

# 2024 Annual Report

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

U.S. Department of Commerce

*April 2025*



## Executive Summary

During 2024, the Visiting Committee on Advanced Technology (VCAT) observed that NIST plays a vital role for the United States in the following ways:

1. It directly contributes to the technological underpinnings of **U.S. national security**
2. It is a leader in enabling **industrial and scientific competitiveness for U.S. economic growth**
3. It provides a focal point for science-based research that enables **U.S. leadership in Artificial Intelligence and Quantum Information Science**

NIST's cybersecurity and disaster resilience leadership contribute to U.S. national security in both the digital and physical worlds. All government and private sector information security systems depend upon the ongoing cryptography work led by NIST and in the past year this field realized far-reaching benefits with groundbreaking NIST work on quantum-safe cryptography algorithms. The Nation's disaster resilience advances via careful NIST studies of past disasters, which yields science-based changes to codes, standards, and future infrastructure. The VCAT recognizes the unique and essential leadership roles that NIST plays on these topics.

U.S. research and development leadership and all industrial competitiveness are built on a foundation of world-class measurement science. NIST is the U.S. National Measurement Institute (NMI) and, through this unique mission, continues to provide the basis for each of the three areas of national capability listed above. The VCAT observed that this core mission is under threat due to resource constraints and deteriorating facilities. The VCAT recommends against ceding measurement science leadership to other nations as that represents a long-term threat to U.S. competitiveness in every field of science and commerce.

NIST acts as a critical bridge between government and industry through technical collaborations and as a convener of experts from industry, civil society, and academia. U.S. industry is taking a leading role in the development of cutting-edge artificial intelligence (AI) technologies. Yet U.S. economic opportunity from realizing the promise of AI will depend on the trusted use of these powerful tools. The VCAT recognizes the global leadership NIST has *provided* in advocating for the development of trustworthy AI systems.

The VCAT also acknowledges the NIST Director's prioritization and support for the safety of NIST employees. Leadership has addressed safety at every level of the organization, introduced essential process and procedure changes, redirected funds for essential physical plant safety improvements, and maintained executive sponsorship and attention to this issue.

NIST is a world-class, one-of-a-kind asset for the Nation and plays essential roles in the U.S. economy. If the United States is to meet its ambitious global technology leadership goals, NIST needs to have the allocation of resources necessary to meet national priorities while enhancing its ability to attract and retain top talent.

<b>27,000+</b>	<b>~1 Million</b>	<b>\$24.60</b>	<b>3.1 million</b>
Reference materials sold each year	Web requests per second for NIST standard time	In new manufacturing sales growth for every \$1 funded	IT Labs technical series publication downloads

## Summary of VCAT Recommendations

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The VCAT recommends the following:

### 1. Emphasizing NIST's Core Mission

- **1a. Emphasizing the NIST core mission:** NIST should consider leveraging communications to highlight how metrology, and being an NMI, provides the foundation for all of NIST's work and contributions across fields and sectors.
- **1b. Recruiting new talent:** When looking to recruit metrology-based talent, NIST should keep metrology integrated with other fields to help attract necessary staff.
- **1c. Blending role knowledge:** When looking to blend roles at NIST, for example service roles and research/technical roles, NIST should increase use of rotation assignments to help build understanding and knowledge.
- **1d. Involving academia in standards activities:** NIST should emphasize the importance of being engaged in standards to academia, including pre-standardization research, and involve academia more in the standards space. NIST could also consider a standards bootcamp catered solely to academia.
- **1e. Adding new perspectives to hazard reviews:** NIST is encouraged to engage with third-party experts to bring new perspectives to hazard reviews.
- **1f. Adding staff perspectives to safety culture changes:** NIST is encouraged to have NIST staff provide safety culture change recommendations they want to see implemented.
- **1g. Simplifying Job Hazard Analyses:** NIST is encouraged to simplify Job Hazard Analyses (JHAs) with use of a short form.
- **1h. Expanding the granularity of the safety dashboard:** NIST is encouraged to modify the dashboard to allow management to explore multiple crosscuts of safety data (e.g., by Organizational Unit (OU), job category, seniority, etc.) to ensure training, modifications to work practices, or incentives are effective as intended.

### 2. Meeting National Demands in Critical and Emerging Technologies (CETs) and Other Cross-Cutting Programs

- **2a. Building credibility and understanding of AI guidelines:** To enhance credibility, NIST-released AI guidelines, should include explanations of how AI technology works and why counterfactual output is produced. In addition, it is recommended that NIST help the public understand what the properties are of the statistics used for the training of large language models.
- **2b. Risks of fragmentation:** NIST is encouraged to balance pursuing science with what is being asked for by external entities in AI to prevent fragmentation and to maintain a clear vision and end goal.
- **2c. Strengthening internal responsible AI practices:** NIST leadership is encouraged to strategize responsible AI practices, both as a discipline and as external taskings.
- **2d. Analyzing energy consumption of AI:** NIST is encouraged to focus resources on energy consumption of AI, including developing metrics for measurement and evaluation.
- **2e. Ensuring proper implementation of Post-quantum Cryptography (PQC) Standards:** NIST should identify a process that outlines consistent and effective implementation of PQC standards.

Specifically, NIST should help with organizing a test plan for each of the new PQC algorithms so that the implementations can be done in a stable manner and without compromising security.

- **2f. Utilizing existing consortia to drive PQC adoption:** The VCAT suggests having a focused discussion with the Quantum Economic Development Consortium (QED-C) to help drive adoption of NIST's PQC standards.
- **2g. Growing Next-generation communications research areas:** NIST is encouraged to consider satellite communications as a growth area in the next-generation communications programmatic priority area.

### 3. Strengthening U.S. Manufacturing Leadership

- **3a. Avoid duplication of efforts:** NIST is encouraged to look for efficiencies across funding recipients to avoid duplication of efforts, where possible.

### 4. Future Opportunities and Strategic Planning

- **4a. Building new CET convergence areas:** NIST is encouraged to bring together NIST technical leads to discuss and map potential convergence opportunities for future focus NIST priority areas. Once mapped, opportunities should be ranked, by advantageousness, timeliness, or similar metric, and further strategized how to focus resources to support these new efforts.
- **4b. Providing more learning opportunities for AI:** NIST is encouraged to provide opportunities to teach their staff or give them opportunities to explore AI to help foster the development of new convergence areas with AI.

### 5. NIST Budget

- **5a. Assess core priorities:** The VCAT recommends that NIST leadership continually reassess core priorities to prepare for potential reductions in budget.

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## Introduction

In 2024-2025, the VCAT focused their efforts and discussions on the following priority themes to ensure NIST is fully supporting America's competitiveness in the global economy and adequately equipped to carry out their mission:

1. Emphasizing the NIST Core Mission
2. Meeting National Demands and Needs in Critical and Emerging Technologies (CETs) and Other Cross-Cutting Programs
3. Strengthening U.S. Manufacturing Leadership
4. Future Opportunities and Strategic Planning
5. NIST Budget

No new VCAT subcommittees were established in 2024, with all priorities being addressed through regular VCAT efforts.

The VCAT received detailed programmatic briefings in all listed areas within this section. This report summarizes the VCAT's work, observations, and recommendations related to these topics along with NIST efforts. The specific topics covered in this year's VCAT meetings are highlighted in **Table 1** below:

*Table 1. NIST VCAT Meetings and Topics Covered in this Report*

<b>June 11-12, 2024 (hybrid)</b>	<b>October 29-30, 2024 (hybrid)</b>	<b>February 12, 2025 (hybrid)</b>
Safety Update	Discussion on Safety at NIST	Ethics Briefing
Measurement Services and the Core NIST Mission	Intersections of AI Work at NIST – A Discussion with VCAT	Cybersecurity Priorities and Outlook
Climate and Energy Technologies Focus	Discussion on Global Standardization	Safety Key Performance Indicators (KPIs) and Goals
NIST Facilities Focus	Post-Quantum Cryptography and Cybersecurity	
NIST Response to VCAT Annual Report Recommendations	Advanced Communications	
AI Updates: NIST Labs Technical Portfolio and Launch of the U.S. AI Safety Institute	CHIPS Metrology Program	
Boulder Research Highlights	Opportunities for Convergence within CETs – a Discussion with VCAT	
NIST Budget Overview	Disaster Resilience	
Closed Session on NIST Budget	Closed Session on NIST Budget	

## 1. Emphasizing NIST's Core Mission

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Throughout the past year, NIST briefed the VCAT on NIST history as the United States' National Metrology Institute (NMI) and how NIST is participating in global standardization efforts. Noteworthy discussions on and recommendations for NIST to continue emerging as a leader in standards activities and metrology are described below. As facility conditions and safety of NIST staff are also a necessity to execute NIST's core mission, these topics will also be discussed in this section.

### 1.1. Measurement Services

Article I, Section 8 of the Constitution of the United States states "The Congress shall have the power to ...coin money, regulate the value thereof, and of foreign coin, and **fix the standard of weights and measures.**" Later, the National Bureau of Standards (NBS) was founded in 1901 with the mandate "to provide standard weights and measures, and to serve as the national physical laboratory for the United States." In 1987, NBS changed to NIST with the mission of "to promote U.S. innovation and industrial competitiveness by advancing measurement science, standards, and technology in ways that enhance security and improve our quality of life." As an NMI, NIST is charged by the government to maintain the primary standards and provide metrological traceability for the United States. While being the NMI of the United States is the original unique role of NIST, NIST's portfolio has also expanded greatly over the years, with Congress adding many other responsibilities and authorities over time to ensure that the agency addresses national needs.

As an NMI, NIST has many responsibilities and roles beyond solely maintaining the primary standards for the United States. NIST also provides traceability by performing 13,000+ calibrations a year, 27,000+ sales of standard reference material (SRM) units, and standard reference data that have over 25 million views. NIST staff is also engaged in important international metrology efforts and holds many leadership positions within them. NIST is also a trusted partner and engages with industry, through consortia and service programs, government, and academia to determine measurement needs. Finally, NIST uses measurement expertise to support the development of documentary standards, with over 400 technical staff on almost 1,700 standards committees. All of these roles advance measurement science and improve standards to promote U.S. competitiveness.

Despite the successes, there are many concerns with NIST's ability to continue to succeed in its role as an NMI. Only a small portion of the NIST budget goes to NMI-specific roles. Staffing levels are also low for these roles, with 60 percent of the calibration staff being eligible for retirement. These challenges and shortages lead to insufficient time for innovation and for responding to new measurement needs. Resource constraints have doubled the turnaround time for NIST's calibration services and the number of unavailable SRMs. In addition to these concerns, the expansion of NIST's responsibilities, despite growing NIST's impact and reputation and requiring a strong foundation in measurement science, has diminished the recognition of NIST as the NMI of the United States. The VCAT notes these concerns, with recommendations detailed below.

### 1.2. Global Standardization

The VCAT notes the unique role that NIST has within global standardization, which was highlighted during a deep-dive session during the October 2024 meeting. Specifically, NIST developed the U.S. Government National Standards Strategy for Critical and Emerging Technology (USG NSSCET) Implementation

Roadmap, which was released in July 2024 along with a corresponding fact sheet. To develop the roadmap, NIST implemented a robust stakeholder engagement plan, including using feedback from a Fall 2023 Request for Information on USG NSSCET implementation. The roadmap identified immediate actions including investing in pre-standardization research, removing barriers to stakeholder participation in standards development activities, expanding workforce development efforts, and enhancing international standards communication and cooperation with likeminded partners and allies. Additionally, the roadmap includes seven strategic actions for sustained implementation outcomes, including enhanced coordination and communication across the government, industry, and academia to support emerging technologies and participation in standardization.

In addition, NIST awarded \$15 million to ASTM International to lead the Center of Excellence for Standardization with its network of partnerships. The Center will support U.S. engagement in international standardization for critical and emerging technologies (CETs) by developing generalizable tools in many different technical fields for rapid standards development, leveraging existing NIST programs, creating an information hub, engaging in pre-standardization activities, building workforce capacity, and promoting small business participation in standards processes.

The VCAT is pleased with NIST's continued leadership in standards-related activities, especially NIST's investments in pre-standardization research and active engagement with stakeholder groups including industry, academia, and civil society.

### **1.3. Supporting Effective and Safe Operations**

NIST requires a safe working environment and world-class facilities to uphold its reputation and continue to execute on its mission and national needs. As noted in the 2023 VCAT Annual Report, safety is multifaceted. It affects everything from daily operations to advanced research and the Institute's ability to recruit and retain staff. An organization's overall effectiveness in meeting its mission is tied directly to its safety culture and the condition of the facilities in which the employees must work. Below is a summary of the discussions the VCAT had on NIST facilities and safety over the last year, along with recommendations on how to continue to support and grow NIST safety culture.

#### **NIST Facilities**

As discussed in the 2023 Annual VCAT report, the VCAT continues to note the intersection of under-investment in facilities and challenges with safety despite NIST continuing to prioritize improving the Laboratories and NIST facilities in budget requests. Not only do poorly maintained facilities lead directly to hazards, require unexpected funding to be used for repair, or require costly workarounds; they also reduce the impact and timeliness of work. The VCAT reemphasizes that safety issues alone should justify funding and guide all designs and implementations.

As of the beginning of FY 2024, nearly 78 percent of the Gaithersburg campus facilities and nearly 75 percent of research facilities are in poor to critical condition by square foot area, greatly necessitating renovation and repair. To address these facility issues, the National Academies of Sciences, Engineering, and Medicine (NASEM) recommends funding of \$300-\$400 million each year for construction and major innovations and \$120-150 million each year for Safety, Capacity, Maintenance, and Major Repairs (SCMMR) over a period of 12 years. In addition to this, other reports have emphasized the need for facility repairs including the Department of Commerce's Office of Inspector General's "Top Management and



Performance Challenges Facing the Department of Commerce in Fiscal Year 2024” and the Office of Science and Technical Policy (OSTP) report on U.S. Federal Research and Development Infrastructure. Finally, the VCAT Annual Reports continue to emphasize the importance of upkeep and repair of NIST facilities to ensure NIST can continue to meet national demands and executing its mission that’s critical to U.S. competitiveness.

### **Safety Culture and Practices**

Safety continues to be a focus area, for both the VCAT and NIST as a whole. NIST is being proactive towards implementing recommendations from multiple sources, including the VCAT and external auditors, and is having robust discussions to ensure the safety of their staff. The VCAT is pleased to see the progress being made on FY 2024 goals, including having a fully functional Safety Management System (SMS), improving the NIST safety culture, strengthening the Office of Safety, Health, and Environment (OSHE) roles and responsibilities, and establishing goals to improve leading metrics. In terms of FY 2025 goals, VCAT looks forward to seeing continued progress in having a fully functional safety management system and improving the NIST safety culture, and new progress in improving NIST’s safety performance and ensuring OSHE resources and staff are adequate to support implementation of the NIST SMS. The VCAT is also pleased to see the implementation of a previous recommendation to establish numerical goals for safety performance metrics and the outputs of these metrics, along with new and planned metrics to measure, and looks forward to tracking these outputs.

In addition to these metrics, discussing implementation of safety practices throughout multiple Laboratories was helpful to the VCAT to gain a holistic view of the safety culture across NIST. However, the VCAT notes challenges associated with safety practices while also promoting workplace flexibility options and evolving approaches to workplace safety, including enhanced observations of safety practices during experiments, focusing on significant injury and fatality (SIF) potential activities, having comprehensive equipment phases, and implementing training programs and tools to ensure safety. It is evident to the VCAT that safety continues to be a priority area for NIST and NIST leadership, and the VCAT notes the significant progress made over the last year.

### **Recommendations**

- **1a. Emphasizing the NIST core mission:** NIST should consider leveraging communications to highlight how metrology, and being an NMI, provides the foundation for all of NIST’s work and contributions across fields and sectors.
- **1b. Recruiting new talent:** When looking to recruit metrology-based talent, NIST should keep metrology integrated with other fields to help attract necessary staff.
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## 2. Meeting National Demands in Critical and Emerging Technologies (CETs) and Other Cross-Cutting Programs

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Throughout the past year, the VCAT was briefed by NIST on significant contributions that the Laboratories made in the advancement of critical and emerging technologies (CETs). Despite the challenges being faced, NIST continues to excel in their research programs and emerge as leaders. Currently, NIST focuses on seven CETs:

- Artificial Intelligence
- Biotechnology
- Cybersecurity and Privacy
- Energy Technologies
- Next-generation Communications
- Quantum Information Science
- Semiconductors

These are important technologies for the Nation and the VCAT notes that NIST plays a unique role in America's economic competitiveness. Recent NIST achievements in these CET focus areas are highlighted in the sections below.

### 2.1. Select Recent NIST Achievements in CETs and Programmatic Priority Areas

Over the course of the three meetings covered by this report, NIST provided specific updates to their efforts on multiple CETs, including Next-generation Communications, AI, cybersecurity and privacy, energy technologies, quantum information science, and semiconductors. Selected achievements over the last year for each of these CETs can be found below.

#### **Artificial Intelligence:**

Over the past year, the VCAT has observed that NIST has continued to be a global leader in AI. NIST's strong research and measurement science expertise is filling a critical gap by developing empirically grounded tests and evaluations of AI technologies and developing technical guidance and tools to support the development of technical standards. NIST aims to build the tools to ensure AI systems are safe and trustworthy, allowing organizations and consumers to realize the full potential of AI.

The VCAT appreciates NIST's robust approach to AI. NIST's AI vision is accomplished through multiple angles, including through:

- The NIST AI Innovation Lab (NAIIL), which provides foundational research to support evaluation and testing for AI and is anchored by the AI Risk Management Framework.
- Integration of AI into various other NIST programs across NIST’s laboratory and extramural programs.
- The newly established U.S. AI Safety Institute, which seeks to advance the science of AI safety and address the most harmful risks posed by advanced AI systems.

The VCAT applauds the many initiatives and efforts NIST has undertaken to engage stakeholders on this important and rapidly evolving topic. For example, NIST released the NIST Trustworthy & Responsible Artificial Intelligence Resource Center (AIRC), a one-stop shop for documents, data, and tools about risk management to help stakeholders with the development and deployment of trustworthy and responsible AI. NIST also convened a generative AI public working group with more than 2,000 volunteers to study and understand the risks of generative AI. NIST is also working with stakeholders to advance the measurement science of AI. In 2024, NIST awarded \$6 million to Carnegie Mellon University (CMU) to establish a joint center to support cooperative research and experimentation for the test and evaluation of modern AI capabilities and tools.

Because of NIST’s expertise and strong reputation for working with stakeholders, NIST was tasked in several U.S. government actions, including developing guidelines, promoting the development of consensus-based standards, providing a test environment for evaluations of AI systems, and building community and global engagement. NIST rose to the challenge and completed their taskings, releasing various guidelines and documents. NIST also launched the Assessing Risk and Impacts of AI (ARIA) evaluation research program, which will assess models and systems that are submitted by technology developers to help support the safe, secure, and trustworthy development of AI. NIST also released Dioptra, a new software package designed to measure how adversarial attacks can degrade the performance of an AI system.

NIST also established the U.S. AI Safety Institute (AISI), which has a mission to advance the science of AI safety and advance the implementation and adoption of the science. AISI is evaluating the most highly capable AI models through agreements with major companies including Anthropic and OpenAI. AISI worked to build a global ecosystem of AI safety institutes and held the first convening of the International Network of AI Safety Institutes in San Francisco in November of 2024. NIST also established the AISI Consortium (AISIC), which has more than 280 members and is working to develop science-based and empirically backed guidelines for AI measurement and policy, laying the foundation for AI safety across the world. The AISIC working groups focus on five topics, including risk management for generative AI, synthetic content, capability evaluations, red-teaming, and safety and security. The VCAT is pleased to see all of the rapid progress made in the last year and looks forward to seeing future outcomes and impacts resulting from NIST’s AI work.

### **Biotechnology:**

Although not having a specific session dedicated to biotechnology this past year, the VCAT notes great progress made throughout the CET priority, including NIST entering into a two-year cooperative research agreement with the nonprofit Engineering Biology Research Consortium (EBRC) to develop screening and safety tools to defend against the potential misuse of AI related to nucleic acid synthesis. NIST also signed a cooperative research and development agreement (CRADA) with the Bill & Melinda Gates Foundation

to begin creating standards and testing protocols for a new generation of breathalyzers that can diagnose malaria and tuberculosis. Finally, NIST's RADaR program that provides near real-time identification of illicit street drugs has expanded into more than ten states and has a publicly available monthly newsletter which reports on trends in detected drugs along with never-before-seen substances. The VCAT notes the importance of these achievements and looks forward to seeing the outcomes of these partnerships.

### **Cybersecurity and Privacy:**

Over the past decade, NIST has led a collaborative process to develop and evaluate Post-Quantum Cryptography (PQC) algorithms. NIST's role was not to design the algorithms, but to manage a process that brings in global experts to design the algorithms, evaluate the algorithms internally, facilitate external analyses, and then select algorithms for standardization. In August 2024, NIST published its first three Federal Information Processing Standards (FIPS) for PQC. In the future, NIST work includes enhancing "crypto agility" to enable easier transitions to future cryptographic algorithms as well as continuing updates to NIST guidance and documents. These efforts feed into the United States' goal to transition to PQC standards and new algorithms by 2035.

The VCAT was also presented an update on the overall cybersecurity program at NIST. The foundation of cultivating trust by advancing cybersecurity and privacy standards, guidelines, and measurement science is evident throughout the program. NIST's unique role and collaborative approach, working closely with organizations across the United States and globally, is well-noted by the VCAT. The VCAT also notes that much of the direction of the cybersecurity program is driven by Congressional mandates, Executive Orders, and the needs of industry and other federal agencies, further supporting the notion that NIST is well-trusted in this space, with a proven track record, experience, and expertise.

During the presentation, NIST described nine of their cybersecurity focus areas, including education and workforce, identity and access management, cybersecurity measurement, human-centered cybersecurity, privacy, emerging technology, cryptography, trusted networks and platforms, and risk management. NIST also shared a few cybersecurity program success stories over the last year, including the major milestone release of the Cybersecurity Framework (CSF) 2.0 in 2024, which added new governance and supply chain considerations to the Framework. Released in conjunction with CSF 2.0 was a suite of updated resources to help all organizations manage and reduce risks and offer practical and actionable suggestions to help organizations immediately improve their cybersecurity posture. The CSF 2.0 is widely used domestically and internationally and proves to be a vital resource to U.S. industry. Another success story included recent updates to NIST's Digital Identity Guidelines, which are also broadly adopted and used, including, and beyond, the United States Government. The updates expanded the scope of activities under the guidelines to meet increasing technological demands for stronger identity solutions and these efforts are driving global interest and awareness of emerging technologies, such as mobile Driver's Licenses, digital credentials, and Syncable Authenticators. A final story noted the success of the National Cybersecurity Center of Excellence (NCCoE), a public-private partnership that helps enable the creation of practical cybersecurity solutions. The Center collaborates and works with industry and innovators to understand industry challenges and provide recommendations for solutions and implementation plans using real technologies and standards. This is a valuable cross-NIST resource that furthers NIST's role in multiple cybersecurity sectors and through interdisciplinary work. For example, projects at the NCCoE cover a broad range of topics from manufacturing and the supply chain to the

intersection between AI and genomics with cybersecurity. NIST also shared plans for other guidance document updates and workshops planned throughout 2025, illustrating the vital work that is to come in the next year.

### **Disaster Resilience:**

During a special highlight session on disaster resilience, NIST detailed two ongoing disaster investigations; the impact of Hurricane Maria on Puerto Rico, looking at how the built environment responded to the hurricane, including the infrastructure; and the Champlain Towers South building collapse in Surfside, Florida. These investigations yield science-based findings that suggest changes to building codes and standards that can help prevent incidents like these from happening again, and for reducing community recovery time when they do occur.

In fire research, NIST, along with the California Department of Forestry and Fire Protection (CAL FIRE) and the Insurance Institute for Building and Home Safety (IBHS), created a wildland-urban interface (WUI) fire hazard mitigation methodology (HMM), which is a performance-based framework that helps communities assess and mitigate WUI fire risks at the structure, parcel, and community-level. NIST is currently working with the U.S. Fire Administration to make this HMM concept part of the National Wildfire Response Strategy and the International Building Code is planning on implementing the basic principles underlying the HMM into the 2027 International Wildland Urban Interface Code. NIST also published “A Legacy of Fire Safety: NIST Marks 50 Years of the Federal Fire Prevention and Control Act of 1974” to showcase some of the varied scientific and technical advances by NIST’s fire research – together with external partners – that have advanced fire science and positively impacted the U.S. fire problem.

Finally, Forward-Looking Building Codes is a new program started in Fiscal Year 2023. On this front, NIST has been collaborating with the National Oceanic and Atmospheric Administration (NOAA) and the American Society of Civil Engineers (ASCE) in a partnership that began in late 2021, with support from the University of Maryland. The scope was to identify the needs of the civil engineering community, as it considers ways to help communities understand and reduce their natural hazard vulnerability, especially regarding extreme weather events, with emphasis on better and more useful forecast information, new technologies, and more up-to-date codes and standards. Three workshops were hosted by NIST, the National Oceanic and Atmospheric Administration (NOAA), and the American Society of Civil Engineers (ASCE) to support the use of long-term weather projections for community resilience planning. In 2025, NIST will host four workshops to collect data that will assist NIST in developing a roadmap for advancing building and infrastructure codes. The VCAT is pleased to have discussed these topics as part of a special highlight session.

### **Energy Technologies:**

The June 2024 VCAT meeting highlighted projects from two researchers detailing recent accomplishments and projects relevant to energy technologies. The first highlighted frequency combs, which can record a high-fidelity spectrum with high precision and are a NIST-generated technology. The second focused on radiometry for climate metrology, which highlighted that microfabricated broadband radiometers are being used to make very precise measurements of light in small packages and are useful for satellites. The use of far infrared virtually imaged radiometer (FIRVIR) technology for climate metrology combines detector technologies, traceability, and spectroscopy to build a very high resolution far infrared tool to

provide more accurate calibrations for climate metrologists. The VCAT enjoyed hearing and discussing the technical work being done in energy technologies and looks forward to the outcomes of future NIST work in this space.

#### **Next-generation Communications:**

To guide and inform NIST's work, NIST has recently completed the Next-Generation Wireless R&D Gaps Analysis in collaboration with other agencies that identifies technical gaps that are crucial to sustain innovation in post-5G wireless systems. NIST is also listed as a contributing stakeholder in three of the four pillars of the National Spectrum Strategy's Implementation Plan, which aims at promoting innovation in the public and private sectors to maintain U.S. leadership in wireless technologies and highlights NIST's unique role in this CET area. Additionally, spanning multiple CET areas, NIST has equities working to improve chip-level measurements and evaluate new chip platforms. Finally, NIST's role in innovative technologies like indoor mapping, wearable augmented reality, virtual reality technologies, and unmanned aerial vehicles for remote connectivity help improve public safety and are vitally important for the safety of first responders in emergencies.

#### **Quantum Information Science:**

The June 2024 VCAT meeting in Boulder provided a unique opportunity to highlight the tandem work being completed at NIST and JILA, a joint institute of the University of Colorado Boulder and NIST, which resides on the University of Colorado Boulder campus and is the home of the NIST Quantum Physics Division. In this session, examples of discoveries made at JILA, including ultracold polar molecules, entangled interferometers, and the nuclear transition in thorium with the scientific vision of harnessing quantum complexity for many-body quantum systems and using them for applications ranging from quantum simulation information to metrology were discussed.

The VCAT notes the significant impact of precision measurements developed at JILA to fundamental research in physics. This unprecedented level of accuracy enables new experiments and applications, and the key techniques are being adopted by extramural researchers. The VCAT also notes additional scientific breakthroughs coming out of JILA, where researchers have both developed an atomic clock more precise and accurate than any clock previously created. Scientists at JILA also demonstrated key elements of a nuclear clock, including precise frequency measurements of an energy jump in a thorium-229 nucleus, which could lead to improved timekeeping and navigation, faster internet speeds, and advances in fundamental physics research.

### **Recommendations**

The VCAT recommends NIST take the following steps to ensure that the Institute's expertise and capabilities are best used to make significant contributions on CETs:

- **2a. Building credibility and understanding of AI guidelines:** To enhance credibility, NIST-released AI guidelines, should include explanations of how AI technology works and why counterfactual output is produced. In addition, it is recommended that NIST help the public understand what the properties are of the statistics used for the training of large language models.

- **2b. Risks of fragmentation:** NIST is encouraged to balance pursuing science with what is being asked for by external entities in AI to prevent fragmentation and to maintain a clear vision and end goal.
- **2c. Strengthening internal responsible AI practices:** NIST leadership is encouraged to strategize responsible AI practices, both as a discipline and as external taskings.
- **2d. Analyzing energy consumption of AI:** NIST is encouraged to focus resources on energy consumption of AI, including developing metrics for measurement and evaluation.
- **2e. Ensuring proper implementation of Post-quantum Cryptography (PQC) Standards:** NIST should identify a process that outlines consistent and effective implementation of PQC standards. Specifically, NIST should help with organizing a test plan for each of the new PQC algorithms so that the implementations can be done in a stable manner and without compromising security.
- **2f. Utilizing existing consortia to drive PQC adoption:** The VCAT suggests having a focused discussion with the Quantum Economic Development Consortium (QED-C) to help drive adoption of NIST’s PQC standards.
- **2g. Growing Next-generation communications research areas:** NIST is encouraged to consider satellite communications as a growth area in the next-generation communications programmatic priority area.

### 3. Strengthening U.S. Manufacturing Leadership

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NIST supports U.S. manufacturing through many avenues, including through internal NIST Laboratory programs underpinning measurement methods and standards to advance manufacturing, the Manufacturing USA program creating a national network supporting U.S. manufacturers, the Hollings Manufacturing Extension Partnership (MEP) utilizing a public-private partnership helping small and medium-sized manufacturers grow, and through the implementation of legislation aimed toward revitalizing the U.S. semiconductor industry. Since the last VCAT report, the VCAT notes great progress made under these programs highlighted in the sections below.

#### 3.1. Advanced Manufacturing Legislation

This past year, considerable effort was expended on the CHIPS Program which is representative of the care NIST shows in meeting Congressionally directed programs. Last year’s report and coverage period detailed the beginning of the Preliminary Memorandum of Term (PMT) agreements coming from the CHIPS Program Office (CPO) and the start of the National Semiconductor Technology Center (NSTC) and the National Advanced Packaging Manufacturing Program (NAPMP) from the CHIPS Research and Development Program Office (CRDO), this year saw growth in the implementation of the CHIPS and Science Act, including the first final awards made from both offices. These initiatives provide a sound technical basis for any U.S. advanced manufacturing initiatives. For example, CPO continued to announce PMT agreements and began finalizing awards, currently having over \$33 billion of funds awarded. CRDO has also currently announced over \$7.2 billion and has disbursed over \$219 million, signifying a large portion of allocated funds being awarded. In addition to these funds, NIST is also prioritizing workforce development, which is evident through partnerships with the National Science Foundation to establish the Network Coordination Hub that will manage the National Network for Microelectronics Education and the NSTC Workforce Center of Excellence, which are essential to the continuation of a strong

semiconductor manufacturing base in the United States. The VCAT is pleased with this progress and commends the work helping to build a more robust semiconductor ecosystem here in the United States.

In addition to these, the VCAT was presented with details on a new Metrology Program, at the October 2024 VCAT meeting. The Metrology program, as of October 2024, has funded over 40 NIST project teams in the amount of over \$190 million across six of the seven Grand Challenges identified by over 800 external stakeholders from industry, academia, and other government agencies. To help facilitate collaborations to help improve data and knowledge sharing across stakeholders and to inform industry standards, the Metrology Community was established. In addition, the Metrology Exchange to Innovate Semiconductors (METIS) was also launched to make research and data available in a manner that guards intellectual property, protects U.S. security interests, and is aligned with the approach used by NIST for access to research results. The VCAT is pleased to see NIST's direct involvement in Advanced Manufacturing R&D Programs, as metrology is critical to a vibrant semiconductor R&D system.

### 3.2. Other Manufacturing Programs

Since the last VCAT report, two new Manufacturing USA institutes have been announced. The first, a Manufacturing USA Institute for Digital Twins was announced and awarded to the Semiconductor Research Corporation Manufacturing Consortium Corporation (SRC) for \$285 million to establish and operate a new Manufacturing USA institute headquartered in Durham, North Carolina. The new institute, known as SMART USA (Semiconductor Manufacturing and Advanced Research with Twins USA) will focus on efforts to more rapidly develop, validate, and use digital twins to improve domestic semiconductor design, manufacturing, advanced packaging, assembly, and test processes. The second Manufacturing USA Institute announced is focused on the use of AI to increase the resilience of U.S. manufacturers, anticipating funding up to \$70 million in federal funds invested over 5 years, with an equal or greater contribution from private and other non-federal funding. The VCAT believes these two institutes will be valuable and unique additions to the Manufacturing USA Institute portfolio and looks forward to the impacts these two institutes have on the U.S. manufacturing ecosystem.

### Recommendations

- **3a. Avoid duplication of efforts:** NIST is encouraged to look for efficiencies across funding recipients to avoid duplication of efforts, where possible.

## 4. Future Opportunities and Strategic Planning

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Throughout this past year, and especially in the February 2025 VCAT meeting, the VCAT has been presented with the current state of NIST, along with being involved in discussions of the future of many parts of NIST, including the Director's Office, the Laboratory Programs, Innovation & Industry Services, and Management Resources. The VCAT is pleased to be engaged in these discussions, with summaries and recommendations described below.



#### 4.1. Future Directions for NIST

An individual session during the October 2024 VCAT meeting focused on opportunities for convergence within NIST's CET priorities. This session, which prompted especially robust discussion, highlighted the expansive collaborations NIST Laboratories have across multiple disciplines, both internally and externally. The VCAT is pleased to hear the cross-cutting collaborations discussed and incorporation of technologies like AI and quantum chemistry to solve new challenges and expand the reach of these technologies. The VCAT stresses the importance of having both formal and non-formal conversations to help build relationships and spark opportunities for new convergence areas and collaborations to form. However, it is clear that NIST continues to be in the spotlight for innovation of new technologies and the VCAT looks forward to seeing new opportunities emerge.

#### Recommendations

- **4a. Building new CET convergence areas:** NIST is encouraged to bring together NIST technical leads to discuss and map potential convergence opportunities for future focus NIST priority areas. Once mapped, opportunities should be ranked, by advantageousness, timeliness, or similar metric, and further strategized how to focus resources to support these new efforts.
- **4b. Providing more learning opportunities for AI:** NIST is encouraged to provide opportunities to teach their staff or give them opportunities to explore AI to help foster the development of new convergence areas with AI.

### 5. NIST Budget

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The VCAT recognizes that the passing of multiple continuing resolutions has made budgetary and programmatic planning challenging for FY 2024 and beyond. The high-level differences in the FY 2023 enacted funding levels, compared to the core budget reductions enacted in FY 2024 are shown in **Table 2** below. Note that the community projects (including community construction projects) are one-time directed funding to be spent outside of NIST, not within NIST's intramural scientific and research programs or for NIST's facilities. The VCAT notes how important it is to recognize that the NIST budget is growing because of these one-time community project funds, but that these community project funds do not increase the base funding for NIST and, when directed without additional funding for management and execution of these activities, the community projects also pull resources from execution of NIST's core mission. For NIST to sustain their scientific capabilities and the ability to respond promptly to new needs presented by changing and emerging technologies, base funding must be increased. For FY 2025, a full-year continuing resolution was enacted, keeping the funding consistent across NIST's accounts for programs and facilities, while eliminating the one-time community project funding.

Table 2. NIST Budget (dollars in millions)

Activity	FY 2023 Enacted*	FY 2024 Enacted	FY 2025 Enacted
<b>Scientific &amp; Technical Research Services (STRS)</b>	<b>953.0</b>	<b>1,080.0</b>	<b>857.2</b>
<i>Laboratory Programs (STRS)</i>	890.5	857.2	857.2
<i>Community Projects (STRS)</i>	62.5	222.8	0.0
<b>Industrial Technology Services (ITS)</b>	<b>212.0</b>	<b>212.0</b>	<b>212.0</b>
<b>Construction of Research Facilities (CRF)</b>	<b>462.3</b>	<b>168.0</b>	<b>87.8</b>
<i>Construction of Research Facilities (CRF)</i>	130.0	87.8	87.8
<i>Community Construction Projects (CRF)</i>	332.3	80.2	0.0
<b>Total, NIST Discretionary</b>	<b>1,627.3</b>	<b>1,460.0</b>	<b>1,157.0</b>

\*Excludes one-time supplemental funds.

## Recommendations

- **5a. Assess core priorities:** The VCAT recommends that NIST leadership continually reassess core priorities to prepare for potential reductions in budget.

## Appendix

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### About the VCAT

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 2024 annual report covers the period from March 2024 through February 2025.

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.

The Committee reviews a significant portion of NIST programs through direct discussion with NIST leaders, scientists, and engineers. Committee members present candid feedback to NIST senior management and other attendees at each meeting and encourage continuous dialogue. This feedback encourages continuous improvement in key areas in the overall operation of the Institute. The Committee periodically visits various NIST laboratories and satellite facilities to discuss research projects directly with NIST technical staff. These laboratory visits and associated 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 how effectively the existing facility infrastructure meets the needs of the NIST mission. During this period of performance, meetings were both hybrid and virtual.

Under the Committee charter, the Director of NIST appoints the VCAT members. Members are selected on a transparent, standardized basis, in accordance with applicable Department of Commerce (DOC) 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, organizational culture, safety, the environment, and international relations; and shall be selected in accordance with applicable DOC guidance. No employee of the Federal Government can serve as a member of the Committee. Members are appointed for staggered three-year terms.

During this reporting period, six new VCAT members, Dr. Gaurab Chakrabarti, Dr. Glenn A. Fox, Dr. Michael J. Holland, Dr. Cherry A. Murray, Dr. Jacqueline (Jack) Meszaros, and Dr. Joseph Broz were appointed.

This report highlights the Committee's observations, findings, and recommendations. Detailed meeting minutes and presentation materials are available on the NIST website at [www.nist.gov/director/vcat](https://www.nist.gov/director/vcat).

## VCAT Members during the Period Covered by this Report

**Mr. Jason Matusow**, Chair

Microsoft

Term: September 14, 2022 – September 13, 2025

**Dr. Mark Pierpoint**, Vice Chair

Keysight Technologies, Inc.

Term: April 1, 2023 – March 31, 2026

**Dr. Joseph Broz**

IBM Quantum

Term: December 20, 2024 – December 19, 2027

**Dr. Anthony M. Johnson**

University of Maryland Baltimore County (UMBC)

Term: October 4, 2021 – October 3, 2024

**Dr. Vinton G. Cerf**

Google

Term: December 21, 2018 – December 20, 2024

**Dr. Eric Kaler**

Case Western Reserve University

Term: December 21, 2018 – December 20, 2024

**Dr. Gaurab Chakrabarti**

Solugen

Term: December 2, 2024 – December 1, 2027

**Dr. Mehmood Khan**

Hevolution Foundation

Term: November 13, 2018 – November 12, 2024

**Mr. George Fischer**

T-Mobile

Term: May 22, 2018 – May 21, 2024

**Ms. Katharine Ku**

Wilson Sonsini Goodrich and Rosati

Term: May 22, 2018 - May 21, 2024

**Dr. Glenn A. Fox**

Lawrence Livermore National Laboratory

Term: April 30, 2024 – April 29, 2027

**Dr. Jacqueline (Jack) Meszaros**

National Science Foundation (Former)

Term: December 20, 2024 – December 19, 2027

**Dr. Monisha Ghosh**

University of Notre Dame

Term: April 1, 2023 – March 31, 2026

**Dr. Cherry A. Murray**

University of Arizona

Term: April 30, 2024 – April 29, 2027

**Dr. Michael J. Holland**

University of Pittsburgh

Term: October 25, 2024 – October 24, 2027

**Dr. Michelle Parker**

Boeing

Term: January 14, 2022 – January 13, 2025

**Dr. Dana (Keoki) Jackson**

MITRE Corporation

Term: May 22, 2018 – May 21, 2024