NIST Smart Grid and CPS Newsletter

December 2016

2016 Year-End Greetings from Chris Greer

Dear Colleague,

This past year has been a busy and productive one for us at NIST. This year-end newsletter provides a brief summary of some of our accomplishments, with convenient web links to those subjects that might be of interest to you.

These achievements would not have been possible if we worked alone. We owe you—our colleagues and partners in the smart grid and cyber-physical systems (CPS) communities—a big measure of gratitude for your help and support throughout the year. Our mission is to promote U.S. innovation and industrial competitiveness by advancing measurement science, standards, and technology in ways that enhance economic security and improve our quality of life. We do this best when we interact widely and deeply with leaders and experts from the sectors and industries we serve. Thank you for your engagement in these issues.

One group that has been especially insightful and supportive is the Smart Grid Federal Advisory Committee, established six years ago to provide high-level input to NIST. Earlier this fall, several members reached the end of their terms on the committee, and I want to thank those outgoing members and recognize their valuable service.

Our Smart Grid and Cyber-Physical Systems Program added three new staff members this year. Avi Gopstein is serving as Smart Grid Program Manager and Deputy National Coordinator for Smart Grid Interoperability. Tom Roth and Eugene Song, Electronics Engineers, are conducting research in our testbeds. In addition to the core staff in our program, we work very closely with a number of talented scientists and engineers from across the NIST organization, in areas ranging from cybersecurity and electrical metrology to mechanical engineering and power electronics.

Looking back at 2016 and ahead to 2017, I believe our society is reaching a critical point where we can—and must—begin to take full advantage of recent developments in both the realm of physical technologies and the realm of information technologies. Whether it's the modernization of the electric grid, the growth of smart services in cities and communities, or the expansion of the Internet of Things (IoT), we are witnessing transformations that will affect every one of us. To take advantage of these opportunities and meet the many challenges that will arise, it is essential that we understand and apply the measurement science underlying these systems and these systems of systems.

At NIST, we are invigorated by the prospect of contributing our scientific and technical expertise to this effort. We look forward to working with our colleagues in industry, government, and academia to create critical measurement solutions and facilitate the development of useful standards.

We hope and expect that 2017 will be another active and fruitful year for all of us in the smart grid and cyber-physical systems communities. Thanks in advance for your continued involvement and support.

Best regards,
Chris Greer, Director
Smart Grid and Cyber-Physical Systems Program Office

Back to Top

Smart Grid Program Highlights

Testing and Certification: In May, the National Electrical Manufacturers Association (NEMA) published a new standard—ANSI/NEMA SG-IPRM 1- 2015 (IPRM), the Smart Grid Interoperability Process Reference Manual (IPRM). The standard codifies the IPRM publication, which was developed and refined over the past six years by the Smart Grid Testing and Certification Committee (SGTCC) of the Smart Grid Interoperability Panel (SGIP). NIST's Cuong Nguyen served as the lead for NIST's Smart Grid Testing and Certification Project, vice chair of the SGTCC, and chair of the NEMA committee that drove the standard development process. Nguyen discussed the key role that testing and certification must play in grid modernization in an article, "A 'Certified' Stamp for the Smart Grid," on NIST's "Taking Measure" blog.

Facility Smart Grid Information Model: In June, the American Society of Heating, Refrigerating, and Air-Conditioning Engineers (ASHRAE) and NEMA published ASHRAE/NEMA Standard 201P, Facility Smart Grid Information Model (FSGIM). This new standard provides a common basis for electrical energy consumers to describe, manage, and communicate about electrical energy consumptions and forecasts. It offers very significant potential benefits for energy providers and for owner of facilities of all kinds—whether a single family house, a commercial or institutional building, a manufacturing or industrial building, or multiple buildings such as a college campus. Among the many energy management applications enabled by this standard are potential gamechangers, such as on-site generation, demand response, electrical storage, and peak demand management. NIST's Steve Bushby, Manager of the NIST Embedded Intelligence in Buildings Program, served as chair of Standard Project Committee (SPC) 201P that developed the standard. The standard development process, which often requires many years, was accelerated for the FSGIM by the establishment of the Smart Grid Interoperability Panel's (SGIP) PAP-17 in 2010 (co-chairs Steve Bushby, NIST, and Martin Burns, NIST). The FSGIM standard has also been unanimously approved in a draft international standard ballot by ISO/TC 205, Building Environment Design. Because of the unanimous approval, it will proceed directly to publication as ISO 17800 without additional ballots.

Synchrophasors: One of the smart grid standards for which NIST has been playing an important role in recent years is IEEE C37.118.1-2011, Standard for Synchrophasor Measurements for Power Systems. Three members of the NIST Smart Grid Team, Allen Goldstein, Gerald Fitzpatrick, and Eugene Song, are active researchers in this area. For the past several years, key members of the global synchrophasor community—including NIST, IEEE, and the North American SynchroPhasor Initiative (NASPI)—have worked to fill a gap in the power industry regarding testing and certification of Phasor Measurement Units (PMUs). These organizations have established the IEEE Synchrophasor Certification Program, which offers buyers of PMU technology a method to determine compliance of a product to the IEEE C37.118.1a standard before purchase and large-scale deployments. Earlier this year, two companies became the first companies to successfully complete the program requirements. The registry of IEEE-certified PMUs can be found online here.

Transactive Energy: Transactive energy (TE) has been a topic of great interest to NIST and the smart grid community in 2016. To advance progress in this field, NIST launched the Transactive

Energy Modeling and Simulation Challenge for the Smart Grid ("TE Challenge") in September 2015. The challenge brings researchers and companies with simulation tools together with utilities, product developers, and other grid stakeholders to create and demonstrate modeling and simulation platforms while applying TE approaches to real grid problems. Seven challenge teams have been working for the past year on projects addressing different aspects of transactive energy. The leaders of the teams—along with David Holmberg, NIST lead for the challenge—reported on their progress at the third Transactive Energy Systems Conference and Workshop (May 17-19, 2016, in Portland, OR) and again in a September 20 webinar (presentations available online). As the TE Challenge program moves forward, NIST recently held two outreach workshops on "Harnessing the Power of Distributed Energy Resources: Quantifying Transactive Energy and Economics" (October 20, 2016, in San Jose, CA; December 6, 2016, in New York City, NY). Further details about the TE Challenge—including plans, participants, and publications—are available at the TE Challenge Collaboration Website.

Precision Timing: Precision timing—such as one microsecond synchronization to a traceable time and frequency reference—is an issue of growing interest and concern to engineers and scientists working with the smart grid and other cyber-physical systems. The proliferation of synchronous sensors for wide-area monitoring, along with the increasing need for dynamic control based on time-sensitive algorithms and analyses, require precision timing. These new capabilities offer increased flexibility to grid operators, but they also raise time-related security concerns. To explore the opportunities, concerns, and challenges related to timing, NIST and IEEE held a workshop on "Timing Challenges in the Smart Grid" (October 26, 2016, in Gaithersburg, MD). The meeting provided an opportunity for diverse stakeholders from utilities, system integrators, national labs, academia, and government to learn about each other's expertise and needs, as well as discuss future plans and priorities. According to Ya-Shian Li-Baboud, NIST's lead for this workshop, the outcomes of the workshop will inform a NIST report summarizing the challenges and potential solutions for wide-area clock synchronization as well as prioritizing future R&D and standards efforts in precision timing for power systems and other domains.

Smart Grid Interoperability Testbed Facility: In 2016, NIST completed construction of this new testbed, started an expansion, and began conducting research. The testbed, with a particular emphasis on microgrids, is a resource allowing NIST scientists and engineers to test and understand smart grid interoperability between many different components in many different situations. The testbed enables NIST to accelerate the development of smart grid interoperability standards by addressing the measurement needs of the evolving smart grid industrial community. According to Paul Boynton, Testbed Manager, the testbed has been designed and built with three key principles in mind: composability, internal interconnectivity, and external interconnectivity. Taking advantage of the interactivity offered by the multiple interacting lab modules, the testbed measures and characterizes key smart grid components, standards, and protocols. The testbed is also able to make measurements of system-level, end-to-end smart grid performance and interoperability. Current research projects underway include:

- Standards and testing for microgrid interconnection equipment and controllers
- Interoperability requirements and tests for phasor measurement units (PMUs)
- Use of synchrophasor measurements in electric power systems protection and control applications

Smart Grid Interoperability Panel (SGIP): Throughout 2016, NIST staff members continued to participate actively in SGIP technical meetings, playing leadership roles in the following Domain Expert Working Groups, Priority Action Plans, and Standing Member Committees:

Domain Expert Working Groups (DEWGs)

- Distributed Renewables, Generation, and Storage (DRGS)

- Home, Building, and Industrial (HBI) Domain Expert Working Group

Priority Action Plans (PAPs)

- Facility Smart Grid Information Standard (PAP-17)
- Green Button Energy Services Provider Interface (PAP-20)
- Microgrid Operational Interfaces (PAP-24)
- Weather Information (PAP-21)

Standing Member Committees (SMC)

- Smart Grid Cybersecurity Committee (SGCC)
- Smart Grid Testing and Certification Committee (SGTCC)

Elections for the 2017 SGIP Board of Directors were recently held, and NIST's David Wollman was elected for a two-year term, filling one of the two seats allocated to the "Consumers, Policy, and Government" interest category.

Back to Top

Cyber-Physical Systems Program Highlights

Cyber-Physical Systems Framework: In May, the NIST CPS Public Working Group published its "Framework for Cyber-Physical Systems, Release 1.0." The document—developed in partnership with industry, academic, and government experts—is intended to help, assure, and manage the evolution of CPS that can work seamlessly with other such smart systems that bridge the physical and computational worlds and are the basis for connected infrastructures. According to NIST's David Wollman, Deputy Director of the Smart Grid and Cyber-Physical Systems Program Office, the framework provides a CPS analysis methodology for understanding, designing, building, operating, and assuring CPS, including those with multi-domain applications. The document reflects nearly two years' effort by the public working group. Detailed information about the CPS PWG, along with the Framework document, is available online at the collaboration site.

One of the important dimensions of CPS outlined in the CPS Framework is "trustworthiness"—a cluster of concerns encompassing security, privacy, safety, reliability, and resilience. NIST's Edward Griffor, a co-chair of the CPS Framework effort, organized a workshop on this topic, "Exploring the Dimensions of Trustworthiness: Challenges and Opportunities" (August 30-31, 2016, in Gaithersburg, MD). The meeting—attended by CPS and IoT technical experts and policy leaders—focused on the integration of approaches from engineering to the conceptualization, realization, and assurance of safe, secure, and effective CPS and IoT systems to address multiple concerns, their interactions, and the interaction between the "logical" and the physical.

Smart Cities: The centerpiece of NIST's smart cities effort is the Global City Teams Challenge (GCTC), led by NIST's Sokwoo Rhee. Its long-term goal is "to establish and demonstrate replicable, scalable, and sustainable models for incubation and deployment of interoperable, standards-based IoT solutions and demonstrate their measurable benefits in smart communities/cities." Since the program was launched in September 2014, GCTC has recruited and incubated over 160 action clusters with participation from over 150 cities and 400 companies/organizations from around the world. The Global City Teams Challenge (GCTC) Expo—convened by NIST and US Ignite in June 2016 in Austin, TX—attracted 2000 attendees to see the latest developments in the rapidly

expanding smart city sector. Representatives from more than 110 cities from 11 countries gave on-stage presentations and hosted display booths.

In October 2016, the GCTC program embarked on a new phase—"SuperClusters." At a SuperCluster Kickoff Event, held in Washington, D.C., over 250 participants from local government, industry, non-profits, universities, and international cities began work on SuperClusters. These will be multi-city, multi-stakeholder deployments of smart city projects in sectors such as energy, transportation, and public safety. At the October 2016 event, six "Seed SuperClusters" were formed and have begun regular conference call meetings, in the following areas:

- Energy/Utility/Water
- Public Safety/Emergency/Resilience
- City Platform
- Healthcare/Environment
- Transportation
- Public WiFi

In September 2016, four smart city projects, involving eleven cities and communities, were selected for grant funding through NIST's Replicable Smart City Technologies (RSCT) Cooperative Agreement Program. These projects involve these communities taking a lead role in one key element of the overall program—establishing measurable performance metrics, thereby helping drive the adoption of replicable, standards-based solutions that improve the quality of life for residents of communities of all sizes.

Thousands of smart city projects are underway worldwide, as government and technology leaders seek to use the Internet of Things (IoT) to bring tangible benefits to the citizens in their communities. A number of organizations are developing and proposing various architectural design principles, taxonomies, and standards for these projects. However, there has not yet been a convergence of standards efforts that will enable IoT's full potential to be realized in the smart city market. Addressing this issue earlier this year, NIST—together with six domestic and international partners—launched an international technical working group to develop an IoT-Enabled Smart City Framework (IES-City Framework). In consultation with city stakeholders, the group has begun to compare and distill current architectural efforts, with a goal of producing a consensus framework document of common architectural features. According to Martin Burns, NIST's lead for the project, this framework document will help cities employ interoperable and scalable smart city solutions that will meet the needs of their communities.

Back to Top

Looking Ahead to 2017

The coming year will see the completion of the Smart Grid Interoperability Testbed expansion and the start of construction for the CPS testbed—realizing our vision of a common research testbed across the multiple domains and involving expertise that exists at NIST on common challenges for the smart grid and cyber-physical systems. The technology that will enable a testbed strategy that enables the study of the growing cross-domain composition of CPS is a "Universal Cyber-physical systems Environment for Federation" (UCEF). This technology prototype will be made available to a broad set of industry, government, and academic stakeholders at an "Open Source" workshop at NIST.

To advance the projects discussed above, NIST will be hosting and/or co-sponsoring a variety of workshops, meetings, and conferences in the coming year. At this time, workshops are being organized in the following areas:

- Synchrophasors (The NASPI Work Group meeting will be held at NIST-Gaithersburg, March 22-23, 2017.)
- GCTC SuperCluster Face-to-Face Meetings (The Transportation SuperCluster meeting has been scheduled, and other SuperCluster meetings are being planned.)
- GCTC Expo (planned for Summer 2017)
- Precision Timing
- TE Challenge
- CPS Framework
- Grid 3.0 Business Models
- NIST Smart Grid Interoperability Framework (In 2017, we will begin work on Version 4.0 of this important document, with a workshop on architecture, cybersecurity, and interoperability issues.)

As further details become available, they will be announced in this newsletter and on the NIST Smart Grid website and the NIST CPS website. We look forward to seeing and working with many of you in the coming year.

Back to Top
