

RECOMMENDATIONS FOR INCREASING U.S. PARTICIPATION & LEADERSHIP IN STANDARDS DEVELOPMENT



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PURPOSE

The National Security Agency (NSA) and the Cybersecurity and Infrastructure Security Agency (CISA) developed this document in furtherance of their respective cybersecurity missions, including their responsibility to develop and issue cybersecurity recommendations and mitigation strategies. This information may be shared broadly to reach all appropriate stakeholders.

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Enduring Security Framework Recommendations for Increasing U.S. Participation and Leadership in Standards Development

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Introduction

Standards development is a priority for technological security among the United States, like-minded nations, foreign adversaries, and competitors. Standards promote interoperability across vendor offerings and set boundaries on features that can be offered. For this reason, U.S. participation in standards development is critical to maintaining the U.S.'s robust position in the marketplace. While standards development is primarily an economics-driven activity, national security equities are also reflected in the standards development process. Decisions on the strength of authentication, privacy, and the ability to share threat information impact not only personal security but also the ability of nations to architect defensible networks.

Open, transparent, rules-based standards processes—processes that represent multiple stakeholders and do not give undue influence to a limited number of voices—are necessary to ensure that globally relevant standards meet U.S. national security requirements. The need for standards that support U.S. national security is reflected in the U.S. National Security Telecommunications Advisory Committee (NSTAC) Letter to the President on Standards,¹ which provides key findings and recommendations to enhance U.S. competitiveness in international communications technology standards. In this letter, the NSTAC states:

“As cyberattacks have grown more frequent and serious—and as geopolitical and economic competition has increased—concerns with security, resiliency, interoperability, and other critical information and communications technology (ICT) issues have caused governments, industry, and users to focus more intently on how those standards are developed and whether products and services are compliant with robust standards. In addition, there is concern that one actor (nation or company) may unduly influence the standardization system, which would represent a threat to national security. Against this backdrop, some

¹ [NSTAC Letter to the President on Standards \(cisa.gov\)](https://www.cisa.gov/nstac-letter-to-the-president-on-standards)

governments are asserting new standards strategies to promote their domestic agendas within the global standardization system.”

International standards development will impact security and privacy across the technology landscape for coming generations. Given the impact that the decisions made within Standards Development Organizations (SDOs) have on emerging technologies, it is critical that standards and standards-related policies are open, transparent, and consensus-driven. “Failing to [work with all nations committed to an open and transparent standards system] will risk the United States’—and the world’s—innovation, security, and prosperity.”²

The U.S. has long enjoyed robust standards of participation, leadership, and influence from industry, government, and academia. However, the standards landscape is changing. It is critical that interest in standards be strengthened in the U.S. public and private sectors. The Biden administration recently released the May 2023 United States Government’s National Standards Strategy for Critical and Emerging Technology (USGNSSCET) augmenting steps already taken to strengthen the U.S.’s participation and position within standards organizations, including the CHIPS and Science Act of 2022³; proposed increases to the FY 2024 budget for emerging technologies like quantum computing and artificial intelligence; and proposed federal spending increases aimed at research and development in support of standards. As the strategy states, “[s]tandards for [critical and emerging technologies]—advanced technologies that are significant for U.S. competitiveness and national security—carry strategic significance.” Rebuilding U.S. and allied leadership in standards underpins strategic national and economic security decision-making.⁴

In the U.S., standards development is an industry-led endeavor. While this offers dynamic, market-focused participation, it makes the U.S.’s standing in standards highly dependent on private enterprises investing the time and money required for robust engagement. This is a long-term investment. Before the standardization work begins, there is often a period of research to develop new technology. As a result, standards can take years to reach completion, and return on investment (ROI), in the form of standards-compliant products reaching the marketplace, may not be realized fully until the standard is completed and implemented. The eventual pay-off (leadership in the marketplace, creation of intellectual property that can be licensed, or opening new markets and value-added services) can be lucrative. However, not every company will make that calculation.

Decisions made in standards bodies impact national security. Choices made in writing a standard will directly determine the security provided by products implementing that

²[US-Gov-National-Standards-Strategy-2023.pdf \(whitehouse.gov\)](#)

³[govinfo.gov/content/pkg/PLAW-117publ167/html/PLAW-117publ167.htm](#)

⁴[US-Gov-National-Standards-Strategy-2023.pdf \(whitehouse.gov\)](#)

standard. Indirectly, a nation's companies' success in including features and intellectual property in standards can significantly influence their financial success (contributing to the nation's economic security) and availability of domestic suppliers for critical networks. National security is often affected by standards and private industry's decision to participate. Industry investment in the standards development process and impactful U.S. government and industry involvement are crucial to protecting national security.

This paper, authored by government, industry, and academic participants in the Enduring Security Framework, provides recommendations to help achieve increased participation and leadership in SDOs.⁵ It may be useful to implementors of the U.S. Government National Standards Strategy, standards development organizations, and industry and academic representatives seeking to strengthen their participation in standards.

Because the authors of this paper were primarily based in the U.S., the recommendations for governments listed here are directed to the U.S. government. However, standards are necessarily collaborative efforts, and the U.S. cannot and should not act alone in the standards development space without coordinating with other democratic nations. It is the opinion of the authors that these recommendations are also applicable to like-minded, democratic nations that wish to increase their participation in standards development organizations for the sake of their own economic and national security.

The following sections delve into four recommendations derived from the NSTAC letter, designed to increase U.S. and like-minded nations' presence and participation in the global standards landscape:

- Establish the U.S. as a venue of choice for standards development meetings.
- Engage early in emerging technology standards.
- Develop a more standards-savvy workforce.
- Engage academia to grow the next generation of standards development experts.

By responding to these proposals, the U.S. can take decisive strides toward shaping the future of emerging technologies, bolstering security and resilience, and fostering a skilled workforce to navigate the complex challenges of the digital era. To foster U.S. leadership in SDOs, this paper also underscores the significance of inclusive, participatory, and rules-based standards development processes. By embracing multiple stakeholders the U.S. can promote standards that improve national security and serve as catalysts for innovation and progress on the international stage.

⁵ For the purpose of this document the National Institute of Standards and Technology (NIST) definition of SDO is used. SDOs "include professional societies, industry and trade associations and membership organizations that develop standards within their area of expertise."

Establish the United States as a Venue of Choice for Hosting Standards Meetings

The United States has long maintained a positive reputation as a reliable partner in international standards development. Global SDOs have planned their meeting cycles to include meetings in the U.S. However, in the past several years, organizers have held fewer standards meetings in the U.S. Some SDOs have avoided meeting in the U.S. at the strategic urging of members, claiming logistical challenges, which put U.S. participants at a disadvantage. Addressing the barriers to hosting standards meetings in the U.S. would encourage more SDOs to meet in the U.S. and buoy the community of U.S. participants.

In-person participation in standards meetings builds rapport among participants, allowing them the opportunity to network and access invaluable hallway discussions. Participants physically present at meetings can better represent their work, facilitating acceptance of their contributions. If achieving a leadership position in the SDO is a goal, in-person participation is critical. Members of the SDO are more likely to support a candidate they know well. Including U.S.-hosted meetings in the cycle of meetings for developing critical and emerging technology (CET) standards reduces the cost of participation for U.S. participants, allowing greater opportunities for more U.S.-based professionals to attend meetings in-person and gain critical standards experience.

The ease of travel for accessing U.S.-hosted SDO meetings has been challenging in recent years. SDO meetings should take place somewhere with a wide availability of flights, as they draw participants from all over the world. The U.S. has several international airports in various regions that can accommodate large SDO meetings, with transportation and accommodations in these cities to accommodate the various price points of SDO meeting attendees. These factors guide which U.S. cities are the most appropriate for hosting SDO meetings.

When hosting SDO meetings in the U.S., it is important to consider easily accessible facilities. The facilities for international standards meetings need to be able to accommodate large groups of people and support remote/virtual participation. This requires reliable internet access, power access for attendees, and access to break-out rooms for smaller working groups within the SDO to meet. In addition, it is important to consider the need for translation services and disability accommodations.

While global SDOs seek to meet in diverse locations to spread the difficulty and cost of travel among active participants, more meetings in the U.S. would be beneficial. To bolster U.S.-hosted meetings, there needs to be a focus on ways to incentivize U.S. industry and other stakeholders to fund meetings and make standards attractive to those who can contribute.

Recommendations to U.S. Government

To support increased U.S. hosting of SDO meetings, the U.S. government should position standards development activities—and meetings in the U.S.—as critical to national and economic security. It should consider allocating appropriated and approved resources to support hosting meetings in the U.S.

It is also essential for the U.S. government to establish and maintain a stable, predictable regulatory and policy environment that welcomes foreign participants in standards-related meetings. This means that the U.S. government should identify visa challenges that may exist around standards meetings—e.g., restrictions or flags relating to specific employers, industry sectors, or technical backgrounds. Recognizing the importance of maintaining adjudicator independence in making visa decisions, the U.S. government must work to reduce excessive visa backlogs and provide additional guidance for standards meeting attendees to establish that standards meeting organizers know how to ensure successful visa applications, as well as areas that trigger application denials. This guidance could help U.S. groups identify potential issues ahead of hosting.

Recommendations to Private Sector Stakeholders

Private sector stakeholders can help facilitate U.S.-hosted standards meetings by offering the use of their own facilities for SDO meetings or providing other in-kind support. Private sector stakeholders can also sponsor special events at SDO meetings, such as social tours, lunches, or breakfasts, in order to provide networking opportunities that industry, academic, and individual participants might find valuable to the furtherance of their work. Stakeholders in the private sector, particularly local businesses, can often cost share with other businesses to provide funding for facilities. Additionally, private sector stakeholders can directly support hosting standards meetings in the U.S. by providing funding support. Most SDOs offer sponsorships that allow private companies to donate money or resources to support SDO meetings.

Standards developers should recognize and enhance collaboration and information exchange opportunities at SDO meetings. These opportunities could offer additional funding mechanisms such as sponsorships and/or holding external workshops for interested parties not engaged in committee work. Local universities may be interested in partnering with SDOs for meetings, providing additional facilities and resources in exchange for the opportunity to engage students in standards.

Engage Early in Emerging Technology Standards-Related Activities

Early engagement in emerging technology standards development is critical to maintaining and, in some cases, reclaiming the U.S.'s competitive edge and leadership in standards.

Standards development is an integral part of the technology development life cycle, which means that to compete in a global market, U.S. companies need to not only engage in the development of new technologies, but also engage early with SDOs working to standardize these technologies. To ensure that U.S. participation in standards development does not come too late in the process, U.S. companies must closely monitor efforts in SDOs related to the technologies they are developing and consider launching such efforts proactively.

Standards Process

The life cycle for standardizing CETs or specific applications of CETs begins with pre-standardization activities that occur before standardization starts. These include research and development (R&D) activities that feed technical contributions to standards. Pre-standardization guidance, such as National Institute of Standards and Technology (NIST) special publications, informs these technical contributions to SDOs. A pre-standardization focus on research can drive early engagement in standards bodies.

It is important to not standardize too early in the development of a new technology. Doing so can limit innovation and create a drag on development and adoption. In fact, the standards process can be “weaponized”—purposely leveraged to slow down development. Standards participants themselves must decide when the time is best to bring new technologies to SDOs to the benefit of a technology’s interoperability, security, or adoption.

Standardization priorities and needs are identified by industry, government, and academia in their participation in SDOs, resulting in a plan to engage one or more SDOs. This plan could be to form a group to further explore the topic or to begin drafting standards immediately. The processes for introducing new work items or study items—and the specific phases for standards development—will vary for each SDO and will determine timelines, drafting, and standards publication.

As industry adoption of a particular standard is voluntary, standards will have varying levels of use. The U.S. government encourages the adoption of private-sector standards through the National Technology Transfer and Advancement Act of 1995 (NTTAA)⁶. The NTTAA requires federal agencies and departments to use voluntary consensus standards in lieu of government-unique standards to the extent that they are practicable and consistent with applicable laws. The NTTAA also states that federal agencies should consult with the private sector and voluntary consensus standards bodies and participate in developing standards when it is in the public interest and aligns with missions, authorities, priorities, and budget resources.

⁶ [National Technology Transfer and Advancement Act of 1995 | NIST](#)

Publishing and adopting a standard is not the end of the standards life cycle. A continually changing technical landscape necessitates updating and occasionally retiring existing standards. Part of ongoing research and development within standards organizations is reviewing existing standards to ensure they stand the test of time and updating them when needed to coincide with changing technical requirements. This sometimes means publishing revisions to standards or writing new ones that supersede old ones.

Benefits of Early Engagement

Early engagement in the standardization of CETs can provide many benefits for the U.S. government and industry. Being involved in early standardization efforts can give U.S. companies a competitive edge in emerging markets as well as advance U.S. leadership. Early technical standardization presents an opportunity for regulatory harmonization, in which international and various national regulating authorities develop shared guidelines and compatible regulations. The benefit of this harmonization is that it can provide global access to new technologies that are secure and effective. Early engagement also promotes competition in emerging technology development.⁷ Early standardization efforts also help to reduce trade barriers, furthering access to new technologies.

Finding the right time for standardization is important. There are many examples of early standardization that allow for the rapid proliferation of a technology (e.g., the Internet Protocol). While there are also examples of “dead ends” in standardization (e.g., early attempts to create incompatible stacks for wireless devices), those attempts usually sort themselves out by not seeing widespread adoption and don’t cause long-term harm (see Appendix A). Today, there are pre-standardization efforts to set the direction for important technologies such as 6G; waiting for these technologies to arrive before engaging would be dangerous for companies that wish to compete for market share and stakeholders that have requirements for those technologies.

Pre-Standardization Activities

There are a variety of pre-standardization activities that contribute to emerging technology standards. De facto standardization often comes from early research in new technologies. These early standards are commonly adopted by industry and their customers. Informal industry specifications are the earliest standards engagement for many technologies. For example, the Ethereum community has adopted a series of standards that help maintain interoperability across Ethereum implementations.⁸ Open-source software is another tool that developers utilize to develop technically sound standards. Hackathons held at regular Internet Engineering Task Force (IETF) meetings bring together software and standards

⁷ <https://standardsboostbusiness.org/companies.aspx>

⁸ [Ethereum Development Standards | ethereum.org](https://ethereum.org/en/development/standards/)

developers, providing a mechanism for developing and testing implementations of network protocols.⁹

Pre-standardization also includes the research and strategic planning forums that partner with SDOs for early standards engagements. The Internet Research Task Force (IRTF)¹⁰ focuses on long-term research related to the Internet, promoting research that leads to standardization efforts in IETF. For federally-funded research, the Networking and Information Technology Research and Development (NITRD) Program¹¹ is a formal program composed of 25 member agencies that invest billions of dollars in research and development programs for advanced information technologies in computing, networking, and software capabilities needed by the Federal Government and the Nation.

Recommendations for Individual Participants

At an individual level, the first step to participating in the standardization of CETs is to be involved in related research and development activities. Generally, the individual would already be part of the technical community and could begin considering which aspects of the technology would benefit from standardization. They could take the time to understand the technology and its place in the greater ecosystem to prepare for its transition to implementation and standardization. They could engage in open-source communities that typically drive the development of new critical and emerging technologies.

Another thing an individual can do is become involved in study groups and communities of interest related to their technology. Such groups, especially those affiliated with SDOs, represent a first step toward understanding the problems that an eventual standard must address. They also serve to form a consensus on the direction that the technology and standardization should take—a valuable opportunity for thought leadership on the subject.

Recommendations for Private Sector Stakeholders

The private sector has a vital role in moving CETs toward standardization. They can apply resources beyond the ability of an individual and can set direction for the development of a technology that anticipates eventual work to create standards. One aspect of this recommendation is to recognize standardization as part of the development of any technology. In this way, as the technology progresses through R&D, experts are considering which aspects should be standardized and what the appropriate SDO should be. Making standardization part of the technology life cycle also helps ensure that once the research matures, the transfer of the technology to an SDO will follow naturally.

⁹ <https://www.ietf.org/how/runningcode/hackathons//>

¹⁰ [Internet Research Task Force \(irtf.org\)](http://www.irtf.org)

¹¹ [The Networking and Information Technology Research and Development \(NITRD\) Program - The Networking and Information Technology Research and Development \(NITRD\) Program](http://www.nitrd.gov)

Another thing that the private sector can do is ensure that security is considered from the earliest phases of development. Securing a technology often becomes more complex as features become locked in; making security a priority while there is still flexibility allows the technology to be used more safely and allows the eventual standards creators to make better choices.

Recommendations for Academia

Academia has an important role standardizing CETs as they, along with industry, perform the fundamental research that underpins emerging technologies. One thing academia can do is consider the technologies identified in the USGNSSCET (and other consensus documents) as suggested priorities for research. This prioritization will help ensure that the research underpins standardization in these essential technologies. Academia can also expand course offerings and other programs related to CETs, building the pipeline of future participants in standards activities for these technologies. In some cases, creating specialized certifications in some technical areas could help focus attention on areas where expertise is needed.

Finally, academia can partner with industry and government to gain support for research and coordinate priorities. Programs such as NSA's National Centers of Academic Excellence (NCAE)¹² offer support for research and curricula related to cybersecurity, benefitting academic institutions that achieve certification to employ for a standards savvy-workforce. Making knowledge of standards a part of this type of certification is an important step toward making standards a national priority.

Recommendations for U.S. Government

While standards and industry research decisions are led by the private sector, the U.S. government has important roles to perform. The U.S. government can express future requirements that they identify, particularly in the area of national security, so that academia and industry can consider them as they plot a course for research. The U.S. government can also work to focus funding of private sector research on important problems. The U.S. government could evaluate whether agreements such as Cooperative Research and Development Agreements (CRADAs) and research grants have, or can be negotiated to include sufficient license rights to transition research results to standards. Programs such as NITRD can consider the need for standardization in their prioritization. At a more general level, the U.S. government can encourage the adoption of emerging technologies in their programs. The U.S. government can define use cases for emerging technologies early enough to promote timely adoption.

¹² [National Centers of Academic Excellence \(nsa.gov\)](https://www.nsa.gov)

Develop a more Standards-Savvy U.S. Workforce

The U.S. government and industry must have a standards-savvy workforce to maintain strong U.S. participation in international standards. Standards savviness is understanding how to engage with SDOs as part of a broader industry influence strategy. Within standards engagement, there are a variety of roles that are important for strengthening U.S. influence. Technical experts are needed to ensure that standards meet technical requirements and are secure and effective. Experts in standards processes can engage in SDOs to ensure that robust standards development processes are followed. Engagement teams and sponsors are necessary to research state-of-the-art and emerging global technologies, plan standards engagements, and allocate resources to standards meeting attendance. Individuals and organizations each play a vital role in creating a more standards-savvy workforce.

Recommendations for Individual Participants

The most immediate role of the individual in standards development is to be aware of relevant SDOs and standards in designated subject areas. This means being familiar with SDO proceedings, such as the frequency of SDO meetings and the processes for standards development within specific SDOs. In addition, individuals can maintain awareness of particular standards by monitoring, observing, and tracking standards drafts being developed at any given time. Individuals only need to be aware of some standards in a given technical area. However, understanding trends in standards and standards related to your specific work can go a long way.

The next level of involvement for an individual is understanding the activities and scope of relevant SDOs in relation to their own organizations' objectives. Organizations generally have clear goals for product development and technical objectives that research and development teams are working towards. Individuals working on these teams should coordinate their product and technical objectives with the standards objectives being worked on by their organization in relevant SDOs, and with policy and regulatory considerations.

Individuals who have built an awareness of SDO activities and objectives can further their standards savviness by engaging directly in SDO activities. Engagement could mean participating directly in SDO meetings or engaging in SDO mailing list conversations. Someone with technical expertise can contribute to standards development by commenting on drafts or writing and editing draft standards. Many individuals seek external technical engagement opportunities, including technical presentations, research publications, and collaborations, or participation in open-source development. Ultimately, individuals can take on leadership roles within SDOs. Leadership within SDOs include a range of positions with varying levels of authority and responsibility. Anything from taking on a lead-editor

role to running for an elected administrative position within an SDO can increase an individual's influence in standards development.

Recommendations to Private Sector Stakeholders

Industry leads U.S. engagement in standards organizations. Effective participation in standards development requires leadership commitment and resources, both staff and budget. Employers can provide internal training opportunities, including mentor programs for new and junior employees.

Having a workforce involved in standards benefits the U.S. as a whole and the individual organization. Private sector stakeholders should develop policies that enable and encourage standards development as a part of their technology development.

Organizations should identify priority subject matter areas and relevant SDOs. Acting on these priorities facilitates organizational presence in standards that benefits their projects and products. Mentoring younger or newer SDO participants can help guide new minds to standards development, building an even stronger workforce for the future. Investing in mentoring requires endorsement from leadership. A standards-savvy workforce helps ensure leaders are aware of standards.

Private sector stakeholders set goals for technology development, and standards should be considered a part of the development life cycle. Internal objectives should account for standards considerations, seeking opportunities to drive the development of related standards. Organizational policy should encourage engagement with standards.

Participating in writing standards can directly increase economic competitiveness.

Organizations can direct the impact of standards participation toward specific technical goals by connecting internal objectives with the scope of relevant SDOs.

Managing employee engagement in SDOs is essential at the organizational level by setting specific expectations for planning, reporting, and participation. Empowering employees to participate in standards can be more effective with consistent organizational support. Organizations should budget resources for travel and the time spent engaging with SDOs. In addition, organizations should consider SDO sponsorships, or sponsoring events at SDO meetings, such as lunches or socials. These investments can provide the organization with influence in the SDO and create additional awareness of the organization with meeting attendees. Designating engagement team leads and executive sponsors within the organization increases participation and helps to focus participation where it has the most impact.

Organizations can also support SDO leadership opportunities for their employees. SDO leadership can give an organization a competitive edge within the standards community and in the marketplace. It can also be seen as a workforce development objective.

Leadership within an SDO can prepare employees for more senior leadership positions by providing networking and recruitment opportunities. Practically, leadership in SDOs allow an organization's products and research to reach a broad audience of subject matter experts.

Companies can increase their workforce's standards-savviness by ensuring that standards and other external technical engagements are a visible, company-wide effort. Various educational opportunities exist to provide standards knowledge to the workforce (see Engage Academia below). In addition to these resources, employers can provide internal training for employees to help develop standards savviness within their organizations. SDOs also offer training and information for individuals to self-train.

Standards engagement is only valuable to employees if it is worthwhile and profitable to engage throughout their careers. Increased participation occurs at varying career stages, from early-career interns to experienced executives. The organization is responsible for ensuring that employees who participate in standards are given the resources necessary to maintain engagement while growing their careers.

Supporting leadership and participation in SDOs is key to developing a standards-savvy organization. Organizations can ensure that their workforce is made up of well-informed, standards-savvy employees by prioritizing standards and professional development in standards development. Mentorship programs create a workforce that is both technically savvy and engaged in standards at all levels. Standards mentorship programs or other education and training opportunities for junior employees can bridge the gap between high-level executives and developers working directly on developing technical products.

Recommendations for SDOs

SDOs play an essential role in developing a standards-savvy workforce. Most SDOs offer orientation for new members at their meetings. This training could be offered as a form of outreach, at trade shows, or on a one-off basis to companies developing products in technologies relevant to the SDO. Attending an SDO meeting for the first time can be intimidating, especially when participants try to jump aboard already underway projects. Some SDOs offer technical talks, presenting background on a given technology and its standards. These talks can be impactful if provided to a broader audience, perhaps in a session adjacent to the SDO meeting but open to interested parties who are not registered for the meeting.

Recommendations for the U.S. Government

In addition to implementing the recommendations for private sector stakeholders, the U.S. government is uniquely positioned to support industry and academia standards efforts. The U.S. government has the authority to allocate appropriated funding and grants to encourage

research and development for specific technologies. The USGNSSCET is an example of the U.S. government offering priorities and stating goals for financial support.

Recommendations to Academia

The USGNSSCET identifies academia as a “critical partner” necessary to train the next generation of standards professionals. The strategy states that academia “should renew a commitment to teaching and highlighting the value, development, and use of standards and standardization in a range of career fields.” Academic institutions should invest in students and educators who are interested in emerging and developing technologies and standardization of these technologies.

Academic engagement in standards development makes students aware of the role of standards in CETs. Engagement with industry and government through intern or summer hire programs can get students directly involved in standards development work. These engagements improve the student’s knowledge of standards and bring a new perspective to standards developers. Partnering with research groups can improve the U.S.’s competitiveness in developing new emerging technologies and standards to support them.

Establishing a student ambassador program can encourage and mentor new students to the standards community. In this type of program, an upper-level student can be sponsored as an “ambassador” to a specific SDO. The student ambassador reports to the program coordinator and, optionally, a faculty member at the student’s academic institution. The program funds the student’s membership and travel, allowing students to attend SDO meetings and engage in the standards process firsthand. Mentors within the SDO guide the students throughout the entire process.

At the program’s end, students have an opportunity to offer a seminar presenting their experience and thoughts on standards. Additionally, the ambassador program could host an annual summit, allowing student ambassadors to meet each other and network with other students with standards experience, and other standards professionals in the workforce. This type of direct engagement in standards provides firsthand experience and immersion within the standards process.

Colleges and universities can also host SDO meetings on their campuses. Academic campuses often have the space and facilities necessary to host SDO meetings, are accessible, and offer the technical capabilities for virtual participation. Universities and colleges hosting SDO meetings increase the U.S. hosting capacity for international standards development bodies. Academic institutions can work with SDOs to allow students to participate in standards meetings for free during events held on their campuses. Participation will enable students to engage in standards when the cost of attending

meetings might otherwise deter participation. Other activities, such as hackathons, can be co-located to engage students in the technical work done by SDOs.

Hosting an SDO can spotlight an institution's research, highlighting advanced labs and technical work in emerging technologies. Because of the variety of participants attending SDO meetings, hosting a meeting can bring networks of possible partners to an academic institute. This exposure provides excellent networking opportunities for students, faculty, and researchers.

Engage Academia to Grow the Next Generation of Standards Experts

The U.S. government and American National Standards Institute (ANSI) standards strategies both support maintaining robust participation in standards and developing a well-educated, technically advanced workforce in standards development. To ensure that today's students become tomorrow's standards experts, it is critical that the U.S. government and industry build strong partnerships with academic institutions. "The first step in getting young, emerging professionals and students—our future standardization leaders—involved in standards development activities is educating them about the importance of standardization."¹³ Engaging academic institutions, particularly by exposing students to the work being done in SDOs, allows the standards community to center standards engagement for the future workforce.

Unfortunately, some colleges and universities do not see the benefits of standards engagement for students. Such institutions perceive standards development to have little or no impact on a student's ability to find a job after graduation. A lack of industry interest in standards supports this position. If the companies that hire entry-level workers do not support standards engagement at every level, students will not see the benefit of standards experience.

A lack of support within academic institutions and inadequate messaging from industry and government can hinder student engagement in standards. If colleges and universities do not agree on the benefits of standards work for students, then they will not support students engaging in standards bodies. Without clear academic support, students are not likely to engage in standards development. Therefore, academic engagement must include forming strong relationships with both students and institutions. Establishing outreach to colleges, universities, and technical and trade schools should be a joint effort between the government, industry, and SDOs. Government, industry, and academia need to develop messaging to explain the standardization process and highlight the importance of standards for CET engagement.

¹³ [Education & Standardization \(ansi.org\)](https://www.ansi.org/education-standardization)

Recommendations to the U.S. Government

The U.S. government must designate standards as a priority for national and economic security for the United States. The U.S. Government National Standards Strategy addresses strategies to raise awareness and increase participation in SDOs. The strategy discusses promoting engagement between academic institutions, private sector stakeholders, and the U.S. government.

The U.S. government can leverage relationships with academic institutions to engage students in standards development activities. Cooperative Research and Development Agreements (CRADAs) between Federal labs and academic institutes can be leveraged for standards development activities and research. NSA's NCAE program designates lead academic institutions in cyber defense, research, and operations. Schools that obtain one of these designations can compete for DoD grants. This type of relationship with schools can be used to develop standards engagement efforts.

Recommendations to Private-Sector Stakeholders

Private-sector stakeholders can encourage academic engagement in standards development to make students aware of the role of standards in CETs. Private sector stakeholders can contribute to student outreach by speaking at meetings where academics in STEM fields gather. U.S. government and industry can work with these organizations to create talking points extolling the benefits of working in standards for individual students, faculty, institutions, and the development of technologies.

Recommendations to Standards Organizations

Some SDOs offer education and training opportunities for students and the workforce, including ANSI's Standards Education and Training program. SDOs and organizations involved in standards work put a lot of effort into planning how to train individuals to work within their frameworks. NIST¹⁴ offers standards training for U.S. government agencies to understand standards development processes and be prepared to participate effectively. The Society for Standards Professionals¹⁵ offers certification recognizing experts in the field of standards "who have demonstrated a high degree of professional competence in different areas of standards, consensus standard development, and standards developing organization management." Programs like these can be used as a template for creating engagement and training plans for academic engagements.

Engagement plans should include details on which institutes or organizations to engage, how to communicate with these groups, and specific strategies for encouraging standards development engagement. In addition, it is important to identify resources, including

¹⁴ [Standards education | NIST](#)

¹⁵ [SES - The Society for Standardization Professionals \(ses-standards.org\)](#)

funding for academic engagement in standards forums. One factor for low academic participation in standards is funding, so it is important to plan to leverage grants and existing funding from the industry to increase academic engagement. Many SDOs also allow students to have special memberships at a lower cost, an important consideration when identifying engagement opportunities during the planning phase. Publications can be a valuable tool for explaining the importance of standards to students. Posters and brochures explaining the importance of standards can be provided to academic institutions to aid in raising awareness and recruiting students who are interested in technical fields. Publishing students' work that comes from engagement with academia can also be an incentive for students to engage in standards. If their work in standards forums is published and highlighted by the organizations they are partnering with, academic institutions may begin to see the benefit of these relationships. In addition, some SDOs support student-led publications, such as technical magazines, that showcase student research and standards engagement.

Conclusion

As technology continues to develop at an increasingly rapid pace, standards have become ever more critical to both U.S. national security and economic prosperity. Strengthening U.S. participation in standards is critical to protecting the security of the American people, expanding economic opportunity, and defending democratic values. Critical and emerging technologies are especially important to the U.S. position in standards. The U.S. government and industry must be aware of the threat landscape associated with an increasing level of politicization of standards and related standards processes.

Standards development in this technical landscape is a complex, transnational issue that requires strong leadership to promote democratic values globally. These recommendations position the U.S. to provide this kind of leadership. Promoting democratic values in standards is a global effort; these recommendations should be used by the U.S. and like-minded democratic nations to promote open, transparent standards to secure future technologies. A strong academic standards curriculum, a well-educated, standards-savvy workforce, and an improved landscape for domestically hosted standards meetings can help to build the positions of the U.S. and like-minded nations in international standards development bodies.

The U.S. government and private-sector stakeholders must ensure that robust standards participation is maintained long term. Investment in human resources and funding requires commitment from the U.S. government, industry, and standards organizations to ensure that the U.S. and like-minded nations maintain leadership in standards development and that democratic values are preserved within global standards development organizations. Standards are a collaborative effort, and it is necessary for the U.S. government, industry,

academia, and all individuals who support secure, democratic standards to work together to progress standards for the technologies of the future.

Appendix A: Timing Considerations in Standardization

Internet Protocol

A classic example of the benefits of early engagement in standards is the Internet Protocol (IP). Developed in the 1970s as part of ARPANET, the U.S. Department of Defense’s computer networking project, IP became standardized in September 1981 and has since become the basis of digital communications worldwide.

The early engagement of the ARPANET researchers and other technical experts in standardizing the fourth version of the protocol—codified in RFC 791¹⁶, “Internet Protocol,” and now known as IPv4—was arguably a key to its widespread deployment. Indeed, a decision to wait until a “better” protocol was available may well have slowed the growth of the Internet as local experiments continued rather than a rapid convergence on an interoperable specification.

One of the outcomes of the proliferation of IPv4 was that its limited address size—only 32 bits, enough for around 4 billion devices—became the “standard” too, eventually leading to the exhaustion of the address space. Vint Cerf, who led the team that developed the protocol, is quoted¹⁷ as saying although a 128-bit address space (the same as today’s alternative, IPv6) would have been better, it “wouldn’t have seemed realistic back then,” particularly given the limited computer power of the day. He decided on a 32-bit address, trading between a successful experiment and indefinite enhancements.

The ATIS NEXT G Alliance

A new generation of mobile wireless communications is developed on approximately a 10-year cycle. Early engagement in the next iteration of this cycle, starting with the development of the International Telecommunication Union (ITU) 6G Vision and Draft Framework, can maximize the benefits of standards engagement and align with what North America envisions for the future network. The Alliance for Telecommunications Industry Solutions (ATIS) launched the Next G Alliance¹⁸ as an initiative to advance North American wireless technology leadership through private-sector-led efforts, with deliberate, collaborative steps and an aligned commitment between government, industry, and academia to ensure that the United States maintains a competitive technology position in 5G networks today and 6G networks in the future before they are standardized.

¹⁶ Postel, J., “Internet Protocol”, STD 5, RFC 791, DOI 10.17487/RFC0791, September 1981, [rfc791 \(rfc-editor.org\)](https://www.rfc-editor.org/rfc/rfc791)

¹⁷ Noyes, K., “Vint Cerf’s dream do-over: 2 ways he’d make the internet different,” InfoWorld, September 23, 2016, <https://www.infoworld.com/article/3123539/vint-cerfs-dream-do-over-2-ways-hed-make-the-internet-different.html>

¹⁸ [Next G Alliance](https://www.atis.org/next-g-alliance)

While 5G and 5G Advanced networks are still being standardized, the ATIS Next G Alliance developed a Roadmap to 6G, which presents a 6G vision for North America and is working to establish national priorities that will influence government-applied research funding and promote incentivized government actions for 6G and beyond, giving the United States a solid footing in future technologies before they are standardized. This kind of early engagement shows that pre-standardization efforts can facilitate alignment and are an important aspect of developing new technologies.

Engaging Too Early

Though early standards engagement is important, there are some risks in engaging too early. If standardization efforts begin before the market is ready, technical standards may not be effective. This can result in standards that are not adopted, or if they are adopted, do not have enough investment to keep them up to date and secure. Rohit_Khare published a note¹⁹ in 2000 arguing that standardization of new “wireless web” protocols in the form of WAP, which were incompatible with their established wired counterparts, would ultimately prove counterproductive. The “W* effect,” as Khare characterized the WAP standards, was predicated on the assumption that “handheld wireless devices intrinsically require optimized transport, applications, and content due to unavoidable technology limitations.”

As anticipated by Khare, in the long term, wireless devices were able to support the same web protocols as the wired Internet and this support was instrumental in creating the modern smartphone experience. The WAP standards, which had been widely supported by the wireless industry, were a dead-end. The mobile web differs from the non-mobile web today, of course, but the differences are mostly a matter of device capabilities and user interfaces rather than separate protocol stacks. When it may be too soon to standardize a new technology, there are still ways to engage with SDOs in pre-standardization. Many SDOs form study groups for emerging technologies dedicated to the research and development of early prototypes and security features.

¹⁹ Khare, Rohit, and 4K Associates. "W* effect considered harmful." *Mobile Networking with WAP: The Ultimate Guide to the Efficient Use of Wireless Application Protocol* (2000): 361-391, https://link.springer.com/chapter/10.1007/978-3-322-86790-2_27