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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. I am 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. Upon retirement in 1999, I founded two companies, an information technology and a technology consulting firm, also 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 as 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, VCAT created 3 subcommittee as allowed by its charter, in order to more thoroughly explore and understand NIST's activities, competencies, organizational effectiveness and alignment with the industry segment "voice of the customer". The subcommittees were Healthcare/Bioscience, Information Technology, and Nanotechnology. The VCAT 2007 annual report provides the foundation for my testimony in this hearing.

I have been asked to address several topics regarding VCAT's interaction with NIST and its staff:

- VCAT assessment of the NIST 2009 proposed budget including the alignment of budget priorities with technology investments that NIST should be pursuing
- The VCAT perspective on NIST's strategic planning and priority setting process including VCAT's role in the processes
- VCAT assessment of the Three-year Programmatic Plan
- NIST's cross-organizational processes to ensure strategic synergy in multi-disciplinary fields

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 being able to measure and identify 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 Tassey, 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 also world class for a wide variety of disciplines and this 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 our 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 considerable 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 Healthcare/Bioscience. NIST needs to be aggressive in finding new ways 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 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 record, 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 the reveal computing and communications capacity, security, compliance and reliability. The US is lagging in broadband capacity and better data is needed on national access and use of high capacity data communication capabilities.

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 20s, they 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 NISTresearch 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 included 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. 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 Nanofab 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. 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 with 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 the clarity of its 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.

Overall, the Three-year Programmatic Plan represents an excellent and 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.

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 lead 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

The committee agrees 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, however we do not 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?
- What 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. Some of the VCAT committee members 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:

As stated previously, 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 in part to the lack of sufficiently clear links between strategy, programs and prioritization processes, and in part to VCAT agenda content and time allotted for NIST staff and VCAT member interactions. 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 manage external influences and requests carefully.

It is a 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 critical 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 effectiveness in serving their customer. 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 organizational 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 numerous examples of cross department coordination and the creation of external partnerships to gain access to 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).

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 American Chemical Society
- 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 Nation 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)