

Overview Of Distributed Resources, Standards and Trends that have Implications on Testing

ComRent®

Global Leader in Load Bank Rentals and Service

Agenda

- Introduction
- Background
- Standards, Applications and Interoperability
- Energy Storage
- Load Testing Project Examples



ComRent Solutions

Solutions from ComRent

MARKET	SOLUTIONS
UTILITY - Wind Farms	Commissioning Tests, Reactive Power Correction, Low Voltage Ride Through
UTILITY - Substations	Partial Load Commissioning Tests, Station Battery Testing, Interconnection Test
UTILITY – Generating Station Black Out (SBO), Emergency Diesel Generator (EDG)	Commissioning Tests, Maintenance Tests, Reactive Load Test
Data Centers	Commissioning Generators, UPS, Power Distribution, HVAC, CRAC, Hot Aisle/Cold Aisle Server Loads

Solutions from ComRent (Continued)

MARKET	SOLUTIONS
Generator/Switchgear Maintenance	Commissioning Tests, Sequence of Operation Tests, Emission Test, Type Testing (UL2200, UL1741)
Temporary Power Commissioning	Interconnection Tests for Mobile Generators, Site Services
Maritime	Emergency Generator Commissioning, Emergency Systems Sequence Test
Power Quality Monitoring	Integrated Power Quality Testing and Analysis

Interconnection and Interoperability Standards

Distributed Energy Resources Interconnection

Distributed Energy Technologies



Fuel Cell



PV



Microturbine



Wind



Energy Storage



PHEV;
V2G



Generator

Interconnection Technologies



Inverter



Switchgear,
Relays, &
Controls

Functions

- Power Conversion
- Power Conditioning
- Power Quality
- Protection
- DER and Load Control
- Ancillary Services
- Communications
- Metering

Electric Power Systems



Utility System



Microgrids

Loads

Local Load Simulators



IEEE SCC21 1547 Series of Interconnection Standards

IEEE Std 1547TM (2003) Standard for Interconnecting Distributed Resources with Electric Power Systems

P1547a Amendment 1

IEEE Std 1547.4TM (2011)
Guide for Design, Operation, and Integration of Distributed Resource Island Systems with Electric Power Systems

**Guide
For
Interconnection
System Certification**

IEEE Std 1547.1TM (2005)
Standard for Conformance Test Procedures for Equipment Interconnecting Distributed Resources with Electric Power Systems

P1547.8 Draft Recommended Practice for Establishing Methods and Procedures that Provide Supplemental Support for Implementation Strategies for Expanded Use of IEEE Standard 1547

P1547.7 Draft Guide to Conducting Distribution Impact Studies for Distributed Resource Interconnection

IEEE Std 1547.6TM (2011)
Recommended Practice for Interconnecting Distributed Resources with Electric Power Systems Distribution Secondary Networks

IEEE Std 1547.3TM (2007)
Guide for Monitoring, Information Exchange and Control of DR Interconnected with EPS

IEEE Std 1547.2TM (2009) Application Guide for IEEE 1547 Standard for Interconnecting Distributed Resources with Electric Power Systems

Changes in Standards

Distributed Energy Resource Interconnection

Standards

- IEEE 1547-2003 Standard for Interconnecting Distributed Resources to the EPS
 - IEEE1547-2003 Restricts Voltage, Frequency Regulation or Power Factor Correction at the PCC
 - Amendment approved in August, 2013
 - Wording added to allow **Voltage, Frequency Regulation (by injecting reactive Power) and Power Factor Correction** in collaboration with EPS operator.
 - **IEEE 1547 full revision project planned start April 2013**

Key:

- Current Situation
- Probable 2014 Activity

Changes in Standards

Distributed Energy Resource Interconnection

Standards

- IEEE 1547.1 (Test Procedures) Amendment Working Group initiated
 - Today, IEEE1547-2005 provides test criteria for interconnection
 - **1547.1 Amendment Working Group Scheduled**
 - Initial meeting December 5, 2013
 - Likely to include testing for:
 - **Voltage and Frequency Ride Through Capability**
 - Voltage Regulation
 - Additional voltage and frequency trip limits and times

Key:

- **Current Situation**
- **Probable 2014 Activity**

Changes in Standards

Special Standards

➤ Special Cases

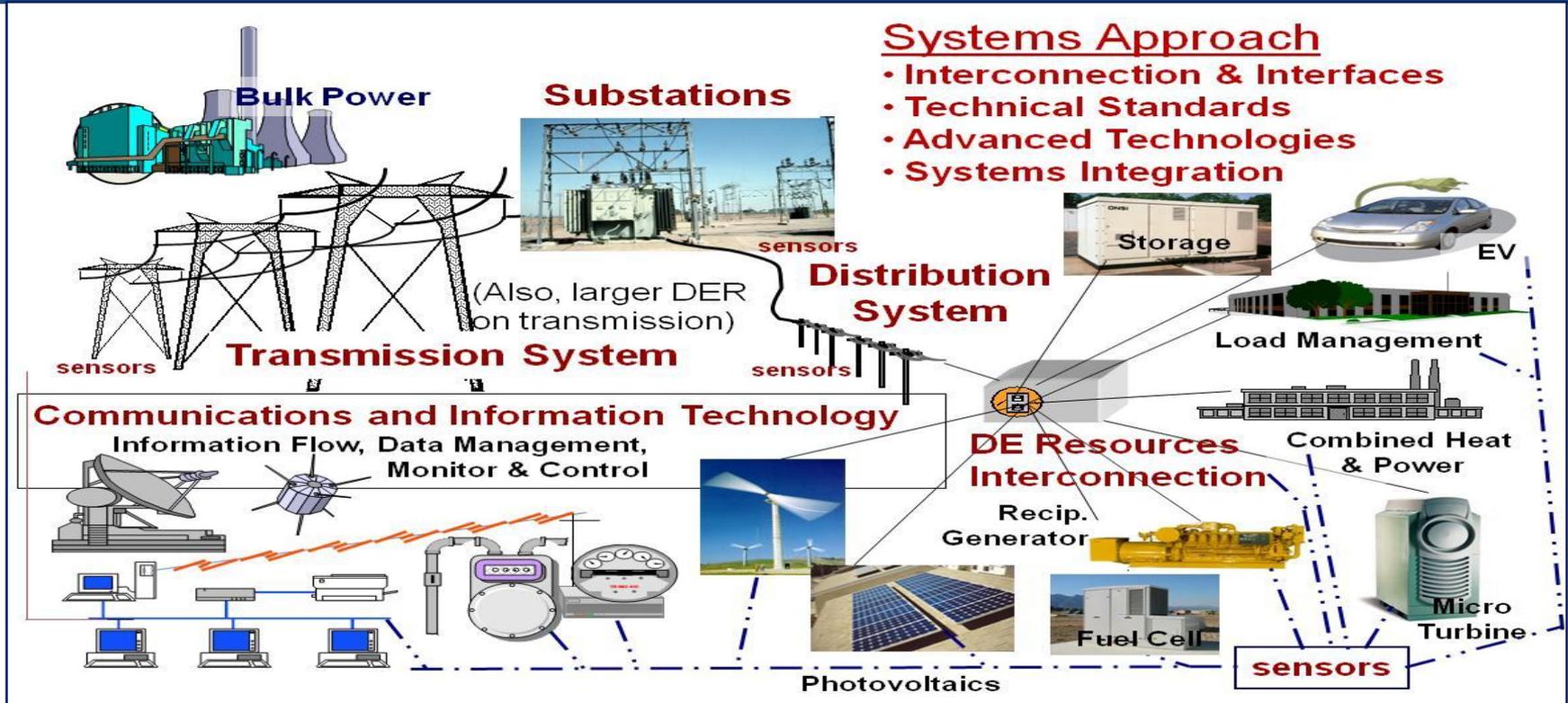
- UL Standards Technical Panel 1741 (Inverters and Converters)
 - Type Testing Standard for Inverters and Converters
 - Revision due in 2013
 - Adding **Special Purpose Utility Inverter** class
 - Evaluating CEC *“Smart Inverter Working Group Recommendations”*
- UL Standards Technical Panel - UL 6171 – Standard for Wind Turbine Converters and Interconnection Systems Equipment
 - No standards exist today in NA
 - Last Ballot Draft was Rejected by STP - Clarity on interconnection and field load testing requirements.
 - Meeting held February 19-20

Key:

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Smart Grid Concepts: Interconnection (1547) & Interoperability (2030)

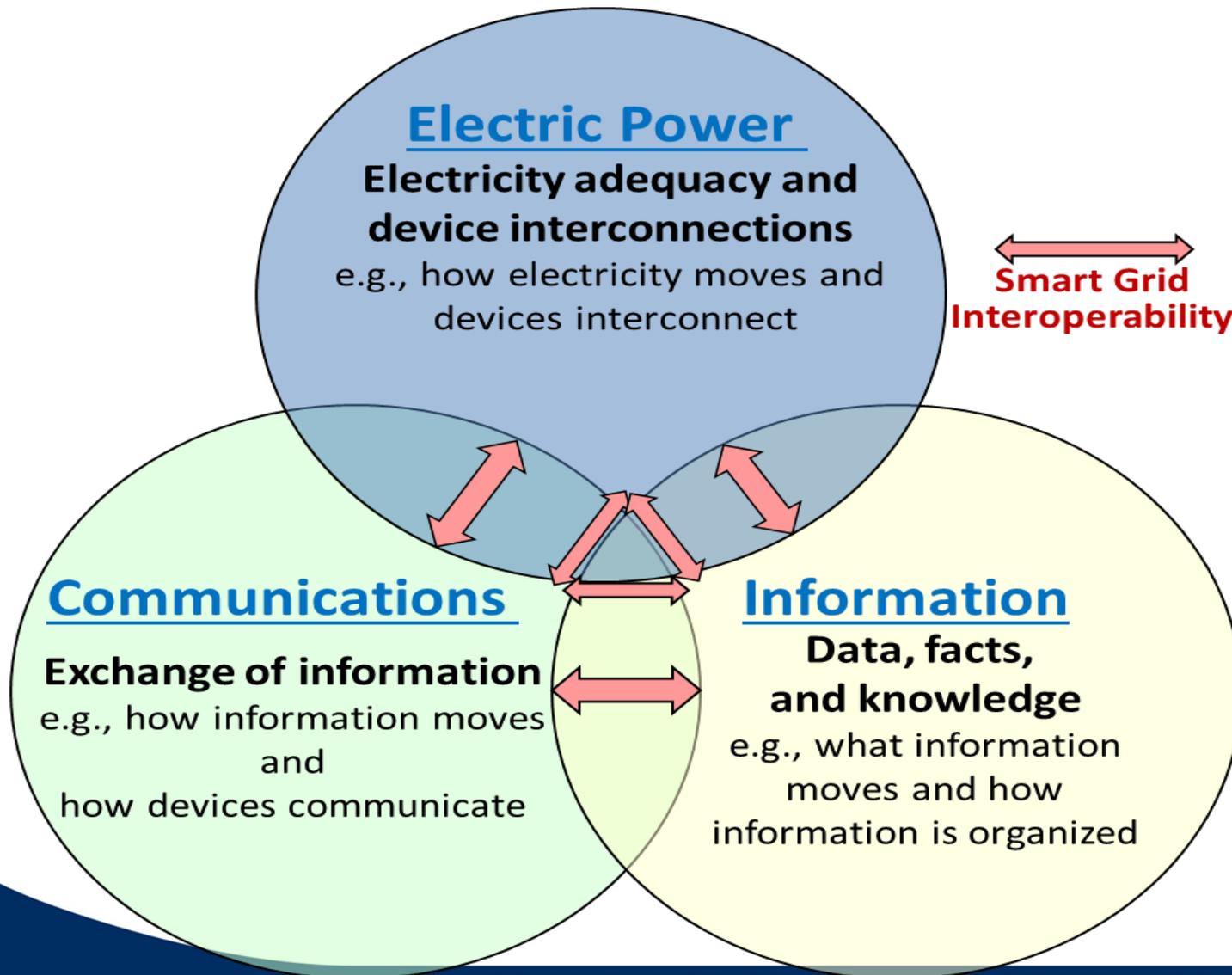
→ System of Systems Approach ←



Smart Grid: the integration of power, communications, & information technologies for an improved electric power infrastructure serving loads while providing for an ongoing evolution of end-use applications (Std 2030)

Interoperability: the capability of two or more networks, systems, devices, applications, or components to externally exchange and readily use information securely and effectively. (Std 2030)

Smart Grid Interoperability: the Integration of Power, Communications and Information Technologies



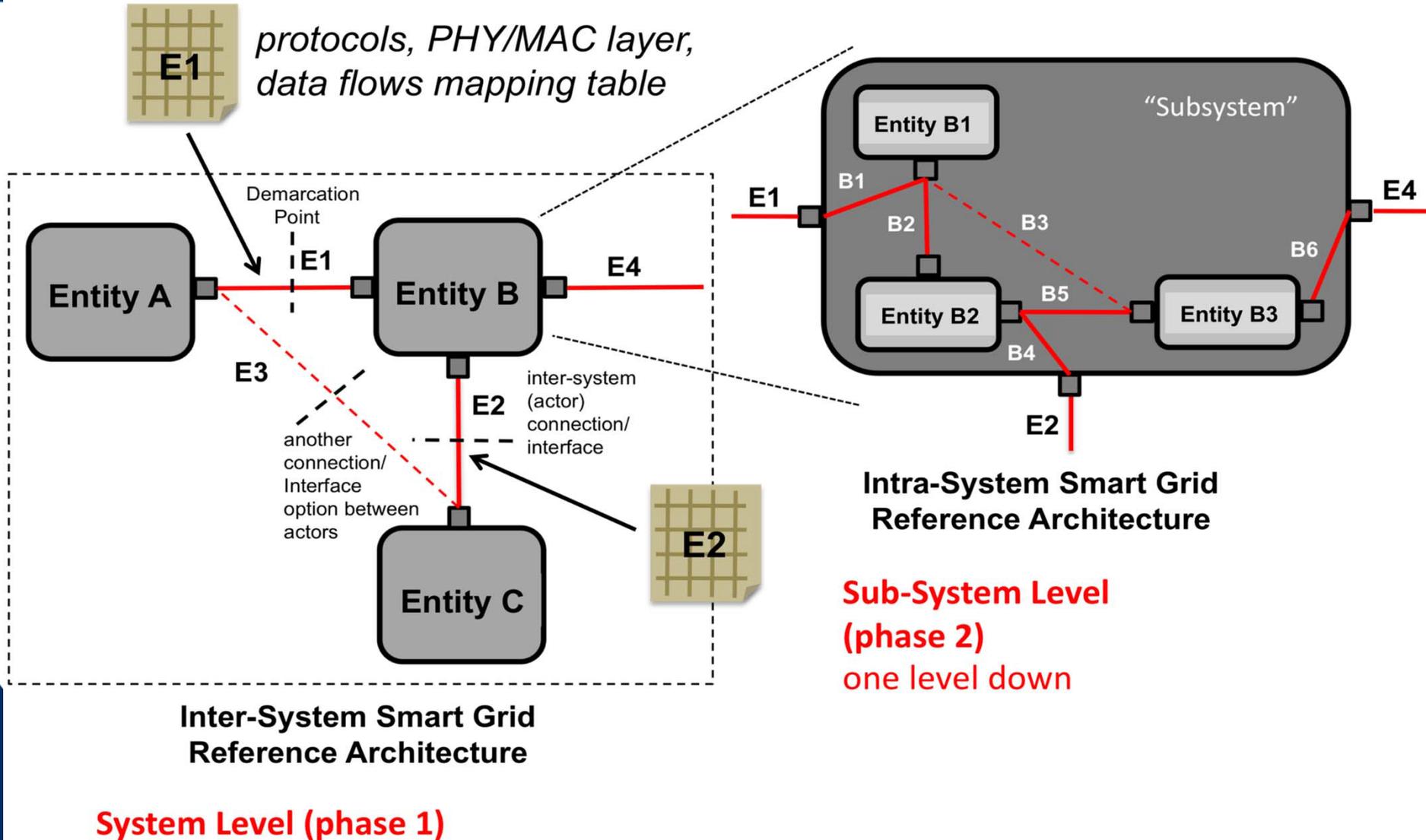
IEEE 2030 Spans Three Distinct Perspectives

- Designed for and developed by Three IEEE Societies:
 - **Power & Energy**
 - Defines the numerous data flows necessary for reliable, secure, bi-directional flow of power and energy throughout the entire electric power system
 - **Communications**
 - Identifies the communications infrastructure necessary for smart grid, from high-speed synchrophaser data to in-premise meter and customer notification systems
 - **Information Technology (IT)**
 - Defines the system-to-system communications requirements and data flow to leverage individual systems into a system of systems

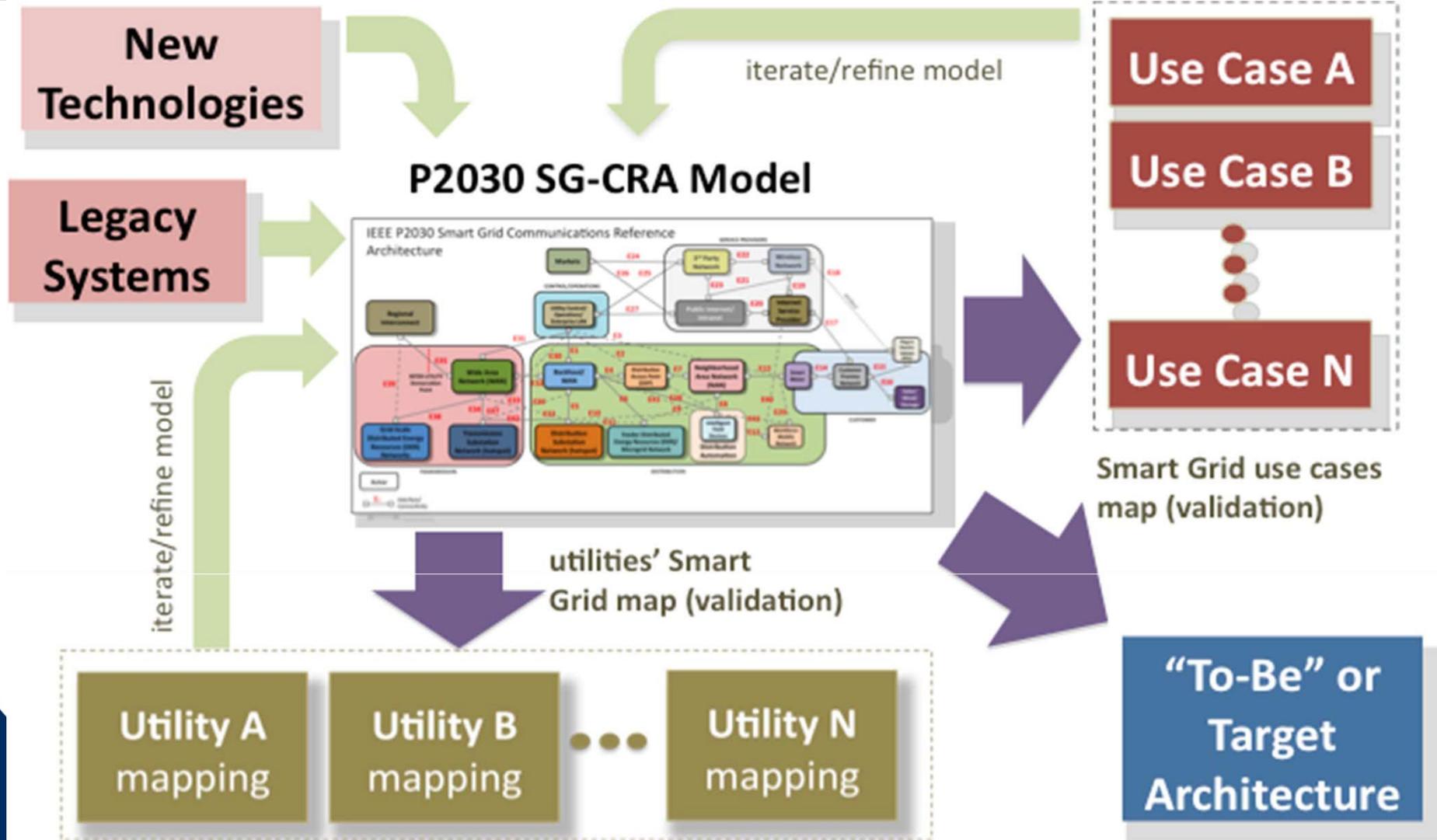
IEEE Std 2030 Smart Grid Interoperability

- Provides a knowledge base addressing terminology, characteristics, and smart grid functional performance.
- Establishes the 2030 SGIRM (Smart Grid interoperability reference model)
 - SGIRM defines three integrated architectural perspectives: power systems, communications technology, and information technology.
- SGIRM emphasis is on: functional interfaces, logical connections and data flows.
- Establishes design tables and classification of data flow characteristics, templates for establishing power perspective needs and for identifying and integrating information/communication technology protocols, standards, etc. (... reliability/security/cyber, quality of service, connection medium).

Two-Levels SG System Architecture



SG Reference Model Development Methodology

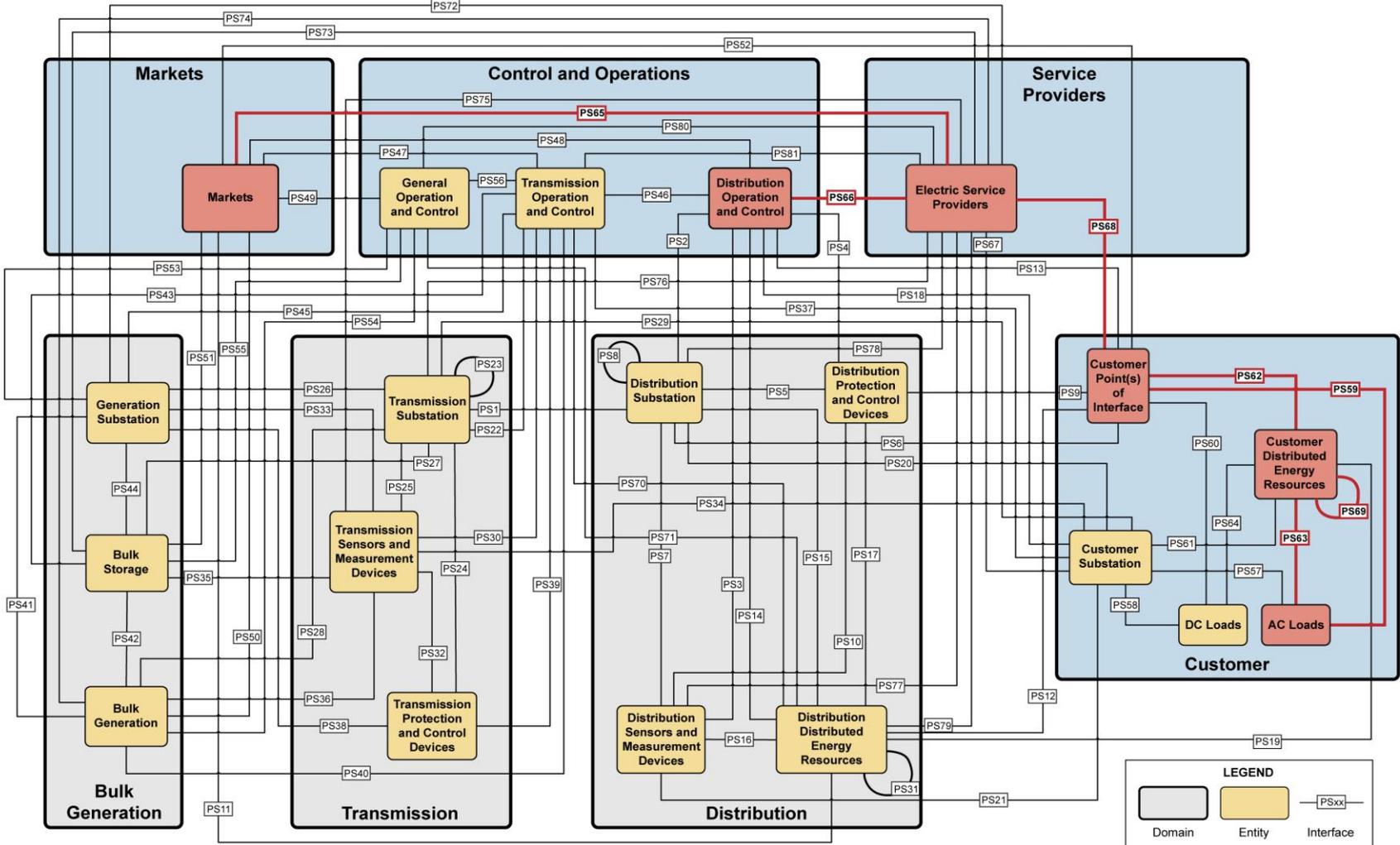


IEEE 2030 Series Smart Grid Projects

- IEEE 2030 Series – Smart Grid Interoperability
 - **IEEE 2030™ Guide for Smart Grid Interoperability**
 - **IEEE P2030.1™ Guide for Electric-Sourced Transportation Infrastructure**
 - **IEEE P2030.2™ Guide for Energy Storage Systems Integrated with the Electric Power Infrastructure**
 - **IEEE P2030.3™ Standard for Test Procedures for Electric Energy Storage Equipment and Systems**
 - IEEE P2030.4™ Guide for Control and Automation Installations Applied to the Electric Power Infrastructure
 - IEEE2030.100™ Recommended Practice for Implementing an IEC 61850 Based Substation Communications, Protection, Monitoring and Control System
 - IEEE P2030.5™ Standard for Smart Energy Profile 2.0 Application Protocol
 - IEEE P2030.101™ Guide for Designing a Time Synchronization System
 - IEEE P2030.102.1™ Standard for Interoperability of Internet Protocol Security (IPsec) Utilized within Utility Control Systems

IEEE 2030: 1st/Only Consensus, SG System Architecture Standard

Simplified Example - Power System Perspective: Service Provider controls Customer DG, Community Energy Storage & Controllable ac Loads (protection, reliability, security, testing, etc. aspects not highlighted)



IEEE Std 2030 Power System Integrated Architectural Perspective (PS-IAP)

Changes in Standards

Smart Grid Interoperability of DR with EPS

Smart Grid Interoperability

- IEEE P2030.2 - Guide for Interoperability of Energy Storage Systems
 - First standard using the IEEE 2030 Smart Grid Interoperability model.
 - Targeting ballot by end of 2013.
 - **Ballot approval in early 2014**
 - Includes recommended **commissioning and testing practices.**

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Changes in Standards

Smart Grid Interoperability of DR with EPS

Smart Grid Interoperability

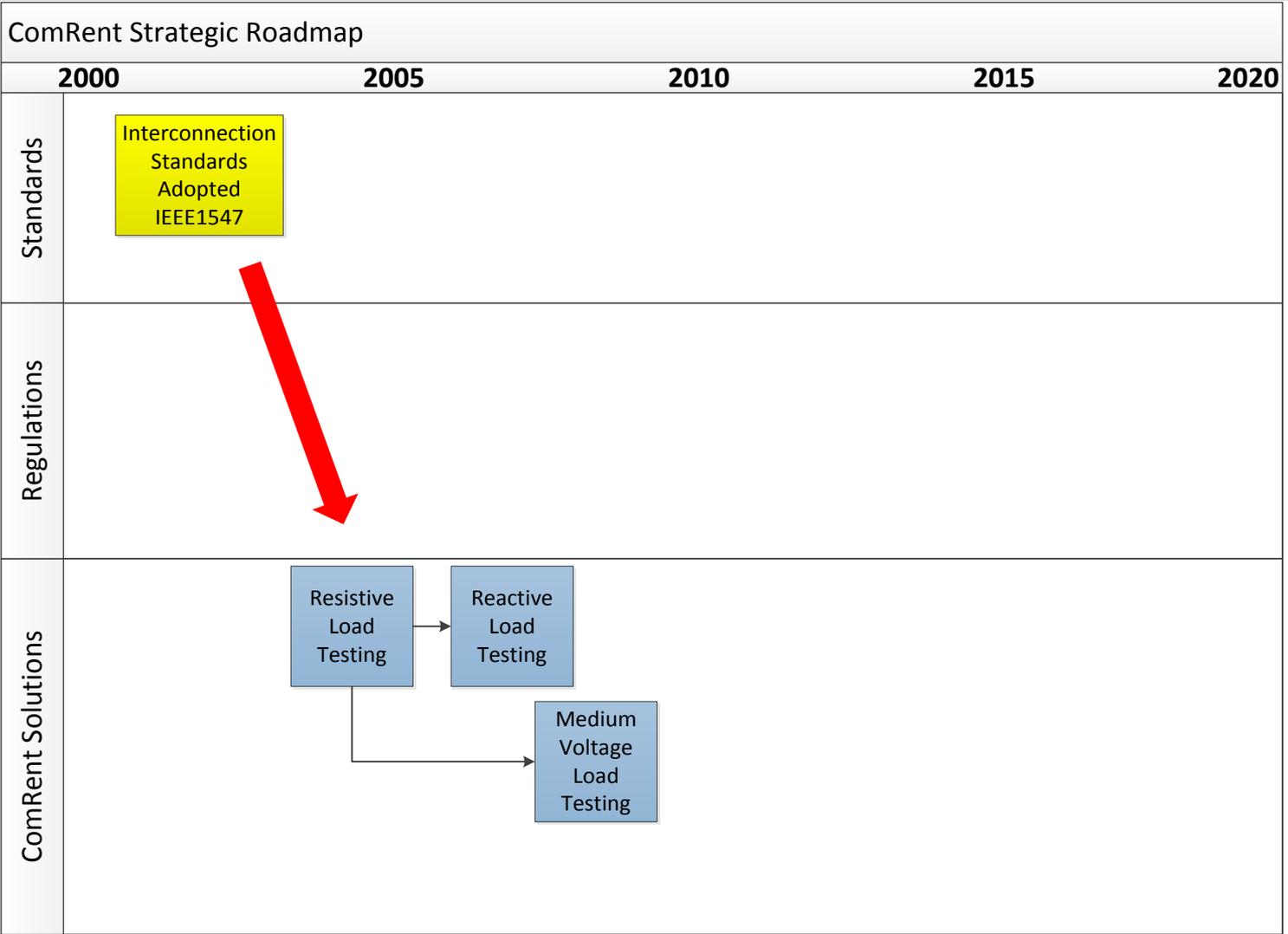
- IEEE P2030.3 - IEEE P2030.2™ Guide for Energy Storage Systems Integrated with the Electric Power Infrastructure
 - Standard being developed by National Grid of China
 - Organization similar to EPRI
 - Last Draft review in November 2013 suggested more reference to SGIRM and linkage to IEEE 2010-2011
 - **Ballot approval in early 2014**



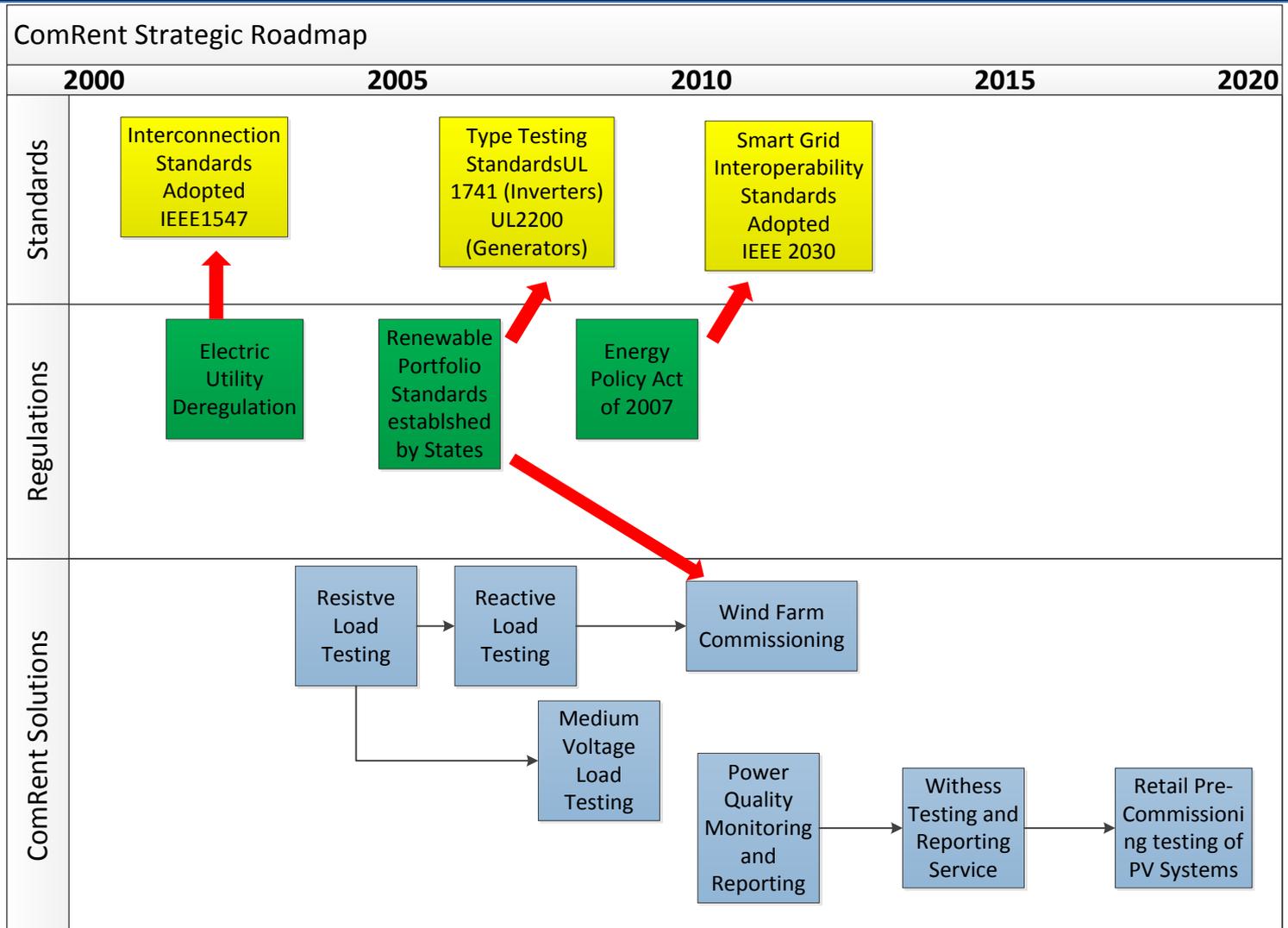
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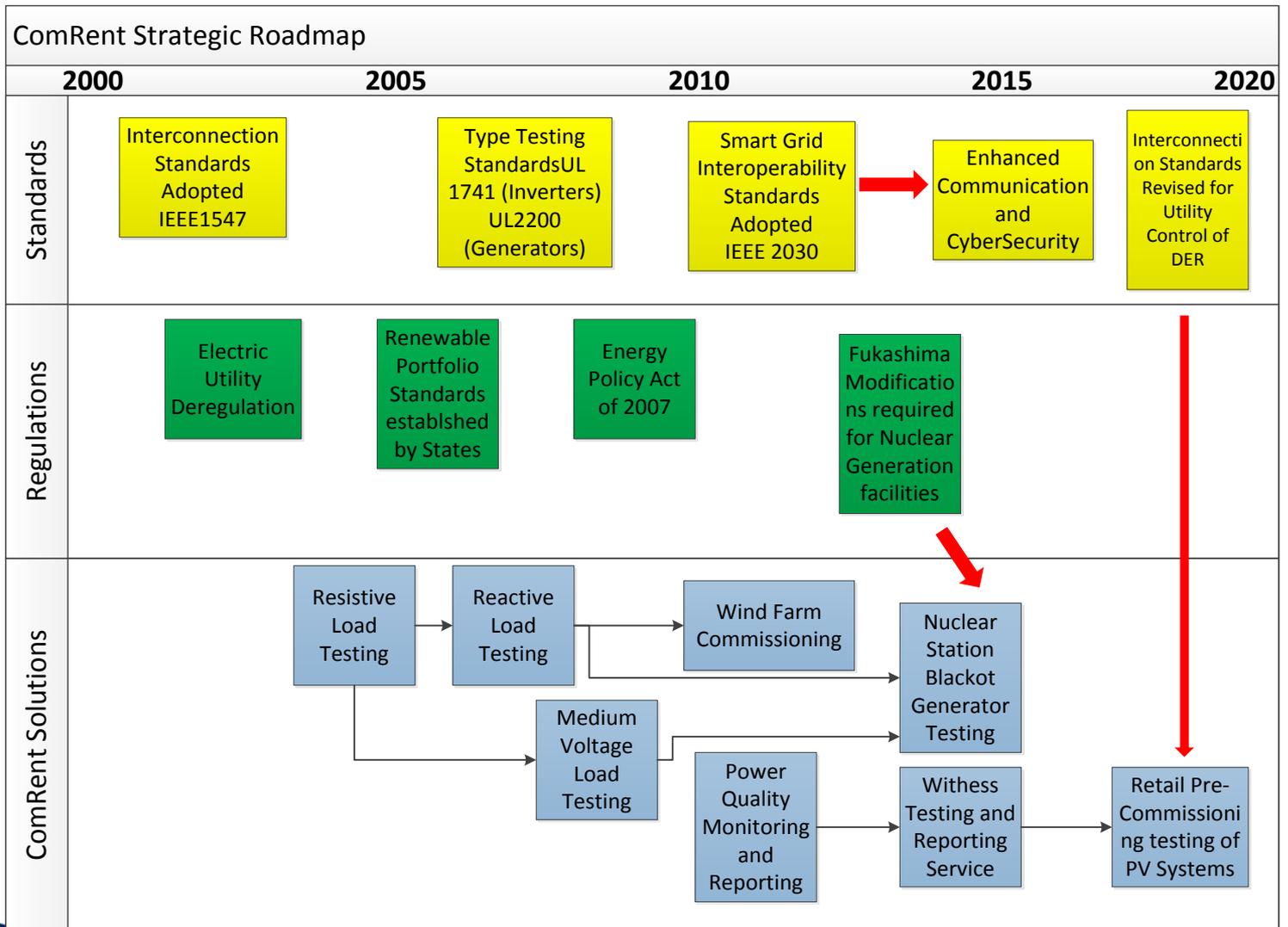
The Testing Landscape is Changing



The Testing Landscape is Changing (Continued)



The Testing Landscape is Changing (Continued)



Summary – Gaps in Testing Capability

- Interconnection
 - Measurement of reactive power
 - Measurement of frequency regulation
- Transmission Interconnection and commissioning
- Substation commissioning
- Harmonics are commonly an issue – should they be in standards for tests?