

Testimony of James W. Serum, Ph.D.
President
Scitek Ventures LLC

**before the U.S. Congress, House of Representatives, Committee on Science and
Technology, Subcommittee on Technology and Innovation**

March 11, 2008

Thank you Chairman Wu and members of the House Subcommittee on Technology and Innovation for the opportunity to testify before you today on matters related to the President's Fiscal Year 2009 budget proposal for the National Institute of Standards and Technology and NIST's recently submitted Three-year Programmatic Plan.

My name is James W. Serum and I am testifying on behalf of VCAT, The Visiting Committee on Advanced Technology, an advisory committee to the Director of NIST. I am the President of Scitek Ventures, a science and technology consulting firm focused on helping young companies commercialize innovative ideas and early stage technology. I have been deeply engaged in developing and commercializing measurement technologies and applications for over 40 years, having spent most of my career with Hewlett Packard Company. Upon retirement in 1999, I founded an information technology business, Viaken Systems Inc. and a technology consulting firm, Scitek Ventures LLC, both focused on measurement systems. I have been associated with NIST for the past 10 years, having served first as a member of the National Research Council Assessment Panel for the Chemical Science and Technology Laboratory (CSTL), and, since 2004, as an elected member of NIST's Visiting Committee on Advanced Technology (VCAT). I was recently elected to chair that organization for the next two years.

About VCAT: The NIST Visiting Committee on Advanced Technology (VCAT) was established in its present form by the Omnibus Trade and Competitiveness Act of 1988 and was updated by the America COMPETES Act. The VCAT charter includes reviewing and making recommendations regarding general policy for NIST, its organization, its budget and its programs within the framework of applicable national policies as set forth by the president and the Congress. The 2007 annual report covers the topics reviewed and discussed from the March 2007 meeting through the February 2008 meeting.

The Committee reviews the Institute's strategic direction, performance and policies, and provides the Secretary of Commerce, Congress, and other stakeholders with information on the value and relevance of NIST to the US science and technology base and to the economy. Over the past year, the Committee has been active in assessing NIST's progress in the following:

- Strategic direction and performance
- Infrastructure and process in support of strategic needs
- Outreach - Assessing and responding to external drivers
- Organizing and executing with excellence

Throughout the year, the Committee seeks to cover a significant portion of NIST programs through direct discussion with NIST leaders, scientists and engineers. Reactions and observations are discussed candidly with the NIST representatives and other guests at each meeting. This feedback is used to seed continuous improvement in key areas in the overall operation. At most meetings, the Committee also visits various NIST laboratories and discusses the research projects directly with the technical staff. These laboratory tours help the committee assess the relevancy of measurement technology research and NIST's progress against the strategic plan and the development of the NIST infrastructure.

Members of the Committee have careers in industry and in academia, and are selected solely on the basis of established records of distinguished service and eminence in their fields: research, engineering, business and other fields relevant to the NIST mission. Appointed by the NIST Director for staggered three year terms, the members have diverse backgrounds and provide a representative cross-section of traditional and emerging US industries.

In 2007, the VCAT created 3 subcommittees for Bioscience/Healthcare, Information Technology, and Nanotechnology as allowed by its charter, in order to more thoroughly explore and understand NIST's programs, competencies, organizational effectiveness and alignment with the industrial segment "customer" need. These subcommittees were chosen not only because of the size of the industry and impact on the US Economy but also, because each one cuts across a wide segment of the broad spectrum of US industry. The VCAT 2007 annual report provides the foundation for my testimony in this hearing.

I have been asked today to provide testimony on the VCAT's perspective related to NIST's current and future strategic investments. This includes our assessment of the proposed budget for 2009, alignment of the budget priorities with key technology investment areas, the NIST strategic planning process and the effectiveness of cross-laboratory coordination within NIST.

Importance of Measurements to US Industrial Competitiveness:

We believe that accurate and precise measurements and measurement technology provide the underpinning for economic success and competitiveness in almost all US industries -- whether it is for the Healthcare Sector, Information Technology, Homeland Security or traditional manufacturing. For example, the future economics and effectiveness of our healthcare industry depends on developing a thorough understanding of the cause of diseases and the development of specific therapeutics to treat those diseases. Only a few short years ago we hailed the announcement of the identification of the human genome. Yet today, inaccurate DNA measurements lead to incorrect and confusing conclusions about genetic causes of disease. Dramatic improvements need to be achieved relative to manufacture of DNA chips and application processes for interpreting the results from DNA chips. NIST can play a key role in developing standards and technologies for both DNA and protein measurements to enable and accelerate this critical industrial segment. A NIST report (The Economic Roles and Impacts of Technology Infrastructure, Gregory Tasse, 2008) describes many examples of the value of measurement technology in many industrial sectors.

VCAT General Observations about NIST:

We believe that NIST is performing high quality, state-of-the-art measurement and technology research. Their equipment in general is current and provides for world class measurement of chemical, biological and physical parameters. Their staff is highly competent, and is validated through many peer awards including three Nobel Prizes since 1997. NIST is recognized world wide for its leadership in helping to develop industry standards and they are sought after to provide global leadership for international standards organizations. NIST has put a much-needed emphasis on its strategic planning in recent years, and it is the committee's view that they have shown considerable improvement. We observe that the quality of strategic planning continues to vary by organizational unit and program within NIST. We also observe that NIST has strong proactive programs to gain customer input from various industry sectors in which it is involved.

We recognize that NIST faces an immense challenge to balance its spending, resource allocation and research prioritization while serving such a broad group of industrial sectors from cement manufacturing to newer industry segments such as biotechnology, information technology and nanotechnology.

NIST FY 2009 Budget Proposal:

The VCAT has long believed that NIST is dramatically under funded to effectively accomplish its designated mission. The final 2008 budget – which was well below the levels requested by the President for the NIST laboratories -- has led to setbacks in initiating important new programs in bioscience and other areas. We are pleased that the 2009 proposed budget increases – if funded by Congress -- will allow these programs to get funded and launched. The development and maintenance of NIST standards have proven critical to the ongoing success of a very broad group of industrial sectors. Existing standards and reference materials need to be maintained at significant expense while simultaneously developing new measurement technologies and standards for industrial segments vital to our nation's competitiveness such as IT, Nanotechnology and Bioscience/Healthcare. NIST needs to be aggressive in finding new ways to maintain the credibility and integrity of existing standards and materials. Their NIST Traceable Reference Materials (or NTRM) program is an excellent example of possible approaches.

The VCAT is pleased with the proposed 22% increase in NIST's 2009 core budget. We support the proposed new initiatives for Nanotechnology EH&S (\$12M), Measurement Innovations in Bioscience (\$10M), National Cybersecurity Initiative (\$5M) and Optical Communication and Computing (\$5.8M), along with the other initiatives that were pending in FY 2008 and did not get funded – yet still are critical.

The ability to perform state-of-the-art measurement research depends on state-of-the-art facilities. Building environments related to vibration, temperature, humidity and environmental pollutants can prevent necessary measurements to be developed or standards enacted. VCAT applauds the investment in new and renovated facilities during the past several years and we support the continued facilities investment at Boulder, JILA and the Neutron Research Center (NCNR) in the 2009 proposed budget.

In summary, the VCAT strongly supports the proposed budget increase for NIST as part of the American Competitiveness Initiative and the America COMPETES Act.

VCAT Focus on Information Technology, Bioscience/Healthcare and Nanotechnology:

As stated earlier, in 2007 VCAT established 3 subcommittees on Bioscience/Healthcare, Nanotechnology, and Information Technology in order to more thoroughly explore NIST's programs and research in these very important technology and industry sectors. The following comments reflect a summary of our findings.

Information Technology – Key priorities include Cybersecurity (a 5 fold increase in malicious software was detected in 2007 compared to 2006), technology for sustainable “green” data centers for lower power consumption and less water cooling, standards for data archiving that enable representation of complex information in easily accessible, low capacity formats. We emphasize the importance of information technology to a wide number of industrial sectors including healthcare (electronic medical records, etc), nanotechnology and biotechnology.

VCAT strongly endorses NIST's research program in quantum computing and communication. NIST can make a significant contribution in developing metrics that reveal computing and communications capacity, security, compliance and reliability. The US is lagging in broadband capacity and better data is needed on national access to and use of high capacity data communication capabilities. The IT subcommittee recommends that NIST consider possible measurements and metrics to assist in the assessment of broadband access to Internet and related services in the United States.

The subcommittee recommends that NIST consider investigating computing requirements and algorithms used for climate and natural disaster modeling with the objective of validating them.

Bioscience/Healthcare – NIST has a long history of developing measurements and standards for the Healthcare Industry when in 1918 NBS launched a dental materials group and in the 1920s, established X-ray radiation standards for imaging technicians. Some of the current research in bioimaging has been a result of the sustained effort in this research area. However, the amount of NIST research dollars dedicated to Bioscience/Healthcare is minute relative to the greater than \$2 Trillion dollar annual expenditure for this industrial sector. The need for development of advanced measurement technology to support the US Bioscience/Healthcare industries is vital. Despite the need and the enormous size of the industrial sector, there is no laboratory specifically devoted to supporting the bioscience/healthcare industry. Research projects are limited in scope and scale and are individually located in laboratories across many different sites. We believe that the current projects are well managed but in general we do not see an overall strategic plan to provide direction and prioritization. We believe that the staff has recognized these challenges and is making considerable effort to coordinate and cross fertilize their bioscience research projects. The bioscience/healthcare subcommittee is concerned about continuing under funding of this sector in the Three-year Programmatic Plan. The NIST management team has identified five areas of focus in 2007: Biospectroscopy, Cell and Tissue Measurement, DNA Technology, Structural Biology and Quantitative Imaging. While we support these program areas, most lack sufficient funding resources and applications expertise to be successful or to have a major impact. NIST has identified Bioimaging as one of its key opportunities. This is appropriate and has the potential to have a major impact on disease understanding and development of effective therapeutics in the future.

We applaud the America COMPETES act for doubling the NIST budget in the future. NIST staff is becoming quite proactive in gaining the “voice of the customer” related to prioritization of research programs for this industry segment. A NIST conference is scheduled in October with the specific purpose of gaining expert feedback on measurement priorities for innovation in bioscience. The NIST staff and Bioscience/Healthcare subcommittee worked in excellent harmony during 2007 to focus on priorities and future measurement needs. We would like to see a comprehensive strategic plan developed for Bioscience/Healthcare in 2008.

Nanotechnology – The National Nanotechnology Initiative (NNI) provides the foundation for NIST’s work in this area. The US government spends over \$1 Billion dollars annually in these efforts. Within NIST, a new Center for Nano Science and Technology (CNST) has been established and the VCAT subcommittee has reviewed NIST’s efforts as part of the overall NNI activity. The component areas in this initiative include; nanoscale phenomena and processes, nanoscale devices, instrumentation research and metrology and standards for nanotechnology. A major US issue relates to the environmental health and safety of nanomaterials. In response to widespread concerns about the responsible development of nanotechnology as well as a recommendation by VCAT, NIST initiated in 2007 a program to develop standards and metrics associated with the responsible development of nanotechnology. We support this program and caution them to develop appropriate toxicology applications partnerships rather than bringing this expertise inside. Although the Nanotechnology programs are highly distributed, it is VCAT’s assessment that they are well run and well coordinated.

Concerning CNST, we find that with respect to the Nanofabrication facility as well as the research programs residing in CNST, there has been significant progress in planning and execution of both elements. The acquisition, installation and commissioning of the major equipment for CNST is essentially complete. Approximately 85% of the planned technical personnel have been hired or authorized under existing funding. Completion of the personnel and equipment ramp-ups will require restoration of the funds deleted from the FY2008 budget to at least the level in the President’s proposed 2009 budget. The Nanofab facility is intended to serve both internal and external users. As the facility is gearing up, its primary users remain internal and academic. A person has been recently hired to run the new facility with one of his specific responsibilities to grow industry representation among its users. We have reviewed the industrial interactions to date and the goals for establishing external partnerships. We believe that CNST management recognizes the importance and priority of developing these external partnerships. Still developing are NIST internal partnerships, which involve the following OU’s: MSEL

(Nanomagnetics; thin film nanostructure, bistable switch; probe beams); EEEL (Nanomagnetics; low noise sensors; theory; magnetization dynamics) ITL (Nanomagnetics; domain properties); CSTL (Atomic Scale Measurement; atom switching dynamics); PL, (Nanofabrication; edge roughness). Other connections and projects are under consideration. A Nanotechnology Coordinating Council is being established within NIST and we recommend that this council work to enhance collaborations through all relevant OU's involved with nanotechnology.

VCAT assessment of the Three-year Programmatic Plan:

The foundation of an effective strategic plan is a clear mission and an accurate identification of the Core Competencies of the organization. NIST has a concise mission statement focused on innovation and industrial competitiveness through measurement science, technology and standards. The organization has appropriately articulated its competencies as measurement science, rigorous traceability, and development and use of standards.

The VCAT committee did not have access to the Three-year Programmatic Plan with sufficient time to thoroughly evaluate and critique its content this year. However, the following comments reflect the consensus feedback of VCAT members at its last meeting plus my personal feedback as the VCAT chairperson having reviewed the document more completely following the last VCAT meeting.

Overall, the Three-year Programmatic Plan represents a comprehensive strategic document that reflects clearly the goals of the organization, its core competencies, current research priorities as well as identification of future measurement needs and a discussion about how technology priorities will be established in the future. NIST has improved significantly in its overall strategic planning process as evidenced by this document. However, the process is not yet implemented consistently throughout the organization.

The committee endorses the four pillars of strategic planning found in the 3 year strategic plan:

- Enhanced Stakeholder outreach and identification of critical measurement and technology challenges;
- Strategic, multi-year investment framework
- Development of infrastructure to optimize and support the Nation's technological and organizational innovation – and staff/equipment to succeed
- Rigorous evaluation of all NIST investments

As stated previously, The NIST organization is constantly faced with the formidable challenge of establishing appropriate program and technology priorities across an extremely broad area of industries and technologies. They have identified stakeholders both within the government (OMB, OSTP, PCAST, NSTC and DOC) and across industries that have or can help establish those priorities related to US innovation and industrial competitiveness. In addition, NIST has proactively conducted workshops and programs such as USMS (United States Measurement System) to gain feedback on the critical needs for measurement in US Industry. Those have led to more than 700 measurement needs being identified. We encourage NIST management to continue to evaluate and integrate these diverse lists of measurement needs into more focused programs with adequate goals and deliverables and a visible process for establishing priorities.

The committee agrees with the Core Competencies identified in the 3-year plan:

- Measurement science
- Rigorous measurement traceability
- Development and use of standards

We agree with NIST that biotechnology, advanced nano materials and IT infrastructure and communications are areas in which strategic investments are needed. We also endorse the report's detailing of the construction and renovation needs described in the appendix.

We strongly endorse NIST's proposed project evaluation strategy, in particular the seven Heilmeier questions listed below from the Defense Advanced Research Projects Agency (DARPA) adapted to NIST's work. We do not currently see these strategic questions being effectively implemented throughout the organization:

- What is the problem and why is it hard?
- How is it solved today and by whom?
- What is the new technical idea and why can we succeed now?
- Why should NIST do this?
- What is the impact if successful and who would care?
- How will you measure progress?
- How much and how long?

We believe that the current and pending budget initiatives to: Strengthen Core Competencies, Address Rapidly Developing Technology, Expand the Frontier of Measurement Science and Meeting Critical National Needs, are appropriate. We support technology measurement advancements in optical computing and communication, nanotechnology, and alternative energy research. NIST has identified quantum information science, nanotechnology and Bioscience as High Risk, High Reward areas of focus. Members of the Bioscience Subcommittee consider Bioscience/Healthcare research as a critical priority and would encourage a significantly higher investment in the short term than is currently proposed.

The committee is satisfied that NIST has a vigorous process for consulting with customers, industry and academia for purposes of formulating its strategic and tactical plans.

VCAT supports NIST's commitment to phasing in and phasing out of programs and agrees with NIST's investment posture in quantum science, atomic, molecular and optical physics.

Finally, we concur with NIST that it must be responsive to mandates (e.g. Help America Vote Act) and to other national needs in manufacturing, energy demand and supply, climate change measurement, modeling and analysis and safety in commerce. The committee notes the extensive collaboration undertaken by NIST and recommends continued support for these wide-ranging activities.

The VCAT endorses the articulation of the issues surrounding Nanotechnology Measurement Science and the movement of Nanotechnology from discovery to manufacture. The importance of this field to both US technological leadership and industrial competitiveness is clearly described. The negative impact of the 2008 budget on the important role NIST must play in the responsible development of nanotechnology cannot be overemphasized. We agree with the assessment of the importance of enhancing the NIST Center for Neutron Research but suggest that the case could be even stronger by enhancing the important symbiosis between NCNR and CNST.

NIST Strategic Planning, Technology Prioritization Processes and Organizational Effectiveness:

NIST has a clear mission and understands its core competencies. They recognize the importance of getting stakeholder and customer feedback into their processes for establishing priorities for technology and research programs and we believe that they have incorporated effective methods to gain the "voice of the customer". We commend them for working to make this a part of the NIST culture but observe that these practices are not yet uniform throughout the organization.

During recent years, VCAT has recommended an improvement in strategic planning, particularly a strong demonstrated link between strategic plans, priority setting and selecting and staffing projects. Although NIST has developed strategic plans such as the NIST 2010 document and the USMS document, the committee has not been able to fully embrace and evaluate the programs and priorities within an overall strategic framework. We would attribute this at least in part to the lack of sufficiently clear links between strategy, programs and the prioritization processes. The current Three-year Programmatic Plan appears to be a good foundation for better strategic dialog between NIST staff and VCAT.

Due to NIST's expertise in measurement systems and standards, they are often called upon to initiate "ad hoc" studies for the benefit of the nation, such as the study of the World Trade Center disaster and the Help America Vote Act. We support these efforts and recognize their importance but they have the capability of distracting from the strategic mission and vision of the organization. Care must be taken to effectively manage external influences and requests.

It is always difficult for any organization to stop projects that are no longer of critical priority or that are not producing expected results in order to dedicate those resources and funds to more important projects and priorities. NIST has been proactive in this area and VCAT applauds these efforts. However, it is our belief that NIST still has too many programs that are not sufficiently coordinated and appropriately funded and staffed to achieve the desired projects and program goals. We also recognize the need for independent pioneering research of the type that provides the foundation for "innovation in US industry" and we do not propose that every project be managed and coordinated within defined strategic programs. A balance is entirely appropriate.

A "metrology" organization such as NIST should be able to evaluate its own effectiveness in serving their customers. In recent years, NIST has authorized independent outside evaluation studies to determine the leverage of dollars invested in NIST compared to its "value" to a particular industrial segment. An average return on investment (ROI) is reported to be 44:1, a very impressive number and a number which we consider to be a conservative calculation. One may conclude that at least those programs chosen for evaluation were highly effective and chosen properly to effectively and efficiently benefit US industry.

Organizationally, NIST laboratories are primarily structured by disciplines and technology including Information Technology, Chemical Science and Technology, Physics, Electronics and Electrical Engineering, Manufacturing Engineering, Materials Science and Engineering, Neutron Research, and Building and Fire Research. No structure can effectively reflect the rapidly changing needs in the industries that NIST serves and the technologies and applications that it needs to develop and standardize. It is our impression that historically research projects were chosen within these "silos" according to perceived industry need and capability within the laboratory. It is evident that NIST has now become proactive in establishing NIST wide programs that require coordination across organizational boundaries for access to innovative ideas, technology and applications expertise. We also observe that cross fertilization of ideas and expertise is becoming an integral part of the NIST culture. We observe a new vigor for cross laboratory coordination for key technology areas such as information technology, nanotechnology and bioscience and we encourage it to become a pervasive behavior throughout the organization. We urge caution, that as new initiatives are launched, an appropriate assessment is made of necessary resources and expertise and plans are developed to acquire that expertise or partner within the organization or externally. There are numerous examples of cross department coordination and the creation of external partnerships to gain access to new technology and expertise needed to accomplish their goals. An internal example is the new Nanotechnology program to explore environmental, health and safety issues utilizing resources from the Chemical Science and Technology Laboratory but also many of the other NIST labs. The Hollings Marine Laboratory in South Carolina represents an outstanding partnership with NOAA to gain applications expertise in marine biology. We believe that this type of relationship can serve as a model for future partnerships where applications expertise in a particular field is necessary, for example in pursuing measurement solutions for the field of Diagnostics in Healthcare.

Research in Information Technology including optical computing and communication, cybersecurity, and data structures permeate most industrial sectors – so it is not surprising that each of the NIST laboratories relies heavily on IT-related research in order to perform their missions. The IT lab, with a strict focus on IT, has been proactively coordinating its efforts across all relevant parts of the NIST organization to assure efficiency and effectiveness of its programs. (See IT subcommittee summary for more detail).

The VCAT 2007 Annual Report provides much more detail regarding our findings and recommendations.

Biography of James W. Serum

Dr. Serum received a B. A. in Chemistry from Hope College and was awarded a Ph.D. degree in Organic Chemistry in 1969 from the University of Colorado. His doctorate research was directed toward studies in Mass Spectrometry. Following his graduate studies, he taught and did research at the University of Ghent, Belgium. He spent a year at Rice University as a Welch Fellow, and then joined the staff at Cornell University as Director of the National Institutes of Health High Resolution Mass Spectrometry Facility.

Dr. Serum joined the Hewlett-Packard Company in 1973 as Applications Chemist for Mass Spectrometry. Since then he has held a number of management positions, including Technical Support Manager for Mass Spectrometry in Europe (Paris, France); Marketing Manager for Mass Spectrometry and Spectroscopy at the Scientific Instruments Division; R&D Manager at the same division; and R&D Manager for the Avondale Division (Laboratory Automation and Chromatography Instrumentation). Since 1984 he has held business unit level positions as Operations Manager for Laboratory Automation Systems, Automated Chemical Systems Operation and Analytical Group Research & Development Manager. In 1992 Dr. Serum was named General Manager for Mass Spectrometry, Infrared, and Protein Chemical Systems. He was the founder of HP's Bioscience Products business. He has served as chairman of HP's Bioscience Council, co-chairman of the Hewlett-Packard R&D Council and the Pharmaceutical Business Council. He retired from Hewlett Packard in August 1999 to co-found Viaken Systems Inc, where he was a Director and served as Executive Vice President and Chief Operating Officer. Dr. Serum has been a Venture Partner with Flagship Ventures and currently serves as President of SciTek Ventures, a science and technology consulting firm that he founded in 2002. In 2002 he was elected as a lifetime National Associate of the National Academy of Sciences and in 2004 he was elected to serve on the Visiting Committee for Advanced Technology of NIST. In 2005, Dr. Serum was named to the President's Advisory Board for Advanced Technology at the Research Corporation. In 2008 he was elected Chairman of NIST's Visiting Committee on Advanced Technology. Dr. Serum has served or currently serves as a member of the Board of Directors for a number of emerging technology based companies.

OTHER PROFESSIONAL ACTIVITIES

- Member of National Academy of Sciences task force on the Future of Analytical Chemistry in the U.S.(1986)
- Member of National Science Foundation task force to Review Policy for Science Education in the U. S. (1987)
- Invited speaker at numerous educational meetings and conferences on Science Education
- Past member of Hewlett-Packard Education Relations Board
- Review Panel for Hewlett-Packard Grants Program for Analytical Chemistry (1989-1992)
- Member of Science & Technology Board, College of Letters and Science, James Madison University (1988-1993)
- Member of Board of Directors, Biotechnology Research and Development Corporation (1988-1994)
- Member of the National Institute of Standards and Technology (NIST) technology assessment panel (1990-1992)
- Counselor (alt), Analytical Chemistry Division, American Chemical Society (1992- 1995)
- Member of the Board, Center for Photochemical Sciences, Bowling Green State University (1994-Present)
- Member of ACS subcommittee for improvement of chemistry curriculum (1994-1995)
- Member of National Research Council, Committee on Undergraduate Science Education (1996-2001)
- Member of National Research Council, Committee on A National Digital Library (1997)
- Chairperson, NRC Review committee on National Math Standards (1999)
- Member & Vice Chairman of Board of Assessment for Chemical Science & Technology Laboratory, NIST ('97-'01)
- Chairman of Board of Assessment for CSTL, National Institute of Standards and Technology ('01-'03)
- Member National Research Council Committee on Undergraduate Science Education (02-03)
- National Associate (life), National Academy of Sciences (2002)
- Member of Visiting Committee for Advanced Technology, NIST (2004-'09, Vice Chair 2007-2008, Chair 2008-2010)
- President's Advisory Board for Advanced Technology, Research Corporation (2005- present)

**U.S. HOUSE OF REPRESENTATIVES
COMMITTEE ON SCIENCE AND TECHNOLOGY
SUBCOMMITTEE ON TECHNOLOGY AND INNOVATION
HEARING ON**

***NIST'S FY 2009 BUDGET REQUEST: WHAT ARE THE RIGHT TECHNOLOGY
INVESTMENTS TO PROMOTE US INNOVATION AND COMPETITIVENESS?***

March 11, 2008

**Questions for the Record Submitted to
Dr. James Serum
Chair
Visiting Committee on Advanced Technology (VCAT)**

Questions Submitted by Subcommittee Chairman Wu

1. Is NIST's current level of investment in cyber security adequate? What are the areas of cyber security in which NIST can have the greatest impact, given its specific competencies?

RESPONSE: Cyber security is critical to the economic and national security interests of the United States and NIST is essential to the success of our country's cybersecurity efforts with research programs that address topics as diverse as the development of measurement systems necessary to evaluate the efficacy of current cybersecurity strategies to developing the most advanced and secure quantum encryption technologies available. As part of the NIST's proposed budget growth under the ACI and now under the COMPETES Act, NIST has been working to grow its programs and capabilities in this essential area with initiatives submitted in FY07, FY08, and FY09. Unfortunately, NIST is chronically under funded and the full potential of NIST in these areas remains unrealized.

Increased investment would enable NIST to assist in the propagation of measurement software to assess the level of cyber-infection, botnet growth, spam, and other cyber-hazards found in computers connected to the Internet or on private corporate and Government networks. There is no reason for NIST to compete with commercial sector companies in the production of anti-virus (or anti-malware) tools, but NIST can be very helpful in the development of metrics and measures of gross infections in computers in the government, private sector, and general user population. NIST can also be very helpful in analyzing risks associated with the aggregation of health and financial information and the protection of such information from unauthorized access and use. Given sufficient funding NIST is poised to have significant impact in a number of fundamental security technologies such as: cryptography, risk management, biometrics, tokens, industrial controls, operating system security, security protocols, authentication, and quantum encryption. In addition, NIST has experience in design usability of information systems and can establish broad based framework solutions that cut across independent, proprietary solutions. Furthermore, NIST

has the strategic relationships with IT system developers and vendors to promote adoption of the research results.

2. How did NIST determine the size of the FY09 biotechnology initiative (\$10 million)? Is this level of funding adequate? How should NIST identify the appropriate external strategic partners to work with in expanding its investments in the life sciences?

RESPONSE: NIST has for many years, recognized the importance of bioscience research as part of its overall Healthcare Program, however, as NIST is chronically underfunded and is simultaneously called upon to support critical measurement needs in a number of fields, the VCAT Bioscience/Healthcare Subcommittee considers the NIST funds available to target challenges in the Biosciences and Healthcare to be grossly inadequate and new funding is required. We, the VCAT, have worked closely with the NIST staff, with excellent synergy, to focus and direct research to areas of greatest need in bioscience. NIST has been working to ensure that their projected budget growth under the ACI is targeted to have maximum impact. As part of this planning process, NIST has determined that expanding their capabilities to address the measurements and standards needs of the biotech and life sciences communities is of key strategic importance. NIST has defined its role in the biosciences as leveraging its expertise in the quantitative physical and informational sciences to provide the measurement infrastructure necessary for enabling increased innovation in this area, and to provide confidence for measurements of complex biological systems. To develop a robust measurement capability, NIST has been reaching out to stakeholders that include government, industry, and academia (examples include: FDA, NIH, Pharma, Amgen, Genetech, Merck, the Institute for Systems Biology, California Institute of Technology, the Mayo Clinic, and other organizations) to identify critical measurement needs of the biosciences community. The FY 2009 initiative, *Measurements and Standards to Accelerate Innovation in the Biosciences*, reflects this input. It targets the need for quantitative, traceable measurements and standards for biomarkers, the ability to quantitatively make simultaneous multiplexed measurements of multiple biological molecules (including genes, proteins, RNA, etc.), and the informatics and computational tools and standards to manage and manipulate the tremendous amounts of data generated by biological experimentation. Given the range of NIST budget growth in FY 2009 under the President's proposal and the other priority areas that also require additional resources, NIST leadership felt that the \$10 million requested in the President's budget for this initiative would provide a sufficient amount of resources *to begin to acquire* the appropriate expertise and resources necessary for building up a foundation to meet anticipated future needs in biosciences measurement. We, the VCAT, agree that this is a good beginning but the amount should be significantly increased in coming years. It is our understanding that NIST plans additional growth in this area in the coming years.

As NIST expands investments in the life sciences, they plan to continue to work with stakeholders to continue our efforts in identifying other critical measurements and standards needs. As part of this planning process, NIST is working with the University of Maryland Biotechnology Institute to sponsor a meeting entitled "Accelerating Innovation in 21st Century Biosciences: *Identifying the Measurement Standards and Technological Challenges*". The meeting will be held from October 20-22, 2008, at NIST and will be open

to leaders from industry, academia, and government. Details of the meeting can be found at <http://www.cstl.nist.gov/Biosciences.html>. Input from this meeting and other outreach activities will form the basis of NIST's strategic plan for future program expansion in the biosciences. NIST intends to reach out intensively to a wide cross-section of the biosciences and health community to ensure that they are properly focused and resourced. VCAT has participated in this planning process and supports the activities as they are currently defined. External feedback will also be gained through a variety of one-on-one meetings as well as group contacts with key players in the field. We believe that this activity will indeed assist them in developing a comprehensive Strategic Plan and provide the foundation for greater investment in this critical area of measurement science.

3. In each of the last five years, NIST has spent approximately 20 percent of its research budget on nanotechnology, the highest percentage of all the agencies in the National Nanotechnology Initiative. Is this an appropriate level of investment in this one technology area? How is NIST ensuring that nanotechnology work is coordinated across labs?

RESPONSE: On the surface, a 20% investment in nanotechnology seems high. However, the VCAT Nanotechnology subcommittee has been deeply involved with the NIST staff during the past two years and we support the efforts underway. A deeper dive into applications of nanotechnology and the actual research being conducted at NIST supports their current level of research. The focus of a majority of research at NIST is the advancement and application of measurement science. This work relies increasingly upon advances at the nanoscale – one billionth of a meter – and smaller (the single atom, ion, photon, electron, etc.) It is a natural development as the capabilities and needs of science and industry have advanced, and it has been part of NIST's measurement science strategy before the term “nanotechnology” became commonly used.

The label nanotechnology is, in fact, a broad one, linked mainly to the size at which a material is being fabricated or examined. So it is relevant to multiple disciplines ranging from physics, chemistry, and materials science to electronics, building and fire research, and information technology. That also makes nanotechnology relevant to many scientific and engineering advances and industrial applications being pursued by the customers served by NIST—and makes NIST measurement-oriented contributions important to the nanotechnology revolution. This multidisciplinary, multi-sector involvement explains the relatively high percentage of work at NIST that is classified as nanotechnology. It should be expected that a good percentage of NIST's work in nanotechnology also can be classified with other labels, such as “materials science” or “bioscience” or “electronics.” This work is conducted and prioritized by current and future needs of industry, academia, and government for measurement-based advances. The National Nanotechnology Initiative is the overarching government effort to identify and address nanotechnology needs, and NIST's priorities are derived from this cooperative planning effort and supplemented by information provided by NIST's primary customers and potential customers in industry, academia, and government.

The Nanotechnology: Discovery to Manufacture initiative and the *Nanotechnology: Environment, Health, and Safety Infrastructure* initiative are two FY 2009 budget initiatives

that tackle specific challenges in the development and manufacture of nano-devices, or products incorporating nanomaterials. Both of these initiatives were mapped out and planned after significant consultation and coordination with multiple stakeholders through interagency working groups, and technical workshops. Moreover, it fits into a multi-year matrix of phased investments in nanotechnology that NIST developed with the active involvement of leaders of all laboratories at NIST working on nanotechnology. The final decision about these planned, phased investments was made by the NIST Director.

I have addressed the question of NIST coordination and cooperation within NNI and across government and research organizations. The VCAT has also worked with NIST staff in creating an effective coordinating function within their own laboratories. Consistent with VCAT's recommendation in 2008, NIST has recently established a Nano-Information Council under the direction of CNST Director Bob Celotta to facilitate the coordination of nano-related work.

Questions Submitted by Subcommittee Ranking Member Gingrey

1. You state in your testimony that the quality of strategic planning within NIST varies, but the agency has been largely successful in soliciting the views and needs of outside collaborators from industry. What areas need improvement?

RESPONSE: As indicated in my congressional testimony, during the past 5 years, VCAT has repeatedly emphasized the need for improved strategic planning throughout the NIST organization. We have observed a progressive improvement in their strategic planning process. In response to the planned budget doubling outlined in the American Competitiveness Initiative, NIST fully recognizes the need for a comprehensive strategic plan and has developed a strategic approach that is intended to establish the programs, plans, and infrastructure necessary to more than double NIST's impact on the economy. As part of this plan they indicate that they will:

- 1) Target research efforts on technologies that are set to drive innovation in the 21st century
- 2) Identify and address the critical measurement barriers to innovation.
- 3) Evaluate NIST's facilities to ensure adequate capacity and capabilities exist to meet current and projected industry and university needs.
- 4) Support academia and industry by enhancing the capabilities and capacity of NIST's User Facilities.
- 5) Develop an expanded federal toolset for support of technology innovation and industrial competitiveness

One of the greatest challenges of strategic planning for NIST relates to the tremendous diversity of critical measurement research across a wide number of industrial sectors within their "mission". They must educate a broad number of employees to understand the strategic planning process and to make strategic planning pervasive across the entire organization. Not all NIST research should fit neatly into the strategic plan (by design to encourage basic innovation research) but the senior staff must carefully determine those projects that should fit

into the strategic plan and assure that the direction and priorities of the projects meet the strategic goals and schedules.

2. In your testimony you warn that "ad hoc" studies may distract from the mission and vision of the agency. What evidence did the VCAT see that suggested this possible problem?

RESPONSE: The VCAT believes that NIST is significantly under funded in many areas relative to the importance of measurement science to the US Economy and National Security. Project "initiatives" that are funded at a base level to get a technology program launched too often languish due to lack of funds in subsequent years. VCAT has consistently urged NIST to implement a stronger strategic planning process and they have made good progress in this area. A good strategic plan has goals and milestones of scientific accomplishment which industry depends on to be achieved. Diversions of resources and funds to "ad hoc" programs, however important, can impede ongoing programs that have critical strategic and economic importance. The VCAT has observed that NIST receives many "assignments" from Congress and the Executive Branch, including OMB that can take people and resources away from NIST's planned research programs. The point I was making in my testimony is that Congress and the Administration need to be aware of the potential for those assignments to distract from already agreed upon priorities, especially when additional resources are not provided in order to accomplish those tasks. For example, NIST has received numerous IT-related assignments that pertain to how federal agencies can improve the effectiveness and security of their operations. The World Trade Center Disaster and the Voting system and standards are other examples. Even when additional funds are added for these types of projects, NIST may spend significant portions of their normal research funds to complete these important ad hoc projects. I should emphasize that we believe, in most cases that NIST is the appropriate organization for these research projects to be undertaken due to its measurement research expertise. However, they do have an impact on the effective implementation of their strategic programs and plans. Unless the agency receives funding to perform this work, its research-oriented priorities will suffer.