Smart Grid and Cyber-Physical Systems Program Overview

Dr. Chris Greer

Senior Executive for Cyber Physical Systems

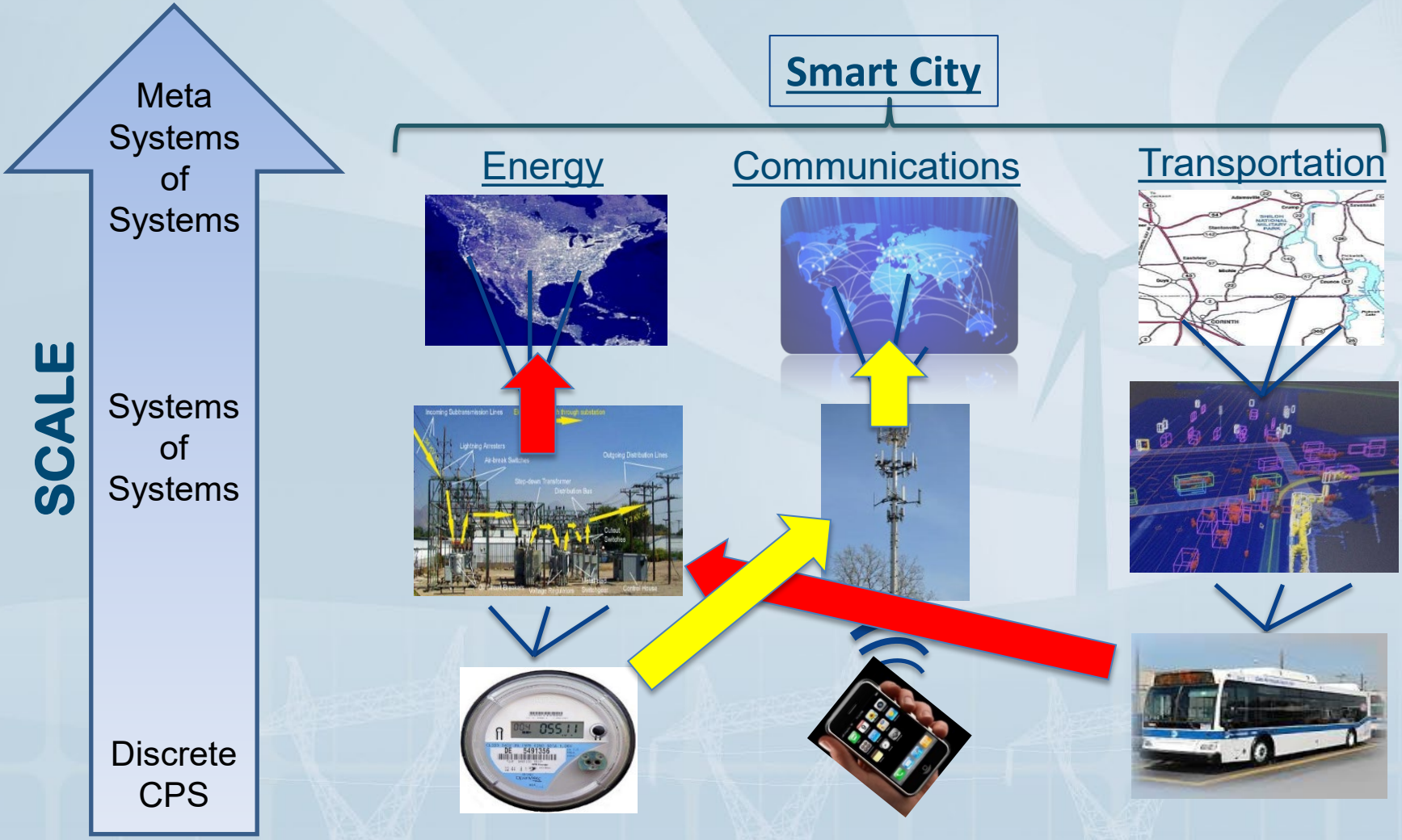
Engineering Laboratory

Smart Grid and Cyber-Physical Systems Program

Through new measurement science, advanced testbed capabilities, and community-based efforts, enable the scalable design and reproducible performance measurement of advanced cyber-physical systems that are reliable, resilient, effective, safe, sustainable, secure, and privacy-enhancing.

NIST
National Institute of Standards and Technology
U.S. Department of Commerce

Cyber-Physical Systems (CPS): Scalability and Compositionality



SG & CPS Program Portfolio

Systems Of Systems

Interacting Systems

Discrete CPS

SCALE

Cyber-Physical Systems

Global Cities Teams Challenge

Public Working Group

CPS Testbed

Global Cities:
- Launch, GCTC 2016
- GCTC 2016 Expo
- Smart Cities Framework
- IoT Fabric Guide

CPS Testbed:
- Modeling and simulation testbed engine
- Federated testbed design
- Construction plan
- Server room construction

CPS PWG:
- Ref. Architecture Initial Framework
- Trustworthiness workshop
- Applicability of Framework
- Technology Roadmap

Smart Grid

Grid 3.0

Transactive Energy Challenge

SGIP

Smart Grid Testbed

Grid 3.0:
- Broad partnership
- NIST, DoE, SGIP, EEI, EPRI, NEMA, UCAIug, GWAC
- Future Grid

TE Challenge:
- Modeling/Simulation
- Launch, Sep. 2016
- Tech Jam
- Expo

SG Testbed:
- Initial Occupancy
- Safety
- First Experiments – Timing, Sensors, & Fault Detection

SGIP:
- Transition to new model
- OpenFMB
- Cyber
- Testbeds

QUESTIONS?

CPS Public Working Group Update

Dr. David Wollman

Deputy Director

Smart Grid and Cyber-Physical Systems Program Office

Engineering Laboratory

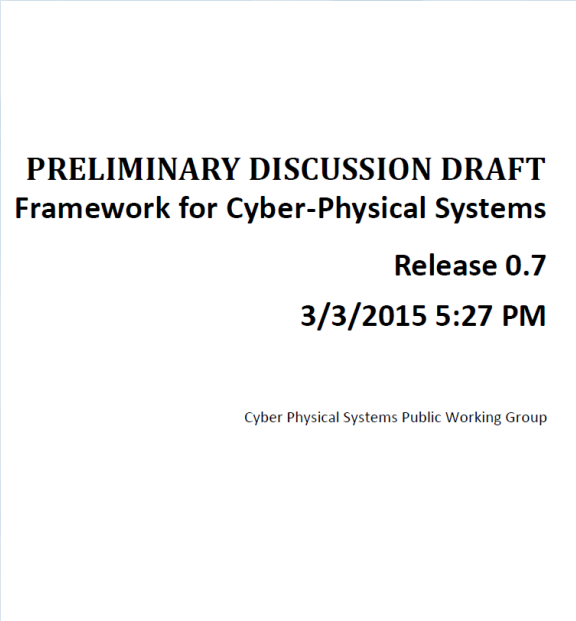
Ms. Victoria Pillitteri

Program Analyst

Program Coordination Office

NIST CPS Public Working Group (PWG)

NIST CPS PWG leadership: David Wollman and Chris Greer					
Co-Chairs	**Reference Arch**	**Use Cases**	**Security & Privacy**	**Timing**	**Data Interop**
NIST	Abdella Battou	Eric Simmon	Vicky Pillitteri	Marc Weiss	Marty Burns
Academia	Janos Sztipanovits	John Baras	Bill Sanders	Hugh Melvin	Larry Lannom
Industry	Stephen Mellor, Shi-Wan Lin, Ed Griffor	Stephen Mellor	Claire Vishik	Sundeep Chandhoke	Peggy Irelan, Eve Schooler


PRELIMINARY DISCUSSION DRAFT
Framework for Cyber-Physical Systems
Release 0.7
3/3/2015 5:27 PM
Cyber Physical Systems Public Working Group

CPS Collaboration Platform:

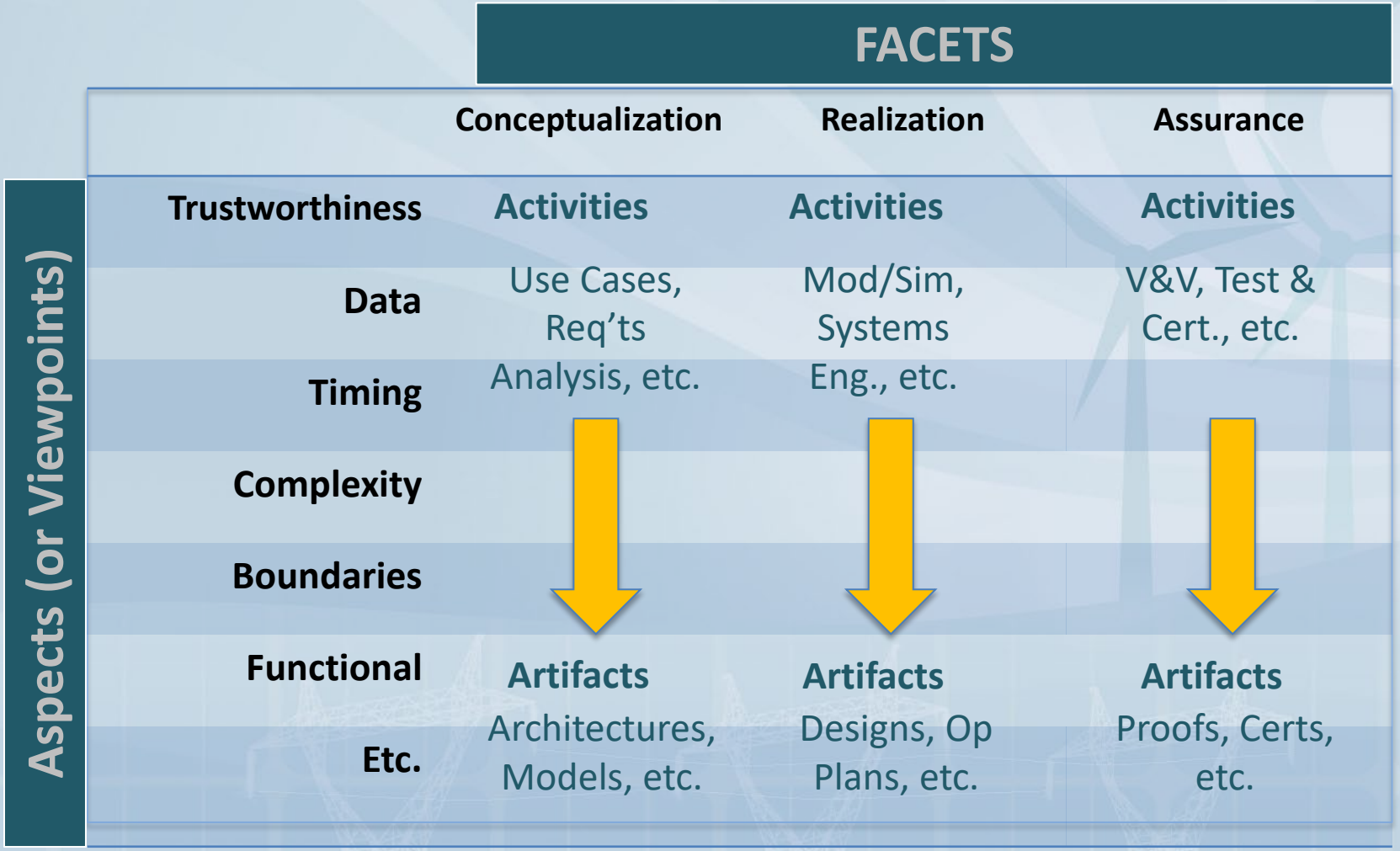
- www.cpspwg.org

CPS Working Group web site:

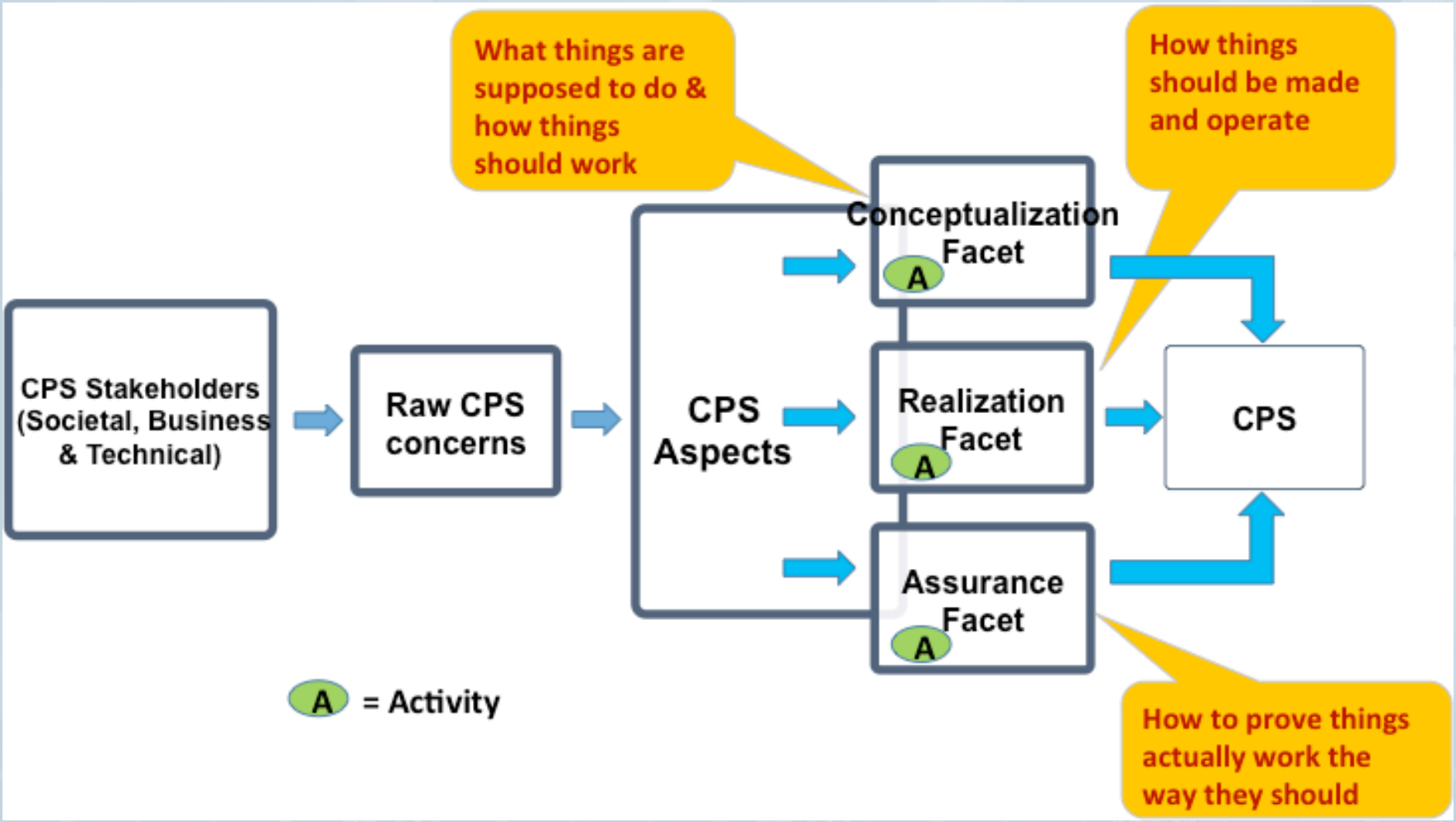
- www.nist.gov/cps/cpspwg.cfm

- F2F Workshops: August 2014 and April 2015
- December 2014: "Framework Element" documents from each subgroup
- March 2015: Preliminary Discussion Draft CPS Framework, Release 0.7 — revision in progress

NIST CPS PWG

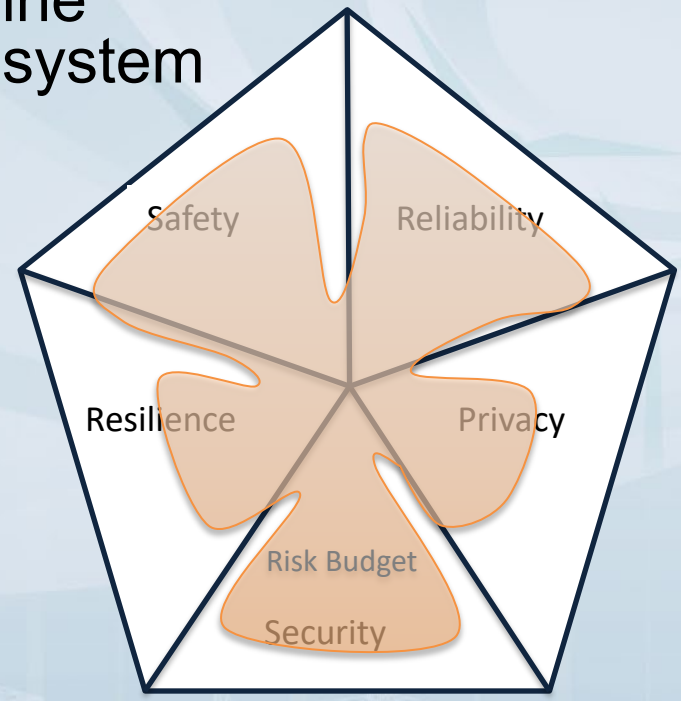

FACETS
Conceptualization
Realization
Assurance
Aspects (or Viewpoints)
Trustworthiness
Data
Timing
Complexity
Boundaries
Functional
Etc.
Activities
Use Cases, Req'ts Analysis, etc.
Activities
Mod/Sim, Systems Eng., etc.
Activities
V&V, Test & Cert., etc.
Artifacts
Architectures, Models, etc.
Artifacts
Designs, Op Plans, etc.
Artifacts
Proofs, Certs, etc.

NIST CPS PWG: Analysis of CPS



NIST CPS PWG: Security and Privacy ➔ Trustworthiness

- CPS is an example of discrete systems engineering disciplines converging; each discipline addresses critical subset of overall system risk

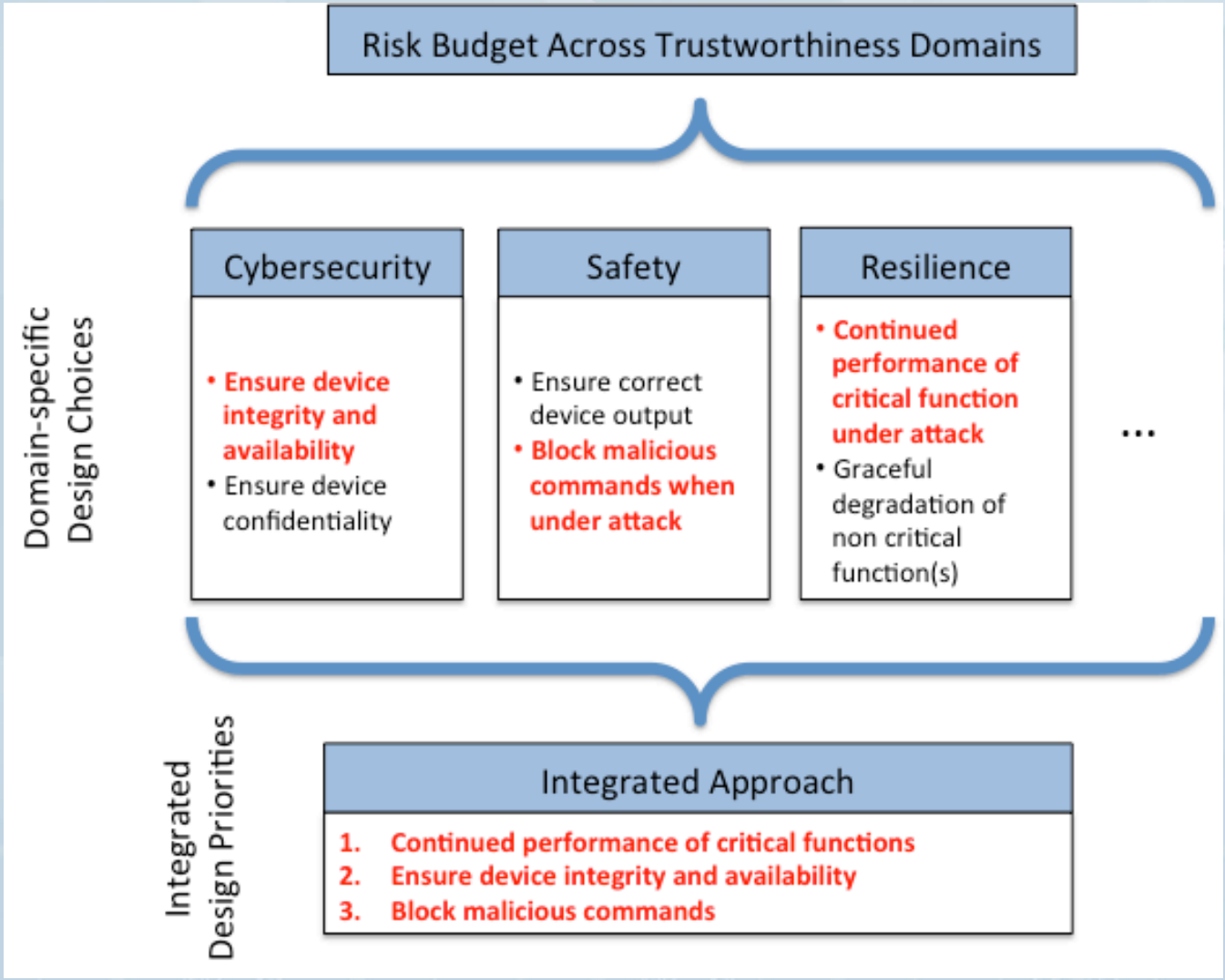


- Design of **trustworthy** CPS requires understanding of impacts of both cyber and physical elements of system; need for **cross-discipline risk analysis**

- Security and privacy requirements need to be determined in conjunction with safety, reliability, and resilience requirements.

CPS Trustworthiness – Notional Integrated Risk Management Approach

Use Case: Pacemaker



NIST CPS PWG: Path Forward

- Draft CPS Framework – Release for public comment in August 2015
- Trustworthiness Workshop
- Applicability of the CPS Framework
- CPS Technology Roadmap

QUESTIONS?

SGIP Update

Dr. David Wollman

Deputy Director

Smart Grid and Cyber-Physical Systems Program Office

Engineering Laboratory

Organization Update - Personnel

- Sharon Allan
  - President and CEO
- Stuart McCafferty
  - Vice President of Operations
- Gabrielle Puccio
  - Vice President, Member and Public Affairs
- John Gillerman
  - Director Technology Dev and Architecture
- Amanda N. Thaxton
  - Marketing and Communications Specialist

SGIP 2015 Focus is Three-Fold

Execute Industry Prioritized Project Work

- DER- Open FMB
- DRGS microcontroller
- Std P2030
- Std Financial data

Strengthen Cybersecurity

- Use Case on C2M2 & cyber frameworks

Drive Interoperability via Testbed Activity

- Survey Test beds
- Identify areas of collaboration
- 61850 Test profile

QUESTIONS?

NIST Smart Grid and CPS Testbeds

Smart Grid Federal Advisory Committee Meeting

July 30, 2015

Paul Boynton

Testbed Manager

Smart Grid and Cyber-Physical Systems Program Office

Engineering Laboratory

NIST

NIST Smart Grid Testbed

NIST Smart Grid Interoperability Testbed

Gaithersburg, MD
Building 220, Basement

Electrical Flow

PHASE 1

Timing and Synchronization

Time-stamping and location for devices on the grid

Cyber Security

Develop / evaluate requirements to keep the grid secure

Rooms A29-31

Microgrid Power

Simulates the power generation on the microgrid

Room A27

Microgrid Communication and Control

Controls the operation of the microgrid

Rooms A23-25

PHASE 2

Smart Storage

Electric vehicle and residential batteries

Room A21

Smart Sensors

Situational Awareness--smart sensors that tell operators what's happening on the grid

Rooms A13-19

Smart Meters

Watthour meters that communicate with the grid

Rooms A13-19

Network and Communication

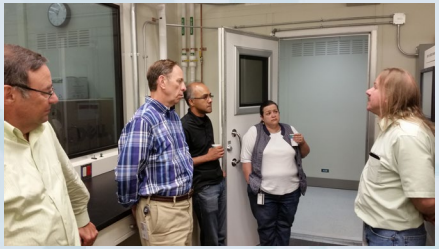
Simulates networks and protocols used to communicate among sensors, substations and other grid components

Rooms A13-19

Communication/Data Flow

NIST Smart Grid Testbed

- Smart Grid Test Bed Phase I Construction Complete
  - Operational by year end
  - Microgrid Capability
  - Phase II Construction to begin early FY16



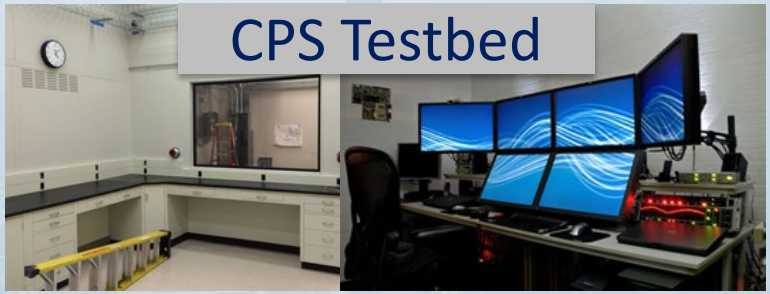
- Advancing the Program
  - Test Bed Launch

    Plan for three significant successes over the next three years
    - Standards and Test for Microgrid Interconnection Equipment and Controllers (PAP 24) - *Hefner*
    - Develop interoperability requirements and tests for Merging Units based upon IEC 61869-9 (and possibly mapping onto OpenFMB) - *FitzPatrick*
    - The Use of Synchrophasor Measurements in Electric Power Systems Protection and Control Applications - *Gharavi, Li-Baboud, FitzPatrick*
  - New Test Bed Hire Planned

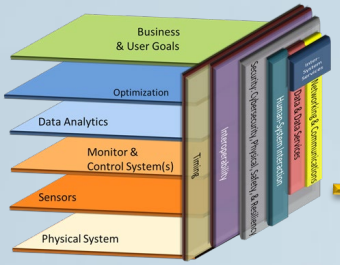
NIST CPS Testbed

- Goal:
  - To develop general design principles useful to all CPS testbed developers to NIST's CPS testbed
  - To establish a cross-sector CPS federated testbed

- Key elements
  - Modeling and simulation testbed engine
  - Federated testbed design
  - Construction plan
  - Server room construction



CPS Testbed Architecture



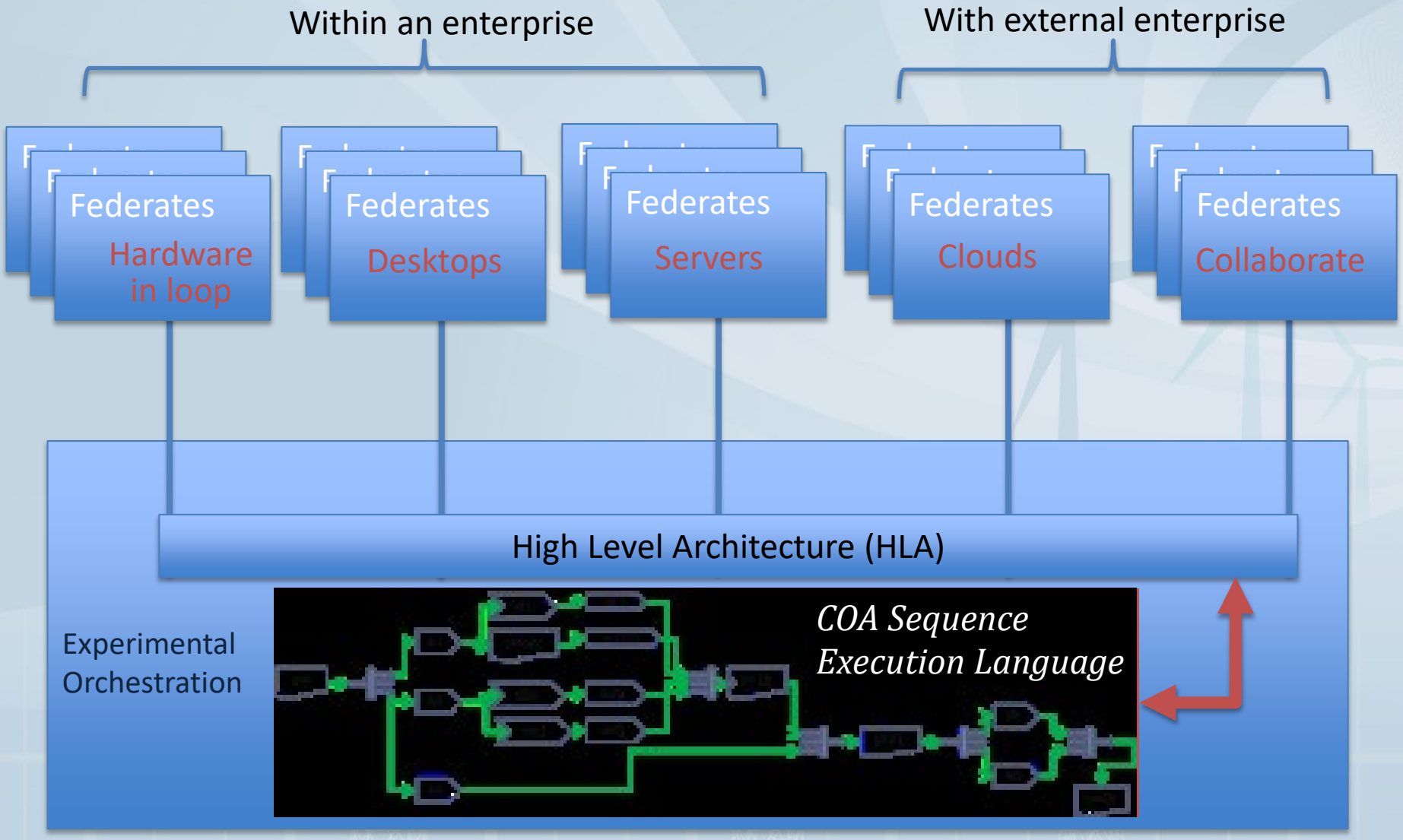
Model Library based on Reference Architecture

Physical and Virtual Test Benches

At-scale Validation

Model Integration Platform

CPS Testbed Architecture



CPS Testbed Design

- Testbed Design Inventory and Analysis Completed
- CPS Testbed Workshop February 2015
- Draft Design Principles and Requirements March 2015
- Final Conceptual Design and Architectural Requirements Oct. 2015
- Follow up Workshop late 2015
- Final Design Principles document
- Initial Facility Renovation, Server Room Construction (Bldg 220 A49) to begin FY16

QUESTIONS?

GREEN BUTTON UPDATE

Dr. Marty Burns

Smart Grid and Cyber-Physical Systems Program Office

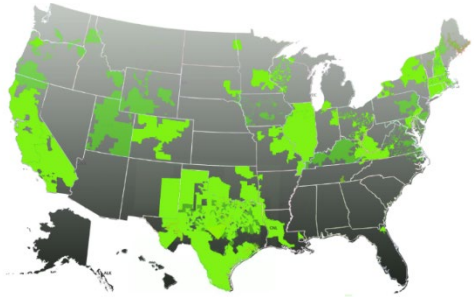
Engineering Laboratory

Green Button Initiative

http://www.greenbuttondata.org

- **Mission/goals:** Enables electronic consumer access to energy data and supports development of ecosystem (apps and APIs – see developer sandbox https://services.greenbuttondata.org).
- **Why this is important:** Consumers can only control what they can measure. Green Button represents the currency of demand response and energy efficiency. In addition to private sector implementations, the Federal Government is committed to Green Button as part of US Climate Action Plan/Presidential Memorandum.
- **Progress Today:** US: Available to 100+ million people. CANADA: Available to ~8 million people.
- **Relevant Timeline:** Ecosystem pieces in place 2Q15 with standards, trade association, and testing and certification. Further growth within federal agencies 3Q15.
- **Problem areas:** Motivating a few key software vendors to update their alpha implementations to be certifiable and certified.

Map of US Green Button Commitments



Presidential Memorandum (to all Federal agencies)

"Sec. 3. Building Performance and Energy Management .. each agency shall: ***… incorporate Green Button into reporting****, data analytics and automation, and processes, in consultation with local utilities …" [.. GSA, EPA pilots …]*
Presidential Memorandum on Federal Leadership in Energy Management, December 5, 2013

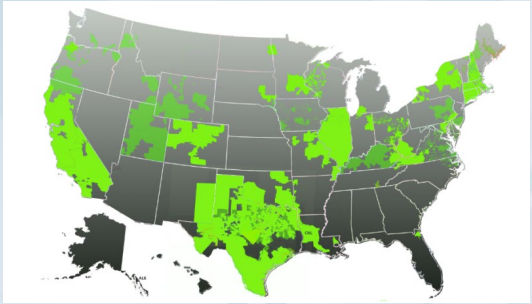
Results to date with NIST/DOE support:
- GSA 5-building pilot
- EPA Portfolio Manager Integration
- DOE American Energy Data Challenge

U.S. DEPARTMENT OF ENERGY

NIST National Institute of Standards and Technology U.S. Department of Commerce

Green Button Across the Nation

- Enables electronic consumer access to energy data and supports development of ecosystem (apps)
- Available to 60+ million customers in the US and and additional CANADA: 2.6 million+
- Result of collaboration among White House, NIST, DOE, state regulators, utilities, vendors, SGIP, and North American Energy Standards Board
- Green Button Download My Data and Green Button Connect My Data



Map of US Green Button Commitments

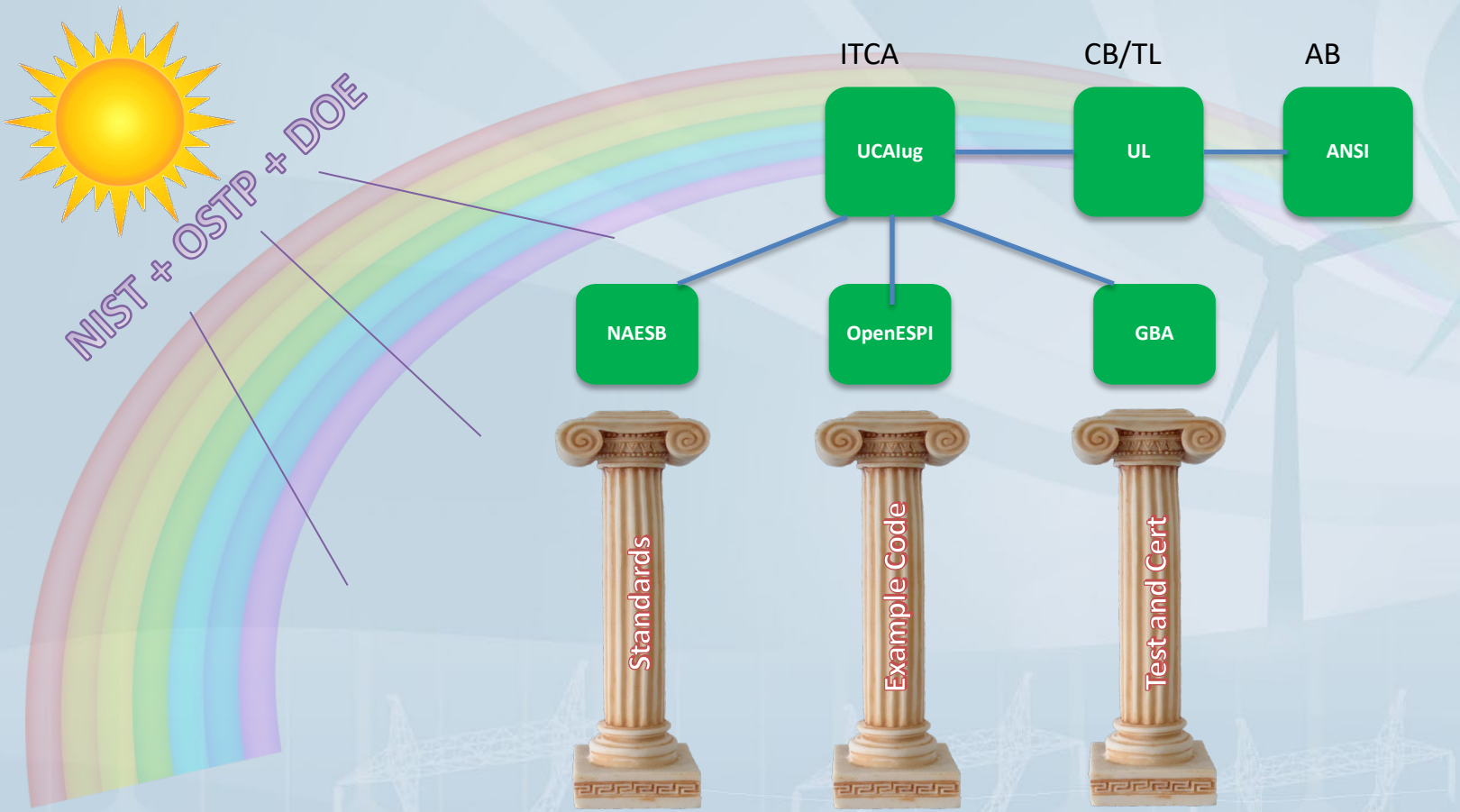
Green Button Connect My Data

Green Button Download My Data

Creation of Green Button – Inspire an Industry

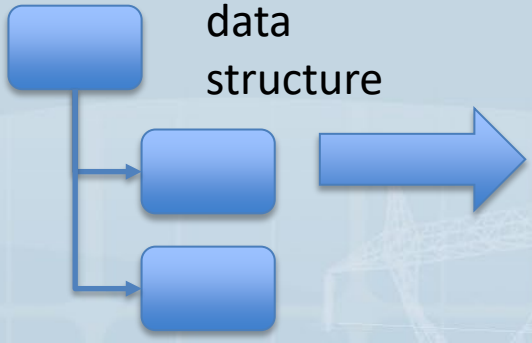
- Inspire Utilities to voluntarily offer standardized Energy Usage Data
- Inspire the creation of an ecosystem to support standardized data exchange
- Inspire UCAIug/UL/ANSI to take up the data exchange certification challenge

Green Button Ecosystem

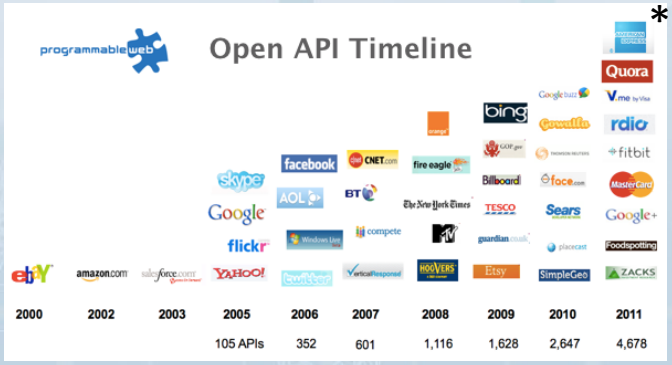


Going Forward

- Ecosystem
  - Complete Green Button CMD Certification
  - Support the ecosystem as needed
- NIST Research
  - Stand up campus server (Summer SURF project)
  - Basic API Research based on GB Lessons Learned



Data Exchange
Third Party Access
Manage Data Life Cycle
Standard Metadata
Interoperable Time



* http://www.programmableweb.com/news/over-2000-apis-added-2011-social-telephony-open-government/2012/01/04

QUESTIONS?

Transactive Energy Update for SG Advisory Committee

David Holmberg

July 30, 2015

SGIP™
TE Coordination Group

Transactive Energy Update

- NIST, SGIP and others continue to lay the foundation for TE
  - SGIP TE Coordination Group is working with the SGIP SG Architecture Committee to develop a use case set that expresses the TE landscape. This will provide input to the TE Challenge and other efforts.
  - Working on key protocols for TE: OpenADR, FSGIM and Green Button
  - Developing research capabilities in the NZERTF (NIST Net Zero house) and SG Testbed.
  - TE Challenge

TE Challenge

- Bring 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
  - and advance standards and applications
- The Challenge will help industry better understand the potential for TE and create a path for real-world trial implementations.
- The Challenge will build the TE community, and provide a stage for teams to present exciting work.
- Project teams are forming now around:
  - Common model and scenarios
  - Interoperable co-simulation platform
  - Open-source TE standards and reference implementation
  - Transactive controls approach and implementation
- Participants: PNNL, Vanderbilt, CMU, MIT, CleanSpark, EPRI, Siemens, OATI, GA Tech, Iowa State, and others

Timeline

- TE Challenge Preparatory Workshop, Mar 24-25—demonstrated TE community agreement on the vision and need for the TE Challenge.
- TE Challenge **website** at: http://www.nist.gov/smartgrid/techallenge.cfm
- **Collaboration Site** — provides resources, team information, and link to join the TE Challenge.
- **Kickoff Meeting** for team formation (September 10-11, 2015 at NIST)
- Midpoint Coordination and Team Building Meeting (December 3-4)
- **Summit Expo/Report out** (April 2016)—Goal is to present the good work that has been done.
- Second Expo/Report (September 2016)

QUESTIONS?

Grid 3.0 Update

Dr. David Wollman

Deputy Director

Smart Grid and Cyber-Physical Systems Program Office

Engineering Laboratory

Grid 3.0 Workshop Organizing Committee

- SHARON ALLAN, SGIP
- JOHN CASKEY, NEMA
- ARYEH FISHMAN, EEI
- CHRIS GREER, NIST
- ERICH GUNTHER, ENERNEX
- CHRIS IRWIN, DOE
- JOHN MCDONALD, GE
- RON MELTON, PNNL
- RAY PALMER, FERC
- DON VON DOLLEN, EPRI
- DAVE WOLLMAN, NIST
- (AND ADDING OTHERS TO GRID 3.0 PLANNING PROCESS – TERRY OLIVER, BPA; BRAD RAMSAY, NARUC; RON CUNNINGHAM, AEP; OTHERS….)

Grid 3.0 Planning Process

- Two workshops have been held at NIST to lay the ground work for the future of the electrical power grid
- Example Grid 3.0 “future states” include:
  - Clear, sustainable business models and value propositions that allow the industry stakeholders to profitably support the needs of the economy
  - Well defined and clearly understood proactive security ecosystem that sustains the operational and business needs of all stakeholders
  - Well defined points of interoperability characterized by agreed upon standards that exist and are utilized by all electric sector stakeholders
  - Provide a set of conceptual architecture models across the architecture domains which can be made available to any electric sector stakeholder as a starting point for sustainable businesses and processes

QUESTIONS?

Opportunity for Smart Cities "Global City Teams Challenge"

Sokwoo Rhee

- Establish and demonstrate replicable, scalable and sustainable models for incubation and deployment of interoperable, adaptable and configurable IoT/CPS technologies and solutions in Smart Communities/Cities

Stats

- Primary Partners
  - US-Ignite
  - National Science Foundation(NSF)
  - International Trade Administration(ITA)
  - US Department of Transportation (DoT)
  - IBM, Intel, Qualcomm, Cisco, AT&T, GE, Juniper Networks, Extreme Networks
- More than 200 corporations/organizations and 50+ cities are participating from around the world in transportation, energy, disaster resilience, public safety, healthcare and education

Participating Cities included (Partial list):

- Portland, OR
- Annapolis, MD
- Greenville, SC
- Ammon, ID
- Chicago, IL
- Montgomery County, MD
- Columbus, OH
- Chattanooga, TN
- New York, NY
- Washington, DC
- San Francisco, CA
- Kansas City, MO
- Nashville, TN
- Austin, TX
- Amsterdam, Eindhoven (Netherlands)
- Genova, Milan (Italy)
- Coruna, Valencia (Spain)
- Tel Aviv (Israel)
- Bandung (Indonesia)

GCTC Expo on June 1 at National Building Museum in Washington DC

Source: National Building Museum web site

- Exhibitions and presentations from over 64 teams in partnership with 50+ municipal governments
- Special Session with the **King Willem-Alexander and Queen Maxima** of the Netherlands
- Keynote Speeches
  - **Anthony Foxx**, US Secretary of Transportation
  - **Tom Kalil**, Deputy Director of White House Office of Science and Technology Policy
  - **Willie May**, Director of NIST and Under Secretary of Commerce
  - **Jim Kurose**, Assistant Director, NSF
- 1500 attendees including smart cities experts, CPS/IoT stakeholders, cities, communities, federal governments, industry and academia
- 50+ media outlets from around the world

GCTC Expo – June 2015

Photo Credits: NIST / US-Ignite

Next Challenge: GCTC 2016

- Announcement: 3Q, 2015
- Quantifiable/measurable goals with tangible benefits to cities and communities
  - Traffic jam reduction by 20%?
  - Air pollution reduction by 25%?
  - Energy reduction by 30%?
- Deployments of shared and replicated solutions based on extensive multi-city and international collaborations
- 2-Phased approach with "Prize Challenge"
- Smart City/IoT architecture based on deployments

QUESTIONS?