EPRI | ELECTRIC POWER RESEARCH INSTITUTE

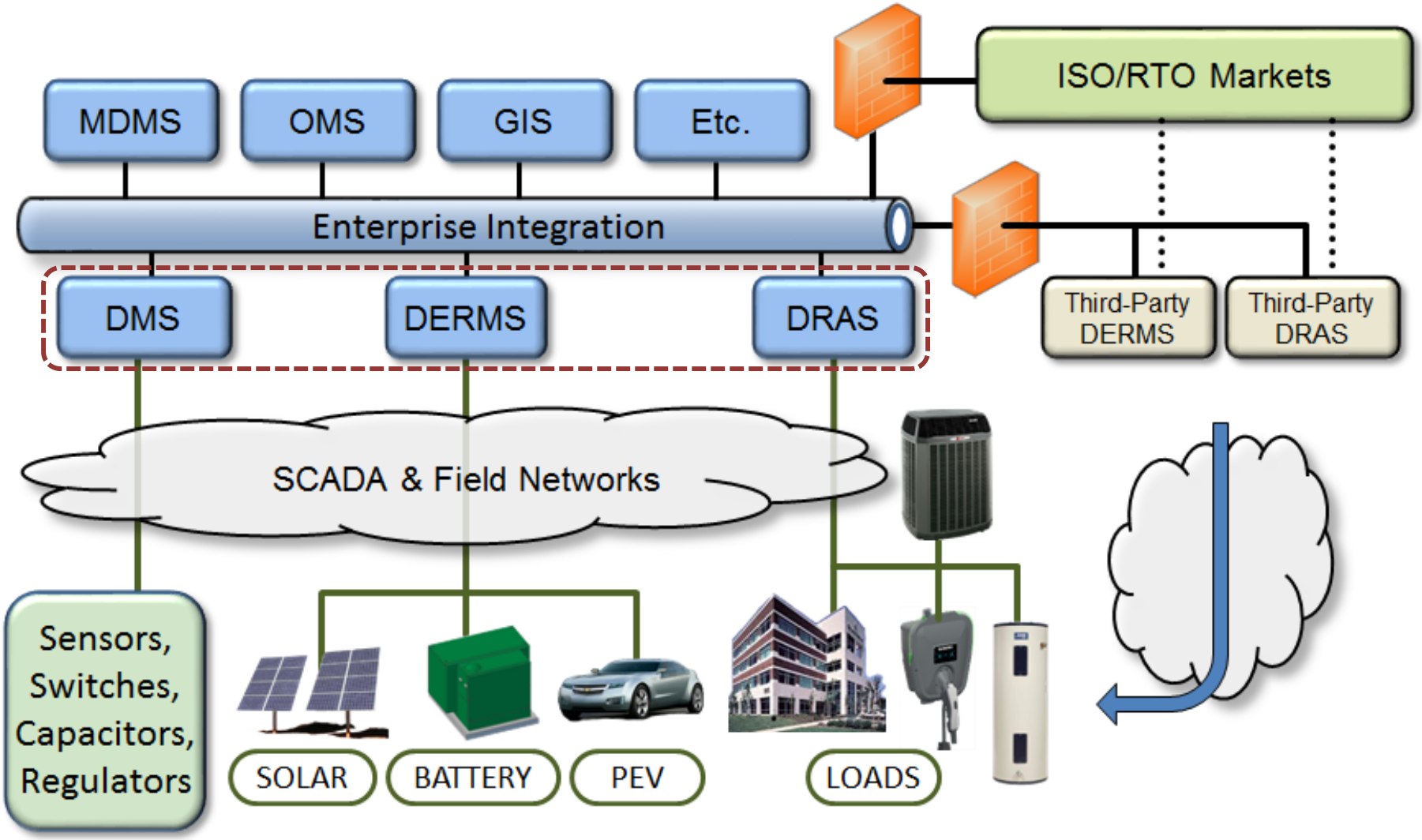
Communication Standards for Demand Response and Distributed Energy Resources

EPRI ICT Staff

EPRI IntelliGrid Smart Grid Information Sharing Webcast

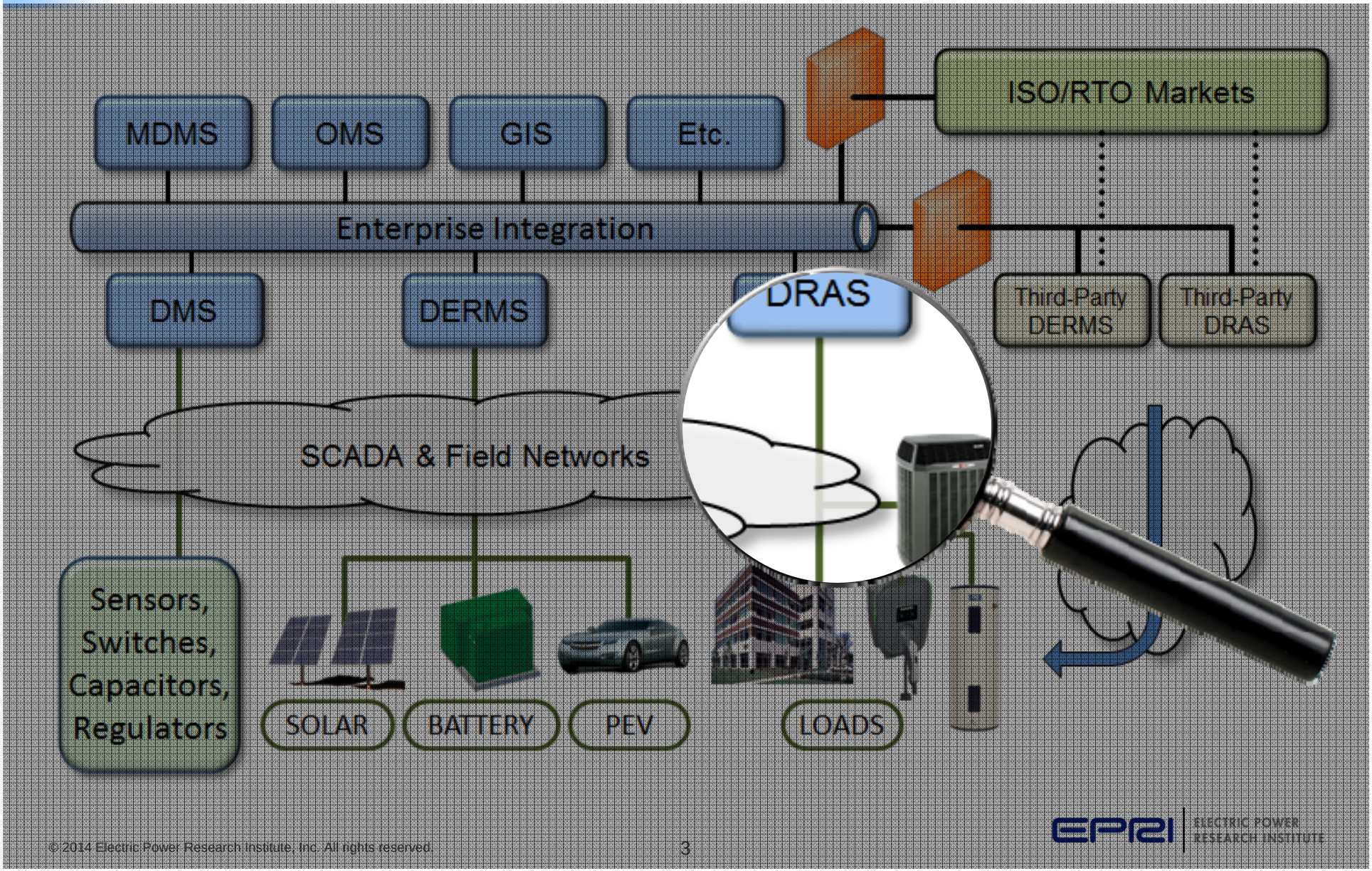
November, 2014

Reference Diagram



EPRI ELECTRIC POWER RESEARCH INSTITUTE

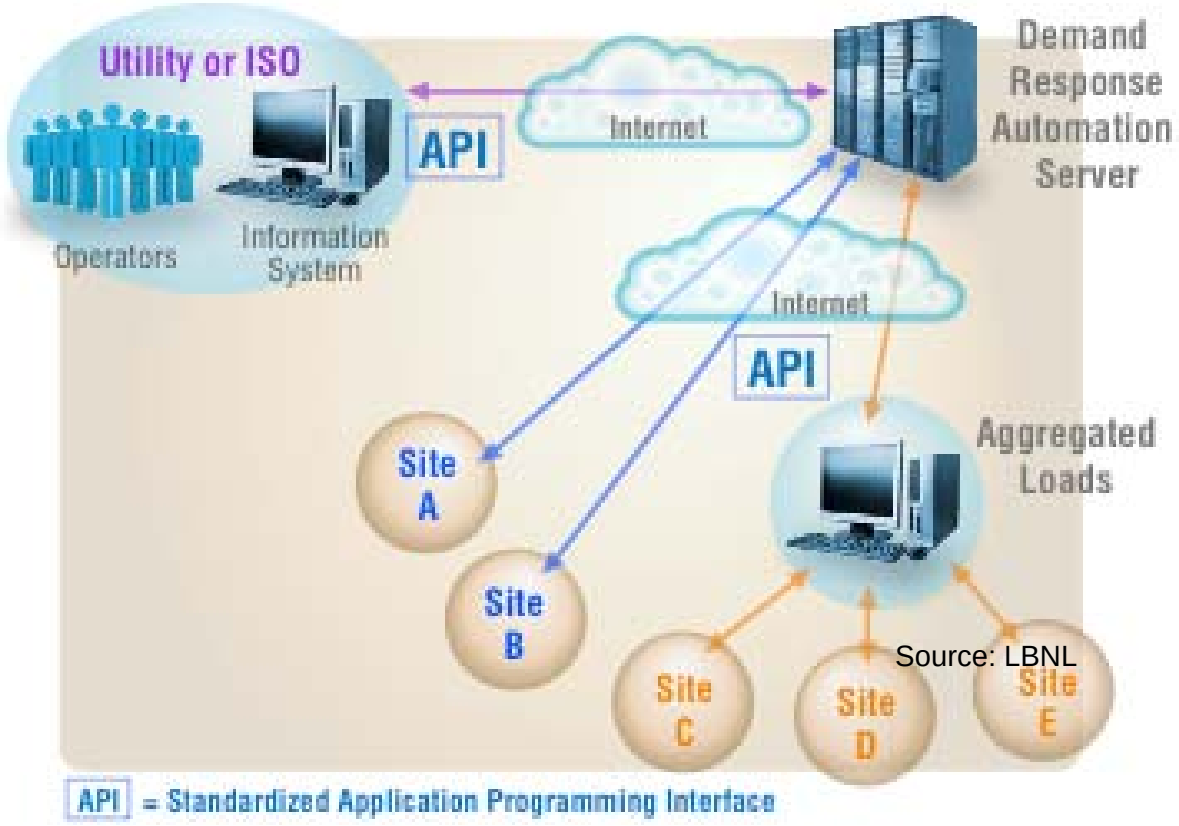
Field Communication for Demand Response



EPRI ELECTRIC POWER RESEARCH INSTITUTE

Applying OpenADR

- Provides non-proprietary, open, standardized DR communications
- Allows electricity providers to communicate DR signals directly to customers
- Uses a common language and existing communications (such as the Internet)



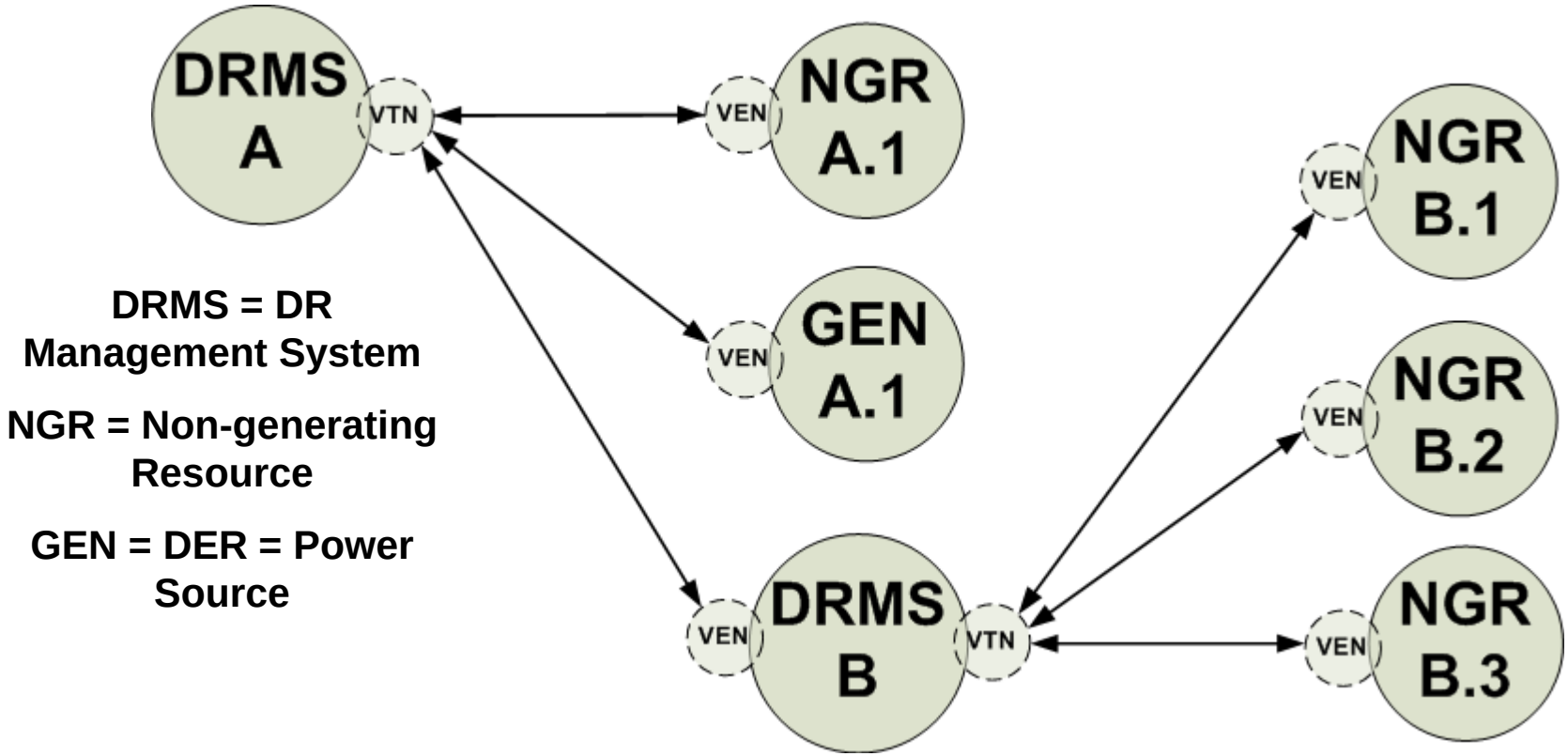
OpenADR Technical Workshop DVD – 6.19.2013. PID 3002001822.

EPRI ELECTRIC POWER RESEARCH INSTITUTE

Interactions Between VTNs and VENs

OpenADR defines the interactions between Virtual End Nodes (VEN) and Virtual Top Nodes (VTN)

NOTE: VEN and VTN refers to the INTERFACE ONLY and not the machine



DRMS = DR Management System

NGR = Non-generating Resource

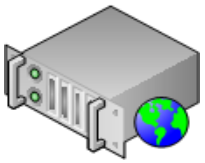
GEN = DER = Power Source

EPRI's OpenADR2.0b Software

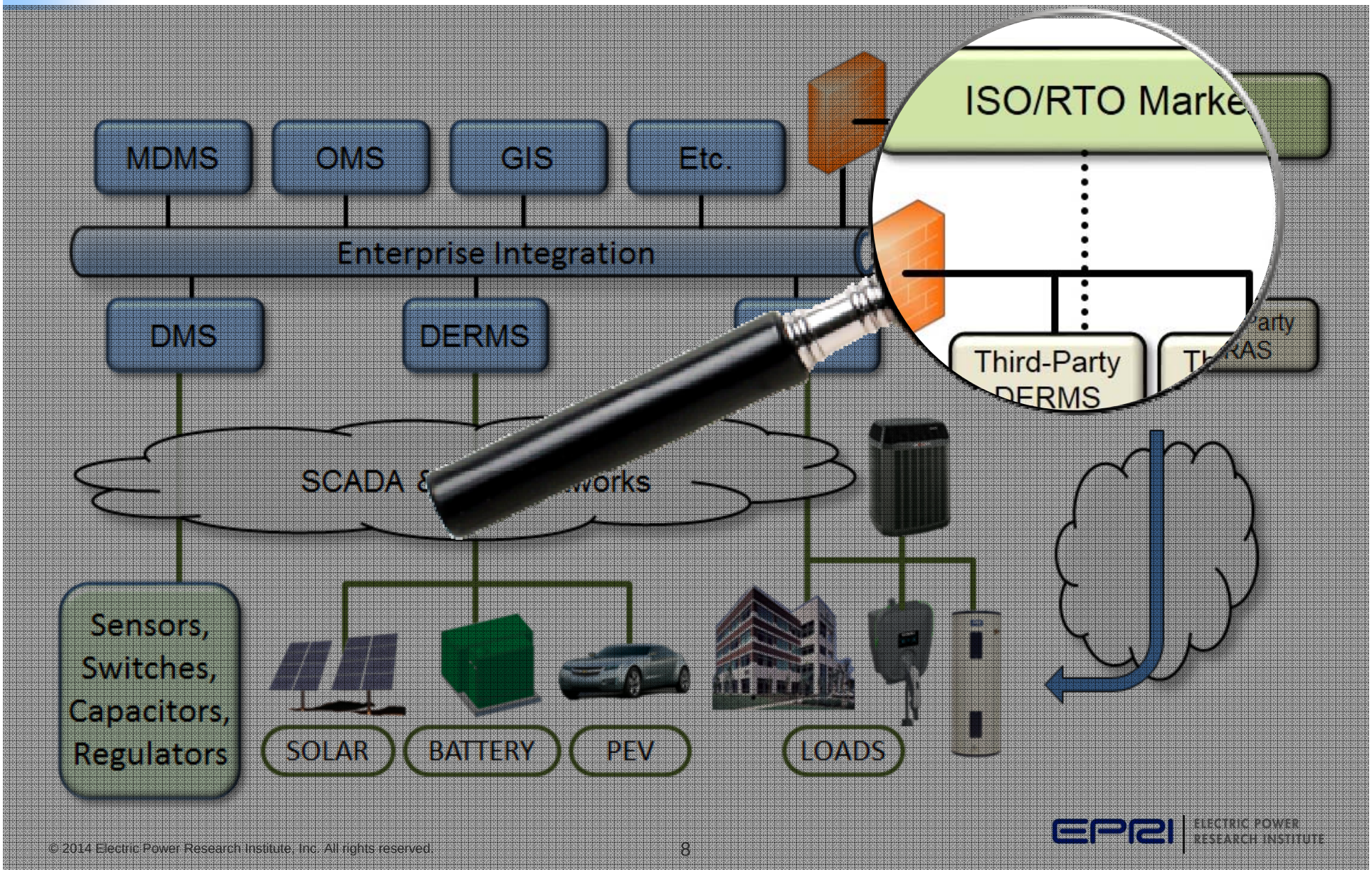
Available on:


- Virtual Top Node (Server)
  - Certified by OpenADR Alliance
  - Available on SourceForge (>890 downloads)
  - EPRI PID 1026755
- Virtual End Node (Standalone Client)
  - Certified by OpenADR Alliance
  - Available on SourceForge (>880 downloads)
  - EPRI PID 1026751
- Virtual End Node C++ Library (Embeddable Client)
  - Undergoing EPRI QC Process
  - Will be available on SourceForge soon

EPRI's OpenADR Open-Source Software

	 VTN	 VEN	 VEN
Role	Virtual Top Node	Virtual End Node	Virtual End Node
Design Use	DRMS	Desktop Client	Embedded Client
License	BSD 3-Clause	BSD 3-Clause	BSD 3-Clause
Profiles	2.0a and 2.0b	2.0b	2.0b
Data Models	Push or Pull (Poll)	Pull (Poll)	Pull (Poll)
Transports	HTTP, XMPP	HTTP	HTTP
Programming Language	JRuby, Java	C#	C++
Tested Operating Systems	Linux, Mac OS X	Windows 7, 8	C++
Available on www.SourceForge.net	Yes	Yes	Coming
	>890 Downloads	>880 Downloads	

Enterprise Integration for Demand Response



EPRI ELECTRIC POWER RESEARCH INSTITUTE

Communication for Demand Response Markets

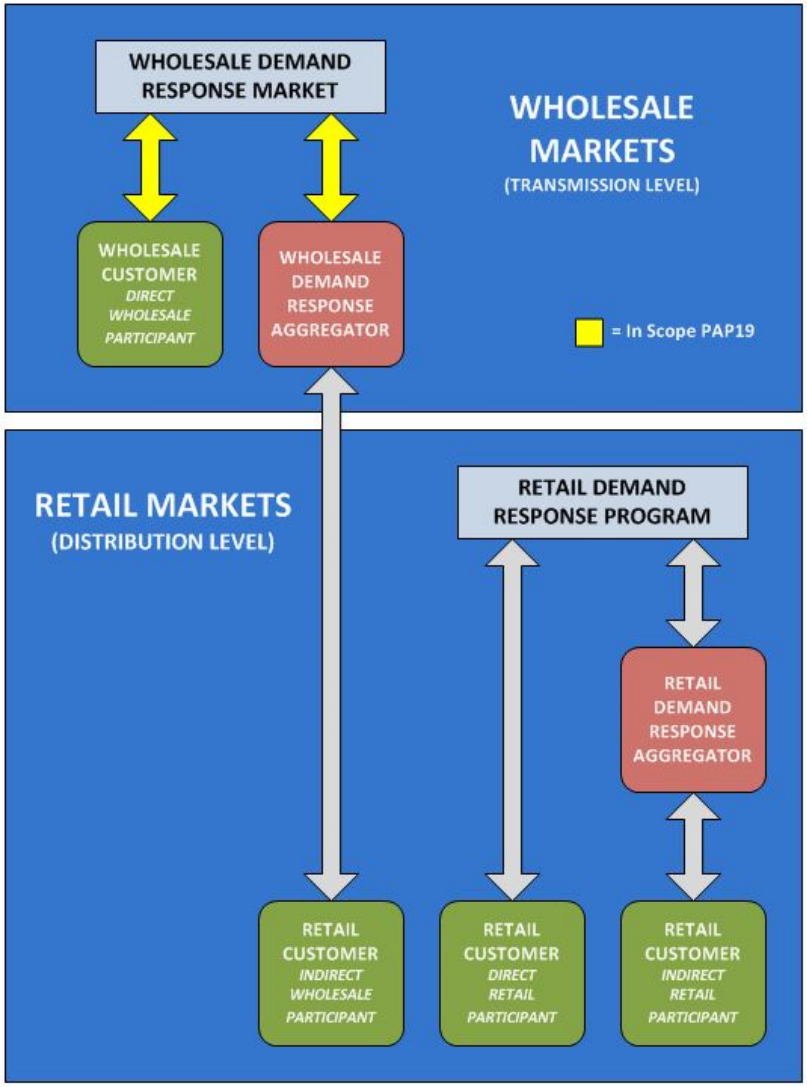
NIST PAP19 Activity

- PAP19 Purpose: An information model for **wholesale** DR communications based on the International Electrotechnical Commission (IEC) Common Information Model (CIM)
  - Which then mapped to other relevant profiles such as OpenADR 2.0b and MultiSpeak

- Principle issues addressed:
  - Standardize interfacing between ISOs/RTOs and wholesale market participants for DR signaling
  - Ensure adequate market coverage for DR
  - Eliminate the need for *de facto* proprietary interfaces

Communication for Demand Response Markets

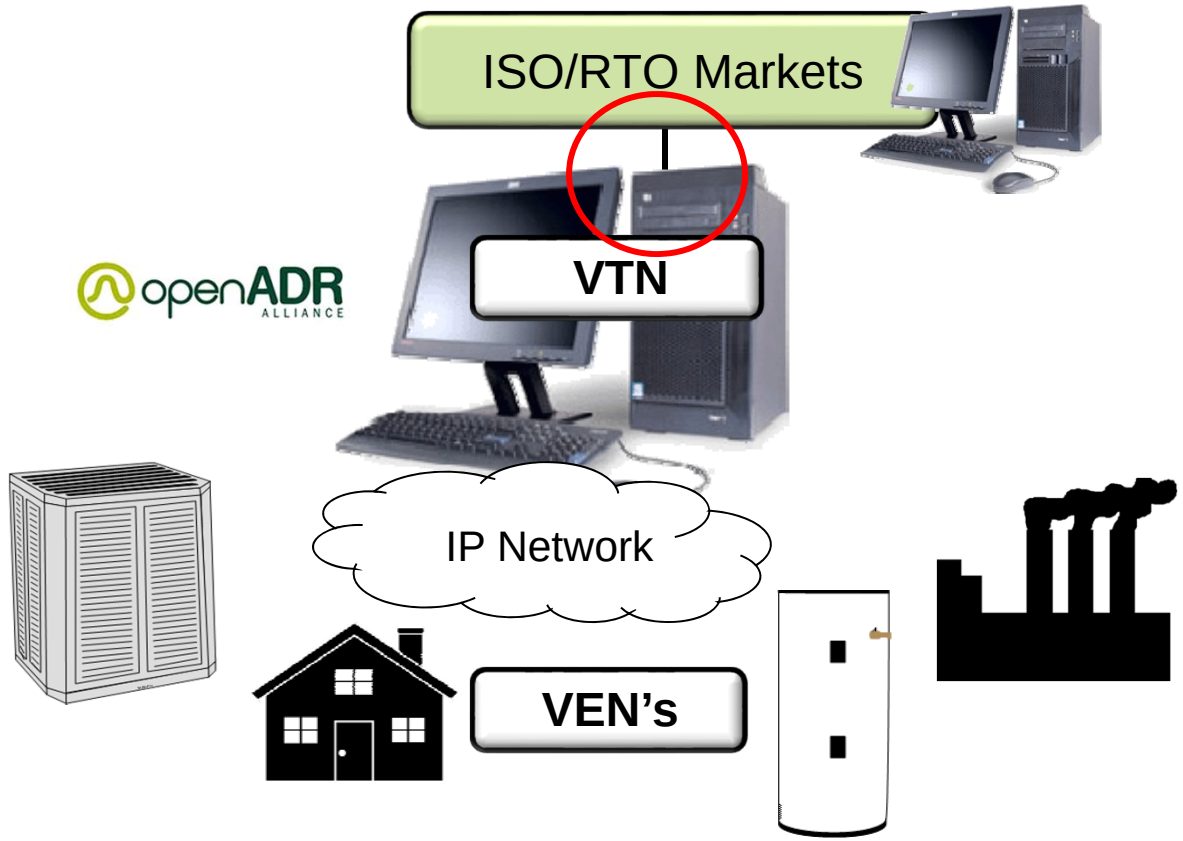
- Completed in September 2012
- A proposed extension to the IEC Common Information Model
- Covers:
  - DR Deployment (and response)
  - DR Meter Data
  - DR Resource Enrollment
  - DR Resource Market Qualification
  - DR Resource Performance
  - DR Schedule Bid
  - DR Schedule Award
- TC57 WG16 is working on this for CIM



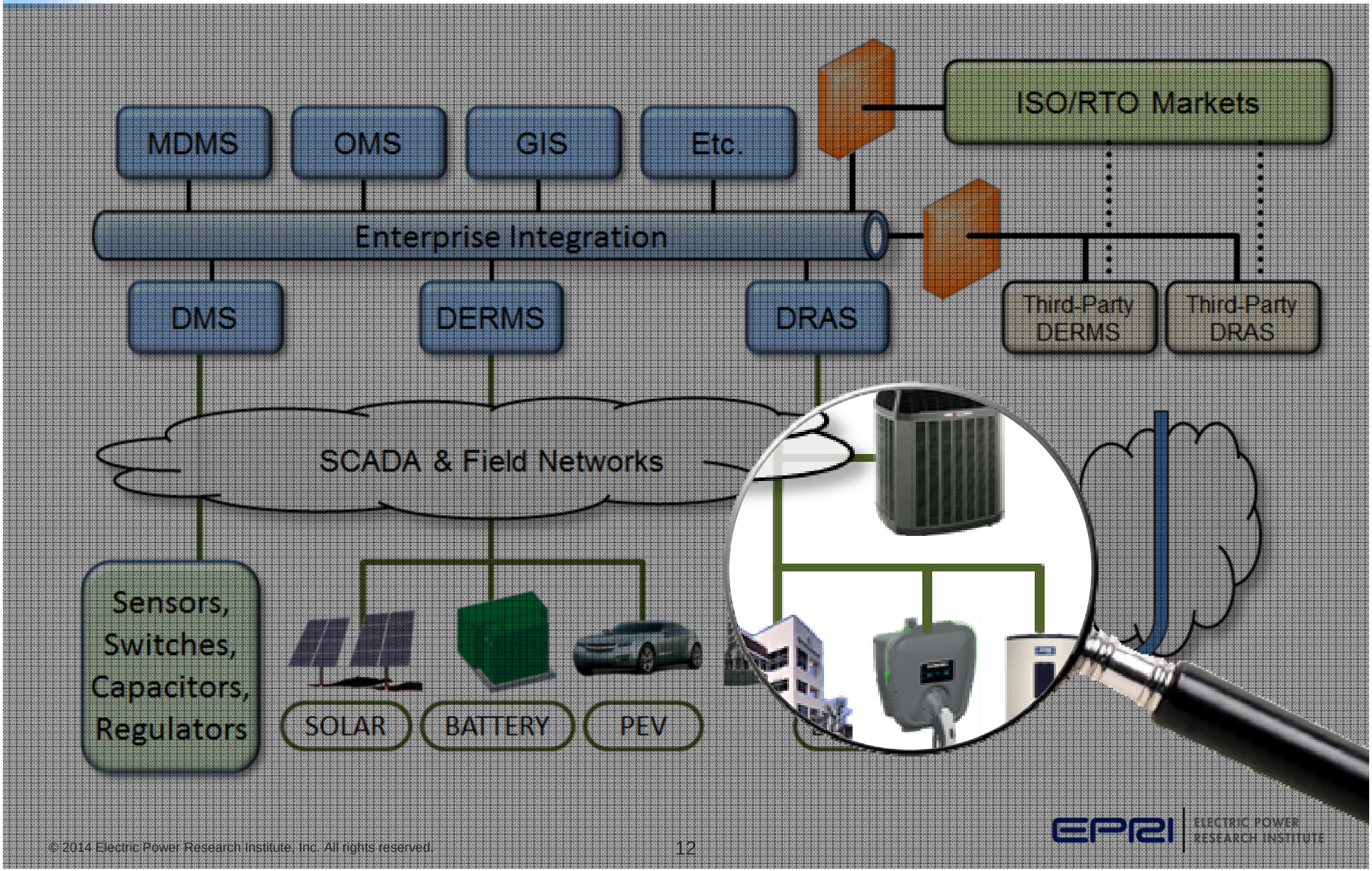
EPRI ELECTRIC POWER RESEARCH INSTITUTE

Implementation of the Market Interface for the EPRI OpenADR Server

- Building on prior success of the VTN, VEN open source codes
- Scope and use cases were taken from the PAP19



Connectivity to Devices for Demand Response



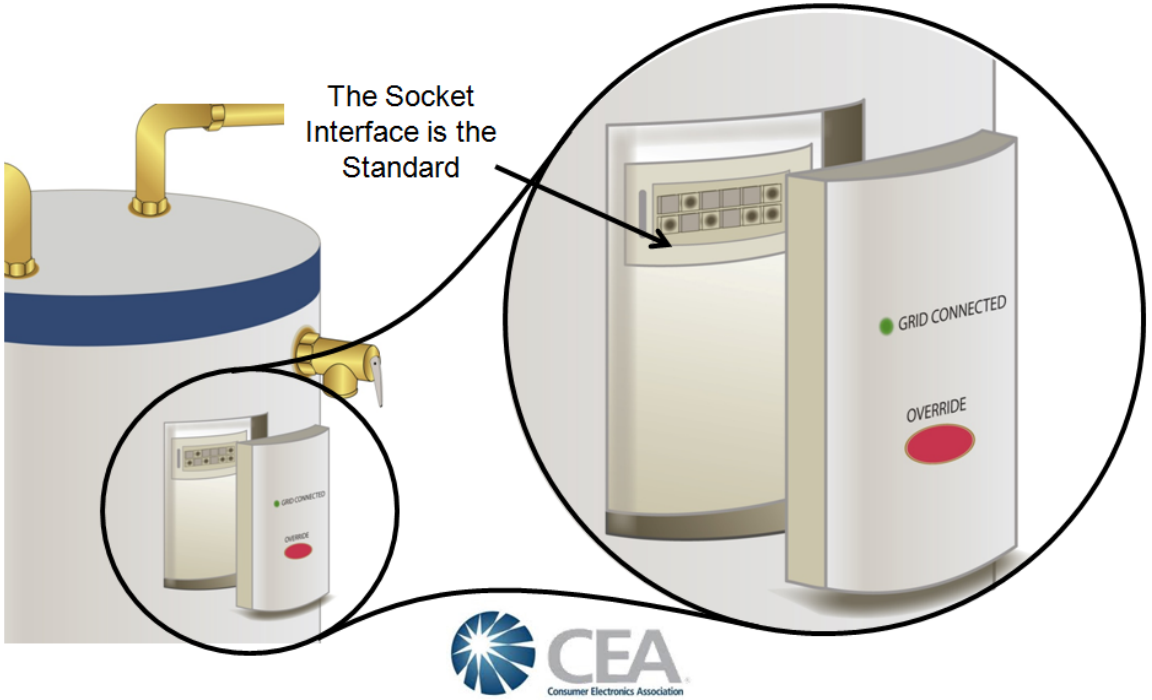
EPRI ELECTRIC POWER RESEARCH INSTITUTE

Modular Interface for Demand Response

The ANSI/CEA-2045 standard defines a modular port interface for demand response

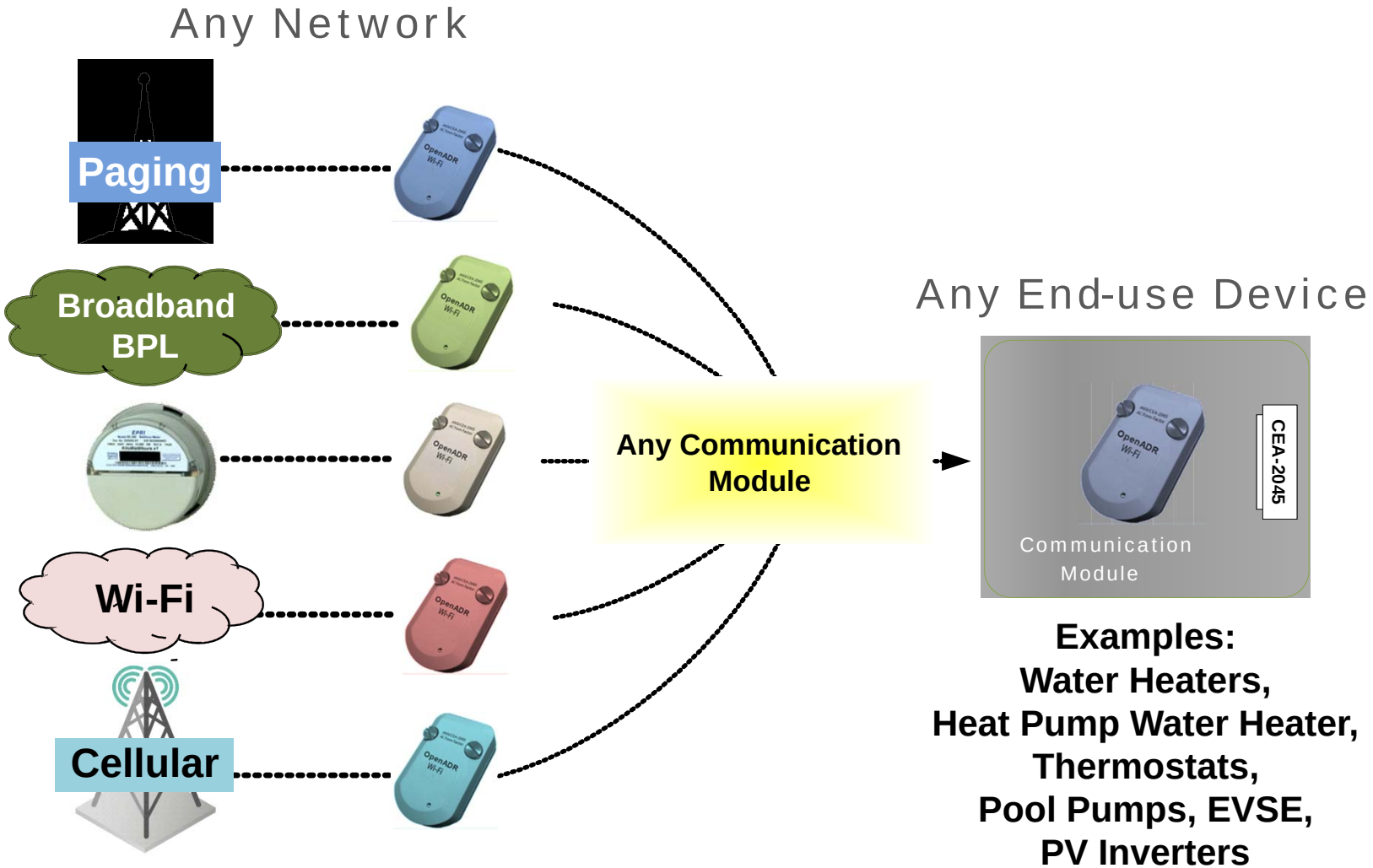
Goals of the Standard:

- Support mass production by enabling products to be compatible with any communication system
- Minimize upfront product cost
- Networks can evolve over the life of the appliance
- Enable customer program installability, avoid truck rolls



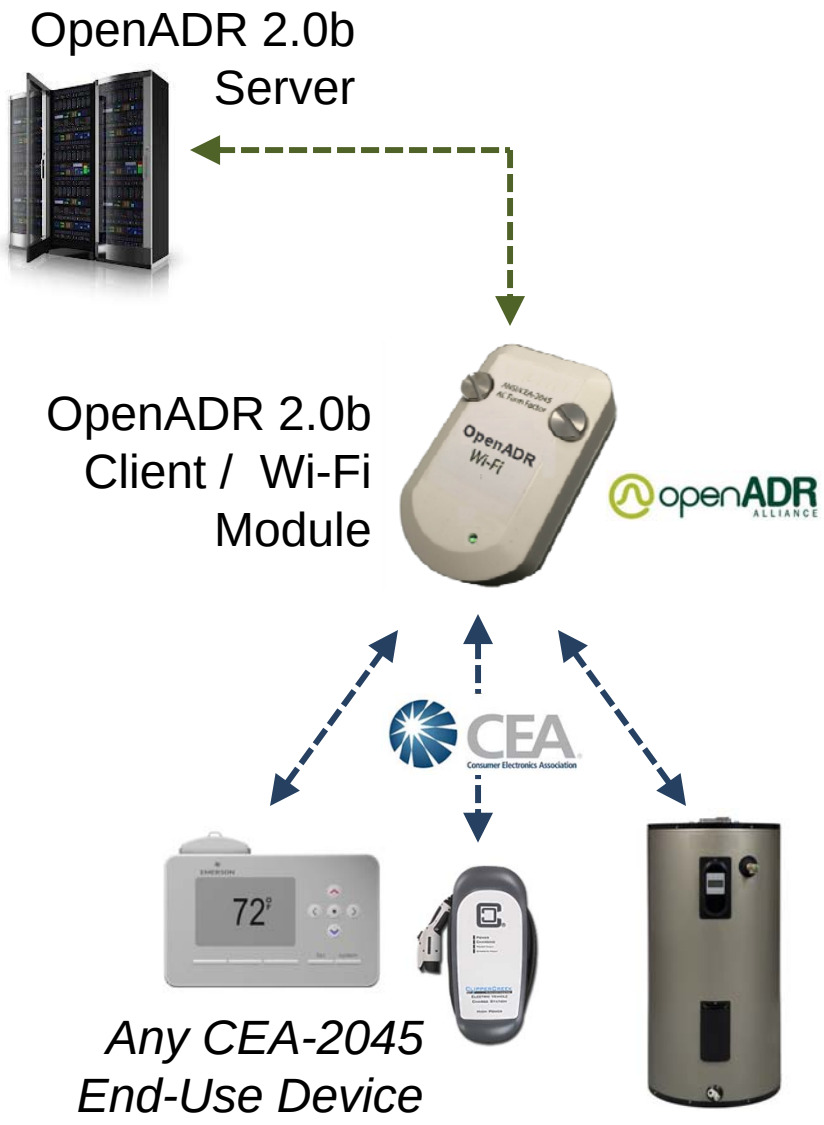
Additional Information about the CEA-2045 standard: Report # 3002004020

Enabling Devices to be Network-type Neutral



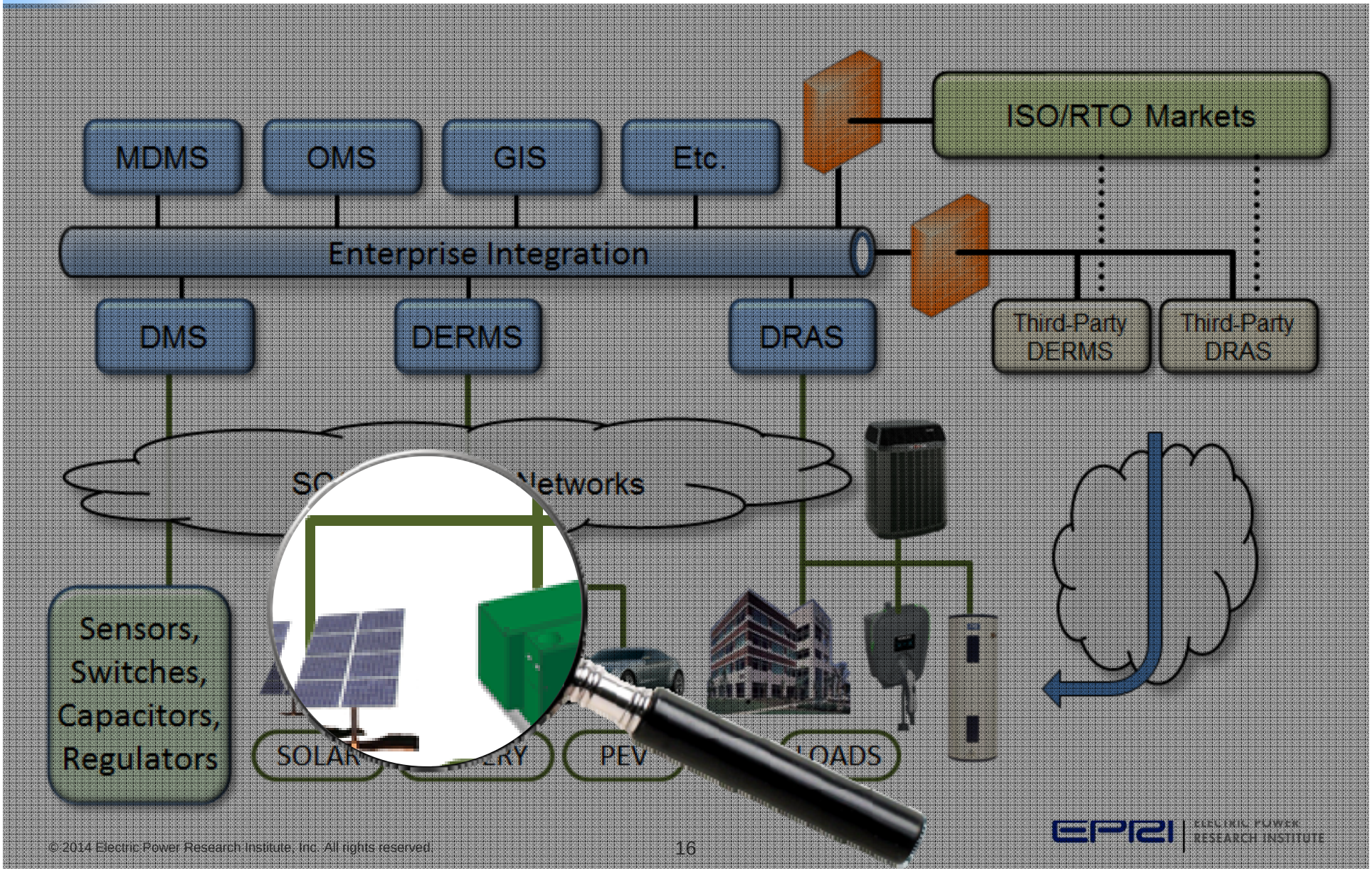
Example CEA-2045 Application

Additional Information about the Field Demonstration Project: Report # 3002004009



EPRI ELECTRIC POWER RESEARCH INSTITUTE

Field Communication for DER



EPRI ELECTRIC POWER RESEARCH INSTITUTE

Field Communication for DER

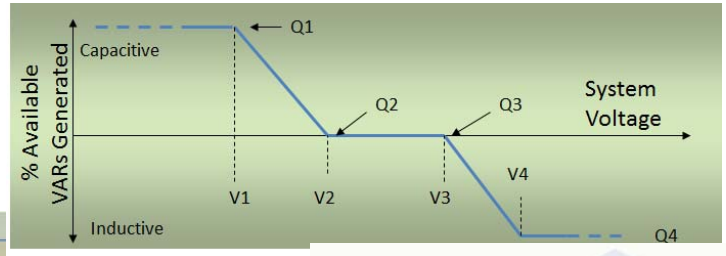
IEC 61850-90-7 → IEC 61850-7-420

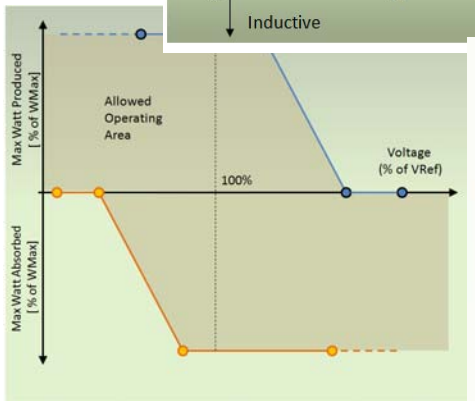
Standard Function Descriptions

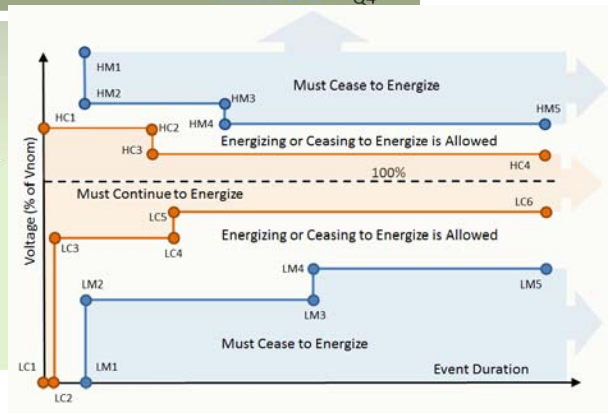
Standard Information Model (IEC 61850)

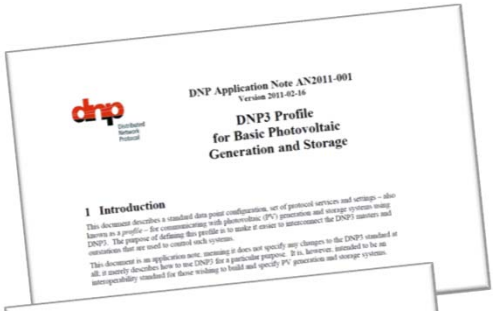
Mapped to Protocols

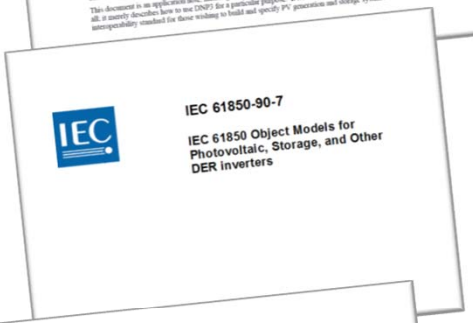
- DNP3
- SunSpec Modbus
- SEP2.0
- 61850 MMS

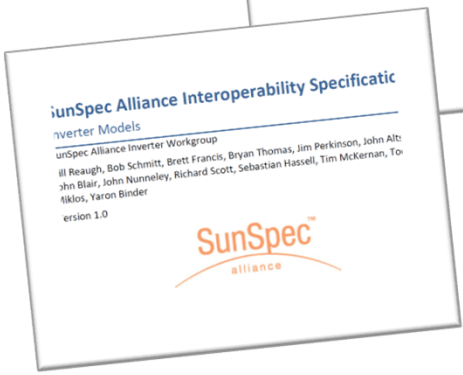








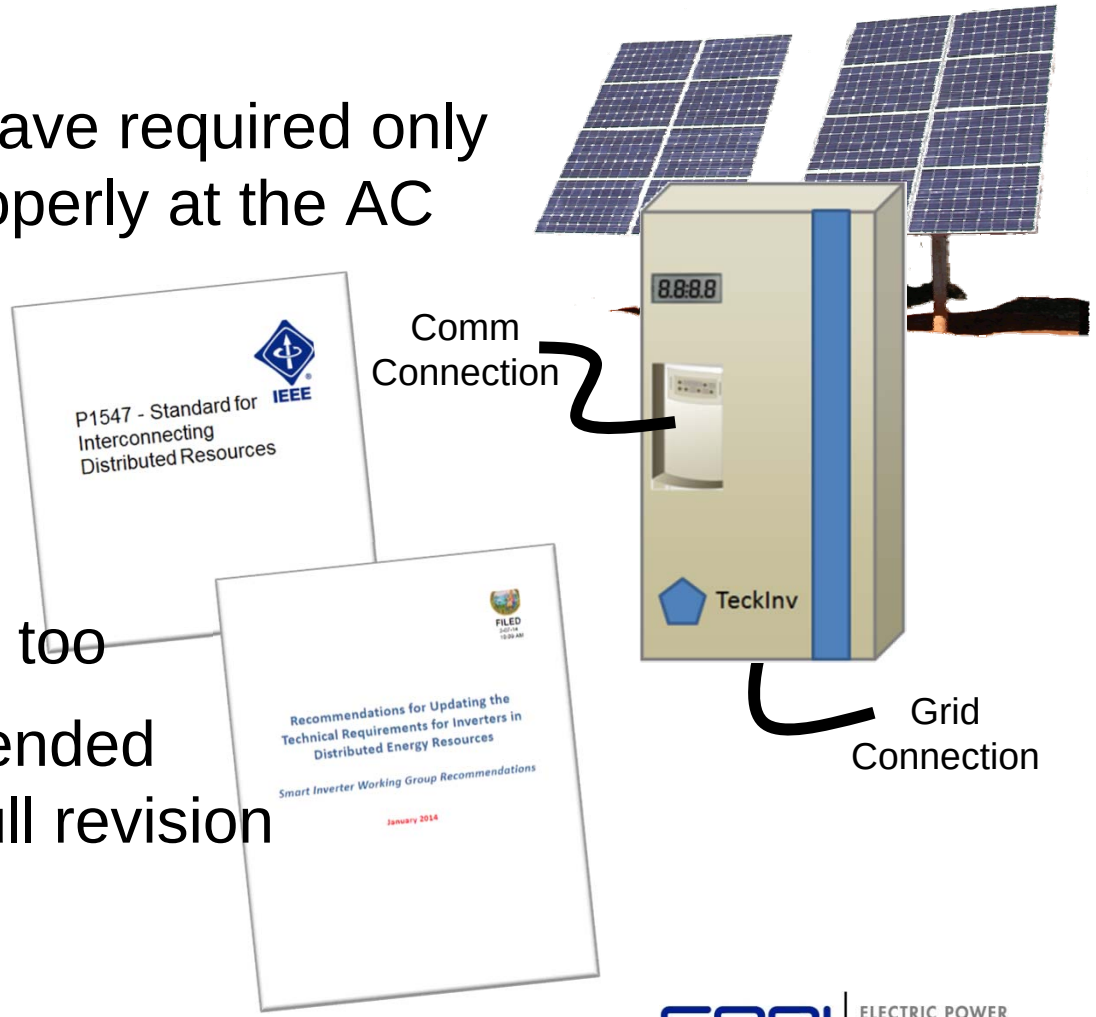




EPRI ELECTRIC POWER RESEARCH INSTITUTE

Grid Codes for DER

- Grid codes are laws that require that DG meet certain requirements
- Historically, grid codes have required only that inverters behave properly at the AC power connection
- IEEE P1547
- New grid codes are considering the DER communication interface too
- IEEE P1547.8 (recommended practice), P1547-2017 full revision
- CA Rule 21 Revisions

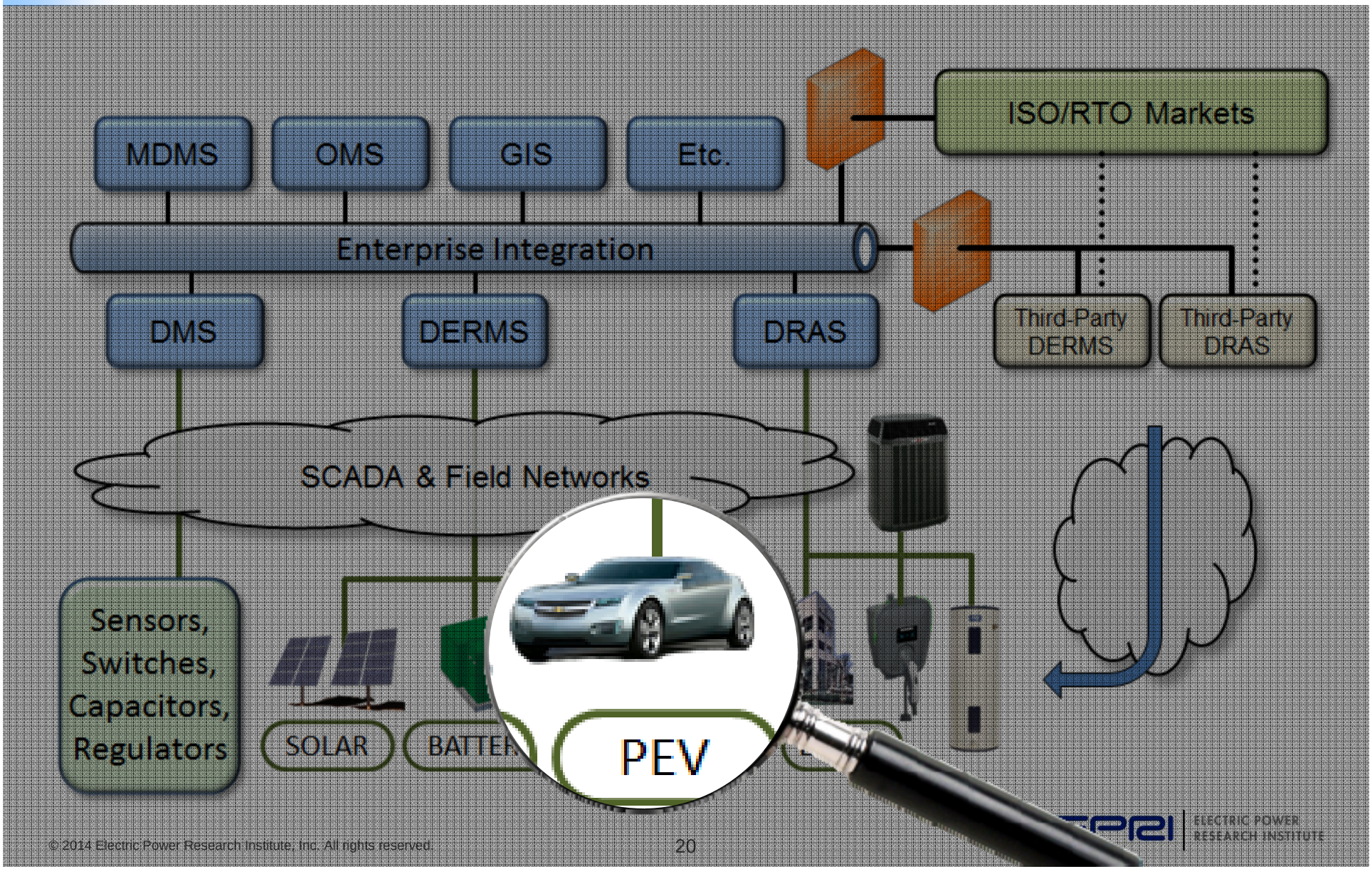


EPRI ELECTRIC POWER RESEARCH INSTITUTE

References for Field Communication for DER

Document	Description
EPRI 1020435	Development of a Standard Language for PV and Storage Integration
EPRI 1020906	Standard Language Protocols Whitepaper
EPRI E237894	Common Functions for Smart Inverters, Update DNP3 Standard
IEC 61850-90-7	Information Model for DER + Standard Function Definitions
EPRI 1021674	Specification for Smart Inverter Interactions with the Electric Grid Using International Electrotechnical Commission 61850
EPRI 3002002233	Common Functions for Smart Inverters, Version 3
EPRI 1017909	Advanced Metering Infrastructure (AMI) Considerations for Distributed Renewables Integration
DNP AN2011-001	DNP3 Profile for Basic Photovoltaic Generation and Storage
DNP AN2013-001	DNP3 Profile for Advanced Photovoltaic Generation and Storage
Multiple	DRGS DEWG Documentation (www.sgip.org/distributed-renewables-generation-storage-drgs-dewg)
SunSpec	Sunspec Alliance Specifications, Including Modbus mapping
IEEE P2030.5	Draft Standard for Smart Energy Profile 2.0
IEEE 1547	Standard for Interconnecting Distributed Resources
CA Rule 21	California's Electric Tariff Rule 21, revisions in process

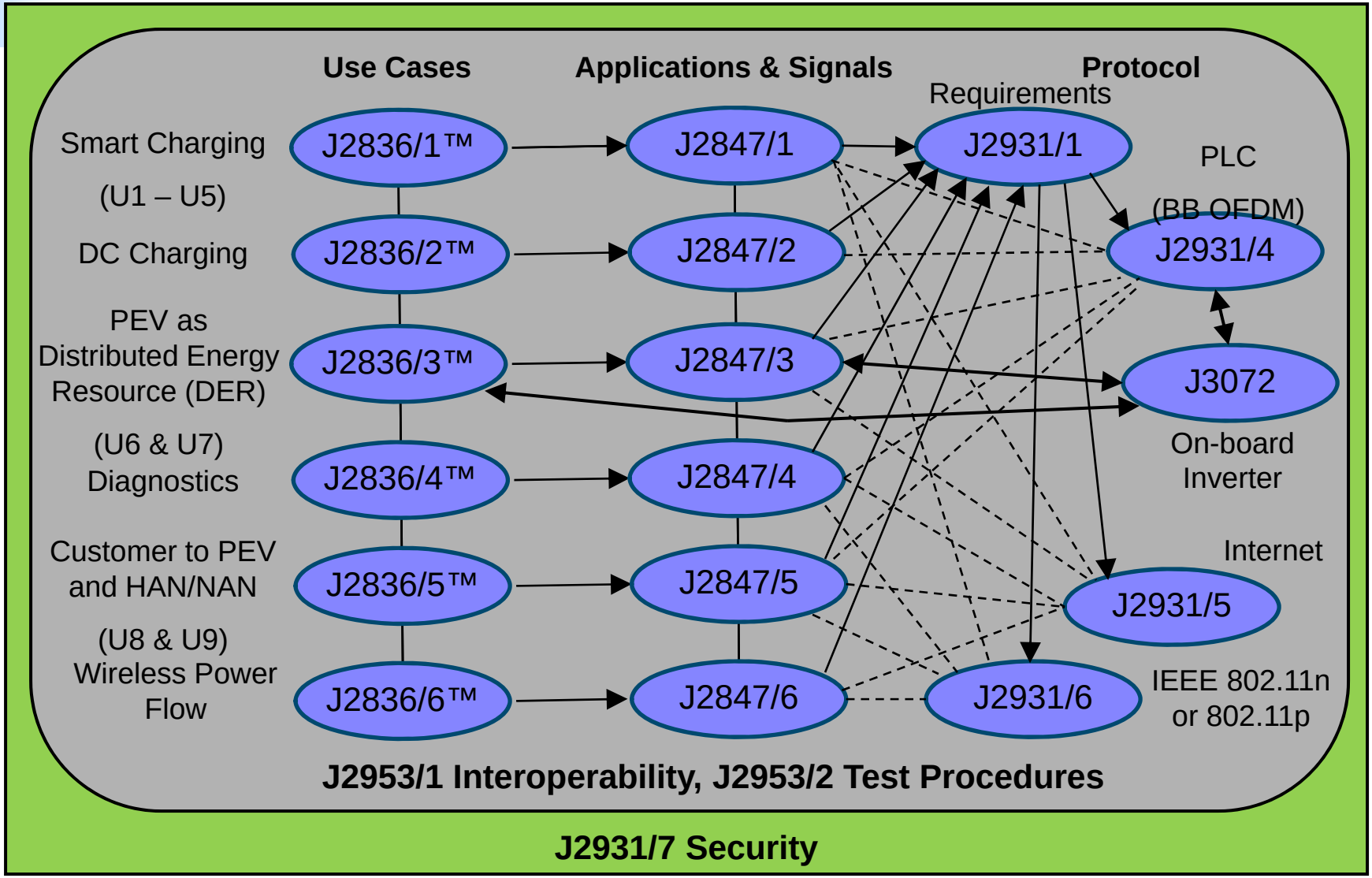
Electric Vehicle Integration



Standards for Plug-in Electric Vehicles

- The Society of Automotive Engineers (SAE) - develops most vehicle standards and recommended practices
- SAE standards - not legally required to be followed in US unless mandated (usually through Federal Motor Vehicle Safety Standards – FMVSS)
- SAE standards being developed for:
  - Connectors and low level charging function (SAE J1772™)
  - Communications (SAE J2836 family of standards)
  - Wireless charging (SAE J2954)
  - Power Quality (SAE J2894)
  - PEV as distributed resource (SAE J3072 – on board inverter)
- UL safety standard for off board PEV inverter (UL 9741)

SAE J2836 Family of Documents



Key Communications Standards

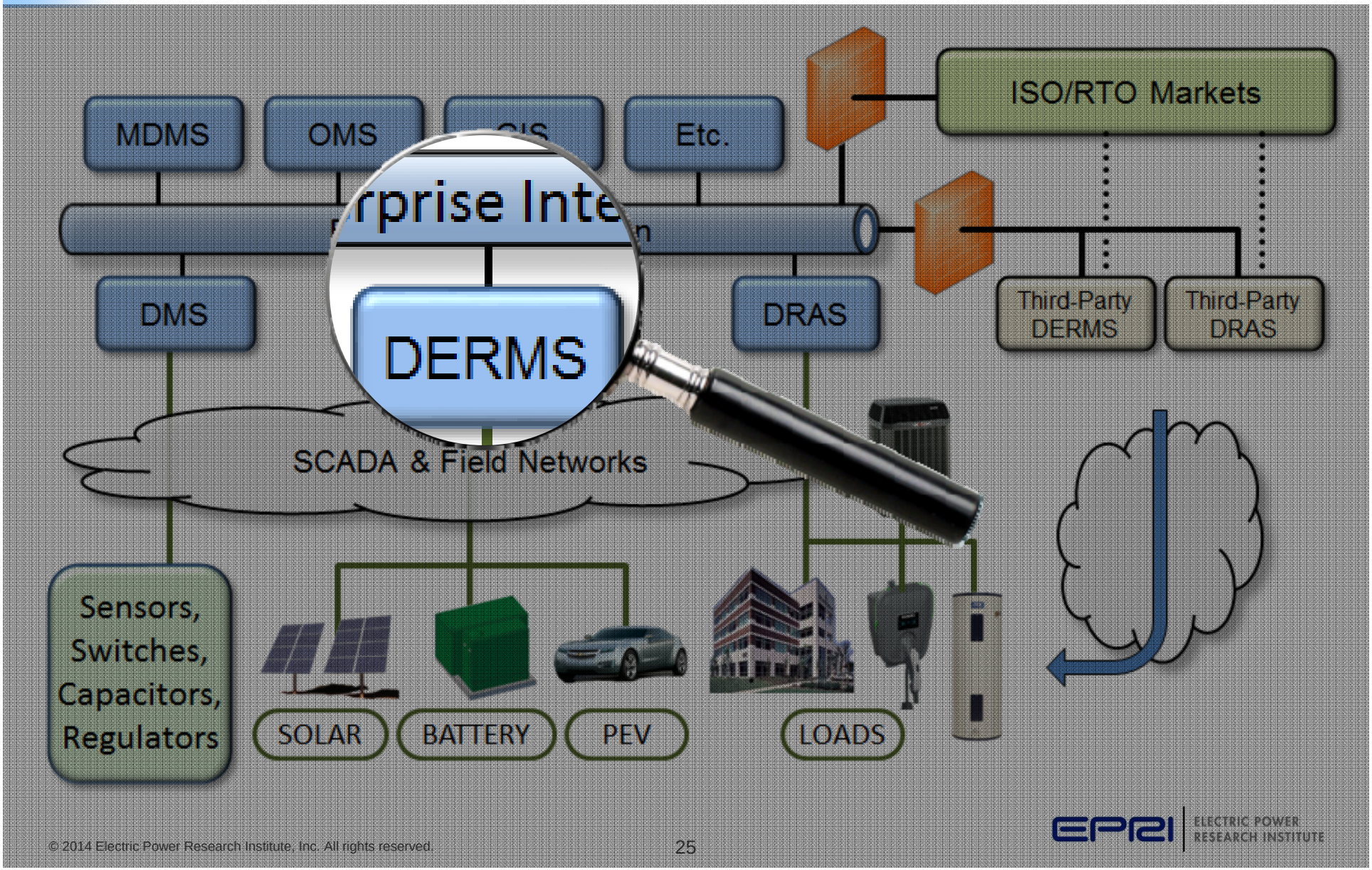
- SAE J2836/1, J2847/1, J2931/1 and J2931/4:
  - Utility to vehicle communications; based on use of SEP2.0
  - HomePlug GreenPHY
- SAE J2836/2, J2847/2, J2931/1and J2931/4:
  - DC Charging communications; based on use of XML based protocol developed in Germany (under DIN 72121) and adopted into 15118 and J2847/2
  - HomePlug GreenPHY
- ISO does not plan to use SEP2.0 for utility communications – they will use elements built into 15118

ISO/IEC Has Parallel Standards

- Technical Committee 69
  - IEC 61851 series documents ~ J1772™
  - 61851-1 is general requirements
  - 61851-22 is AC charging
  - 61851-23 is DC charging
  - 61851-24 is PEV to charge station communication
- ISO 15118-1 similar to J2836 family of documents
- ISO 15118-2 similar to J2847 family of documents
- ISO 15118-3 similar to J2931 family of documents

Work continues to ensure harmonization of SAE and ISO/IEC standards

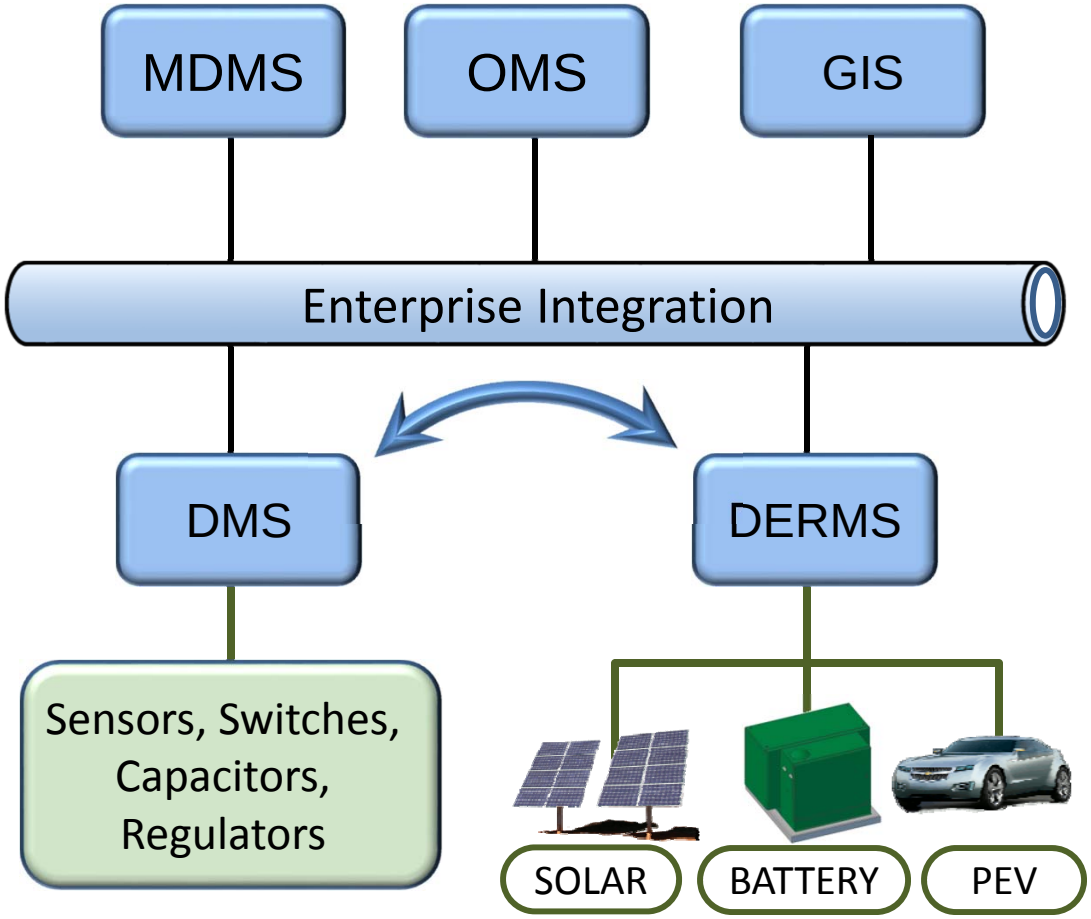
Enterprise Integration of DER



EPRI ELECTRIC POWER RESEARCH INSTITUTE

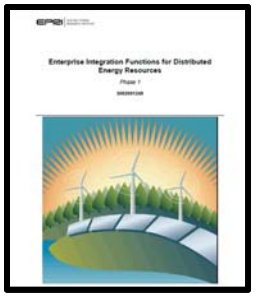
Enterprise Integration of DER

Developing CIM, MultiSpeak Support (2012-2014)



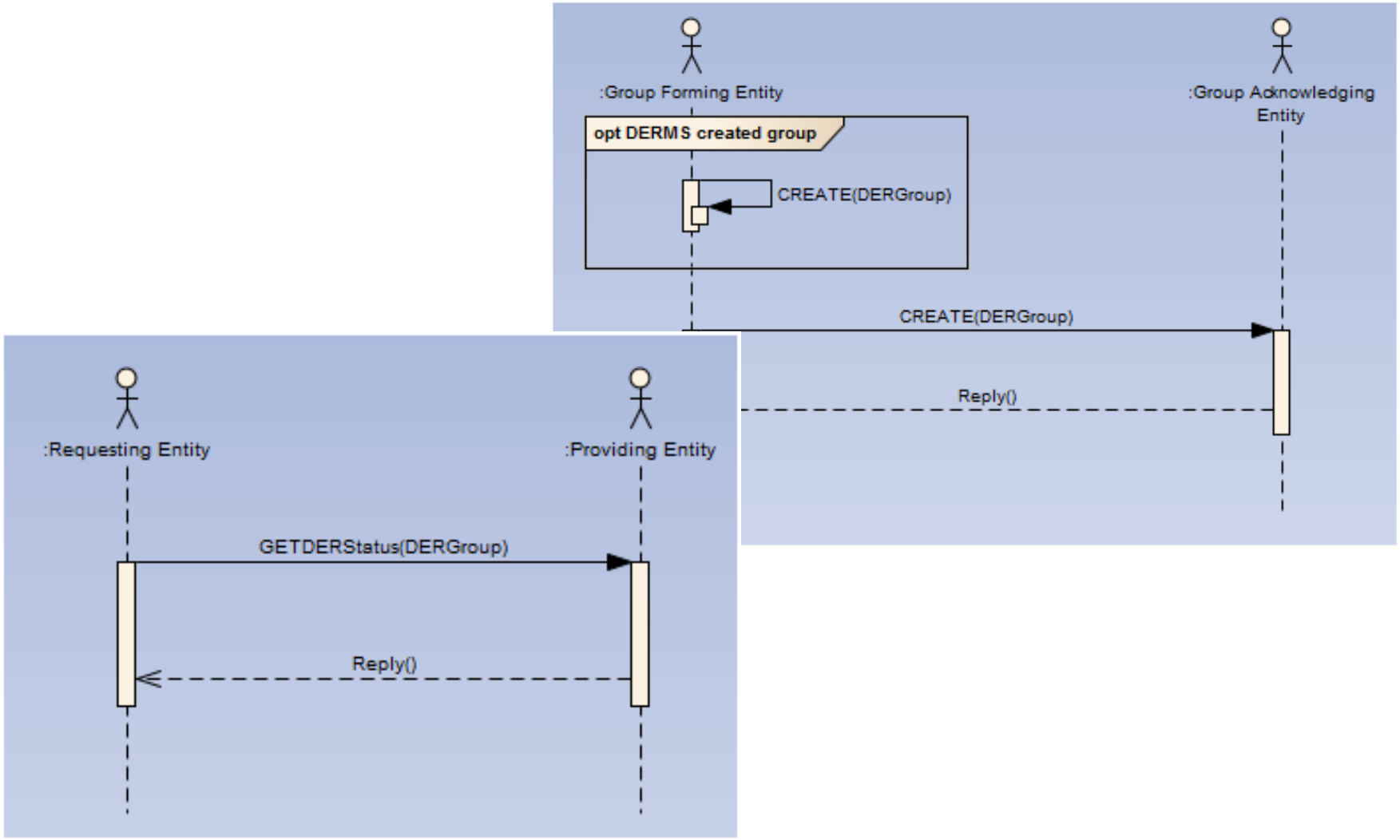
- Creation and management of groups and sharing of group definitions
- Capabilities discovery
- Monitoring of group status
- Dispatch of real and reactive power
- Forecasting of group capabilities

Report 3002001249 Enterprise Integration Functions for Distributed Energy Resources

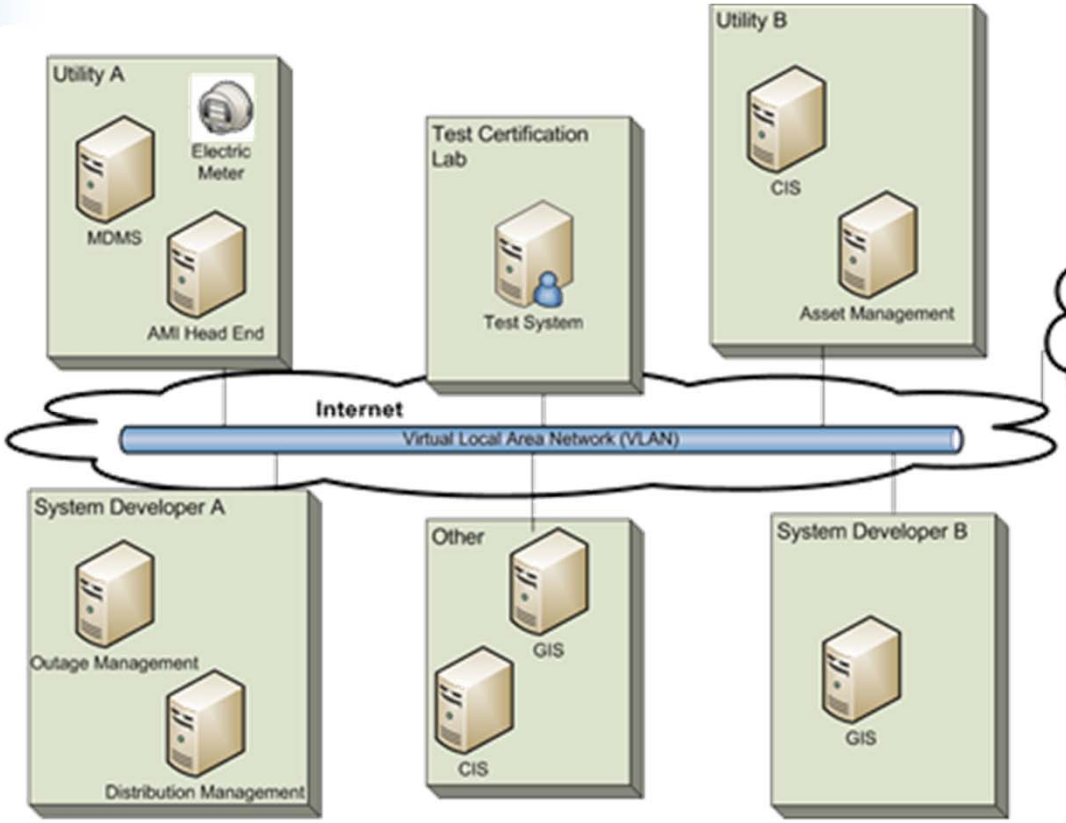


EPRI ELECTRIC POWER RESEARCH INSTITUTE

Supporting Sequence Diagram Examples



Interoperability Testing



Tests conducted anytime, anywhere

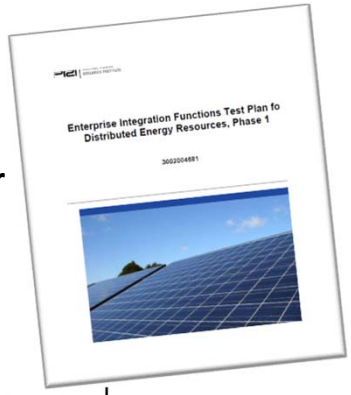
Cloud Computing

amazon web services™

Test Script for DERMS to DMS

st Script DERMS to GIS

Report 3002004681 Enterprise Integration Functions Test Plan for Distributed Energy Resources, Phase 1



EPRI ELECTRIC POWER RESEARCH INSTITUTE

Next Steps

- Finalize support in CIM and MultiSpeak
- Interest Group – take on the next round of needs
- Define and Document New Test Cases
- Update Test Harness
- Conduct 2nd Workshop
- Feedback to Standards Organizations

Discussion

Together…Shaping the Future of Electricity

Reference Materials

References for EPRI's OpenADR Project

1. *Automated Demand Response and Ancillary Services Demonstration Project Update: Volume One.* EPRI, Palo Alto, CA: 2014. 3002002782.
2. *The Impact of EPRI's Automated Demand Response Collaborative on Advancing OpenADR Standards.* EPRI, Palo Alto, CA: 2014. 3002004635.
3. *OpenADR Technical Workshop DVD – 6.19.2013*. EPRI, Palo Alto, CA: 2013. 3002001822.
4. *OpenADR 2.0 Open Source Virtual Top Node.* EPRI, Palo Alto, CA: 2014. 1026755.
5. *OpenADR 2.0b Open Source Virtual End Node - VEN v0.5.0.* EPRI, Palo Alto, CA: 2014. 1026751.