Preventing DER Chaos:

A Guide to Selecting the Right Communications Protocol for DER Management

QualityLogic

Introductions & Workshop Overview

Test Tools and Services for over 30 Years

QualityLogic

James Mater

Co-Founder & General Manager, Smart Grid

James Mater co-founded and has held several executive positions at QualityLogic from June 1994 to present. He contributes to the industry as a speaker, consultant and contributor to industry standards activities including:

- Emeritus Member, GridWise Architecture Council,
- SEPA Test and Certification Committee,
- Member, OpenADR Marketing and Technical Work Groups,
- Participant in IEEE 2030.5 and 1547.1/2 Work Groups
- Participant in SAE J3072 Work Group
- Participant in UL 3001 Microgrid Standard sub-group
- Instructor at DistribuTech Utility University

James holds a bachelor's degree in physics from Reed College, Portland, OR and an MBA from the Wharton School, University of Pennsylvania.

QualityLogic

Mark Osborn

Senior Technology Advisor

Mark T. Osborn is a distributed generation and smart grid expert with over 30 years of experience in the energy industry, developing and guiding innovative and nationally recognized solar and smart grid projects. For QualityLogic, he directed a two-year interview/survey project of grid interoperability issues for the 11 electric utilities participating in the Pacific Northwest Smart Grid Demonstration Project and developed test specifications for the advanced inverter test plan (solar/storage inverters), for Hawaiian Electric Company under a Docket for the Hawaii Public Utilities Commission.

- Mark's recognition and awards include:
- Federal Highway Administration, Exemplary Human Environment Initiative 2012 - America's First Solar Highway projects;
- Oregon Department of Energy, Solar Pioneer Award;
- The Peak Load Management Alliance, Program Innovation

Mark is an Adjunct Professor at Portland State University and the author of numerous papers and articles.

QualityLogic

Co-Sponsor: Triangle MicroWorks, Inc.

- Established in 1994
- Headquarters in Raleigh, NC
- Customers in over 70 countries
- Customer Base:
  - Equipment Manufacturers
  - Electric Utilities
  - System Integrators

- Source Code Libraries:
  - Faster time to market, lower total cost
  - Tech Support starts during implementation and continues in the field
  - DNP3, IEC 61850, IEC 60870-5, Modbus, IEC 60870-6 (TASE.2/ICCP)
- Simulation and Testing Tools:
  - Communication testing in the lab or field
  - Troubleshoot, simulate, or automate
- Protocol Gateway:
  - Translate SCADA protocols
  - Data Concentrator or simple Protocol Converter

Agenda

- Introductions, Background and Definitions
  - Protocols reviewed: DNP3, IEC 61850, OpenADR, IEEE 2030.5
  - Protocol Selection Process
- Utility DER Use-cases
  - SCADA, DR, DER
- DER Messaging Requirements
  - SCADA, DR, Solar Smoothing, Duck Curve Mitigation, Black Start, CA Rule 21 Solar and Storage, V2G.
- Messaging vs Protocols
  - Other considerations
- Summary of Protocol Selection Recommendations
- Q&A – 20 min
- Announcements

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Workshop Introduction

QualityLogic's Perspective

- **QualityLogic has a unique perspective on DER communication protocols**
  - Develops test tools for IEEE 2030.5 and OpenADR
  - Trains and supports developers and implementers of these standards
  - Tested and distributes IEC 61850 test tools
- **Advisers to industry stakeholders on DER protocols**
  - Utilities
  - Vendors
  - Alliances
  - Test Labs
  - Regulators
- **This is QualityLogic's perspective**
  - Starting point for analysis of specific applications

- **Open ADR:**
  - Official OpenADR Test Tool
  - In-person/Online Workshops
- **IEEE 2030.5**
  - CSIP Client/Server Certification Test Tools
  - Ad Hoc Client/Server Test Tools
  - In-person Workshops
- **DER Protocols**
  - Protocol Selection Workshop
  - Consulting and test planning

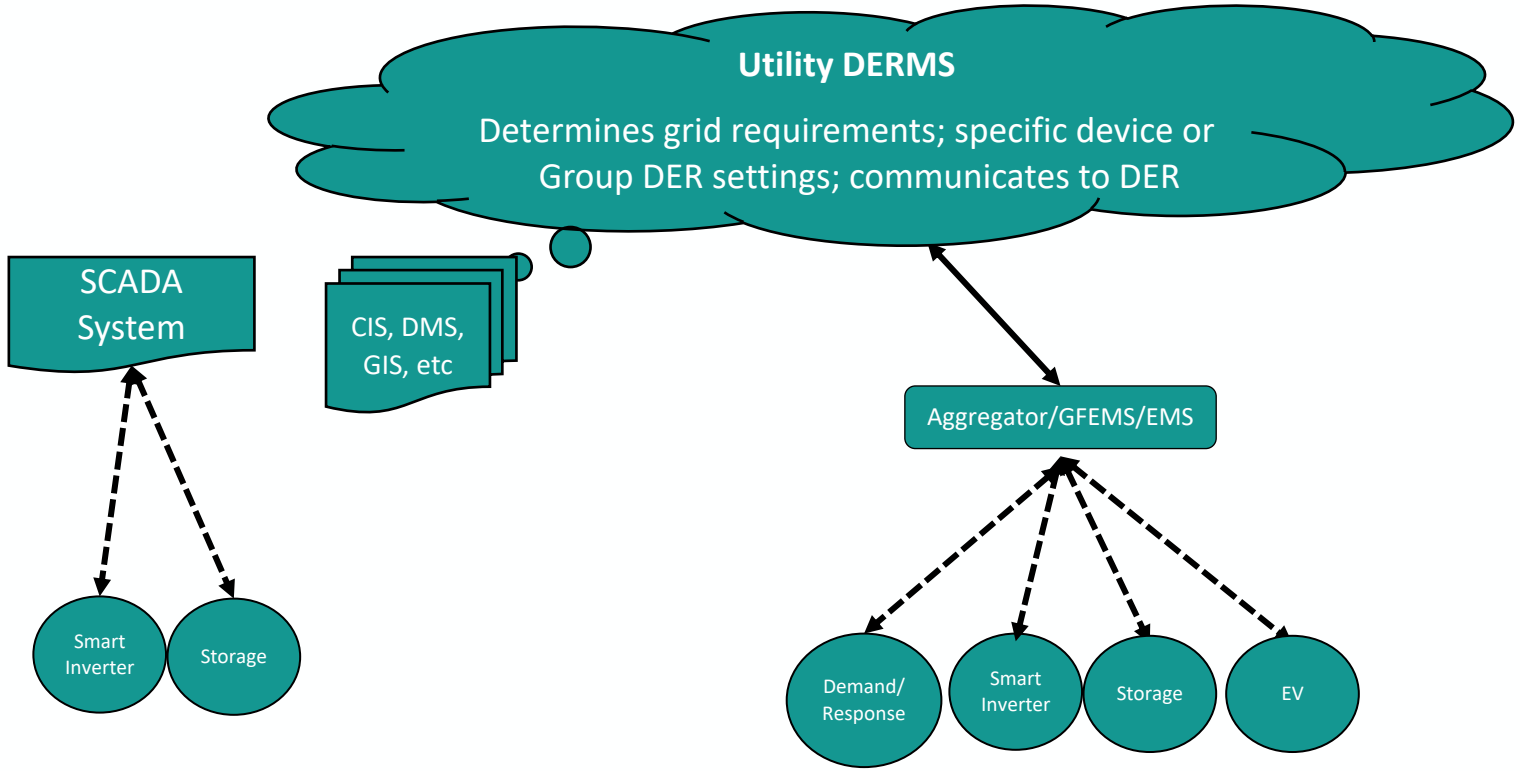
https://www.qualitylogic.com/industries/smart-energy/

Definitions: What is a Standard Protocol? What is a Use Case?

1. A ***standard*** is an internationally adopted agreement, typically done by IEEE, IEC, ISO, SAE, etc.
2. A communications "***protocol***" is simply a way of standardizing how machines communicate with each other – e.g., TCP/IP, Wi-Fi
3. A ***messaging protocol*** is a standard agreement on the information format and meaning that is communicated between two devices – e.g., OpenADR, IEEE 2030.5, DNP3, SunSpec
4. A ***use case*** can be considered as an application: includes actors, behaviours and interactions
5. A ***control architecture*** is the reference design or architecture for the communications between a distribution utility and DER being managed
6. ***DER*** is a Distributed Energy Resource and could be solar, battery storage, an EV in V2G mode, diesel generator or other "distributed", probably behind a customer meter, energy and power resource.

Distribution Utility Focus

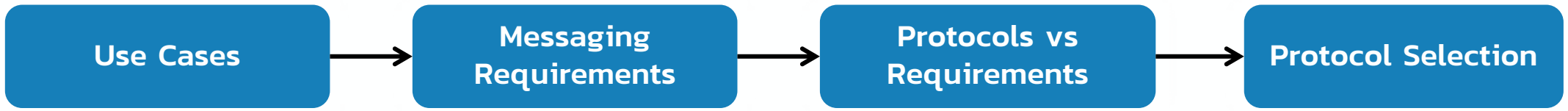
Communication link of concern is between the distribution utility and a DER. ISO/RTO/Bulk Power is out of scope.

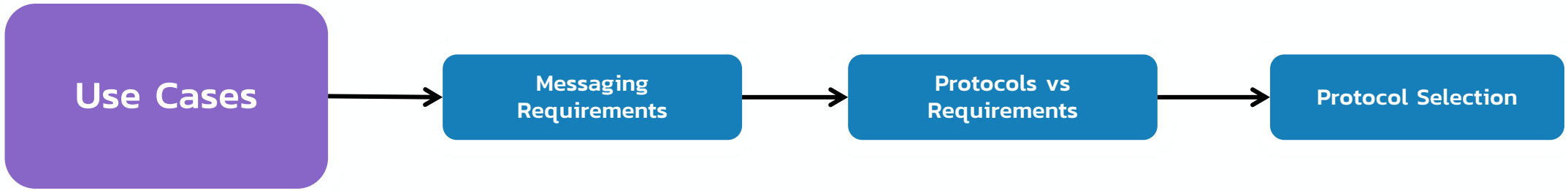


Leading DER Protocols

1. *OpenADR* (Open Automated Demand Response) protocol was developed in California but has been adopted as an IEC standard and is used in Japan, Korea, the US, Europe and elsewhere for DR program communications.
2. *IEEE 2030.5-2018* has recently been updated to incorporate the CA Rule 21 and IEEE 1547-2018 functionality in the standard.
3. *DNP3* (IEEE 1815-2010): Distributed Network Protocol 3 is popular in the US and used for real-time SCADA control of substations and utility controlled DER.
4. *IEC 61850* is a broad standard that encompasses not only communications but system engineering. While originally designed for the substation domain, it has expanded to include, and provide the basis for modelling of DER.
5. Other important protocols/standards such as IEEE 1547-2018, UL 1741, SunSpec, OCPP (Open Charge Point Protocol) and ISO 15118 for EV

Selecting the Right Protocol





Utility DER Application & Use Cases

What is a DERMS and an (A)DMS?

- **Distributed Energy Resource Management System (DERMS)**
  - Hardware and software platform to monitor and control distributed energy resources (DER) in a manner that maintains or improves the reliability, efficiency, and overall performance of the electric distribution system.
  - Typically operated via Web-based Custom Applications by Siemen, Enbala Power Networks, AutoGrid Systems, GE, EnergyHub, SGS, Opus One Solutions, Schneider Electric, OATI, Oracle Corporation or utility SCADA - many still under development and refinement
  - Typical communications protocols used: DNP3, OpenADR, IEEE 2030.5, IEC 61850 or Modbus
- **Distribution Management System (DMS), or an advanced DMS (ADMS)**
  - Decision support system intended to assist the distribution system operators, engineers, technicians, managers, and other personnel in monitoring, controlling, and optimizing the performance of the electric distribution system without jeopardizing the safety of the field workforce and the general public, and without jeopardizing the protection of electric distribution assets. An ADMS could be a DMS with the addition of a DERMS capability.
  - Typically operated via Proprietary Systems from Oracle, GE, Schneider, AutoGrid. ABB, Etap and/or utility asset database & SCADA
  - Typical Communication protocol is DNP3 with IEEE 2030.5 emerging for DER assets

SCADA Control
DNP3 or IEC 61850

AMI System
Proprietary RF mesh

Collects AMI Data from Smart Meters

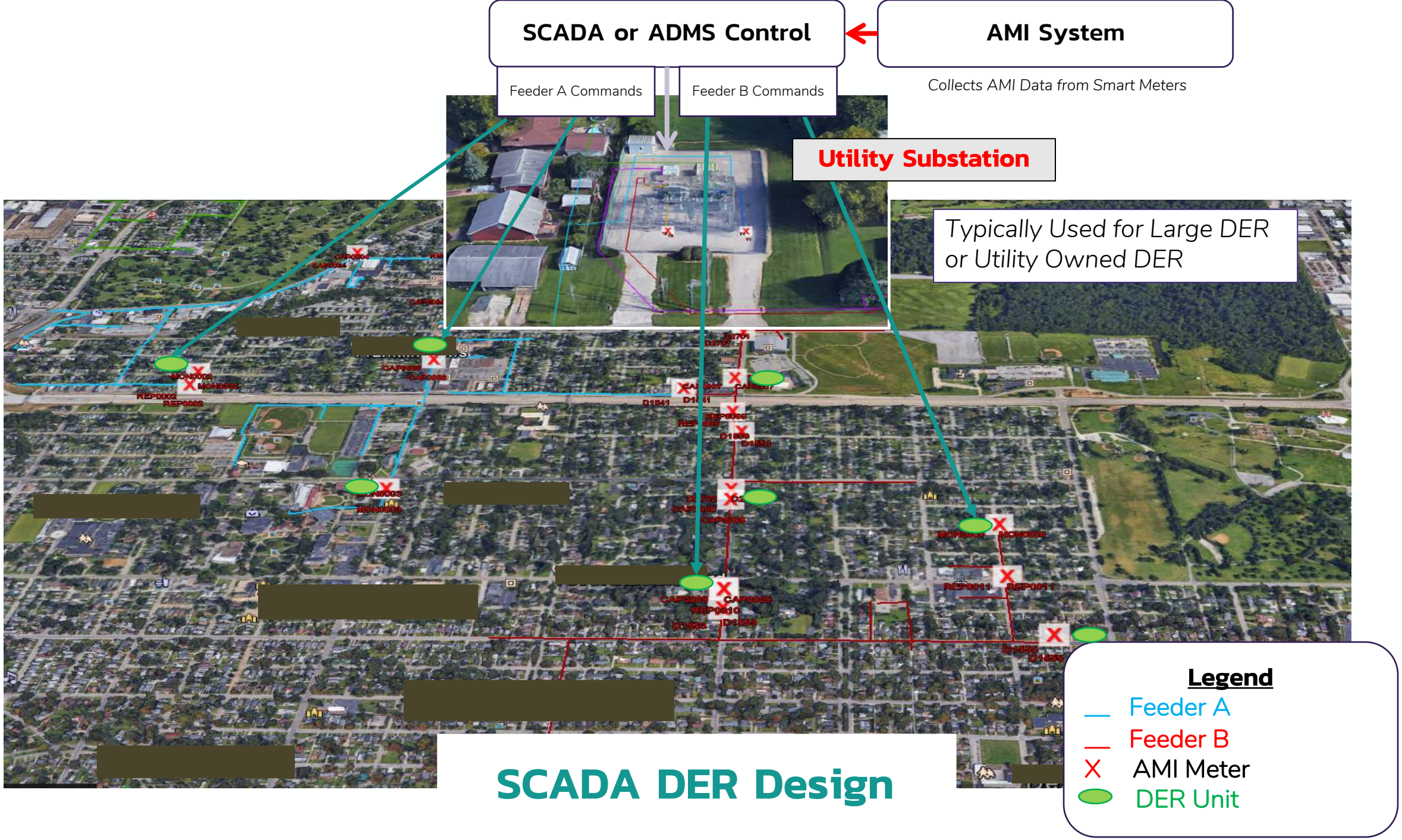
Utility Substation

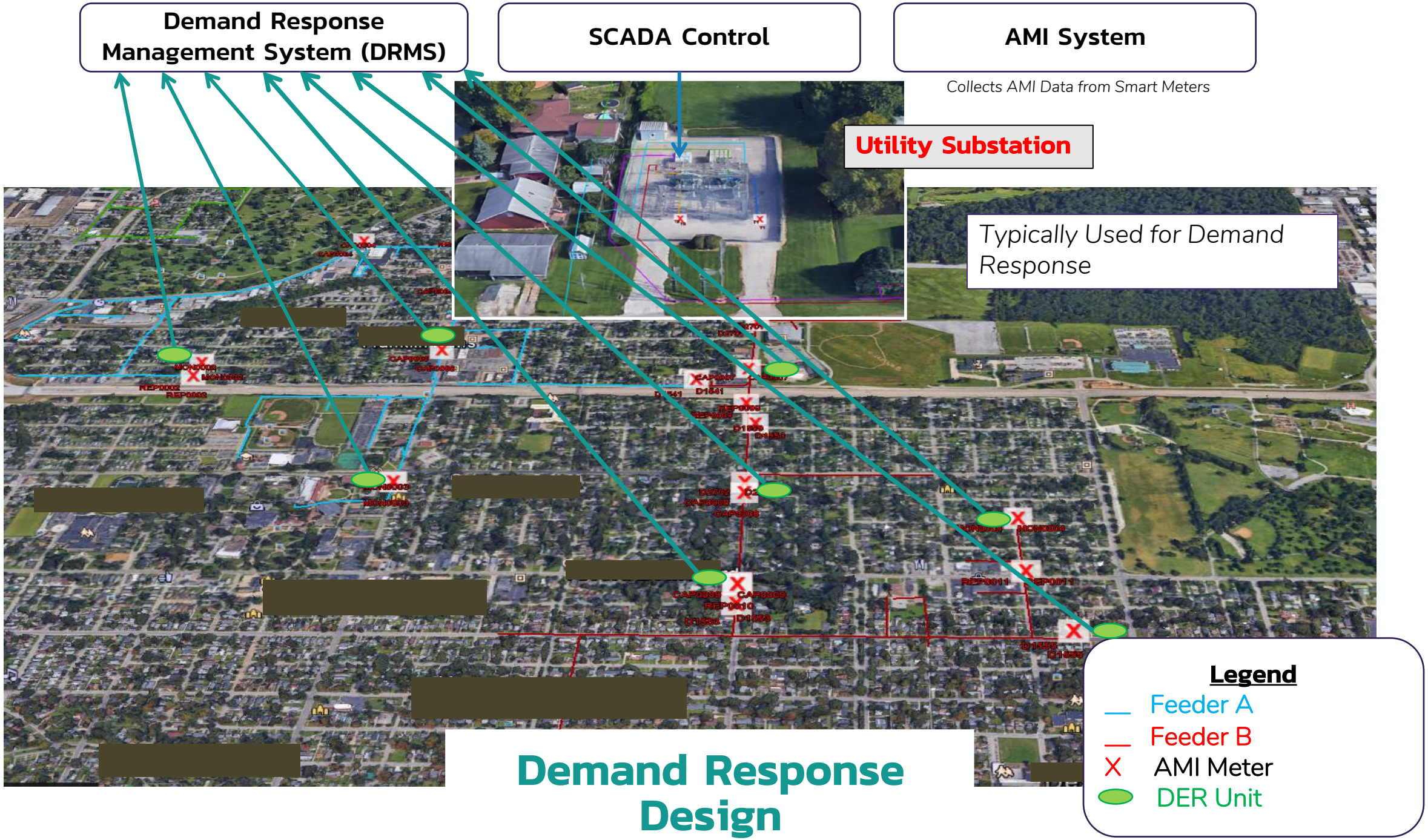
Typical Current Situation - Net Metering with No DER Control

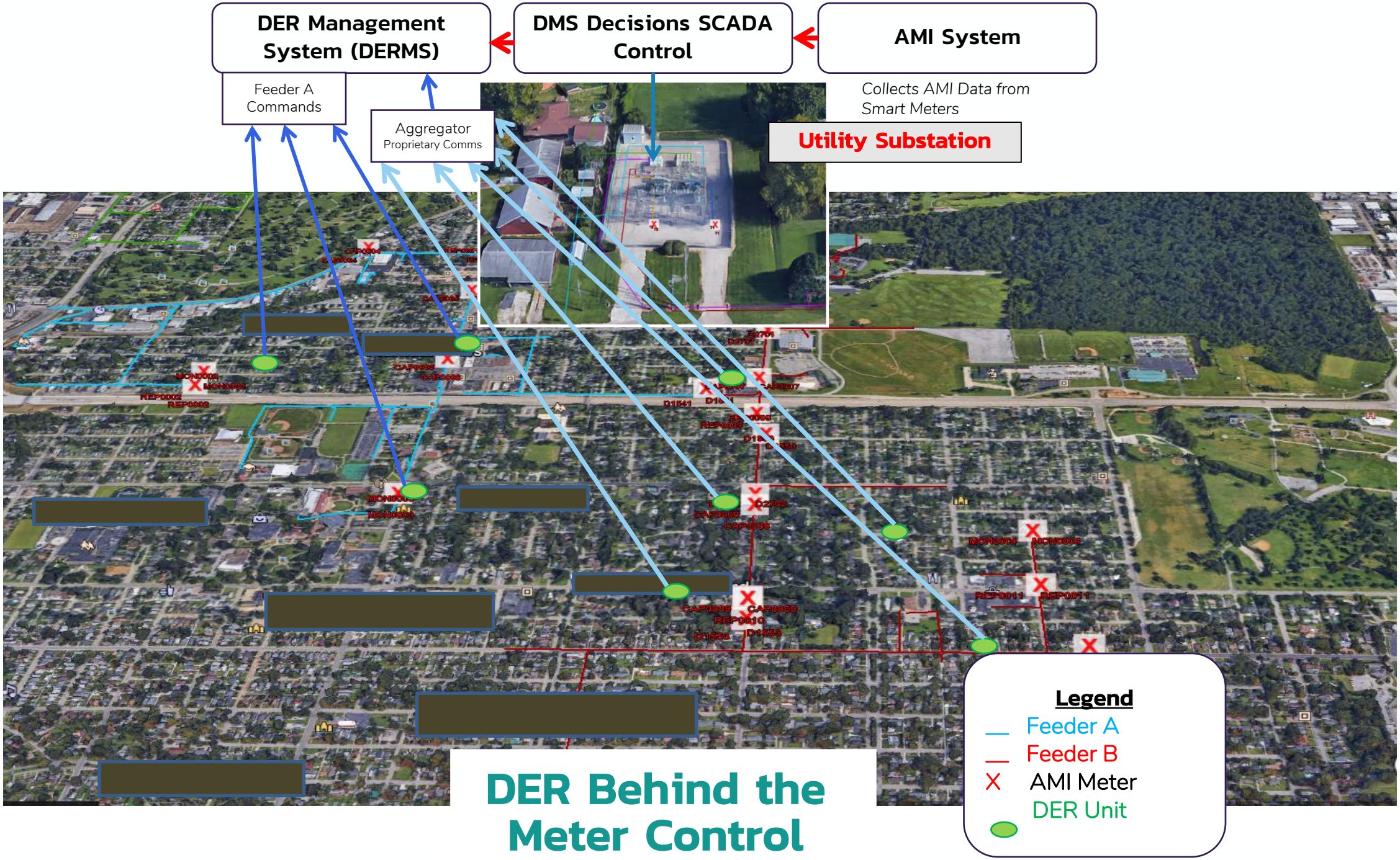
Current Utility Design

Legend

- Feeder A
- Feeder B
- X AMI Meter
- DER Unit


SCADA or ADMS Control
AMI System
Collects AMI Data from Smart Meters
Feeder A Commands
Feeder B Commands
Utility Substation
Typically Used for Large DER or Utility Owned DER
Legend
Feeder A
Feeder B
AMI Meter
DER Unit
SCADA DER Design


Demand Response Management System (DRMS)
SCADA Control
AMI System
Collects AMI Data from Smart Meters
Utility Substation
Typically Used for Demand Response
Legend
Feeder A
Feeder B
AMI Meter
DER Unit
Demand Response Design


DER Management System (DERMS)
DMS Decisions SCADA Control
AMI System
Feeder A Commands
Aggregator
Proprietary Comms
Collects AMI Data from Smart Meters
Utility Substation
Legend
Feeder A
Feeder B
AMI Meter
DER Unit
DER Behind the Meter Control

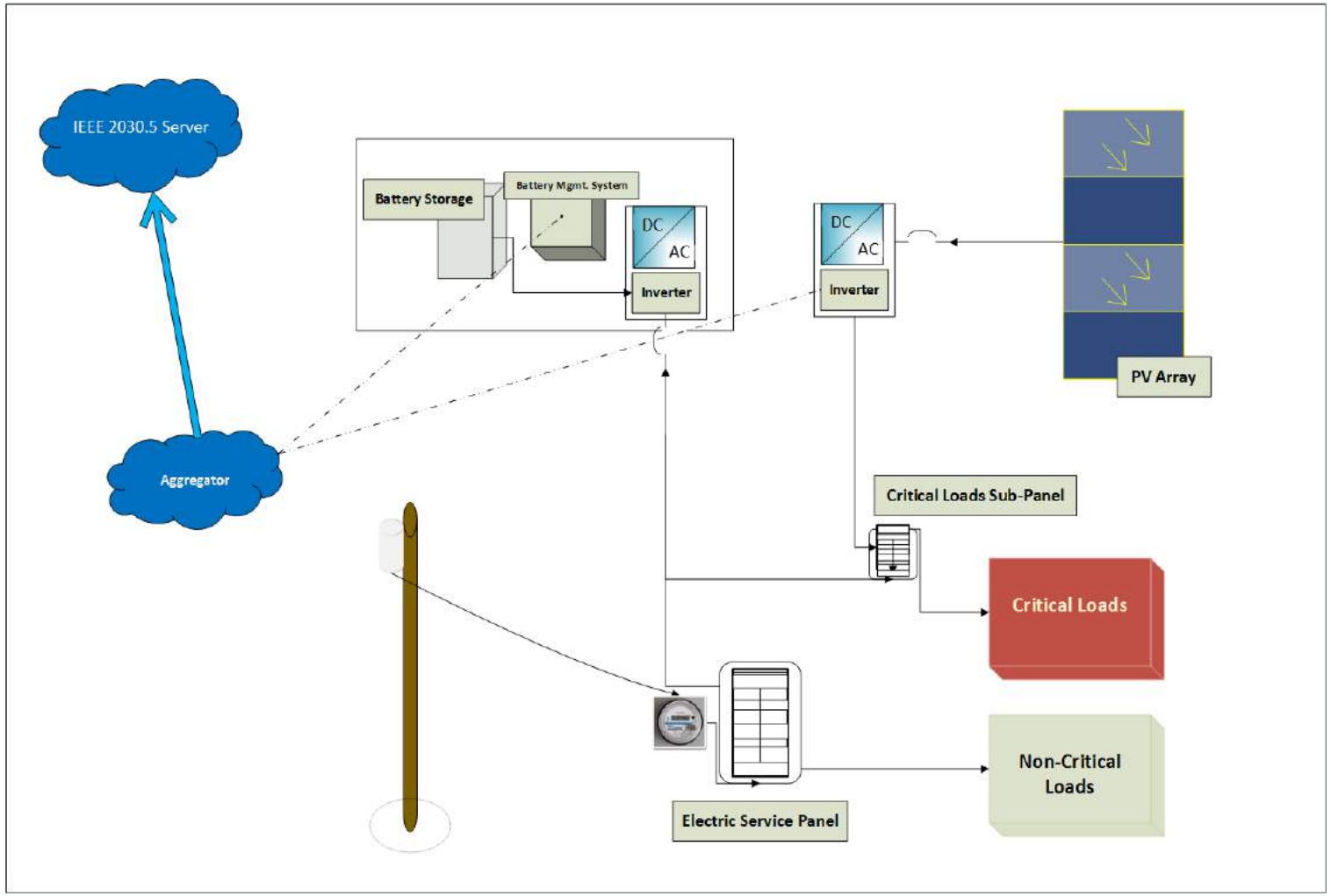
Residential AC Coupled PV + Storage System

Critical Messaging Requirements

- Near real-time > 1 sec
- Directed operations (Rule 21 DER Functions)
- Device discovery
- Pricing/Events/Schedules
- Group mgt/targeting
- Administration and reporting
- Security

Best Protocols

- IEEE 2030.5
- DNP3
- IEC 61850



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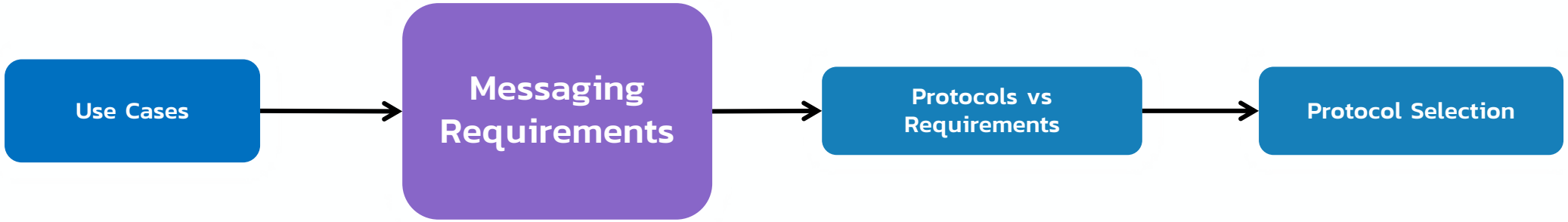


DER Messaging Requirements

DER Applications (Use Cases)

1. SCADA for larger solar or storage (or combined solar/storage)
2. Traditional DR incentivizes customers to allow changes in demand to manage peak loads or generation (duck curve)
3. DER Behind the Meter Control use-cases involve battery storage to shift peak loads or store excess power for higher-demand periods
    1. Solar Smoothing uses a battery system to slow rapid ramps(+/-) of power due to clouds
    2. Duck Curve Mitigation using a combination of solar smoothing and peak time load/solar shifting
    3. Black Start capability of a DER provides enough capacity and energy after a system failure to serve loads for a period
    4. CA Rule 21 Solar and Storage mandates the use of IEEE 2030.5 for communications from a utility DERMS to some form of “gateway”
    5. Special Case: V2G standardization of communications protocols for vehicle to grid (V2G) applications is in its infancy

Defining DER Messaging Requirements

The DER messaging requirements are derived from leveraging prior works and examining the applications (use cases). Key sources include

- CPUC SIWG Phase 2 Recommendations and associated documents (CSIP)
- OpenADR-EPRI DER Communications Workshop, June 2017
- CA CPUC VGI Workgroup Staff Report, Feb 2018

What Messages are Required for DR/DER Management?

SCADA Control Only

Directed operations (real-time behaviors)
- DER curves and controls
- Emergency dispatch
- Notifications/Alarms

Reporting / Monitoring
- DER information / status
- Configuration
- Metering / performance
- Telemetry

DR and DER Control Messages

DER operations (near real-time behaviors)
- DER curve, controls, settings, schedules
- Emergency dispatch
- Notifications/Alarms
- 61850-7-420 Information Model

DER Administration
- Enrollment/Registration
- Asset owners/Utility Programs
- Individual DER device knowledge

Grid Requirements
- IEC 61968-5
- Volt/Freq Support
- Load Management
- Emergency dispatch
- Notifications/Alarms

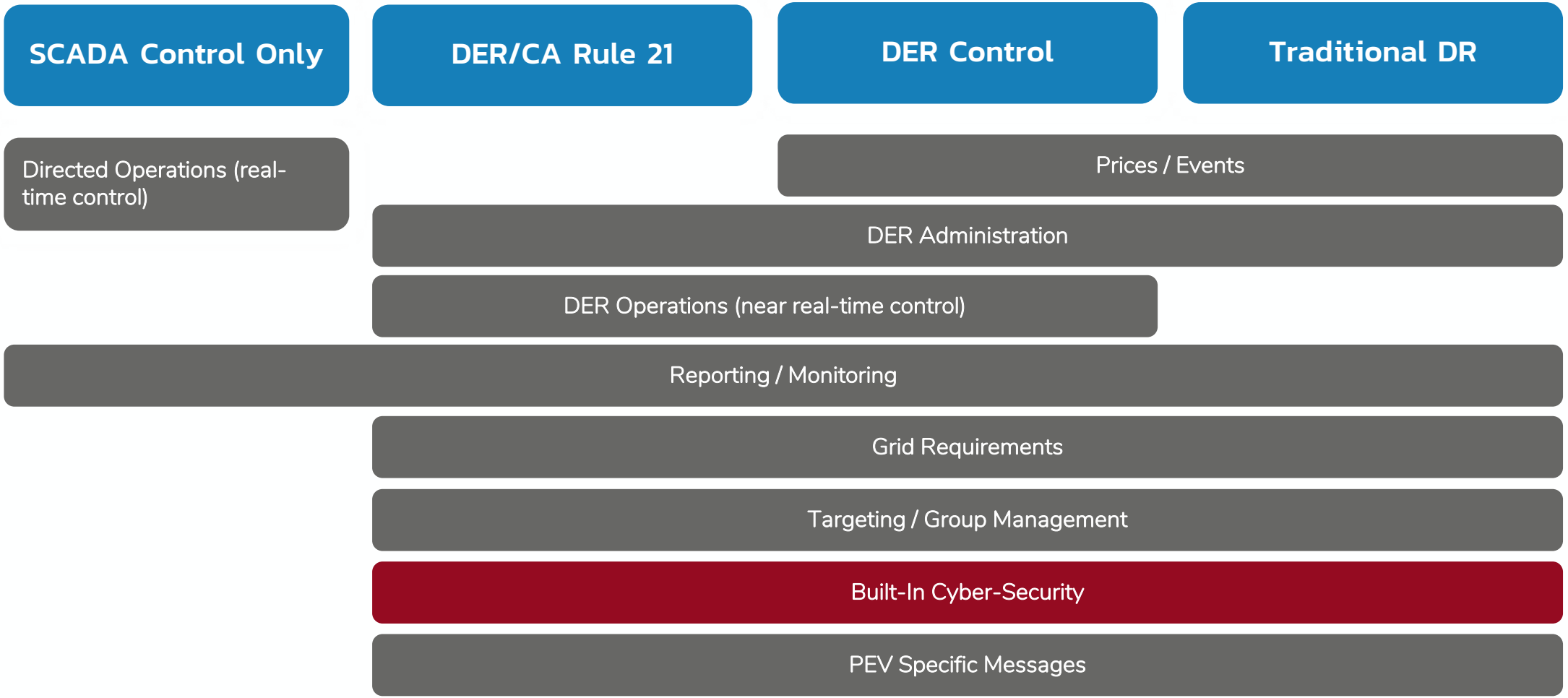
Targeting/Groupings
- Group Management
- Aggregation

Built-In Cyber-Security

Prices / Events
- Price Signals: TOU, CPP
- RT Pricing, CPR
- Event / Schedules

PEV Specific Messages
- PEV SoC/status
- Start/end times
- Energy required
- Ramping/Charge rate
- Restart

What Messages are Required for DR/DER Management?



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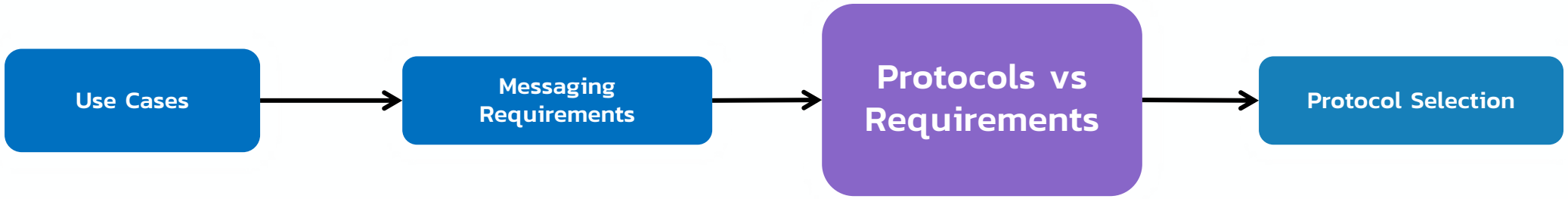

Messaging vs Protocols

Messaging Requirements by Application

	SCADA CONTROL	DEMAND RESPONSE	DER CONTROL
DER Real-Time Control	✓		
DER Operations (Curves/Settings)			✓
Reporting/Monitoring	✓	✓	✓
DER Administration		✓	✓
Prices/Events		✓	✓
Grid Requirements		✓	✓
Targeting/Group Management		✓	✓
Cyber-Security		✓	✓
PEV V2G Messaging			✓
Total Messaging Groups	9	9	9
Relevant Application Groups	2	6	8

Messaging Requirements vs Protocols

	1. OpenADR	2. IEEE 2030.5	3. DNP3	4. IEC 61850
DER Real-Time Control			✓	✓
DER Operations (Curves/Settings)	✓	✓	✓	✓
Reporting/Monitoring	✓	✓	✓	✓
DER Administration	✓	✓		
Prices/Events	✓	✓		
Grid Requirements	✓	✓		
Targeting/Group Management	✓	✓		
Cyber-Security	✓	✓	✓	✓
PEV V2G Messaging	✓	✓		
Total Messaging Groups	9	9	9	9
Relevant Application Groups	8	8	2+	2+

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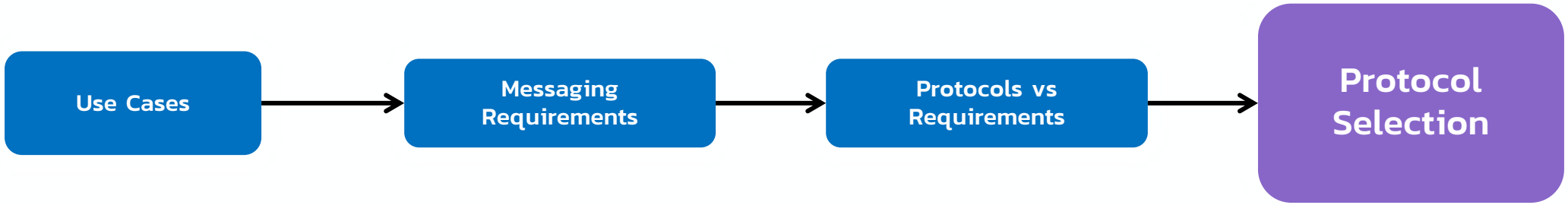
Applications and Protocols

	1. OpenADR	2. IEEE 2030.5	3. DNP3	4. IEC 61850
DER SCADA Control			✓	✓
Demand Response	✓	✓		
DER Behind the Meter Control		✓	✓	✓

Protocol Differences: Other Factors

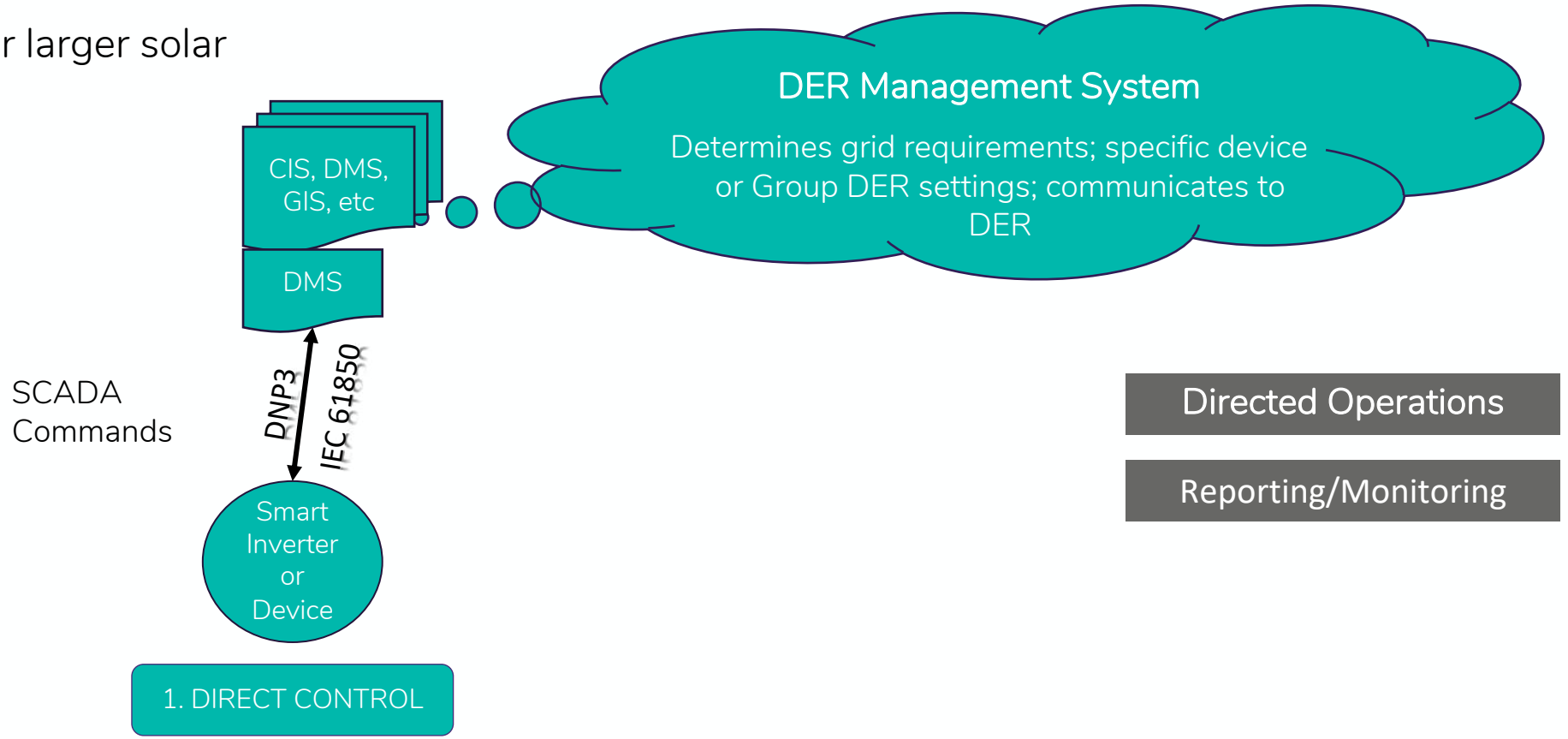
Requirement	OpenADR 2.0	IEEE 2030.5	DNP 3	IEC 61850
IEC 61850-7-420 Information Model	NO – uses CIM and Energy Interop			
SCADA Speed Support	Not in design. XMPP for fast persistent connections	Not designed in standard		
Product Maturity and Interoperability	Wide adoption. No DER Specific Certification	DER Certification Program 2019	Wide adoption. DER Specific Certification in development	Wide adoption. No DER Specific Certification
Mandates for DER Communications	CA Title 24	CA Rule 21, Title 24 and IEEE 1547	IEEE 1547	IEC
Applications Covered	Most DR	DR and DER	Direct SCADA and potential DER	Direct SCADA and potential DER



Summary of Selection Recommendations

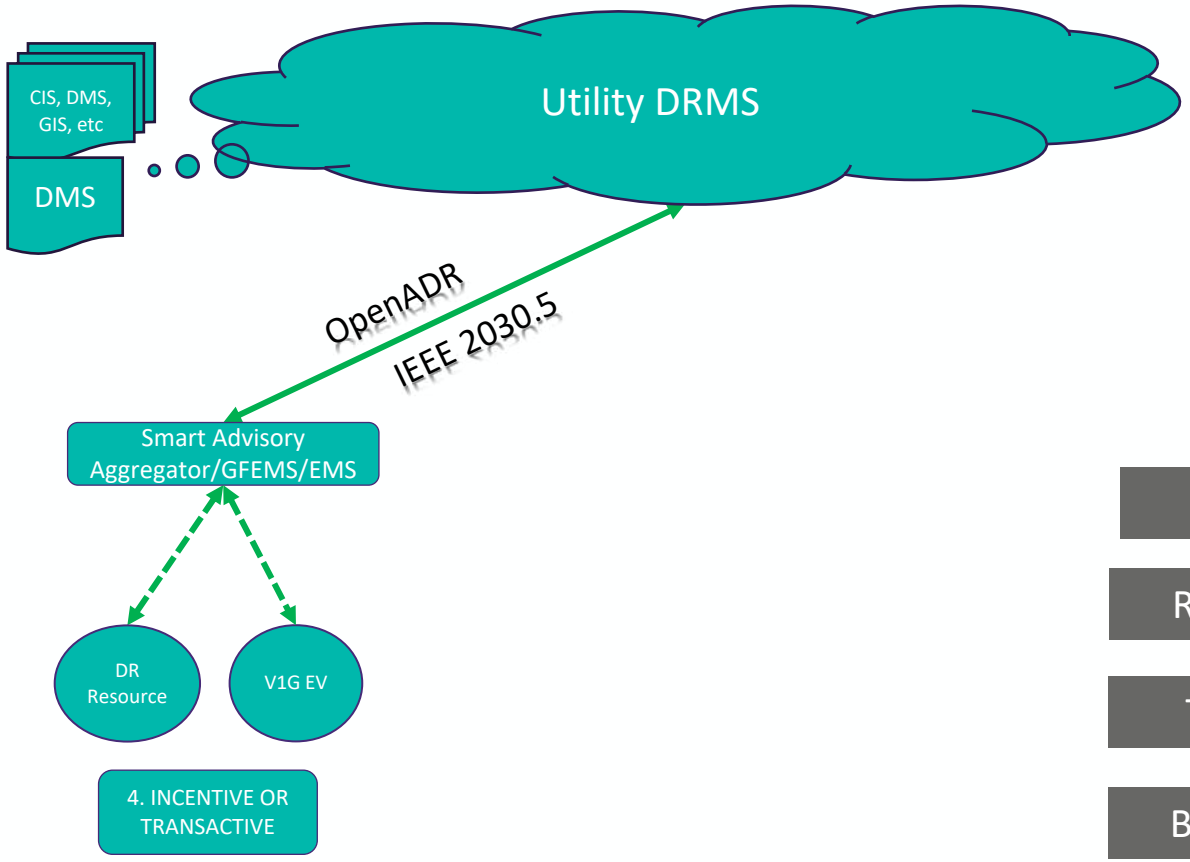
Summary: SCADA Protocol Selection

SCADA direct control for larger solar or storage (or combined solar/storage)



Example Application: DR Messaging & Protocols

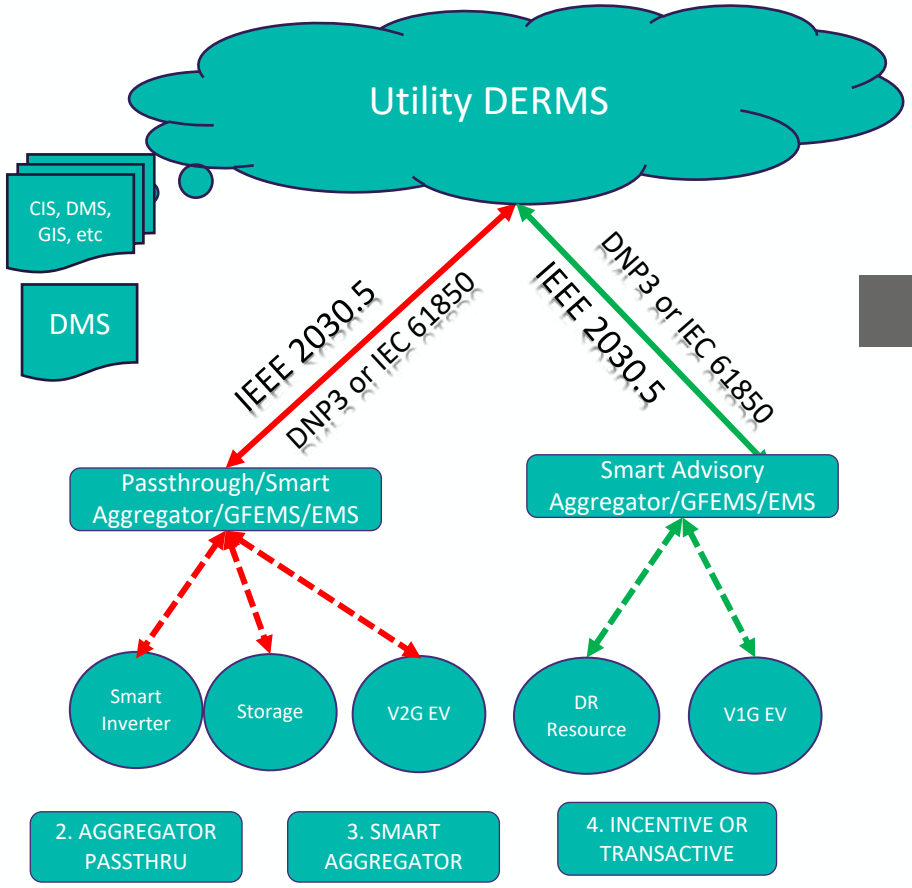
Traditional DR for peak shaving, peak shifting, etc. No energy export



- Prices/Events
- DER Administration
- Reporting/Monitoring
- Targeting/Groupings
- Built-In Cyber-Security

Summary: DER Behind the Meter Control

1. **Solar Smoothing** uses a battery system to slow rapid ramps(+/-) of power due to clouds
2. **Duck Curve Mitigation** using a combination of solar smoothing and peak time load/solar shifting
3. **Black Start** capability of a DER provides enough capacity and energy after a system failure to serve loads for a period
4. **CA Rule 21** Solar and Storage mandates the use of IEEE 2030.5 for communications from a utility DERMS to some form of "gateway"
5. **Special Case: V2G** standardization of communications protocols for vehicle to grid (V2G) applications is in its infancy



Prices/Events

DER Administration

DER operations (near real-time behaviors)

Reporting/Monitoring

Grid Requirements

Targeting/Groupings

Built-In Cyber-Security

PEV Messages

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Summary Matrix — Applications and Protocols

Use Case/Application	Recommended Protocol(s)	Alternative Protocols
Utility Scale Solar/Storage – SCADA Control	DNP3, IEC 61850	IEEE 2030.5
DR: Utility to EMS/Aggregator	OpenADR	IEEE 2030.5
Solar Smoothing	DNP3, IEC 61850	IEEE 2030.5
Duck Curve Mitigation	IEEE 2030.5	DNP3, IEC 61850
Black Start – Wildfire Prevention	IEEE 2030.5	DNP3, IEC 61850
CA Rule 21 Solar and Storage	IEEE 2030.5	DNP3, IEC 61850
V2G Applications: Utility to EVSE/PEV/Gateway	IEEE 2030.5	DNP3, IEC 61850, OpenADR, OCCP, ISO 15118

Questions & Answers

Thank You

Contact Information

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- Mark Osborn – mosborn@qualitylogic.com

Free DER Protocol Selection Guide

https://www.qualitylogic.com/knowledge-center/content-library/der-communication-protocol-selection-guide/

Surveys

- Webinar Feedback: https://www.surveymonkey.com/r/NL5HFGW
- Newsletter Interest ($100 Amazon Card Drawing): https://www.surveymonkey.com/r/QLQJZ3H

EV Messaging Protocols

EV Messaging Protocols Presentation, SEPA EV WG, Tomorrow, March 19, 4PM EDT

https://global.gotomeeting.com/join/824235597

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