



Leadership Under Challenge: Information Technology R&D in a Competitive World

An Assessment of the
Federal Networking and Information Technology
R&D Program



Executive Summary

The United States is today the global leader in networking and information technology (NIT). That leadership is essential to U.S. economic prosperity, security, and quality of life. The Nation's leadership position is the product of its entire NIT ecosystem, including its market position, commercialization system, and higher education and research system.

Other countries and regions have also recognized the value of NIT leadership and are mounting challenges. The challengers are not only established competitors in Asia and Western Europe but also newcomers such as India and China. Their methods include bolstering their overall NIT capacity, their institutions for educating NIT professionals, and their NIT research and development (R&D) programs.

This report addresses how the U.S. Government can support continued U.S. leadership in two components of the NIT ecosystem – NIT R&D and NIT education – through its investment in the Federal Networking and Information Technology Research and Development (NITRD) Program. Assessment of the NITRD Program is authorized in Federal law, and Executive Order 13385 assigned responsibility for this assessment to the PCAST.

The NITRD Program is a key mechanism through which the Federal government contributes to NIT R&D leadership. The NIT frontier remains full of opportunity: new NIT capabilities wait to be developed and integrated into products and processes to meet agency and national needs. In 2007, the Program is enabling more than a dozen Federal agencies to work together as they invest over \$3 billion in R&D to meet their needs for advanced NIT capabilities.

This assessment benefited from responses to the PCAST's requests for input from a wide range of stakeholders in NIT R&D, including experts from academia and industry and Federal employees. A snapshot of the global NIT ecosystem was developed at PCAST request.

Based on these inputs, the PCAST found that the NITRD Program has by and large been effective at meeting agency and national needs. However, looking forward it is clear that changes are needed in order for the United States to ensure its continued leadership and ability to meet these needs. Specifically, the PCAST concluded that the most critical need is to rebalance the NITRD investment portfolio to include more long-term, large-scale, multidisciplinary NIT R&D and more visionary NIT R&D. The PCAST also believes that changes are needed in NIT education, the NIT workforce, the technical areas in which the NITRD Program invests, the rate of technology transfer, and the NITRD Program's planning and assessment processes.

The number of people completing NIT education programs and the usefulness of that education fall short of current and projected needs.

- ***National Study:*** The NITRD Subcommittee should charge the NITRD National Coordination Office (NCO) to commission one or more fast-track studies on the current state of and future requirements for NIT postsecondary education.
- ***Visas:*** The Federal government should:
 - Streamline the process for obtaining visas for non-U.S. students admitted to accredited graduate degree programs in NIT subjects.
 - Make it routine for foreign nationals who have obtained advanced degrees in NIT subjects at accredited U.S. universities to be permitted to work and gain citizenship in the United States by easing the visa and Green Card processes for them.



- *Fellowships*: The Federal government should increase the number of multiyear fellowships for graduate study by American citizens in NIT fields each year, with the target number and fields of such fellowships informed by needs identified in sources such as the national study on NIT education.

The Federal NIT R&D portfolio is currently imbalanced in favor of low-risk projects; too many are small-scale and short-term efforts. The number of large-scale, multidisciplinary activities with long time horizons is limited and visionary projects are few.

- *Federal Funding Programs*: Federal agencies should rebalance their NIT R&D funding portfolios by increasing:
 - Support for important NIT problems that require larger-scale, longer-term, multidisciplinary R&D
 - Emphasis on innovative and therefore higher-risk but potentially higher-payoff explorations
- *Government and Academia*: The Director of the Office of Science and Technology Policy (OSTP) should call on senior officials from Federal NIT R&D funding agencies and major research universities to address how to better conduct large-scale, long-term, multidisciplinary academic R&D in the development and application of networking and information technology important to the Nation.

As new funding becomes available, the following four areas should receive disproportionately larger increases because they address issues for which progress will have both the greatest effect on important applications and the highest leverage in advancing NIT capabilities.

- *NIT Systems Connected with the Physical World* (which are also called embedded, engineered, or cyber-physical systems): The NITRD Subcommittee should develop and implement a Federal Plan for high-confidence NIT systems connected with the physical world.
- *Software*: The NITRD Subcommittee should facilitate efforts by leaders from academia, industry, and government to identify critical issues in software design and development to help guide NITRD planning on software R&D.
- *Digital Data*: The Interagency Working Group on Digital Data, in cooperation with the NITRD Subcommittee, should develop a national strategy and develop and implement a plan to assure the long-term preservation, stewardship, and widespread availability of data important to science and technology.
- *Networking*: The PCAST endorses the ongoing effort to produce a Federal Plan for Advanced Networking Research and Development, expected in 2008, which includes an R&D agenda for upgrading the Internet and R&D in mobile networking technologies, and addresses network security and reliability.

To sustain the Nation's NIT leadership over the long term, the following four areas must continue as Federal R&D priorities.

- *High-End Computing (HEC)*: The NITRD Subcommittee should develop, implement, and maintain a strategic plan and roadmap for Federal investments in HEC R&D, infrastructure, applications, and education and training.
- *Cyber Security and Information Assurance (CSIA)*: The Federal NIT R&D agencies should give greater emphasis to fundamental, longer-term CSIA R&D and the infrastructure for CSIA R&D.
- *Human-Computer Interaction (HCI)*: The Federal NIT R&D agencies should give greater emphasis to fundamental investigations of technologies and tools that make NIT systems easier to use by people, including those with specialized needs.

- *NIT and the Social Sciences:* The Federal NIT R&D agencies should continue to invest in this multidisciplinary field to inform public understanding of NIT's societal benefits and costs, guide policy making, and point to new directions for NIT R&D over all.

While in general the NITRD Program has effectively balanced agency needs with national needs and priorities, the current nature and scale of NITRD Program coordination processes are inadequate to meet anticipated national needs and to maintain U.S. leadership in an era of global NIT competitiveness.

- *Planning and Evaluation:* The NITRD Subcommittee should:
 - Develop, maintain, and implement a strategic plan for the NITRD Program
 - Conduct periodic assessments of the NITRD Program Component Areas and restructure the NITRD Program when warranted
 - Develop, maintain, and implement public R&D plans or roadmaps for key technical areas that require long-term interagency coordination and engagement
 - Develop a set of metrics and other indicators of progress for the NITRD Program, including an estimate of investments in basic and applied research, and use them to assess NITRD Program progress

NITRD National Coordination Office activities have resulted in increased NITRD interagency R&D coordination and planning.

- *Planning Support:* Under NITRD Subcommittee guidance, the NITRD NCO should develop and implement a plan for supporting the development, maintenance, and implementation of the NITRD strategic plan and R&D plans.
- *Communication:* The NITRD NCO should be more proactive in communicating with outside groups.