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 multiagency 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 IT R&D and the level of funding to allot to it. Proponents of federal support of information technology (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.

Actual NITRD spending in FY2010 totaled $3.793 billion, $0.133 billion below the budget request of $3.926 billion. The President's FY2012 budget request for the NITRD Program is $3.866 billion, an increase of $0.073 billion, approximately 1.9%, above FY2010 actual expenditures. The overall change is due to both decreases and increases in individual agency NITRD budgets**.** For purposes of this report, the FY2012 Budget request for the NITRD Program is compared with FY2010 actual NITRD spending, since FY2011 spending levels remain uncertain. The estimated FY2011 spending level of $3.652 billion reflect the annualized amounts provided by the continuing resolution that extended through April 8, 2011.

No legislative action has been taken to this date in the 112th Congress.

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The Federal NITRD Program

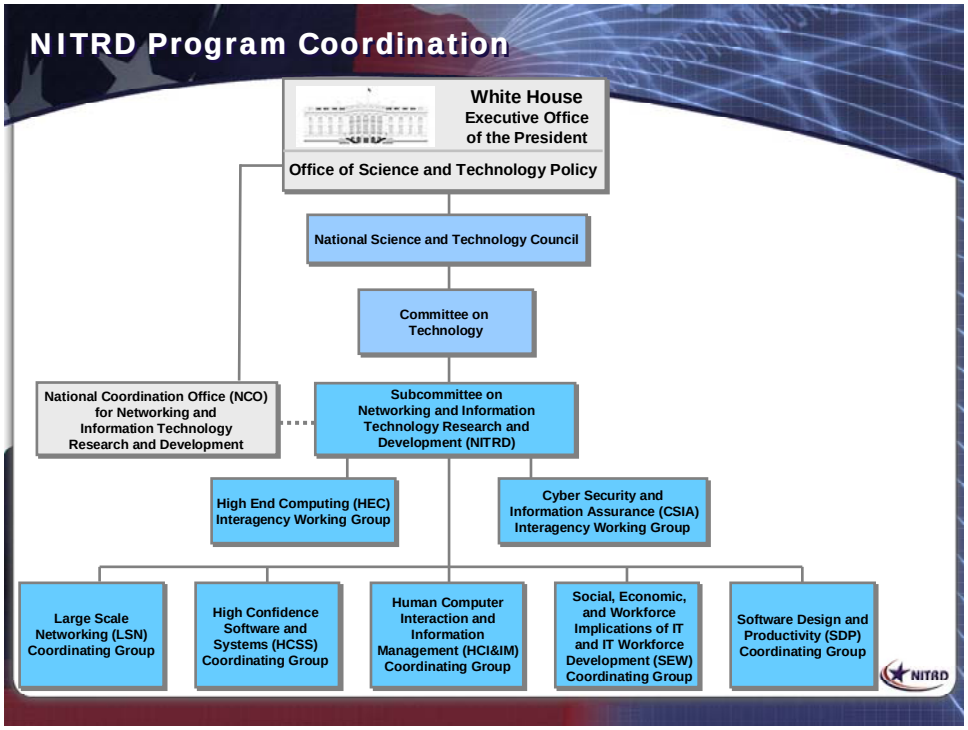
The federal government has long played a key role in the country's information technology (IT) research and development (R&D) activities. The government's support of IT R&D began because it had an important interest in creating computers and software that would be capable of addressing the problems and 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 the government's evolving needs (e.g., homeland security) will continue to be met in the most effective manner possible.

Structure

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) research and development (R&D) investments. Fourteen 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.

[1] Agency for Healthcare Research and Quality (AHRQ), http://www.ahrq.gov; Defense Advanced Research Projects Agency (DARPA), http://www.darpa.mil; Department of Homeland Security (DHS), http://www.dhs.gov [*Cyber Security Program*, http://www.cyber.st.dhs.gov]; Department of Energy - National Nuclear Security Agency (DOE/NNSA), http://www.nnsa.doe.gov; Department of Energy - Office of Science (DOE/SC), http://www.sc.doe.gov [*Office of Advanced Scientific Computing Research*, http://www.sc.doe.gov/ascr/*]*; Environmental Protection Agency (EPA), http://www.epa.gov [*High Performance Computing and Scientific Visualization*, http://www.epa.gov/nesc/index.htm]; National Archives and Records Administration (NARA), http://www.nara.gov [*Center for Advanced Systems and Technologies*, http://www.archives.gov/ncast/]; National Aeronautics and Space Administration (NASA), http://www.nasa.gov [*High-End Computing Program*, http://www.hec.nasa.gov]; National Institutes of Health (NIH), http://www.nih.gov [*Biomedical Information Science and Technology Initiative*, http://www.bisti.nih.gov*; Center for Information Technology*, http://www.cit.nih.gov*; National Cancer Institute*, *http://*http://www.nci.nih.gov*; National Center for Research Resources*, http://www.ncrr.nih.gov*; National Institutes of General Medical Sciences*, http://www.nih.gov/nigms*; National Library of Medicine*, http://www.nlm.nih.gov]; National Institute of Standards and Technology (NIST), http://www.nist.gov [*Information Technology Laboratory*, http://www.itl.nist.gov*; Manufacturing Engineering Laboratory*, http://www.mel.nist.gov]; National Oceanic and Atmospheric Administration (NOAA), http://www.noaa.gov [*High Performance Computing and Communications*, http://www.hpcc.noaa.gov]; National Security Agency (NSA), http://www.nsa.gov [*National Information Assurance Research Lab*, http://www.nsa.gov/niarl/index.cfm]; National Science Foundation (NSF), http://www.nsf.gov [*Directorate for Computer and Information Sciences and Engineering*, http://www.nsf.gov/home/cise/start.htm]; Office of the Secretary of Defense (OSD) and Department of Defense (DoD) Service research organizations [*Defense Research & Engineering*, http://www.acq.osd.mil/ddre*; Deputy Under Secretary of Defense (Science and Technology)*, http://www.dod.mil/ddre/org_SandT.html]. Source: http://www.nitrd.gov/Subcommittee/agency-web-sites.aspx.

Figure 1. Management Structure of the NITRD Program



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

The National Coordinating Office (NCO) coordinates the activities of the NITRD Program. On July 1, 2005, the NCO became the "National Coordination Office for Networking and Information Technology Research and Development." 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, and the NCO. Two Interagency Working Groups and five Coordination Groups reporting to the NITRD Subcommittee focus their work in eight Program Component Areas.[3]

The NITRD budget is an aggregation of the IT R&D components of the individual budgets of NITRD-participating agencies. 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 Office of Management and Budget and become part of the President's annual budget submission to Congress. The NITRD budget is then

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

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

calculated by aggregating the IT R&D components of the appropriations provided by Congress to each federal agency.

The NITRD Program has undergone a series of structural changes since its inception in 1991 and both it and the NCO have had a number of different names over the years. When the Program was created in December 1991, it was named the High Performance Computing and Communications (HPCC) Program, and when the NCO was created in September 1992, it was named the NCO for HPCC. The name was changed to the National Coordination Office for Computing, Information, and Communications per the FY1997 Supplement to the President's Budget (also known at that time as the "Blue Book"). The name was changed to the National Coordination Office for Information Technology Research and Development per the FY2001 Blue Book.[4] Most recently, on July 1, 2005, the name was changed to the National Coordination Office for Networking and Information Technology Research and Development. These changes were made to reflect the evolution of the program as it came to encompass a broader range of related topics.

Funding and Spending

Actual NITRD spending in FY2010 totaled $3.793 billion, $0.133 billion below the FY2010 budget request of $3.926 billion. The President's FY2012 budget request for the NITRD Program is $3.866 billion, an increase of $0.073 billion, approximately 2%, above FY2010 actual expenditures. The overall change is due to both decreases and increases in individual agency NITRD budgets. The estimated FY2011 spending level of $3.652 billion reflect the annualized amounts provided by the continuing resolution that extended federal agency funding through April 8, 2011.

American Recovery and Reinvestment Act of 2009

Under the American Recovery and Reinvestment Act (ARRA) of 2009, five federal agencies reported preliminary allocations of $706 million to investments in NITRD research areas (these figures may change). The NITRD agencies are using their ARRA funds to modernize, expand, and upgrade networking and high-end computing infrastructures and facilities for advanced scientific research; expand R&D in cyber security, human-computer interaction and information management, high-confidence software and systems, and software design; and increase investments in education and training for a diverse, highly skilled IT workforce.

Recent Reports

As explained earlier, the NCO provides technical and administrative support to the NITRD Program and the NITRD Subcommittee. This includes supporting meetings and workshops and preparing reports. The NCO interacts with OSTP and Office of Management and Budget (OMB) on NITRD Program matters. Additionally, in accordance with a Presidential executive order and law, the NITRD Program is reviewed biannually. Two reports published in 2009 and 2010 about the NITRD Program and by the NITRD NCO are discussed in this report. Older documents can be found on the NITRD NCO website.[5]

[4] That change was effective October 2000.

[5] http://www.nitrd.gov.

Designing a Digital Future: Federally Funded Research and Development in Networking Information and Technology

In December 2010, the President's Council of Advisors on Science and Technology (PCAST)[6] released, "Designing a Digital Future: Federally Funded Research and Development in Networking and Information Technology."[7] This report fulfilled PCAST's responsibility to report on the status of the NITRD Program under Executive Order 13539 and the High-Performance Computing Act of 1991 (P.L. 102-194).[8] PCAST appointed an expert 14-member Working Group, which consulted with more than 50 individuals, including government officials, industry representatives, and experts from academia, to develop a comprehensive review of the program. PCAST found that NITRD is well coordinated and that the U.S. computing research community, coupled with a vibrant NIT industry, has made seminal discoveries and advanced new technologies that are helping to meet many societal challenges. Importantly, however, PCAST also found that:

> a substantial fraction of the NITRD multi-agency spending summary represents spending that supports R&D in other fields, rather than spending on R&D in the field of NIT itself. As a result, the United States is actually investing far less in NIT R&D than the $4 billion-plus indicated in the Federal budget. To achieve America's priorities and advance key research frontiers to support economic competitiveness in NIT, this report calls for a more accurate accounting of this national investment and recommended additional investments in NIT R&D, including research in networking and information technology for health, energy and transportation, and cyber-infrastructure.[9]

The PCAST stated its belief that NIT has yielded enormous benefits for the nation's economic competitiveness, national security, and quality of life. It stressed the importance of maintaining the country's leadership in NIT in an ever more competitive global environment, encouraging the federal government to be bold in its investments, including funding of high risk/high reward research with the potential to move NIT in unanticipated directions.

High-Confidence Medical Devices: Cyber-Physical Systems for 21st Century Health Care

This report, published in February 2009, presents the perspectives of the senior scientists of the NITRD Program's High Confidence Software and Systems (HCSS) Coordinating Group (CG), with input from experts from other federal agencies, on the R&D challenges, needs, and strategies for developing and deploying the next generations of high-confidence medical devices, software, and systems.[10] HCSS agencies whose missions are not medical device-specific have found it beneficial to partner in this area because medical device research challenges are similar, if not identical, to those within their purview. Digital technologies are increasingly being assigned high-level control over the monitoring, sensing, actuation, and communications of medical devices—

[6] The PCAST was acting in its role as the President's Innovation and Technology Advisory Council (PITAC).

[7] This report is available online at http://www.nitrd.gov/pcast-2010/report/nitrd-program/pcast-nitrd-report-2010.pdf.

[8] As amended by the Next Generation Internet Research Act of 1998 (P.L. 105-305) and by the America COMPETES Act of 2007 (P.L. 110-69).

[9] Designing a Digital Future: Federally Funded Research and Development in Networking and Information Technology, p. v.

[10] This report is available online at http://www.nitrd.gov/About/MedDevice-FINAL1-web.pdf.

often with human life in the balance. Through this report and associated HCSS-sponsored national workshops, the HCSS agencies are seeking to illuminate fundamental scientific and technical challenges that they believe must be addressed before high-confidence devices, software, and systems that operate flawlessly from end to end can be designed and built. The report authors sought to paint the landscape of the evolution of medical device technology and the federal investments that have benefitted medical device R&D over time.

Federal Technology Funding: Background and Context

In the early 1990s, Congress recognized that several federal agencies had ongoing high-performance computing programs,[11] 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 (NRC) 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."[12] The CSTB's observation was that the

[11] "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). House of Representatives, Committee on Science, *Supercomputing: Is the United States on the Right Path* (Hearing Transcript), http://commdocs.house.gov/committees/science/hsy88231.000/hsy88231_0f.htm, 2003, pp. 5-6.

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

unanticipated results of research are often as important as the anticipated results. For example, electronic mail and instant messaging were by-products 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 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."[13] 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.[14]

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.[15]

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.[16] 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, 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.[17]

[13] Ibid, p. 4.

[14] Ibid, p. 4.

[15] Ibid, p. 18.

[16] Cato Institute, *Encouraging Research: Taking Politics Out of R&D*, September 13, 1999, http://www.cato.org/pubs/wtpapers/990913catord.html.

[17] National Research Council, *Innovation in Information Technology*, 2003, p. 22.

Activity in the 112th and 111th Congresses

112th Congress

No legislative action has been taken to this date in the 112th Congress.

111th Congress

Five bills were introduced in the 111th Congress that affected, or had an effect, on the NITRD Program.

H.R. 1, the American Recovery and Reinvestment Act of 2009 (P.L. 111-5), was signed into law on February 17, 2009. Prior to being signed by the President, H.R. 1 was amended to include two NITRD-related related bills, **H.R. 598**, "To provide for a portion of the economic recovery package relating to revenue measures, unemployment, and health," and **H.R. 629**, the Energy and Commerce Recovery and Reinvestment Act .

H.R. 4061, the Cybersecurity Enhancement Act of 2009, was passed by the House on February 8, 2010, and referred to the Senate Committee on Commerce, Science, and Transportation, but was not passed by the Senate. The bill was intended to improve the security of cyberspace by ensuring federal investments in cybersecurity were better focused, more effective, and that research into innovative, transformative technologies would be supported. It also addressed recommendations from the Administration's Cyberspace Policy Review and included input from four hearings held on cybersecurity during the first session of the 111th Congress. H.R. 4061 would have also reauthorized and expanded the Cyber Security Research and Development Act (P.L. 107-305). In addition to promoting cybersecurity R&D by the member agencies of the NITRD, the legislation addressed cybersecurity workforce concerns and the continued advancement of the development of cybersecurity technical standards.

H.R. 2020, the Networking and Information Technology Research and Development Act of 2009, was introduced on April 22, 2009; it was passed by the House of Representatives and referred to the Senate Committee on Commerce, Science, and Transportation on May 13, 2009 (see H.Rept. 111-102). It died in Committee. The purpose of this bill was to strengthen the planning and coordination mechanisms of the NITRD Program and to update the research content of the program.

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 five to ten 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;
- possible over-reliance 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,[18] 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,[19] 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

This law 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.[20]

Next Generation Internet Research Act of 1998

This law 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

[18] 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.

[19] 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.

[20] The first report mandated 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.

human resources. The second was to provide for the development and coordination of a comprehensive and integrated U.S. research 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.

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