

# The Big Picture – Connecting the Dots Between Metrology, Standards and Conformity Assessment

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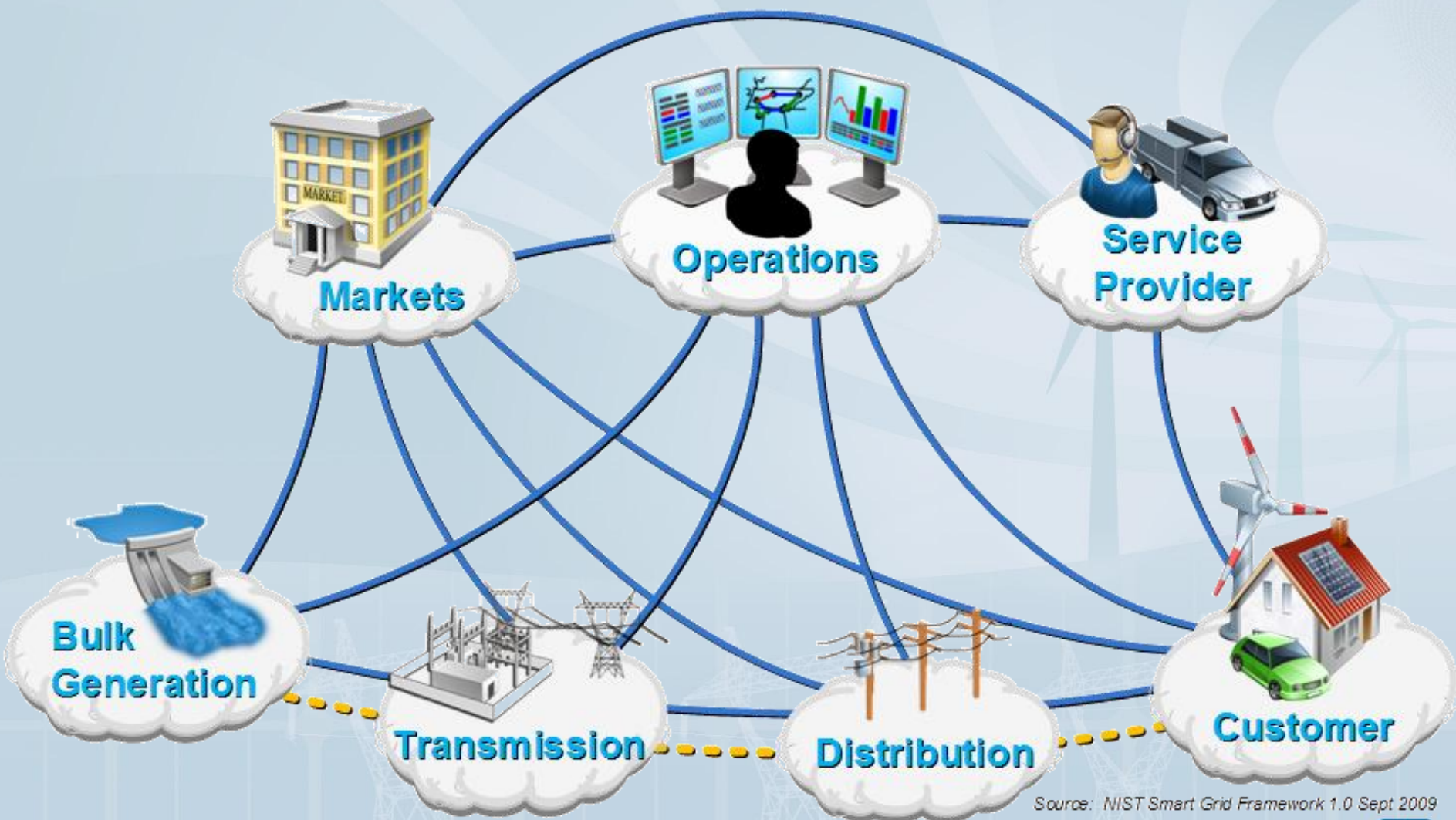
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# Metrology, Standards and Conformity Assessment

- To demonstrate “big picture” strategy and interrelationship of metrology, standards and conformity assessment at NIST, there are many examples of programs to choose from:
  - Health IT, Cloud computing, Cryptographic/security testing
  - Smart Grid
  - NVLAP (Calibration lab accreditation, specific programs...)
  - Law Enforcement Standards Office (body armor, ...)
  - Many more ...see following panel session discussion
- Today I will focus on three Smart Grid examples and coordination strategies we have used



# Smart Grid

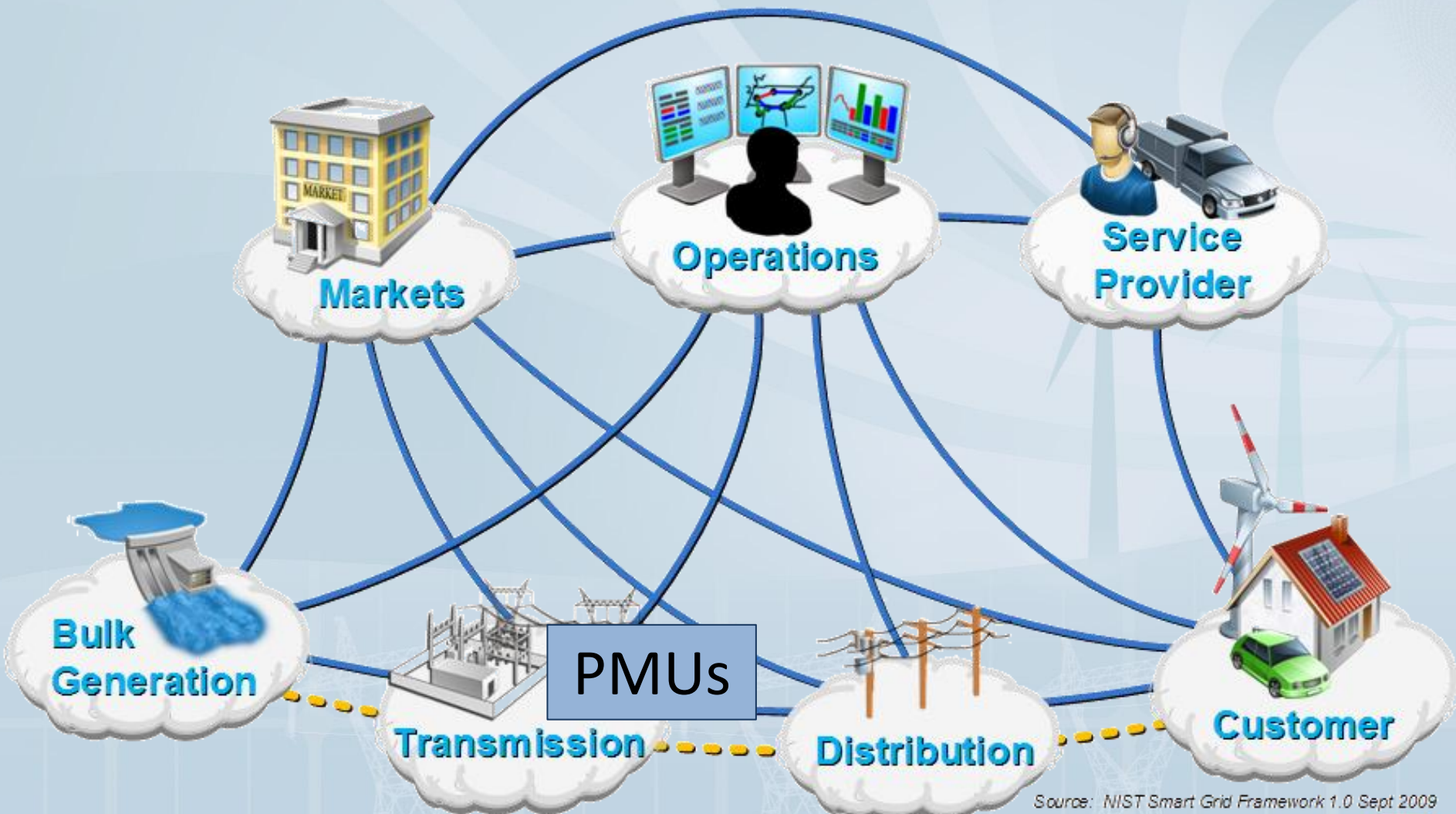


Source: NIST Smart Grid Framework 1.0 Sept 2009





# Smart Grid



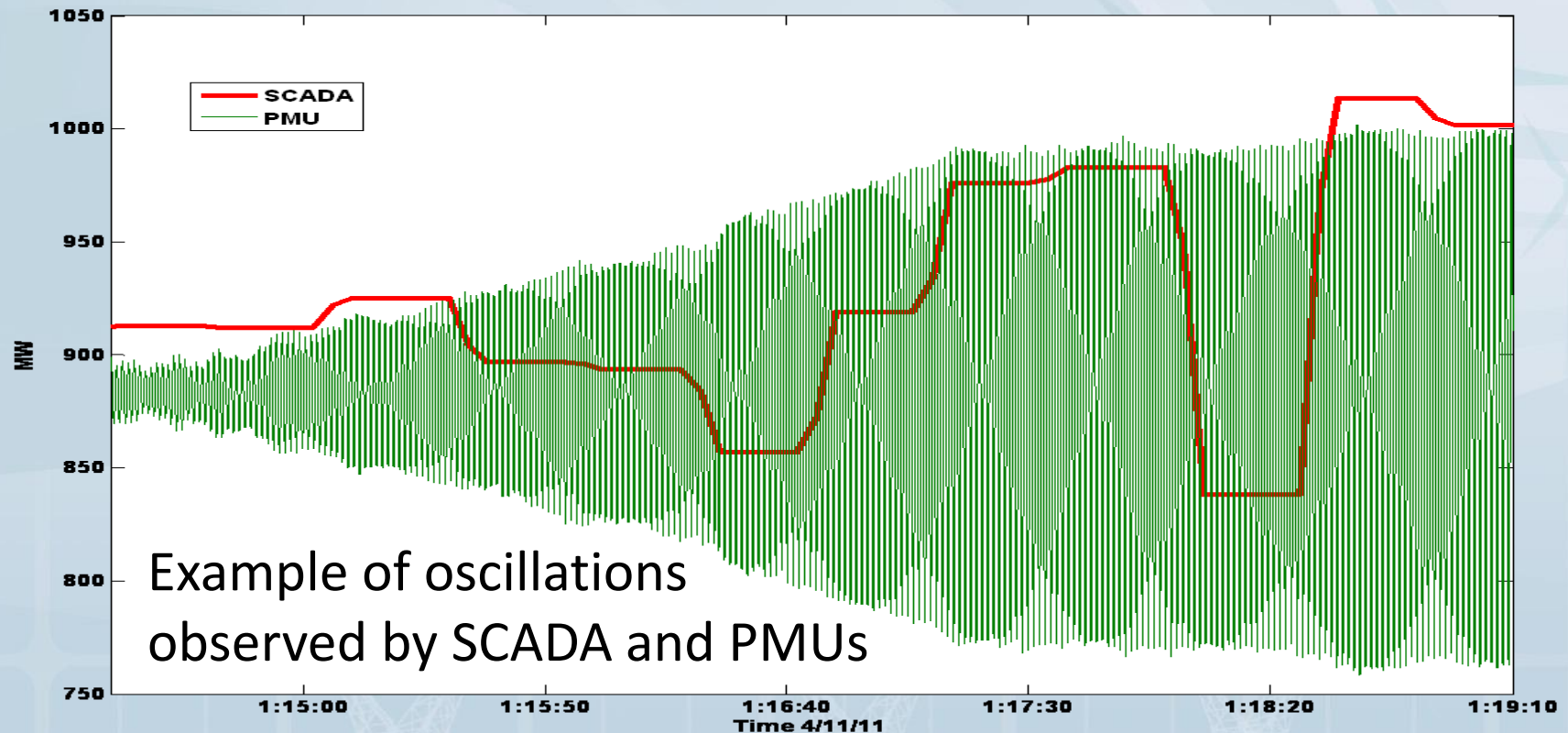
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## Phasor Measurement Units



# Reduce wide area blackouts (2003, \$6B losses) using better sensor data and predictive models

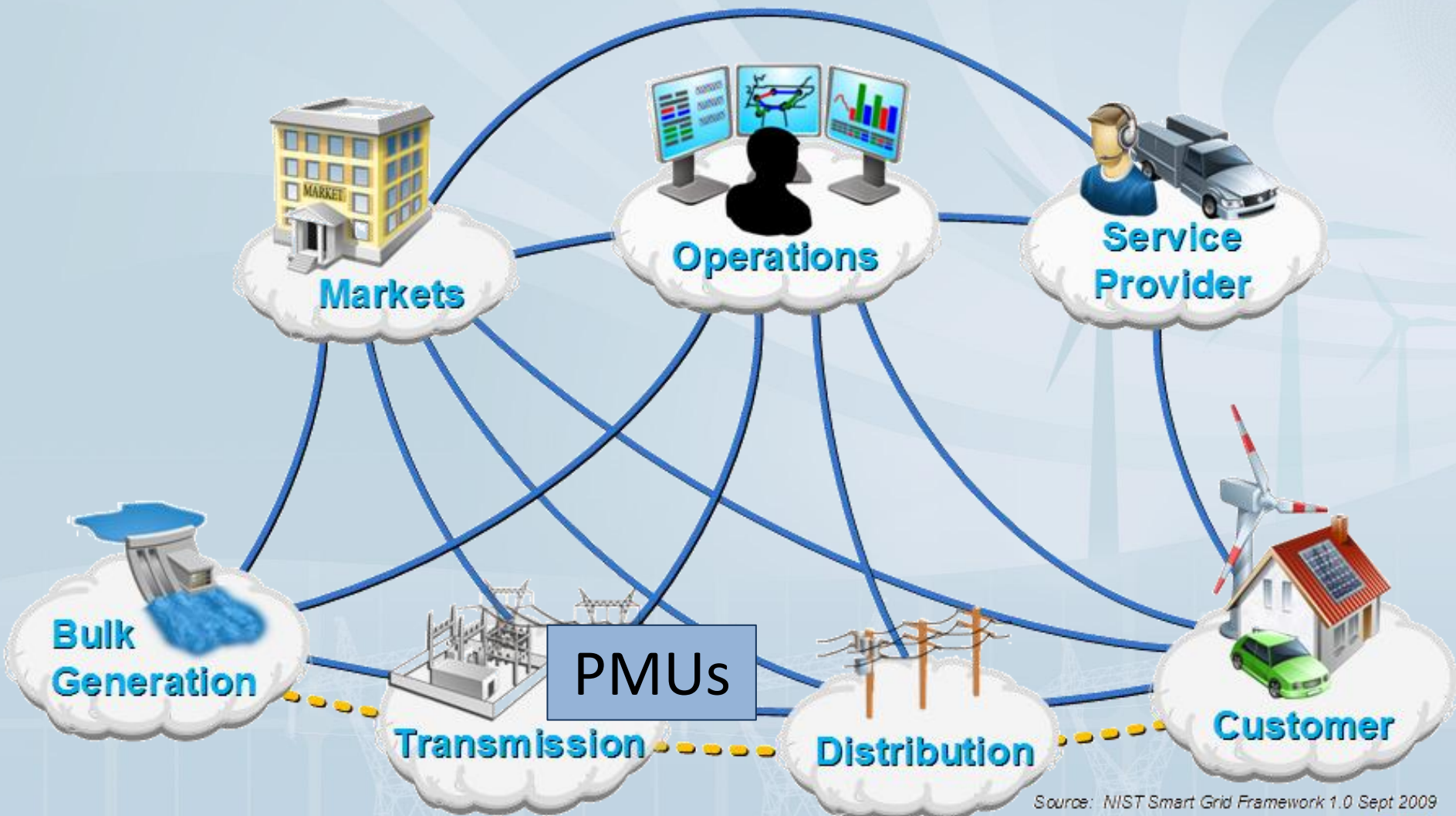
- SCADA measurements cannot see most oscillations, can be misleading
- PMUs are needed to observe oscillations - faster data sampling, greater data resolution, and wide-area synchronization



Source: Mahendra Patel at PJM



# Smart Grid



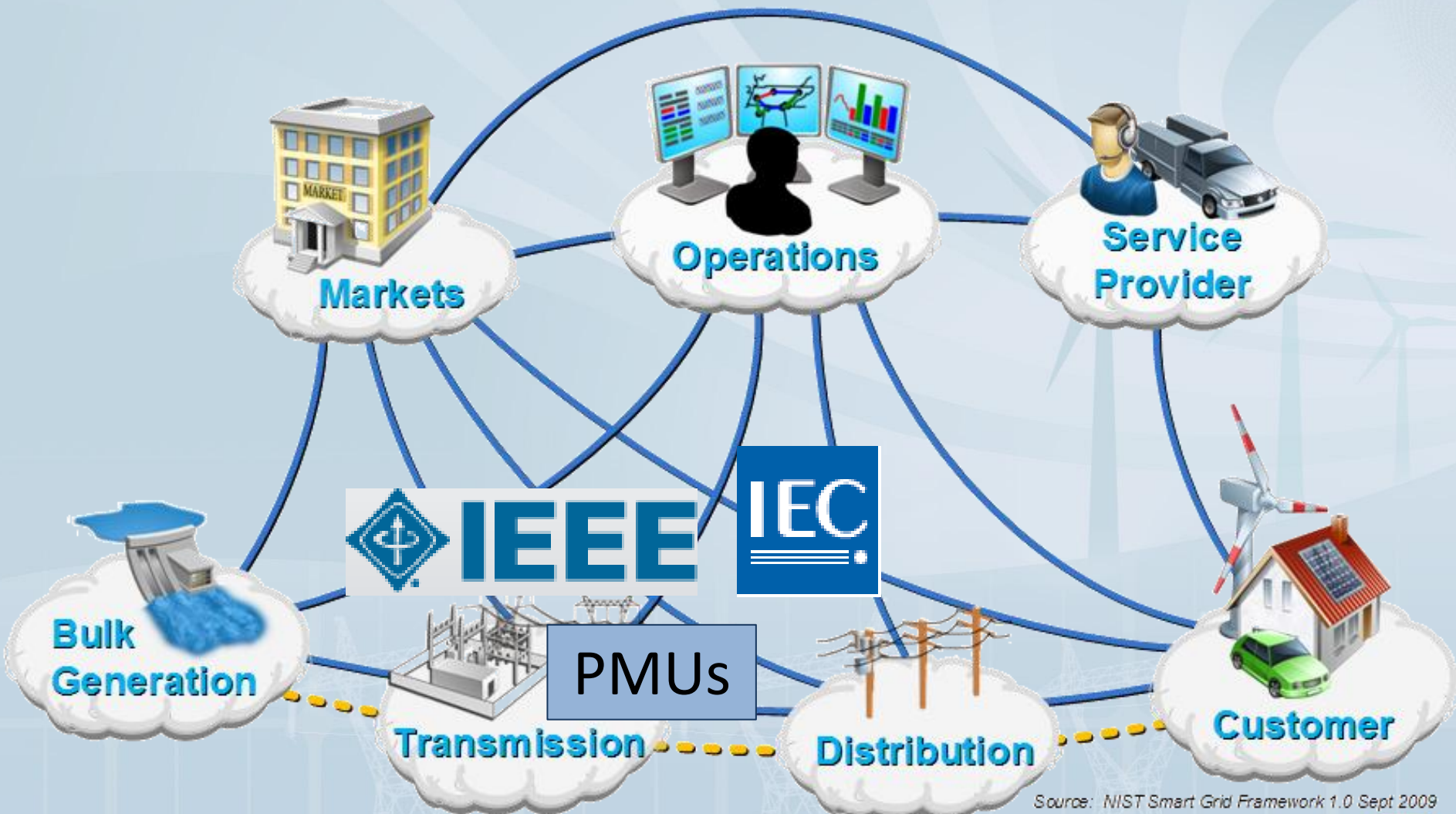
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## Phasor Measurement Units





# Smart Grid



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## Phasor Measurement Units

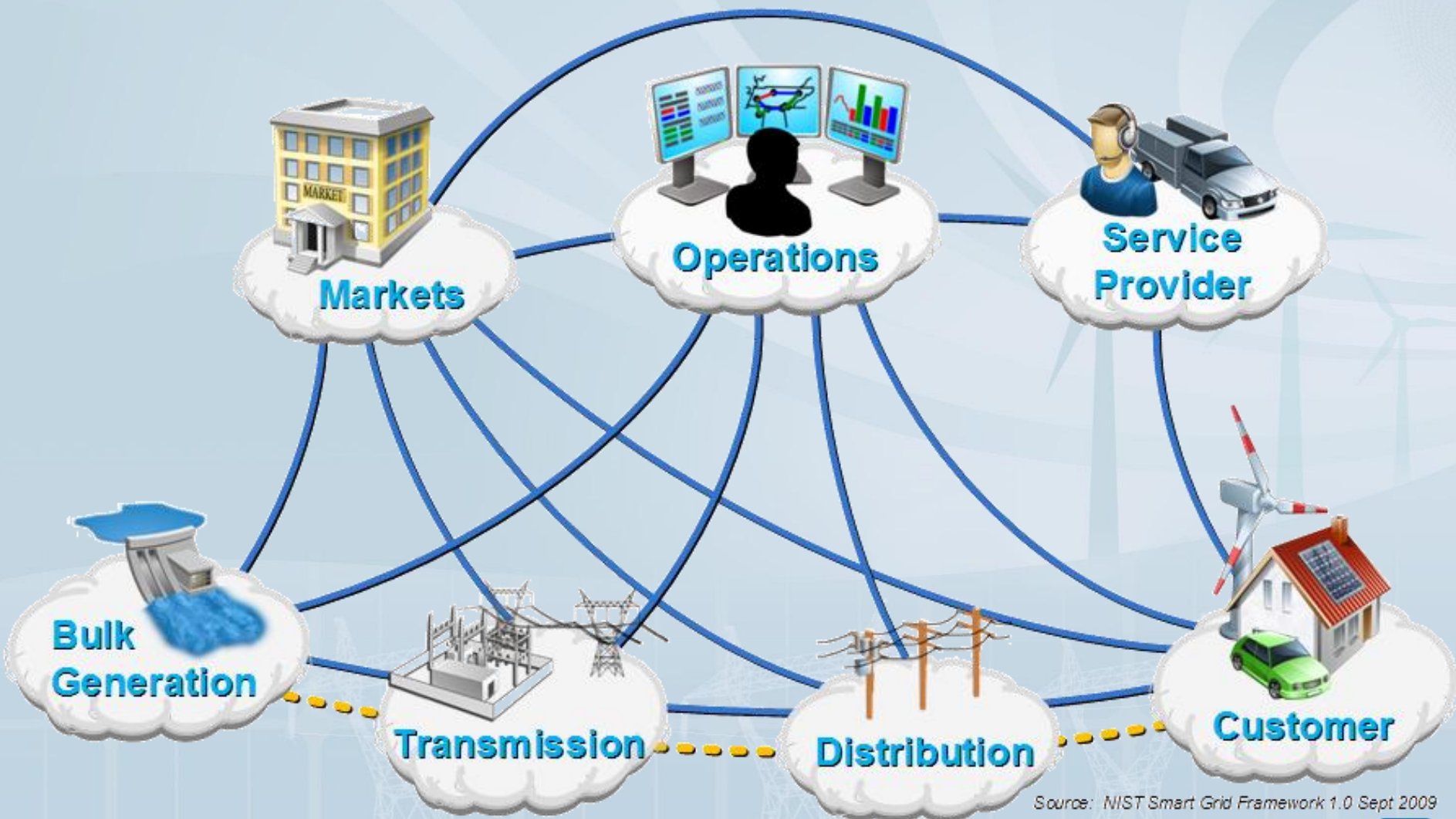


# Smart Grid





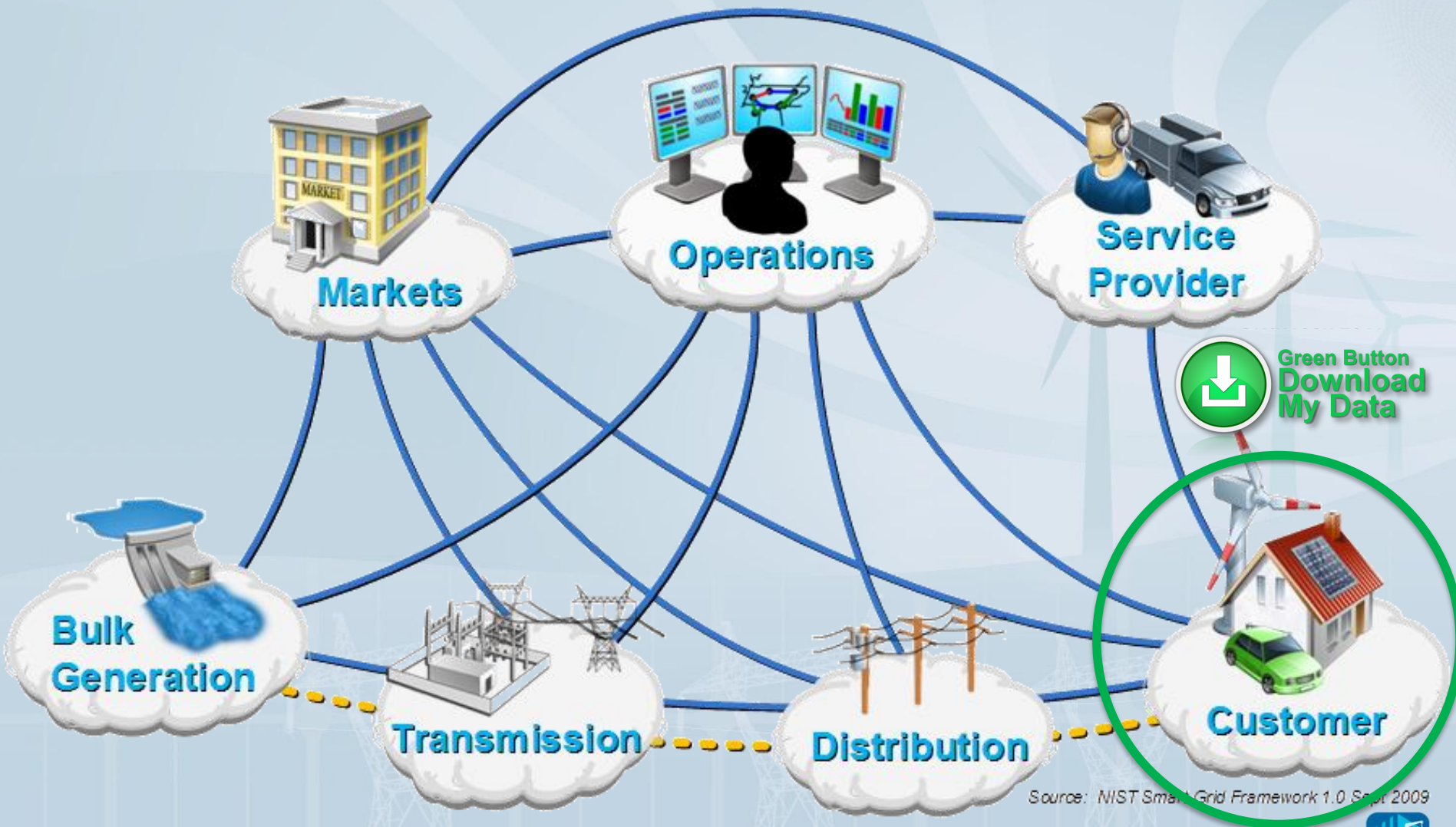
# Smart Grid



Source: NIST Smart Grid Framework 1.0 Sept 2009



# Smart Grid



Source: NIST Smart Grid Framework 1.0, Sept. 2009



# Metrology, Standards and Conformity Assessment

- Phasor Measurement Units (PMUs)
  - “Traditional” NIST testbed/standards/calibration service
- Smart Grid Program (as a whole)
  - “Non-traditional” national (plus int’l) leadership and coordination of standards (plus testing/certification)
- Energy Usage Information (Green Button)
  - “Very non-traditional” extensive NIST technical support for industry implementation of Green Button initiative based on White House “call-to-action” + interagency team





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Coordination = working effectively together in a team, aligned through good communications, timely decisions and meaningful actions, to deliver significant outcomes



# Phasor Measurement Units (PMUs)

Vision

SI traceability  
and NIST mission

Standards environment

Internal funding environment

NIST measurement capability  
and potential for advances

External (OA) funding  
environment

Calibrations/testing  
environment

Applications

Strategy,  
Planning

Management  
Decisions,  
Resources

People

Project Trajectory

External  
Engagement

External  
Drivers



# Phasor Measurement Units (PMUs) - 2005

Vision – accurate distributed electrical meas. with accurate timestamps

Standards environment – IEEE standards involvement

Internal funding – Calibrations, DR

NIST measurements –

New testbed w/power+GPS

External (OA) funding environment – DOE priority

Calibrations/testing environment - needed

Applications - new

Strategy, Planning (2005)

EEEL Directors Reserve plus DOE OA (2006)

People

Jerry Stenbakken

Project Trajectory

2005 Letter of support to NIST leadership from DOE + others, PMU vendor request

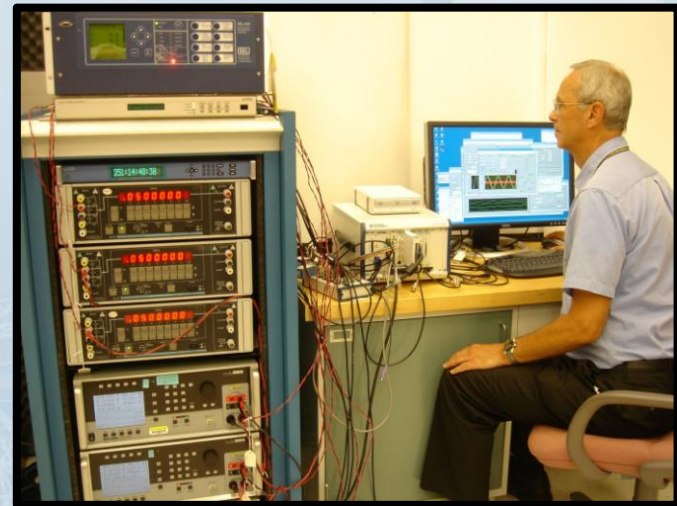
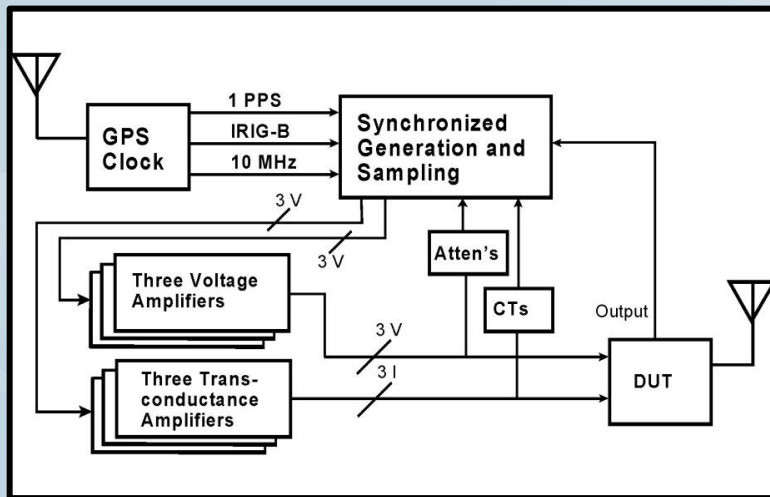
2003 Blackout, Grid Reliability





# Phasor Measurement Units (PMUs)

- **Metrology:** Implemented static measurement testbed and PMU calibration system combining electrical and GPS time synchronization, upgraded to dynamic measurement testbed, extended to IEEE 1588 synchronization
- **Standards:** Significant technical contributions to IEEE C37.118 standards development including IEEE C37.118.1-2011 (dynamic test requirements) and PMU testing guide IEEE C37.242, ... plus others
- **Calibrations:** Developed C38.118-2005 test procedures, implemented NIST “special test” measurement service, testing of PMUs for Brazil grid, interactions with PMU vendors to improve their instruments



# Phasor Measurement Units (PMUs) - 2009

Vision – nation wide deployment of PMUs + Phasor Data Concentrators

Standards environment – SGIP, IEEE plus IEC (comms)

Internal funding – NIST ARRA \$

NIST measurements – Upgraded testbed, network time

External (OA) funding environment – DOE ARRA

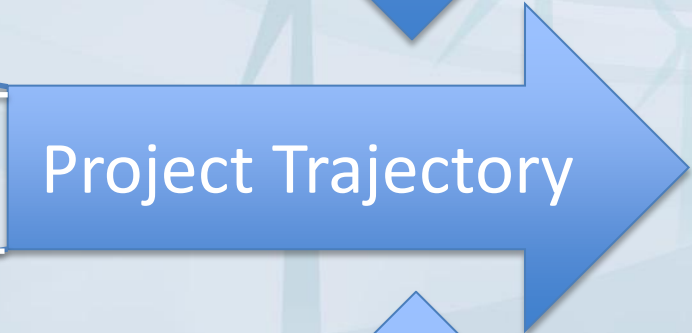
Calibrations/testing – PMU calibrator needed

Applications - growing

Strategy, Planning (what is impeding deployment?)

ARRA funding, NIST EISA role, SGIP PAP13

People several



SGIP, NASPI, IEEE, IEC, DOE labs, many other stakeholders

DOE ARRA PMU deployments



# Phasor Measurement Units (PMUs) – bigger picture

- Thinking outside NIST “traditional box” needed to solve bigger issues than just ensuring technical accuracy of standards and testing

NASPI

Standardization for  
PMU communications,  
Phasor Data  
Concentrators,  
security issues

DOE,  
Nat'l Labs

Research needed to  
enable effective use of  
PMU data in utility  
control centers,  
optimal placement  
and use of PMUs, ...

Utilities,  
Vendors

Calibration  
Services  
evolution:  
PMU  
calibrator





# Phasor Measurement Units (PMUs) – bigger picture

- Multi-pronged NIST investment and engagement has resulted in impact!

New standard IEC 61850-90-5



**NERC**  
NORTH AMERICAN ELECTRIC  
RELIABILITY CORPORATION

**Announcement**  
New Technical Standard for Synchrophasors Adopted  
by the International Electrotechnical Commission

May 18, 2012

**ATLANTA** – The North American Electric Reliability Corporation (NERC) and the North American Synchrophasor Initiative (NASPI) is pleased with the International Electrotechnical Commission's (IEC's) adoption of a technical standard that establishes improved synchrophasor data communication. The approval of technical interoperability standards is an important milestone marking the maturity synchrophasor technology and systems. Further, industry consensus allows manufacturers to standardize their offerings.

"Adoption of this IEC standard supports the integration of synchrophasor technology into day-to-day grid operations," said Mark Lauby, vice president and director of Reliability Assessment and Performance Analysis at NERC. "We appreciate the hard work of volunteer experts from IEC, the Institute of Electrical and Electronics Engineers (IEEE), NASPI and the federal government who contributed to the development of this technical standard."

IEC 61850-90-5 is one of several key technical interoperability standards adopted to advance smart grid technology. The new standard addresses delivery of high-speed data collected by synchronized phasor measurement devices over wide-area communications networks. Further, they incorporate data latency requirements for Wide-Area Monitoring Protection and Control applications and assure cybersecurity protection for this data.

The Department of Energy is working with the National Institute of Standards and Technology (NIST) to accelerate the development of key smart grid interoperability standards, including IEC 61850-90-5, with funding and coordination. NASPI's Performance and Standards Task Team (PSTT), working with NIST, continues to develop standards and guidelines for phasor measurement units, phasor data concentrators, GPS time-stamping of phasor data, and related synchrophasor technology elements.

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**RELIABILITY | ACCOUNTABILITY**

SGIP PAP13  
completed

New standard  
IEEE C37.118.1-  
2011

broader time  
synchronization  
(IEEE 1588)  
effort (ITL, PML)

People: NIST  
recently hired  
PMU engineer  
from Fluke  
project

Equipment: PMU  
calibrator now installed  
at NIST, approaching  
commercial availability  
(beta now)

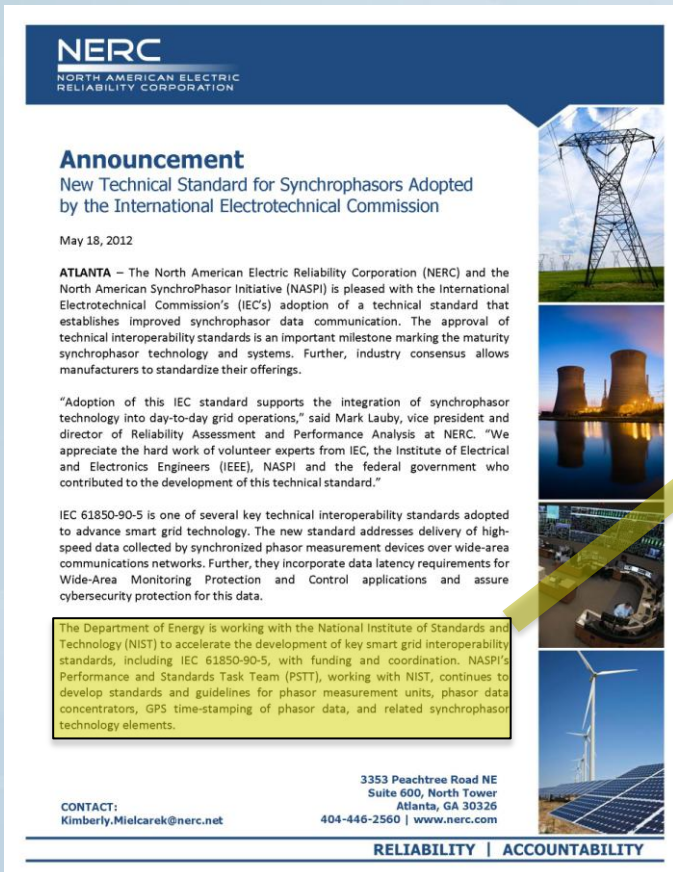
PMU calibrator-  
NIST ARRA grant  
to Fluke, collaboration



# Phasor Measurement Units (PMUs) – bigger picture

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# Fruit tree vs. orchard management





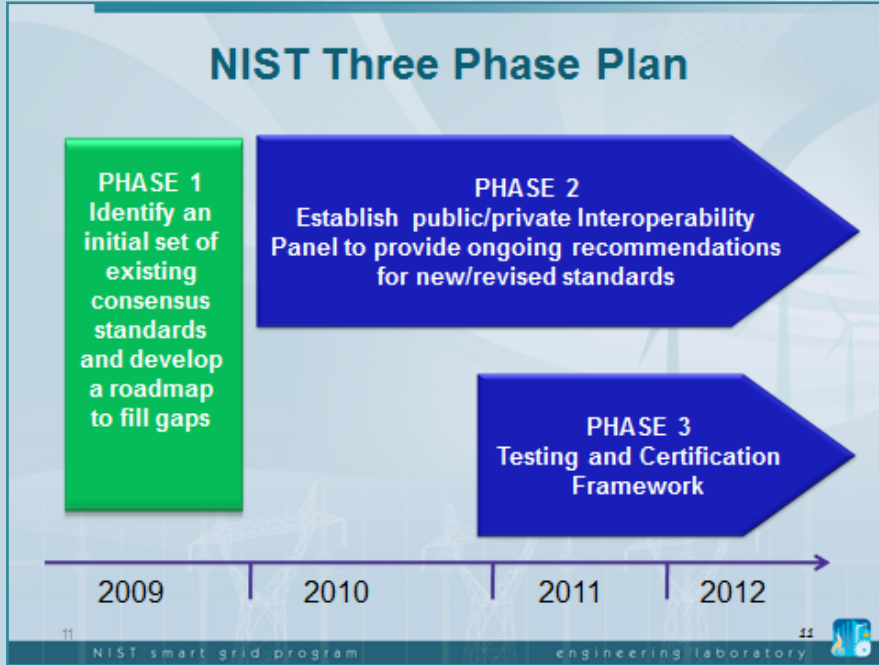
# NIST role in smart grid – interoperability standards coordination and acceleration

The Energy Independence and Security Act of 2007 gave NIST “*primary responsibility to coordinate development of a framework that includes ... **standards** ... to achieve interoperability of smart grid devices and systems...*”



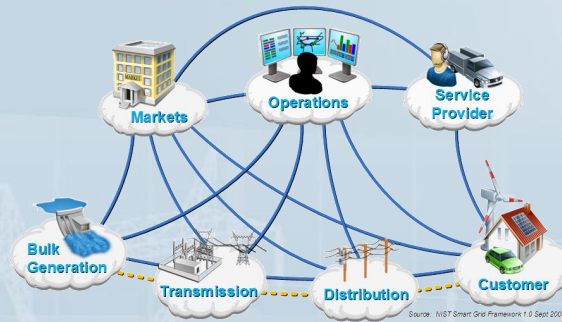
- National priority (Congress, Administration)
- Leverage NIST metrology efforts
- Standards needed to support ARRA investments
- Interoperability requires both standards and conformity assessment

# NIST Plan – and – NIST Framework 2.0

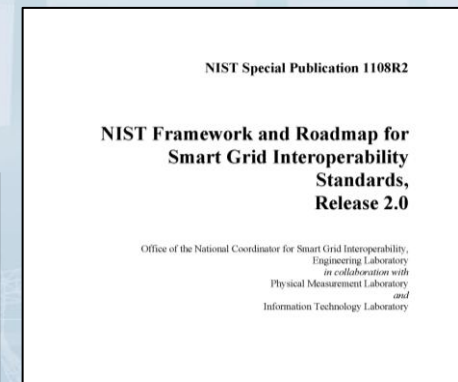
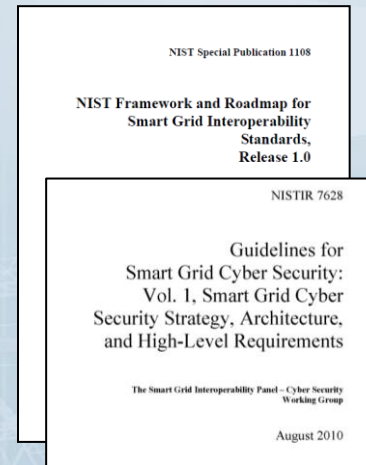


- Release 2 - February 2012
- Release 1 - January 2010
- Smart Grid vision & reference model
- Identifies 100 standards
- Cybersecurity guidelines
- Testing and certification framework
- Provided a foundation for IEC, IEEE, ITU, and other national and regional standardization efforts

White House kickoff and NIST stakeholder meetings



NIST Smart Grid Domains



<http://www.nist.gov/smartgrid/>





# Smart Grid Interoperability Panel

- Public-private partnership created by NIST in Nov. 2009
- 780+ member organizations, 1,900+ individual participants
- Open, public process with international participation
- Web-based participation , 22 stakeholder categories
- Coordinates standards developed by Standards Development Organizations (SDOs)
  - Identifies requirements and prioritizes standards development programs, guidance for testing and certification programs
  - Works with over 20 SDOs including IEC, ISO, ITU, IEEE, ...
  - IEC, IEEE and ITU roadmaps all leverage the NIST/SGIP Framework
- New SGIP 2.0 legal entity now established, membership campaign



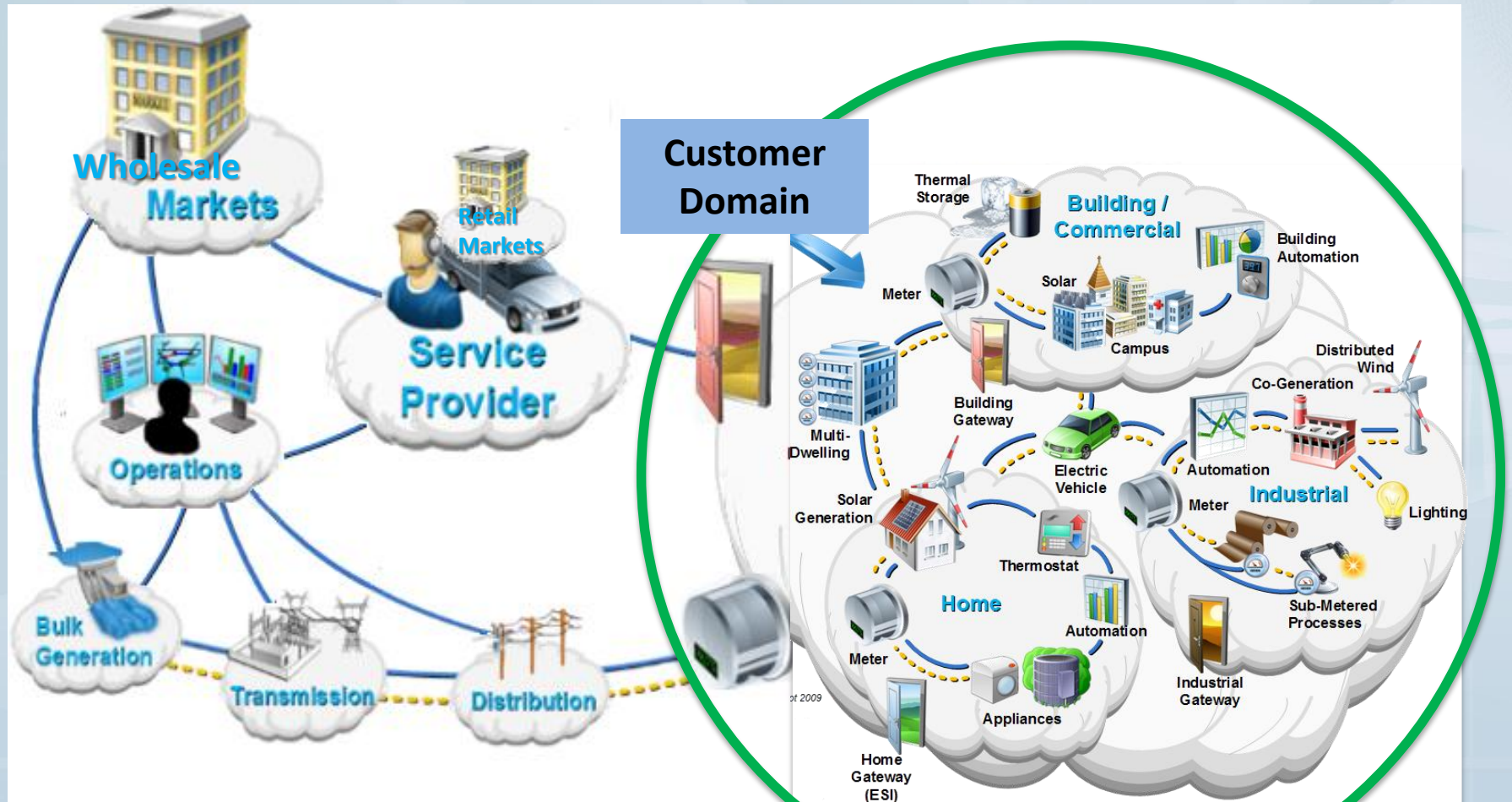


# Smart Grid Program (as a whole)

Metrology	Standards	Testing/Certification
<ul style="list-style-type: none"> <li><u>Initial condition:</u> Some NIST projects, low industry R&amp;D, lack of univ. power engineer programs</li> </ul>	<ul style="list-style-type: none"> <li><u>Initial condition:</u> Heterogeneous mix of often competing int'l &amp; national standards groups without coordination</li> </ul>	<ul style="list-style-type: none"> <li><u>Initial condition:</u> Virtually non-existent initial ecosystem, scattered electric utilities testing capabilities, some user groups</li> </ul>
<ul style="list-style-type: none"> <li><u>Approach:</u> Identify new R&amp;D needs w/ increased industry interactions, fund/grow NIST research, outreach</li> </ul>	<ul style="list-style-type: none"> <li><u>Approach:</u> SGIP, technical champion and NIST co-leads of priority action plans, Framework, outreach to SDOs/SSOs + int'l</li> </ul>	<ul style="list-style-type: none"> <li><u>Approach:</u> Bottom up (no top-down FedGov authority model), SGIP TCC Interop Process Ref Manual (ISO/IEC 17025 and Guide 65) + outreach</li> </ul>
<ul style="list-style-type: none"> <li><u>Future direction:</u> R&amp;D needs workshop; DOE &amp; EPRI; system-level CyberPhysSystems</li> </ul>	<ul style="list-style-type: none"> <li><u>Future direction:</u> Transition to SGIP 2.0 non-profit legal entity with greater private sector funding</li> </ul>	<ul style="list-style-type: none"> <li><u>Future direction:</u> SGIP support for initial ITCA programs, work with utilities and regulators on value proposition</li> </ul>



# Energy Usage Information



# Energy Usage Information

## Initial standards landscape analysis

Zigbee  
SEP2  
(home area  
network)

IEC CIM  
(utilities  
core info  
model)

Building  
/Facility  
info  
models

OpenADE  
(California  
mandates)

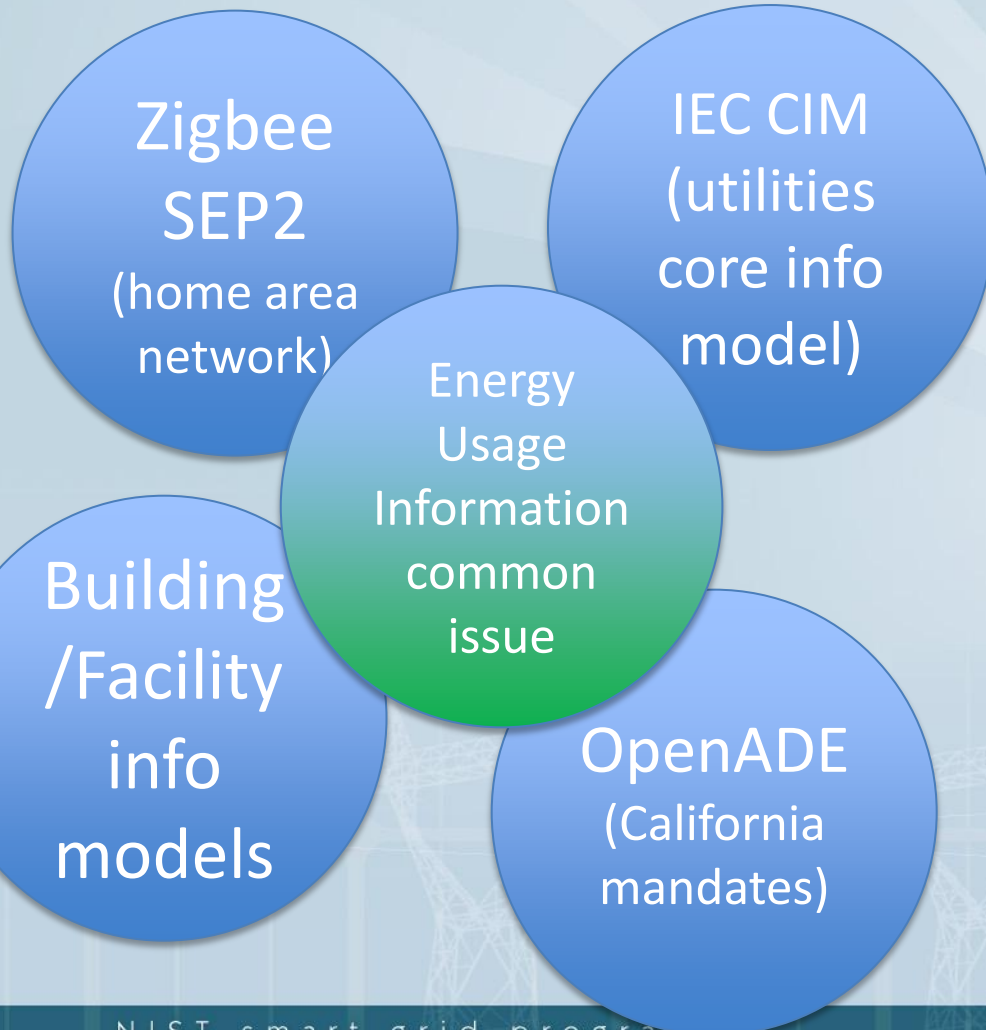
Independent standards or user group efforts likely to lead to fractured application ecosystems w/o intervention





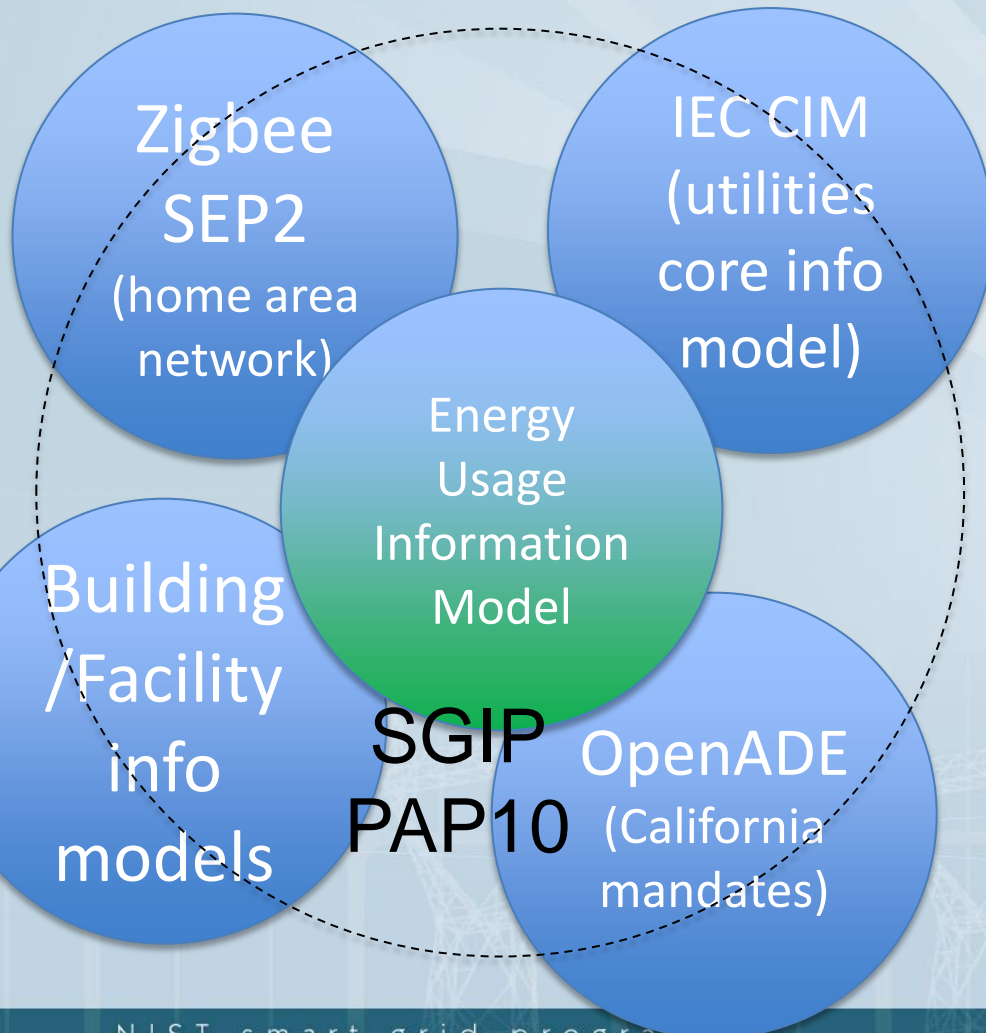
# Energy Usage Information

- NIST identified a standards gap - need common way to represent energy usage information (central to many efforts)



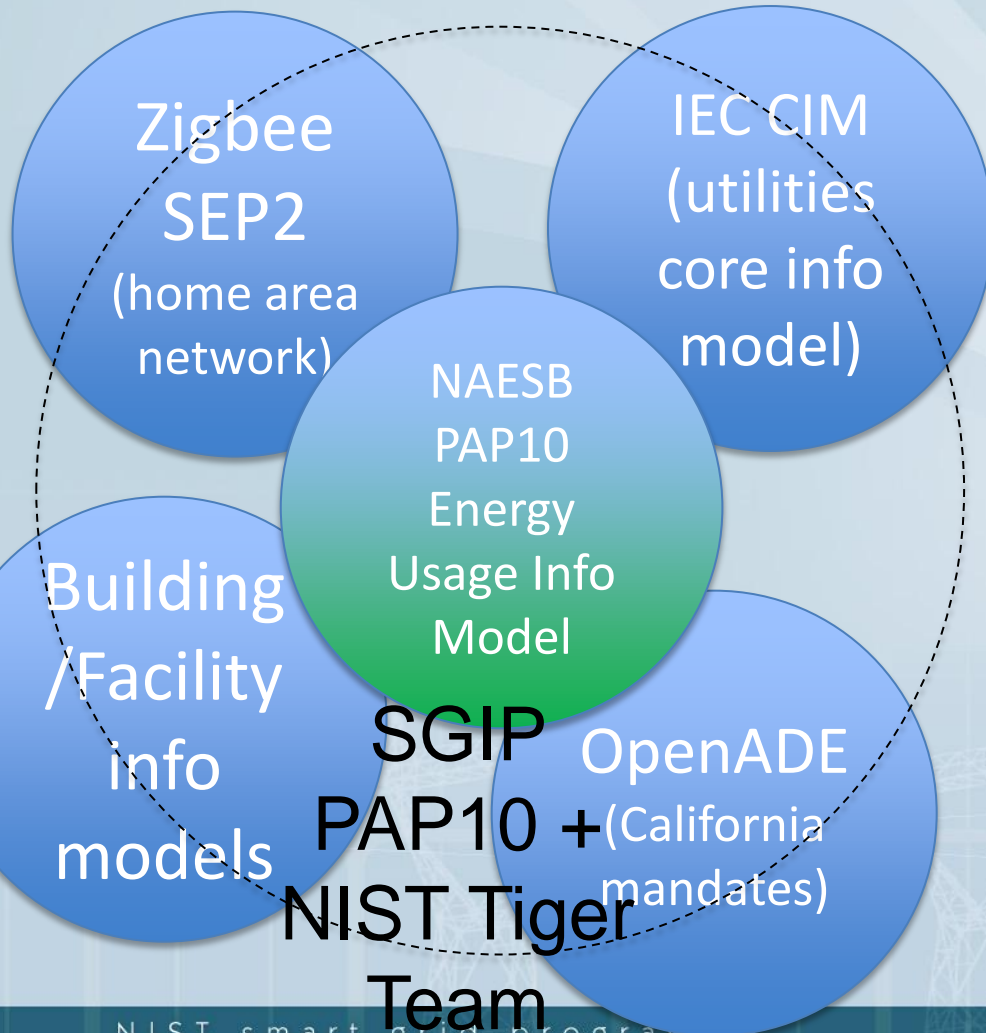
# Energy Usage Information

- NIST leadership resolved difficult multi-stakeholder standards coordination issue (SGIP Priority Action Plan 10)



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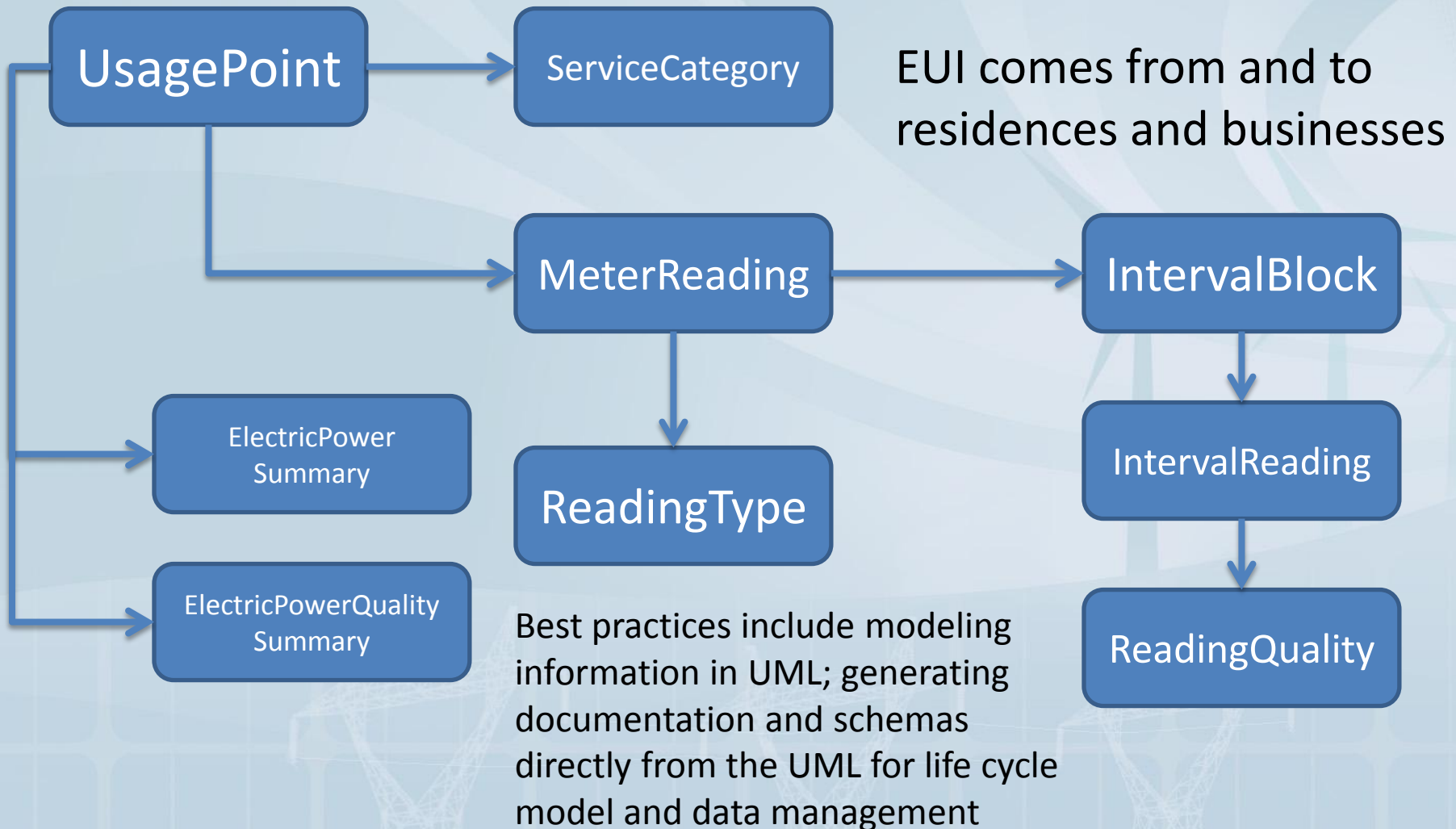


- After much head banging and teeth gnashing, the community agreed to a NIST brokered compromise to develop a core Energy Usage Information Model standard in NAESB (SGIP PAPER 10) and Facility Smart Grid Information Model in ASHRAE/NEMA (SGIP PAPER 17)





# Composition of Energy Usage Information: North American Energy Standards Board

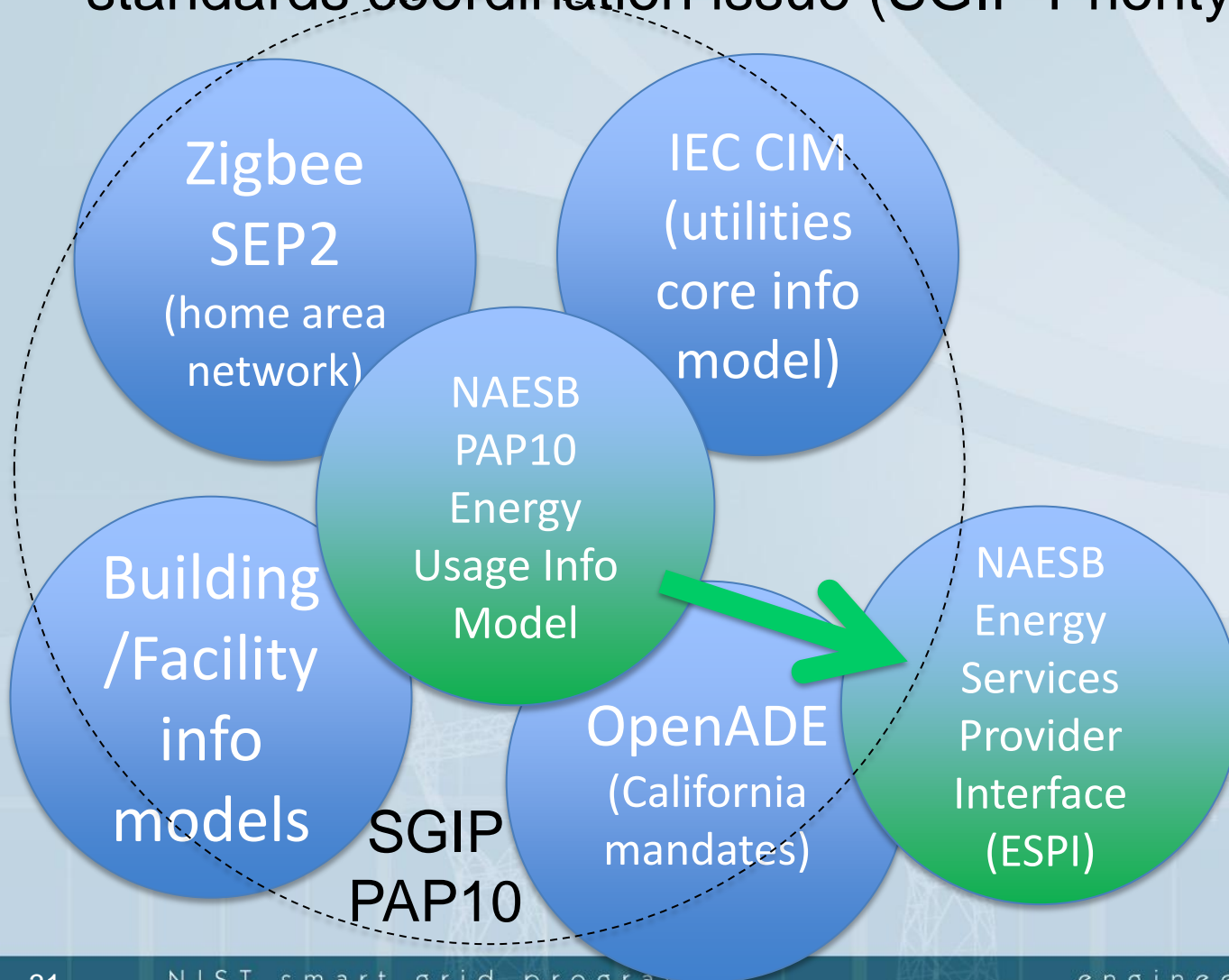


Note: This information is multidimensional. Many different reading types, summaries, and readings possible.



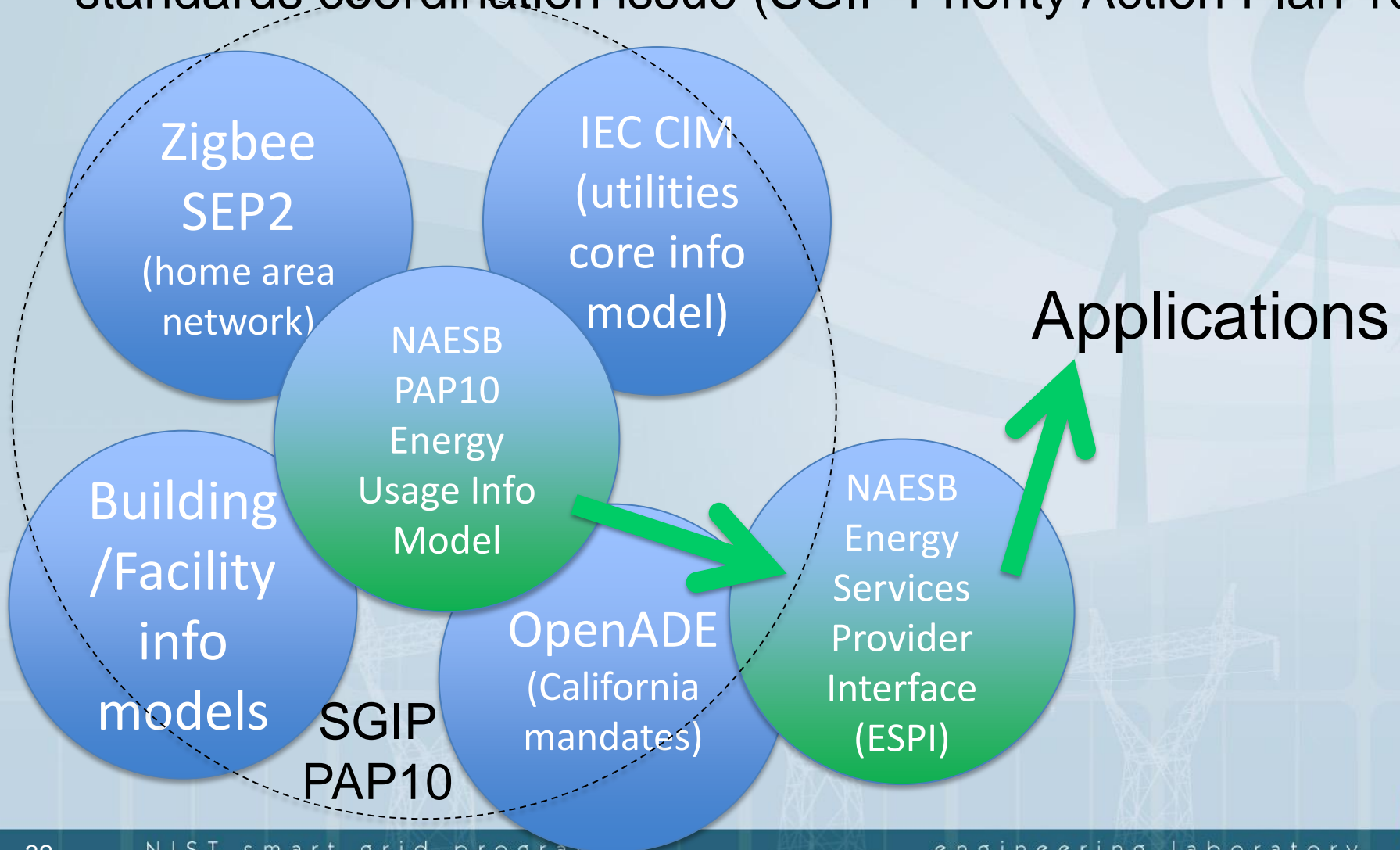
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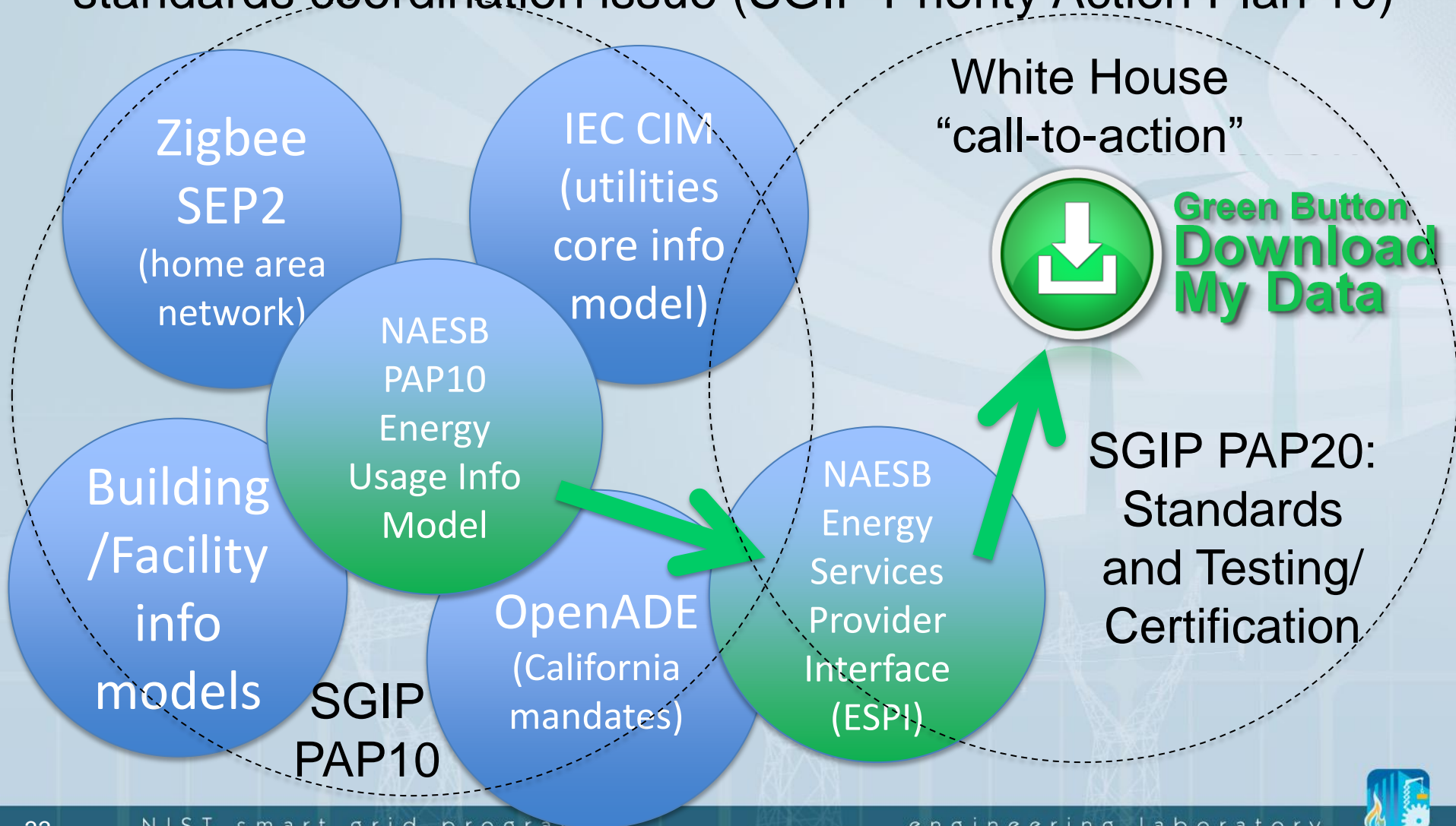
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# Green Button Initiative



- Green Button is
  - A policy
    - White House call-to-action and initiative
    - Inspired by Blue Button concept – medical information
  - A brand
    - Green Button logo implies specific capabilities
    - Interoperability standards and testing and certification are necessary to ensure expectations are met
  - A set of technologies and associated standards
    - Green Button Download My Data (NAESB ESPI xml data file)
    - Green Button Connect My Data (NAESB ESPI automated exchange)



# Green Button Initiative – live!

- *Common-sense idea that electricity customers should be able to download their own energy usage information in a consumer- and computer-friendly electronic format from their utility's secure website*
- *Result of collaboration among White House, NIST, DOE, state regulators, utilities, vendors, SGIP, and North American Energy Standards Board*



**15+ million consumers have access to Green Button data NOW, and 36+ million will by 2013**



**Green Button  
Download  
My Data**

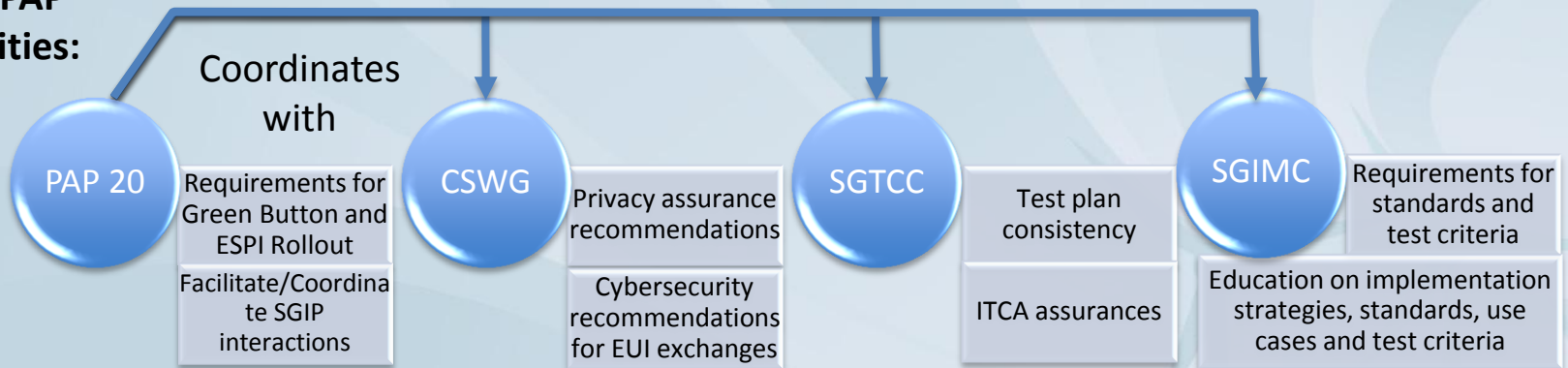
[www.greenbuttondata.org](http://www.greenbuttondata.org) & [www.nist.gov/smartgrid/greenbutton.cfm](http://www.nist.gov/smartgrid/greenbutton.cfm)





# SGIP PAP20: Green Button ESPI Evolution Roadmap Going Forward ...

## SGIP PAP Activities:



## Specification Deliverables:

<b>Standards (NAESB)</b>	REQ.18/WEQ.19 Maintenance Update	ESPI Errata Update	REQ.21/REQ.22 ESPI New Reqs Update	International Version
<b>T&amp;C (UCAIug)</b>	Green Button Download My Data Test Plan	Green Button Connect My Data Test Plan	UCAIug ITCA	
<b>Implementation (EnergyOS)</b>	Green Button SDK	OpenESPI		



# Loop all the way back to research

- Energy usage information applications assume availability of good measurements
  - NIST electric metering project (PML) enables traceability of all US electric meters back to NIST
  - Goal to build new NIST electric meter testbed to explore metering issues over broad range of conditions
  - NIST has made key technical contributions to DOE, EPA EnergyStar energy efficiency programs
  - New Net zero residential testbed facility (EL) and smart grid testbed (EL + PML + ITL)



# Net zero residential testbed facility

NIST  
Research  
testbed



## Objectives

- Demonstrate Net-Zero Energy for a typical home
- Provide “real world” field data to validate/improve models
- Provide a test bed for in-situ measurements of various components and systems
- Improve laboratory test procedures of systems/components to give results that are representative of field performance



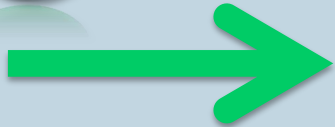


# Net zero residential testbed facility

Goal:



Green Button  
Download  
My Data






## Objectives

- Demonstrate Net-Zero Energy for a typical home
- Provide “real world” field data to validate/improve models
- Provide a test bed for in-situ measurements of various components and systems including system and device energy consumption data
- Improve laboratory test procedures of systems/components to give results that are representative of field performance



# Conclusion - quick recap

<p>NIST PMU project Synchro metrology:</p>	<p>NIST Smart Grid Interoperability Panel:</p>	<p>Green Button Initiative:</p>
<p>IEEE C37.118.1 and IEC 61850-90-5, NASPI group</p>	<p>“The” forum for smart grid standards coordination, testing and certification</p>	<p>energy usage information for consumers (xml)</p>
		
<ul style="list-style-type: none"> <li>• Recognition of NIST contributions; 287 of 800+ new PMUs w/DOE ARRA \$ (started 2005)</li> </ul>	<ul style="list-style-type: none"> <li>• Over 780 participating organizations, 1900 participants, 21 priority action plans (SGiP started Nov2009)</li> </ul>	<ul style="list-style-type: none"> <li>• Available to 15+ million consumers, will grow to 36+ million by 2013 (started Oct2011)</li> </ul>

