VISITING COMMITTEE ON ADVANCED TECHNOLOGY (VCAT)
MINUTES OF THE OCTOBER 16-17, 2012, MEETING
BOULDER, CO

ATTENDANCE:

Visiting Committee Members Attending
Cerf, Vinton
Chowdhry, Uma
Haymet, Tony
Holt, William
Kerr, Karen
Kheradpir, Shaygan
Khosla, Pradeep
Padovani, Roberto
Solomon, Darlene
Taub, Alan

VCAT Exec. Dir.
Ehrlich, Gail

NIST Leadership Board/Designee
Boehm, Jason
Brockett, Del
Celotta, Bob*
Dimeo, Robert
Fiotes, Stella
Gallagher, Patrick
Harary, Howard
Kayser, Rich
Kelley, Michael
Kimball, Kevin
Locascio, Laurie
Olthoff, James
Romine, Chuck
Singerman, Phillip

NIST Staff
Allocca, Clare*
Arrisueno, Gladys
Averill, Jason
Briggman, Kim
Cavanagh, Richard
Evans, Heather
Fraser, Gerald
Hardis, Johnathan*
Hight-Walker, Angie*
Jillavenkatesa, Ajit*
Migler, Kalman*
Miller, Cameron*
O'Brian, Tom
Orr, Dereck
Ost, Laura
Shaw, Stephanie
Wilson, Perry
Wineland, David

Others
Jain, Kanti – National Research Council
Reed, Travis* -- Lewis-Burke Associates LLC, Government Relations
Rogers, Kenneth – Former Commissioner of the Nuclear Regulatory Commission
VanSchalkwyk, William – Massachusetts Institute of Technology
Webber, Naomi* – Lewis-Burke Associates LLC, Government Relations

Participated by Webinar

Call to Order – *Dr. Vinton Cerf, VCAT Chair*

Dr. Cerf called the meeting to order at 9:30 a.m. and pointed out the emergency exits. He announced that his membership term expires on March 31, 2013 which will result in a vacancy for the Chair, and called for nominations. The election for the interim chair will take place at the February 2013 meeting.

Agenda Review and NIST Update – *Dr. Patrick Gallagher, Under Secretary of Commerce for Standards and Technology and NIST Director*

Presentation Summary – After welcoming the members to the Boulder laboratories, Dr. Gallagher spoke about NIST's fourth Nobel Laureate, Dr. Dave Wineland, recognized for his "ground-breaking experimental methods that enable measuring and manipulation of individual quantum systems." The award ceremony will be held on December, 10, 2012. Another prestigious award, the Samuel J. Heyman Service to America Medal, was presented to NIST physicist Jacob Taylor on September 13, 2012, for his work in quantum information and quantum communications.

With respect to the budget, Dr. Gallagher noted that NIST is currently operating under a Continuing Resolution for Fiscal Year (FY) 2013 at the FY 2012 level and reviewed the House and Senate marks for the FY 2013 President's budget request. The FY 2013 budget request includes $1 billion in mandatory funding for the National Network for Manufacturing Innovation (NNMI) and $300 million for the Wireless Innovation Fund. Both of these increases require separate legislation. NIST submitted the FY 2014 budget request to the Department of Commerce (DOC) and has started planning for the FY 2015 budget.

Four program updates were provided. Dr. Gallagher described how the Smart Grid effort has matured and summarized NIST's role in the new tax-exempt, not-for-profit fully private entity, Smart Grid Interoperability Panel 2.0, to begin on January 1, 2013. He also provided the status of the SHA-3 Cryptographic Hash Algorithm competition in which five finalists were announced. In addition, he reviewed the purpose and funding of National Cybersecurity Center of Excellence (NCCoE) which has secured space at the University of Maryland's Shady Grove campus as a vehicle for the NIST cybersecurity program to work more closely with industry. The NCCoE is currently exploring a Federally Funded Research and Development Center (FFRDC) as a possible governance structure. Lastly, Dr. Gallagher summarized the three parts of the National Strategy for Trusted Identities in Cyberspace (NSTIC) effort and noted the five organizations that received over $9 million in the first set of pilot awards in support of the NSTIC.

Turning to new issues, NIST is in the planning stages with DOC to create a Center for Advanced Communications Technology. This Center will provide unique infrastructure available to Government and industry partners for the testing research, and standards capabilities needed to address spectrum sharing and other advanced communication technology challenges.

Dr. Gallagher remarked that the VCAT should become familiar with NIST's entire manufacturing portfolio which includes the laboratory programs, the NNMI, the Advanced Manufacturing Technology Consortia (AMTech), the Baldrige program, and the Manufacturing Extension Partnership (MEP) which is moving from competitiveness toward innovation and growth.

Two significant organization changes have occurred at NIST since June. Del Brockett, the former NIST Chief Information Officer, is now the Acting Associate Director for Management Resources. Katharine Gebbie, the Director of the Physical Measurement Laboratory, has announced her intention to retire and the recruitment process for her successor is underway.

Another new issue is the Business of NIST, a campaign to address the transformation of NIST business practices involving fund transfers for acquisitions, grants, and interagency agreements; revision of the NIST working capital fund collection to provide a budget for indirect funded activities; and a new budget planning process for indirect accounts and new service level agreements for programs. NIST plans to begin making these changes in FY 2013 and is in the process of recruiting a senior executive level head of Acquisitions, Grants, and Agreements. This transformation will involve all of NIST, not just the servicing organizations.

Lastly, Dr. Gallagher reviewed the meeting agenda. He agreed that the members of the VCAT Subcommittee on Safety could visit Building 2 instead of the tour of the Precision Measurement Laboratory at the end of the day.

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For more details, see Dr. Gallagher's presentation.

Discussion Summary – The group discussed the following topics:

- The not-for-profit spinoff of the Smart Grid Interoperability Panel is unusual in the standards arena especially at this scale, and represents a major achievement by George Arnold.
- An attack on the new SHA-3 algorithm is remote.
- NCCoE – With regard to the NCCoE, an FFRDC can draw on multiple funding sources. Historically, neither NIST nor DOC have engaged in FFRDC so an analysis is underway to determine if this is the right vehicle to operationalize the NCCoE to work best with industry and to provide additional flexibilities in meeting the goals of the NCCOE.
    - The initial ad hoc space for the NCCoE is a shared facility with the University of Maryland, but the actual location will be open for competition.
    - Some members expressed concerns that industry cannot wait until 2015 for an off-campus concentration of capability and that there are some basic burning issues which need to be addressed now.
- Business of NIST – NIST recognizes the importance of reintegrating the mutual accountability between the programs and the servicing organizations.
    - Some type of ticketing capability for all of NIST transactions would be a big asset.
    - There have been a lot of internal and external reviews of NIST operational processes that have resulted in a list of problem areas, rather than actionable plans to move forward involving the whole organization. Although the staff agrees that problems exist, they have different understandings of the level of the problems.
    - NIST may want to consider a social networking tool to help the staff solve these problems.
    - Metrics are an important part of the initial approach. To be most beneficial, the metrics for the programmatic staff and the service organizations should point to each other, reflecting a shared strategy and approach.

Review Activities of the VCAT Subcommittee on Safety – *Dr. Tony Haymet, Chair, VCAT Subcommittee on Safety and Mr. Bill VanSchalkwyk, Technical Expert*

Presentation Summary – In his introductory remarks, Dr. Haymet noted that the VCAT Subcommittee on Safety, which met in Boulder on October 15, 2012, should be considered as a third review in a series of intensive investigations of NIST safety and its safety culture. The first review was conducted by the Blue Ribbon Commission on Management and Safety (BRC) I in response to a serious safety incident in the Boulder laboratories. In the fall of 2008, the BRC I met in Gaithersburg and then in Boulder four years and eight days ago following a serious safety incident in the Boulder laboratories. Dr. Haymet was a member of the BRC II which convened in the fall of 2010.

As a member of the BRC I and BRC II, Mr. VanSchalkwyk summarized their findings. Mr. VanSchalkwyk is the Managing Director for Environmental Health and Safety Programs at the Massachusetts Institute of Technology and also served as a technical expert to the VCAT Subcommittee on Safety. The purpose of the BRC I was to evaluate the safety programs at NIST. In November 2008, the BRC I issued a stark report with key conclusions: safety was not a core value at NIST; safety was not integrated into operations; NIST had not benchmarked safety performance; NIST safety resources are inadequate; and the NIST staff was eager, willing, and ready to embrace a safety culture. Awareness of safety metrics and data was also low. NIST's response to these recommendations was refreshing and strong. The NIST leadership recognized the need to create roles with responsibility for safety and to increase resources. Most important, participation in safety performance was beginning to be seen as everyone's responsibility and NIST set out to create a Safety Management Program. In the BRC II's review in the fall of 2010, they found the beginnings of a credible Safety Management Program with a two-pronged effort where there was lots of desire from the bottom up as well as the top down.

Dr. Haymet reviewed the three high-level recommendations from the BRC II and remarked that the VCAT Subcommittee on Safety believes that the NIST management had responded well. First, Willie May was appointed as the Associate Director for Laboratory Programs. Secondly, the Subcommittee did not detect an enthusiasm gap in senior management. Lastly, there has been a solid effort to establish an audit mechanism but it is still a work-in-progress. Dr. Haymet congratulated everybody at NIST for a job well done over the past four years.

Now that NIST has begun to collect data, the Subcommittee is concerned that the Occupational Safety and Health Administration (OSHA)-reportable incidents are too high and are not changing over time. Also, there are some peer institutions that have better safety statistics than NIST.

Dr. Haymet summarized five possible recommendations from the Subcommittee and emphasized that these may change. These recommendations cover the need for senior trained NIST executives to frequently walk around and audit individual laboratory rooms; the need for NIST to set targets for reducing each OSHA recordable statistic; the need to distribute and discuss the Incident Reporting and Investigation Statistics (IRIS) with everyone at NIST; the need to know where hold-ups occur in non-closed IRIS cases; and the need to address ergonomic factors.

In closing, Dr. Haymet noted that the Subcommittee heard a few service-related safety problems from some of the NIST staff and acknowledged the staff for being so frank.

For more details, see Dr. Haymet's presentation.

Discussion Summary – The VCAT Chair remarked that the Subcommittee meeting was very productive and that the NIST Director should be given a lot of credit for creating an atmosphere for his staff to be so candid.

Visit by David Wineland 2012 Nobel Laureate in Physics

Dr. Tom O'Brian, Chief of the Time and Frequency Division and the Quantum Physics Division, Physical Measurement Laboratory, introduced Dr. David Wineland, winner of the 2012 Nobel Prize in Physics with Serge Haroche of the College de France. He won the Nobel Prize for "for groundbreaking experimental methods that enable measuring and manipulation of individual quantum systems" which basically means quantum state engineering. Some of this groundbreaking work is relevant to atomic clocks and Dr. Wineland's team has the two best atomic clocks in the world using different technologies: quantum computing, quantum simulation, and extremely précised quantum-based measurements. Dr. O'Brian noted how gratifying it is to be able to work with Dr. Wineland and NIST's other laureates: Jan

Hall, Eric Cornell, and Bill Phillips. Their work is not only at the absolute cutting edge of science and technology but has direct applications to NIST's measurement science mission.

After a long applause, Dr. Wineland described his Nobel-prize winning work and noted that the last few days have been an "overwhelming experience." He acknowledged the support and great work of his colleagues that led to this Prize. Dr. Wineland remarked that his experience at NIST has been "really great" and described his initial work at NIST in 1975. In 1977, he started the Ion Storage Group to work in laser cooling and the original four core individuals are still together. Although it will be a long time until a useful quantum computer will be developed, some of the basic ideas developed for quantum information and quantum computing are now being used in atomic clocks. Physicists are most interested in using a smaller quantum computer to simulate other quantum systems of interest, which may come to fruition in the next decade.

Discussion Summary – Relatively standard lasers were used to manipulate the atomic ions but there was a lot of innovation to develop the ion traps used to hold the atomic ions. The lithographic facilities at NIST were used to help fabricate these ion traps.

NIST on a Chip: Revolution in Measurement Services – *Dr. Thomas O'Brian, Chief, Time and Frequency Division and Quantum Physics Division, Physical Measurement Laboratory (PML), NIST*

Presentation Summary – NIST on a Chip is a revolution in measurement services as well as measurement science which makes use of very small devices which bring the precision of quantum-based measurements in most cases out of the NIST laboratory and into the customer's lab. The NIST on a Chip is an integrated program to develop and deploy NIST-traceable measurements and physical standards that are deployed in the customer's lab, factory floor, device, or system; easily used and integrated due to their small size, weight, low power consumption, and ruggedness; provide a broad range of measurements and standards relevant to the particular customer needs or applications; and manufacturable with the potential for production costs low enough to enable broad deployment. For example, chip-scale devices could help with quality control on traditional assembly lines or in advanced biomanufacturing. Eventually, these devices could be built into applications, such as jet fighters for continual calibration of their complex avionics. With lower production costs, these devices could be used in more consumer-oriented products, such as automobiles. Looking forward, the NIST on a Chip capability could actually enable future products, such as nanosatellites.

NIST traditional measurement services were compared to NIST on a Chip. Although NIST has been providing critical measurement needs as efficiently and effectively as possible for many years through traditional measurement services, there are some limitations, including customer downtime, expense, periodic recalibrations, and limited range of available calibrations and measurements. With NIST on a Chip, the customer has 24/7/365 access to a NIST-traceable standard; no need for periodic recalibration; and potential for much broader and more flexible range of measurements and standards.

Turning to how realistic is NIST on a Chip, Dr. O'Brian remarked that this program is quite likely to succeed and provided examples of remote services to show how NIST is already making substantial progress in realizing each of the four key areas: 1) remote deployment; 2) small size, low power, and rugged; 3) broad range of measurements; and 4) manufacturability. These examples include the quantum voltage standard, NIST chip-scale atomic clocks and magnetometers, a sampling of NIST on a Chip measurement technologies that are in a proof-of-concept phase, and commercialization of the chip-scale atomic clock by Symmetricom and other companies. Symmetricom began selling the first commercial chip-scale atomic clock in January 2011, based on NIST's demonstration of the technology in 2004. These commercial clocks are also being built into third party applications, such as a GPS receiver board. Substantially more work is needed for fundamental measurement science, integration of multiple

measurement technologies, and manufacturability. With sufficient resources, planning, coordination, and external partnering, there is a high likelihood of a successful NIST on a Chip. The "Lab on a Chip" which includes chemical, biological, and biomedical type measurements using microtechnology will be a crucial part of the NIST on a Chip program.

NIST should carry out this program for many reasons. As the nation's measurements and standards laboratory, NIST's mission is to provide measurements and standards enabling innovation and productivity. NIST also has world-leading scientists in measurement science; unique capabilities in micro/nanofabrication for precision measurement technology through the NIST Center for Nanoscale Science and Technology and Boulder's new fabrication facility and the Precision Imaging Facility; expanded roles in manufacturing; and success in convening broad external partnerships. In addition, NIST's recent Three-Year Programmatic Plans call for NIST to improve the development and delivery of measurement services; drive innovation through measurement; develop and deliver measurement science tools that will support advanced manufacturing; and accelerate technology transfer and commercialization. Lastly, a National Research Council panel evaluated NIST's manufacturing-related programs and its report highlights the importance of the rice-size atomic clocks to nanomanufacturing.

Dr. O'Brian provided examples of current and developing NIST on a Chip measurement technologies, emphasizing that these examples are only a small sample of current NIST technologies. He also discussed efforts toward the potential integration of measurements so that a single package can provide many measurements simultaneously.

In addition to providing new measurement services, the NIST on a Chip will drive new measurement science based on unique measurement and technologies resulting from microscale interactions. Initial applications are likely to be NIST Chips performing a single measurement or a few closely related measurements. Functionality will continue to grow over the longer term. Adoption will initially be for high-value applications where cost is not an important factor. Manufacturing improvements are expected to bring about broader adoption and deployment.

NIST is not planning to eliminate its traditional measurement service model; however, over time, many of these services would be replaced by NIST on a Chip. This would free up NIST resources to be redirected to other programs to expand the frontiers of measurement science and provide better services to customers.

A preliminary idea for the NIST on a Chip program is a vertically integrated three-tiered program with fundamental measurement science as the base; the development, integration, and manufacturability of new NIST on a Chip technologies as an intermediate step; and the deployment of NIST on a Chip technologies at the top level. This program would span all NIST laboratories, rely on NIST's fabrication facilities in Boulder and Gaithersburg, and strengthen and expand existing external partnerships, including the possibility of a future Center of Excellence. Next steps include holding an internal NIST workshop in Boulder in November to help inventory NIST on a Chip technologies, brainstorm new approaches, and develop preliminary recommendations to NIST senior management on the NIST on a Chip program. A public workshop would also be held to better clarify needs and partnerships to develop a more complete set of recommendations for NIST senior management.

Lastly, Dr. O'Brian asked the VCAT's advice on a few business model issues, such as commercialization of these products, external partnerships and technology transfer, and licensing. He also presented his opinions about the program, including the need to ensure that "bottoms up" ideas are carefully considered. The final two slides listed eight questions where the VCAT's advice and guidance would be helpful.

For more details, see Dr. O'Brian's presentation.

Discussion Summary – The group discussed the following topics:

- The patents associated with the chip-scale atomic clock reside in the public domain.
- NIST may want to think more broadly by examining the competitive landscape from other laboratories and entities involved with measurements on a chip to identify and map NIST's unique niche within those application areas based on NIST's mission and capabilities.
- NIST may want to consider the opportunity to provide measurements that are "just enough" for other applications rather than the highest quality and most precise measurements.
- Can NIST prevent Fraud on a Chip?
- The current competition and landscape for chip-scale measurements in the chemical and biological arena are more involved with general analysis and detection rather than precision physical measurements. NIST plans to bring a combination of its unique measurement technology and ability to take big risks to the current landscape.
- NIST's business model could be a hybrid where only some chips are manufactured at NIST especially those of high value but only a small quantity are needed throughout the world.
- An important measurement service issue is the traceability to NIST especially for business decisions involving commercialized products.
- One VCAT member cautioned against focusing on the business case for monetizing rather than on the significant impact that the NIST on a Chip could have on innovation.
- NIST may want to engage in more field trips to industry to identify their needs.
- In selecting areas for the NIST on a Chip, NIST may want to identify the chief use cases for improving the quality of life and health care.
- The NIST on a Chip design could be used for quantum gravity measurements in the future, but not in the next ten years.
- The VCAT Chair suggested that Dr. O'Brian give this presentation at the Technology, Entertainment, and Design (TED) Conference to highlight what can be done with this technology rather than how it works.

NIST Chip-Scale Atomic Device Program – *Dr. Thomas O'Brian, Chief, Time and Frequency Division and Quantum Physics Division, PML, NIST*

Presentation Summary – The NIST Chip-Scale Atomic Device Program is a collaboration across NIST but most of this program's work and vision falls under the Time and Frequency Division's Atomic Devices and Instrumentation Group led by John Kitching. The NIST Chip-Scale Atomic Clock (CSAC) and the NIST Chip-Scale Atomic Magnetometer (CSAM) were developed under this program. Several artifacts were passed around.

Dr. O'Brian explained the motivation for the CSAC, emphasizing that atomic-clock quality timing and synchronization underpin a broad range of technologies and infrastructure including GPS, telecommunications, and power distribution, and that many of these applications would benefit from a device in the field that could make accurate measurements with atomic-clock-timing. DARPA was stimulated by NIST's pioneering demonstrations and follow-up workshops on ultraminature atomic clocks. In 2002, DARPA started the CSAC program by funding NIST to perform fundamental research and metrology and funding a few companies to perform manufacturable demonstrations. NIST focused on coherent population trapping as a new approach and used commercial off-the-shelf MEMS and microfabrication techniques to show that the device could be manufacturable, in principle, through wafer-level assembly. The atomic vapor cell technology used in this process was pioneered by NIST. In 2004, NIST demonstrated the world's first chip-scale atomic clock with an initial performance of 10^{-11}, the

Stratum 1 telecom standard, and later improved to a 10^{-12} uncertainty. Several manufacturers built on the NIST's demonstration technology. Symmetricom commercialized the first CSAC in January 2011. The current cost of these CSACs is about $1,000 and likely to decrease.

A natural outcome of the CSAC was NIST's development and demonstration of the world's first CSAM in 2005. Its performance has rapidly improved by a factor of five magnitude to rival the best in the world Superconducting Quantum Interference Device (SQUID).

NIST is now engaged in a follow-on program with a broad range of chip-scale sensors. Some of the current research directions are zero-field nuclear magnetic resonance (NMR) for "remote" chemical analysis and zero-field magnetic resonance imaging; biomagnetic field measurement arrays for diagnostics/imaging on the head, brain, and muscles, as well as brain/machine interface; and NMR gyroscopes and accelerometers. This work serves as a feasibility demonstration of NIST on a Chip, and Dr. Kitching is currently at a meeting at DARPA discussing some of these applications.

Lastly, Dr. O'Brian remarked that this program does very effective technology transfer through its more than than130 scientific publications, 8 patents, dozens of conferences and workshops, and training of dozens of postdocs and graduate students. In addition, the individuals involved with this program have received multiple national and international scientific awards. There continues to be on-going interest and funding in this program from other Federal agencies.

For more details, see Dr. O'Brian's presentation.

NIST Centers of Excellence – *Dr. Jason Boehm, Director, Program Coordination Office, NIST*

Presentation Summary – Dr. Boehm provided an update on the NIST Centers of Excellence (CoE) proposed at $20 million in the President's FY 2013 budget. As context for this initiative, NIST has demonstrated very effective partnerships with academia and industry with different operating models to help leverage its resources and expertise. These partnerships include JILA, the Joint Quantum Institute, the Hollings Marine Laboratory, the NIST Manufacturing Extension Partnership, and the Institute for Bioscience and Biotechnology Research.

The goal of this proposed program is to create multidisciplinary centers that complement and extend U.S. measurement capabilities in critical areas of emerging technologies. There is strong support for this initiative in the House and the Senate; however, the current Continuing Resolution will delay this program. In preparation for this program, NIST is working with the Institute for Defense Analyses Science and Technology Policy Institute to prepare a trend analysis to help identify emerging technology areas and soliciting the NIST laboratories for potential CoE ideas. Dr. Boehm shared a partial list of potential topic areas under discussion with the NIST laboratories. These include big data, quantitative biology, and complex systems.

The CoE's key objectives are to: 1) assist NIST in meeting is mission needs in new or expanding areas of strategic focus, and provide expanded opportunities for NIST to engage with industry and entrepreneurs; 2) enhance technical innovation through earlier alignment of measurement science in new areas of research and technology; 3) foster and facilitate the expanded development of measurement science expertise for students and early-career scientists and engineers; and 4) expand NIST's strategic foot print so that NIST is located in several communities across the United States.

There are numerous potential roles for a Center. Some of these roles include the ability to leverage resources of pre-existing hubs of institutional/regional expertise in areas of science and technology that are aligned with the long-term strategic needs of NIST; utilize and leverage existing NIST facilities;

provide environments or frameworks for multidisciplinary or multiorganizational collaborations; enable closer engagement with industry and entrepreneurs; enable greater knowledge transfer through co-location of researchers; improve diversity in topical areas and geography; and include under-represented groups working at NIST.

Lastly, Dr. Boehm explained why flexibility is critical when constructing a center. A center must be tailored to best address the challenge. NIST is considering a number of different business models. A center may be a long-term collaboration with an academic institution similar to JILA; a more problem focused multi-stakeholder collaboration similar to the NCCoE; or a user facility model similar to the Center for Nanoscale Science and Technology. NIST is leaning toward issuing a call for centers to compete in a number of areas.

For more details, see Dr. Boehm's presentation.

Discussion Summary – The group discussed the following topics:

- With regard to sustainable funding, NIST might make awards for five to seven years, and then build on other modes of support depending on the center's performance. NIST intends to have a long-standing commitment with each of the centers.
- NIST on a Chip is one of many center ideas submitted by the laboratory directors. Some of these ideas could be considered for internal funding. NIST may want to consider DARPA's Metal Oxide Silicon Implementation System (MOSIS) as a model for pursing NIST on a Chip rather than a CoE.
- Each of the potential topic areas is important; however, to help the selection process, the strategic benefit of each area should be clarified. It is important to know which areas can have the most leverage going forward.
- The NIST laboratories have been identifying gaps as targets of opportunities for the centers as reflected on the list of potential topics, but the entire list was too long for one slide.
- Technology transfer is also an important role of a center.
- The organizational design of a center must be flexible and will depend on the strategic goal and the competitive process. Many different partnering options exist ranging from traditional models to new models not used by NIST.
- The purpose and focus of the CoE was elaborated. The focus of the COE is to amplify NIST's laboratory intramural activities via partnerships, which is a very different and distinct focus than the extramural programs. The CoE was designed to strengthen the NIST laboratory mission and provide new tools to make its mission more effective.
- Congress and the Administration understand that the CoE is clearly focused but is designed to have an entrepreneurial flexibility for structuring partnerships that add the most value in a needed area.
- A VCAT member noted the importance of separating the prioritization of high-level strategic areas from the mechanism for augmentation.

NIST's Unique Role in Intramural Technology Transfer – *Dr. Phillip Singerman, Associate Director for Innovation and Industry Services, NIST*

Presentation Summary –NIST has a unique role in federal technology transfer policy. These activities include the policy coordination and promulgation of technology transfer regulations; chair of the Interagency Work group for Technology Transfer; support to the Federal Laboratory Consortium as mandated by statute; and the traditional role of preparing two annual reports for the President, Congress, and the Office of Management and Budget (OMB) on utilization of technology transfer by DOC and across all agencies. These two reports cover traditional metrics such as disclosures, patents, patent applications, licenses, and Cooperative Research and Development Agreements (CRADAs).

NIST's role was broadened under the Presidential Memorandum, "Accelerating Technology Transfer and Commercialization in Support of High-Growth Businesses" issued on October 28, 2011. This memorandum identified a number of goals and tasks for federal agencies. Each federal agency with intramural research was required to prepare five-year plans to improve the rate of technology transfer, including goals and metrics. NIST was explicitly called out to lead the development of metrics and to identify opportunities for improving technology transfer by convening and leading the Interagency Workgroup for Technology Transfer. In addition, the NIST Director convened a NIST senior management leadership policy committee to develop the agency's five-year plan and define the full range of NIST's technology transfer mechanisms. Dr. Singerman summarized the work of this Committee and noted that it recognized that technology transfer is not defined just by the traditional and narrow metrics of patenting and licensing, but includes various mechanisms that NIST researchers use to disseminate their work with significant impacts to society and the economy, such as Standard Reference Materials, Standard Reference Data, and accreditations.

To illustrate the diversity of technology transfer in the NIST laboratories, Dr. Singerman reviewed several graphs covering the number of patents, CRADA metrics, Facility Users, Research Participants, and intellectual property metrics. With regard to the development of new technology transfer metrics for use across the government, agencies are beginning to report on the number of licenses granted to small businesses and the number of start-up companies created.

In closing, Dr. Singerman remarked that NIST is now an exemplar of good technology transfer and that its analysis of the issues stands out among other federal agencies. Each of the agencies' multi-year plans will be available on the NIST website.

For more details, see Dr. Singerman's presentation.

Discussion Summary – The group discussed the following topics:

- Are patents and CRADAs being used to promote or inhibit commercialization? Although the Stevenson-Wydler Technology Innovation Act lays out the requirements on how the federal government is to use patents, the Work Group is looking at the best approaches for getting the technology commercialized and widely disseminated. The goal is to broaden the toolbox to include more than patents.
- Decisions regarding licensing a patent for free to U.S. companies but for a fee to foreign companies is expected to be a big policy issue going forward. The boundary between creating and protecting information needs to be addressed.
- The use of the Federal Register to publish licensing information was summarized.
- NIST may want to consider segregating its external metrics provided to stakeholders from its internal metrics which are used to drive behavior. Metrics that leverage commercialization by industry are important.
- Building a network of innovation across the U.S. to trigger the passion and imagination of younger people would be a huge leverage.

NIST's Portfolio of Programs in Advanced Manufacturing – *Dr. Patrick Gallagher, Under Secretary of Commerce for Standards and Technology and NIST Director*

Presentation Summary – In response to some confusion that NIST only focuses on manufacturing through its new proposed programs, the motivation for this talk is to reinforce and articulate the fact that NIST has a portfolio of programs in advanced manufacturing with different roles. The portfolio consists of five programs. These are the NIST Laboratory Programs, the Hollings MEP, the Baldrige Performance Excellence Program which was erroneously omitted from the slide because it is no longer supported by

Federal funds, and the proposed AMTech and proposed NNMI. Although operating with outside funding, the Baldrige program has a clear role in manufacturing and large companies are still actively engaged, particularly through the Baldrige Executive Fellows Program.

The NIST laboratories address manufacturing needs by providing measurement science and standards services, interoperability standards and tools, unique facilities that involve a much larger industrial participation than its U.S. counterparts, and technology and knowledge transfer. The NIST laboratories play a role in the development of new materials, new processes, and new methods as well as the market adoption side of manufacturing. The emerging areas with NIST laboratory investments are biomanufacturing, nanomanufacturing, advanced materials modeling and simulation, smart manufacturing and cyberphysical systems, and energy efficiency and sustainability.

The MEP was designed specifically as a partnership program with states and regions to provide services that support small and mid-size manufacturers. Dr. Gallagher remarked that MEP is remarkably successful in that context and is now undergoing a reinvention focused on next-generation MEP strategies in support of innovation. MEP could help leverage small and mid-size manufacturers engagement in AMTech and the NNMI.

There may be an issue with AMTech's scale of funding and the desired impact. One possibility to address this issue is for AMTech to get some leverage from the NIST laboratory programs in working with industry consortia to tackle shared problems. The VCAT may be asked for their advice on this pending issue. In contrast, the NNMI is concerned with creating an R&D infrastructure around a particular problem or issue and is not focused on NIST's activities. The NNMI was assigned to NIST instead of a larger mission-focused agency because of its broader view of opportunities from a national perspective.

For more details, see Dr. Gallagher's presentation.

Discussion Summary – The group discussed the following topics:

- The confusion over NIST's programs in manufacturing is coming from the Hill as well as public comments regarding the NNMI. For example, questions have been raised regarding duplication between the NNMI and the MEP.
- Modeling and Validation – NIST has an important role in developing and validating models as well as providing on-line resources to help others carry out simulations and tests, particularly in support of the Materials Genome Initiative. The Material Measurement Laboratory and the Information Technology Laboratory (ITL) are close partners in the Materials Genome Initiative effort and NIST intends to collaborate with the communities of interest outside of NIST in carrying out activities ranging from web- based validation of models, web-based databases, and experimental design modeling.
    - The definition of "traceability" is different from "validation." NIST has already done extensive validation and verification of some existing models which have led to their greater utility for the community.
    - ITL has a major program that addresses the computational issues associated with metrology.
    - A VCAT member remarked that NIST has pioneered a lot of the molecular modeling that is now routine.
    - NIST is exploring ways to have its tools available on cloud-based systems.
- Should consortia members of AMTech include large companies as well as the suppliers to foster a pre competitive collaboration? As an example, SEMATECH's successful operations were summarized whereby the companies could provide common input to the suppliers.

- A major issue within the Administration and the manufacturing community is how to reenergize the U.S. supply chain.
- If AMTech does not receive an adequate budget, NIST will not use the laboratory resources to fund this new program.
- With regard to the NNMI, the characteristics of the "network" are still being determined. An explicit topic in the public comments and workshops address the functionality of the network component of the Institutes. NIST does not want to overdesign the Institutes since they will be required to be self-sustaining after six years.

Review of the Manufacturing-Related Programs at NIST, Summary of the Report by the National Research Council (NRC) Panel of the National Academies – *Professor Kanti Jain*, Chair, NRC Panel

Presentation Summary – As part of his introductory remarks, Dr. Gallagher noted that Dr. Kanti is chair of the NRC panel that reviewed NIST manufacturing-related programs and a professor of electrical and computer engineering at the University of Illinois at Urbana-Champaign. In contrast to past NRC reviews which have been done by organization, NIST requested that the review of manufacturing-related programs be a crosscut assessment due to the timeliness and urgency of this topic. Although this was a very broad crosscut theme, Dr. Gallagher remarked that NIST was delighted with the outcome of the report.

Dr. Kanti acknowledged that this review was very challenging due to the broad scope of manufacturing. The 14 NRC panel members represented broad expertise in various areas and a broad range of institutions in industry, academia, industry, and government. The scope of the review included manufacturing research at NIST broadly, with an emphasis on three specific advanced manufacturing areas: 1) nanomanufacturing; 2) smart manufacturing; and 3) next-generation materials measurements, modeling, and simulation. The panel was charged with assessing the technical merit and scientific caliber of NIST's manufacturing programs, the efficacy of NIST's engagement with outside stakeholders, and the coordination and cohesion across NIST of programs in the specific advanced manufacturing topics.

Dr. Kanti described the key findings in each of the three topic areas followed by an overall summary. Overall, NIST is a national asset because of its world-class equipment and facilities, and highly qualified researchers who are among the best in the world. However, project selection needs improvement with greater attention to industry need, manufacturability, and commercial potential. Also, programs give the appearance of a collection of projects. Program metrics should be more quantitative and industry interactions should be expanded with more visits to companies and greater awareness of industry practices. Coordination across the NIST laboratories seems ad hoc and informal, and greater benefits would be realized with structured coordination. Lastly, NIST deserves more national visibility for its technical and scientific capabilities and accomplishments.

In conclusion, Dr. Kanti noted the impact of NIST contributions on manufacturing. Because the vast scope of manufacturing encompasses a wide array of disciplines, systems, applications, and environments, NIST's contributions impact the U.S. in a multitude of ways. As a result of its highly qualified researchers and advanced facilities that are a national asset, NIST is uniquely qualified to support U.S. manufacturing broadly. Perhaps in recognition of these capabilities, NIST was accorded the leading role for the Advanced Manufacturing National Program Office.

To view the key findings in each of the topic areas and other details from this talk, see Dr. Jain's presentation.

Discussion Summary – The group discussed the following topics:

- Industry statements that attest to the benefits of NIST work to their company are valuable and can serve as a powerful metric for the manufacturing programs.
- NIST was surprised by the panel's critique of the Smart Manufacturing activities with respect to its research lagging behind industry's needs and its stakeholder engagement. NIST has been highly engaged with the Additive Manufacturing Consortium and is also playing a key role in leadership and technical contributions to a new ASTM standards committee in additive manufacturing.
- Since consortia usually deal with the lowest common denominator in order to meet the non-competitive needs of all of its member companies, it is also important to also engage directly with individual companies through visits to their sites. Both forms of engagement are needed.
- To help balance the different needs across industry in selecting priorities and projects, NIST looks for broad enablers as the focal point and identifies those gaps.
- Project selection criteria should involve the needs of small businesses, as well.
- NIST will invite the appropriate NRC panel members to provide input to the VCAT's future studies, as needed.

Update on the Administration's Advanced Manufacturing Initiatives – *Dr. Phillip Singerman, Associate Director for Innovation and Industry Services, NIST*

Presentation Summary – In his opening remarks, Dr. Singerman noted that the President mentioned "manufacturing" and "advanced manufacturing" several times in his October 16, 2013, Town Hall Meeting. Dr. Singerman summarized the recommendations of the Advanced Manufacturing Partnership (AMP) Steering Committee Report, the accomplishments of the Advanced Manufacturing National Program Office (AMNPO), and the status of the NNMI public design efforts.

The AMP Steering Committee, comprised of representatives from major corporations and research universities, prepared a detailed report entitled, *Capturing Domestic Competitive Advantage in Advanced Manufacturing*, which was released and adopted by the President's Council of Advisors on Science and Technology in July 2012. The report grouped its 16 recommendations into three categories: 1) enabling innovation; 2) securing the talent pipelines; and 3) improving the business climate. Under enabling innovation, Dr. Singerman highlighted the recommendations for establishing a National Advanced Manufacturing Strategy to be coordinated by the AMNPO in close collaboration with industry and academia, establishing partnerships in top cross-cutting technologies, and establishing a network of Manufacturing Innovation Institutes to help fill existing technology and workforce development gaps through a network of shared facilities. With regard to securing the talent pipeline, Dr. Singerman remarked that the private sector should lead the effort to improve the image of manufacturing and noted that MEP has been involved with the community college efforts, among others.

AMNPO, hosted by NIST on behalf of the federal government, is focused on interagency planning and coordination of advanced manufacturing activities. Its early accomplishments include building the interagency team with a very light NIST footprint along with industry and academic fellows; revising the manufacturing.gov portal; and participating in the review process for selecting the National Additive Manufacturing Innovation Institute (NAMII) in Youngstown, Ohio, led by the National Center for Defense Manufacturing and Machining with many regional partners. This Institute captures the Administration's concept of using regional innovation clusters as a mechanism for enhancing U.S. competitiveness.

AMNPO has also been leading the public design of the NNMI, including issuing a Request for Information (RFI) open through October 25, 2013 and organizing and conducting workshops. Approximately 250 participants with strong industry representation have attended each of these workshops held in Troy, New York, Cleveland, Ohio, and Irvine, California. The next workshop will be

held in Boulder, Colorado, on October 18. The RFI and the workshops are collecting information in four major categories: 1) technologies with broad impact; 2) Institute structure and governance; 3) strategies for sustainable Institute operations; and 4) education and workforce development. The next step in the design process is to develop a White Paper after the RFI closes, which will be discussed in early January at a workshop in Huntsville, Alabama.

For more details, see Dr. Singerman's presentation.

Discussion Summary – The group discussed the following topics:

- The purpose and operational structure of the NNMI was elaborated. The agendas will be driven by industry needs and executed through the various organizations in the regional hubs. The design of the NNMI is still in the development process and AMNPO is looking for a bottoms-up approach with guidance from the stakeholders, as reflected in the questions regarding technologies, structure and governance, sustainability, and education and workforce development. The aim is not to be overly prescriptive in the design since there will most likely be great diversity among these Institutes.
- The overall objectives and goals of the Institutes for Manufacturing Innovation were distributed in advance of the workshops to help design a national program which meet these objectives and goals.
- The most important goal of the Institutes is to create a concentration of research capacity that is driven by industry and can be done collectively.
- Examples were provided on how companies benefit by participating in the workshops. The high level of industry participation reflects the recognition of the importance of manufacturing.
- NIST's role in the NNMI is to keep the Institutes cohesive as a program in terms of making sure that the governance structure is driven by industry rather than the mission agency and that the structure is focused to create the appropriate leverage.
- Some concerns were raised about sustaining these Institutes after their initial one-time funding, including the possibility of an Institute becoming focused on self-propagation as a means for additional funding.

Tour of the NIST Boulder Laboratories

The VCAT members visited the following laboratories:

- Quantum Voltage Laboratory – Develops superconducting electronic circuit and system technology for precision measurement applications and fundamental metrology.
- Public Safety Communications Research Demonstration Network – As a joint effort by NIST and the National Telecommunications and Information Administration, the Public Safety Communications Research Program develops standards and conducts research to improve the quality and interoperability of emergency communications.
- NIST Precision Measurement Laboratory – Houses a new 9,000-square foot clean room which includes tools for fabricating micorelectromechanical systems (MEMS) and a Precision Imaging Facility.

Wrap Up – *Dr. Vinton Cerf, VCAT Chair*

Discussion Summary – Dr. Cerf announced his plans for sending the draft 2012 VCAT Annual Report to the other members by December 25 for their review and comments by the February 2013 meeting. The group discussed options for the length of the VCAT meetings as well as the timing and number of meetings per year in order to facilitate better attendance by the members. The fall and spring meetings are the best time to provide input into NIST's internal budget process.

With regard to safety, the group agreed that the next meeting of the VCAT Subcommittee on Safety should be held in Gaithersburg in conjunction with the February 2013 VCAT meeting and that the agenda include a discussion with the Gaithersburg safety representatives and a tour of one of the "borderline" safety buildings. The VCAT also requested that a report on safety metrics be presented at every VCAT meeting.

Adjournment

The meeting was adjourned at 11:20 a.m. on Wednesday, October 17, 2012.

I hereby certify that, to the best of my knowledge, the foregoing minutes are accurate and complete.
Gail Ehrlich, Executive Director, NIST Visiting Committee on Advanced Technology
Dr. Alan Taub, Chair, NIST Visiting Committee on Advanced Technology