Investing in Communications for Tomorrow's Innovations:
The Case for Increased Communications Basic Research Funding

Background

Research is the backbone of the communications industry, a critical national resource. It is the building block for the future development of advanced telecommunications products and services. In recent years, the need for federally funded communications research has dramatically increased. As a result of the communications market crash of 2000, intense market competition and a focus on low price points keeping profit margins at a minimum, companies remain focused on survival. This has translated into an era of deep cost cutting and lean workforces, as well as a focus on product development and incremental research, rather than innovating for the future and seeding technology development. While the United States has been and continues to be regarded as a leader internationally in technology research, the innovation of recent years *cannot be taken for granted*.

Why Federally Funded Communications Research is Necessary

The nature of communications industry investment is long-term, capital intensive and generally, non-cyclical. At the same time, the process of conducting communications research is extremely complex – involving time, money and foresight that must be sustained for a decade or more to yield the full fruits of investment.[1] Because of the tremendous infrastructure requirements associated with the deployment of communications networks, a great deal of time, money and vision is needed to advance challenging, high-risk, enabling technologies that could provide broad-based economic and societal benefits for the U.S.[2] This is precisely why, with constantly diminishing corporate research funds available, the federal government's budget for research has become an increasingly important source of funding for U.S. communications research.

Advances in communications dramatically transform the way in which people live, work, learn, communicate and conduct business, and long-term research is essential to ensure that these transformations serve human needs, are productive for society and sustainable over the long term. Moreover, long-term communications research has significant positive effects, in terms of technical and economic spillovers. Research is a key factor in enhancing innovative performance and productivity, as well as long-term economic growth. This is because communications is a supporting sector for the economy as a whole, affecting many specific industry sectors, such as distribution, retail, agriculture, financial services and machine building, among others. In fact, all sectors depend on and derive benefits from communications research. This is precisely why the federal government should be concerned about the poor state of funding for communications research and should more actively support the sector.

Research in this area is the principal source of fundamental advances in the digital technologies powering vital national defense, national security and homeland security capabilities. A strong, well-funded communications research program benefits innovation in vital infrastructure protection measures, such as increased information security, reliability and survivability of networks, as well as facilitates development of the technologies and tools used to detect and prevent terrorist attacks.[3]

Current State of Federal Communications Basic Research Funding in the U.S.

For years, when compared with other industries, communications basic research has not been well supported in the U.S. government's federal budget. In fiscal year 2007, the federal government budgeted a

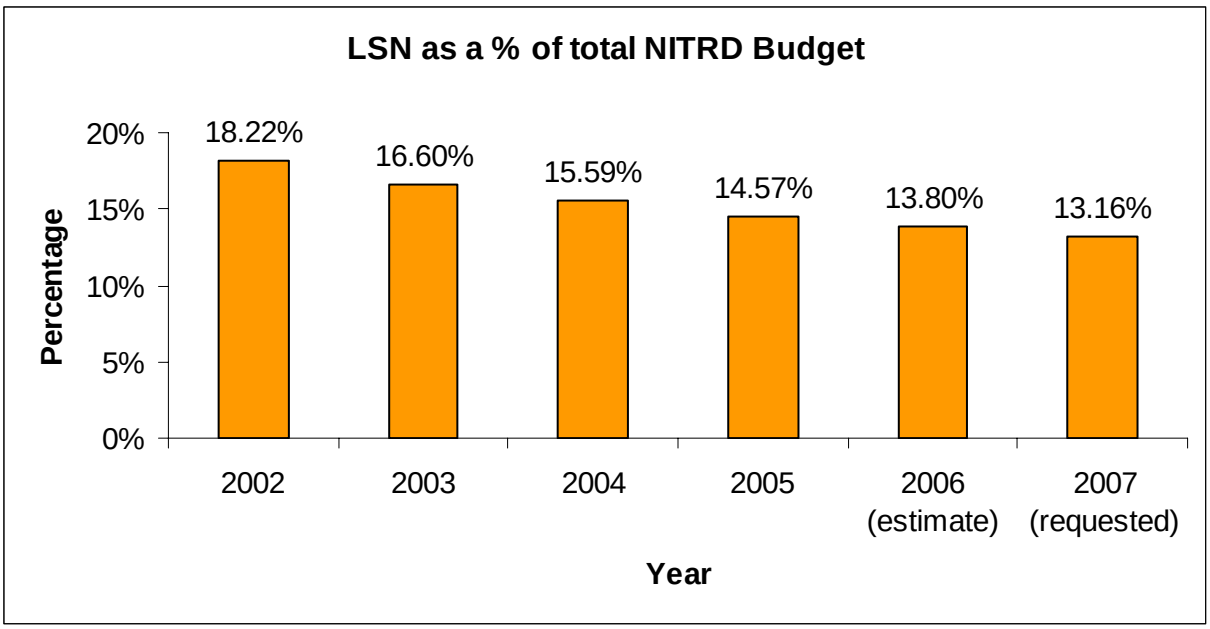
[1] See PITAC presentation at http://www.itrd.gov/pitac/meetings/2004/20041104/compsci.pdf.
[2] ATP Document on Investments in Telecom and Related Technology Fields, 2003.
[3] See Networking and Information Technology Research and Development FY2004 report.

little more than $3 billion[4] across relevant agencies for networking and information technology research and development (NITRD). This is a minute fraction – **about 2 percent** – of the $137.2 billion[5] in total research and development funding requested for this fiscal year.

To further illustrate the lack of federal focus on communications basic research, the total amount of federal funding budgeted for **large scale networking (LSN) research** – the part of NITRD that includes communications and high-performance networking research and development in leading-edge technologies and services – **totaled about $400 million[6] in fiscal years 2006 and 2007**, or about **0.3 percent** of the federal government's total research and development budget. Given the fact that LSN includes more than just communications-focused basic research, and this figure includes both research AND development spending, as well as spending on infrastructure and applications, only a fraction of this number is actually spent on communications basic research, likely **no more than $100 million**.

Moreover, between fiscal years 2002 and 2007, the percentage of U.S. government research funding allocated to the large scale networking program area **declined by five percentage points**, from 18 percent to 13 percent (see the table[7] below). All of these statistics suggest that the federal government views communications-sector basic research with decreasing importance to the economy and security of the United States, this despite the fact that communications is a critical infrastructure and it is the backbone for all information technologies. Communications are an indispensable part of every other industry, from automobile manufacturing to healthcare to financial services and more. No industry today could survive without communications technologies and services.

The following chart depicts LSN as a percentage of the total NITRD budget during the past six fiscal years.



[4] See http://www.nitrd.gov/pubs/2007supplement/07%20Supp%20Sections/07Supp_FINAL-AgencyNITRDBudgets.pdf.
[5] See http://www.ostp.gov/html/budget/2007/2007FactSheet.pdf.
[6] For the first time, the NITRD LSN budget for FY 2006 and FY2007 includes research statistics from the OSD budget. The OSD budget includes funding from the DoD Service research organizations (Air Force, Army and Nay), as well as DoD's High Performance Computing Modernization Program Office. Once this line item is subtracted, the total amount of funding allocated for the LSN Program Area in FY2006 is $252.1 million, and FY2007 is $273.8 million. No similar statistics are publicly available pre-FY 2006, and the addition of these statistics into federal reporting charts makes year-on-year comparisons nearly impossible to make.
[7] See http://www.nitrd.gov/pubs/2007supplement/07%20Supp%20Sections/07Supp_FINAL-AgencyNITRDBudgets.pdf.

U.S. Communications Research Falling Behind Other Countries

Communications is a highly competitive, global industry. With relatively little federal and industry money going toward long-term, high-risk communications research, the leadership position of the United States in this vital area is waning, threatening our country with potential innovation declines. Decreasing emphasis domestically, both in terms of political support and dollars, on the importance of funding research in this field is strengthening the growth of research funding and related institutions overseas, as other countries seize an opportunity to outpace the U.S. in this important, strategic field, and companies find high-level support from other governments. This creates an incentive for companies to move research facilities to other countries where funding and support exist.

For example, Europe is in a competitive race with the U.S. and Asia for a leadership position in technology, especially technology that will impact global markets. In the European Union's (EU) 6th Framework Programme,[8] 3.98 billion euros of funding has been prioritized for information society technologies (IST) research, making it the main source of EU funding for IST research projects.[9] This is part of the EU's overall goal to increase research and development expenditures to 3 percent of GDP by 2010, and this also makes IST research the largest funding priority in the entire EU research program. According to the European Commission, "Europe can lead the world if it can develop a common vision embracing researchers, industrialists, governments and societies across Europe."[10]

The EU also is currently developing its 7th Framework Program (FP7).[11] Entitled "ManuFUTURE Vision for 2020," the EU's new framework focuses on innovation in underlying technologies that will enable more efficient manufacturing. FP7 aims to move the EU from an economy of quantity to one of quality by using digital methods to integrate new technologies into the design and operation of manufacturing processes. The EU's goal is to optimize resources and transfer them to all areas where they can be employed, thereby remaining competitive in a global marketplace. Funding for IST research in the 7th Framework Programme has increased more than three fold over the 6th Framework Programme, to 12.7 billion euros.[12]

China has developed a five-year plan for the 2001-2005 period, which purports that the communications industry will be the leading industry among all other industries in its national economy, and the country announced plans to shift resources toward achieving this goal.[13] In fact, between 1996-2002, China's science and technology research and development funding, as a share of GDP, doubled from 0.6 percent to 1.2 percent.[14] According to the OECD, its total R&D investments lag only those of Japan and the United States in absolute terms.

The United Kingdom (UK) has set a target to increase its share of publicly funded science and technology research and development from 1.9 percent to 2.5 percent of GDP by 2014. The country's *Science and Innovation Investment Framework*[15] proposes that the public science budget increase 5.8 percent annually, in real terms, from 2004-2005 and 2007-2008.[16]

In December of 2005, the Academy of Finland and the National Technology Agency Tekes launched a new research funding program. This program aims to strengthen science and technology research by attracting top foreign personnel to conduct research for a fixed time period in Finland. Researchers will focus on

[8] 2002-2006.
[9] See http://europa.eu.int/information_society/research/index_en.htm.
[10] See http://europa.eu.int/information_society/research/index_en.htm.
[11] See http://europa.eu.int/comm/research/future/index_en.cfm.
[12] See http://www.cordis.lu/fp7/breakdown.htm.
[13] See summary of China's tenth five-year plan.
[14] OECD Science, Technology and Industry Outlook, 2004, p.18.
[15] See http://www.hmtreasury.gov.uk/spending_review/spend_sr04/associated_documents/spending_sr04_science.cfm.
[16] OECD Science, Technology and Industry Outlook, 2004, p.56.

basic research, science and researcher training.[17] Tekes, the main Finnish research funding body, allocated 409 million euros to research programs in 2004, with 122 million Euros going to information and communication technology research.[18]

Japan raised the total amount of government research and development spending by nearly 24 trillion yen (about $233 million) between FY2001 and FY2005. And, the Korean government set a target to double national research and development spending between 2001 and 2007.[19]

An increasing number of OECD governments are offering special fiscal incentives to businesses to increase spending on research and development, largely because R&D and innovation are considered keys to productivity and growth performance. For example, the countries of Japan, Korea, Portugal and Spain all offer greater tax incentives than the U.S., at rates of 45-50 percent, on incremental increases in science and technology research and development investment.[20] Additionally, unlike in the U.S., many countries – including Australia, Austria, Belgium, Denmark, Hungary and the UK – offer generous tax allowances of greater than 100 percent for research and technology development.

These are just a few examples of how other countries are investing the time, money and intellectual capital to create attractive environments for science and technology research. The United States cannot afford to ignore the fact that U.S. industry needs federal government support in order to remain competitive for the long-term.

TIA's Solution

With this background, TIA's Communications Research Division has identified four mechanisms to address the funding problem and six technical areas where we would like to see federal funding for communications research directed. Further information about these items is attached. In addition, we believe policymakers should reflect on these issues as discussion occurs regarding a rewrite of the 1996 Telecommunications Act.

[17] See http://www.tekes.fi/eng/news/uutis_tiedot.asp?id=4593.
[18] See http://www.tekes.fi/eng/tekes/rd/statistic04.html.
[19] OECD Science, Technology and Industry Outlook, 2004, p.57.
[20] OECD Science, Technology and Industry Outlook, 2004, p.66.

TIA Priority Areas for Federally Funded Communications Basic Research

Mechanisms to Address the Funding Problem:

1. **Prioritize communications research funding within Department of Defense (DoD) 6.1 Basic Research Programs.**
   a. In the 1990s, the Department of Defense and the Defense Advanced Research Projects Agency (DARPA) began to rely heavily on dual-use and industry research funding. Thus, DoD funding became unavailable for technologies that were commercially available. As a result, DoD restricted its research funding to military-unique needs, which at the time was acceptable because private-sector-led research was driving high-end research.
   b. With the communications downturn, however, the commercial sector has ceased to be the major driver of high-end, long-term research. As a result, DoD - and DARPA - need to increase their focus on and investment in dual-use technologies.

2. **Prioritize communications research funding within the National Institute of Standards and Technology (NIST).**
   a. Miniaturization of electronic components in communications devices continues, resulting in faster, more powerful and more reliable products. Yet, the continued shrinking of component parts, at the nanoscale, is hindered by metrology and manufacturing challenges. NIST programs address some of these key issues and should be adequately funded.
   b. Additionally, we support the continuation of the National Information Assurance Partnership (NIAP), a collaboration between NIST and the National Security Agency. The long-term goal of NIAP is to help increase the level of trust consumers have in their information systems and networks through the use of cost-effective security testing, evaluation, and validation programs.

3. **Prioritize communications research funding within National Science Foundation (NSF) Research Programs.**
   a. Federal funding for physical sciences research, the foundation of our nation's economic competitiveness, has dramatically decreased. Technological advances driving the economy require the reversal of this trend.
   b. The National Science Foundation Authorization Act of 2002 called for doubling the NSF budget over six years; fulfillment of that goal is lagging.
   c. In conjunction with increasing NSF's budget, we advocate for the creation of an NSF Communications Technology Research (CTR) program, similar to the Information Technology Research (ITR) program that recently concluded. Such a program would greatly benefit the communications sector by creating opportunities at the frontiers of communications research and education.

4. **Establish a National Technology Council, whose charter would be to define and guide strategic areas in communications that require further research critical to the future growth of the U.S. economy. Such a Council should include representation from different sectors, such as government, academia and industry.**
   a. To utilize scarce financial resources effectively, representatives from government, academia and industry should be sought to establish long-term priorities. Additional research would help identify the technologies likely to be most relevant to U.S. economic growth and competitiveness.
   b. This Council should be modeled after the European Union's 6th Framework Programme initiative, wherein the Council receives proposals from industry consortia regarding specific areas of focused research and development and has available substantial funding from the government to help fund those proposals.
   c. This Council should also borrow from the United States Alliance for Technology and Engineering for Automotive Manufacturing (U.S. A-TEAM), a partnership created between the

U.S. Department of Commerce's Technology Administration (TA) [consisting of the Office of Technology Policy (OTP), the National Institute of Standards and Technology (NIST), and the National Technical Information Service (NTIS)] and the United States Council for Automotive Research (USCAR). U.S. A-TEAM brings together engineers from the government and industry bodies that are parties to the agreement to facilitate technological research and technology policy analysis focused on improving the manufacturing competitiveness of the U.S. automotive industry.

d. The Council, in cooperation with industry, would determine the priority of the specific research initiatives of national concern.

Technical Areas Where Research Is Needed:

1. **Universal Broadband – Affordable broadband access and connectivity, using all available media (copper, coax, fiber, spectrum, etc.), carrying all services (voice, data, video) to all customers everywhere (urban, suburban, rural, mobile) in order to enable a greatly upgraded "superhighway."**
    a. Broadband Internet access is critical to support technology convergence and advanced communications. A forward-looking U.S. Government should support universal access for broadband Internet, as well as policies that promote widespread connectivity. Infrastructure upgrades create increasing returns to our economy and encourage the development of businesses, entertainment, education, and e-government solutions and capabilities.
    b. Additional *federally funded* research in this field is needed, particularly because special technologies will be needed for rural access, and corporate and venture capital financing for research has dropped significantly over the last several years. Extremely significant cost reductions are necessary in order to meet the technology needs of rural areas. Additionally, the provision of broadband access in rural areas is costly due to challenges associated with terrain, low population density, etc.

2. **Security – New authentication, encryption and monitoring capabilities for all public broadband networks to protect communications assets from attack.**
    a. The U.S. is a post-industrial information society, and as such, its cyber-infrastructure is vulnerable to attack.
    b. Continued research is needed to prevent systemic attacks to infrastructure and may provide an opportunity for university-based "centers of excellence."

3. **Interoperable Mobility – The ability to access commercial mobile services and emergency services over any mobile network from any mobile instrument.**
    a. Interoperable mobility enables public safety and law enforcement officials to use the various public safety and cellular mobile networks while avoiding the necessity of carrying multiple mobile devices. It also promotes coordinated communications between various public service agencies and allows higher priority use of scarce spectrum resources for emergency use.
    b. Federally funded research is necessary because the emergency services market is critical for the common good. Also, bringing commercial technologies and emergency services technologies closer together will result in lower costs and more advanced features for critical emergency services.

4. **Communications Research for Homeland Security, including interoperability, security, survivability and encryption.**
    a. Homeland Security is a superset of several other listed visions. Security technologies can help protect public networks and other public infrastructure from malicious attacks. A large amount of economic activity today depends on the continued availability of public broadband networks and infrastructure. Successful attacks can significantly slow down national economic activity and can have other disastrous consequences (e.g., in case of identity theft).
    b. Research is needed in all areas (interoperability, security, survivability and encryption) because the needs of first responders and critical infrastructure protection far exceed the needs of "typical" commercial applications. Further research also is needed because new worms and viruses constantly are being invented, and new techniques are needed to prevent attacks before there is significant resulting damage.

c. The country needs a broad program to address our vulnerabilities and ensure the integrity of first responders' systems. The government should support these "extreme case" applications, since they are unlikely to be sufficiently developed in normal commercial systems.

5. Nanotechnology

a. Many of the advances in communications have been driven by fundamental scientific discoveries of materials at the nanoscale level.
b. Examples of important research areas include: sensors, displays, power systems, radio frequency and nanomicrophones.
c. Advances will reduce cost, increase mobility, decrease power consumption, and improve healthcare, homeland security and public safety.

6. Networking Architectures

a. Advanced networking research on hardware and software for secure and reliable communications and tools that provide the communication, analysis and sharing of very large amounts of information will accelerate discovery and enable new technological advances.