Critical Infrastructure Committee

BREAK

NARUC Summer Policy Summit

Critical Infrastructure Committee

Grid Complexity and Cyber Risks: Days of Future Past?

NARUC Summer Policy Summit

Interoperability for a Modern Grid: NARUC Summer Policy Summit

Avi Gopstein

Engineering Laboratory
NIST Smart Grid & Cyber-Physical Systems Office

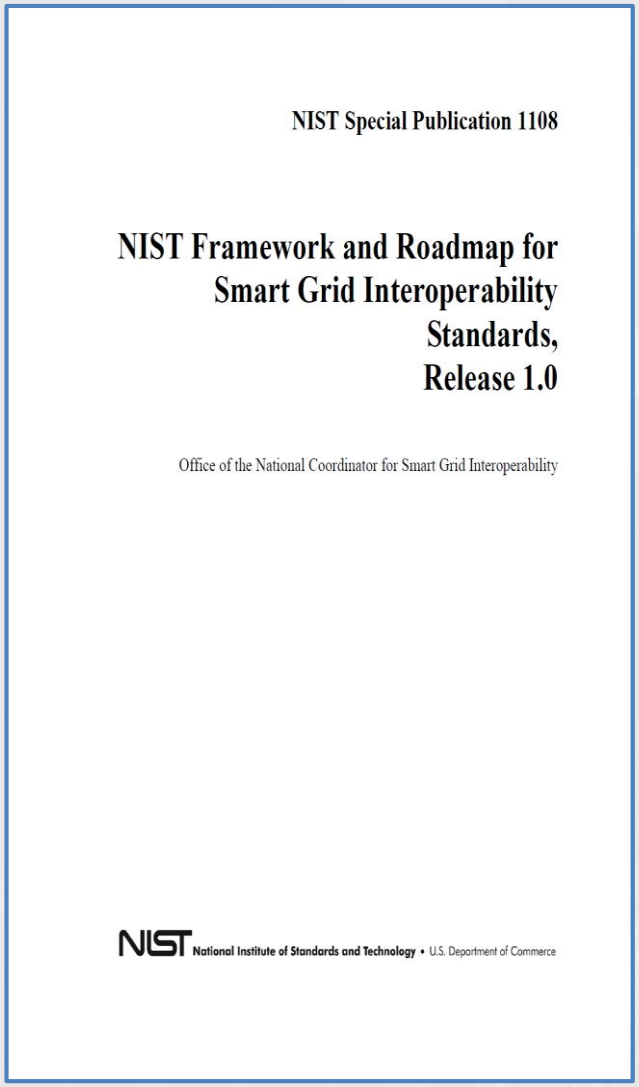
July 15, 2018

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

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

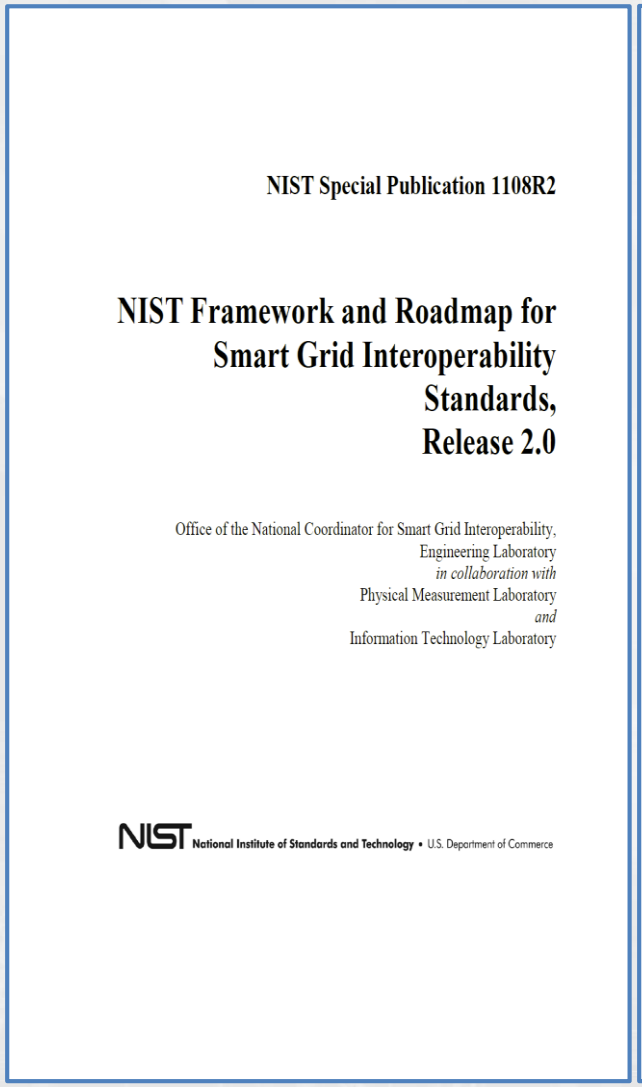

NIST Special Publication 1108

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

Office of the National Coordinator for Smart Grid Interoperability

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

2010

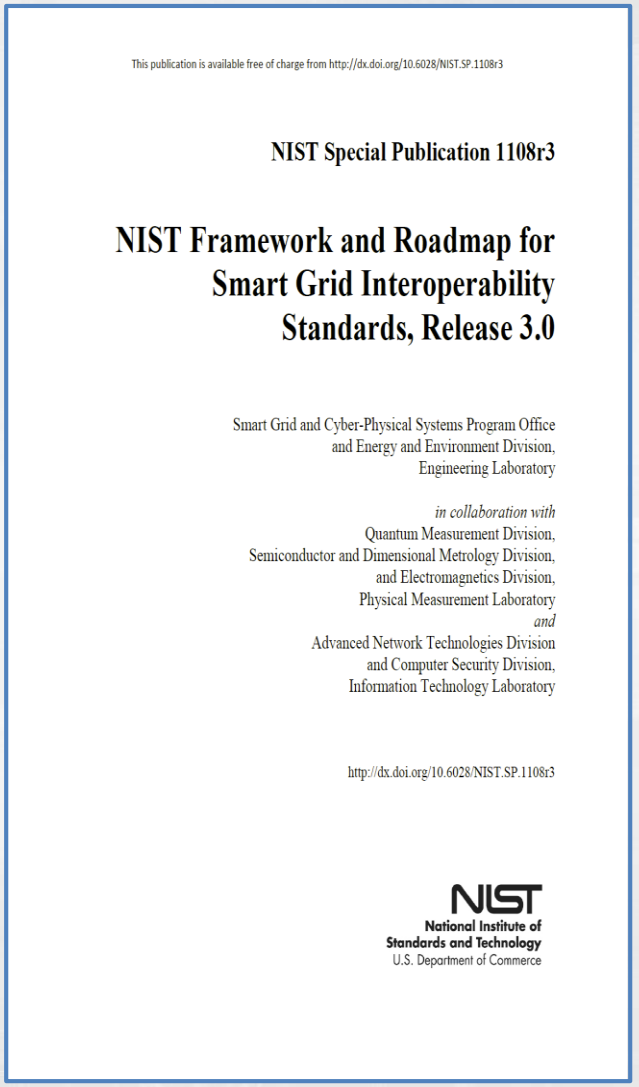

NIST Special Publication 1108R2

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

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

2012


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

NIST
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U.S. Department of Commerce

2014

Interoperability Frameworks to date

NIST Special Publication 1108

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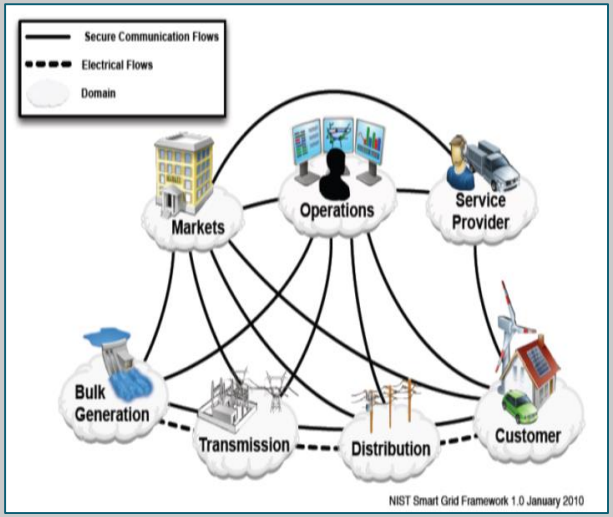

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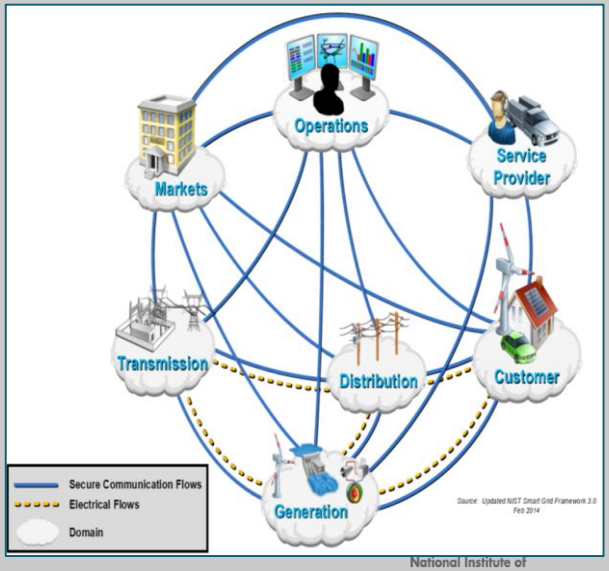

National Institute of Standards and Technology
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2014

Motivations / Themes

Motivations

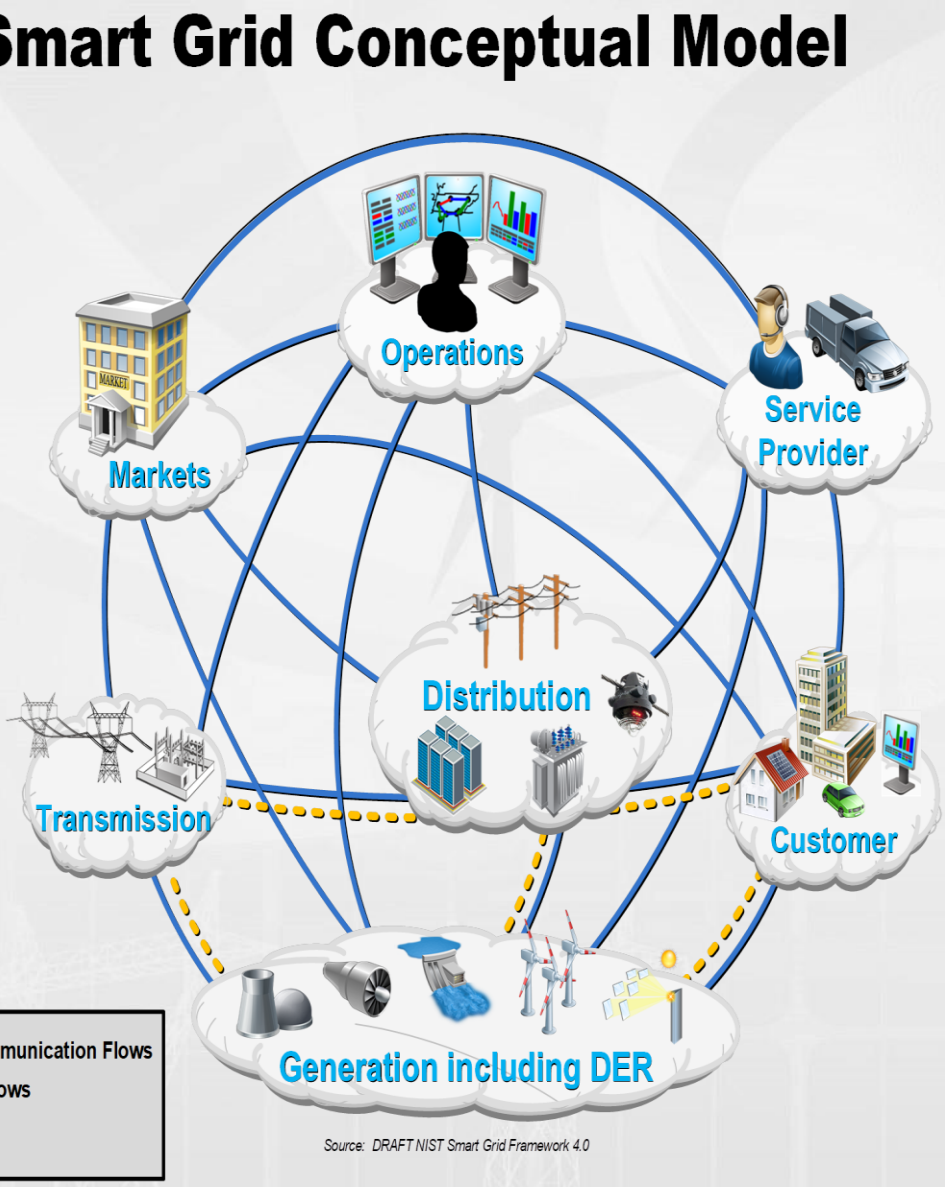
- Technology is advancing rapidly
- Evolving capabilities bring:
  - New opportunities
  - New concerns / challenges
  - Structural change
- Modular and scalable technologies enable:
  - Disaggregation of system physics
  - Hyper-local optimization
  - A new set of cascading concerns
- Distribution models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

Framework 4.0 Themes

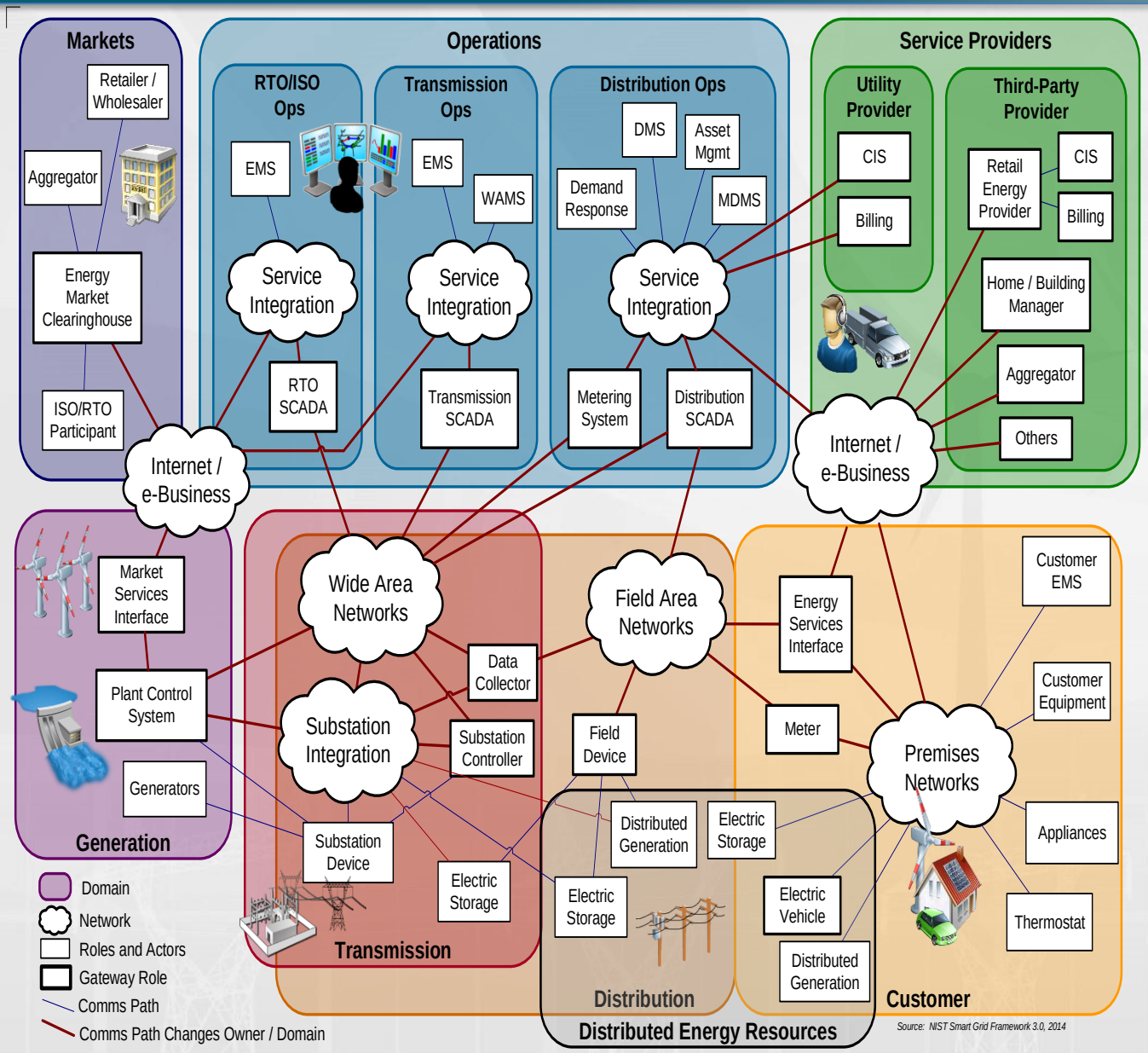
- Structural changes are occurring in the grid
- System complexity is increasing
  - Interoperability is a critical element of modern grid function
- No single architecture is correct
  - Common trends
  - Unique conditions
- Grid architectures affect:
  - Operations
  - Economics
  - Cybersecurity
-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

Conceptual Model

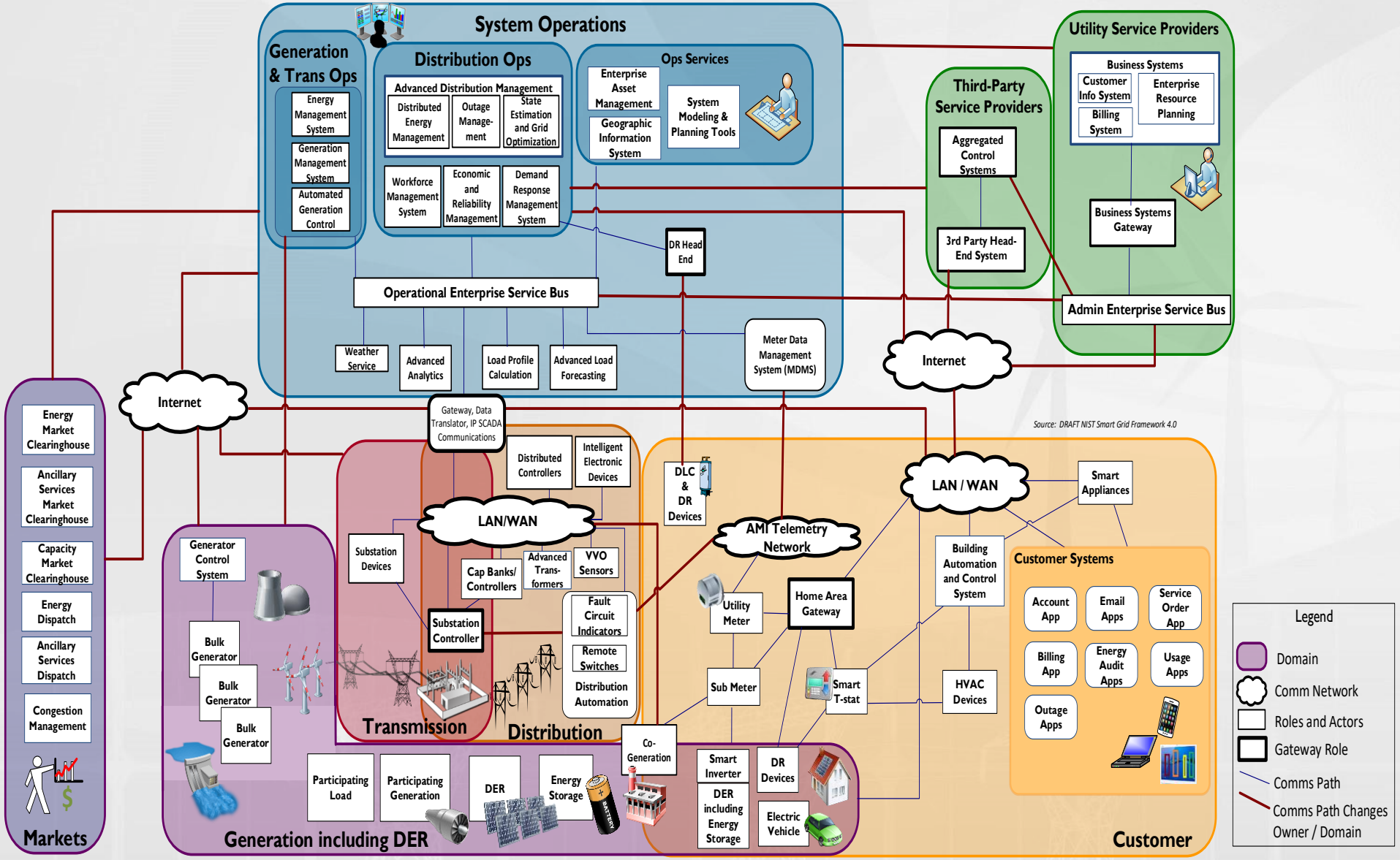
- Generation including DER
  - Technology diversity
  - Physical proximity to transmission, distribution + customer domains
- Intelligent distribution system
  - Increasing importance (location + size)
  - Improved controllability + intelligence
  - Connected to service provider domain (e.g., congestion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



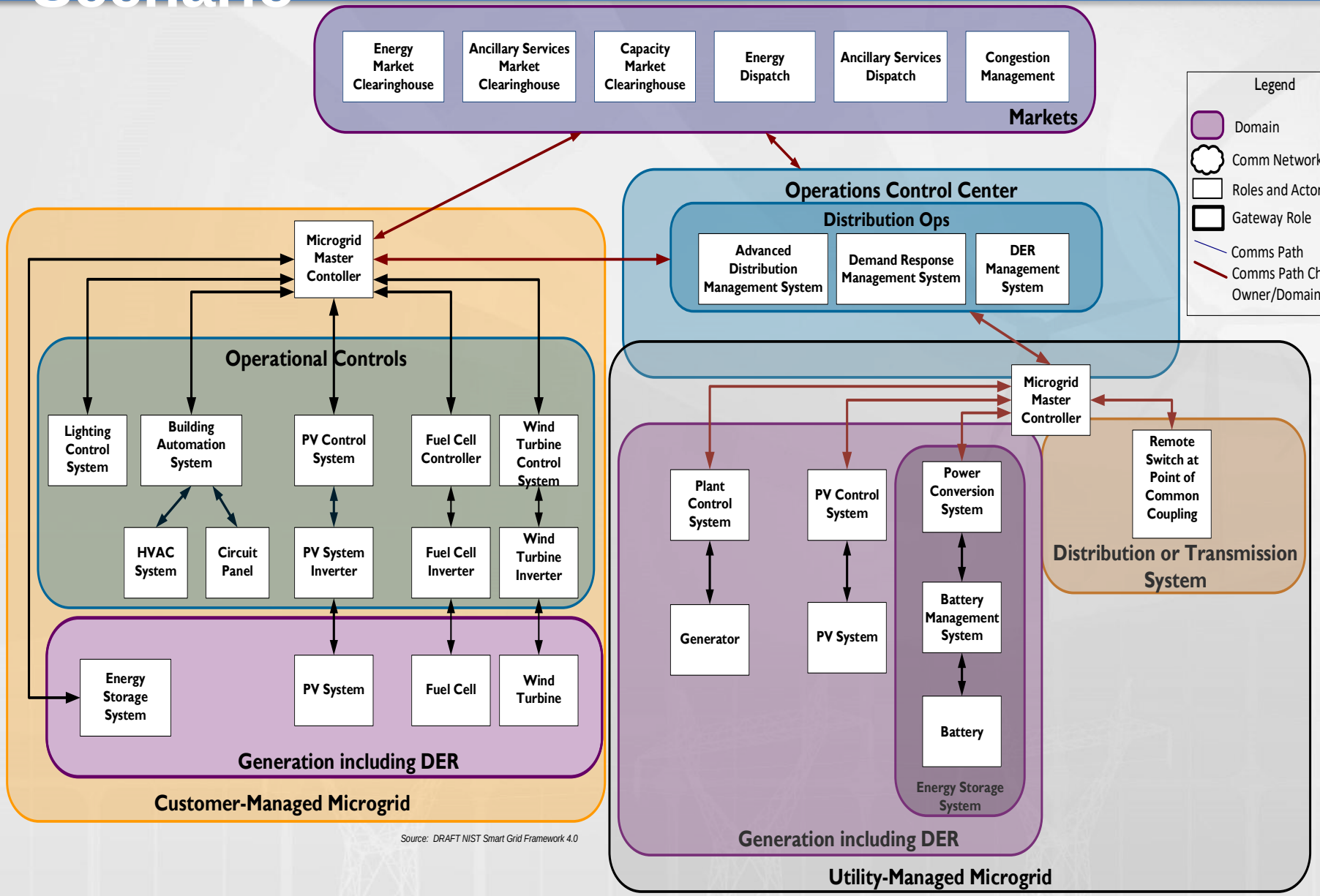
Legacy Communications Pathway Scenario



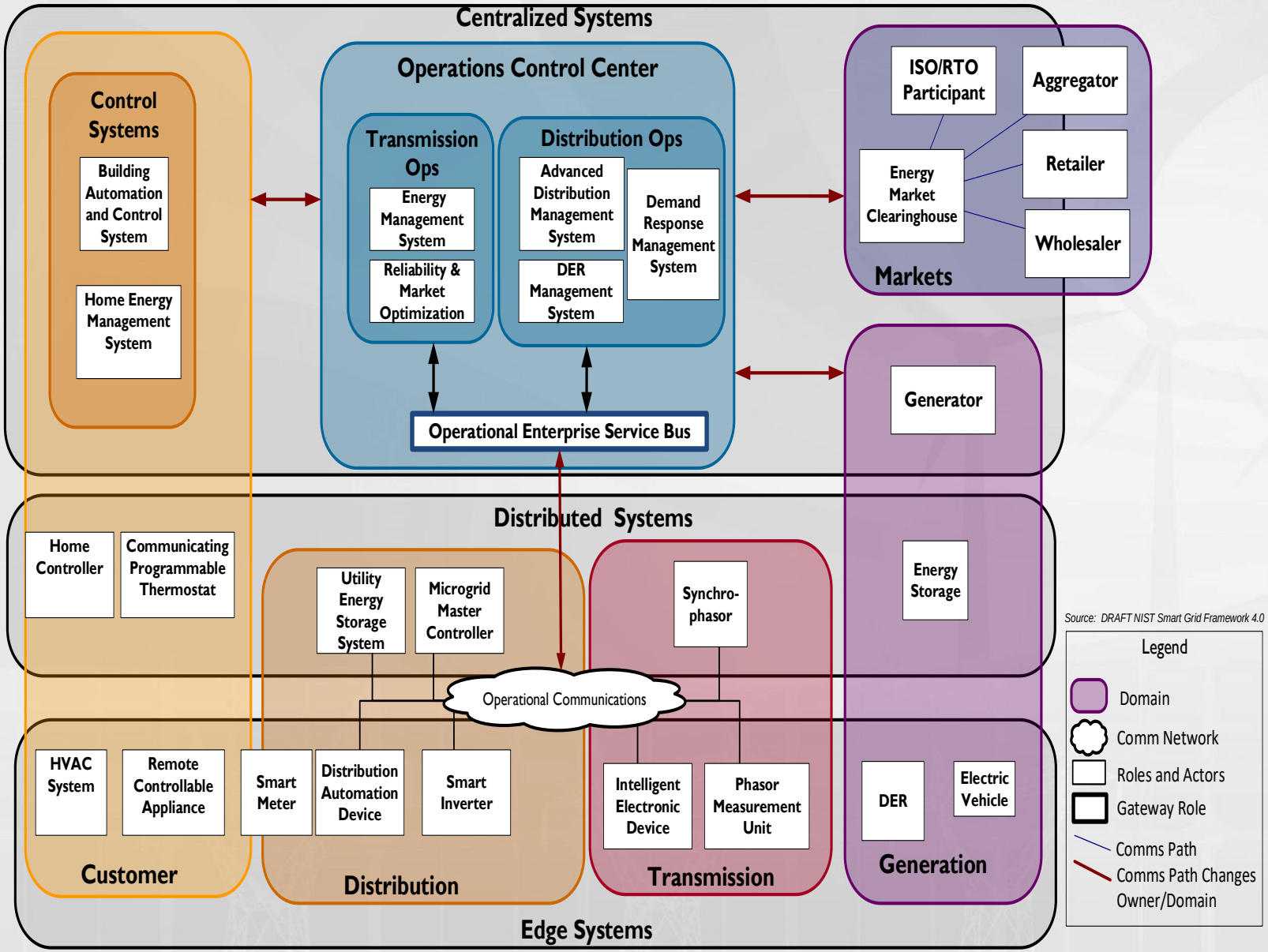
High-DER Communications Pathway Scenario



Microgrid Communications Pathway Scenario

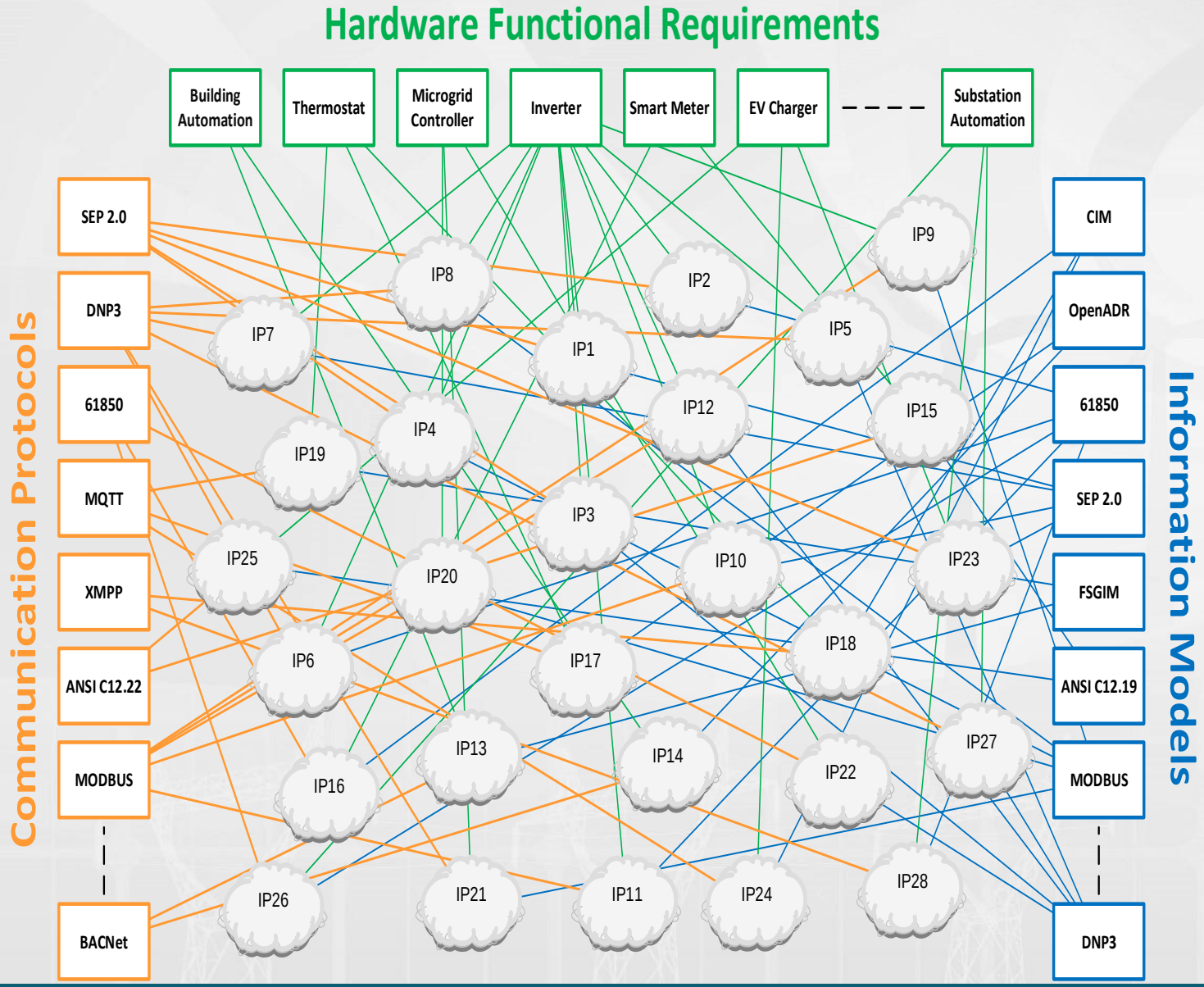


Hybrid Utility Communications Pathway Scenario



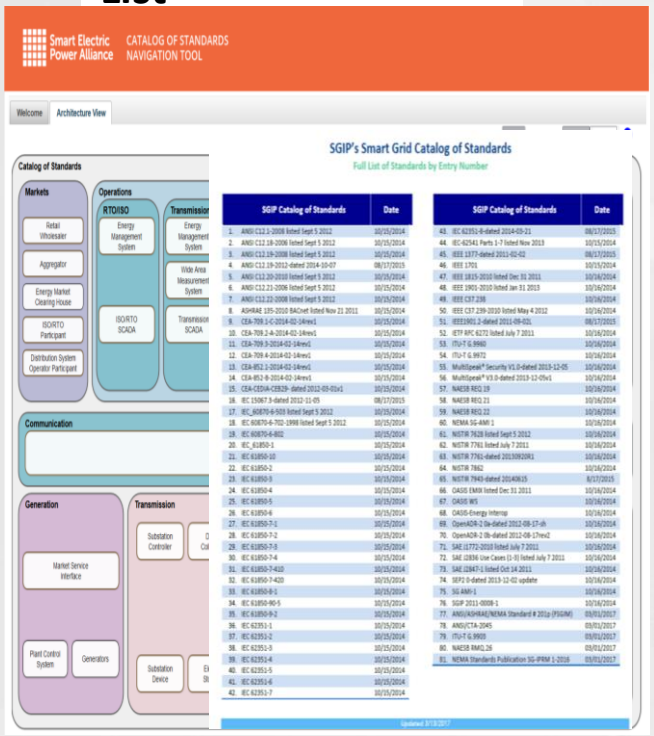
What does all of this mean for how we operate a modern grid?

Interoperability Profile: Illustrative Landscape



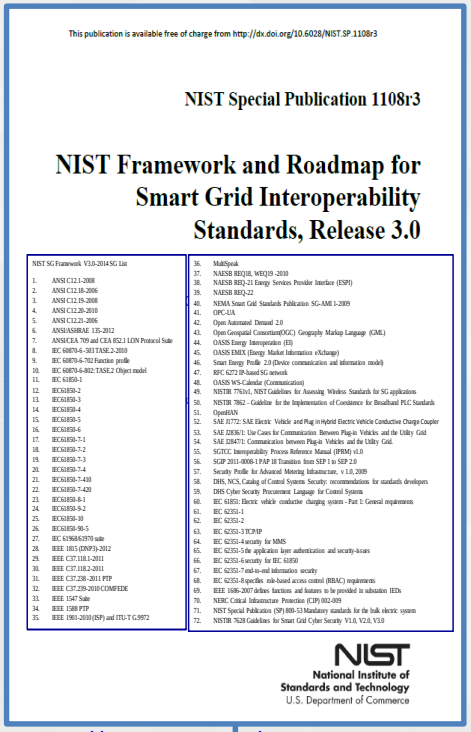
Interoperability standards landscape assessment

SEPA/SGIP SG CoS List



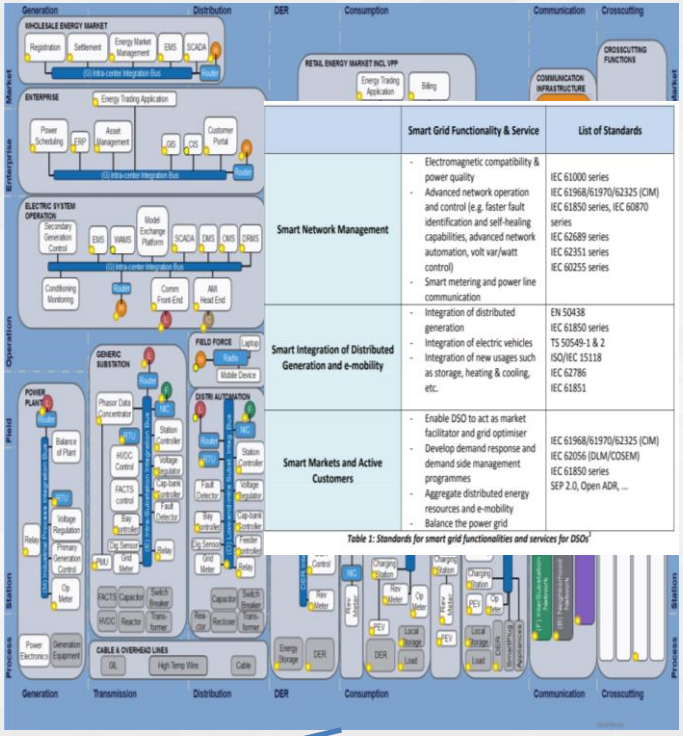
Source: http://www.gridstandardsmap.co

Identified SG Standard List of NIST Framework R3.0



https://www.nist.gov/news-events/news/2014/10/nist-releases-final-version-smart-grid-framework-update-30

DSO Priority List

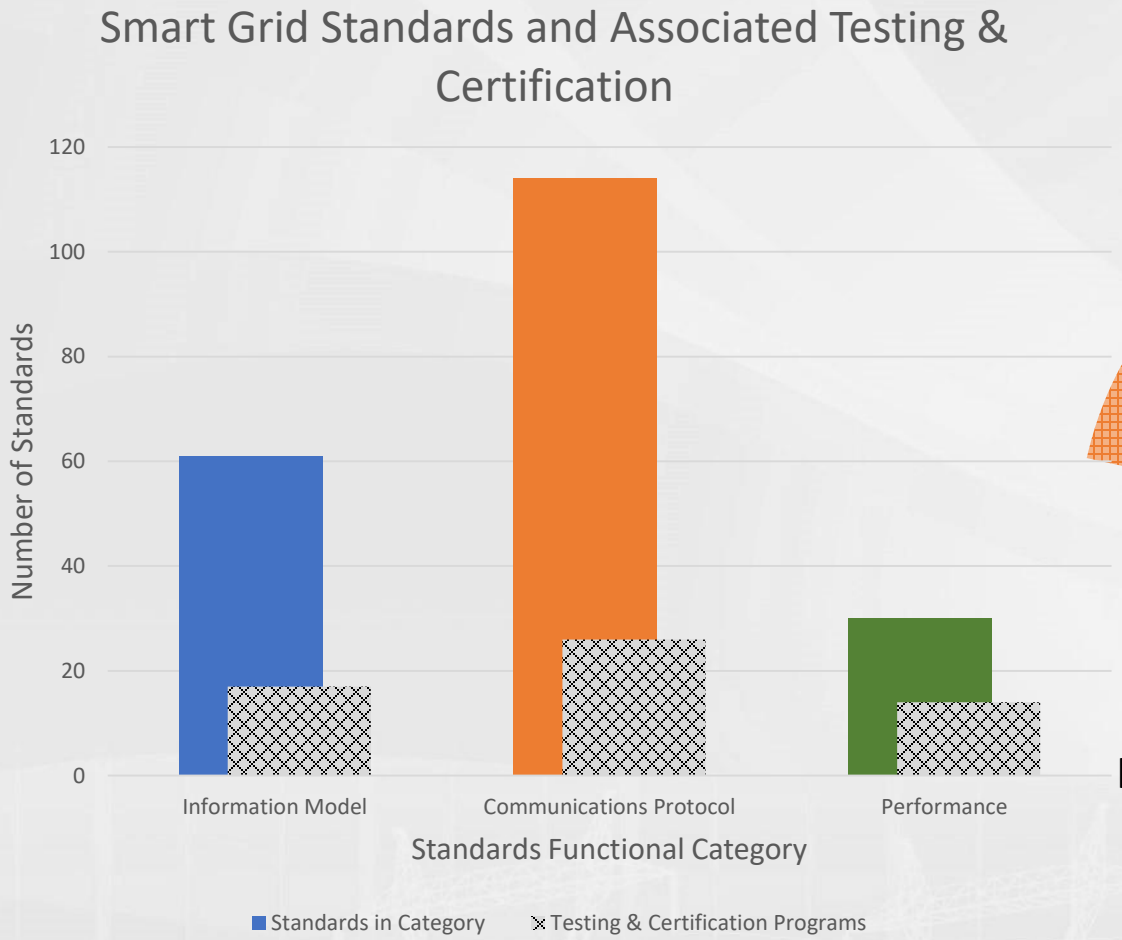


Source: https://www.edsoforsmartgrids.eu/wp-content/uploads/public/DSO-Priorities-Smart-Gird-Standardisation.pdf

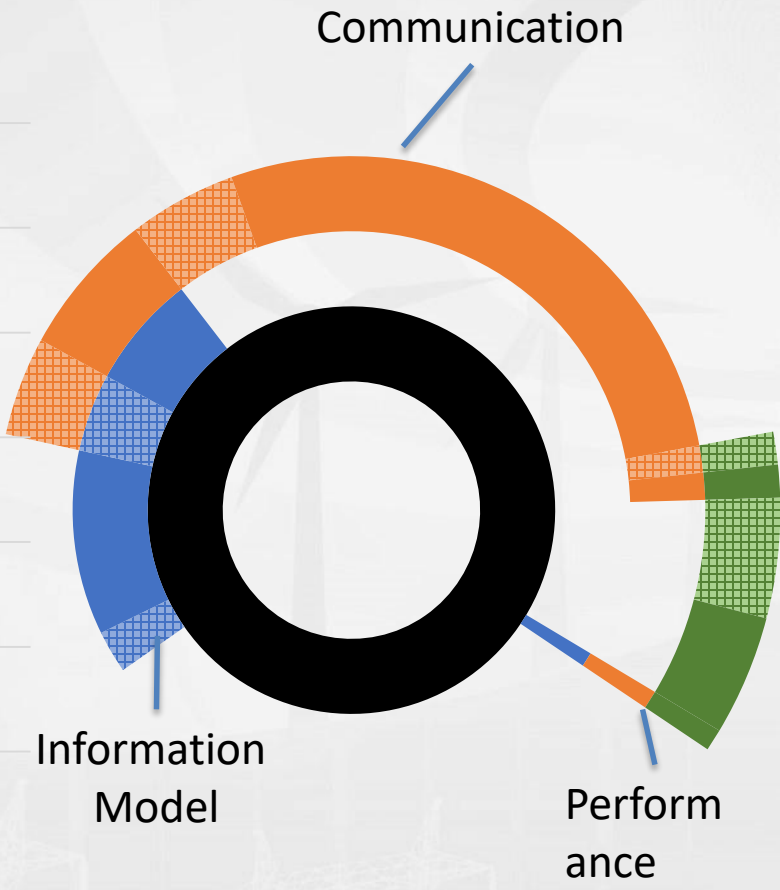
New Standards:
- New Standards
- New versions of old standards

Smart Grid Standards for Evaluation (244 Standards)

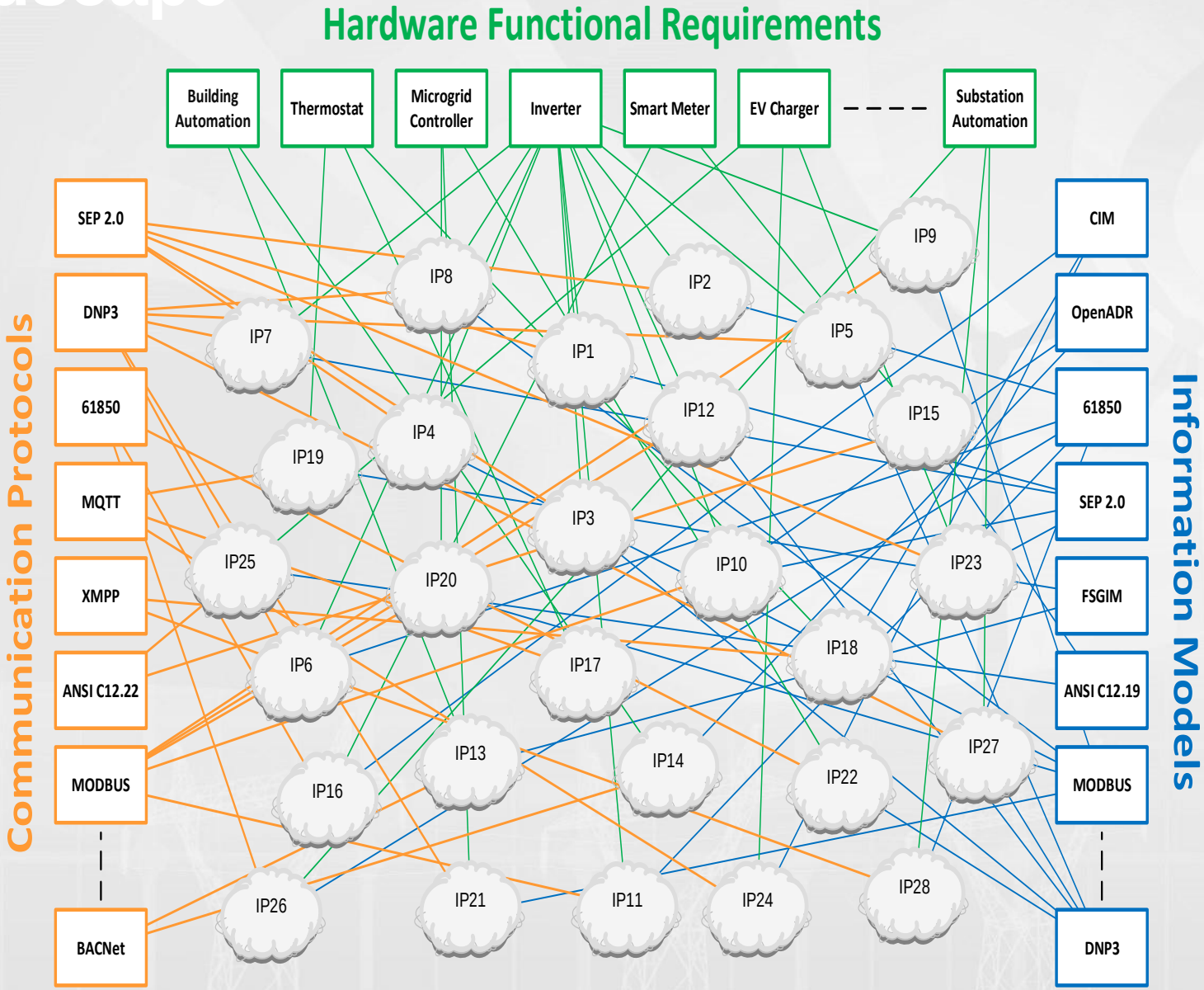
Interoperability landscape assessment



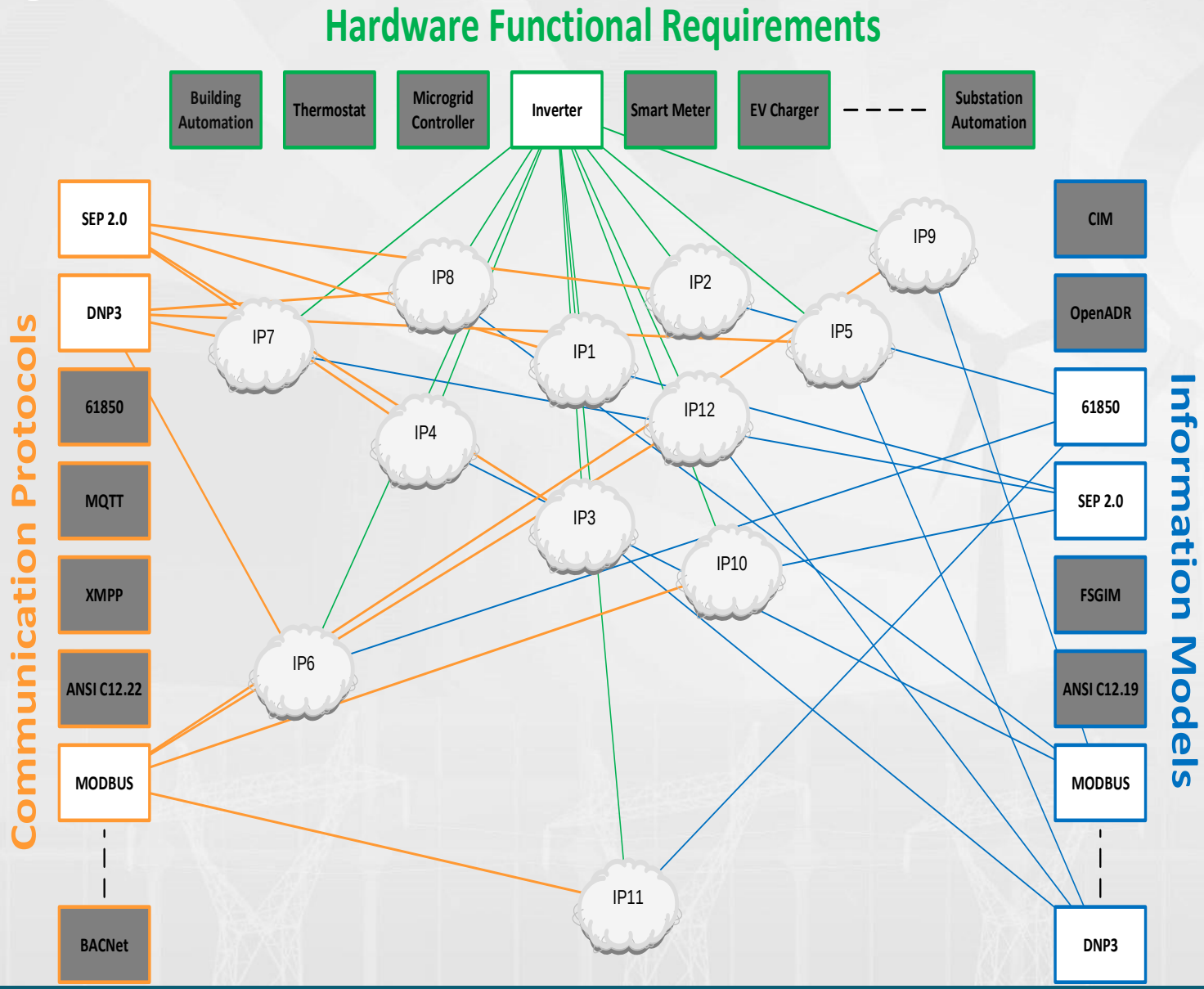
17/61 26/114 14/30



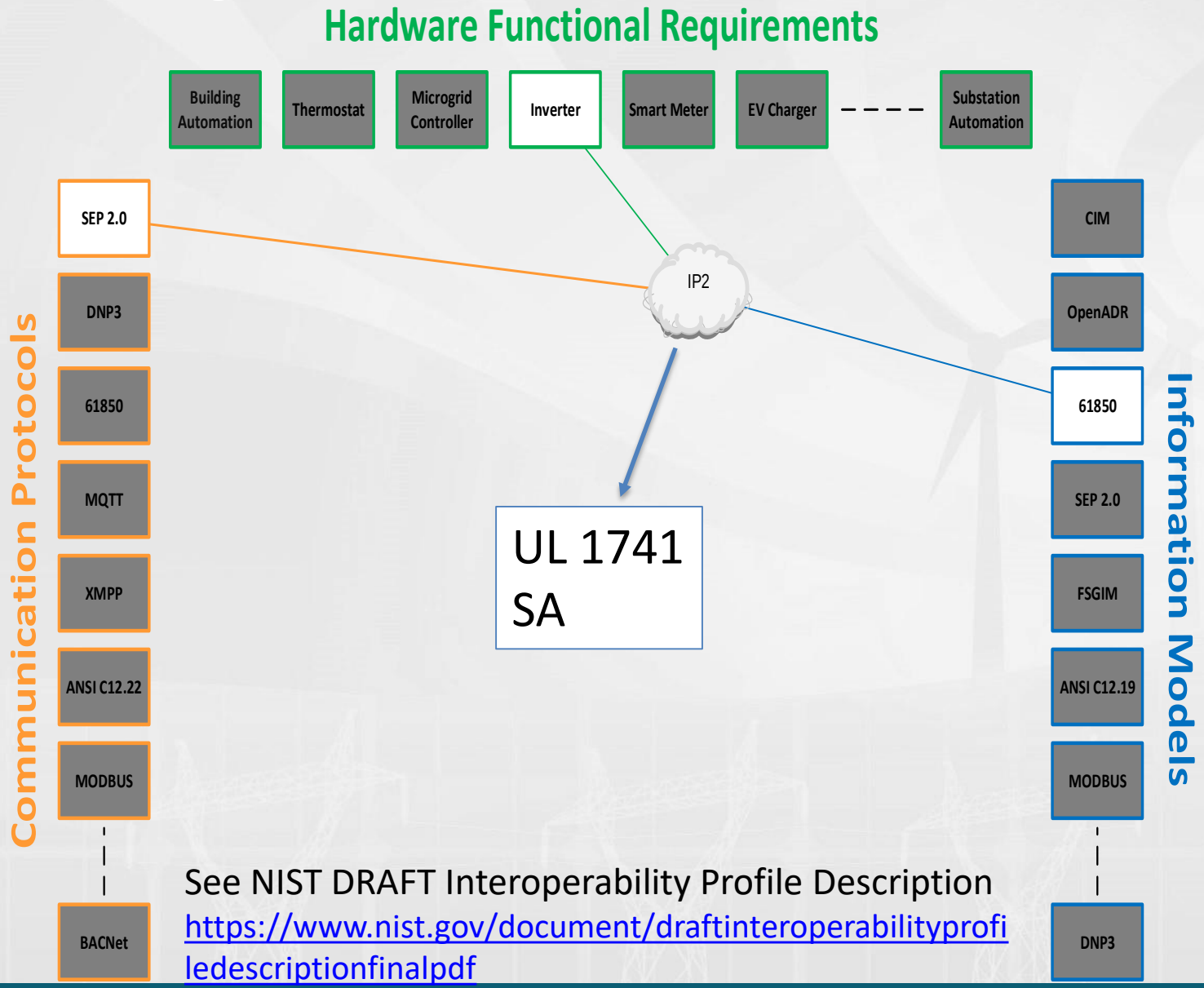
Interoperability Profile: Illustrative Landscape



Interoperability Profile: IEEE 1547 Case Study



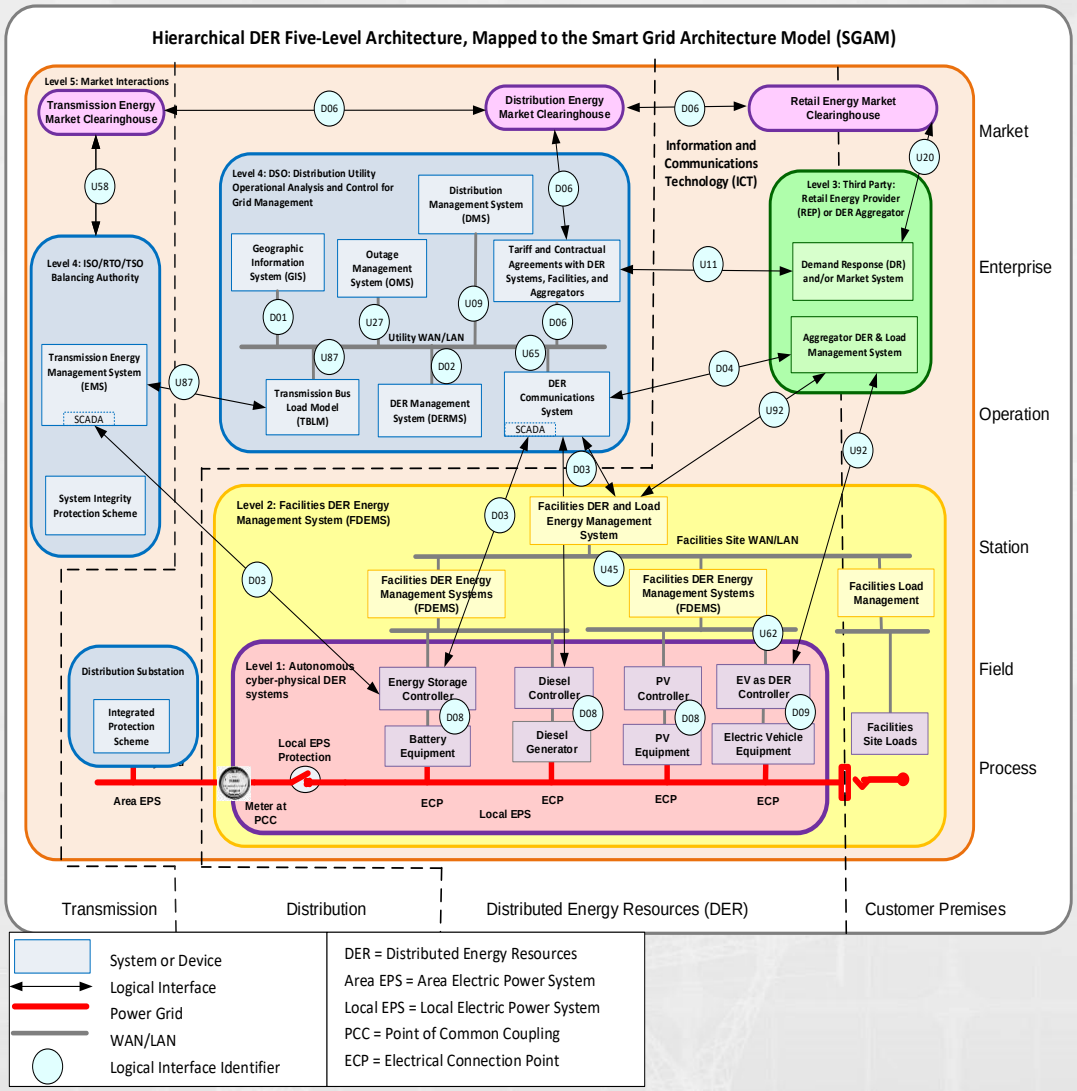
Interoperability Profile: California Rule 21 Case Study



See NIST DRAFT Interoperability Profile Description
https://www.nist.gov/document/draftinteroperabilityprofiledescriptionfinalpdf

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: August-October, 2018
Locations: 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

THANK YOU

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

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NARUC Summer Meetings

How are State PUC's Addressing Cybersecurity?

Cameron Brooks, President

July 15, 2018

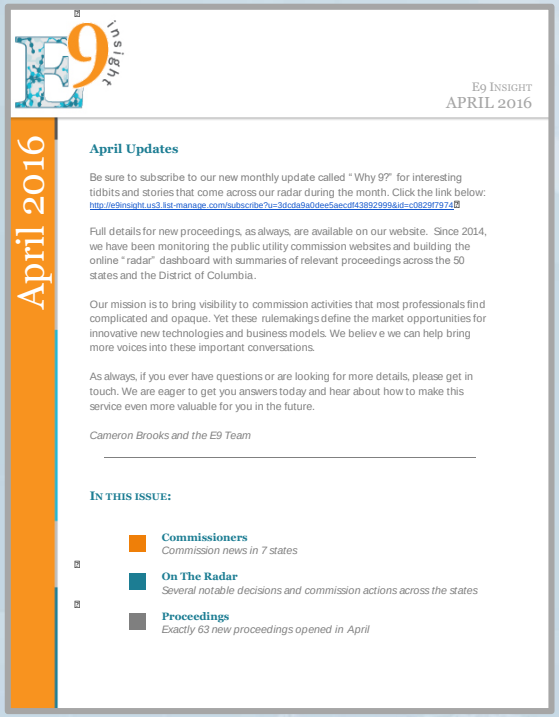
Cybersecurity: *A New PUC Challenge*

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 expanded role for state regulators.

E9 Insight



E9 INSIGHT
APRIL 2016

April 2016

April Updates

Be sure to subscribe to our new monthly update called "Why 9?" for interesting tidbits and stories that come across our radar during the month. Click the link below:
http://e9insight.us3.list-manage.com/subscribe?u=3dcda9a0dee5aecdf43892999&id=c0829f7974

Full details for new proceedings, as always, are available on our website. Since 2014, we have been monitoring 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.

Our mission is to bring visibility to commission activities that most professionals find complicated and opaque. Yet these rulemakings define the market opportunities for innovative new technologies and business models. We believe we can help bring more voices 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:

Commissioners
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)

Periodic Table of State Policy

Revenue ($B) → 31.2 | Large IOU's (>$250m) → 4 | Commissioners → 3 | Texas → Tx

23 / 4 / Fl / 5								21.7 / 6 / Ny / 5	7.6 / 3 / Ma / 3
12.3 / 1 / Ga / 5	11.7 / 3 / Nc / 7	7 / 4 / Mo / 5				35 / 3 / Ca / 5	13.9 / 6 / Oh / 5	14.3 / 6 / Pa / 5	4.6 / 2 / Ct / 3
8.9 / - / Tn / 4	9.8 / 2 / Va / 3	4.5 / 2 / Ok / 3	6 / 2 / Mn / 5	7.4 / 2 / Az / 5	3.1 / 2 / Nv / 3	6.4 / 3 / Wa / 3	12.1 / 3 / Il / 5	10.3 / 3 / Nj / 5	1.5 / 1 / Nh / 3
7.9 / 1 / Al / 3	7.1 / 3 / Sc / 7	3.8 / 3 / Ks / 3	3.5 / 2 / Ia / 3	5 / 1 / Co / 3	1.6 / 2 / Id / 3	3.8 / 2 / Or / 3	11.5 / 2 / Mi / 3	7 / 4 / Md / 5	1.4 / 1 / Me / 3
5.8 / 5 / La / 5	6.5 / 4 / Ky / 3	2.6 / - / Ne / 5	1.2 / - / Nd / 3	2.3 / 1 / Ut / 3	1.2 / 1 / Wy / 3	3.3 / 3 / Hi / 3	8.7 / 5 / In / 5	1.3 / 1 / Dc / 3	1 / 1 / Ri / 3
4.2 / 2 / Ms / 3	2.5 / 3 / Wv / 3	3.6 / 2 / Ar / 3	1 / - / Sd / 3	2 / 2 / Nm / 5	1.1 / 1 / Mt / 5	1 / - / Ak / 5	7.1 / 5 / Wi / 3	1.3 / 1 / De / 5	.8 / 1 / Vt / 3
Deep South	*Upper South*	*Lower Plains*	*Upper Plains*	*Intermountain West*		*Pacific Rim*	*Midwest*	*Mid-Atlantic*	*New England*

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

Periodic Table of State Policy

Market Size

- Large (>$10B)
- Medium ($2.5-10B)
- Small (<$2.5B)

Revenue ($B)	Large IOU's (>$250m)	Commissioners	State	Size
31.2	4	3	Tx (Texas)	Large

Deep South	Upper South	Lower Plains	Upper Plains	Intermountain West	Intermountain West	Pacific Rim	Midwest	Mid-Atlantic	New England
Fl 23 / 4 / 5 (Large)								Ny 21.7 / 6 / 5 (Large)	Ma 7.6 / 3 / 3 (Medium)
Ga 12.3 / 1 / 5 (Large)	Nc 11.7 / 3 / 7 (Large)	Mo 7 / 4 / 5 (Medium)				Ca 35 / 3 / 5 (Large)	Oh 13.9 / 6 / 5 (Large)	Pa 14.3 / 6 / 5 (Large)	Ct 4.6 / 2 / 3 (Medium)
Tn 8.9 / - / 4 (Medium)	Va 9.8 / 2 / 3 (Medium)	Ok 4.5 / 2 / 3 (Medium)	Mn 6 / 2 / 5 (Medium)	Az 7.4 / 2 / 5 (Medium)	Nv 3.1 / 2 / 3 (Medium)	Wa 6.4 / 3 / 3 (Medium)	Il 12.1 / 3 / 5 (Large)	Nj 10.3 / 3 / 5 (Large)	Nh 1.5 / 1 / 3 (Small)
Al 7.9 / 1 / 3 (Medium)	Sc 7.1 / 3 / 7 (Medium)	Ks 3.8 / 3 / 3 (Medium)	Ia 3.5 / 2 / 3 (Medium)	Co 5 / 1 / 3 (Medium)	Id 1.6 / 2 / 3 (Small)	Or 3.8 / 2 / 3 (Medium)	Mi 11.5 / 2 / 3 (Large)	Md 7 / 4 / 5 (Medium)	Me 1.4 / 1 / 3 (Small)
La 5.8 / 5 / 5 (Medium)	Ky 6.5 / 4 / 3 (Medium)	Ne 2.6 / - / 5 (Medium)	Nd 1.2 / - / 3 (Small)	Ut 2.3 / 1 / 3 (Small)	Wy 1.2 / 1 / 3 (Small)	Hi 3.3 / 3 / 3 (Medium)	In 8.7 / 5 / 5 (Medium)	Dc 1.3 / 1 / 3 (Small)	Ri 1 / 1 / 3 (Small)
Ms 4.2 / 2 / 3 (Medium)	Wv 2.5 / 3 / 3 (Small)	Ar 3.6 / 2 / 3 (Medium)	Sd 1 / - / 3 (Small)	Nm 2 / 2 / 5 (Small)	Mt 1.1 / 1 / 5 (Small)	Ak 1 / - / 5 (Small)	Wi 7.1 / 5 / 3 (Medium)	De 1.3 / 1 / 5 (Small)	Vt .8 / 1 / 3 (Small)

Periodic Table of State Policy

Market Structure

Restructured

Integrated

Other

Revenue ($B)

Large IOU's (>$250m)

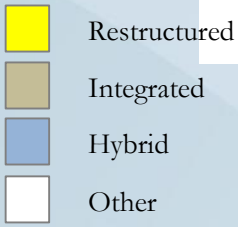
Commissioners

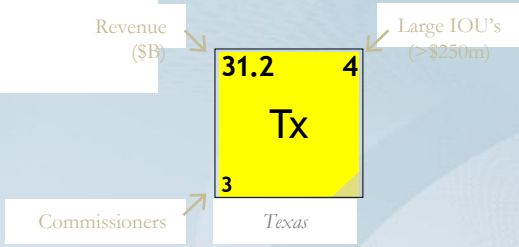
Texas

Deep South	*Upper South*	*Lower Plains*	*Upper Plains*	*Intermountain West*	*Pacific Rim*	*Midwest*	*Mid-Atlantic*	*New England*
							21.7 6 Ny 5	7.6 3 Ma 3
23 4 Fl 5					35 3 Ca 5	13.9 6 Oh 5	14.3 6 Pa 5	4.6 2 Ct 3
12.3 1 Ga 5	11.7 3 Nc 7	7 4 Mo 5			6.4 3 Wa 3	12.1 3 Il 5	10.3 3 Nj 5	1.5 1 Nh 3
8.9 - Tn 4	9.8 2 Va 3	4.5 2 Ok 3	6 2 Mn 5	7.4 2 Az 5 / 3.1 2 Nv 3				
7.9 1 Al 3	7.1 3 Sc 7	3.8 3 Ks 3	3.5 2 Ia 3	5 1 Co 3 / 1.6 2 Id 3	3.8 2 Or 3	11.5 2 Mi 3	7 4 Md 5	1.4 1 Me 3
5.8 5 La 5	6.5 4 Ky 3	2.6 - Ne 5	1.2 - Nd 3	2.3 1 Ut 3 / 1.2 1 Wy 3	3.3 3 Hi 3	8.7 5 In 5	1.3 1 Dc 3	1 1 Ri 3
4.2 2 Ms 3	2.5 3 Wv 3	3.6 2 Ar 3	1 - Sd 3	2 2 Nm 5 / 1.1 1 Mt 5	1 - Ak 5	7.1 5 Wi 3	1.3 1 De 5	.8 1 Vt 3

Periodic Table of State Policy

Market Structure





								21.7 6 Ny 5	7.6 3 Ma 3
23 4 Fl 5						35 3 Ca 5	13.9 6 Oh 5	14.3 6 Pa 5	4.6 2 Ct 3
12.3 1 Ga 5	11.7 3 Nc 7	7 4 Mo 5							
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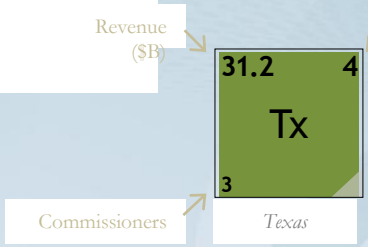
7.9 1 Al 3	7.1 3 Sc 7	3.8 3 Ks 3	3.5 2 Ia 3	5 1 Co 3	1.6 2 Id 3	3.8 2 Or 3	11.5 2 Mi 3	7 4 Md 5	1.4 1 Me 3
5.8 5 La 5	6.5 4 Ky 3	2.6 - Ne 5	1.2 - Nd 3	2.3 1 Ut 3	1.2 1 Wy 3	3.3 3 Hi 3	8.7 5 In 5	1.3 1 Dc 3	1 1 Ri 3
4.2 2 Ms 3	2.5 3 Wv 3	3.6 2 Ar 3	1 - Sd 3	2 2 Nm 5	1.1 1 Mt 5	1 - Ak 5	7.1 5 Wi 3	1.3 1 De 5	.8 1 Vt 3
Deep South	*Upper South*	*Lower Plains*	*Upper Plains*	*Intermountain West*		*Pacific Rim*	*Midwest*	*Mid-Atlantic*	*New England*

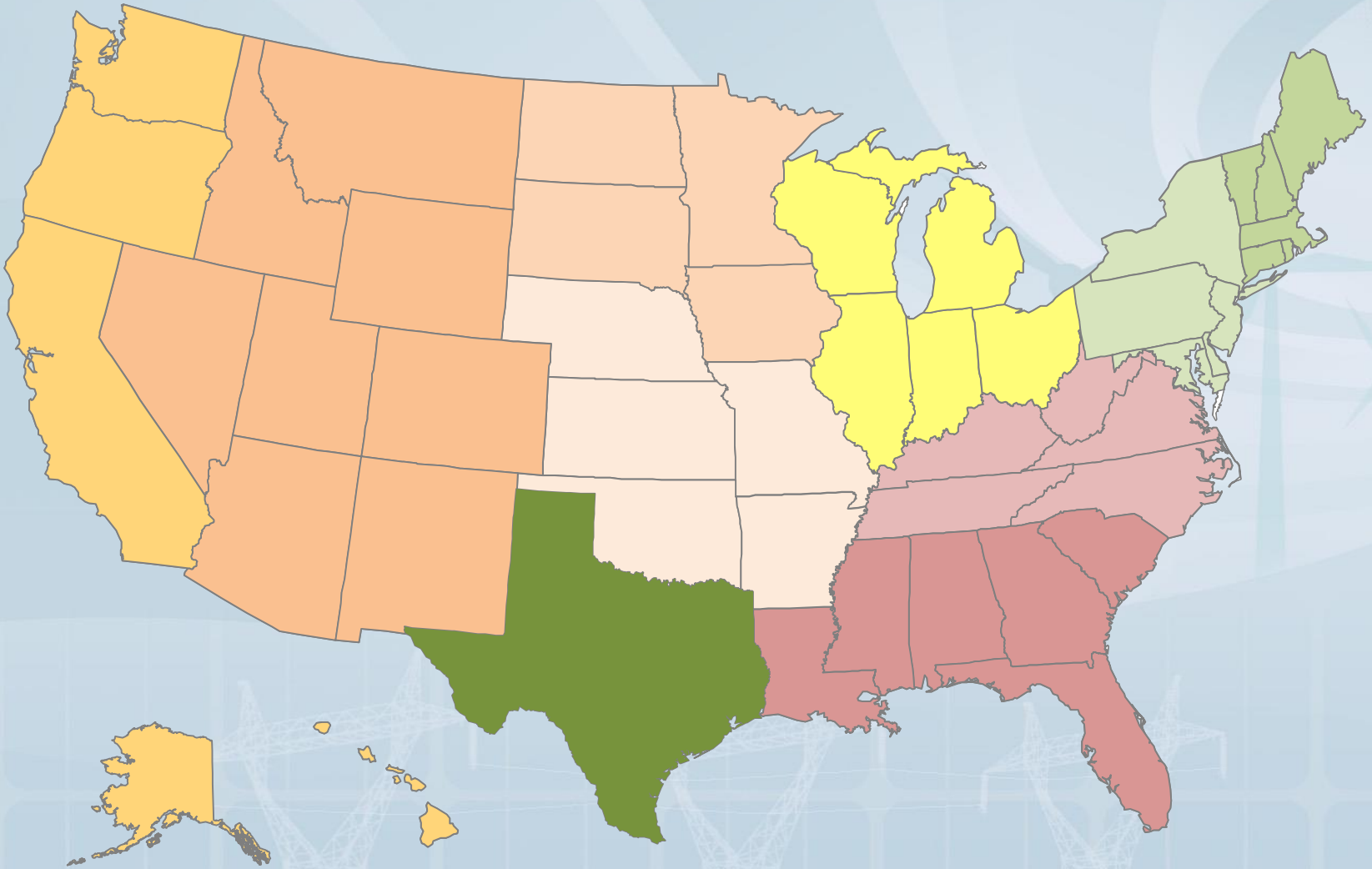
Periodic Table of State Policy

FAMILIES

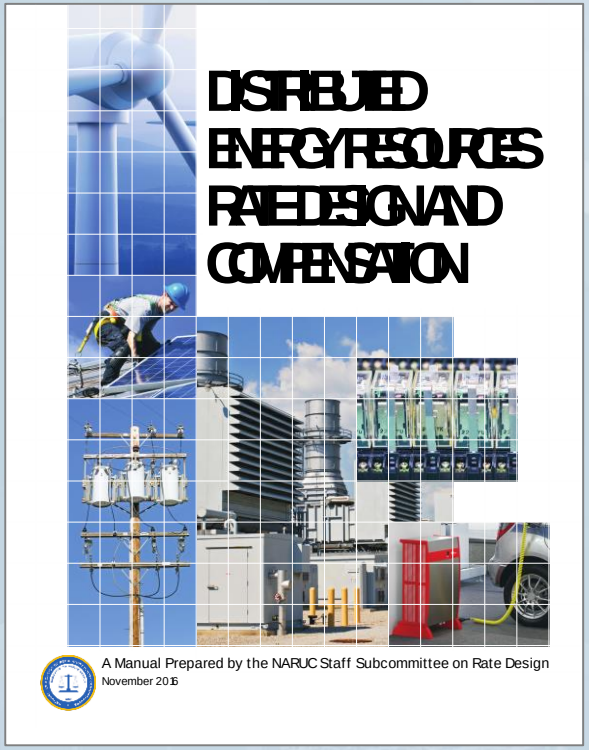


23 / 4 Fl / 5								21.7 / 6 Ny / 5	7.6 / 3 Ma / 3
12.3 / 1 Ga / 5	11.7 / 3 Nc / 7	7 / 4 Mo / 5				35 / 3 Ca / 5	13.9 / 6 Oh / 5	14.3 / 6 Pa / 5	4.6 / 2 Ct / 3
8.9 / - Tn / 4	9.8 / 2 Va / 3	4.5 / 2 Ok / 3	6 / 2 Mn / 5	7.4 / 2 Az / 5	3.1 / 2 Nv / 3	6.4 / 3 Wa / 3	12.1 / 3 Il / 5	10.3 / 3 Nj / 5	1.5 / 1 Nh / 3
7.9 / 1 Al / 3	7.1 / 3 Sc / 7	3.8 / 3 Ks / 3	3.5 / 2 Ia / 3	5 / 1 Co / 3	1.6 / 2 Id / 3	3.8 / 2 Or / 3	11.5 / 2 Mi / 3	7 / 4 Md / 5	1.4 / 1 Me / 3
5.8 / 5 La / 5	6.5 / 4 Ky / 3	2.6 / - Ne / 5	1.2 / - Nd / 3	2.3 / 1 Ut / 3	1.2 / 1 Wy / 3	3.3 / 3 Hi / 3	8.7 / 5 In / 5	1.3 / 1 Dc / 3	1 / 1 Ri / 3
4.2 / 2 Ms / 3	2.5 / 3 Wv / 3	3.6 / 2 Ar / 3	1 / - Sd / 3	2 / 2 Nm / 5	1.1 / 1 Mt / 5	1 / - Ak / 5	7.1 / 5 Wi / 3	1.3 / 1 De / 5	.8 / 1 Vt / 3
Deep South	*Upper South*	*Lower Plains*	*Upper Plains*	*Intermountain West*		*Pacific Rim*	*Midwest*	*Mid-Atlantic*	*New England*

Periodic Table: *FAMILIES*



NARUC Rate Design Manual

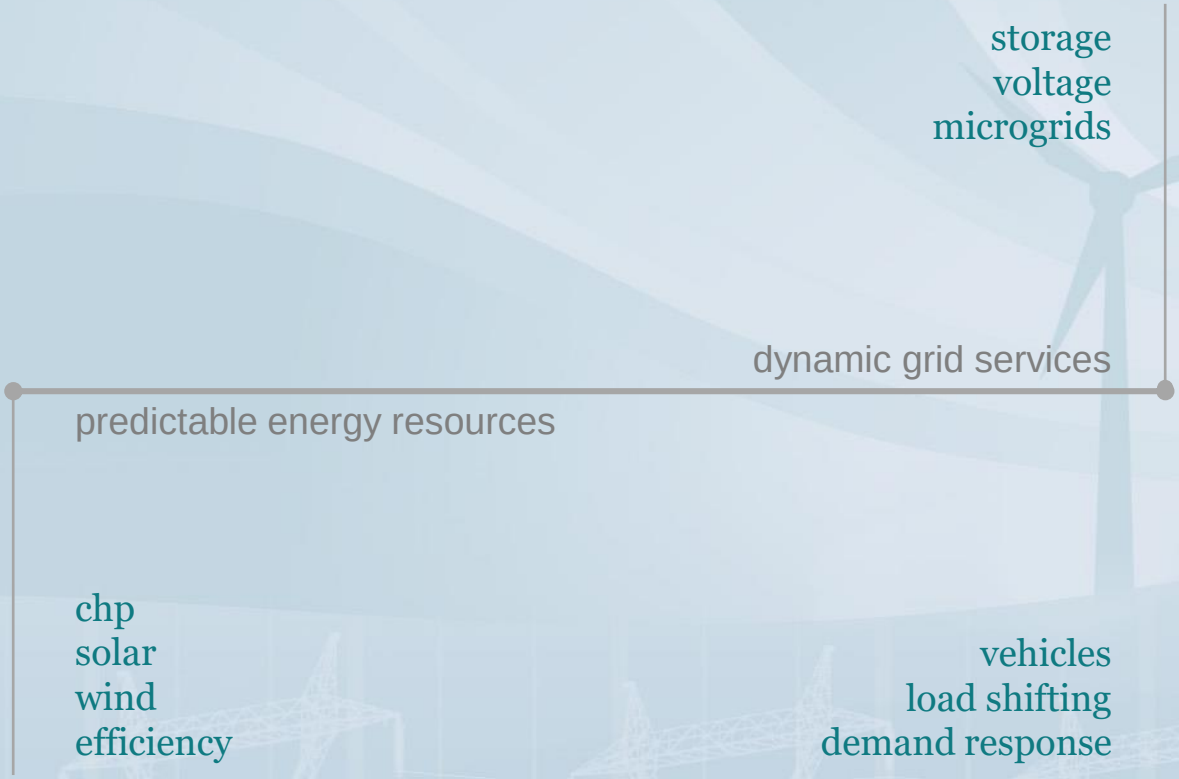


Source: National Association of Regulatory Utility Commissioners (https://www.naruc.org/rate-design/)

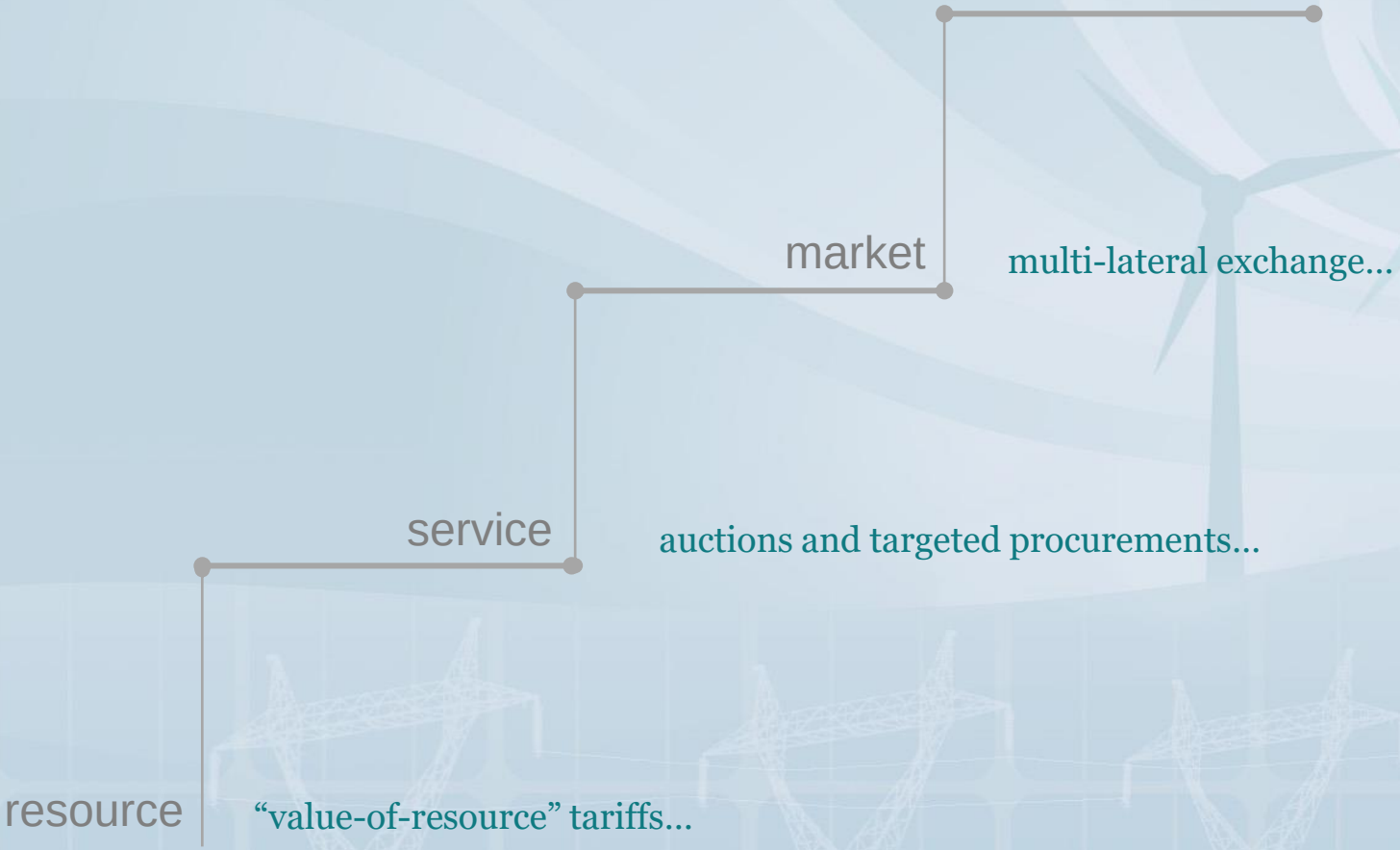
- *A DEFINITION OF RESOURCE?*

  "Simply put, the term 'resource' has traditionally referred to a resource for electricity generation…. When compared with the traditional, central-generation 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



Market Structure Framework



NARUC Manual on DER Rate Design

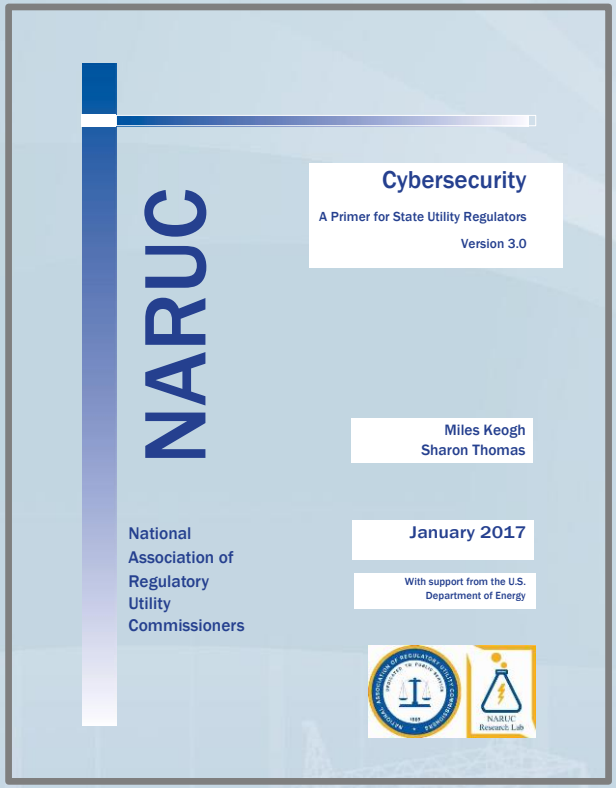
PUF Jan 2017: http://e9radar.link/narucmanual

- *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

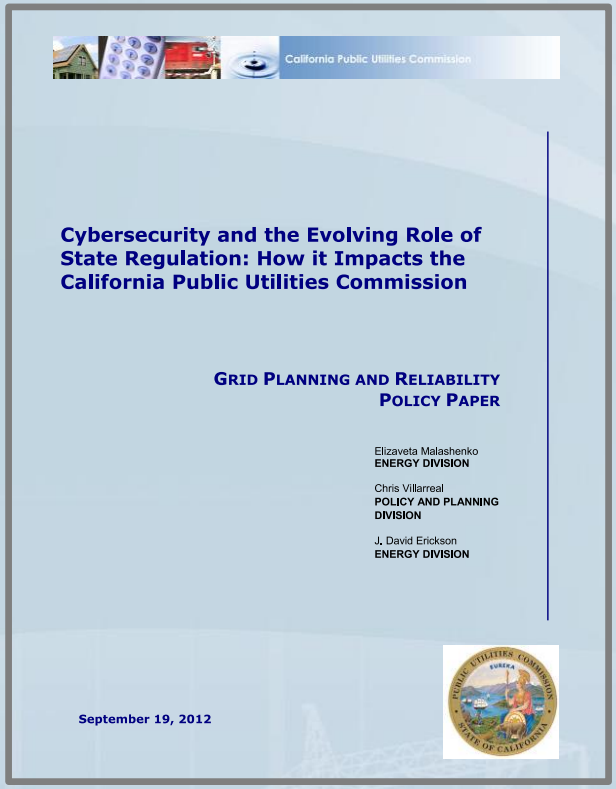


- JANUARY 2017
  Primer for State Regulators

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

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

California PUC



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

- SEPTEMBER 2011
  Cybersecurity & the Evolving Role of State Regulation

  - Recommended Staff Cybersecurity Group

E9 Insight & EnergySec: Regulatory Review

E9 INSIGHT
Research Brief
Public Utility Commissions & Cybersecurity

MARCH 2018

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 American 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 today[1].

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.

[1] Testimony of Ernie Hayden, Managing Principal, Energy Security, Verizon Energy & Utility Practice, in: http://www.cpuc.ca.gov/uploadedFiles/CPUC_Public_Website/Content/About_Us/Organization/Divisions/Policy_and_Planning/TheEvolvingRoleofStateRegulationinCybersecurity9252012FINAL.pdf

Research Brief: *Public Utility Commissions & Cybersecurity* - 1

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

- MARCH 2018
  Review of state commission activity related to cyber security

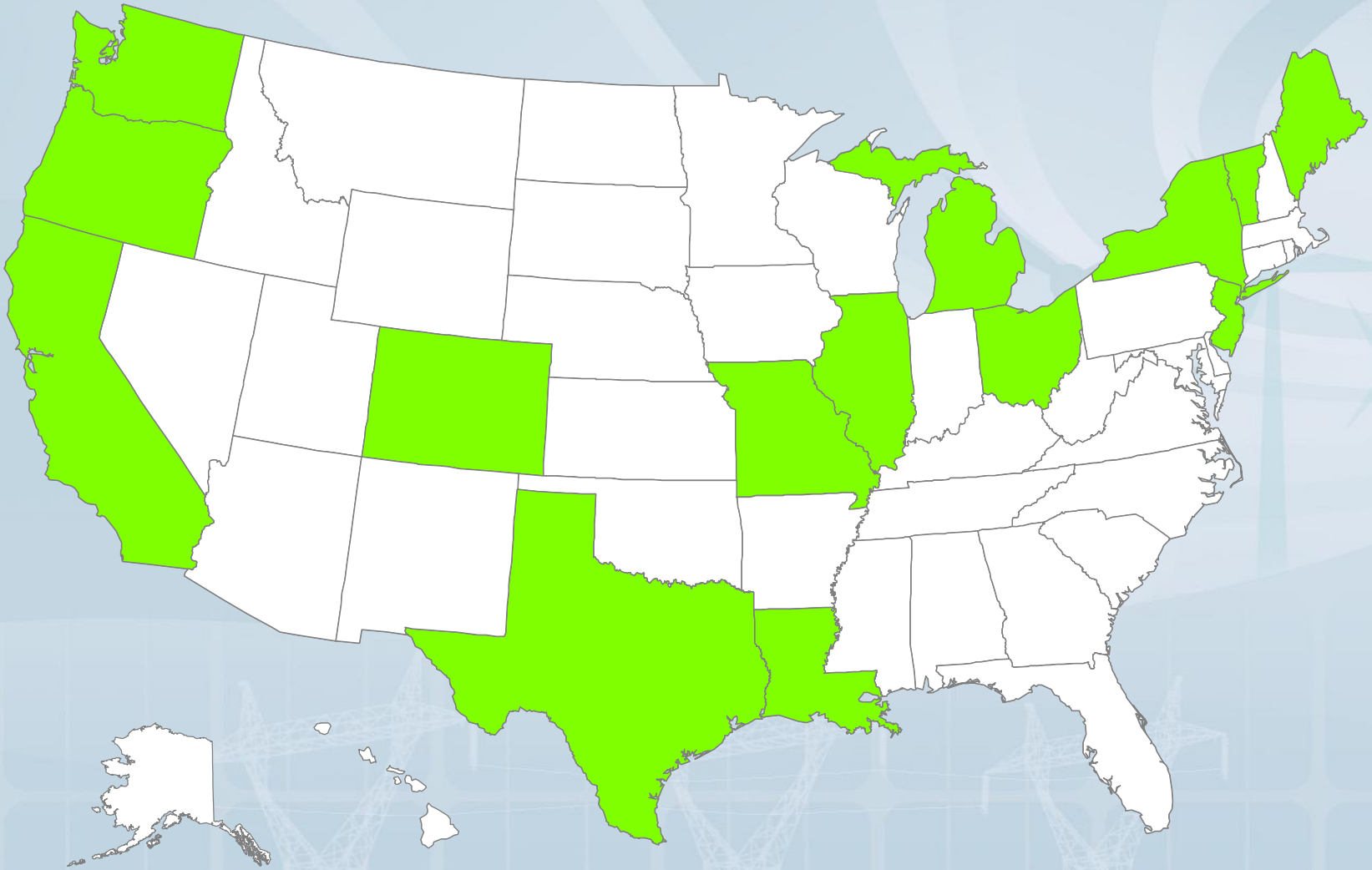
- Developed in collaboration with EnergySec
- Identified notable activity across 50 states
- Organized by proceeding or initiative type
- Outlook for future activity

PUC Activities

In general, commission activities organized by:

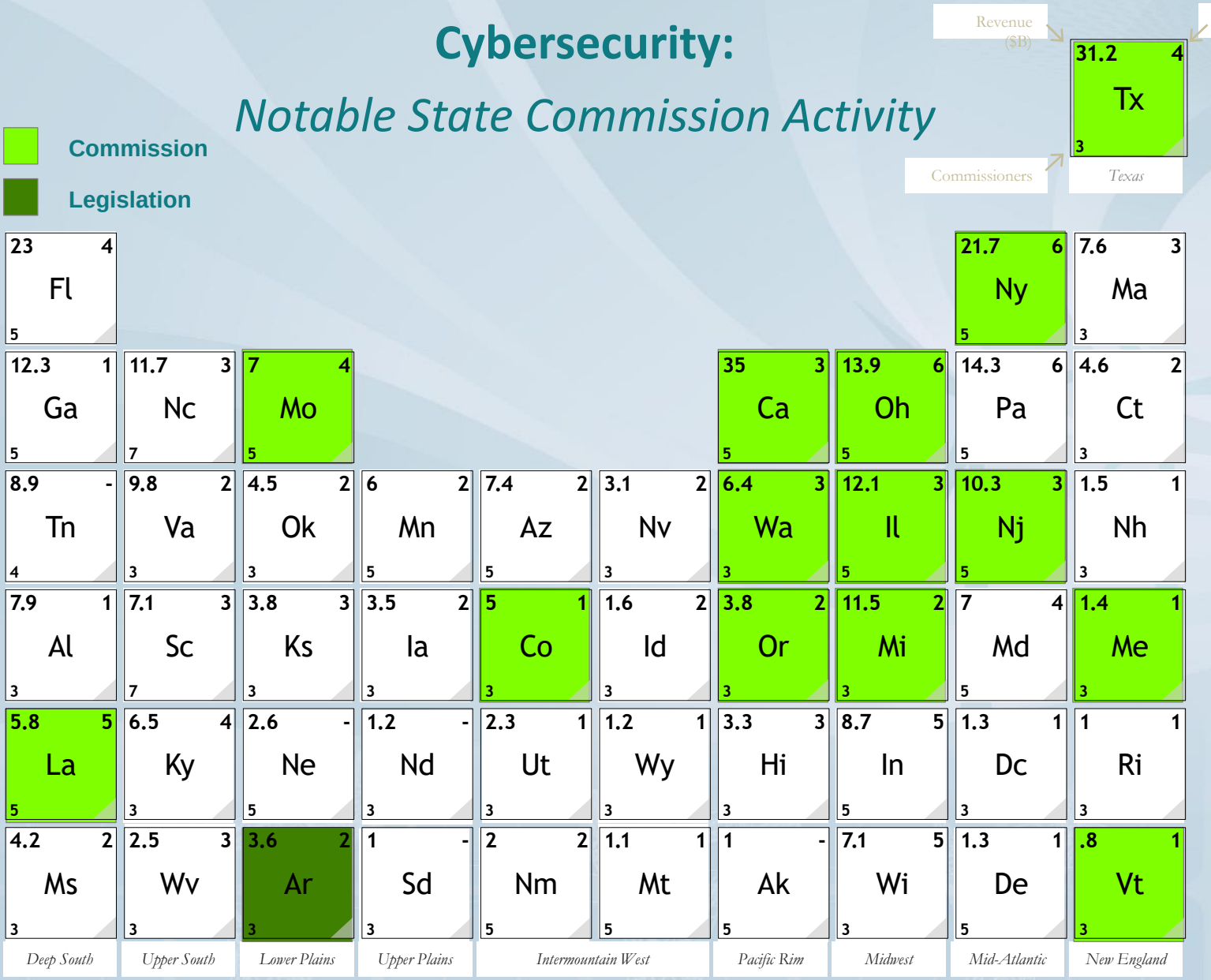
- Cyber-specific proceedings
- Cyber within broad scope (e.g., ‘grid modernization’)
- Resiliency & emergency preparedness
- Data privacy & consumer access
- Legislative action

Cybersecurity: *Notable State Commission Activity*



Cybersecurity:

Notable State Commission Activity



Notable: *Louisiana*

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

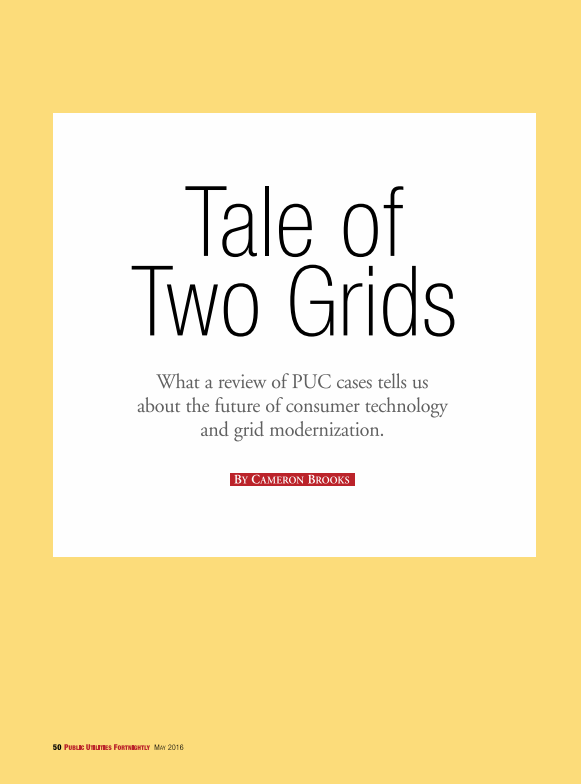
Moving Forward?

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

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

State activity likely will aligned with policy "orientation"

The Best of Grids; The Worst of Grids…



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

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

1. Markets with new entrants
2. Expanded monopoly offerings

Thank you

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Critical Infrastructure Committee

NARUC Summer Policy Summit