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CRS Issue Brief

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

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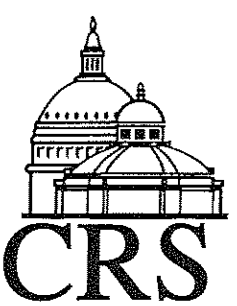
Patricia Moloney Figliola
Resources, Science, and Industry Division



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

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 program (NITRD), to better reflect its expanded mission. The NITRD is composed of 13 agencies; its members work in collaboration to increase the overall effectiveness and productivity of federal information technology (IT) R&D. A National Coordinating Office oversees the activities of the NITRD and reports to OSTP and the National Science and Technology Council.

Proponents assert that federal support of IT R&D has produced positive outcomes for the country. 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. 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.

Finally, 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.

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 may encourage industry to follow the government's lead on research directions rather than selecting those directions itself.

The FY2004 budget provides $2.2 billion for the NITRD; $2.0 billion has been proposed for FY2005. During the 108th Congress, three bills (S. 2176, H.R. 824, and H.R. 4218) were introduced that would have an impact on high-performance computing R&D. All three measures await action in their respective committees.

MOST RECENT DEVELOPMENTS

The FY2004 budget provides $2.2 billion for the Networking and Information Technology Research and Development Program (NITRD),[1] a 6% increase over FY2003. The President has proposed a budget of $2.0 billion for FY2005. During the 108th Congress, three bills (S. 2176, H.R. 824, and H.R. 4218) were introduced that would have an impact on high-performance computing R&D. All three measures await action in their respective committees.

BACKGROUND AND ANALYSIS

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 R&D began because it had an important interest in creating computers that would be capable of addressing the problems and issues the government needed to solve and study — problems such as simulations of nuclear testing, cryptanalysis, and weather modeling. That interest continues today as evidenced by the complexity of the interrelationships among existing government programs. That complexity requires there be adequate coordination to ensure the government's evolving needs (e.g., homeland security) will continue to be met in the most effective manner possible.

Overview of the Federal NITRD Program

The NITRD is a collaborative effort in which 13 agencies coordinate and cooperate to help increase the overall effectiveness and productivity of federal IT R&D.[2] Of those 13 members, the majority of funding goes to the National Science Foundation, National Institutes of Health, National Aeronautics and Space Administration, Defense Advanced Research Projects Agency, and the Department of Energy, Office of Science.

The National Coordinating Office (NCO) oversees the activities of the NITRD and reports to the White House Office of Science and Technology Policy (OSTP) and the National Science and Technology Council (NSTC). The NCO also coordinates the activities of the Interagency Working Group (IWG) and the President's Information Technology Advisory Committee (PITAC)[3]:

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[1] The main website of the NITRD is [http://www.nitrd.gov].

[2] The members of the NITRD, as listed in the FY2004 Supplement to the President's Budget are: Agency for Healthcare Research and Quality (AHRQ); Defense Advanced Research Projects Agency (DARPA); Department of Defense, Office of the Director, Defense Research & Engineering (DODDR&E); Department of Energy, National Nuclear Security Administration (DOE/NNSA); Department of Energy, Office of Science (DOE/SC); 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 National Science Foundation (NSF).

[3] The PITAC was established on February 11, 1997 to provide the President, OSTP, and the federal agencies involved in IT R&D with guidance and advice on all areas of high performance computing,

(continued...)

- The IWG provides policy, program, and budget planning for the NITRD and is composed of representatives from the NCO, OSTP, each of the participating agencies, Office of Management and Budget, and National Economic Council. The IWG is further broken down into six Coordinating Groups, which focus their work in six Program Component Areas (PCAs).[4]

- The PITAC is composed of representatives of private industry and academia who are appointed by the President. The group provides expert independent advice to the President and Congress on the federal role in maintaining U.S. preeminence in advanced IT and works with the NITRD agencies through the IWG.

Figure 1 on the next page illustrates the management structure of the NITRD.

The NITRD 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 September 1992, it was named the National Coordination Office for High Performance Computing and Communications (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 as the "Blue Book") and then to its current name, the National Coordination Office for Information Technology Research and Development, per the FY2001 Blue Book (that change was effective October 2000). These changes were made to reflect the evolution of the program as it came to encompass a broader range of related topics. The chronology of funding since the NITRD was created as the HPCC Program in 1991 is detailed in Figure 2, also on the next page.

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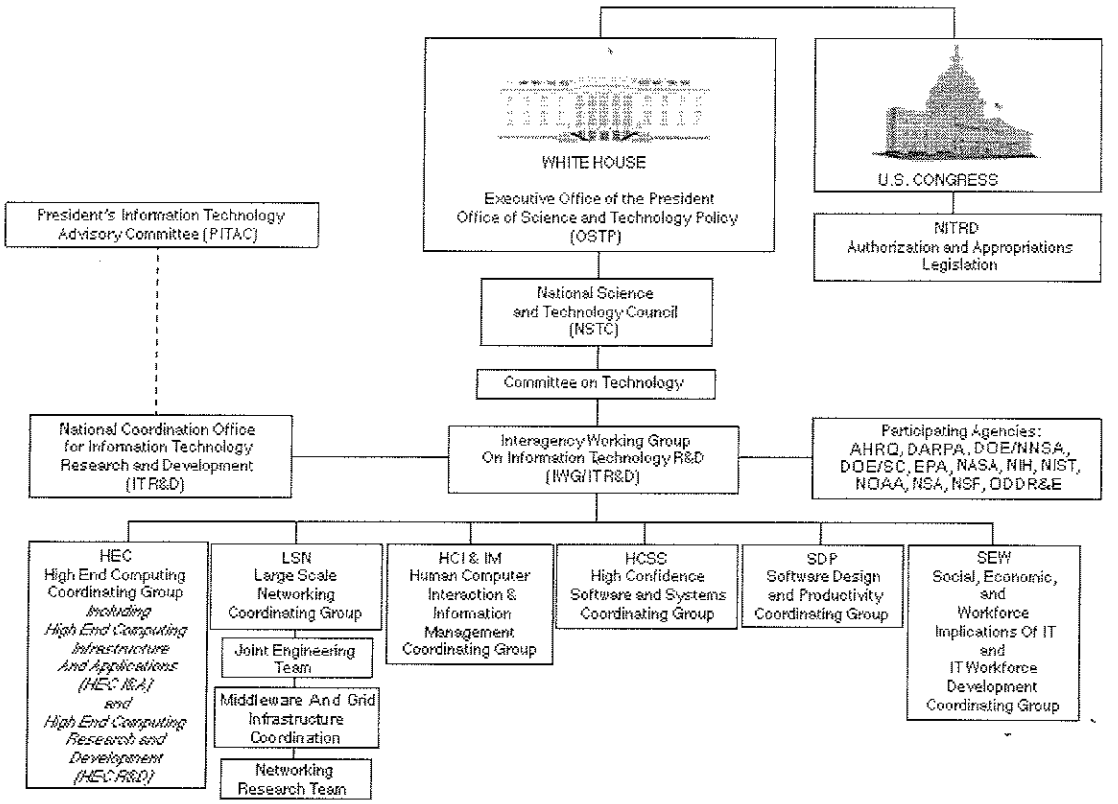
[3] (...continued)
communications, and information technologies. Representing the research, education, and library communities and including network providers and representatives from critical industries, the Committee advises the Administration's effort to accelerate development and adoption of information technologies. The membership roster of the PITAC is available online at [http://www.nitrd.gov/pitac/members.html].

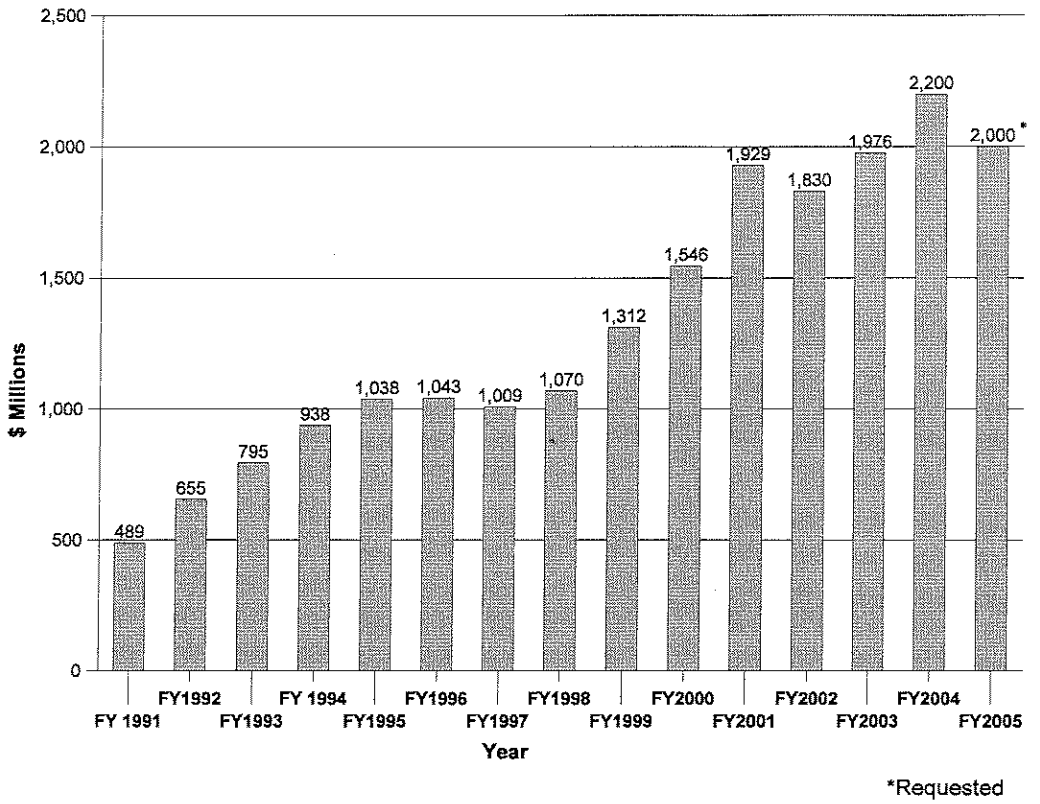
[4] The six PCAs and their concentration areas are: (1) *High End Computing (HEC)* — Concentrates on research and development dedicated to maintaining and expanding U.S. leadership in high-performance computing; (2) *Large Scale Networking (LSN)* — Ensures U.S. technological leadership in communications through efforts that advance the leading edge of networking technologies and services; (3) *High Confidence Software and Systems (HCSS)* — Concentrates on research and development into critical technologies that will foster high levels of availability, reliability, safety, security, survivability, protection, and restorability of information services; (4) *Human Computer Interaction and Information Management (HCI&IM)* — Researches and develops advanced technologies that expand human-computer interaction and improve information resources and systems management; (5) *Software Design and Productivity (SDP)* — Focuses on enabling improvements in software quality and its development; (6) *Social, Economic, and Workforce Implications of IT and IT Workforce Development (SEW)* — Addresses the complex interactions of information technologies with people and society. Additional information about the program component areas is available online at [http://www.nitrd.gov/iwg/index.html].

Figure 1: Management Structure of the NITRD[5]



[5] This diagram is available on the NITRD website, [http://www.nitrd.gov]. The Defense Information Systems Agency does not appear in the diagram; however it is included in the list of NITRD Agencies on page 2 of the FY2004 Supplement to the President's Budget.

Figure 2: History of NITRD Funding[6]



Enabling/Governing Legislation

The NITRD is governed by two laws. The first, the High-Performance Computing Act of 1991, P.L. 102-194,[7] expanded federal support for high-performance computing R&D and called for improving interagency planning and coordination. The second, the Next Generation Internet Research Act of 1998, P.L. 105-305,[8] amended the original law to expand the mission of the NITRD to cover Internet-related research, among other goals.

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[6] This chart was developed using data available in the FY2004 Supplement to the President's Budget (available online at [http://www.nitrd.gov/pubs/blue04/]) and the President's proposed FY2005 budget (available online at [http://www.whitehouse.gov/omb/budget/fy2005/pdf/spec.pdf]).

[7] High Performance Computing Act of 1991, Public Law 102-194, 15 U.S.C. 5501, 105 Stat. 1595, December 9, 1991. Additional information is available online at [http://www.nitrd.gov/congressional/ laws/pl_102-194.html].

[8] Next Generation Internet Research Act of 1998, Public Law 105-305, 15 U.S.C. 5501, 112 Stat. 2919, October 28, 1998. Additional information is available online at [http://www.nitrd.gov/ congressional/laws/pl_h_105-305.html].

High-Performance Computing Act of 1991.. This law was the original enabling legislation for what is now the NITRD. Among other requirements, it called for:

- Setting goals and priorities for federal high-performance computing research, development, and networking
- Technical support and research and development of 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 two annual reports to Congress: (1) a report on grants and cooperative R&D agreements involving foreign entities and on the "Supercomputer Agreement" between the United States and Japan; and (2) a report on network funding, including user fees, industry support, and federal investment.

Next Generation Internet Research Act of 1998. This law amended the High-Performance Computing Act of 1991. The overarching purpose of the law was to authorize research programs related to high-end computing and computation, human-centered systems, high confidence systems, and education, training, and human resources. It was also intended 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.

Context of Federal Technology Funding

In the early 1990s, Congress recognized that several federal agencies had ongoing high-performance computing programs,[9] 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 to enhance the effectiveness of the various programs.

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[9] "High-performance computing" is a term that encompasses both "supercomputing" and "grid or parallel 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 or parallel 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, p. 5-6.

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 a framework for a multi-agency program, the HPCC.

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

- Federally funded research laboratories, such as Lawrence Livermore Lab
- Single-agency programs, such as the Department of Commerce's Advanced Technology Program (ATP)
- Multi-agency programs, including NITRD, but also programs focusing on nanotechnology and combating terrorism
- Funding grants to academic institutions
- Funding grants to industry (ATP is also an example of this type of program).

In general, supporters contend that federal funding of IT research 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."[10] One of the most significant of the CSTB's observations was that the 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."[11] 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.[12]

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 likely to invest in proprietary products and will diverge

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

[11] Ibid, p. 4.

[12] Ibid, p. 4.

from a common standard if it is sees a potential competitive or financial advantage; this has happened with standards for such things as transport, electronic mail, and instant messaging.[13]

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.

Critics assert that the government, through its funding mechanisms, may be setting itself up to pick "winners and losers" in technological development, a role more properly residing with the private sector.[14] For example, the size of the NITRD may encourage industry to follow the government's lead on research directions rather than selecting those directions itself.

Overall, CSTB states 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.[15]

NCO and Related Activities

As explained earlier, the NCO oversees the work of the NITRD, IWG, and PITAC. It develops material for panel meetings, presentations to NITRD partner agencies and other meetings, and develops reports based on NCO and NITRD member agency activity. The NCO, IWG, and PITAC have been active over the past year on a number of activities.

One NITRD effort has been the work of the High-End Computing Revitalization Task Force (HECRTF). The task force was charged in 2003 with developing a five-year plan to guide federal investment in high-end computing R&D. The task force released its first report, *The Road Map for the Revitalization of High End Computing* in January 2004.[16] The report detailed findings in eight areas, for example, how to encourage the development of more advanced enabling technologies, such as power management systems, and commercial, off-the-shelf technologies. The work of the task force will continue through 2008.

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[13] Ibid, p. 18.

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

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

[16] Materials related to this panel are available online at [http://www.nitrd.gov/hecrtf-outreach/sc03.html]. Additional materials related to the HECRTF are available at [http://www.itrd.gov/hecrtf-outreach/index.html].

Activity in the 108th Congress

Other than the agency-specific appropriations bills, two bills have been introduced in the 108th Congress that would have a direct impact on high-performance computing or networking R&D.

Representative Larson introduced H.R. 824, the Research on High-Performance Networking for Science Education Act, "to authorize the National Science Foundation (NSF) to carry out research projects to develop and assess novel uses of high-performance computer networks for use in science, mathematics, and technology education in elementary and secondary schools." The bill was referred to the House Committee on Science on February 13, 2003, and then forwarded to the Subcommittee on Research on February 20, 2003. No further action has been taken.

Senator Bingaman introduced S. 2176, the High-End Computing Revitalization Act, to establish a high-end computing R&D program within the Department of Energy; it would authorize appropriations of $150 million for FY2005 and $155 million for FY2006. The bill was introduced and referred to the Senate Committee on Energy and Natural Resources on March 8, 2004.

Representative Biggert introduced H.R. 4218, the High-Performance Computing Revitalization Act, to amend the High-Performance Computing Act of 1991. The bill would further delineate the responsibilities of the NITRD, including setting the goals and priorities for Federal high-performance computing research, development, networking, and other activities and providing more specific definitions for the responsibilities of the PCAs. The bill was introduced and referred to the House Committee on Science on April 27, 2004

The House Committee on Science held a hearing on high-performance computing on July 16, 2003. The purpose of the hearing, *Supercomputing: Is the U.S. on the Right Path?*, was to examine whether the United States is losing ground to foreign competitors in the production and use of supercomputers and whether federal agencies' proposed paths for advancing the nation's supercomputing capabilities are adequate to maintain or regain the U.S. lead.[17]

Issues for Congress

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

In its July 2003 hearing, the House Committee on Science began investigating issues related to U.S. competitiveness in high-performance computing and the direction the IT R&D community has been taking. Those issues and others remain salient and may merit further

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[17] The charter for this hearing is available online at [http://www.house.gov/science/hearings/full03/jul16/charter.pdf]. The hearing transcript is available online at [http://commdocs.house.gov/committees/science/hsy88231.000/hsy88231_0f.htm].

investigation if the United States is to implement a comprehensive IT R&D policy. Included among the possible issues Congress may wish to pursue are: the United States' status as the global leader in high-performance computing research; the apparent bifurcation of the federal IT R&D research agenda between grid computing and supercomputing capabilities; the 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.

Many Members of Congress as well as those in the research community have expressed concern over whether the United States is maintaining its position as the global leader in high-performance computing research. That concern has been highlighted by the fact that Japan now has the fastest and most efficient supercomputer in the world.[18] While this may be reason for some concern, it also may be an indicator of how the United States' research agenda has become bifurcated, with some in the R&D community focusing on traditional "stand-alone" supercomputing capabilities and others focusing more on grid computing. Each type of computing has its advantages, based on its application. Stand-alone supercomputers are often faster and are generally used to work on a specific problem. For example, cryptanalysis and climate modeling applications require significant computing power and are best accomplished using specialized, stand-alone computers. Grid computing, however, allows the use of commercially available hardware, which helps contain costs. The grid configuration is useful for applications in which a problem can be broken into smaller components, such as data analysis.[19]

Without a clear plan as to how to proceed, pursuing two disparate research agendas (with goals that could be viewed as being at odds with each other) could split the research community even further, damaging its ability to provide leadership in either area. The NITRD already is working on a "roadmap" for future directions in supercomputing; therefore, one possible course for Congress at this time would be to monitor closely the work of the High-End Computing Revitalization Task Force and provide input or a more visible forum for discussion (i.e., additional hearings involving task force participants). Congress may wish to conduct its own inquiry into the debate over grid versus stand-alone computing. For example, at the July 2003 hearing, one of the overarching questions the panelists were asked to address was whether federal agencies were pursuing conflicting R&D goals and, if so, what should and could be done to ensure they moved toward a more coordinated, unified goal.

Another issue is whether the United States is relying too heavily on commercially available hardware to satisfy its R&D needs. While use of computers designed for mass-market commercial applications can certainly be a part of a successful high-end computing R&D plan, Congress may wish to monitor how this reliance may be driving the new emphasis on grid computing.

As noted earlier, critics of IT R&D funding often state that industry and academia should conduct more fundamental R&D on their own, without government backing, and that fiscal

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[18] 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, p. 13.

[19] Ibid, p. 6-7.

restraint dictates that less funding should be made available. Conversely, supporters of government funding would point out that IT R&D has a very long cycle from inception to application and that any reductions in funding now could have a significant negative impact for many years to come in terms of innovation and training of researchers. Therefore, Congress may monitor and assess the potential impact of deficit-cutting plans on progress in IT R&D.

Relevant Laws

P.L. 102-194, the High-Performance Computing Act of 1991, expanded federal support for research, development, and application of high-performance computing; and called for improving the interagency planning and coordination of federal research and development on high-performance computing and maximizing the effectiveness of the federal government's high-performance computing efforts.

P.L. 105-305, the Next Generation Internet Research Act of 1998, amended the High-Performance Computing Act of 1991 to authorize appropriations for fiscal years 1999 and 2000 for the Next Generation Internet program; and required the President's Information Technology Advisory Committee to monitor and give advice concerning the development and implementation of the Next Generation Internet program and report to the President and the Congress on its activities.

LEGISLATION

H.R. 824 (Larson)

Research on High-Performance Networking for Science Education Act. Authorizes the NSF to carry out research projects to develop and assess novel uses of high-performance computer networks for use in science, mathematics, and technology education in elementary and secondary schools. Introduced and referred to the House Committee on Science on February 13, 2003; forwarded to the subcommittee on Research February 20, 2003.

H.R. 4218 (Biggert)

High-Performance Computing Revitalization Act. Amends the High-Performance Computing Act of 1991 to further delineate the responsibilities of the NITRD, including setting the goals and priorities for Federal high-performance computing research, development, networking, and other activities and providing more specific definitions for the responsibilities of the PCAs. Introduced and referred to the House Committee on Science on April 27, 2004

S. 2176 (Bingaman)

High-End Computing Revitalization Act. Establishes a high-end computing R&D program within the Department of Energy and authorizes $150 million for FY2005 and $155 million for FY2006. Introduced and referred to the Senate Committee on Energy and Natural Resources on March 8, 2004.

FOR ADDITIONAL READING

CRS Reports

CRS Issue Brief IB10129, *Federal Research and Development Funding: FY2005*, by Michael E. Davey.

CRS Issue Brief IB10088, *Federal Research and Development: Budgeting and Priority-Setting Issues, 108th Congress*, by Genevieve J. Knezo.

CRS Issue Brief IB10117, *Federal Research and Development Funding: FY2004*, by Michael E. Davey.

CRS Report RL31175, *High Performance Computers and Export Control Policy: Issues for Congress*, by Glenn J. McLoughlin and Ian F. Fergusson.

Websites

The National Coordination Office for Information Technology Research and Development, [http://www.nitrd.gov/].

The President's Information Technology Advisory Committee, [http://www.nitrd.gov/pitac/index.html].

The Interagency Working Group, [http://www.nitrd.gov/iwg/index.html].

Other Reports and Documents

"The Technology Industry at an Innovation Crossroads," Electronic Industries Association, May 2004, [http://www.eia.org/docs/innovation_playbook.pdf].

"Roadmap for the Revitalization of High-End Computing, Computing Research Associates, 2004, [http://www.nitrd.gov/hecrtf-outreach/20040112_cra_hecrtf_report.pdf].

"Innovation in Information Technology," National Research Council, Computer Science and Telecommunications Board, 2003, [http://www7.nationalacademies.org/cstb/pub_itinnovation.html].

"Future of Supercomputing: An Interim Report," National Research Council, Computer Science and Telecommunications Board, 2003, [http://www7.nationalacademies.org/cstb/pub_supercomp_int.html].

"Human Computer Interaction and Information Management Research Needs," HCI&IM Coordinating Group of the Interagency Working Group on Information Research and Development, [http://www.nitrd.gov/pubs/hci-im_research_needs_final.pdf], 2003.

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