VISITING COMMITTEE ON ADVANCED TECHNOLOGY
National Institute of Standards and Technology

2019 Annual Report

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

U.S. Department of Commerce

April 2020

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 2019 annual report covers the period from the beginning of March 2019 through February 2020.

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 programs in emerging technologies and national priorities
  - Quantum Information Science
  - Artificial Intelligence
  - Advanced Communications
  - Cybersecurity
  - Advanced Manufacturing
- The Evolving Role of NIST in the Digital Economy
- NIST efforts to strengthen Technology Transfer
  - The Return on Investment Initiative
  - The NIST-on-A-Chip Program
- NIST Strategic Planning
- NIST facility needs and ongoing renovation projects in both Gaithersburg and Boulder
  - Plans for the NIST Center for Neutron Research

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.

Two members were reappointed to a second term: Mr. David Vasko (Rockwell Automation) and Dr. Gail Folena-Wasserman (MedImmune) and one member served two complete terms: Dr. Rita Colwell (University of Maryland, VCAT Chair).

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
Univer sity of Maryland at College **Park**
Term: January 6, 2014-January 5, 2020

Dr. Allen Adler
HRL Laboratories, LLC
Term: January 25, 2016 -January 24,2022

Mr. Jay Alexander
Keysight Technologies
Term:May 22, 2018-May21,2021

Dr. Rodney Brooks
Robust Al
Term:June 1, 2014 - May 31, 2020

Dr. Vinton G. Cerf
Google
Term: December 21, 2018-December 20, 2021

Mr. George Fischer
Verizon Enterprise Solution s
Term : May 22, 2018 - May 21, 2021

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

Dr. Waguih Ishak
Corning Incorporated
Term: January 25, 2016 - January 24, 2022

Dr. Dana (Keoki) Jackson
Lockheed Martin
Term: May 22, 2018 - May 21, 2021

Dr. Eric Kaler
University of Minnesota
Term: December 21, 2018- December 20, 20il

DrMehmood Khan
PEPSICO
Term : November 13, 2018- November 12, 2021

Ms. Katharine Ku
Stanford University, Emerita
Term: May 22, 2018- May21, 2021

Ms. Hemma Prafullchandra
Microsoft
Term: **October** 27, 2014-October 26,2020

Dr. Theodore Sizer
Nokia Bell Labs
Term: August 28, 2015 -August 27, 2021

Mr. David Vasko
Rockwell Automation
Term: February 2, 2017- February 1, 2023

Or. Gail Folena-Wasserman
Med Immune
Term: January 30, 2017 - January 29, 2023

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1. VCAT Focus in 2019

In 2019, the VCAT focused their efforts on 5 main topics: the role of NIST in emerging technologies (focusing in particular on quantum science and artificial intelligence); the evolving role of NIST in the digital economy; NIST's continuing efforts to update federal technology transfer policy; NIST's efforts on strategic planning; and ongoing efforts to upgrade NIST's facilities-including an in-depth exploration of the NIST Neutron Center for Research. The VCAT received detailed programmatic briefings in all these areas and met with key policy makers. This 2019 Annual report summarizes the VCAT's work, observations, and recommendations related to these topics.

2. NIST Programs in Emerging Technologies and National Priorities

NIST is well positioned to play a key role in supporting the advancement of multiple emerging technologies that have been identified as national priorities and will be critical to future national security and economic competitiveness for the U.S.• The VCAT reviewed NIST plans for programs addressing the Administration's R&D priorities. In addition, the VCAT had the first-hand opportunity to review NIST's research programs, facilities, partnerships, and industry services. Additionally, the VCAT was updated on NIST's continuing efforts to advance and support work in advanced manufacturing and cybersecurity. The work of the VCAT on these issues is summarized below.

2a. Alignment of NIST's Programmatic Priorities with National Need

For the past several years NIST has engaged in a comprehensive effort to chart a course for ensuring the continued relevance and success of the Laboratory Programs over the coming decade. This process, which built on years of work developing short-term prioritized operational plans for each Laboratory and a year of engagement identifying NIST's values, sought to identify key areas for sustained effort and investment across the NIST labor atories. Through this process NIST recognized that it would need to develop new capabilities over the next decade in order to best support the evolving measurements and standards needs of the nation. In order to position NIST for the future, NIST leadership has identified and been prioritizing efforts in four focus areas. The four focus areas identified by NIST are quantum science, artificial intelligence, engineering biology, and work addressing the continuing evolution of the Internet of Things (IoT). Each of these areas hold promise to transform U.S. manufacturing, communications, health care, transportation, and beyond. It is clear to the VCAT that by developing new capabilities in these areas NIST will also be able to transform how it approaches its mission delivery, both by unleashing new measurement capabilities and by requiring NIST to develop methods for measurement dissemination to best serve the needs of new and evolving industry sectors.

The areas that NIST has identified as strategic focus areas are well aligned with the R&D priority areas of the Administration, which OSTP refers to as the Industries of the Future (Artificial Intelligence, Quantum Science, SG/Advanced Wireless Communications, Advanced Manufacturing, and the Bioeconomy). NIST is clearly well-engaged with the interagency groups developing plans in each of these areas. and is working to strengthen and build additional stakeholder connections and awareness about the important role that NIST plays in each area.

However, Administration budget requests over the past 3 years have not matched this prioritization. The budget requests have not provided robust support and much needed increased funding that would enable NIST to strengthen its programs and maximize its impact in each of these areas. Despite this disadvantage, the VCAT is glad to see that NIST has made significant efforts to make progress in each of these areas with existing resources. As the funding situation appears to be constrained for the foreseeable future, it will be important for NIST to approach and deal with increasing demands for NIST expertise and involvement in a way that does not dilute or degrade the laboratory research capabilities upon which NIST is able to deliver the measurement tools and measurement standards that are an important component of technological innovation.

2b. NIST and Quantum Science

Given the significant focus on quantum science by Congress and the Administration, and the important role that NIST plays in this field, the VCAT continued to receive updates on NIST efforts throughout 2019.

A major development that took place just prior to the beginning of the VCAT's 2019 work was the passage of, and signature by the President, of the National Quantum Initiative (NQI) in December 2018. The NQI formally authorizes NIST's work on measurements and standards necessary to advance commercial development of quantum applications, calls upon NIST to expand collaborative ventures with other public and private sector entities (industry, universities, etc.), and to continue to utilize existing NIST programs to support the development of the quantum workforce. The NQI also gave NIST *other transaction authority (OTA),* an important development which will provide NIST with greater flexibilities in entering into cooperative agreements and contracts in furtherance of the NQI. The VCAT is glad to see that NIST now has at least limited OTA and would like to see that authority assigned to NIST more broadly.

As expected, the NQI calls upon NIST to establish a *"consortium of stakeholders to identify the future measurement, standards, cybersecurity, and other appropriate needs for supporting the development of a robust quantum information science and technology industry in the United States."* NIST had begun laying the foundations for this consortium in 2018, and in 2019 made significant progress towards the establishment of and creation of the Quantum Economic Development Consortium (QED-C) in furtherance of this act. NIST established a CRADA with SRI to create the QED-C, the first use of OTA by NIST, and has held a number of meetings with potential stakeholders to generate interest and define the operational structure of the consortium. To date over 90 letters of intent have been received. The QED-C is playing an important role in helping U.S. industry identify priorities for research and standards relating to Quantum Information Science. The group Is also playing a critical role in helping organize US leadership and participation in related consensus-standards activities. Importantly, the application of the OTA to establish and administer the Quantum Economic Development Consortium (QED-C) and Important progress made by the QED-C is a telling example of how expanding OTA to NIST broadly can potentially help NIST accelerate the important work that it is doing.

In addition to the work to establish the QEO-C NIST continues to a coordinated quantum research portfolio, drawing upon the expertise resident at NIST as well as through the three existing quantum focused joint institutes JILA, JQI, and QuICS. The NIST research program is organized along three main lines of effort: foundational QIS research emphasizing metrology applications, work aimed at the realization and dissemination of the Quantum SI, and quantum engineering - work aimed at engineering and improving the robustness of prototype quantum devices.

NIST is clearly a leading force in this field and continues to produce a number of significant breakthroughs. NIST's focus on the metrological applications of quantum is in direct alignment with its mission, and as witnessed by efforts around the Quantum SI will transform future measurement traceability. Furthermore, the metrological focus of NISTs quantum work will be necessary for the development and benchmarking of the prototype quantum components and systems that will be necessary to realize industry focused and commercialized quantum applications. For the U.S. to remain a leader in this field additional investment in quantum R&D is required. As stated previously the VCAT strongly recognizes that increased funding is necessary for NIST, and that the President's budget requests do not provide sufficient support for NIST's important role. Furthermore, the VCAT is concerned that without additional new funds, it will be difficult for NIST to balance the need to support the fledgling QED-Cat a level sufficient for it to have meaningful impact, while also ensuring that the NIST research programs continue to receive robust support. If funding stagnation continues, combined with increased pressure for NIST external engagement, the VCAT is concerned that there could be significant long-term repercussions to NIST's intramural quantum research efforts and to NIST's ability to attract and retain the needed talent.

2c. NIST and Artificial Intelligence

International investment in AI is exploding, and companies, governments and policy makers around the globe are seeking answers that can provide greater confidence in AI technologies. The AI market is expected to have a $14 trillion cross-industry impact by 2035, according to one estimate. Significant questions around security, trust, impacts to the workforce, and a number of other significant issues make AI a major priority for the Nation and the Administration. AI and Machine learning (AI/MI) work has been going on at NIST for decades, and NIST has made significant contributions to the field. For example, the mNIST database, a dataset of handwritten digits, is among the most widely used standardized datasets in the U.S. and around the world for training and testing AI systems. NIST scientists worked with the Defense Advanced Research Projects Agency (DARPA) to develop and deploy smartphone-based systems that enabled U.S. service personnel to seamlessly converse with native Pashto-speaking Afghans. This research has informed the development of ubiquitous voice-based recognition systems such as those we encounter when calling a credit card company or even in smart home assistants such as Alexa and Siri. NIST has a demonstrated track record of their measurement methods, tools, and standards providing a foundation of trust that helps enable the acceptance and adoption of new technologies. The VCAT agrees that it will be important for NIST to expand its efforts in AI to develop new measurement capabilities, training sets, AND algorithm evaluation tools that will be required to answer the looming questions necessary to support responsible application and uses of AI systems.

The Executive Order on Maintaining American leadership in Artificial Intelligence signed by the President in February of 2019 lays out a coordinated government approach to AI covering research, regulation, workforce, international engagement, national security applications, and enhanced utilization. The VCAT was pleased to hear that NIST was closely engaged in the work, outreach, and deliberations that led to the development of the Order. In addition to expected contributions in R&D the E.O. gave NIST the specific responsibility to develop a plan for the Federal engagement in the development of technical standards and related tools in support of reliable, robust, and trustworthy systems that use AI technologies. Among other objectives, the plan is intended to "ensure that technical standards minimize vulnerability to attacks from malicious actors and reflect Federal priorities for innovation, public trust, and public confidence in systems that use AI technologies; and develop

international standards to promote and protect those priorities." To fulfill this tasking NIST issued a request for information and held a workshop in May of 2019 to gather community input. NIST issued its plan on August 10, 2019. The plan provides a path to ensure the federal government supports AI standards that areflexible and inclusive-and suited for a world of rapidly changing technologies and applications." The Plan recommends the federal government:

1. bolster AI standards-related knowledge, leadership and coordination among agencies that develop or use AI;
2. promote focused research on the trustworthiness of AI systems;
3. support and expand public-private partnerships; and
4. engage with international parties.

Due to the rapid pace of technology development and changing understandings of the utrustworthiness, accessibiltiy, and human-centered implications of AI," the plan emphasizes the need for federal agencies to *be flexible* in selecting AI standards for use in regulatory or procurement actions. It also calls for prioritizing multidisciplinary research and expanding public-private partnerships to advance reliable, robust and trustworthy AI. The plan also highlights related tools that will beneeded to support AI, including benchmarks, evaluations and challenges that could drive creative problem solving. While realizing that resources are limited the VCAT recognizes the importance of increased engagement in standards development for AI to ensure that the U.S. has a strong and consistent voice in the relevant standards development organizations.

It is clear to the VCAT that NIST is heavily engaged in using AI across its research portfolio in a host of areas including biometrics, advanced materials discovery, smart manufacturing systems, and the design and characterization of engineered biological systems. Additional efforts to produce well characterized data sets, and continued NIST efforts in microelectronics and nanofabrication that have application to the development of hardware required to run AI systems are important contributions to the national effort around AI.

In addition to these efforts the VCAT was also briefed on NIST's nascent efforts aimed at defining and developing the key concepts of trustworthy AI, where NIST is beginning to work with the community to develop ways to measure, define, and characterize the concepts of accuracy reliability, privacy, robustness, and explainability of AI systems. The VCAT recognizes the importance of these issues and believesthat it isvery important for NIST to focus on, and continue to strengthen, its technical expertise and capabilities that can inform-the development of solutions for these issues. The VCAT looks forward to continued updates on these efforts. As with efforts in quantum, in the current limited funding environment it will beimportant for NIST to balance investment in NIST R&D on AI challenges with demands from external stakeholders for short-t erm deliverables, that while havingan important near-term impac,t may not ultimately advance the long-term interests of the U.S.

RECOMMENDATIONS;

The VCAT supports NISrs focus on quantum science and trustworthiness of Al and commends the work that NIST hasdone in these areas. It was highlighted that Al is a tool, and not the goal in itself, and therefore, NIST should consider focusingon specific application of Al, where perhaps, the characteristics of trustworthy Al are more generalizable. Furthe rm ore, VCAT agrees that trustworthiness of Al needs to

be evaluated against a set of criteria, and therefore encourages NIST to develop the measurements and approaches needed for vetting brittleness, bias, and other characteristics of the Al algorithm.s

3. The Evolving Role of NIST in the Digital Economy

Rapid advances and new deployments of digital technologies are creating both significant new opportunities for economic growth and leadership, as well as creating significant new challenges (e.g., disruptive changes to the workforce , new security vulnerabilities brought about by loT devices, the need for major infrastructure upgrades to accommodate autonomous vehicles, etc.) that must be addressed As has already been mentioned these changes have spurred NIST leadership to examine what new research capabilities are needed, to develop new frameworks of metrology, to reevaluate how NIST delivers measurement assurance, and how we engage in the development of standards. Perhaps when it comes to the rapidly evolving digital technology landscape, NIST's role in standards development has received comparably more attention when compared to other elements of NIST mission . Not only has standards development been seen as an important tool in addressing some of the challenges brought about by these technologies, it has also come to be seen as another area of competition that will be critical for establishing global leadership in this technology space. As such NIST has seen a significant increase in interest regarding the role of NIST in standards from Members and Committees in Congress that do not conduct oversight of NIST (e.g., House Energy and Commerce, House Armed Services, Senate Homeland Security and Government Affairs, etc.) and in Executive Office of the President (EOP) offices that NIST has not traditionally engaged with (e.g., National Economic Council and the Council of Economic Advisors - parts of the Domestic Policy Committee, etc.). Over the course of 2019 the VCAT explored an example of the proactive approach NIST is taking to address these new challenges as exemplified by the development of the NIST Privacy Framework, as well as the new pressures being placed on NIST's standards development activities by national and economic security concerns and technology leadership considerations.

3a. The NIST Pr ivacy Framework

Many emerging technologies, digital and smart technologies, combine high-speed connectivity, with large amounts of **data** and compute capabilities clearly enhance convenience, efficiency and economic growth. At the same time, these technologies pose unique challenges to individual priva cy. With increasingly diverse visions inside and outside the U.S. about how to address these privacy challenges NIST set out to develop a framework that will provide a range of tools to bridge the gaps between privacy professionals and senior executives so that organizaitons can respond effectively to these challenges without stifling innovation. After a year of extensive public conversations, NIST posted a draft of the NIST Privacy Framework for formal public comment. The NIST Privacy Framework provides guidance for organizations that need to develop strategies to minimize privacy risks while still accomplishing their mission.slt also provide a way for organizations to have productive dialogues about privacy risks arising from their products or services. Because of the unique link between privacy and security NIST aligned the structure and conceptual design of the Privacy Framework with the widely disseminated NIST Cybersecurity Framework.

The Privacy Framework centers on three parts:

- The *Core* offers a set of privacy protection activities and enables a dialogue within an organization about the outcomes it desires.
- *Profiles* help determine which of the activities in the Core an organization should pursue to reach its goals most effectively.
- *Implementation Tiers* help optimize the resources dedicated to managing privacy risk. One company might have more risks, for example, and might need to have a chief privacy officer, while another might not.

Importantly, as with the Cybersecurity Framework, the NIST Privacy Framework is not a law or regulation, but rather a voluntary tool that can help organizations manage privacy risk arising from their products and services, as well as well as address the privacy requirements in different jurisdictions. It helps organizations identify the privacy outcomes they want to achieve and then prioritize the actions needed to do so. The VCAT commends NIST for its proactive work to develop this tool and looks forward to its formal release.[1]

RECOMMENDATIONS:

As NIST continues to refine and revise the privacy framework, it should ensure that future versions address the issue of the cost incurred by organizations in protecting privacy. It is likely that larger organizations will have the resources to put in place best practices, but smaller organizations may not have the resources to take all the steps necessary. Standards might be developed to lower the cost of compliance.

The VCAT recognizes that NIST has limited capacity to develop all the datasets needed for cybersecurity and privacy frameworks, therefore, NIST should develop a framework on how to build datasets for these frameworks to ensure robust and reliable processes.

3 b. U.S. Government and Emerging Technology Standardization - Implications for NIST's Roles

As discussed, there is a high level of interest in standards development for emerging technologies from executive and legislative branches of the U.S. government that is being driven through a combination of national security and economic security concerns and changing international landscape. The VCAT had the opportunity to explore NIST's role in standards, the changing landscape, and heard from industry representatives on what they saw as the opportunities, challenges and consequently, key elements that NIST must preserve in its approach to standards engagement and development in order for the U.S. to continue to be a leader in technology development and standardization.

An effective standard system is one that looks for speed, agility, and solutions that are fit-for-purpose This is evident in the U.S. approach which is a decentralized system, one which includes private sector

[1] Note that Version 1.0 of the Framework was released fn January of 2020 after the meeting cycle covered by this report.

and government participation. This enables responsiveness in the system to meet stakeholder needs and has directly contributed to U.S. leadership in technology and innovation.

NIST's role is defined by statute and policy in two key areas. The technical aspects are at the heart of the NIST measurements and technology mission. The standards development processes are a logical extension by which knowledge transfer from NIST laboratories happens into the world at large. It is a cost-effective means to get info and expertise from the NIST labs to the world outside. Another advantage is the ability to understand firsthand the emerging market needs and trends when NIST is at the same table with private-sector colleagues and gains a better understanding of what are the issues and solutions. NIST is often called upon to be a technical advisor by federal agency colleagues who are also looking at many of these same issues.

NIST is in an ideal position to see global trends and changes due to innovations emerging in digital technology spaces. This makes NIST a unique resource to agencies such as the Office of the U.S. Trade Representative, State Department and other agencies, who have responsibilities relating to trade negotiations. Recently there have been significant changes in the standards development landscape with increased participation from countries that have not traditionally led standards development activities like China, Korea, and Middle East countries. China has been particularly focused on increasing both their participation in, and leadership of, standards development efforts particularly in emerging technology fields to the concern of many in the U.S. Government. Concerns about government directed participation, skewed incentives for participation, technology transfer policies, and competition and monopoly policies & practices practiced by China are driving suggestions and approaches that in the longterm could jeopardize the effectiveness of U.S. engagement in international standards development in key technology areas. Of prime example is the inclusion of standards development related provisions in export control rules adding Huawei and other entities to the Commerce Department Entity List, which imposes significant restrictions and export controls on the outflow of goods or technology outside of the United States to the entities. This has led to significant confusion amongboth U.S. industry participants and U.S. based standards developing organizations about whether Huawei needs to cease participation in standards developing organizations (SDO's), or whether U.S. participants can engage in standards development efforts where Huawei experts are present. The lack of clarity has led to some industry counsels to err on the side of caution and prevent their experts from participating in standards development activities where Huawei is present, creating a dangerous vacuum. Clarification on this is needed and the VCAT strongly urges the Department to work with NIST to issue the appropriate clarifications to avoid any unnecessary confusion. The VCAT clearly heard from the industry panel members representing the U.S. Chamber of Commerce, the Information Technology Industry Council, and the Alliance for Telecommunications Industry Solutions (ATIS) that the desired result is for U.S., European, and Chinese companies to be in the same room in a voluntary industry-led environment and lettingthemarket and best ideas prevail. It is essential that the U.S. must not be outpaced by other regions when it comes to information and communicationstechnology development and standardization.

Additionally, the VCATwas pleased to hear that there was strong positive support for NIST's work focused on foundations, platforms, and frameworks, all of which are viewed positively by industry as they help promote innovation by providing a sense of stability necessary for the operability of emerging technologies.

RECOMMENDATIONS;

NIST should toke steps to ploy on even moreforward leaning role to help better organize and represent U.S. positions in standards discussions. NIST should continue raising awareness about the importance of technology standardization among key policy leaders and decision-makers, but at the same time also sensitize them to what works and what doesn't work.

Industrial /OT brings great benefits and could have significant sodetal impact. NIST should work to ensure that its programs ore providing the interoperability and connection across a broad set of /OT devices and sensor to enable the maximal utility of /OT technologies.

4. NIST Efforts to Strengthen Technology Transfer

Enhancing and improving the processes and pblicies thatgovern technology transfer both for the federal system and for NIST specifically remains a top NIST priority. In 2019 the VCAT was actively engaged in the launch and implementation of NIST's Return on Investment Initiative. The VCAT was also briefed on a new pilot project beinglaunched at NIST to enhance the transfer and commercialization of highly advanced quantum-based NIST measurement technologies - the NIST-on-A-Chip Program.

To provide further advice on both of these issues the VCAT subcommittee on technology transfer reviewed and provided recommendations on NIST's technology transfer-related programs. The subcommittee is chaired by Ms. Katharine Ku and addresses the following charge:

1. Review NIST's current technology transfer policies and practices, and provide their individual technical assessments on the principles that shoulddrive these policies and practices for effectively engaging the business community and communicating with stakeholders;
2. Assess NIST's performance in the development and dissemination of work products and knowledge and recommend improvements. Specific areas that the visiting technical experts should address include the development and use of intellectual property and collaborative research.

4a. Return on Investment Initia tiv e

The VCAT was briefed on NIST's technology transfer efforts focused on its intramural research programs. Highlighted were the efforts of the NIST Technology Transfer Policy Committee to inform the Technology Partnerships Office's efforts to strengthen technology transfer at NIST. In the area of technology transfer the VCAT Subcommittee on Technology Transfer created a report on the Return on Investment (ROI) Initiative for Unleashing American Innovation, which can be found in Appendix A. The report was adopted unanimously by the VCAT. A major focus has been on streamlining the CRADA process. A new system called Service Now has been deployed for people to request and process agreements. The VCAT was also briefed on NIST efforts on technology maturation. The objective is to develop a comprehensive pathway to support the development of NIST products and services toward commercialization and adoption by private companies for economic growth.

The VCAT was provided with anupdate on the status of NIST's efforts to advance the policy proposals outlined in the Return on Investment Green Paper. The paper addressed review with various

interagency working groups and was published as NIST Special Publication 1234 in April 2019. There were fifteen key findings. The goal of the Green Paper is to raise issues for further discussion and thought and strictly adheres to the CAP Goal structure.

The findings of the Green paper are in support of the five Lab-to-Market CAP Goal strategies:

1. Identify regulatory impediments and administrative improvements in federal tech transfer policies and practices.
2. Increase engagement with private-sector technology development experts and investors.
3. Build a more entrepreneurial R&D workforce.
4. Support innovative tools and services for technology transfer.
5. Improve understanding of global science and technology trends and benchmarks.

Several of the findings will require legislative change to implement. NIST has worked with the interagency community to develop a series of legislative amendments. This "legislative package" is currently under review at the Department and should be submitted to Congress by the end of year.

In efforts to assess the Boulder Innovation Ecosystem and NIST's role therein, the charge from the NIST Director is twofold; first is to engage- recommend purposeful and regular mutually beneficial engagements needed to strengthen NIST's innovation and entrepreneurial ecosystem; and the second is to act - recommend actions NIST should take for the benefit of American society through ecosystem engagement.

It is important to leverage strengths and best practices by partnerships, entrepreneurship, Lab-to-Market, and learning and support. Entrepreneurship is at the heart of innovation. Half of the people working at NIST are associates, postdocs, and graduate students, which are the seedcorn of the innovation activities.

An assessment was made of how NIST fits into the regional innovation ecosystem that will fulfill NIST's equities and needs. A scope of the assessment was made to better understand the perspectives of NIST staff and managers as well as NIST stakeholders about the existing state and future opportunities and is still in progress.

RECOMMENDATIONS:

The VCAT appreciates the work NIST has done to date to facilitate technology trans/er. The VCAT sees additional opportunities for NIST to take steps to ensure that its work has even stronger affinity with industry. The VCAT recommends that NIST looks for opportunities to test its work in the field, thus naturally creating connections necessary for the technology "transfer. This could occur through increased interaction with the MEP program, or through of the newly proposed Technology Uaison position that could also be tasked with facilitating and maintaining interactions between NIST research teams and potential technology adopters.

4b. NIST-on-A-Chip Program

The Technology Transfer Subcommittee provided the VCAT with an update on their objectives on policies and practices in providing individual technical assessments for effectively engaging the business community and communicating with stakeholders, as well as assess NiST's performance and recommend improvements in the development and use of intellectual property and collaborative research.

In August the Technology Transfer Subcommittee held a conference call to discuss various aspects of the technology transfer. Primarily, the call looked at the NIST-on-A-Chip program and discussed IP strategies within the NIST organizations . The members were asked to share information on how their organization has approached various items such as finding licensees and partners for further commercial development and portfolio management. The advantages and benefits of a non-exclusive license was discussed, which provides better access and provides incentives.

Finding partners for commercial development is challenging. NIST must market and make itself known to companies that they want technologies to be transferred from the lab to industry. Most companies do not have the bandwidth to look at each Individual lab. Marketing is key in this endeavor.

Portfolio management is a challenge. The IP strategy has to go with the research products and look 3 to 7 years ahead, monitoring, and predict trends and needs in the form of problems, which is not easy. Though NIST technology is generally in the physical sciences, the physical science companies are very disparate.

The Subcommittee met on October 30th to discuss the NIST Technology Maturation Fund - best practices for how to identify partners, how to market the inventions, how to find industry, and if there are any plans for doing potential site visits.

RECOMMENDATIONS:

The VCAT supports the efforts of the NIST-on-A-Chip program and encourages NJST to continue efforts to develop these technologies beyond the pilot stage of the program.

5. NISf Strategic Planning

The VCAT received ongoing updates on NIST's strategic planning efforts over the course of FY2019. For the past year NIST has been engaged in a community wide strategic planning process designed to position NIST to help the nation adopt to a rapidly evolving technology landscape. As NIST works to build programs in, and adapt to, emerging science and technology areas like artificial intelligence and quantum science, as well as continuing to pursue research that will open new frontiers NIST has identified that it must take steps to ensure that it can still remain the world class institution that it is and can recruit and retain the best staff, deliver services in the most efficient and effective manner possible, improve our facilities, and build a culture that brings out the best in all our staff. To do this the NIST Strategic plan identifies four strategic goals:

1. Position NIST to Advance U.S. Science and Innovation - NIST will make sure that it has the workforce , organizational structures, and partnerships to support the development and

adoption of emerging technologies critical to innovation and the economic competitiveness of the United States.

2. **Maximize NIST's Stakeholder Impact through High-Value SeNice Delivery** - NIST will optimize service delivery, streamline processes, and strengthen stakeholder engagement to transform technology transfer.
3. Create the Infrastructure for a 21st Century Research Institution - NIST will make sure that it has both the physical and IT infrastructure to carry out its programs.
4. **Build a** One NIST Culture - Ensure that our workforce of federal staff and NIST associates are united around NIST's mission and are valued for the expertise they bring.

To formulate the Strategic Plan NIST established four Goal teams made up of staff from across the NIST organization . The strategic plan goal teams worked refine the objectives and strategies that NIST must undertake to achieve the four plan goals, conducting outreach to stakeholders, as well as hosting a number of internal focus groups and open house meetings to engage and get input from the broader NIST community. Bas d on input from the NLB and the NIST community we have identified the following strategies from across the 4 goals as prioritie s for immediate implementation. These 8 actions will be the starting point for implementation of the plan with progress being evaluated at 6 month intervals, at which time progress will be reviewed and additional strategies outlined in the plan will be highlighted for action, ensuring that NIST is systemati cally implementing the proposed strategies and making consistent and steady progress towards its ultimate aim of ensuring that NIST continues to be an essential and valued component of America's innovation ecosystem.

NIST is committing to take concerted action and to track progress and implementation on 8 strategies in 2020. These strategies address critical strategic issues facing NIST in the areas of workforce , facilities, and operations. The selected strategies represent the highest priority strategies developed by each of the four goal teams that y require immediate and focused attention to ensure the future sustainability and viability of NIST. The VCAT is fully supportive of NIST's strategic planning effort s and looks forward to updates on progress throughout the coming year. The VCAT is particularly interested in seeing NIST take steps to improve its branding and strategic communication.s

Strategies Selected for Immediate Action

Workforce:

- Improve collaboration and **agility** across NIST programs
  - Restructuring scientist's performance plans to provide flexibility for collaborative work.
  - Establishing a new ADLP funding mechanism to foster cross OU collaboration.

- Strengthen NIST's ability to attract, retain, and retrain a diverse and Inclusive talent base
  - Appoint a NIST Diversity coordinator to lead efforts to improve the diversity of NISrs workforce
- Provide support for a strong and accountable leadership corps

- Strengthen NIST's leadership core by developing and implementing a NIST leadership competencies model and increase support for development and growth of existing leaders at NIST.

Infrastructure

- **Implement a multifaceted facility renovation and upgrade strategy**
  - Develop a prioritized implementation plan of the NIST Campus Master Plan
  - Optimize ongoing repair activities through the utilization of a predictive facilities maintenance tool to guide future SCMMR investments

Operations and Procedures

- **Make It easier to work with NIST**
  - Increase the successful transfer of NIST-developed technologies by applying best practices to streamline and enhance customer and stakeholder engagements.
- **Strategically communicate NIST's key messages**
  - Improve stakeholder awareness of NIST by clarifying and sharpening NIST's strategic communications and initiating an effort to rebrand NIST.

The VCAT was also briefed on NIST efforts to examine and address issues facing the institution around equity and career advancement, which are directly aligned with NIST efforts under Goal 4 to create a more inclusive and welcoming workplace. The VCAT was given an outline of NISTs plans to build a culture of diversity and inclusivity at all levels of the institution. The VCAT received an update from NIST on their launch of an external assessment of equity disparity in the NISTSTEMcareer track, as well as what NIST other steps NIST is takingto build a more inclusive and equitable workplace environment . The VCAT commends NIST on the steps that it is taking and looks forward to hearing updates as NISTs efforts progress.

RECOMMENDATIQNS;

NIST leadership (meaning the Director and Associate Directors) must personally take ownership and responsibility for addressing issues related to inequity, inc/usivity, and divers,ity much as it did in responding to institutional shortcomings with safety culture

VCAT recommends that NIST aggressively pursue efforts to develop a common, clear, consisten,t and recognized brand, and take the necessary steps to ensure that all parts of the organization and disciplined and consistent in its utilization and deployment.

6. NIST Facilities and Infra str ucture

The VCAT has been tracking the status of NIST facilities and infrastructure for the past several years, and is well aware of the significant challenges facing NIST with a deferred maintenance backlog of well over $700M, and the challenges of aging campuses where the majority of the laboratories facilities were built in the early 1960s. To stay at the cutting-edge of metrology and to meet the needs of stakeholders with higher need for precision and accuracy NIST requires facilities that can maintain ideal environmental conditions, accommodate 21st century requirements around IT and data, and meet today's expectations

for safety and performance. Such facilities would eliminate lost productivity and increase efficiency and effectiveness, providing researchers the opportunity to maximize their efforts on mission-related activities. Other major conditions that must be addressed are the needs to inaease the capacity of NIST facilities, to improve access for people with disabilities, and to safeguard the utility infrastructure of existing buildings. The VCAT was pleased to see the progress being made on the renovation of building 245. This facility will bring much needed upgrades to NIST's Radiation Physics program and will allow NIST to continue to serve the needs to multiple industry sectors from defense to healthcare. The VCAT strongly supports NIST's efforts to obtain a consistent annual level of maintenance funding at a level of $120 to $150 million a year which would allow the agency to make steady progress on addressing its maintenance backlog and make slow but steady progress on needed modernization and renovation efforts.

In addition to maintaining and operating traditional laboratory facilities NIST also runs and operates a major National User Facility, the NIST Center for Neutron Research, which comes with its own unique challenges and demands, not the least of which is that the facility is built around a research reactor fueled by Highly Enriched Uranium. The NCNR is a highly productive research facility supporting over 2700 users this past year representing 51 companies, 37 Federal Agencies and National Labs, and 185 Universities. Furthermore, the NCNR is one of the most highly scientifically impactful Neutron Facilities in the world, with Its publications cited 95% more than the world average With the reactor relicensed through 2029 NIST must begin now to make plans for future upgrades and maintenance, including plans to replace the existing reactor, in order to ensure that NIST will beable to provide access to such a powerful research facility long into the future.

In June of 2019 the VCAT examined in depth the current status of the global neutron research community, the status and needs of the NCNR, and heard directly from members of the NCNR user community.

Dr. Julia Philips of the American Physical Society briefed the VCAT on their report Neutrons for the Nation, which describes the importance of neutron sources in various areas for the foreseeable future; illustrates the importance of neutron sources produced today and how they might be produced in the future; examines how can the U.S. be a global player in neutron science; and finally outlines policy issues that need to be considered in designing and building future neutron sources. A major finding of the report is that the neutron R&D in this country is vulnerable. In the U.S., there are six high-performance research reactors, NIST being the newest and it is SO years old. There are 48 scattering beamlines in the United States, 153 in Europe, and 99 in Asia. Several facilities have been shut down in the U.S., while the rest of the world is continuing to build. The U.S. has lost important capability in neutron R&D in the last two decades and is no longer the world leader. The APS report also states that neutron R&O currently requires the complimentary capabilities of spallation sources, research reactors and high-performance instrumentation.

The APS study makes a series of recommendations to strengthen Neutron research capabilities in the U.S.:

- Continue to support a diversity of neutron R&D capabilities;
- Find a balance in retaining and enhancing the capabilities and reducing or eliminating the use of highly enriched uranium (HEU);
- Sharply increase investment in neutron instrumentation development and deployment;

- Reaffirm its commitment to the development and deployment of high-density, low enriched uranium (LEU) fuels for existing HPRRs; and
- Initiate an effort to competitively design and build a new generation of LEU fueled HPRRs.

The VCAT also heard from users of the NCNR, who expressed uniformly positive opinions about the NCNR and the importance of such a facility to their research efforts.

NIST Is beginning to take steps to plan for the potential upgrade of the NCNR, looking at a number of options including maintaining the facility in its current configuration, conducting a major upgrade to the reactor to enhance its flux, and complete replacement of the existing reactor with a new model. A key next step will be a future study on this issue by the National Academies. NIST is currently working with other agencies including DOE on the development of the planned study.

RECOMMENDATIONS:

NIST's aging infrastructure is a recurring issue that is a threat to the national economy and security. In light that adequate funding to fully modernize NIST facilities will not be provided in the foreseeable future, the VCAT recommends that in addition to the steps NIST is pursing to obtain stable levels of maintenance and renovation funding that NIST also study alternative options such as the ability to lease additional space, or potential partnerships that could help NIST address its facility needs.

7. **NIST Budget (FY** 2020 Enacted and FY2021 **Request)**

FY 2020 Enacted Budget

FY 2020 EnactedNIST Budget (Dollars in Millions)

	FY2018 Enacted	FY2019 Enacted	FY2020 Pres. Request	FY 2020 Enacted	Delta
Laboratory Programs (STRS)	$724.5	$724.5	$611.7	$754.0	$29.5
Hollings **Mfg Ext Partnership (MEP)**	$140.0	$140.0	$0.0	$146.0	$6.0
Manufacturing USA	$15.0	$15.0	$15.2	$16.0	$1.0
Construction & **Renovation**	$319.0	$106.0	$59.9	$118.0	$12.0
Total	**$1,198.5**	**$985.5**	$686.8	$1,034.0	**$48.S**

The VCAT was briefed on the FY2020 budget and appropriations cycle. The VCAT was pleased to see a positive resolution of the FY2020 budget, with NIST receiving an overall $43.5 million increase over FY2019 enacted levels. The FY 2020 enacted bill provides a $29.5 million increase for NIST research programs. Of this increase $27.3 million (92%) will go directly towards NIST work in key emerging technology areas that will address the industries of the future, namely quantum information science ($10.0 million), artificial intelligence (AI) ($8.0 million), SG/advanced communications ($2.5 million), advanced manufacturing ($4.3 million), and biotechnology ($2.5 million). The VCAT is glad to see NIST focusing efforts on these priority areas in alignment with their planning These increases will allow NIST to make significant new progress in each of these areas.

The VCAT was glad to see that the FY 2020 enacted bill supports both MEP and Manufacturing USA, providing a total of $162 million for NIST Industrial Technology Service Programs a $7 million increase over FY 2019 levels that will enhance NIST's ability to support American manufacturers.

The FY 2020 enacted bill and report language allows NIST to continue its lead role in the coordination of Manufacturing USA, providing a total of $16 million for the program, a $1 million increase over FY 2019 enacted levels. Within this amount $10 million will support continued operation of the National Institute

for Innovation in Manufacturing Biopharmaceuticals (NIIMBL), $5 million will support the Advanced Manufacturing National Program Office and their work to coordinate across the existing network of manufacturing innovation institutes. The additional $1 million will support a competitive grant program that will provide funding to support the development of technology roadmaps as authorized by the National Defense Authorization Act of 2020.

The Hollings MEP willbe funded at $146 million, a $6 million increase over FV 2019 levels. The additional $6 million will bedistributed across the existing network of 51 centers.

Finally, the FV 2020 enacted bill provides $118 million to fund maintenance, repair, and improvements at NIST facilities in Gaithersburg, Maryland; Boulder and Fort Collins, Colorado; and Kauai, Hawaii, and major renovation of specific facilities in Gaithersburg and Boulder. Funding will advance ongoing construction on Boulder Building 1 and will help address NIST's significant deferred maintenance backlog. The VCAT concurs with NIST's plans to establish a stable level of construction and maintenance funding on the order of $120 to $150 million ayear and hopes to see Congress continue to work with NIST to support its infrastructure needs. Without consistent and levels of support that allow NIST to keep up with maintenance needs and address its backlog in a reasonable fashion, NIST facilities will fall further intodisrepair, undermining the science and engineering work of the NIST staff andcausing increased safety risks. The Committee also notes that it is likely that repair and maintenance funds are needed but also funds for renovation to bring in the latest technologies and methods. Without additional funds, NIST willhave to make the choice between programmatic outputs or facility upgrades.

FY 2021Requested Budget

At the time of the February meeting the VCAT had the chance to review the President's requested budget for NIST. Once again, the Administration has proposed significant reductions to the NIST budget. The FV 2021NIST budget request is $737.5 million,a reduction of $296.5 million or 28.6 percent and 479 positions from the FV 2020 enacted level. Significant reductions in FV 2021include: $136.7 million and 81 positions in the Industrial Technology Services (ITS) appropriation (including the proposed elimination of the Hollings Manufacturing Extension Partnership Program (MEP), $102 million and398 positions in the Scientific and Technical Research and Services (STRS) appropriation,and $57.8 millionin the Construction of Research Facilities (CRF) appropriation.

This budget if enacted would have significant negative impacts for NIST's ability to meet its mission and advance U.S. innovation in areas critical to the future economic and nationalsecurity of the nation. While the VCAT applauds NIST leadership for prioritizing its core mission and focusing work on critical emergingtechnologies, the VCAT does not support the proposed reductions to the NIST budget. NIST is currently playingimportant roles in advanced manufacturing,quantum science, advanced communications,cybersecurity,artificial intelligence and many more areas. With increased international competition and growing challenges to U.S. leadership, the VCAT is unanimous in its opinion that reducing the NIST budget is not an effective approach to achieve the Administration's goal of U.S. leadership in the "industries of the future".