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POLICY BRIEF

The National Investment in Information Technology R&D

FREQUENTLY ASKED QUESTIONS

Why is a substantial increase in the federal investment in information technologies R&D necessary?

The federal investment in information technologies (IT) research has not kept pace with the potential of the field to expand the economy, improve public goods and services, and make people's lives better. **IT industries account for more than $500 billion a year of the U.S. economy** and have been responsible for one-third of the overall growth in U.S. production since 1992. No matter what "denominator" you choose – economic and social importance, contribution to Gross Domestic Product, annual federal expenditures on information technologies procurement – support for information technologies research is way too small. This becomes clear when compared to federal investments made in other fields:

Federal Funds for Research by Discipline (actual current dollars, 1996)[i]

Life Sciences	$12,100 million
Engineering	$5,680 million
Environmental Sciences	$2,997 million
Physics	$2,016 million
Social Sciences & Psychology	$1,187 million
Computer Sciences	**$1,103 million**

Why is government support for academic computing research needed to supplement the investments in IT R&D made by the private sector?

The vast majority of corporate R&D has always been focused on engineering: identifying highly promising ideas and creating great products and services from them. Long-term research is much harder to justify in the highly competitive corporate environment where product life-cycles are so short. Short-term returns are what stockholders and venture capitalists expect and demand. **Long-term, fundamental research that generates new knowledge and capabilities – the bank of ideas from which the private sector draws – is a public good with diffuse benefits** that can't necessarily be captured by the performer of the research. This is well understood in other areas of science and industry. For instance, the thriving U.S. chemical industry depends on fundamental advances in chemistry and chemical engineering research generated with federal support ($1,092 million in actual current dollars, 1996).

Doesn't High Performance Computing cover everything we need to be doing in computing research?

No. The High Performance Computing and Communications (HPCC) program, authorized by Congress in 1991, is devoted to developing high-end computational resources to solve grand challenge-scale problems in science and technology. Similarly the Next Generation Internet (NGI) program, authorized by the 105th Congress, focuses on developing advanced networking technologies. But **information technologies encompass far more than networks and high-performance systems, and computer science and engineering have much more to offer** than HPCC and NGI. The President's Information Technologies Advisory Committee (PITAC) in its Interim Report[ii] makes clear the need for expanded research in fundamental areas of computing most likely to lead to breakthroughs and new capabilities in a wide range of information technologies, especially software development, human-computer interfaces, scalability, innovative architectures, and the socioeconomic impact of IT, as well as high-end computing and networking.

Isn't the primary role of computer science and engineering to enable R&D in the other sciences?
No. Providing computing and computational tools that advance other areas of science and engineering is a critical function of the federal investment in computing research, but it should not be the sole function: **Research policies that regard computer science and engineering *only* as enabling disciplines for other fields will under-value many aspects of IT research**, especially those in fundamental areas with broad and potentially revolutionary impact. Computing research directly tied to applications in science and engineering is an effective way to drive progress in today's technologies, but it is not a substitute for research that will give rise to tomorrow's technologies.

What would a strategic initiative in long-term, fundamental information technologies research achieve?
An IT R&D initiative would stimulate R&D efforts in fundamental areas that broadly underpin information technologies and generate revolutionary and transformational advances, tomorrow's "killer" IT applications that cannot even be envisioned today. **Looking beyond mere extrapolations of today's applications and needs is the only way that the extraordinary potential of information technologies will be realized in the future**. Furthermore, a strategic initiative in *long-term* research would complement ongoing activities (eg. HPCC and NGI) dedicated to developing specific parts of our National Information Infrastructure by addressing, for instance, the efficiency, reliability and security, scalability and versatility, and ease of use of information technology systems as a whole. For instance, an emphasis on software research would shore up our understanding of how large systems behave and improve the quality and efficiency of software development, testing, and analysis methods.

Why is research in software so important? Isn't it all about hardware?
It's not all about hardware. Advances in hardware require concurrent progress in software development to fully exploit new capabilities; absent this progress, leading-edge hardware will simply never run at optimum performance. In fact, we are *already* suffering the consequences of severe lags in software technology relative to hardware technology. **The demand for software capabilities – for use with *today's* hardware – far exceeds our ability to produce them. What's more, the software that is produced is unacceptably fragile**. Corporate leaders, in a recent survey[iii] taken by the Science and Technology Policy Institute, cited the state of software as one of the most serious critical technologies issues facing their companies. Software-based systems are also exceedingly important to our public services and our national security, and vigorous research efforts are needed to make these systems more reliable and secure. A report[iv] from the President's Commission on Critical Infrastructure Protection points out that because critical U.S. infrastructure is highly dependent on information and communications systems, it is increasingly vulnerable to a vast array of new threats. Yet development of reliable prevention and protection mechanisms is still in its infancy.

What would expanding federal support for research in software accomplish? Why can't software companies pay for this?
Software companies spend a great deal of money developing and testing their products, with little left over to spend on research dedicated to improving the *process* of developing and testing software. The state of the art in software engineering tools is woefully inadequate given how dependent on software we have become. Expanded federal investment in fundamental computing research would generate the knowledge and tools needed to make software engineering less costly, less time-consuming, and more dependable. As stated by PITAC, "The Nation cannot afford to let the current situation continue. **We must commit to develop the science, technologies, and methods needed to build robust systems – ones that are reliable, fault-tolerant, secure, evolvable, maintainable, and cost-effective**."

Would this research likely lead to fewer bugs in the software I use at home and work?
Yes!

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[i] *Survey of Federal Funds for Research and Development, Fiscal Years 1996, 1997, and 1998*, National Science Foundation, 1998 <http://www.nsf.gov/sbe/srs/ff_dst46/tables.htm>

[ii] *Interim Report to the President*, President's Information Technology Advisory Committee, August 1998 <http://www.hpcc.gov/ac/#interim>

[iii] *New Forces at Work: Industry Views Critical Technologies*, Science and Technology Policy Institute, December 1998 <http://www.rand.org/publications/MR/MR1008/MR1008.pdf>

[iv] *Critical Foundations: Protecting America's Infrastructures*, President's Commission on Critical Infrastructure Protection, October 1997 <http://www.pccip.gov/report_index.html>