Critical Infrastructure Committee

BREAK



Critical Infrastructure Committee

Grid Complexity and Cyber Risks: Days of Future Past?



NIST Smart Grid Program

Interoperability for a Modern Grid: NARUC Summer Policy Summit

Avi Gopstein

Engineering Laboratory NIST Smart Grid & Cyber-Physical Systems Office

July 15, 2018



Energy Independence and Security Act (2007)

NIST has *"primary* responsibility to coordinate development of a framework that includes protocols and model standards for information management to achieve interoperability of smart grid devices and systems..."



Interoperability Frameworks to date

This publication is available free of charge from http://dx.doi.org/10.6028/NIST.SP.1108r3

NIST Special Publication 1108r3

NIST Framework and Roadmap for Smart Grid Interoperability Standards, Release 3.0

Smart Grid and Cyber-Physical Systems Program Office and Energy and Environment Division, Engineering Laboratory

in collaboration with Quantum Measurement Division, Semiconductor and Dimensional Metrology Division, and Electromagnetics Division, Physical Measurement Laboratory and Advanced Network Technologies Division and Computer Security Division, Information Technology Laboratory

http://dx.doi.org/10.6028/NIST.SP.1108r3

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

2014

NIST Special Publication 1108R2

NIST Framework and Roadmap for Smart Grid Interoperability Standards, Release 2.0

> Office of the National Coordinator for Smart Grid Interoperability, Engineering Laboratory in collaboration with Physical Measurement Laboratory and Information Technology Laboratory

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

NIST Special Publication 1108

NIST Framework and Roadmap for Smart Grid Interoperability Standards, Release 1.0

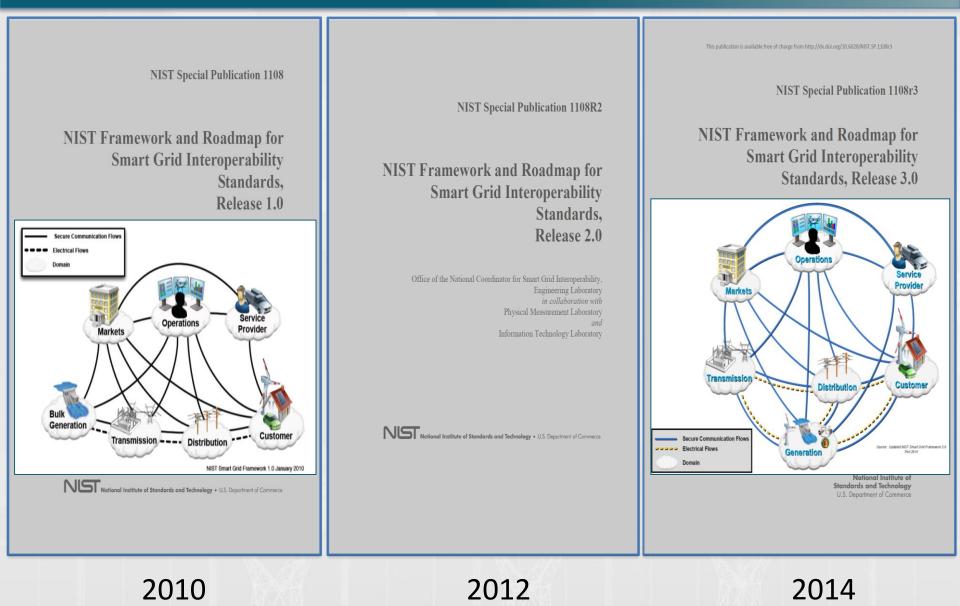
Office of the National Coordinator for Smart Grid Interoperability

Notional Institute of Standards and Technology • U.S. Department of Commerce

2010

2012

Interoperability Frameworks to date



Motivations / Themes

Motivations

- Technology is advancing rapidly
- Evolving capabilities bring:
 - New opportunities
 - New concerns / challenges
 - Structural change
- Modular and scalable technologies enable:
 - Disaggregation of system physics
 - Hyper-local optimization
 - A new set of cascading concerns
- Distribution models diversifying
- Interoperability more critical than ever
- Interoperability more challenging than ever

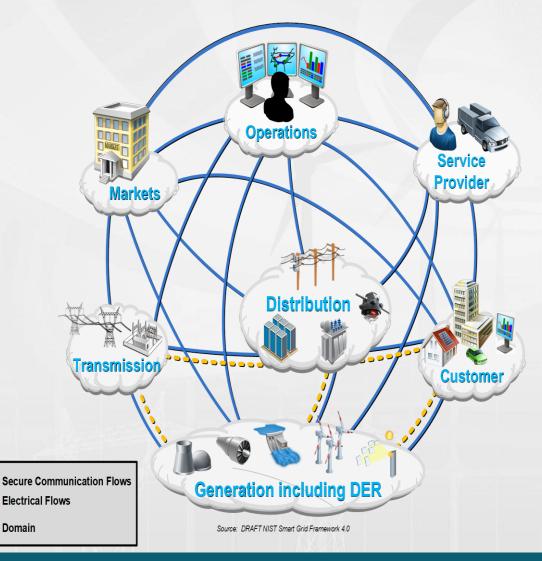
Framework 4.0 Themes

- Structural changes are occurring in the grid
- System complexity is increasing
 - Interoperability is a critical element of modern grid function
- No single architecture is correct
 - Common trends
 - Unique conditions
- Grid architectures affect:
 - Operations
 - Economics
 - Cybersecurity
- As actors take on new roles within the system and new economic forces emerge, interoperability gains new dimensions
 - Testing & Certification

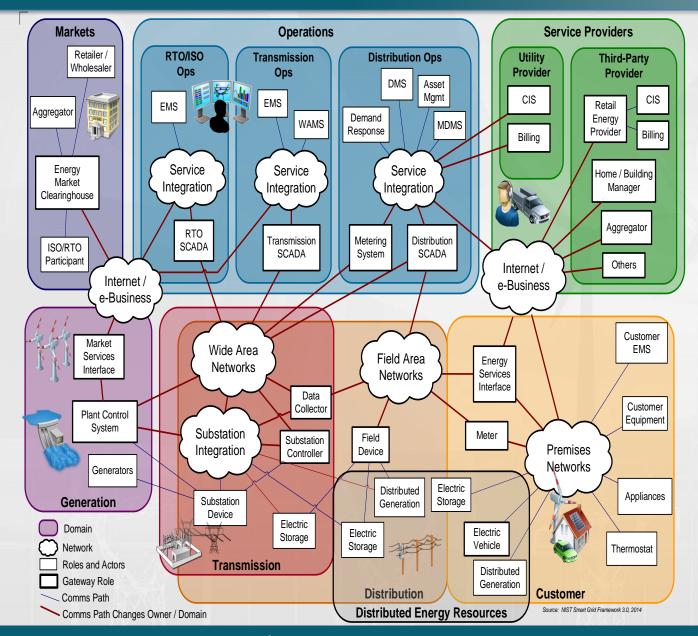
Conceptual Model

- Generation including DER
 - Technology diversity
 - Physical proximity to transmission, distribution + customer domains
- Intelligent distribution system
 - Increasing importance (location + size)
 - Improved controllability + intelligence
 - Connected to service provider domain (e.g., congestion mitigation)
- Empowered consumers
 - Operations & intelligence enters customer domain
 - Customer diversity incorporated

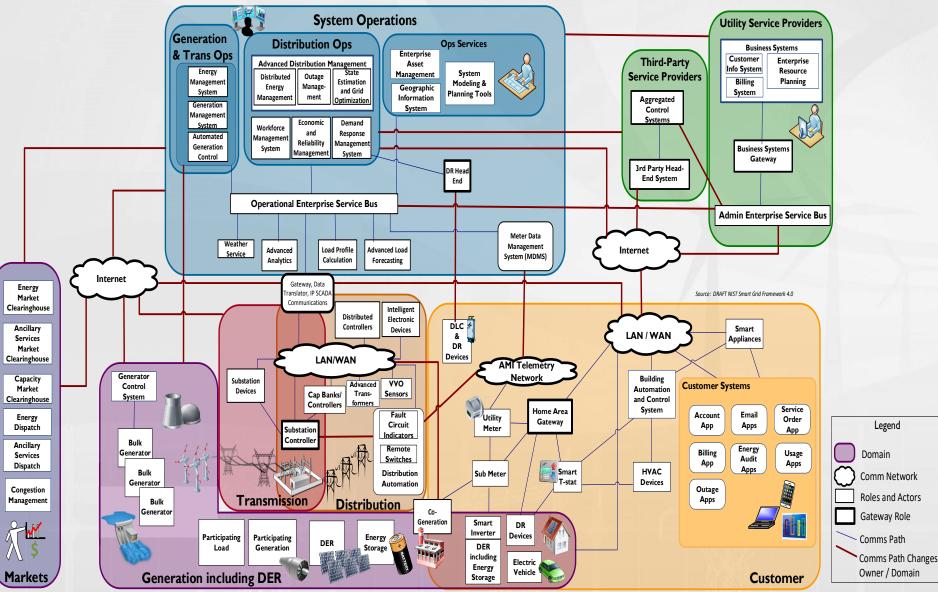
Smart Grid Conceptual Model



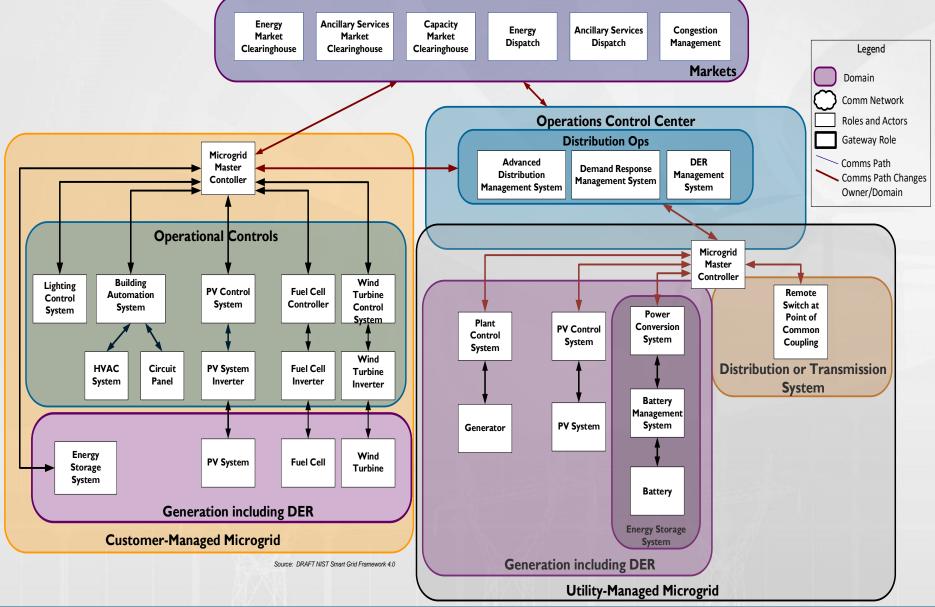
Legacy Communications Pathway Scenario



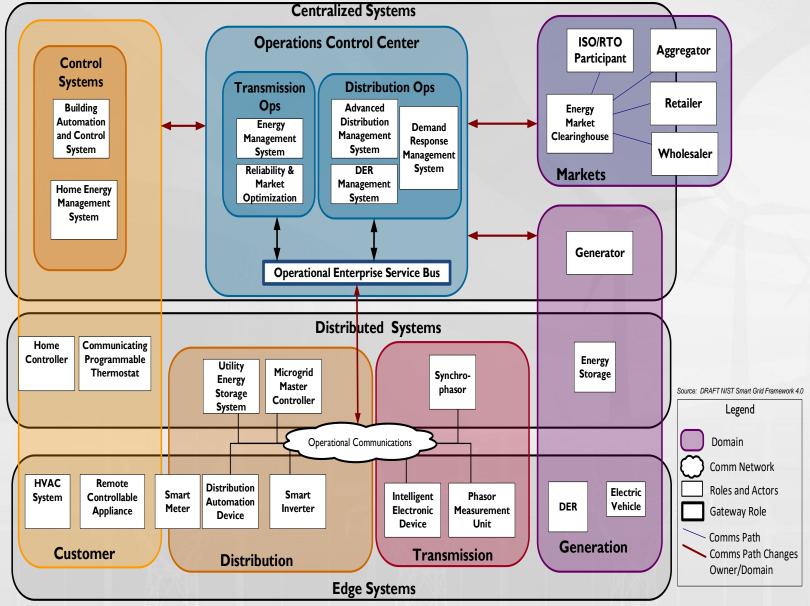
High-DER Communications Pathway Scenario



Microgrid Communications Pathway Scenario



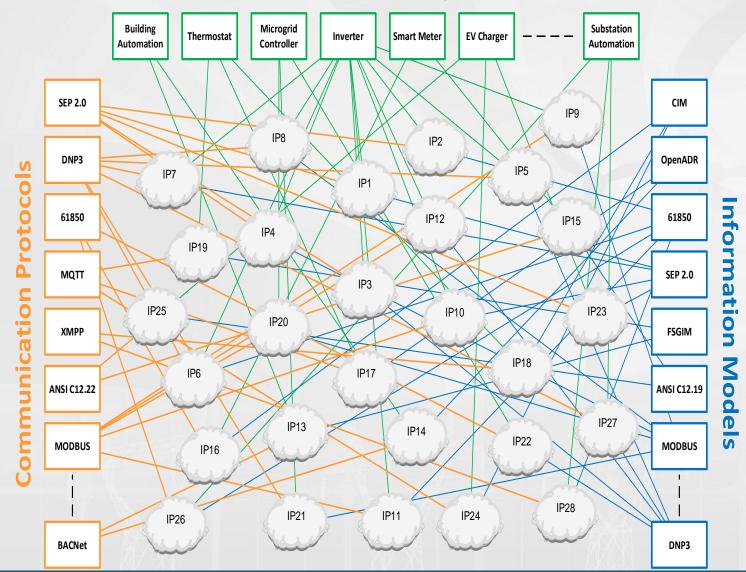
Hybrid Utility Communications Pathway Scenario



What does all of this mean for how we operate a modern grid?

Interoperability Profile: Illustrative Landscape

Hardware Functional Requirements



Interoperability standards landscape

assessment

SEPA/SGIP SG CoS

List

Identified SG Standard List of NIST Framework R3.0

DSO Priority List

	e View				
		SGIP's S	imart Grid C	atalog of Standards	
Catalog of Standards		Fal	List of Standard	is by Entry Number	
Markets	Operations				
	RTO/ISO Transmissio	SGIP Catalog of Standards	Date	SGIP Catalog of Standards	Date
Retail	Energy Energy	1 ANSI C12.1-2008 Inted Sect 5 2012	10/15/2014	43. EC 62151-8-deted 2014-05-21	05/17/2015
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	Systen System	3. ANGI C12.19-2008 lated Sept 5 2012	10/25/2014	45. IEEE 1377-dated 2011-02-02	08/17/2015
Aggregator	Wide Area	4. AND C12.19-2012-dated 2014-10-07	08/17/2015	46. IEEE 1701	10/15/2014
	Measuremen	5. ANSI C12:20-2010 listed Sept 5 2012	30/25/2014	47. IEEE 1815-2010 Inted Dec 31 2011	30/36/2014
Energy Market	System	 ANSI C12.21-2006 Tethed Sept 5 2012 	30/25/2014	48. IEEE 1901-2010 listed Jan 31 2013	10/16/2014
Clearing House		 AND C12 22-2008 listed Sept 5 2012 ASHRAE 135-2010 BACnet listed New 71 2011 	10/15/2014	48. IEEE CS7.238	30/36/2054
	ISORTO Transmission		30/15/2014	50. IEEE C37 239-2010 listed May 4 2012 51. IEEE1901 3-dated 2011-09-021	10/16/2014
ISO/RTO Participant	SCADA SCADA	10. CE4-709.2-4-2014-02-14rev1	10/15/2014	52. IETT RFC 6272 listed July 7 2011	10/16/2014
Pancpart		11. CEA-709.3-2014-02-14-ev(30/35/2014	53. (70-7-6.9940	10/16/2014
Distribution System		12. CEA-709.4-2014-02-14/ev1	10/25/2014	54, ITU-T 6, 9972	10/16/2014
Operator Participant		13. (54-852.1-2014-02-14-ex)	30/35/2014	55. Multilocal* Security V1.0-dated 2013-12-05	10/16/2014
Coloran Landar		14. CEA-852-8-2014-02-14/ev1	30/35/2014	56. MultiSpeak* V3.0-dated 2013-12-05v1	30/34/2054
		15. CEA-CEDIA-CEB29- dated 2012-05-01v1	10/15/2014	57. NAESB REQ 19	10/16/2014
		18. IEC 15067.3-dated 2012-11-05	08/17/2015	58. NAESB REQ 21	10/16/2014
		17. EC_60870-6-503 kited Sept 5 2012	10/15/2014	59. NAESB REQ 22	10/16/2014
Communication		18. EC 60670-6-702-1998 listed Sept 5 2012	10/15/2014	60. NEMA SG-AMI 1	10/16/2014
		19. EC 60870-6-802 20. EC 62850-1	10/15/2014 10/15/2014	61. NISTR 7628 listed Sept 5 2012 62. NISTR 7761 listed July 7 2011	10/16/2014
		20. EL_E160-1 21. EC4185-10	30/25/2024	63. NSTR 7761 HIPE My 7 2011 63. NSTR 7762-dated 2013092081	10/14/2014
		22. #C61850-2	10/25/2014	64. NSTR 7862	10/16/2014
		23. #C 6185-3	30/35/2014	65. NETH 7943-dated 20140635	M/17/2015
		24. EC 61850-4	10/15/2014	66. GASS EMIX Inted Dec 31 2011	10/16/2014
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		27. EC 61850-7-1	30/25/2004	69. OpenADR-2 Oa-dated 2012-08-17-sh	10/15/2014
	Substation		10/15/2014	70. OpenADR-2 0b-dated 2012-06-17rex2	10/16/2014
	Controller Co		30/25/2014	71. SAE (1772-2010 Noted July 7 2011	10/16/2014
Market Service		30. EC 61850-7-4	30/35/2014	72. SAE J2836 Use Cases (1-3) Fotest July 7 2011	10/16/2014
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		32. 82.83850-7-420 33. 82.63850-8-1	30/25/2014	74. SEP2 0-dated 2013-12-02 update 75. SG 4MI-1	10/16/2014
		33. EC 61850-91 34. EC 61850-90-5	30/25/2014	73. 50 4M7-1 74. 50# 2011-0008-1	10/16/2014
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		34. #C62351-1	10/15/2014	78. ANS/CTA-2045	05/01/201
		17. EC4251-2	30/35/2014	79. ITU-T 6.9905	05/01/2017
		38. EC 62351-3	10/15/2014	00. NAES8 RMQ.26	03/01/2017
Plant Control Ger	neators	39. EC 62351-4	30/25/2014	81. NEMA Standards Publication SG-PRM 1-2016	05/01/201
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	Device S		10/15/2014		
		42. IEC 62351-7	30/35/2014		

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	This publication is available free of charge from http://dx.doi.org/10.6522/NIST.9-1108r3 NIST Special Publication 1108r3	Registration Sector	nert Energy Market ENS St Management ENS St Intractorion Hospitation Bus		RETAL ENERGY MARKET INCL. VPP		CROSSCUTTING FUNCTIONS INVERSIFICITINE REALTIONS	
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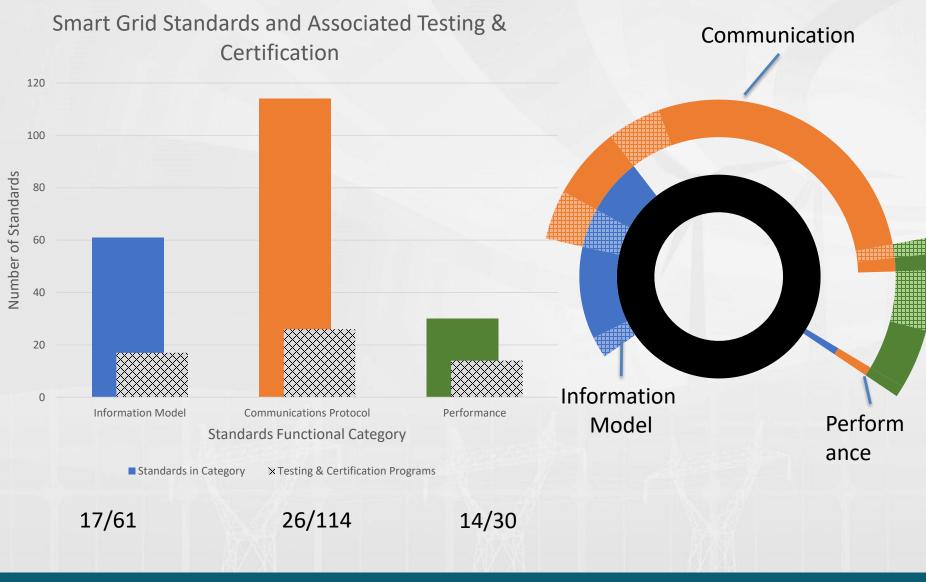
Source: http://www.gridstandardsmap.co

New Standards:

- New Standards
- New versions of old standards

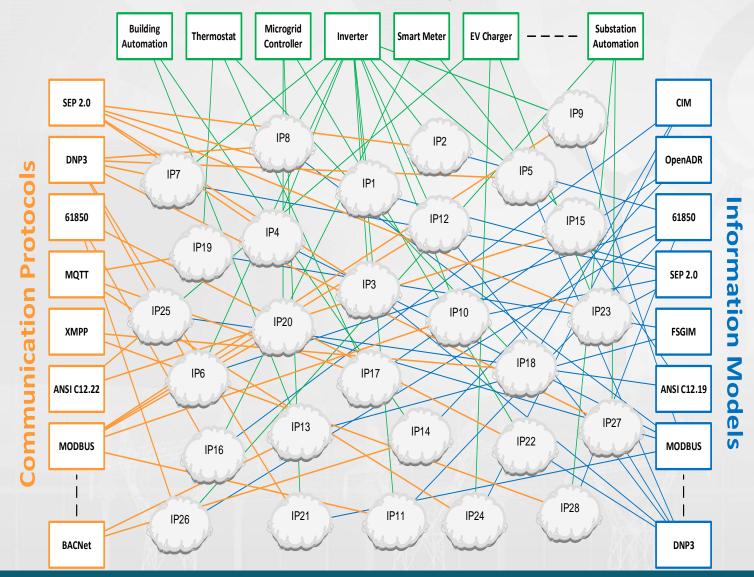
Evaluation (244 Standards

Interoperability landscape assessment



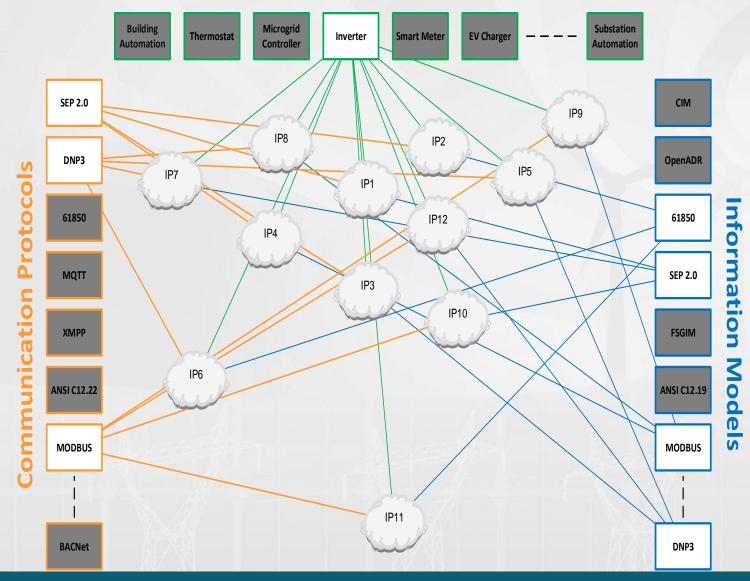
Interoperability Profile: Illustrative

Hardware Functional Requirements



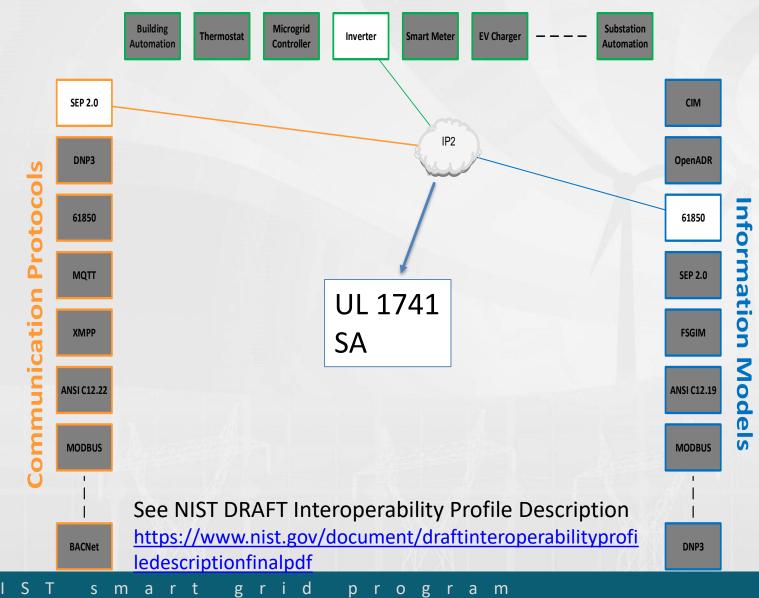
Interoperability Profile: IEEE 1547 Case Study

Hardware Functional Requirements



Interoperability Profile: California Rule 21 Case Study

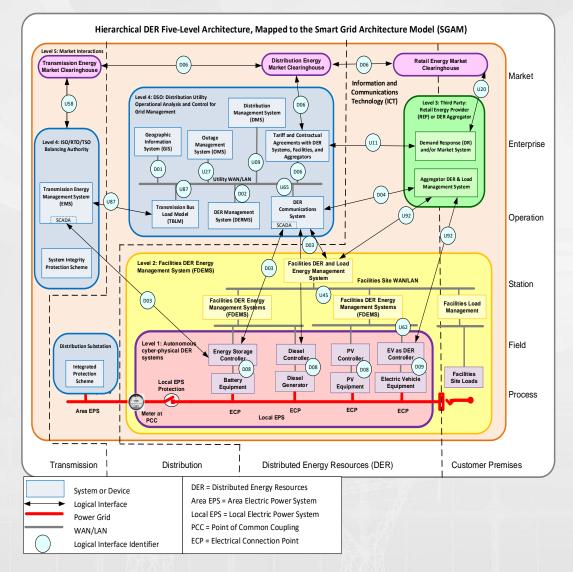
Hardware Functional Requirements



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Smart Grid – Increased benefits, increased cyber risks

- Communications risks
 - Known problem in IT
 - New application in Smart Grid
 - Logical Interface Categories (LIC)
 - Sheer volume of control paths
- Issues with
 Distributed Energy
 Resources (DER)
 - Device ownership
 - Trust
 - Data integrity



Regional Workshops

Date: Locations: August-October, 2018 California PUC Georgia PSC Indiana URC Rhode Island PUC

Co-sponsor: NARUC

Objectives: To explore regionally specific issues affecting grid operations and economics. The workshops will be held at state Public Utility Commissions, allowing participants to learn about interoperability issues and concerns relevant to the respective commission and its stakeholders.

Key Questions:

 Locally specific questions will be developed in partnership with NARUC and the local Commission to explore relevant aspects of the communications pathways scenarios and associated economic and operational issues.

See Framework webpage for updates:

https://www.nist.gov/engineering-laboratory/smart-grid/smart-grid-framework

NIST Smart Grid Program

THANK YOU

https://www.nist.gov/engineering-laboratory/smart-grid/smart-gridframework





NARUC Summer Meetings

How are State PUC's Addressing Cybersecurity?

Cameron Brooks, President

July 15, 2018

Cybersecurity: A New PUC Challenge

What has changed?

- Technology advances in distributed energy
- Consumer choice in devices and services
- Increasing interaction with communication infrastructure

Distribution grid evolving from closed to complex, highly interconnected system leading to new energy transactions and third-party participation...an <u>expanded role for state regulators</u>.



E9 Insight

	E9 INSIGHT APRIL 2016
April 2016	April Updates Be sure to subscribe to our new monthly update called "Why 97" for interesting tidbits and stories that come across our radar during the month. Click the link below: http://edinsatu.usl.lst-manage.com/subscribe?u=3dodsaudeeSaced438829984u=cd8287974
vpril	Full details for new proceedings, as always, are available on our website. Since 2014, we have been moutoring the public utility commission websites and building the online "radar" dashboard with summaries of relevant proceedings across the 50 states and the District of Columbia.
A	Our mission is to bring visibility to commission activities that most professionals find complicated and opaque. Yet these nulemakings define the market opportunities for innovative new technologies and business models. We believe we can help bring more volces into these important conversations.
	As always, if you ever have questions or are looking for more details, please get in touch. We are eager to get you answers today and hear about how to make this service even more valuable for you in the future.
	Cameron Brooks and the E9 Team
	IN THIS ISSUE:
	Commission news in 7 states
	On The Radar Several notable decisions and commission actions across the states
	Proceedings Exactly 63 new proceedings opened in April

Why 9? Newsletter: http://e9radar.link/why9

1. Commission Activity

monthly newsletter and online proceeding database

2. Tailored Research

curated updates and market segmentation

3. Engagement Support Tools

meeting monitoring and stakeholder comments



E9 Insight

Representative Clients and Partners since founding in 2013...

Aclara Alarm.com ChargePoint CleaResult Comverge Croptimize Department of Energy **Direct Energy** E Source Enernoc EnergyHub **Energy Foundation**

Environmental Defense Gravity Renewables **Greentech Media Gridwise Alliance** Honeywell Itron Landis+Gyr LBNL Mission:data Navigant NEMA Nest

NRG **Opus One Solutions** PNNL **Protect Our Winters** Sierra Club Simple Energy SGCC SGIP Tendril Varentec and more



Policy Domains

Monthly "radar screen" of new activity across these topic areas:

- 1. **Resource Planning** (including Integrated Resources Plans)
- 2. Demand Side Management (including energy efficiency and demand response)
- 3. Distributed Energy Resources (including residential solar, net metering and storage)
- 4. Smart Grid (including smart meters and home area networks)
- 5. Distribution Infrastructure (incl. distribution automation & voltage management)
- 6. Community Energy (and microgrids)
- 7. Utility Business Model (including rate reform and adjustments)
- 8. Market Design (and competition)
- 9. Electric Vehicles (and transportation)

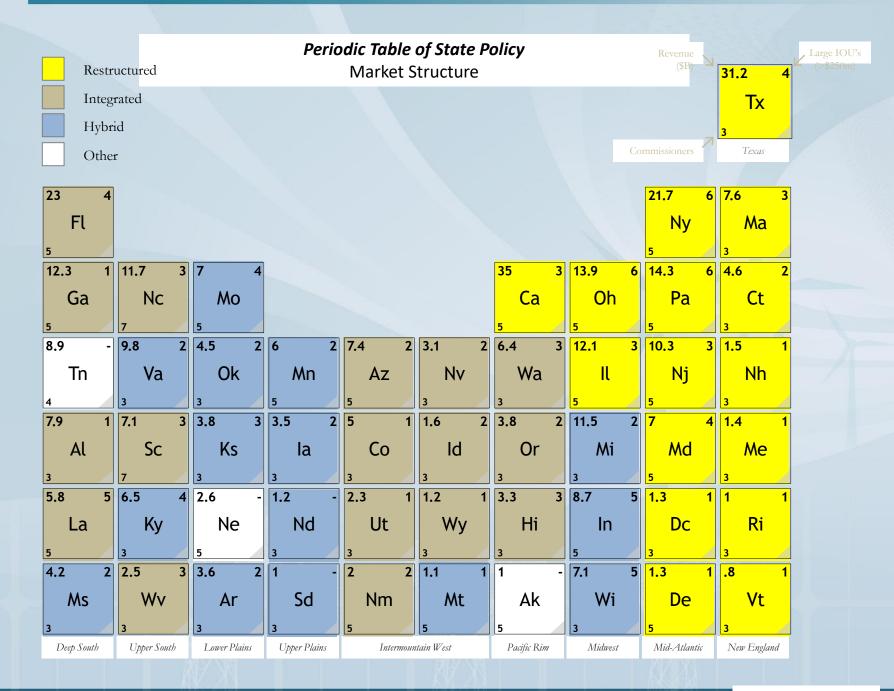


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Electricity Journal: http://e9radar.link/table (July 2015)

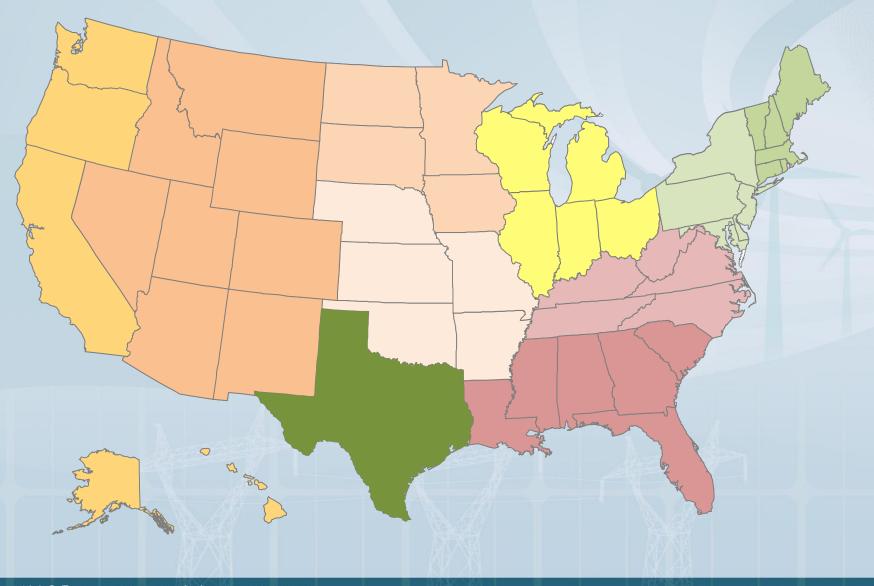
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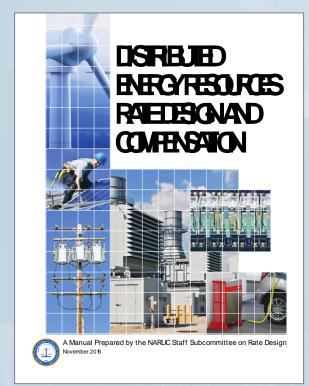


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Periodic Table: *FAMILIES*



NARUC Rate Design Manual



Source: National Association of Regulatory Utility Commissioners (https://www.naruc.org/rate-design/) A DEFINITION OF RESOURCE? "Simply put, the term 'resource' has traditionally referred to a resource for electricity generation.... When compared with the traditional, centralgeneration model, it could be said that a distributed model is turning the traditional model upside down... by integrating new resources at and connected to the distribution grid."

Energy Resource Framework

storage voltage microgrids

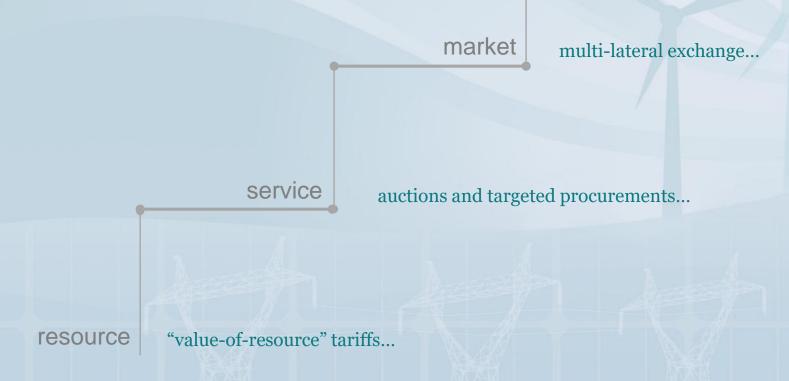
dynamic grid services

predictable energy resources

chp solar wind efficiency

vehicles load shifting demand response

Market Structure Framework



NARUC Manual on DER Rate Design



PUF Jan 2017: http://e9radar.link/narucmanual

OBSERVATION

"These numbers suggest that the questions surrounding distributed energy are ones that regulators must grapple with today.

Over one million customers today are on net metering rates with roof-top solar...The revenue value of the distributed energy resources capacity as a proportion of total revenue is **nearly \$10B annually.**"

NARUC Cybersecurity

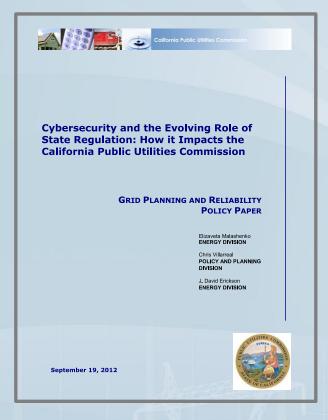
	Cybersecurity
	A Primer for State Utility Regulators
	Version 3.0
NARUC	Miles Keogh Sharon Thomas
National Association of	January 2017
Regulatory Utility	With support from the U.S. Department of Energy
Commissioners	

NARUC January 2017: https://e9radar.link/cyberNARUC17

JANUARY 2017
 Primer for State Regulators

- Informal survey in 2016
- Update to 2012 Manual
- Currently preparing materials for release by early 2019

California PUC



CPUC September 2012: https://e9radar.link/cyberCA12

SEPTEMBER 2011 Cybersecurity & the Evolving Role of State Regulation

Recommended Staff
 Cybersecurity Group

NIST smart grid program

E9 Insight & EnergySec: **Regulatory Review**

E9 INSIGHT





E9 Insight monitors regulatory activities of the nation's public utility commissions and provided tailored research services for industry clients and government agencies. This Research Brief, prepared in collaboration with EnergySec, summarizes the findings of an examination of notable and recent proceedings, legislation and other policy initiatives addressing cybersecurity and the electric distribution grid. Overall, we find that new technologies, grid modernization and distributed energy resources bring with them cybersecurity implications that are new to most state commissions. As a result, we highlight several methods by which energy regulators are responding and expanding the scope of their oversight of electric utilities.

Overview

Distribution edge technologies are evolving the grid from a relatively closed system to a complex, highly interconnected environment, enabling new types of energy transactions and third-party participation. The role of state regulators in developing cybersecurity standards is evolving as grid communication networks become more advanced and distributed.

State regulators have not traditionally had to focus on these issues, especially at the level of the distribution grid. In large part this is because cybersecurity threats were largely confined to the transmission grid and the bulk power electric system (BES) and were addresses by the North America Electric Reliability Corporation's (NERC) Critical Infrastructure Protection (CIP) and National Institute of Standards and Technology (NIST) standards. However, the growing sophistication of cyber threat actors and the increasing utilization of cyber systems at the edges of the grid are prompting states to look more closely at the implications for the distribution system and the consumer edge of the electric system.

The existing standards primarily address only generation and transmission assets, leaving rules related to the distribution grid up to the state agencies and commissions. Today, many states are have embarked on broad reviews of grid modernization and consequently they must consider the increased participation of distributed energy resources and consumer technologies on the distribution grid and the associated implications on grid reliability, safety and customer privacy. By some estimates, up to 80-90% of grid assets are outside NERC-CIP's scope today¹

E9 Insight, in partnership with EnergySec, has completed a review of state utility commission and state legislative activities that address the issue of cybersecurity. This review identified a wide range of proceeding types, some of which directly address security issues but many which include physical and cybersecurity within the scope of larger proceedings. This paper outlines the trends that we see developing as a means to identify emerging practices for regulators and inform other interested stakeholders of likely future directions.

1¹ Testimony of Ernie Hayden, Managing Principal, Energy Security, Verizon Energy & Utility Practice, in: http://www.cpuc.ca.gov/uploadedFiles/CPUC_Pable_Webster/Content/About_Us/Organization/Divisio ExohnonBoleStateReoutation/Decessecuit*Q23012FINAL.odf tent/About Us/Organization/Divisions/Policy and Planning/The

Research Brief: Public Utility Commissions & Cybersecurity - 1

E9 Review: https://e9radar.link/e9cyber

MARCH 2018 Review of state commission activity related to cyber security

- Developed in collaboration with EnergySec
- Identified notable activity across 50 states
- Organized by proceeding or initiative type
- Outlook for future activity

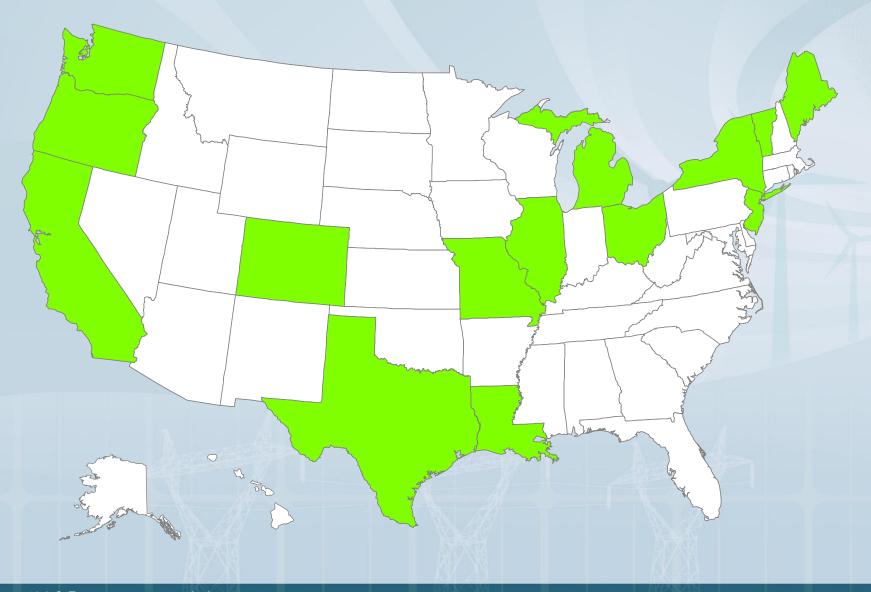
PUC Activities

In general, commission activities organized by:

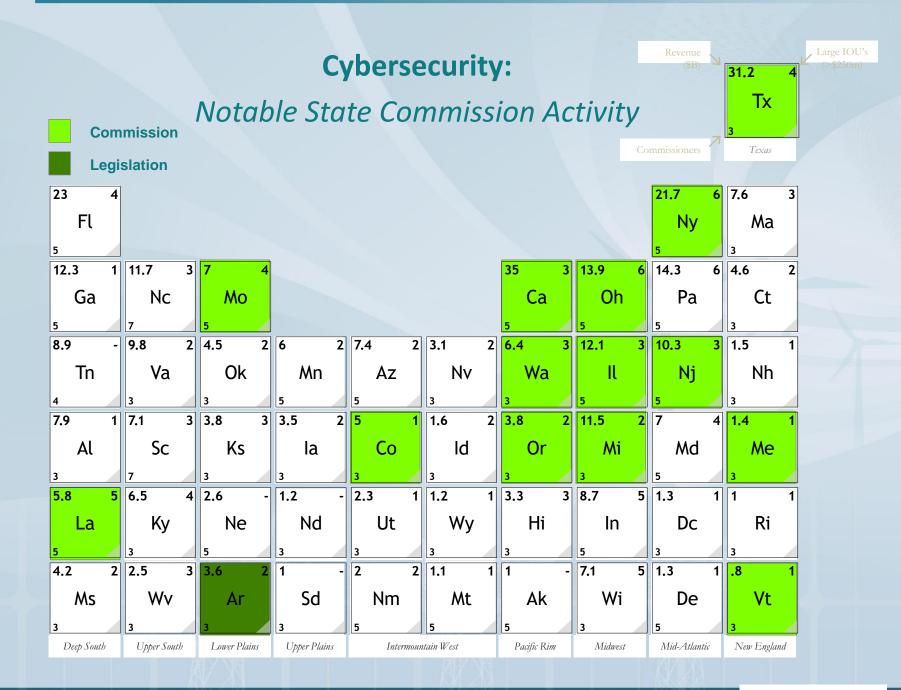
- Cyber-specific proceedings
- Cyber within broad scope (e.g., 'grid modernization')
- Resiliency & emergency preparedness
- Data privacy & consumer access
- Legislative action



Cybersecurity: Notable State Commission Activity



NIST smart grid program



NIST smart grid program

Notable: Louisiana

Las

Cybersecurity Review

Louisiana Public Service Commission (PSC) opened a docket to:

- Study and implement rules regarding utility generation and distribution assets
- Particular amount of attention to issues of Electromagnetic Pulse (EMP)
- Bifurcated review of EMP and Cybersecurity
- No docket activity since 2016



Notable: Ohio

PowerForward

PowerForward reviewing latest technological and regulatory innovation that could serve to enhance the consumer electricity experience, including:

- Planning
- Rate and Market Design
- Cybersecurity (Hearings March 19, 2018)



Notable: Vermont

Advanced Metering

Vermont regulators hosted workshop to discuss principles related to privacy and cybersecurity.

- Review of state & federal law
- Bifurcate issues of cybersecurity and privacy
- Concerns regarding reporting of the distribution utility's cybersecurity activities to avoid public record exposure



Notable: New York

Cybersecurity Review

New York Public Service Commission opened a docket, prompted by March 2018 data security event:

- To protect utility systems and confidential and sensitive customer information
- Includes both energy services entities and distributed energy resource suppliers
- Data Security Agreements filed in July 2018



Concluding Thoughts

Moving Forward?

Cybersecurity will be increasingly relevant to state commissions, driving activity and demand for:

- Expertise among staff
- <u>Coordination</u> across state agencies
- <u>Transparency</u> with regard to best practices
- <u>Guidance</u> to distribution companies

State activity likely will aligned with policy "orientation"



The Best of Grids; The Worst of Grids...



What a review of PUC cases tells us about the future of consumer technology and grid modernization.

BY CAMERON BROOK

PUF April 2016: http://e9radar.link/twogrids

50 PUBLIC UTILITIES FORTMONTLY, May 2016

OBSERVATION

Technology innovation drives a strong divergence in state actions affecting the boundary of the "natural monopoly", leading to either:

- 1. <u>Markets</u> with new entrants
- 2. Expanded monopoly offerings

Thank you

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Critical Infrastructure Committee

