

Report on NIST Leadership for the Implementation of the U.S. Standards Strategy for Critical and Emerging Technology

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

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Subcommittee on U.S. International Standards Development Activity

In April 2023, NIST Director Locascio tasked the Visiting Committee on Advanced Technology (VCAT) with the establishment of an international standards subcommittee to provide recommendations to NIST on its leadership for the implementation of the U.S. Government National Standards Strategy for Critical and Emerging Technology (NSSCET or “the strategy”) and to address three specific concerns related to U.S. participation and competitiveness in international standards development. The VCAT subcommittee invited visiting experts representing civil society, academia, and industry to participate in the process and provide their independent views to support the drafting of this report.

The charter of the subcommittee inquiries specified three areas of inquiry:

- Barriers to U.S. participation in standards development activity, and opportunities for knowledge and resource sharing to ensure U.S. equities from the private and public sector are supported -- especially in potentially disruptive, fast-moving technology areas
- Opportunities to increase the number of professionals in CET sectors engaged in standards development activity, particularly in small and medium size enterprises (SMEs);
- Opportunities for NIST to work effectively with private-sector stakeholders to foster greater U.S. investment in pre-standardization research that is essential to standards development activity.

The following VCAT members participate in the subcommittee:

- Jason Matusow, General Manager Corporate Standards Group, Microsoft – subcommittee Chair
- Vint Cerf, Vice President and Chief Internet Evangelist, Google

The following visiting experts participated in the subcommittee process and provided independent written observations to support the drafting of this report:

- Veronica Lancaster, Vice President of Standards Programs, Consumer Technology Association
- Jim Matthews, Director Technical Standards and Standards Policy, Corning
- Joshua Meltzer, Senior Fellow, The Brookings Institute
- Susan Miller, President and Chief Executive Officer, Alliance for Telecommunications Industry Solutions
- Mary Saunders, Vice President Government Relations and Public Policy, American National Standards Institute
- Tim Simcoe, Professor, Questrom School of Business, Boston University

- Phil Wennblom, Global Director Standards Policy, Intel

The VCAT subcommittee held a series of seven video teleconference meetings to hear presentations from a cross-section of leading experts in the standards community. Presenters represented U.S.-based standards setting organizations, academic institutions, think tanks, industry association groups, legal representatives for U.S.-based standards consortia, the National Academy of Sciences, other federal advisory committees supporting the U.S. Department of Commerce, and select U.S. Government agencies with direct interests in international standardization.

Executive Summary of Findings and Recommendations

The objective of this document is to provide specific, actionable recommendations for NIST as it seeks to both oversee the implementation of the NSSCET and apply its resources to improving U.S. leadership in standardization of CETs. While NIST is the federal agency responsible for promoting innovation and industrial competitiveness through measurement science, standards, and technology, it is not a standards development organization (SDO). The word “standards” holds many meanings and NIST traditionally differentiates between metrology standards for measurement and documentary standards which are technology specifications that provide requirements or guidance on topics such as safety or interoperability of technologies. That said, NIST supports the development and adoption of industry-led, voluntary, consensus standards that enhance the economic opportunity for U.S. industry. NIST also engages with the international standards community to advance U.S. and its allies’ interests and values in global markets and policy arenas. The findings of this report are focused on these elements of NIST’s overall mission.

The VCAT subcommittee on international standards conducted an extensive review of the current state of the U.S. standards system, the challenges and opportunities it faces, and heard presentations from standardization stakeholders regarding recommendations for USG actions. The report aims to help NIST and the U.S. Government (USG) develop and implement a national standards strategy that aligns with the strategic vision, goals, and priorities of the NSSCET and that leverages the strengths and expertise of the U.S. private sector, academia, civil society, and public sector.

The report identifies four major themes that underpin the subcommittee's recommendations:

- Coordination: The USG should enhance its coordination and collaboration across agencies, departments, and offices to develop and execute a coherent and consistent standards policy that supports U.S. leadership and competitiveness in critical and emerging technologies.
- Engagement: The USG should increase its engagement and participation in CET standards development organizations and fora as a stakeholder and expand bilateral and multilateral dialogues and initiatives coincident with U.S. interests and values while mitigating challenges posed by strategic competitors.
- Capacity: The USG should invest in resources and incentives to support the U.S. standards-setting ecosystem by increasing USG and private sector capacity and long-term commitment to active engagement, sponsoring small and medium enterprise engagement in standardization, facilitating the

hosting of international standards meetings in the U.S., and empowering the next generation standards workforce.

- Innovation: The USG should foster a culture of innovation and excellence in standards development and implementation by looking first to its internal science community for pre-standardization materials, encouraging the broader research community to also develop and contribute pre-standardization materials, and engaging in multilateral dialogues with trade partner countries to preserve and foster a healthy standards system which provides fertile ground for U.S. industry to engage in pro-competitive standardization activities.

Findings and Recommendations

USG National Standards Strategy for Critical and Emerging Technology

The subcommittee heard universal support from participating experts regarding the NSSCET as a positive step in recognizing the important role of standardization in the U.S. economy and in the evolution of CETs. There is recognition of the fact that the strategy is focused on standardization from the perspective of national security and national competitiveness. While this is important, the experts noted the risk that the strategy loses sight of the scale and diversity of the U.S. standards system which has been pivotal in the overall competitiveness of the U.S. economy. In addition, the long-standing U.S. policy of supporting an industry-led, voluntary standards system should remain of paramount importance. The subcommittee received clear feedback that the NSSCET should not be used as a mechanism or excuse for government to assert control over the standards system.

Recommendation 1 (R1): NIST should articulate an aligned version of the NSSCET terminology and taxonomy of actions with the American National Standards Institute US Standards Strategy (USSS).

U.S. industrial and national security interests are best served when international standards are developed in open, participatory, rules-based organizations. U.S. Government engagement in international standards organizations is both as a stakeholder for technical specification development and as an advocate for robust governance processes aligned with the principles of neutral, balanced, transparent, and inclusive standardization development. In all instances, U.S. government advocacy should take into account the organization's formal decision making process and work within that process. Experts noted that any USG policy or action that is a deviation from these principles will be seized upon as justification for the exclusion of U.S interests from non-U.S. standardization. This was demonstrated by recent proposals in "like-minded" foreign countries where the justification for the exclusion was based in-part on the 2019 U.S. Department of Commerce Bureau of Industry and Security Temporary General License for Huawei and subsequent lack of policy clarity for standardization activities related to Entity Listed firms in the Export Administration Regulation.

R2 NIST should build capability among USG standards professionals to, where appropriate, take on leadership roles in strategic CET standards organizations so they may facilitate efficient and trustworthy standards development by upholding robust governance processes to protect against perceived abuses by actors of concern.

R3 NIST should maintain unequivocal and effective advocacy that represents a commitment to an open, participatory standards system consistent with the World Trade Organization Technical Barriers to Trade Agreement standardization principles and code of good practice.

The strategy primarily addresses CETs through the lens of international standardization and under the premise that standards are uniformly applicable to all CET domains. Experts noted that this approach is insufficient for the practical implementation of the strategy. Furthermore, the NSSCET lacks recognition of the diversity of standards organizations, which is an important strength of the U.S. standards system that should be protected. Overly broad and Prescriptive solutions to address perceived challenges in a limited number of standards organizations could have negative consequences for the larger standards system. A consistent concern aired by experts in the listening process was the presumption that the telecommunications/mobile communications CET standards discussion is representative of all CET standards dynamics. Such a conclusion is not only factually incorrect, but also dangerous as it leads to policy and actions that have and will harm the broader standards system which continues to be critical to all U.S. industry.

R4 NIST should include the full spectrum of public-private collaboration mechanisms as they lead the USG implementation of the strategy including consideration of formal standards organizations, industry consortia, and open source software.

The strategy does not recognize the diverse role that standards can or should play for different CETs such as where in the maturity cycle of given CET technology or commercialization standards can have the greatest impact. Furthermore, the strategy asserts a linear rather than a continuous cycle of model for standardization in the context of CETs and implies that participation in that standardization is a goal unto itself. This perspective risks missing the importance of creating an environment that facilitates implementation of the resulting standards. Finally, the strategy fails to recognize that commercialization and the treatment of intellectual property is not consistent across CET domains. Using a one-size-fits-all approach for AI or quantum technologies as if they were the same as another technology such as mobile communications is problematic.

NIST is respected for its development of frameworks and other deliverables that offer guidance on various new technologies. The subcommittee noted that these frameworks sometimes overlap with the scope of documentary standards which are either already published or in parallel development. When both a NIST deliverable and a documentary standard provide guidance for a specific CET, there is a concern that having two deliverables may cause industry experts to split their time and attention, potentially slowing the development of both. In the case where the USG applies marketplace pressure for adoption of a NIST framework via the influence of procurement, market actors may be burdened with the costs of supporting two sets of guidance. In such a scenario, small and medium enterprises are likely to be the most impacted.

R5 NIST should make individual assessments as to the role of standards relative to the state of development and commercialization for each of the stated CETs targeted by the strategy.

- R6 NIST should support USG inter-agency strategy and engagement with CET assessments to maximize the impact of standardization outcomes.**
- R7 NIST should consider carefully how to contribute its expertise to international standards organizations rather than develop overlapping deliverables to avoid fragmenting development resources and market attention.**
- R8 NIST should consider how to contribute content from NIST-specific deliverables to a relevant international standard soon after completing the deliverable.**

The NSSCET is necessarily focused on the creation of standards, but there is a danger in this as it assumes that standards are an end unto themselves. The U.S. standards system is a market-based system meaning that it is the implementation of standards by marketplace actors that defines the relevance and impact of a given specification. Marketplace competition is a driver for standards participants, for standards setting bodies, and for implementers of the standards. Standards of all types (e.g. metrology, safety, interoperability, and management practices) establish a baseline from which further innovation and economic opportunity can be realized. Assuming they are created in a voluntary, open, participatory, and rules-based process, participants and implementers alike have equal access to the benefits of the standards. For this reason, standards setting is considered pro-competitive activity under competition law. But it also means that for standards to be responsive to marketplace demands, they must be updated, improved, and sometimes purposely deprecated over time.

USG career executives and political leadership (with each new incoming administration) will be more effective advocates for U.S. interests with an understanding that standardization is not a linear exercise where participation is the only measure of success of the NSSCET. Enhancing the quality of understanding and engagement in the full lifecycle of CET standards should be a priority.

- R9 NIST should build knowledge in the USG leadership community as to the strategic purpose and long-term relationship of standards to CETs to translate the strategy into long-term strength for the U.S. and its trading partners.**
- R10 NIST should encourage CET standards participation where its benefits are greatest leading to a better long-term return on investment for all U.S. stakeholders.** (Note: one method to accomplish this is to explicitly link the “roadmaps” discussed at NSSCET Line of Effort #4 to participation incentives discussed in Line of Effort #5.)

The U.S. is the world leader in innovation, but the reality is that not all CET innovation happens in the United States. Economic opportunities for the creation of and access to new CET-related markets, the opportunity to build global partnerships between diverse industry participants, and the ability to develop complex, resilient supply chains are all network effects of a healthy global standards system. This observation cannot be made without due consideration of national security and/or geopolitical realities but rather, those risks are mitigated via strong governance processes in standards bodies, transparency in the source of contributions, and maintaining strong engagement in the work. Furthermore, the national security interests in CETs also increase the impact and importance of the NSSCET in calling out the strategic importance of long-term engagement, investment, and leadership in U.S. CET standardization. This point further underscores Recommendation 1 that the NSSCET implementation should be coherent with the ANSI US Standards Strategy.

R11 NIST should build knowledge in the USG leadership community as to the strategic advantage of an open, participatory standards environment for CETs where U.S. industry benefits from the opportunity to have both access to, as well as the opportunity to innovate above and beyond technologies contributed to CETs from non-U.S. participants.

Experts noted the important relationship between U.S. competitiveness in international standardization and the ability to and frequency of hosting standards meetings. This point will be further addressed in the Barriers/Hosting discussion below and is closely tied to the implementation of the NSSCET.

R12 NIST should identify specific steps that the USG can take to support a robust program to host standards meetings in the U.S. that directly support NSSCET objectives.

Civil society and industry commentary on the NSSCET noted the lack of an inclusive process during the development of the strategy. The subcommittee recognizes and endorses the efforts by NIST to hold NSSCET listening sessions and a public RFI and comment process to rebuild the connection with stakeholders of the public private partnership that underpins the US standards system.

R13 NIST should incorporate the feedback received from the VCAT process along with that of their community listening sessions and NSSCET RFI responses to inform USG leadership of the implementation of the NSSCET.

Barriers to U.S. participation in standards and opportunities for CET standards knowledge and resource sharing

The fundamental position of the Visiting Experts is that no global, systemic barriers exist for U.S. participation in international standardization. This is primarily because the long-standing principles of openness and a system of contribution-based standards creation drives the need for inclusiveness rather than exclusiveness. Moreover, the broader standardization ecosystem consisting of industry consortia also has no such barriers in place and, arguably, is more available to U.S. participation as most are domiciled in the U.S. and thus small and medium enterprises (SMEs) are more likely to participate due to the lower opportunity and travel costs of participation.

There are challenges to participation that are worthy of discussion and potential USG actions to mitigate those risks. The Visiting Experts received qualitative input on the question of barriers from research institutions, standards development organizations (SDOs), and industry participants. All stakeholders perceive opportunities for improvement, and some identified disturbing trends that could lead to greater problems in the future. These challenges are discussed in this section of the report.

Awareness and Analysis:

SMEs are challenged by a lack of awareness of CET standardization activities and in establishing the applicability of that work to their business. While there are currently numerous efforts by SDOs to disseminate information on standardization activities to a broad range of stakeholders, these efforts may not reach SMEs consistently. The USG alone will not “solve” this challenge, but it can take actions that would be beneficial to expand the possible pathways in which information would be made available

to SME audiences. The secondary issue in this context is that of analysis. Most standardization work begins with a landscape review to determine what standards work has already been started and how those disparate efforts align, overlap, or have gaps to be filled. Again, the USG should not put itself in a position of declaring which standards activities are “right” or “wrong.” Any such assertion would contravene the principals of the standards system being industry-led and market-based. The following recommendations seek to navigate the line between broad market utility and artificial market influence.

- R14 NIST should work with the inter-agency standards community to convene CET-related stakeholder workshops to encourage information sharing and identify gaps in standards engagement.**
- R15 NIST should advocate for including standardization awareness and analysis in existing multiplier programs such as the Manufacturing Extension Partnership centers, Small Business Development Centers, and Economic Development Administration regional offices.**
- R16 NIST should develop specific CET standards landscape analysis materials to facilitate informed community engagement. These landscape materials should be developed in partnership with the relevant SDOs to avoid duplication.**
- R17 NIST should use its role as convener of the Interagency Committee on Standards Policy (ICSP) to establish consistent periodic engagement from the private sector and the USG standards leadership community.** (Note: One possible method for this expansion is to include opening segments of ICSP sessions to private sector participants. Another idea is to establish individual ICSP working groups on specific CETs and to establish visiting expert communications from relevant private sector participants.)
- R18 NIST should establish a community notification process through Standards.gov for standards organizations to be able to make public notifications of standards meetings.**

Hosting International Standards Meetings

The Visiting Experts and presentations from leading SDOs consistently underscored the increasing challenges of hosting international standards meetings in the United States. The reason this topic is included in the Barriers to Participation section of this report is that SMEs are disproportionately harmed by demands for experts to travel overseas to standards meetings both due to the opportunity cost of time for senior employees and in paying for the travel expenses associated with the meetings. There are also challenges associated with the costs to U.S.-based SDOs and with the need for identifying venues that are both able to meet the technical needs of meetings and have the scale to support large events. There are additional barriers to secondary network effects of local meetings are lost to the U.S. by not having domestic events. Traditionally, a large international standards meeting will attract hundreds of experts from dozens of countries and organizers will establish side events with local SMEs, civil society, academia, and government. Such activities certainly contribute to the awareness and analysis section above, but it is also necessary to understand that barriers to events in the U.S. directly equate to a loss of opportunity for U.S. participation in the international standards process.

For example, the mobile communications standards setting organization, 3GPP, has a long-standing policy that an equal number of meetings are to be held in Europe, Asia and North America. Yet, in 2024 only three meetings are scheduled in North America compared to eight in Europe and nine in Asia/Pacific – six of those in China. A single 3GPP meeting requires a budget of upwards of \$1M USD which must be borne by the hosting SDO and members. European, Chinese, and Indian hosts are better funded and eager to take on gaps in hosting where U.S. funds are lacking.

There is a spectrum of possible USG actions related to challenges associated with U.S.-hosted meetings and some reach beyond the role and responsibilities of NIST. The inclusion of such items in this report are an indication of their importance and the desire to have NIST include them in their interagency standardization leadership.

R19 NIST should advocate for budget authorization and appropriations to support the implementation of the NSSCET Line of Action #1 and to direct a portion of those funds to the hosting of international standards meetings in the U.S.

R20 NIST should actively partner with academic institutions and government agencies to provide locations and logistical support for the hosting of international standards meetings.

R21 NIST should initiate a travel and participation funding program that is blind to business or technology strategy and restricted to SMEs. Such a program should be administered independent of the funding source such as through a partnership with ANSI to manage the scholarship program.

The preceding recommendations in the Barriers to U.S. Participation are focused on improving domestic organization and individual participation in international standards activities. There are additional issues that are active barriers to the hosting of international standards meetings in the U.S. but fall outside of NIST's remit. That said, these issues were universally raised by most of the Visiting Experts, every SDO, and industry expert engaged by the subcommittee. If these issues go unaddressed by the USG, any investment to address any of the preceding recommendations regarding participation will be diminished.

Visa delays and outright entry restrictions for non-US participants are directly responsible for the loss of standards meeting hosting possibilities within U.S. borders. It is harder for international delegates to attend meetings in the U.S. compared to other countries due to State Department handling of visas at consulates where wait times for interviews may be anywhere from two to six months or more. The additional "black box" security validation represents as much as six weeks or more of delay and a lack of assurance that experts can attend meetings.

USG policies regarding standards participation have also had a chilling effect on domestic hosting of international standards meetings. In 2019, the Department of Commerce Bureau of Industry and Security (BIS) created significant disruption in the standards community when it released the Huawei Temporary General License (TGL) and subsequent Export Administration Regulation (EAR) guidance related to standardization. Industry and standards setting organization advocacy over a three-year period ultimately helped resolve the ambiguity, but the result of that issue is a lingering mistrust of the U.S.'s commitment to openness in standardization. Any further policy positions and/or rule changes that

reduce the openness of the standardization system will create new barriers to participation by U.S. stakeholders in international standards.

R22 NIST should advocate within the interagency process for preservation of the principles of openness and transparency and protect U.S. stakeholder participation in international standardization by building capacity to robust standards governance processes rather than policy positions that are predicated on exclusionary practices.

There is an additional concern in situations where either “soft” (i.e., visa challenges) or “hard” (i.e., EAR restrictions) participatory exclusion mechanisms are utilized. If non-U.S. stakeholders in international standards who are contributing experts and/or are in elected leadership roles are not able to attend a meeting, it can result in the standards setting organization being forced to invalidate the results of the U.S.-based meeting due to process and quorum failures. In effect, these factors are placing a “closed for business” sign on the U.S. as it related to international standardization which is directly contradictory to the objectives established in the NSSCET.

R23 NIST should host working sessions with SDOs, the State Department, and the Department of Homeland Security to identify solutions to the visa challenges for standardization participants.

The final barrier to U.S. stakeholder participation in international standards is another example of an issue that is outside of NIST’s control and remit. Yet, as a coordination point within the USG on standardization policy, these points are included in this report. There are increasing tensions with Europe and China regarding U.S. stakeholder inclusion in their standards systems. Industry and academic presentations to the subcommittee noted the direct linkage of an increase in these dynamics to the BIS EAR exclusions previously mentioned in this report. A set of proposals related to the reform of European Regulation 1025/2012 included a proposal that only European headquartered organizations would have standing on balloting for harmonized European norms in any European Standards Organization (ESO). That particular policy change was not adopted but is indicative of the increasing sentiment to exclude participants from an open system which will ultimately harm U.S. stakeholders over time. The policy change that was adopted was a mandate for the European Telecommunications Standards Institute (ETSI) to amend its procedures to make it more clear that harmonized European norms would have to go through member state balloting as opposed to direct industry participant balloting. For many U.S. stakeholders, this will require additional resource investment to be active and present at both ETSI meetings and at least one Member State national standards body to have their voice included in the process. For SMEs, this becomes highly improbable for them to participate and for all U.S. stakeholders in ETSI, this represents a dilution of their agency in the standards process.

There is a published policy from the Standards Administration of China that asserts equal engagement opportunity for non-Chinese participants. Yet the practical experience for U.S. and European stakeholders in the Chinese standards system is different. Rules for committee participation, timely access to technical content, predictable notification periods for meetings, and a range of other governance practices are orchestrated to create imbalances in the system. Following the BIS EAR actions, China has also established standards bodies that duplicate existing standards efforts.

R24 NIST should pursue the reaffirmation of open, participatory, and equal treatment principles with their European counterparts in the US-EU Trade and Technology Council (TTC) working group one and other related bi-lateral and multi-lateral fora.

R25 NIST should collaborate with the United States Trade Representative and the Department of State to maintain consistent advocacy with China regarding the World Trade Organization Technical Barriers to Trade Agreement international standards principles and Code of Good Practice.

Opportunities to increase U.S. standards engagement

The Visiting Experts and all presenting experts hold the universal view that standards development activity in the U.S. is innovation-based, industry-led, and voluntary in terms of participation and implementation. They also represented to the subcommittee that there is a need to bolster U.S. participation in standards engagement. Thus, the recommendations in this section tread a careful line to apply the capabilities and reach of the USG in a constructive manner that does not contravene those stated principles. NIST has considerable existing resources designed to promote and coordinate NIST's standards activities (e.g., the Associate Director for Laboratory Programs' Standards Coordination Office and the Information Technology Lab Office of IT Standardization). Moreover, within the NIST Labs, the active standards engagement of NIST scientists and the delivery of long-term collaborations with U.S. stakeholders through mechanisms such as the National Cybersecurity Center of Excellence and the various joint research partnership with universities that could contribute to raising the profile of standards work.

There are three distinct investments where the subcommittee believes NIST can further improve its support for stronger U.S. engagement in standardization: measurement of standardization activities and impact, workforce development, and incentives for U.S. participation in standards.

Measurement of Standardization Activities

The political and policy discourse regarding standards and their relationship to geopolitical tensions and national security pivot on an imperfect understanding of many factors. The reason for this is the lack of any formal or shared method to measure investments in standardization or their impacts. These measurement challenges apply to individual standards as well as the aggregate economic impacts of the overall standards system. If one takes into account that there are as many as 1000 distinct standards organizations across every sector in the U.S. alone which represents hundreds of thousands of experts working on specifications and affecting the implementation of every type of good or service produced and consumed—it is fair to say, “standards are important.”

Yet, the subcommittee consistently faced the fact that in the absence of substantive and disciplined measurement, there is peril in narrow interpretations of facts and experiences in one domain influencing policy decisions that adversely affect all domains. The BIS EAR issue related to Huawei is an example of this. Recent assertions of concerns of nation state-driven dominance within mobile telecommunications standardization is another. Simply counting noses for who is in the room can lead to a deeply flawed perception of the outcomes from a given standards committee. Assuming that the

number of chair and convenor positions defines an actor's power in standards is also flawed. Considering the number of contributions submitted as opposed to those finally adopted into a specification is another common mistake. In each of these cases, the dynamics of correlation and causation are difficult to ascertain as we lack a consistent methodology of measurement and access to the underlying data to be measured. Finally, to understand the outcomes of a given standardization effort, one must also assess qualitative information in conjunction with quantitative data.

The subcommittee recognizes that many SDOs have considered this challenge in the past and will have substantive contributions to make in defining the objectives and parameters of a consistent measurement methodology. Resources such as the [Searle Center database](#) or IETF [datatracker](#) are good examples of research tools but are each focused in specific contexts and questions. A large body of academic research supports the general proposition that standards have significant economic impacts, and that the open voluntary consensus process provides a durable and effective template for effective and relevant standards. Nevertheless, the committee's view is that we currently lack frameworks for measuring the aggregate impacts of standardization, along with the tools and metrics required for assessing the effect of policy interventions in this domain.

R26 NIST should establish a project in collaboration with academia and the standards community to create a defined set of objectives, conceptual framework, taxonomy of metrics, and common qualitative factors for measuring both the value of investment in standards and their impact.

Workforce

The subcommittee received extensive input on the importance of workforce development as an integral component of increasing and improving U.S. standardization engagement. The effectiveness of any organizational commitment to standardization comes down to two key factors: people and substantive contributions. This section will focus on the first, and the discussion below on pre-standardization will address the latter.

The subcommittee recommends that NIST maintain a broad frame of reference for any discussion of the standardization workforce. The topic includes participating technical experts who actively engage in specific committees and working groups, management leaders who make investment decisions for participation in long-term standardization, researchers whose foundational work may become the basis for future standardization, and academic or vocational organizations who provide educational services to support industry's needs for skilled workers. The final scoping split that the subcommittee addressed is the differentiation between the upskilling of USG employees and the mechanisms that NIST can utilize to improve the capabilities of non-government actors.

Most SDOs offer training for new participants in their organization. The degree of sophistication of those training offerings are generally in keeping with the size of the SDO. Almost all standardization training prioritizes the information and skills needed for an individual to be an active participant in working groups and/or specification development. There tends to be a focus on rules and process with additional training on the "soft skills" that can be beneficial in working within a group of individuals with diverse motivations and objectives. Standards training materials point to the importance of technical excellence

but given the unlimited scope of technical topics and the depth required for any given specification, it is assumed participants will garner the technical domain knowledge through other means.

To the extent that university and vocational training programs speak of standardization within the context of technical domain expertise, it is usually from the perspective of implementation rather than development of a given specification. If a mobile communications engineer is learning how to design an antenna for 5G work, they will be taught to use ATIS/3GPP standards. A nanotechnology researcher will be aware of the ASTM metrology nanotechnology standards. A computer science student working on the implementation of Internet protocols will be aware of IETF specifications. But few of those individuals are likely to be exposed to training, or may not even be aware that the opportunity exists, to join the standards process to influence the next generation of standards in their field.

While there are no prohibitions against management/executive participation in such training, it is exceedingly rare for individuals in executive roles to attend. This is especially true as the training materials are not designed to be meaningful to an executive audience. Yet, the executive community is responsible for the resource commitments of people and budget over a multi-year period for any standards work. Thus, the lack of training focused on standardization as a strategic element in the broader context of business, policy, or research objectives means that a key barrier to participation for U.S. stakeholders may be as direct as a lack of executive awareness and/or urgency to invest in the standards development.

- R27 NIST should create a means on Standards.Gov for SDOs and research organizations to post notifications of standards training opportunities for U.S. stakeholders.**
- R28 NIST should produce an evaluation of the workforce impact of the Standardization Center of Excellence if it is realized under the CHIPS and Science Act. This report should inform a possible decision for NIST to convert the one-time Emerging Technologies Standards Engagement program into a long-term program designed to support the NSSCET workforce objectives.**
- R29 NIST should partner with career training services providers and ANSI to facilitate early- and mid-career standards engagement training to bolster the candidate pool for private sector, civil society, and academic standards engagement roles.**
- R30 NIST should modernize the Standards Coordination Office standards bootcamp program and continue to offer it for USG employees. The Standards Coordination Office should create a short and targeted executive education track for mid-level or senior agency management roles with budget authority.**
- R31 NIST should formalize a standards mentorship program within the community of USG standards participants.**
- R32 NIST should create a standards excellence award or range of awards within the USG to create meaningful career recognition and/or compensation incentives for high-quality standards work. Ideally the eligibility criteria for the award would extend to all USG standards participants and not just the NIST community.**

Incentives

The subcommittee heard numerous perspectives on the topic of incentives for standards engagement. Yet this complex topic must be addressed with great care as the old adage from Economics remains true, “incentives work” but they can be positive or negative and the results can be intended and unintended. Government monetary funding of standards work can certainly increase participation, but it can also create market-warping effects by placing the proverbial thumb on the scale for outcomes. Any incentives approach contemplated needs to preserve the fundamental principles of the U.S. standards system being voluntary, industry-led, and pro-competitive.

Standardization is a form of what Economists call, “public goods provision”– investments that produce “spillover” benefits for others. Basic economics suggests, therefore, that private incentives to invest in standards could be too low because participants pay the costs of participation but do not capture the full social benefits of the standard. The past 50 years of private sector investment in CETs shows that the U.S. private sector-led system has generated enough value and a reasonable return on investment to maintain engagement.

As other economies have grown, pressure has increased on U.S. participation as other governments have increased their investment in both direct and indirect support of standards engagement from their stakeholders. This has not been wholly successful. There are unfortunate examples of government incentives creating adverse outcomes in standardization. For example, in the International Telecommunications Union, some committees have been hampered by large volumes of low-value contributions based on government “bounties” for written submissions resulting in the gaming of a system with the unintended consequence of harming the standards system. In other instances, government incentives that select a single participant’s technology as the preferred technology result in sub-optimal technical outcomes and discrimination against other stakeholders’ perspectives in their marketplace.

The subcommittee recognizes the challenge to craft policy that balances the tectonic forces of public goods and private benefits. In this context, good goals for the US government role in standardization system should be:

1. Providing broad-based incentives that lower costs of participation across a wide range of constituencies, and
2. Ensuring that private-sector efforts to capture value from standards do not crowd out social benefits.

Recommendations 17, 18, and 19 earlier in this report point to government economic support for hosting standards meetings in the U.S. The subcommittee wishes to underscore here positive effect such incentives create for meeting point 1 mentioned above. Funds appropriated for the availability of lower-cost, domestic standards meetings would clearly incentivize participation by U.S. SMEs.

The subcommittee recommends that the NSSCET implementation plan should consider opportunities to further increase R&D spending by the U.S. private sector. To promote greater R&D investments, Congress should alter U.S. tax law to allow R&D expenditures to be expensed in the year they are incurred.

R33 NIST should advocate for budget approval and appropriations that enables and encourages U.S. stakeholder engagement in standardization with the caveat that any

such incentives are applied in a neutral manner that does not pick winners or losers in technology nor adversely affect market segments such as SMEs.

Opportunities for NIST to foster U.S. pre-standardization research

The concept of pre-standardization is roughly established as the process under which stakeholders collaborate to formulate principles, guidelines, and objectives in a particular domain that create fertile conditions for standards to be created. Pre-standardization collaborations can also assist in establishing awareness of competing or overlapping standardization efforts in different SDOs and facilitate marketplace actors' ability to understand the potential landscape of standardization activities which may determine the extent of their investment in that particular field of standardization.

The pre-standardization concept is complicated by the fact that there are different types of harmonization activities that may be labeled as "standards" but are not the same. For example, "metrology standards" are frequently quoted as pre-standardization activities for "documentary standards." In that context, documentary standards are specifications developed in voluntary, consensus organizations as opposed to the measurement standards that may come exclusively from a government agency such as NIST.

The subcommittee received extensive commentary on the role of pre-standardization which is an indicator of the importance of the topic. The SDO community has extensive experience with pre-standardization as it is a fundamental part of their viability and longevity in the marketplace. SDO leadership has deep appreciation for the importance of attracting new, market-relevant work and thus, have built sophisticated mechanisms for engaging with industry and the research community to encourage pre-standardization activity. NIST should use its convening power to establish greater awareness in the community, sharing with stakeholders where NIST is heading on key topics, and avoiding a situation where NIST is in competition with the system and is instead looking to increase the velocity of nationally important standards outcomes and reduce costs for all participants.

- R34 NIST should participate in relevant standards organizations that have initiated efforts to connect with the pre-standardization phase of technology development. Efforts can include incubation of standards-related consortia in emerging technology areas. Recent examples are QED-C and the Standards Coordinating Body for Regenerative Medicine.**
- R35 NIST should maximize the network of existing investments such as the Manufacturing Institutes to expand discussion and drafting of pre-standardization materials.**
- R36 NIST should enhance partnerships with organizations such as the Government University-Industry-Research Roundtable (GUIRR) and the Federal Laboratory Consortium to engage more universities and identify relevant pre-standardization activities.**
- R37 NIST should establish pre-standardization collaborations that "de-risk" early development and implementation testing by establishing "sandboxes" for testing interoperability, validation, and regulatory compliance (where relevant).**