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to the
Subcommittee on Technology, Innovation and Competitiveness
Committee on Commerce, Science and Transportation
United States Senate

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Chairman Ensign, Ranking Minority Member Kerry, and Members of the Subcommittee, I am pleased to appear before you today to discuss "The Importance of Basic Research to United States' Competitiveness," which is embodied in the President's American Competitiveness Initiative. The Administration greatly appreciates the efforts of the Senate Commerce Committee—and your work in particular Mr. Chairman—to highlight the importance and priority of Federally-funded basic research, which has resulted in good outcomes for the Nation.

One of these outcomes has been widespread recognition of the critical role the science and technology enterprise plays as the foundation for the United States' economic competitiveness. This is a message President Bush has elevated through his American Competitiveness Initiative (ACI), which he announced in his State of the Union Address and has repeated in many speeches and remarks since then.

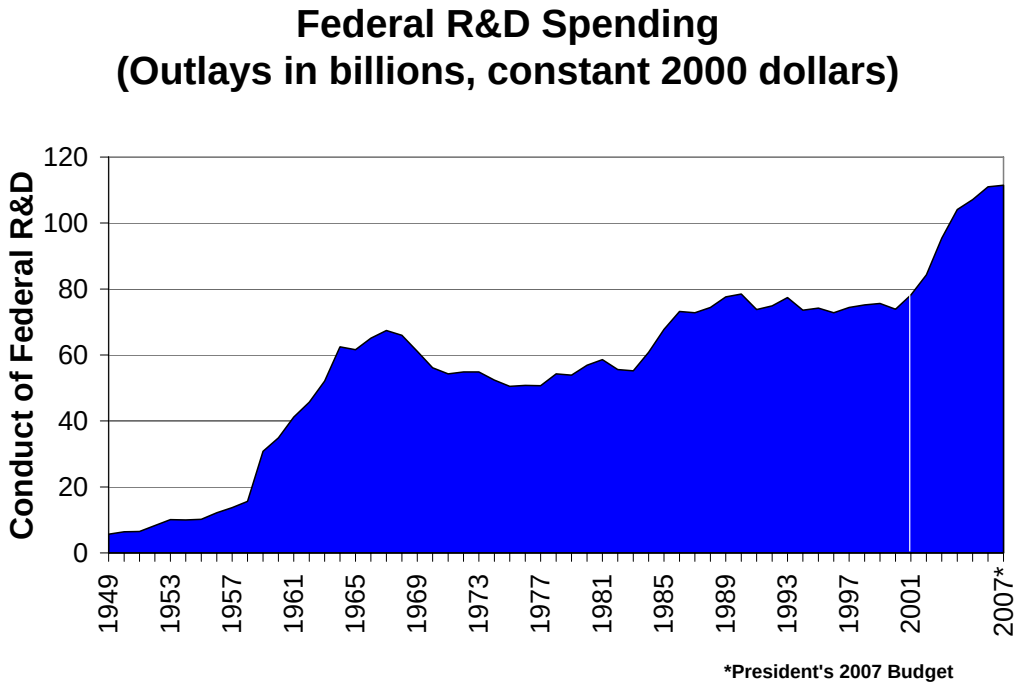
I will discuss the ACI in a moment, and its focus on basic research, but it is important first to place it in the context of this year's budget.

President Bush has made it clear that his top budget priority is to cut the deficit in half by 2009 by continuing this Administration's strong pro-growth economic policies and limiting the growth in Federal spending. The President's FY 2007 Budget does what is required to achieve this goal by reducing non-Department of Defense, non-Homeland Security discretionary spending by almost one-half of one percent. Consequently, this budget is about priorities. And while winning the War on Terror and securing the homeland are necessarily at the top, investing in America's future competitiveness through research and development is also of critical importance to this Administration. That is why the President is seeking a 2 percent increase in non-defense R&D within a declining overall non-defense budget. Under the President's 2007 Budget, R&D is 14.3 percent of non-defense discretionary budget authority, compared to 13.7 percent in 2001 when the President took office. At a record $59 billion, non-defense R&D is up $1.1 billion in this year's request.

Given the overall environment of fiscal discipline, it is notable that President Bush once again proposes a record R&D budget -- over $137 billion, 2.6 percent, or $3.4 billion, more than this year's funding level. This represents an increase of more than 50 percent during this Administration (Figure 1). Funding proposed for the category of Basic Research is $28.2 billion in 2007, up from $21.3 billion in 2001 -- a 32 percent increase. While this year research received prominence in the President's State of the Union address and the American

Competitiveness Initiative, it is an important fact that the President's budgets have consistently supported research and development at levels commensurate with other major priorities throughout this Administration. Real five-year growth in the conduct of the R&D budget has exceeded 40 percent for each of the last two years, the first time five-year inflation adjusted R&D outlays have topped 40 percent since 1967 and the Apollo era.

Figure 1. Federal R&D Spending in Constant 2000 Dollars.



AMERICAN COMPETITIVENESS INITIATIVE (ACI)

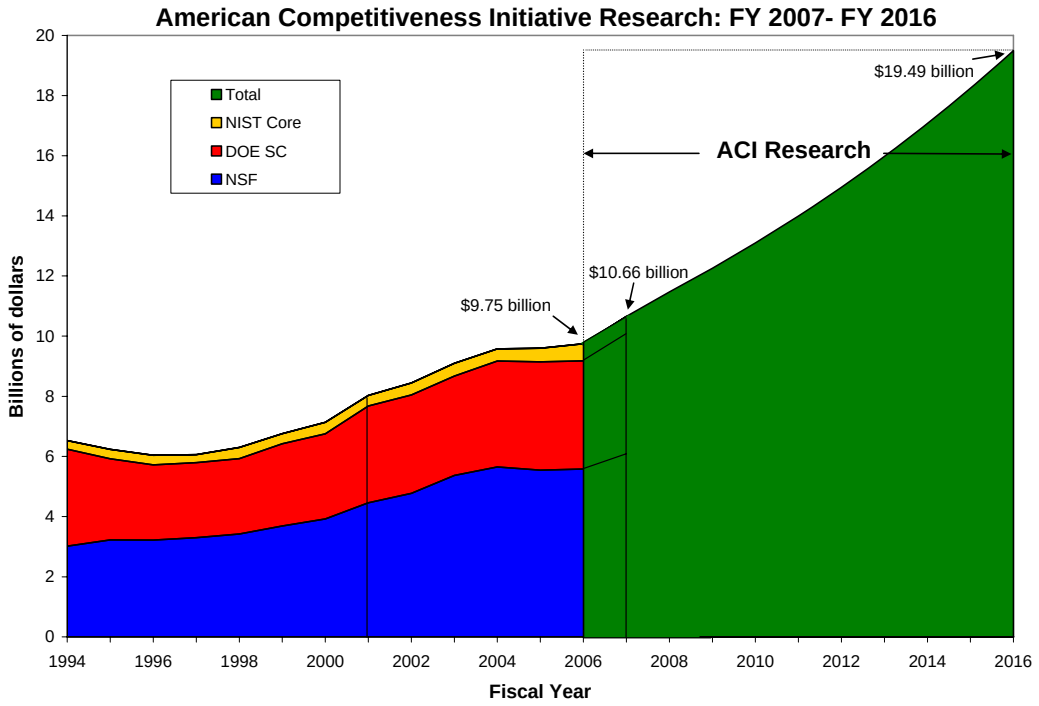
American economic strength and national security depend on our Nation's rich tradition of innovation. To assure our future technological leadership and take full advantage of America's current technological dominance in the world, President Bush launched the American Competitiveness Initiative (ACI). The ACI commits $5.9 billion in FY 2007, and more than $136 billion over 10 years, to increase investments in R&D, strengthen education, and encourage entrepreneurship and innovation.

The centerpiece of the American Competitiveness Initiative is the President's proposal to double, over ten years, funding for key agencies that sponsor basic research in the physical sciences and engineering that is likely to have high impact on future economic competitiveness. Certain areas within the physical sciences not only advance fundamental knowledge, but also generate new technologies that are broadly useful in society as well as in many other fields of science, such as nanotechnology and supercomputing. President Bush seeks to strengthen Federal investments in these priority areas by making landmark initial investments in 2007 in three key, innovation-enabling research agencies: $6 billion for the National Science Foundation (NSF); $4.1 billion

for the Department of Energy's Office of Science (DoE SC); and $535 million for the Department of Commerce's National Institute of Standards and Technology (NIST) core programs. The President's Budget also prioritizes the similarly high-leverage basic and applied research at the Department of Defense in 2007 by requesting $5.9 billion, $442 million (eight percent) more than last year's request.

In 2007, the ACI proposes overall funding increases for NSF, DoE SC and NIST core of $910 million, or 9.3 percent (Figure 2). Overall annual increases for these agencies will average roughly seven percent to achieve doubling in ten years. This amounts to a total of $50 billion in new investments in high-leverage, innovation-enabling research that will underpin and complement shorter-term and mission-oriented R&D performed by other agencies and the private sector. To encourage private investment in innovation to be equally bold, President Bush continues to propose permanent extension of the R&D tax credit and supports steps to modernize it to make it even more effective.

Figure 2. ACI Research: FY 2007 – FY 2016.



While the President has given funding priority to specific physical science and engineering programs in previous budgets, through such coordinated initiatives as the Networking Information Technology Research and Development (NITRD) program, the National Nanotechnology Initiative (NNI) and others, the ACI recognizes the enabling role of broader areas within the physical sciences in contributing to national competitiveness, and proposes a significant ramping up of funding for selected agencies over a sustained budget period. Of course national competitiveness depends on more than research. The ACI identifies similar selected priority strategies in education, workforce training, and immigration practices as well. Members of Congress - including many on this committee - have helped to bring attention to the

need for such strategies in our national discourse. Many other groups also deserve credit for highlighting the importance of investment in these areas, including the President's Council of Advisors on Science and Technology (PCAST), the Council on Competitiveness and the National Academy of Sciences. It is rare that so many different organizations speak the same language. I am optimistic that with your help and the support of the scientific community, we can provide funding for the ACI.

WHY BASIC RESEARCH?

The Administration designed the American Competitiveness Initiative to prioritize and advance those scientific endeavors with the highest marginal value for future economic competitiveness. Public sector research funding that typically has the highest marginal value is not directed toward specific products or technologies, but rather fosters the generation of fundamental knowledge that has significant spillover benefits that cannot be captured through intellectual property protection. Economists have concluded that such research can generate large public returns but does not usually provide a direct profitable return for private sector performers.

The economic payoffs of such research often come in the form of process and product innovations that reduce the costs of production, lower product prices, and result in new and better products and services. This research can even spawn entire new industries. The economic return shows up in economic statistics through increases in firms' output, aggregate GDP, and "total factor" productivity—that is, the amount of economic output that we can get from a given amount of labor, capital, energy, and material inputs. Consumers ultimately benefit from having access to less expensive, higher quality, and more useful products and services, as well as from earnings accruing to innovative companies. Put another way, basic research raises the standard of living.

Economic research finds private rates of return to R&D in the range of 20 to 30 percent, reflecting the returns received directly by the innovator. These private returns to R&D are considerably higher than the roughly 10 percent average return on other types of investments, attributable to the considerable risk and uncertainty associated with the technical and commercial success of R&D projects, as well as the depreciation of innovation value over time. Total social rates of return to R&D—including the "spillover benefits" to firms and consumers that did not conduct the original research—are typically estimated to be much higher than the private returns, ranging from 30 to 80 percent.

Innovation spillovers flow through at least three distinct channels. First, "knowledge spillovers" occur because knowledge created by one firm cannot typically be contained within that firm, and thereby creates value for other firms and other firms' customers. Second, "market spillovers" occur when an innovation creates benefits for consumers and non-innovating firms that are not fully captured by the innovating firm due to competition and other market forces. Third, because the profitability of a set of interrelated and interdependent technologies may depend on achieving a critical mass of success, each firm pursuing one or more of these related technologies creates economic benefits or "network spillovers" for other firms and their customers. Technical standards often have an important role to play in the context of markets with significant network effects.

The location of innovation also matters in that spillovers, at least to some degree, tend to spread from a geographical locus. For example, flows of knowledge to U.S. innovators are more likely to come first from the United States than from abroad. Globalized information flows reduce the impact of the distance factor, but it remains significant in explaining technology diffusion and spillover effects. The comparative advantage of the high-cost countries of North America and Western Europe is increasingly based on knowledge-driven innovative activity. Thus, the location of knowledge-based activity matters for innovation and ultimately comparative advantage.

The Council on Competitiveness summarizes the importance of basic research in a "calculus of innovation": (1) Knowledge drives innovation; (2) Innovation drives productivity; and (3) Productivity drives our economic growth.

WHY PHYSICAL SCIENCES AND ENGINEERING?

Certain areas of physical science and engineering research are strongly correlated with innovation and economic growth. The ACI priority agencies each have special features that merit significant attention even in a period of budgetary constraint.

The DoE Office of Science (SC) is the nation's largest sponsor of physical science research. It supports physical science capabilities and infrastructure used by a large number of investigators in nearly every field of science, and particularly those related to economically significant innovations (e.g. nano-, bio-, info-tech, energy, new materials and processes). Within DOE-SC, the new funding from ACI is expected to improve facilities and support approximately 2,600 new researchers.

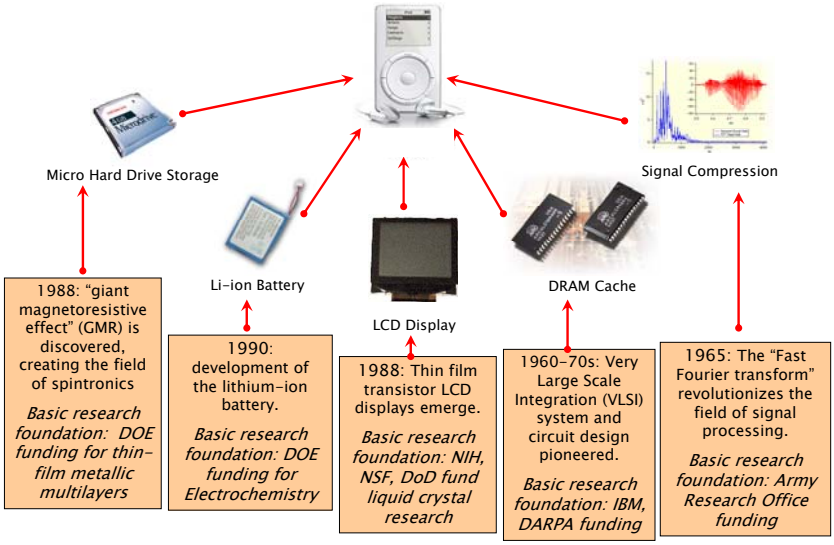
The National Science Foundation (NSF) is the primary source of support for academic research in the physical sciences. It funds potentially transformative basic research in areas such as nanotechnology, information technology, physics, materials science, and engineering. The NSF is well-regarded for management of funding through competitive, peer-reviewed processes. The NSF funding derived from the ACI initiative is expected to support as many as 500 more research grants in 2007 and provide opportunities for upwards of 6,400 additional scientists, students, post-doctoral fellows and technicians to contribute to the innovation enterprise.

The DoC National Institute of Standards and Technology may be the highest leverage Federal research agency supporting economically significant innovations. Its world class team of scientists, recognized by three Nobel prizes during the past decade, plays a critical role in supporting standards development activities that are essential for the commercial viability of new technology. In FY 2007, NIST will seek to focus 3,900 scientists and engineers from government, industry and universities – an increase of 600 researchers over 2006 – on meeting the Nation's most urgent measurement science and standards needs to speed innovation and improve U.S competitiveness.

While the very nature of basic research limits our ability to predict what inventions and technologies will one day arise from investments in these agencies, a look at the past value of basic research provides a sense of what we might expect in the future. In recent decades,

fundamental research advances have provided society with technology that has enabled microchips, personal computers, the Internet, balloon catheters, bar codes, fiber optics, e-mail systems, hearing aids, air bags and automated teller machines, to name just a few quality-of-life improving and standard-of-living raising changes. These inventions can usually be traced back to Federal support for basic research. The development of the portable MP3 player is a timely and useful example of this connection (Figure 3).

Figure 3. Impact of Basic Research on Innovation



The development of MP3 technologies illustrates the unexpected benefits of basic research. In 1965, a hand-sized storage and playback device that would hold 15,000 recorded songs was the stuff of science fiction. Even simple hand-held calculators were rare and expensive at that time. Research funded by the Department of Defense, the National Science Foundation, the National Institutes of Health, the Department of Energy, and the National Institute of Standards and Technology contributed to the breakthrough technologies of magnetic storage drives, lithium-ion batteries, and the liquid crystal display, which came together in the development of MP3 devices. The device itself is innovative, but it built upon a broad platform of component technologies, each derived from fundamental studies in physical science, mathematics, and engineering.

The inventions and innovations of the future that will be advanced in terms of quality, quantity and timeliness by ACI are in the areas of nano-, bio-, and information-technology and manufacturing, solar, nuclear and hydrogen energy, new materials and processes. Specific innovation-enabling potential outcomes of ACI basic research include:

- world-leading capability and capacity in nanofabrication and nano-manufacturing – a determinant industry of the future
- necessary next generation investigation tools to study materials at the nanoscale
- world-leading high-end computing capacity (petascale) and capability (design) and advanced networking as fast as possible to address grand challenges
- overcoming technical barriers for quantum information processing
- new technologies for hydrogen, nuclear and solar energy through novel new basic research approaches in materials science.
- addressing gaps and needs in cyber security to lead the world in information, knowledge and intellectual property protection and control
- basic research on sensor and detection capabilities (e.g. for Improvised Explosive Devices) which can also lead to world-leading automation and control technologies
- solving fundamental technical problems in the application of biometrics
- develop manufacturing standards for unprecedented technologies for the supply chain
- improving building standards in high-risk areas (e.g. hurricane and earthquake-prone regions)
- responding to international standards challenges which affect U.S. competitiveness

MAXIMIZING THE EFFECTIVENESS OF RESEARCH FUNDING

The widespread support for actions such as proposed in the President's American Competitiveness Initiative is deeply gratifying to us in government who labor on behalf of science and engineering. I want to take this opportunity to point out that the recommendations of the many organizations that have spoken out on the need for such an initiative express priorities for action in a very broad and general way. When money is tight, and many needs compete for finite resources, it is necessary to define priorities with much more specificity than these otherwise excellent advocacy reports. The ACI responds to this need to prioritize. It attempts to direct funds to agencies with well-defined programs with a clear relevance to future economic competitiveness. It does not attempt to expand support for every area of basic science, nor even for every field within the physical sciences. It seeks the maximum impact with the minimum of bureaucratic apparatus, taking advantage of programs and processes already in place and working well.

In view of the many proposals for enhancing America's future competitiveness, the challenge now is to retain a focus on the most important actions we must take, and avoid diffusing the impact of the resources at our disposal. The ACI resists the impulse to act on every good idea. Our plea is to reject unnecessary new programs and bureaucratic burdens and to keep the Initiative “clean and simple.”

To that end, President Bush has called upon Congress to ensure that funds provided to the agencies under the American Competitiveness Initiative are free of earmarks. As we discuss the importance of pursuing the best science to contribute to U.S. competitiveness, I hope the Congress will join with us to encourage competition for research funding by rejecting research earmarks in the FY 2007 appropriations process.

CONCLUSION

America currently spends one and a half times as much on Federally-funded research and development as Europe, and three times as much as Japan, the next largest investor. Our scientists collectively have the best laboratories in the world, the most extensive infrastructure supporting research, the greatest opportunities to pursue novel lines of investigation, and the most freedom to turn their discoveries into profitable ventures if they are inclined to do so. We lead not only in science, but also in the productivity, innovation, and technological prowess that is necessary to translate science into economically significant products that enhance the quality of life for all people.

Nonetheless, other nations seek to achieve the quality of life for their own large populations that many Americans take for granted. These nations aim to close the gap by emulating our successful model—devoting increased resources to their scientific and technological enterprises in an effort to better compete with the U.S. on the global economic stage. To ensure that their success does not diminish our own, we must act now with the confidence to which our leadership position entitles us to build upon our strength.

The President's FY2007 budget will sustain this leadership and maintain science and technology capabilities that are the envy of the world. The proposed ACI basic research investments and R&D tax credit changes directly address America's innovation challenges. These are sound in terms of science and technology policy, and consistent with the broader Administration economic policy to foster and maximize America’s long-term growth potential. ACI refocuses the federal R&D portfolio by placing increased emphasis on fundamental research in key areas of the physical sciences and engineering, similar to the increases in fundamental biomedical research over the last decade. A broad consensus exists that these are the most important areas for generating additional breakthroughs that drive the economy, and these are also the areas of the federal R&D portfolio most in need of additional resources. They deserve priority in the FY07 budget over all other R&D, except perhaps for selected programs supporting national and homeland security.

I would be pleased to respond to questions.