] Ibid., p. 4.

[8] Ibid., p. 4.

[9] Ibid., p. 18.

[10] Steve Slivinski and Solveig Singleton, "Encouraging Research: Taking Politics Out of R&D," Cato Institute, September 13, 1999, http://www.cato.org/pubs/wtpapers/990913catord.html.

[11] National Research Council, *Innovation in Information Technology*, p. 22.

- Dr. Edward Seidel
  Director, National Center for Supercomputing Applications, University of Illinois at Urbana-Champaign.

The hearing addressed issues related to the FY2016 budget and the August 2015 PCAST report on the NITRD Program.

There has been no legislation related to the NITRD Program in the 114th Congress.

Potential Issues for Congress

Federal IT R&D is a multi-dimensional issue involving many government agencies working together towards shared, complementary, and disparate goals. Many observers believe that success in this arena requires ongoing coordination among government, academia, and industry.

Issues related to U.S. competitiveness in high-performance computing and the direction the IT R&D community has been taking have remained salient over the last 5 to 10 years and include

- The United States' status as the global leader in high-performance computing research;
- The apparent ongoing bifurcation of the federal IT R&D research agenda between grid computing and supercomputing capabilities;
- The possible overreliance on commercially available hardware to satisfy U.S. research needs; and
- The potential impact of deficit cutting on IT R&D funding.

Appendix. NITRD Enabling and Governing Legislation

The NITRD Program is governed by two laws. The first, the High-Performance Computing Act of 1991 (P.L. 102-194),[12] expanded federal support for high-performance computing R&D and called for increased interagency planning and coordination. The second, the Next Generation Internet Research Act of 1998 (P.L. 105-305),[13] amended the original law to expand the mission of the NITRD Program to cover Internet-related research, among other goals.

High-Performance Computing Act of 1991

The High-Performance Computing Act of 1991 (P.L. 102-194) was the original enabling legislation for what is now the NITRD Program. Among other requirements, it called for the following:

- Setting goals and priorities for federal high-performance computing research, development, and networking.
- Providing for the technical support and research and development of high-performance computing software and hardware needed to address fundamental problems in science and engineering.
- Educating undergraduate and graduate students.
- Fostering and maintaining competition and private sector investment in high-speed data networking within the telecommunications industry.
- Promoting the development of commercial data communications and telecommunications standards.
- Providing security, including protecting intellectual property rights.
- Developing accounting mechanisms allowing users to be charged for the use of copyrighted materials.

This law also requires an annual report to Congress on grants and cooperative R&D agreements and procurements involving foreign entities.[14]

Next Generation Internet Research Act of 1998

The Next Generation Internet Research Act of 1998 (P.L. 105-305) amended the High-Performance Computing Act of 1991. The act had two overarching purposes. The first was to authorize research programs related to high-end computing and computation, human-centered systems, high confidence systems, and education, training, and human resources. The second was to provide for the development and coordination of a comprehensive and integrated U.S. research

[12] High Performance Computing Act of 1991, P.L. 102-194, 15 U.S.C. 5501, 105 Stat. 1595, December 9, 1991. The full text of this law is available at http://www.nitrd.gov/congressional/laws/pl_102-194.html.

[13] Next Generation Internet Research Act of 1998, P.L. 105-305, 15 U.S.C. 5501, 112 Stat. 2919, October 28, 1998. The full text of this law is available at http://www.nitrd.gov/congressional/laws/pl_h_105-305.html.

[14] The first report mandated that information on the "Supercomputer Agreement" between the United States and Japan be included in this report. A separate one-time only report was required on network funding, including user fees, industry support, and federal investment.

program to focus on (1) computer network infrastructure that would promote interoperability among advanced federal computer networks, (2) economic high-speed data access that does not impose a "geographic penalty," and (3) flexible and extensible networking technology.

America COMPETES Act of 2007

Section 7024 of the America COMPETES Act of 2007 (P.L. 110-69) revised the program requirements for the National High-Performance Computing Program. Among other requirements, the bill amended the original enabling legislation to

- Require the director of the OSTP to (1) establish the goals and priorities for federal high-performance computing research, development, networking, and other activities; (2) establish PCAs that implement such goals and identify the Grand Challenges (i.e., fundamental problems in science or engineering with broad economic and scientific impact whose solutions will require the application of high-performance computing resources and, as amended by this section, multidisciplinary teams of researchers) that the program should address; and (3) develop and maintain a research, development, and deployment roadmap covering all states and regions for the provision of high-performance computing and networking systems.
- Revise requirements for annual reports by requiring that such reports (1) describe PCAs, including any changes in the definition of or activities under such areas and the reasons for such changes, and describe Grand Challenges supported under the program; (2) describe the levels of federal funding and the levels proposed for each PCA; (3) describe the levels of federal funding for each agency and department participating in the program for each such area; and (4) include an analysis of the extent to which the program incorporates the recommendations of the advisory committee on high-performance computing. Eliminates the requirement for inclusion of reports on DOE activities taken to carry out the National High-Performance Computing Program.
- Require the advisory committee on high-performance computing to conduct periodic evaluations of the funding, management, coordination, implementation, and activities of the program and to report at least once every two fiscal years to specified congressional committees. Prohibits applying provisions for the termination, renewal, and continuation of federal advisory committees under the Federal Advisory Committee Act to such advisory committee.
- Instruct the NSF to support basic research related to advanced information and communications technologies that will contribute to enhancing or facilitating the availability and affordability of advanced communications services for all people of the United States. Requires the NSF director to award multiyear grants to institutions of higher education, nonprofit research institutions affiliated with such institutions, or their consortia to establish multidisciplinary Centers for Communications Research. Increases funding for the basic research activities described in this section, including support for such centers. Requires the NSF director to transmit to Congress, as part of the President's annual budget submission, reports on the amounts allocated for support of research under this section.

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