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Inverter Advanced Functions, Operability and Communication Update

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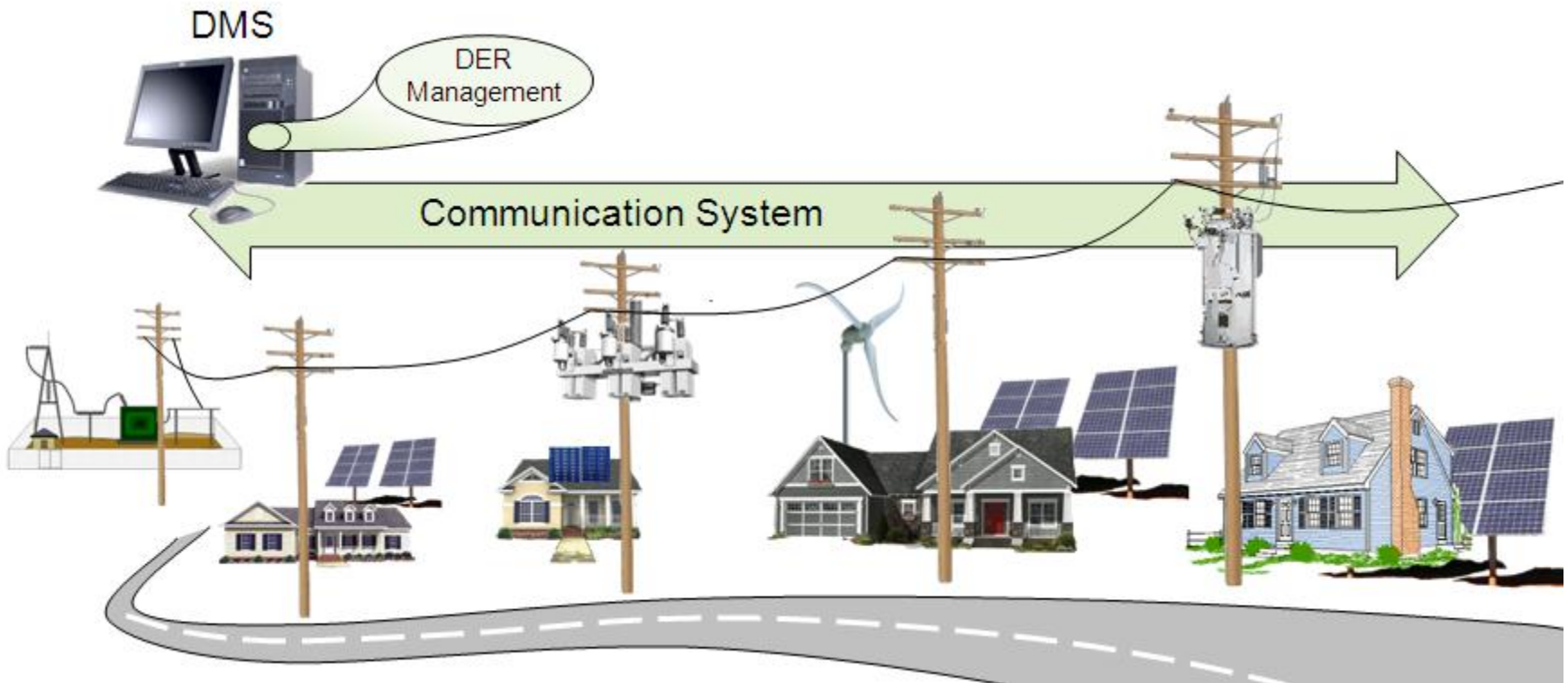
UWIG Solar Integration Workshop

Maui, HI

October 11, 2011

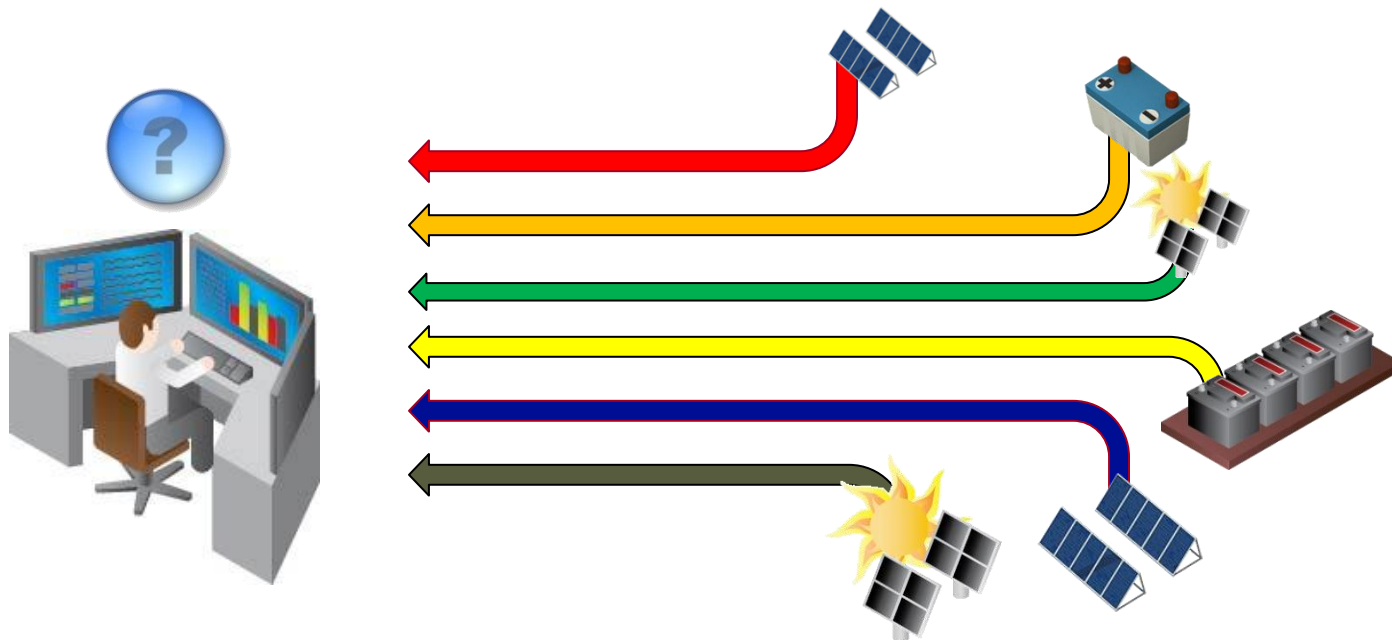
Smart Grid Vision for Advanced Inverters

Communication-Connected Distributed Solar and Storage Systems as **Beneficial** Distribution System Assets



Uniform Definition of “Services” Needed

- All inverters have “grid supportive” capabilities
- Most have set up and/or communication capability
- But all in different flavors and types

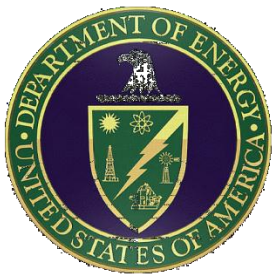


An Industry Collaboration was Formed in 2009 (inverter mngr, utilities, R&D, consultants

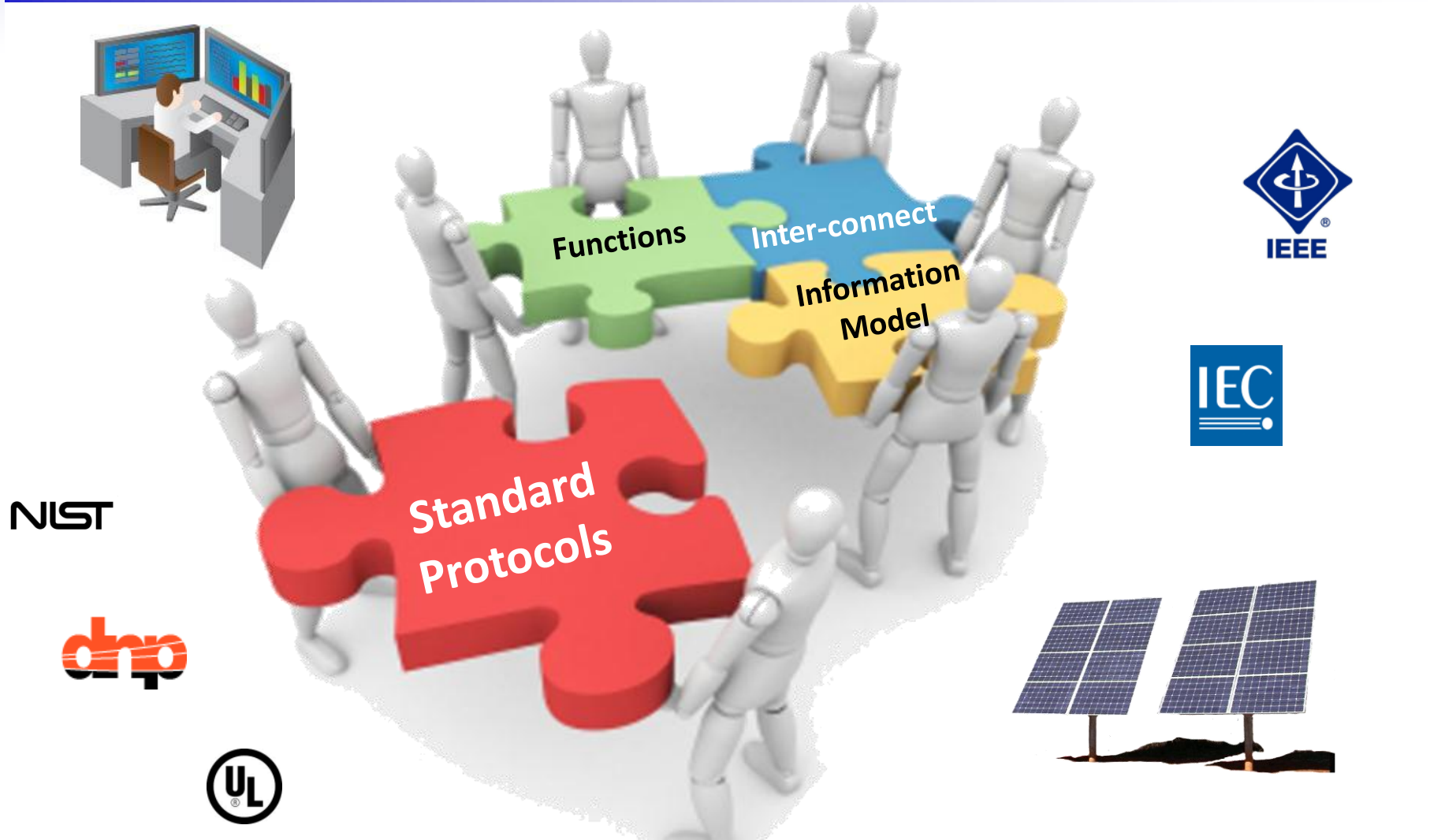
*To identify a standards-based means for the fielding
inverters with a common set of advanced functions*

More than 550 individuals engaged, representing:

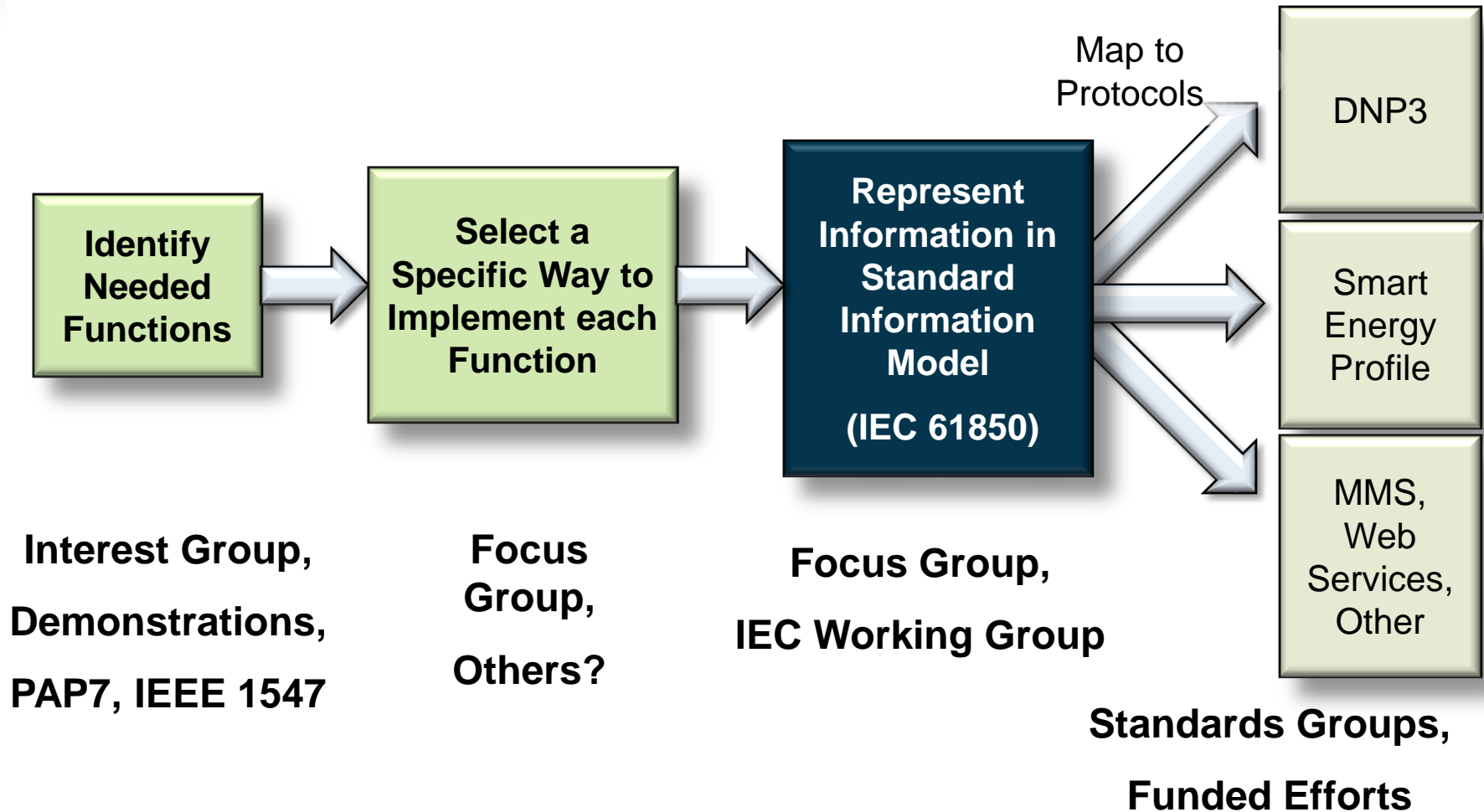
- > 50 PV & Storage equipment providers
- > 60 utilities
- 12 National labs and research organizations



Implementation Requires a Number of Organizations and Pieces



“Smart Inverter Initiative” Collaboration Activity Flow



Result of Utility/Inverter Industry Collaboration

Define Standardized Functions for Inverters

1. Connect / Disconnect from Grid
2. Output Power Management
3. Power Factor and Volt/Var Management
4. Storage Management – PV to grid/storage, grid to/from storage
5. Event/History Logging (basic set)
6. Status Reporting /Reading
7. Time-sync

More in Phase 2

Represent Information in Standard Information Model (IEC 61850)

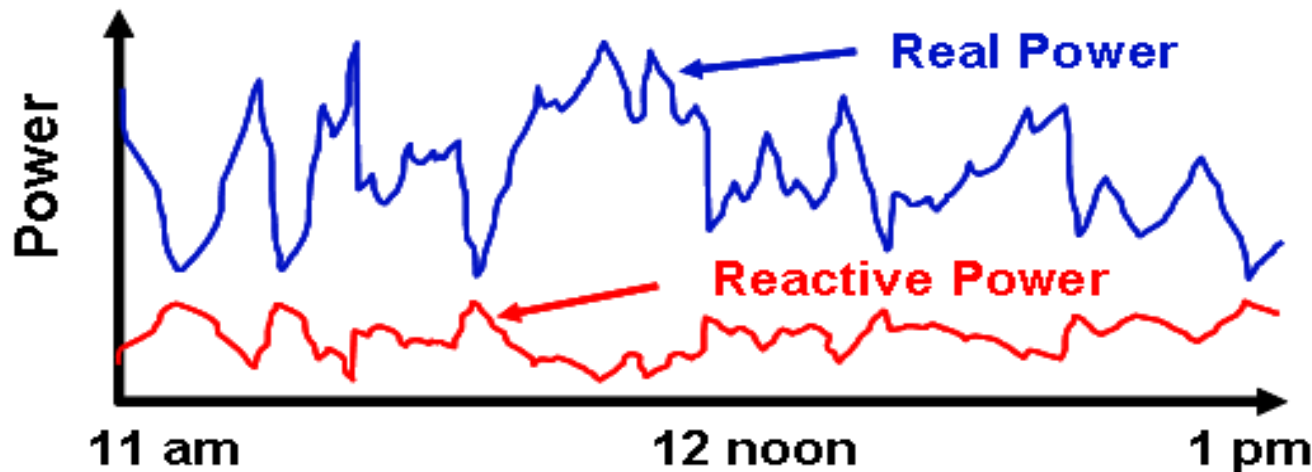
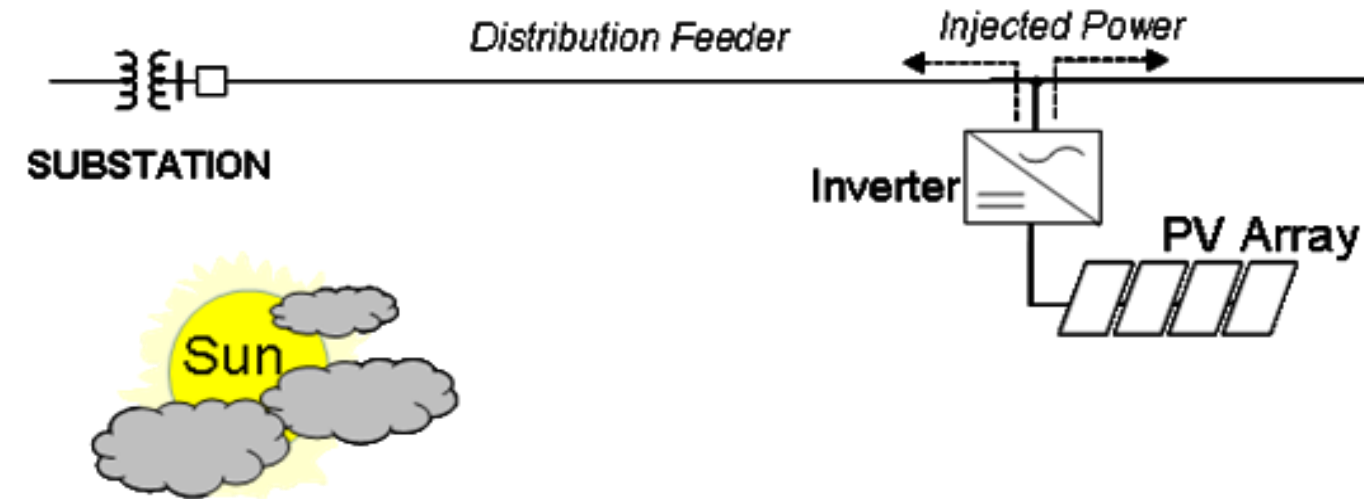
Map to Protocols

DNP3

Smart Energy Profile

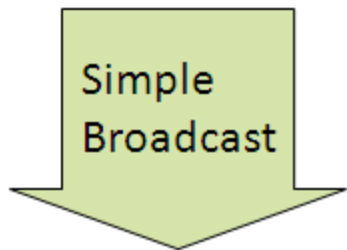
MMS, Web Services, Other

Example: Intelligent Volt-Var Management Autonomous or with Communications



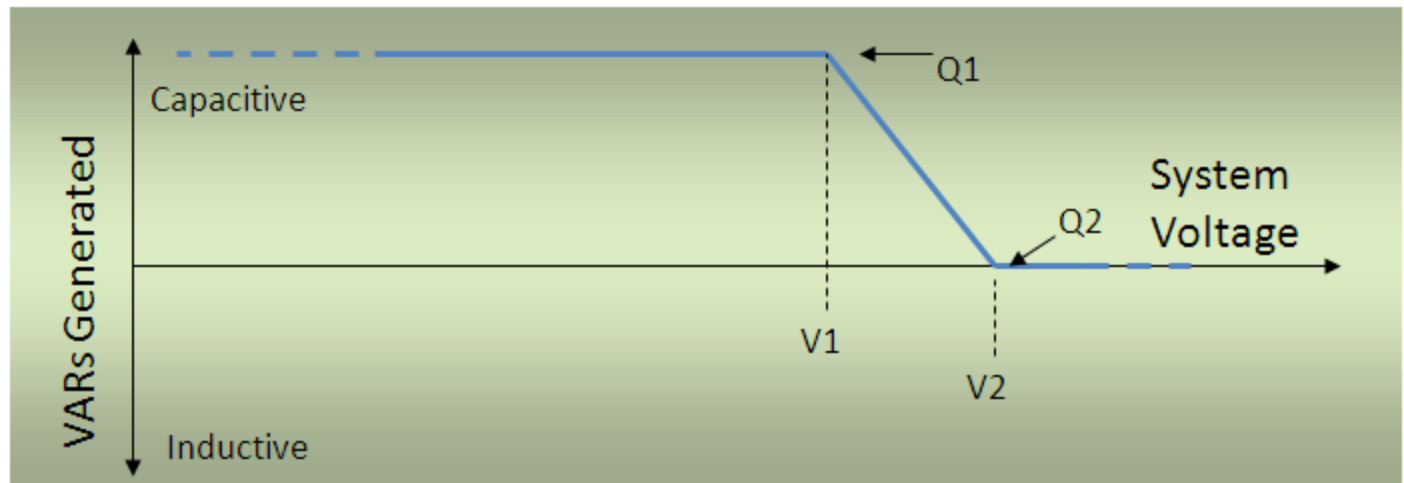
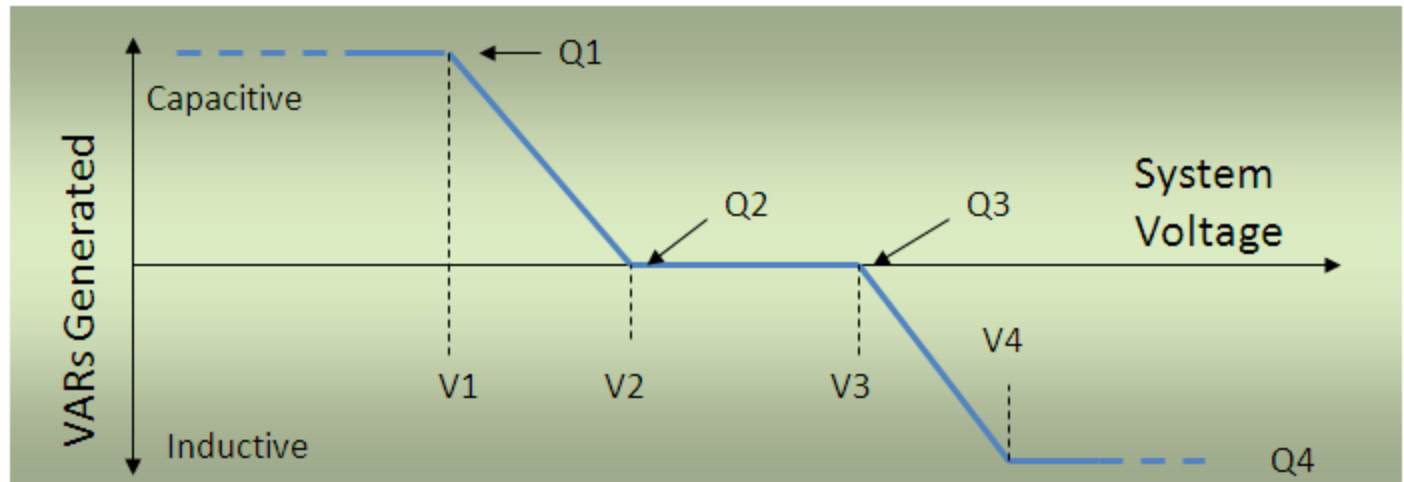
Example: Intelligent Volt-Var Management with communication input

Volt/Var
Mode 1 –
Normal
Regulation



Volt/Var
Mode 2 –
Transmission
VAR Support

Utility-Defined Curve Shapes



Second Phase of Functions Development

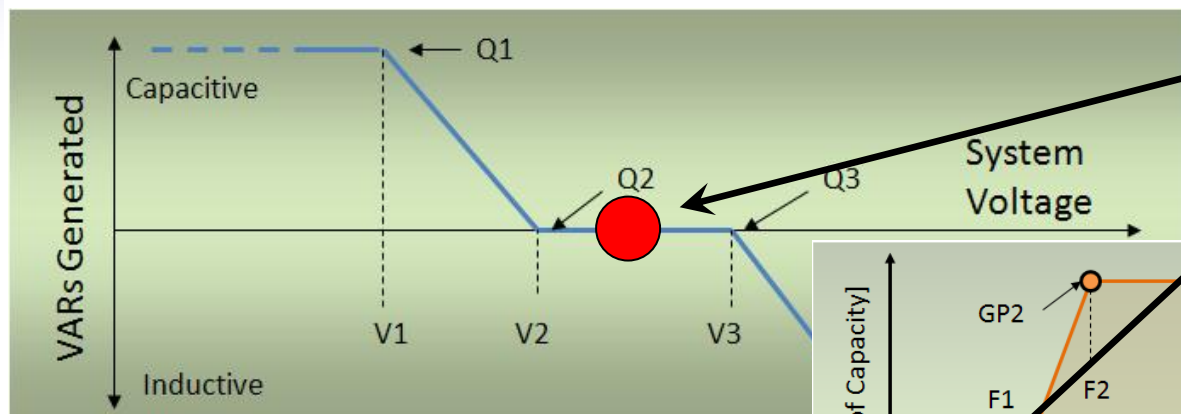
Phase 2 Functions:

- Voltage Sag Ride-Through
- Autonomous Watt-Voltage Management (transient and steady-state)
- Autonomous Watt-Frequency Management
- Islanding
- Additions to State/Status Monitoring

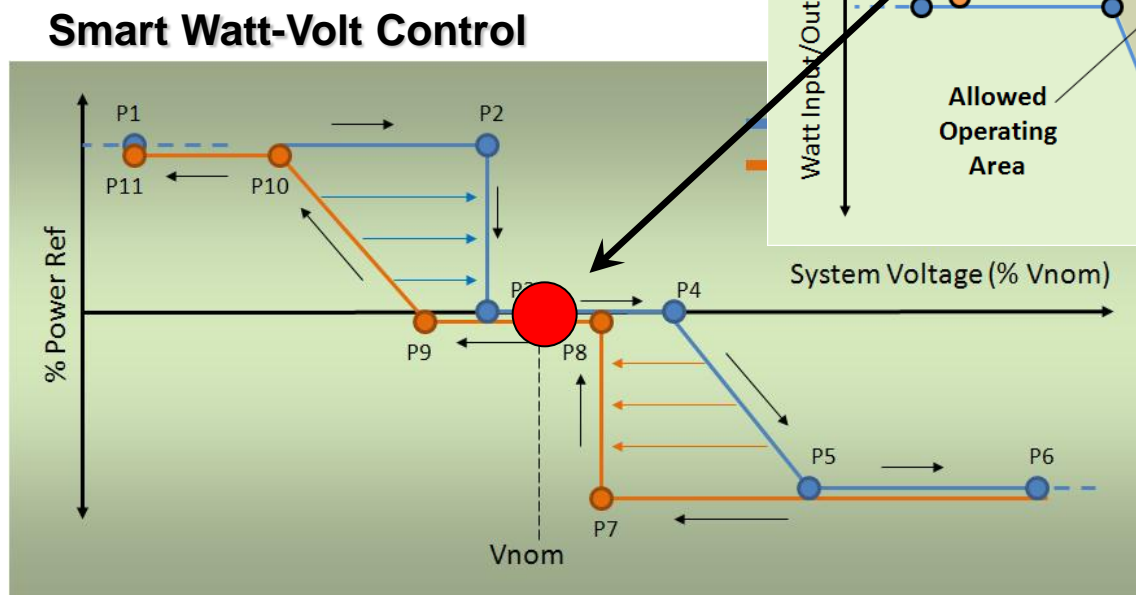
Status:

- In process in coordination with IEEE P1547.8 and NIST PAP7
- Will be Added to the DNP3, SEP2, and other protocol mappings

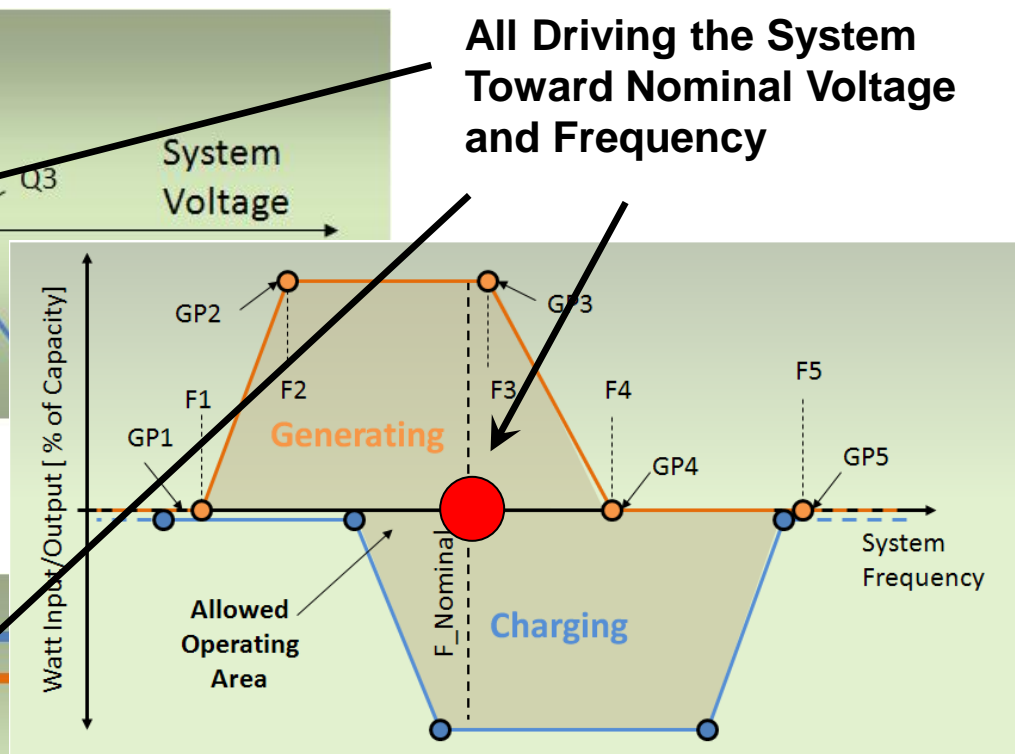
Smart Inverter and Battery Grid Support Functions



Smart Volt-Var Control



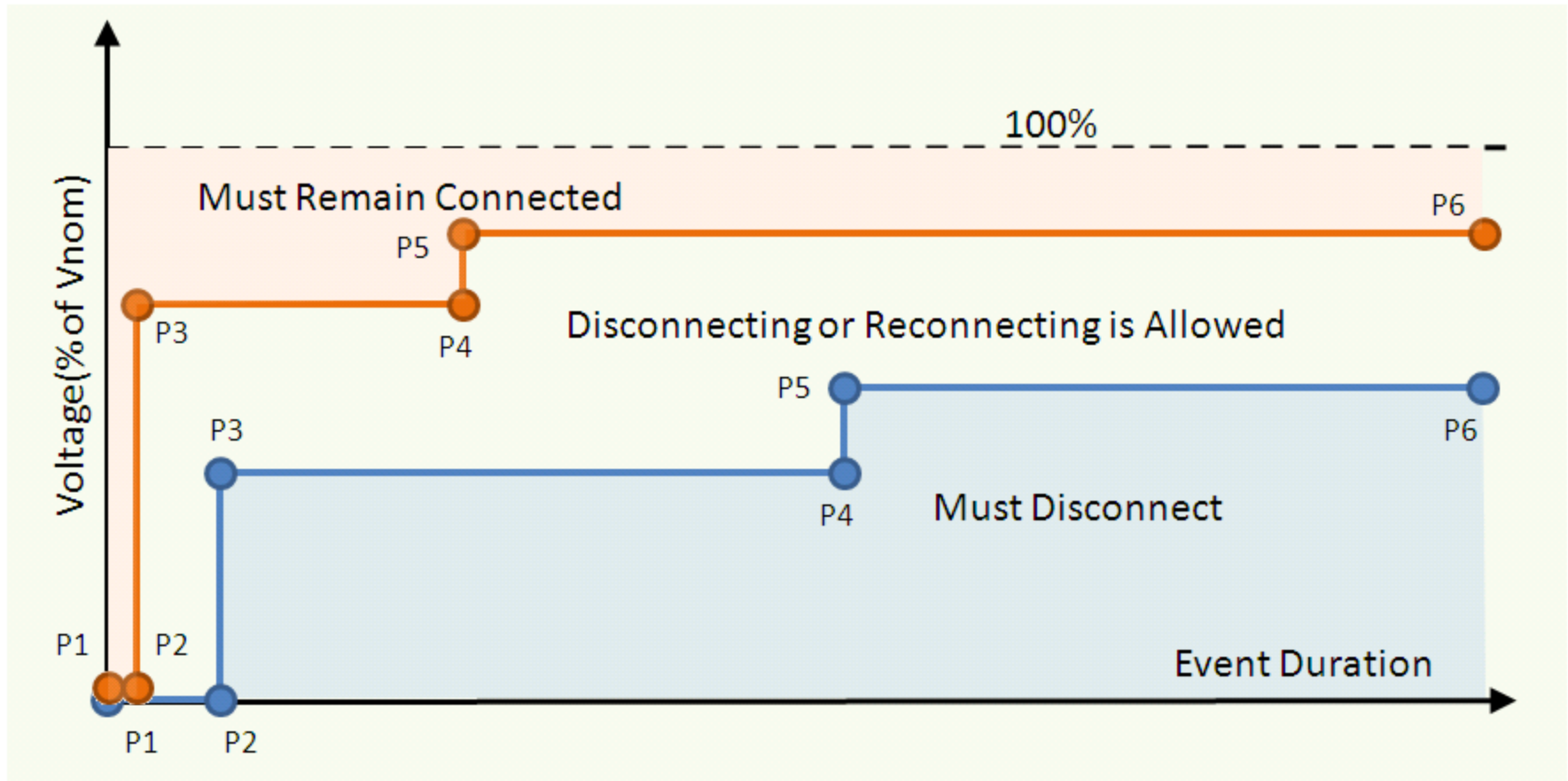
Smart Watt-Volt Control



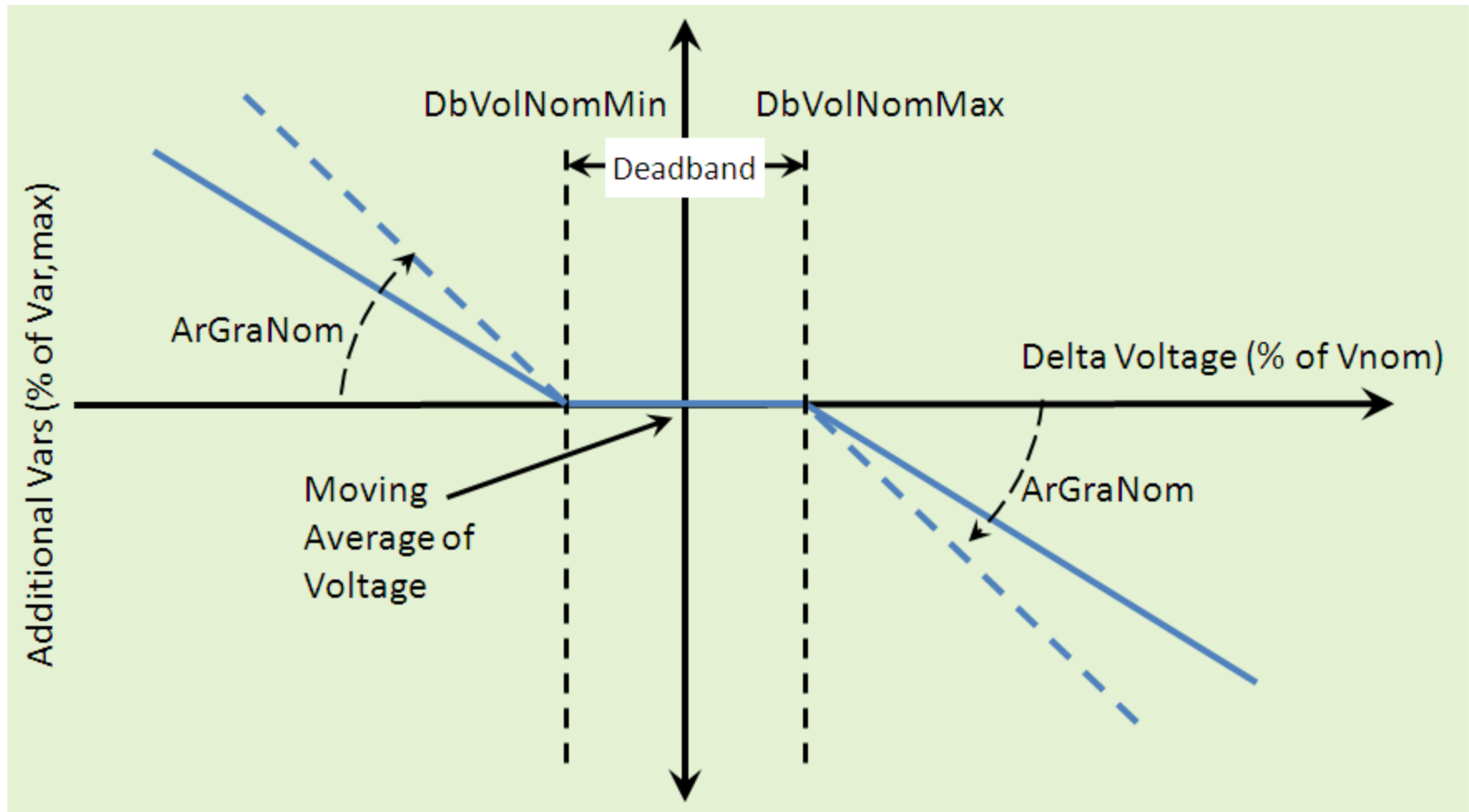
All Driving the System
Toward Nominal Voltage
and Frequency

Smart Watt-Frequency Control
(with battery)

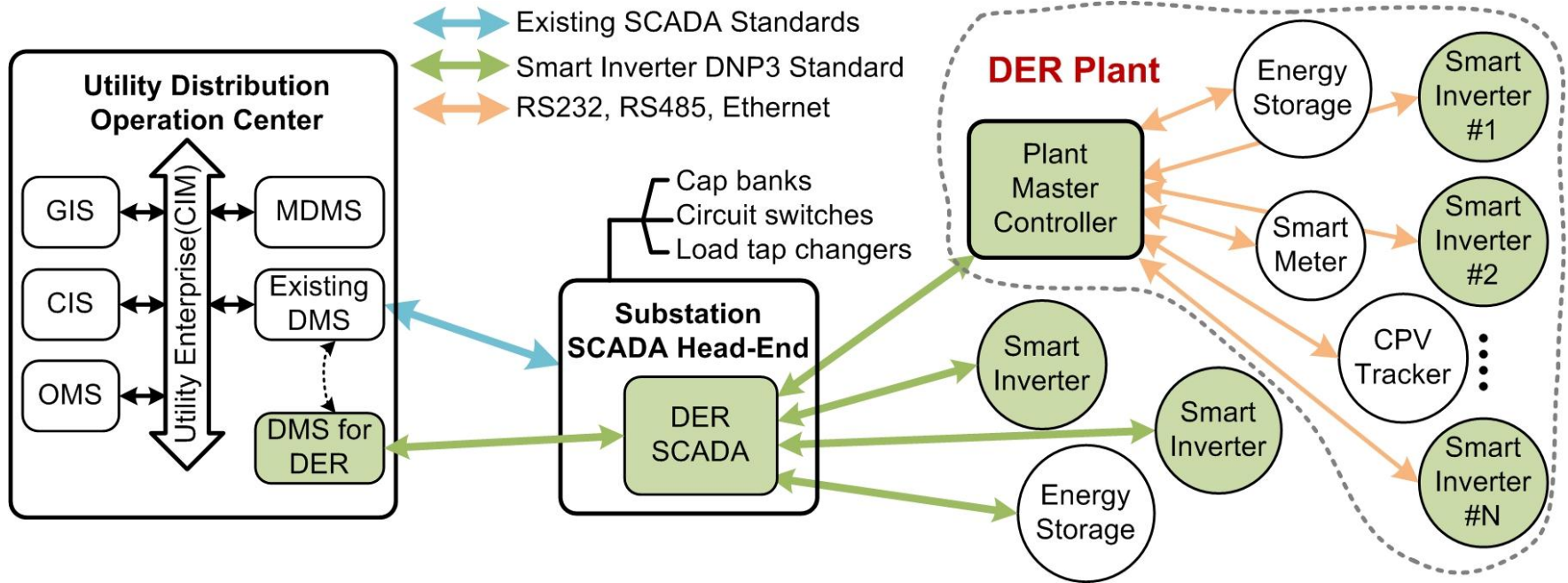
Example: Configurable Voltage Sag Ride-through



Example: Dynamic Sag/Swell VAR Support



Advanced DER Ready DMS Vision



- Head-end communications at the utility operations center;
- Integration into the distribution management system (DMS);
- Back-end PV plant master controller;
- Smart-grid functionality built into inverters

Success Story – IEC Object Models



IEC 61850-90-7

**IEC 61850 Object Models for
Photovoltaic, Storage, and Other
DER inverters**

Draft Version 10a

May be Mapped into Any Protocol

Success Story – DNP3 Standard for Phase 1 Functions



DNP Application Note AN2011-001
Version 2011-02-16

DNP3 Profile for Basic Photovoltaic Generation and Storage

1 Introduction

This document describes a standard data point configuration, set of protocol services and settings – also known as a *profile* – for communicating with photovoltaic (PV) generation and storage systems using DNP3. The purpose of defining this profile is to make it easier to interconnect the DNP3 masters and outstations that are used to control such systems.

This document is an application note, meaning it does not specify any changes to the DNP3 standard at all; it merely describes how to use DNP3 for a particular purpose. It is, however, intended to be an interoperability standard for those wishing to build and specify PV generation and storage systems.

Although this document describes a DNP3 profile, it is designed based on the structured *data models* of

Work in Progress is Smart Energy Profile

SEP 2.0

- SEP 2.0 owned by the ZigBee Alliance, not yet an open standard, primary for residential domain
- SEP progress toward a was delayed for several months during 2011 due to internal conflicts
- August 16th, version 2 release .7 approved, functions:
 - Maximum Power Output limiting, includes randomization of start time and duration of limit
 - Power Factor adjustment
 - Time setting

Thanks!

And, for more Information

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