2017 Annual Report

Visiting Committee on Advanced Technology
of the
National Institute of Standards and Technology

U.S. Department of Commerce

March 2018

Preface

The Visiting Committee on Advanced Technology (VCAT or the Committee) of the National Institute of Standards and Technology (NIST or the Institute) was established in its present form by the Omnibus Trade and Competitiveness Act of 1988 and updated by the America COMPETES Act in 2007 and the American Innovation and Competitiveness Act of 2017. The VCAT is a Federal Advisory Committee Act (FACA) committee and its charter includes reviewing and making recommendations regarding general policy for NIST, its organization, budget, and programs within the framework of applicable national policies as set forth by the president and the Congress. This 2017 annual report covers the period from the beginning of March 2017 through February 2018.

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's programs to the U.S. science and technology base and to the economy. At the first meeting of each year, the Director of NIST proposes areas of focus to the Committee and agreement is reached on a program for the year. Over the past year, the Committee has been active in assessing NIST's contributions to and progress in the following areas:

> - NIST Safety and Security Systems and Culture
> - NIST Laboratory Programs Strategic Planning
>   - Provide Foundation of Trust in New Industries Through Engineered Biological Systems and the Internet of Things (IoT)
>   - Apply New Technologies to Revolutionize Mission Delivery Through Artificial Intelligence (AI) and Data and Quantum Measurements

The Committee reviews a significant portion of NIST programs through direct discussion with NIST leaders, scientists, and engineers. Reactions and observations of the Committee members are presented candidly to the NIST senior management and other attendees at each meeting. This feedback encourages continuous improvement in key areas in the overall operation. The Committee also visits various NIST laboratories and satellite facilities to discuss research projects directly with the technical staff. These laboratory tours help the Committee to assess the impact of NIST research, progress towards achieving research goals, the quality of the staff, institutional culture – especially related to safety and security - and the efficacy of the facility infrastructure.

Under the Committee charter, the Director of NIST appoints the VCAT members. Members are selected on a clear, standardized basis, in accordance with applicable Department of Commerce guidance. Members are selected solely on the basis of established records of distinguished service; provide representation of a cross-section of traditional and emerging U.S. industries; and are eminent in fields such as business, research, new product development, engineering, labor, education, management consulting, environment, and international relations. No employee of the Federal Government can serve as a member of the Committee. Members are appointed for staggered three-year terms.

This report highlights the Committee's observations, findings and recommendations. Detailed meeting minutes and presentation materials are available on the NIST web site at www.nist.gov/director/vcat.

VCAT Members during the Period Covered by this Report

Dr. Rita R. Colwell, Chair
University of Maryland at College Park
Term: January 6, 2014 – January 5, 2020

Mr. William M. Holt, Vice Chair
Intel Corporation Retired
Term : May 13, 2012 – May 12, 2018

Dr. Allen Adler
HRL Laboratories, LLC
Term : January 25, 2016 – January 24, 2019

Dr. Rodney Brooks
Rethink Robotics
Term: June 1, 2014 – May 31, 2020

Mr. Michael Garvey
M-7 Technologies
Term: January 23, 2015 – January 22, 2021

Dr. Waguih Ishak
Corning Incorporated
Term : January 25, 2016 – January 24, 2019

Dr. Karen Kerr
GE Ventures, General Electric
Term: June 1, 2011 - May 31, 2017

Dr. Roberto Padovani
Qualcomm Technologies, Inc.
Term: May 1, 2011 - April 30, 2017

Ms. Hemma Prafullchandra
HyTrust, Inc.
Term: October 27, 2014 - October 26, 2020

Dr. Theodore Sizer
Nokia Bell Labs
Term: August 28, 2015 – August 27, 2018

Mr. David Vasko
Rockwell Automation
Term : February 2, 2017 – February 1, 2020

Dr. Gail Folena-Wasserman
MedImmune
Term : January 30, 2017 – January 29, 2020

Dr. David Wilson
Morgan State University
Term: March 23, 2015 – March 22, 2018

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1. VCAT Focus in 2017

In 2017, the work of the VCAT was centered on two major themes, strategic planning, and safety and security. With the inherent uncertainty in the transition to a new administration, and the shift in programmatic and budgetary priorities, both NIST leadership and the VCAT felt it essential for the VCAT to focus on strategic issues to ensure that NIST's measurement science capabilities were best positioned to meet the current and emerging measurement and standards needs of the U.S. The VCAT examined multiple topics and issues ranging from how NIST could improve its communications and stakeholder awareness, how NIST could optimize its efforts in measurement science and standards to strengthen U.S. Trade priorities, and which areas of emerging technology NIST should focus its limited resources on. In safety and security, the VCAT was briefed on NIST efforts to strengthen its physical security policies and procedures. The VCAT believes that it is essential for the security improvements to strike a right balance of enabling an open working environment while providing robust protection. The VCAT also continued to track NIST's progress in safety and was fully briefed on the Americium-241 (Am-241) incident and NIST's response to that event, which illustrates the significant progress that NIST has made in regard to safety. This 2017 Annual report summarizes the VCAT's work, observations, and recommendations related to these topics.

2. Strategic Planning

The VCAT began its 2017 work period at a time of significant transition, with the new leadership not yet appointed, the science and technology policies of the new administration not yet defined, and signals from both Congress and the Administration suggesting that a significant tightening of the budget was on the horizon. In light of this environment both the VCAT and NIST leadership agreed that an in-depth exploration of key strategic questions to inform NIST's decision makers on what steps it could take to strengthen its strategic position and inform programmatic decisions was to be a key focus of the VCAT throughout the year. The work of the VCAT on these issues is summarized below.

2a. NIST's Role in Supporting the President's Innovation and Economic Agenda

The primary focus of the Department of Commerce in the Trump Administration is the promotion of job creation and economic growth by ensuring fair and secure trade, providing the data necessary to support commerce, and fostering innovation by setting standards and conducting foundational research and development. The VCAT formed 3 working groups that explored a series of questions between the February and June meetings to ensure NIST was positioned to support the Administration in these efforts. A summary of the groups' scope and a summary of what they reported back to the VCAT at the June meeting is provided below:

- **Working Group on Trade –** *(Allen Adler (lead), Dave Vasko, Waguih Ishak)* Through its measurement science, standards, and technology mission, NIST has a unique role in

supporting U.S. trade priorities. How can NIST ensure it is positioned to strengthen this Administration priority? Key issues to examine:
- How NIST can better ensure its measurement research, services, and data are leveraged to remove barriers to trade;
- Key opportunities for NIST's engagement in standards efforts to continue to support U.S. exports; and
- The capabilities that will be critical for the NIST Director to fulfill his authority to serve as the President's principal advisor on standards policy.

Findings: The group emphasized how NIST's metrology and standards work has a fundamental role in supporting U.S. trade. The group encourages NIST to continue to ensure that its measurement research, services, and data are leveraged to remove barriers to trade by evolving measurement standards to ensure U.S. industry maintains first mover advantages with developing technology. NIST should be working with other measurement standards organizations to ensure global adoption of documentary standards that facilitate fair trade. NIST should ensure it continues to be respected as a global authority in all aspects of measurement standards based on NIST's being recognized as a leader in measurement science.

- **Working Group on Innovation and Competitiveness through Fundamental Measurement Research and Development –** *(Rodney Brooks (lead), Tod Sizer, Gail Folena-Wasserman, Hemma Prafullchandra)* Many of NIST's biggest impacts come from investment in fundamental measurement science research that enables new technologies, new markets, and new industries. How can NIST prioritize its measurement science research and development efforts to maximize current impact and ensure continued impact in the years to come? Key issues to examine:
  - The most important measurement science capabilities for NIST to retain or build to meet the current needs of U.S. industry and the Administration's priorities; and
  - The most important measurement science capabilities for NIST to retain or build to meet the future needs of U.S. industry.

  Findings: The innovation working group urged NIST to increase engagement with the communications and biopharmaceutical industries to promote their work and develop additional collaborations to continue to identify and meet the emerging measurement needs of those rapidly growing industry sectors. They recognized NIST's achievements in this kind of engagement and collaboration in cybersecurity and recommended increased investments to that end.

- **Working Group on Communications** *(Rita Colwell (lead), Mike Garvey, David Wilson, Bill Holt)* Through NIST's reauthorization in the American Innovation and Competitiveness Act, NIST was directed to seek improvements to its laboratory programs, in part by optimizing

commercial and industrial applications. To this end, how can NIST more effectively capture and describe the importance of its mission to U.S. industry and national priorities? Key issues to examine:

- Evaluating current and suggesting new efforts to evaluate and communicate the impact of NIST's research, including news stories and performance metrics;
- Evaluating current and suggesting new mechanisms for stakeholder outreach to increase awareness and engagement in NIST's mission in order to increase its impact; and
- Support NIST's documentation of the positive benefits of research on the competitiveness of industry, including manufacturing.

Findings: The group found that NIST utilizes a wide variety of communications media – from traditional press releases and web articles, to blog posts and videos to get the word out about NIST. By having this multifaceted approach, NIST can reach a lot of different audiences. NIST also has a robust social media presence, with an impressive number of followers on Twitter, Facebook, LinkedIn, YouTube, and others. Finally, NIST has custom web content highlighting its Nobel Prizes and the new Industry Impact series. The group agreed upon the importance to engagement and recognition of telling a compelling story, and urged NIST to continue to identify additional ways to get the message of NIST's R&D and its impacts to a broader audience.

A common thread of the VCAT's discussion of the groups findings was the need for NIST to be able to effectively address the emerging measurement science needs of industry, and in light of the restricted budget environment the VCAT agreed that continued discussions of NIST's identification and selection of priority research areas would be important.

2b. NIST Laboratory Strategic Planning

The VCAT reviewed NIST's efforts towards developing a long-range strategic plan for NIST's laboratory programs with the goal to identify high-level research priorities to best position NIST looking towards a 10-year horizon. The goal of NIST's efforts is to produce a long-range plan that allows NIST leadership to be proactive instead of reactive in shaping NIST's research environment in an ever-changing landscape of both federal funding and technical opportunities.

To lay the groundwork for the strategic plan, a scan of the technical landscape was completed, and numerous interviews with NIST senior leadership, former NIST directors, as well as former VCAT members were conducted. The interviews explored major opportunities, risks, areas for investment/divestment, NIST culture, leadership, indicators of success, and advice for Commerce Secretary Ross. During a 2-day workshop held at the end of May, a five-person thought leader panel provided their perspectives on the future of technology. One theme that was clear is that science increasingly depends on systems thinking and learning, multimodal data, and multimodal measurements. The second key theme was NIST has a place and a part in teaching people about measurement science and ensuring measurements are being conducted to get the best data out.

During these early stages of discussion, three possible areas for growth were identified in vertical capabilities, meaning associated with specific disciplines: bioscience, quantum science, and Internet of Things (IoT). In horizontal capabilities, meaning cross-cutting areas, potential areas for growth include data science and artificial intelligence, systems-level thinking and modeling, and democratization of measurement.

With measurement needs in the biological sciences, and converging challenges in IT, communications, and AI having been identified as major themes the VCAT also explored in more depth NIST's biosciences and information technology research efforts. The VCAT was especially pleased to see how NIST had addressed previous VCAT recommendations for NIST's work in this area including efforts to strengthen and expand their partnerships with industry and academia. Both National Institute for Innovation in Manufacturing Biopharmaceuticals and the National Cybersecurity Center of Excellence will provide valuable platforms for NIST moving forward. While the VCAT agrees that both the biosciences and the information technology space will be major drivers of measurement needs, continued efforts to prioritize and focus NIST's research portfolio in these spaces will be necessary to ensure that NIST can build the most effective partnerships and recruit the staff necessary for the programs to have the critical mass necessary for full success.

The VCAT was pleased to see the continued evolution of NIST's laboratory planning work at the October meeting. The NIST strategy effectively addresses advancing technology in two ways, both of which are strongly aligned with NIST's mission. First, the formation of new industries, made possible by scientific and technological advances, gives rise to the need for new measurement standards to support the expanding commerce resulting from the growth of these industries. Second, advances in science and technology make it possible for NIST to more efficiently and effectively support the measurement and standards needs of existing industries. The 2017 Strategy identifies four manifestations of these general concepts.

Theme 1: Provide a foundation of trust in new industries

- **Enabling the future bio-economy.** As proof-of-concept academic work in engineering biology meets the market realities of bringing lab science to product initiation, there are questions in how to compare biological products, measure whether desired outcomes are realized, and optimize biological systems for desired behaviors. NIST will deliver tools and standards to measure biological technologies, outputs, and processes that will enhance economic sectors from healthcare to manufacturing and beyond.

- **Unleashing the economic potential of the Internet of Things.** Robust, secure, and competitive technology advances in the "Internet of Things" must be built on a solid foundation of measurement and standards. NIST will develop new tools and approaches for IoT systems' security and privacy, establish technologies to relieve network congestion and device interference, and facilitate greater confidence in device interoperability.

Theme 2: Apply new technologies to revolutionize mission delivery

- **Enhancing mission-critical research through Artificial Intelligence (AI) and data.** NIST will develop resources and expertise to apply AI and big data techniques to measurement science, including curated datasets to train and test AI systems, model AI behavior and compare AI systems, and apply AI to research efforts where big data requires the application of advanced learning algorithms.

- **Revolutionizing commerce through quantum measurements.** In May 2019 the International System of Units (SI) is slated to be redefined with units based on fundamental constants of nature and NIST must lead in this transition to quantum definitions. NIST will use its world-leading quantum science expertise to develop physical reference standards and "self-calibrating" sensors that will enable a world where measurement devices are ubiquitous, reliable, and affordable.

The VCAT was briefed on the initial scoping statements for each of the four areas and was asked to consider and provide input on the following questions:

- Are these the right priorities?
- Is NIST approaching each priority the right way?
- What are the important considerations in implementation?
- How to balance with the legacy programs?

OBSERVATIONS:

- The VCAT applauds NIST's efforts to define a strategic vision for its laboratory research program and agrees that the topics NIST has identified are consistent with challenges seen across industry. However, at current levels of funding, NIST is under resourced to adequately address all of these areas.
- The VCAT agrees that NIST needs to address the measurement needs in complex multivariable areas of biological sciences, IoT, AI, and machine learning. In these emerging issues, NIST needs to be flexible to combine existing expertise of scientists from across laboratories to develop new methods of delivering trust in measurement. Because of this, NIST must maintain organizational agility and flexibility and deliver on core mission activities.
- Many of these strategic areas are connected to cybersecurity: What if the system thinking and learning could be manipulated? What if the data amassed was leaked or compromised to specific gain or to cause confusion? What is the role of AI in cybersecurity?
- The VCAT agrees that NIST is a leader in the quantum science space and that continued prioritization of these efforts is important.
- A key element in NIST's success in quantum science is the fact that NIST is a lab-based intramural research organization with dedicated infrastructure and staff, while remaining open to collaboration and engaging with the best academic and industry institutions

worldwide. NIST robust fundamental research infrastructure allows for the development of deep technical expertise in key areas while remaining a discipline-based organization focused on measurement science.

- As NIST moves forward with implementing its strategic vision it will need to take advantage of the management tools and methods it has to increase its operation flexibility. One is startup and directed funding and another is cross-organizational program management, which enables bench-level collaboration across the organization.
- Over the last several years, NIST developed organizational flexibility through its expanded use of grant-based partnerships. NIST has created three Centers of Excellence which allows close partnership with some world-class capabilities in areas important for its mission, providing access to expertise, data, and unique facilities not on hand; expand in new fields and minimize risk by not developing formal in-house capabilities; allow visible focus on priority NIST efforts; and build critical mass necessary for impact. However, these types of partnerships must be implemented carefully to ensure balance and integration with its intramural research programs, which are absolutely essential for NIST's success.
- NIST's longer-term joint institutes with universities allow NIST scientists to interact with academic colleagues to build long-term capabilities in technical areas without the constraints of the federal system.

RECOMMENDATIONS:

- In the area of AI and Machine Learning, NIST should not aim at a Moon Shot. Rather, NIST should take reasonable steps to show the power of the technology. NIST should seek to engender trust in the use of AI, to ensure that these technologies are free from bias. A couple of success stories can pave the way to more and more engagements.

2c. NIST Efforts to Improve Operational Efficiency

In addition to examining NIST's efforts to prioritize its laboratory research priorities the VCAT was also briefed on NIST efforts to improve its operational efficiency through the introduction of service management platforms and tools to ensure that the services which support the research program are as effective and customer focused as possible.

At NIST the Management Resources (MR) directorate is the service organization that provides services to both campuses, in Gaithersburg and Boulder. It contains about 1,100 staff or contractors and has a budget of approximately $175 million on an annual basis, which provides for essential mission support functions in finance, acquisitions, safety, security, facilities, human resources, and information technology. MR also has offices that provide for civil rights and diversity, the NIST library function, and a state of the art fabrication facility. MR ensures on a daily basis the lights and computers are on, procurements happen, and it provides infrastructure for 30 billion transactions a day on NIST internet time services. It ensures buildings are built to specs and also provides services directly to the public for encasements.

Currently, the agility and flexibility demanded by NIST's mission are not being met by the current MR services. NIST is taking steps through the implementation of a service management practice or framework, to become a transparent data-driven organization where services are more closely aligned to the NIST mission and are benchmarked with industry leaders. MR's strategic approach will also include efforts to strengthen partnership and governance models between programmatic and service organizations, as well as better risk appetite alignment with the NIST mission.

In addition to the deployment of service management tools NIST is also creating a set of advisory boards for each MR service where internal stakeholders will be tasked with identifying priorities in service areas as well as mission essential objectives. NIST believes that the improved customer awareness combined with data on actual service implementation will provide the necessary improvements to provide the agility and flexibility needed to best serve the NIST scientists.

OBSERVATIONS:

- NIST has made significant strides in implementing a Service Management Program intended to transform how work gets done at NIST. NIST has put in place service management teams addressing 50 ongoing services across 6 different functional areas (Acquisitions, IT, Facilities, Finance, HR, and Telecom). NIST has seen improvements in HR, Agreements processing, and IT incident response that have lowered cost, improved performance, and enabled management to make data-driven decisions.

RECOMMENDATIONS:

- NIST should maintain the focus on the efficiency improvement in the service organization. They should continue to expand the deployment of these efforts and work to create a sustainable model that can react to organizational changes and create competitive advantages.

3. Safety at NIST

Safety has been a focus and priority of the VCAT for several years and the VCAT has been pleased that NIST has developed a safety culture focused on shared responsibility and continuous improvement. NIST has made substantial progress in developing a positive safety culture and the VCAT continues to receive regular updates on the trends in safety incidents, programs on safety training for leaders and staff, and overall progress on the safety culture.

Despite the improvement in NIST safety culture this year's safety data highlights the importance of continued management engagement of safety as a top priority. Over the past year NIST has seen an increase in both OSHA (Occupational Safety and Health Administration) reportable incidents and DART (Days Away, Restricted or Transferred) cases. The majority of these cases were driven by slips, trips, and falls, and through a deeper dive it was determined that a third of these cases were due to inattention and people hurrying. The VCAT encourages NIST management to continue to

engage staff and applauds their efforts to continually seek improvements to its incident reporting and investigation program.

The VCAT was also provided with in-depth briefings on a safety incident and the NIST responses that occurred this past year involving an unexpected release of Am-241. On August 16, 2017, elevated levels of radiation were discovered during a semiannual leak test in one of the NIST facilities. Access was restricted to the facility and particularly the room with elevated levels. An investigation revealed that an ampoule containing high-levels of activity of Am-241 had shattered inside a plastic vial, which was stored in a lead container, which itself was stored in a lead cave.

NIST filed a formal event report to the National Research Council (NRC) on August 19, 2017, and followed up with communication to the NRC Region 1, Congress, and the Department of Commerce. The Radiation Safety Officer (RSO) and Acting Director of PML had a meeting with source users after the incident to determine who may have been exposed to radiation. NIST engaged the Department of Energy Radiation Emergency Assistance Center / Training Site (REAC/TS). Several tests were run to assess the dose to individuals with potential exposure.

Contamination was discovered in unrestricted areas, so access was restricted to Building 245 on September 11th and additional studies were performed. The Department of Energy's Radiological Assistance Program team found no Am-241 outside of the restricted areas. The NRC conducted a special team inspection, which characterized NIST's response effort to this incident as "textbook."

Offices in Building 245 were reopened on September 18th. Before each laboratory space was reopened, sources in the space were identified, evaluated for safety, and NIST assessed whether they were critical to mission delivery. The RSO and line management, including the NIST Director, had to approve opening the building to staff.

The VCAT was appreciative of the transparent nature in which NIST management provided information and updates on the incident and response. The VCAT believes that NIST's response to this incident highlight's how far NIST has come on its safety journey, demonstrated by the fact that NIST leadership was able to quickly make informed decisions to limit the spread of contamination and ensure that potentially exposed employees were given immediate access to appropriate medical and treatment options.

RECOMMENDATIONS:

- The VCAT recommends that NIST document and formalize the incident management processes that were used in the response to the Am-241 incident, so that NIST has a standardized "playbook" for incident response moving forward. This will allow NIST leadership to better prepare for future incidents, ensuring that the staff know what needs to be done saving valuable time in any future response effort.
- Because plans can become outdated, NIST should develop processes for annual review and practice to ensure plans are optimized for current environment.

4. Physical Security at NIST

In response to the unfortunate 2015 incident of a NIST police officer attempting to manufacture methamphetamine while on duty at NIST, there has been heightened attention to the need to strengthen and improve Physical Security at NIST. The public release of the Government Accountability Office's (GAO) investigation into Physical Security at NIST identified a number of issues for NIST and the Department to address. The VCAT was briefed in a closed session on steps that NIST is taking to address the identified shortcomings and concerns. The VCAT feels that NIST is making significant progress in addressing the identified challenges and the recommendations of the GAO. NIST leadership has established and communicated to all staff and associates a set of baseline security requirements that apply to everyone who works at or visits NIST. Those requirements covered NIST badges, access to controlled areas, visitors, reporting security concerns, and police and guards. Developing and communicating those baseline requirements has been a multi-step, multifaceted process to ensure maximum understanding and buy-in and begin changing the NIST culture. NIST leadership has also taken steps to establish the basis for holding NIST employees and associates accountable for meeting NIST's baseline security requirements. Progress has been made in the implementation of other security improvements including a cyber-lock pilot to secure appropriate spaces warranting enhanced security.

OBSERVATIONS:

- NIST is a unique institution and while the VCAT agrees that improvements need to be made to strengthen security, they must be done in a way that minimizes disruption to the open research culture that is so important to the success of NIST's scientific programs.

RECOMMENDATIONS:

- The bifurcated nature of the current security management structure between NIST and the Department is untenable. The VCAT recommends that the NIST director be responsible for the physical security of the NIST campuses, as there are connections between safety and security that only personnel with day to day responsibility for the management of research facility will be familiar with.

5. NIST Budget

NIST Budget (Dollars in Millions) (Under Continuing Resolution)

	FY 2017 Enacted	FY 2018 Annualized CR	FY 2019 Request	+/(-) Over FY 2018 Annualized CR	% Over FY 2018 Annualized CR
STRS	**$690.0**	**$685.3**	**$573.4**	**($111.9)**	**-16.3%**
Laboratory Programs	604.7	600.6	516.6	(84.0)	-14.0%
Corporate Services	17.3	17.2	11.6	(5.6)	-32.6%
Stds Coord & Special Pgms	68.0	67.5	45.2	(22.3)	-33.0%
ITS	**$153.0**	**$151.9**	**$15.1**	**($136.8)**	**-90.1%**
Hollings Mfg Ext Partnership	128.0	127.1	0.0	(127.1)	-100.0%
Manufacturing USA	25.0	24.8	15.1	(9.7)	-39.1%
CRF	**$109.0**	**$108.3**	**$40.5**	**($67.8)**	**-62.6%**
Construc & Major Renovations	60.0	60.0	0.0	(60.0)	-100.0%
Saf, Cap, Maint & Maj Repairs	49.0	48.3	40.5	(7.8)	-16.1%
Total, NIST Discretionary	**952.0**	**945.5**	**629.0**	**(316.5)**	**-33.5%**

The VCAT was briefed on the FY 2018 and FY 2019 President's Requests for NIST and offers the following observations.

The VCAT is disappointed that the FY 2019 President's Budget Request again requests a decrease of total NIST funding by nearly 33% from FY 2017 enacted levels. Relative to other nations, the President's Budget severely undervalues the role that NIST serves, in fact during this same time frame the VCAT notes that the Chinese equivalent of NIST has grown by 18%. The Committee offers the following observations:

- NIST Leadership should be applauded for the logical and thorough effort they made to accommodate the cuts required by the President's FY 2018 and FY2019 Budget Requests. NIST, led by Acting Director Rochford and then Dr. Copan with support by the strong team of senior leaders at the Associate Director and Lab Director levels, was able to identify areas of lower priority while preserving NIST's core capabilities.
- As the VCAT has noted in the past NIST is under resourced compared to the increasing number of important measurement and standards challenges it must address in areas like quantum science, AI, cybersecurity, IoT, etc. that will directly impact the future competitiveness of the U.S. With a 47:1 return on investment, adding resources to NIST is sound long-term investment for the U.S.
- The Committee is concerned about the decreasing support for the NIST infrastructure and facilities. As previously noted, recommended support for facility maintenance is more than double that in the FY 2018 Budget Request. Without adequate support, NIST facilities will fall further into disrepair, undermining the science and engineering work of the NIST staff and causing increased safety risks. The Committee also notes that it is likely that repair

funds will be increasingly pulled from programmatic resources, compounding the already steep cuts outlined in the FY 2018 and FY2019 requests.

- In our experience, uncertainty and the threat of decreasing resources is likely to cause high-performing staff to look for other opportunities. Because of this, the Committee is concerned about attrition of NIST's outstanding research staff, which is so critical to its success and mission delivery. In addition, since NIST's exceptional scientists are a significant recruiting tool, losing those top researchers because of budget uncertainty would likely have significant long-term effects.