Testimony of
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Committee on Government Reform
Subcommittee on Technology, Information Policy,
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Good afternoon, Mr. Chairman and members of the Committee. I am Dr. Peter Freeman, NSF's Assistant Director for Computer and Information Sciences and Engineering, and Co-Chair of the Interagency Working Group (IWG) on Networking and Information Technology Research and Development (NITRD).

INTRODUCTION

I am glad to have the opportunity to testify before you this afternoon and to discuss the topic "*Defining Federal Information Technology Research and Development: Who? Where? What? Why? and How Much*?" As you know, information technology (IT) is vital to all operations of the government and is an essential component of the U.S. economy. I am always appreciative of the opportunity to help key decision makers understand this area better and the key role that government-funded research plays in making sure our Nation remains in a strong leadership position.

In the spirit of your letter of invitation "to provide the Subcommittee with a better understanding" of the scope of IT R&D and its impact on the Federal government, and because others on the panels today will also address your questions, I will first focus my testimony on some general issues that I believe will assist you in developing that deeper understanding. I will then address your specific questions directly. I will be glad to amplify these remarks in response to follow-up questions at the hearing.

TERMS AND A FRAMEWORK FOR DISCUSSION

It is important to understand that the subject of today's hearing is open to different interpretations, both abstractly and in practice. This can lead to misunderstandings and differences in reported activity levels.

For example, it is often reported in industry that a particular company spends a huge sum on IT R&D, sometimes specifically in an organization labeled "research." Closer examination, however, always reveals that the vast majority of that sum is spent on development, not research, even though it may be carried out in an organization with "research" in its title. The same confusion, of course, often occurs in discussing governmental activities.

Thus, let me begin by explicating the terms of the hearing subject, as I believe they are in current use, and by describing the framework used within the Federal research community for discussing them. This will then permit me to respond to your specific questions more effectively.

What is Information Technology?

"Information technology," until perhaps the past decade, was usually taken to refer to data processing as done by large organizations such as the government (in the sense of payroll, accounting, inventory, and other such systems), not the full range of computer- and communications-enabled work to which the term now often refers. This transition in usage is still underway, but for some time, the Federal R&D community has primarily used the more general definition as can be seen in the title of the IWG for NITRD itself.

Distinction Between "Research" and "Development"

Definitions of "research" and "development" are notoriously overlapping and often lumped together in a single category of "R&D." In the technical community, "research" generally refers to activities that produce new knowledge (or technology) while "development" refers to the use of existing knowledge (and technology) to produce new artifacts (systems, products, practices). Even these very general definitions are open to much interpretation in practice, however, since one can often find descriptions of a "research project" which is primarily focused on discovering *new knowledge not currently known to a particular organization*, even though it may have been known to others for a long time.

An important distinction at the core, however, is that research is usually targeted more broadly, is longer-term, and must be provided a broad type of oversight, while development usually has very specific targets, has a shorter time frame, and requires a project-management type of oversight. A related, practical distinction is that research is done by people who view themselves (and are viewed by their peers) as "researchers", while development is done by "developers." For example, NSF/CISE has initiated the Cyber Trust emphasis area this year which will fund about $30M of basic research aimed at improving the security and predictability of computer systems even when they are under cyber attack, at assuring that sensitive information flowing in public computer systems is consistent with public policies about where that information may flow, and at expanding the workforce competent to build and operate such systems. We expect a variety of research results to flow from this work so that perhaps three to five years from

now specific development projects can be initiated that will utilize some of these results to build more secure information systems for the government on a specific timetable.

Who Does IT R&D?

This example illustrates another reality. "Federal" activity in IT R&D is not only, or even primarily in the case of research, done by Federal employees. While two of today's panelists represent organizations that perform some amount of IT R&D "in-house," the bulk of "Federal" IT research is performed in non-US-Government organizations, notably universities. Likewise, while the government employs thousands of IT developers, much of the government's development work is done by outside contractors. A notable recent example is the recent DHS award of a multi-billion IT system development contract to a commercial organization. While I am not conversant with the technical details of this project, based on my experience with other large government systems, I believe it is fair to say that essentially no research will be done on that project but that it will be based almost entirely on the results of research over many years, much of which were supported in part or entirely by Federal funds.

Inclusion of Networking, Separation of Chip Technology

Two final definitions need to be made. First, while "networking" is specifically named in the title of the IWG, it generally is included in the term IT since modern networking depends heavily on the IT component of a network. This is a fairly recent (past twenty years perhaps) usage since communications networks (telephone, radio) not based on computers pre-date the modern computer age. Second, as one peels back the layers of a modern IT system, one eventually reaches the underlying hardware such as computer chips. Integrated circuit technology is, of course, a fundamental driver of and part of IT technology, but for the most part the R&D essential to its advancement is considered a separate topic.

IT Activity Differentiated from IT-Enabled Activity

Let me turn now to two frameworks for discussing Federal activity in IT R&D. The first separates IT from its usage. In a study[1] I co-authored several years ago, we found it very useful to differentiate between IT activity and *IT-enabled* activity. Thus, a research project currently supported by NSF/CISE, "An Assessment of Voting Technology and Ballot Design[2]" seeks to provide an "assessment of information technologies relative to on-line voting and ballot design." This is certainly "IT research," which may lead to some "IT development" of better e-voting systems, but electronic voting would be an "IT-enabled" activity. Similarly, *research* into new computer architectures might enable future *development* of specialized computers, but their usage for weather prediction (or other tasks) would be *IT-enabled activity.*

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[1] *The Supply of Information Technology Workers in the United States,* http://www.cra.org/reports/wits/cra.wits.html

[2] http://www.digitalgovernment.org/projectHighlight/149.pdf

NITRD Program Component Areas (PCA's)

The second is the framework[3] used by the IWG for NITRD to report Federal activity in this area. Despite the fact that NITRD includes a D for *development*, it is important to note that in practice the NITRD focus is primarily on research i.e. the creation of new IT knowledge not currently known to any organization.

The major *research* emphases of the NITRD effort are called Program Component Areas (PCA's):

- High End Computing Infrastructure and Applications
- High End Computing Research and Development
- Human Computer Interaction and Information Management
- Large Scale Networking
- Software Design and Productivity
- High Confidence Software and Systems
- Social, Economic, and Workforce

The work of each PCA is guided by a Coordinating Group (CG) of agency program managers. These groups, which report to the IWG, meet monthly to coordinate planning and activities of the multi-agency projects in their specialized research areas. The PCA's evolve in response to changing research needs. Overall, NITRD accounts for an approximate annual US Government investment in IT research of $2B.

My co-chair, Dr. David Nelson, and I initiated a thorough review of the definitions of these PCA's last year by the various Coordinating Groups. Their assessment after several months of study and discussion was that in the main these areas still describe the current structure of the field. There is, of course, overlap and some amount of interpretation of just where a specific activity might appear.

For example, in September 2002, NSF organized a workshop entitled: "New Vistas in CIP Research and Development: Secure Network Embedded Systems." The focus was on interdependencies of critical infrastructure systems, the need for integral security, and the increasingly distributed nature of these systems. Implications were considered for SCADA and air traffic control. Just from this short description, one can see that subject matter covered by several PCA's was involved, as well as IT-enabled activity (air traffic control); and for that matter, should a workshop devoted to identifying needed research be classified as "research" at all?

In spite of these definitional issues, the PCA's continue to provide a useful framework for developing a comprehensive, cross-cutting look at Federal and Federally-supported research activity in IT. They do not, however, address the issue of development of IT systems in the operational sense.

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[3] See http://www.nitrd.gov/iwg/program.html for a fuller description.

Let me now turn to the questions expressed in your letter of invitation.

SPECIFIC QUESTIONS

Given the above discussion, my particular responsibilities on the IWG, and as head of the largest funder of Federal IT research, I will succinctly address your questions in the context of the NITRD program. The annual "Blue Book" supplement to the President's budget[4] provides comprehensive examples and budgetary crosscuts.

"Who is doing IT research and development?"

At least thirteen agencies or major sub-areas of larger agencies report work in the NITRD program that is self-identified as *research* in the main. Non-US Government personnel, largely at universities and contractors, perform the majority of this work. Given the size of the Federal government and the looseness of definitions, there is undoubtedly additional research supported by the government. For example, it is well known that the Armed Services support some amount of IT research and that is most likely not accounted for in our crosscuts. Again, as noted above, the focus of the NITRD program is on research, so that development projects (such as the DHS project mentioned above) are not included.

"Where are these investments being made?"

Given the breadth of some of the funding programs, especially at NSF and NIH, it is fair to say that there is some amount of investment in every state, every research university (over 200), many colleges, and essentially every company capable of providing research service to the US Government.

"What is government gaining from these investments?"

The annual Blue Book referenced above provides numerous, well-illustrated examples of the results of this research and how, in many cases, they directly address the requirements and programs of the US Government. Many studies have been published of the value of IT research to the Nation and to the government, such as one[5] chaired by one of today's panel members, Dr. William Scherlis, and an earlier report[6] that addressed some of the research needs for a national information infrastructure which has now become essential to the operation of government. In general, the government is gaining directly from the technical base that underlies our military might and governmental operations, while enabling in ways that industry cannot a continuing economic revolution that provides the innovation, productivity, and economic vigor for our Nation.

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[4] http://www.nitrd.gov/pubs/blue04/index.html
[5] http://books.nap.edu/html/itr_e_gov/
[6] http://www.nap.edu/catalog/4948.html)

"Why should the government continue to make these investments?"

I believe that my answer to the previous question largely addresses this. I would only underscore the point that as industry repeatedly and publicly stresses (for example, the CEO of Intel[7]) Federally-funded research is essential to the continued advancement of IT technology because it produces the basic ideas, innovations, and workforce development that industry cannot in general afford to do.

"How much is being spent by the Federal government and how many projects exist?"

As noted above, I believe that within the stated caveats the crosscuts listed in the annual Blue Book provide a good compilation of Federal research activity in this area. It is important to note that for a complex activity of this magnitude (approximately $2 billion in FY2004) and for which definitions are subject to so much interpretation, it is inevitable that reports done at different times and with differing definitions will produce different results.

CONCLUSION

Thank you for the opportunity to appear before you today. I will be glad to respond to your questions.

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7 http://www.computerworld.com/managementtopics/management/itspending/story/0,10801,92552,00.html?nas=AM-92552)