Introduction to DERMS

2018 PV Symposium

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Workshop Agenda

1. Introduction to DERMS (EPRI) – 50 min

2. DERMS with IOU assets (SDG&E) – 45 min

Break: 30 min

3. Tools & Projects (EPRI) – 30 min

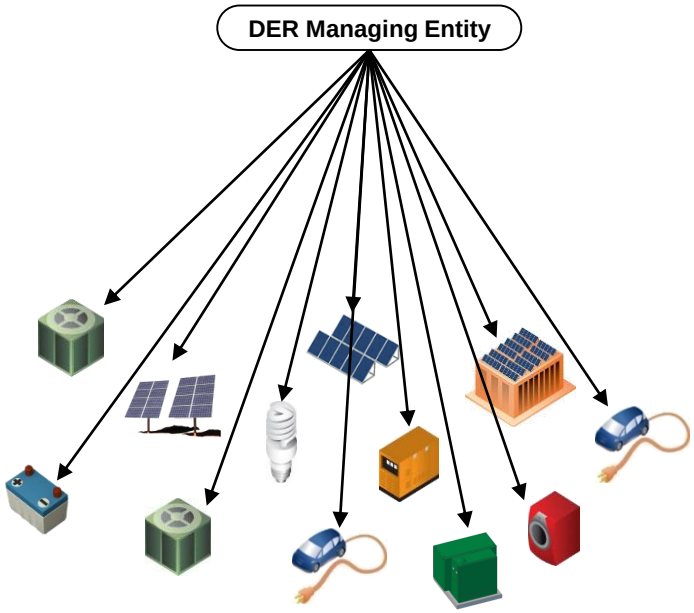
4. DERMS Open Forum (All Participants) – 50 min

Workshop Agenda

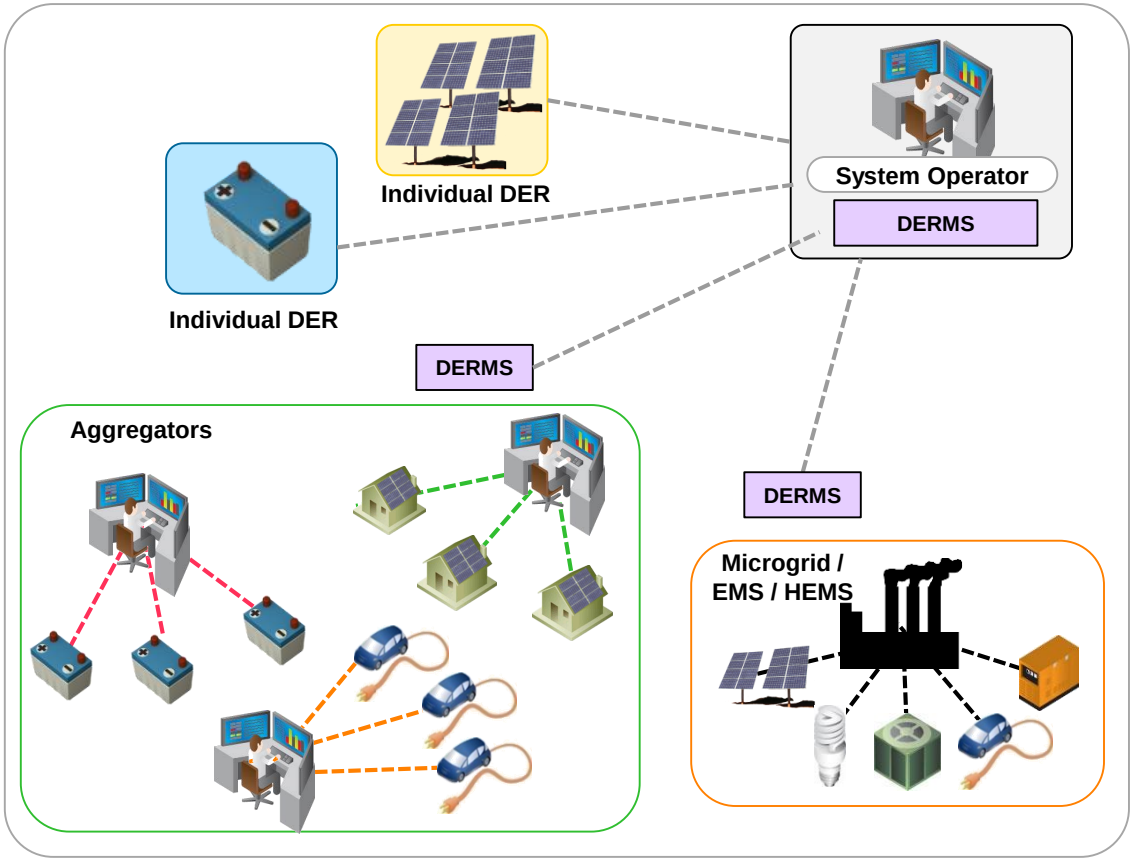
1. Introduction to DERMS (EPRI) – 50 min
   - Definition of DERMS
   - System Architecture
   - Functions for DER Integration
     - Group-Level Functions
     - Device-Level Functions
   - Communication Protocols for DER Integration
     - Group-Level Protocols
     - Device-Level Protocols
     - Update on IEEE 1547

Definition of DERMS

The Need for DERMS



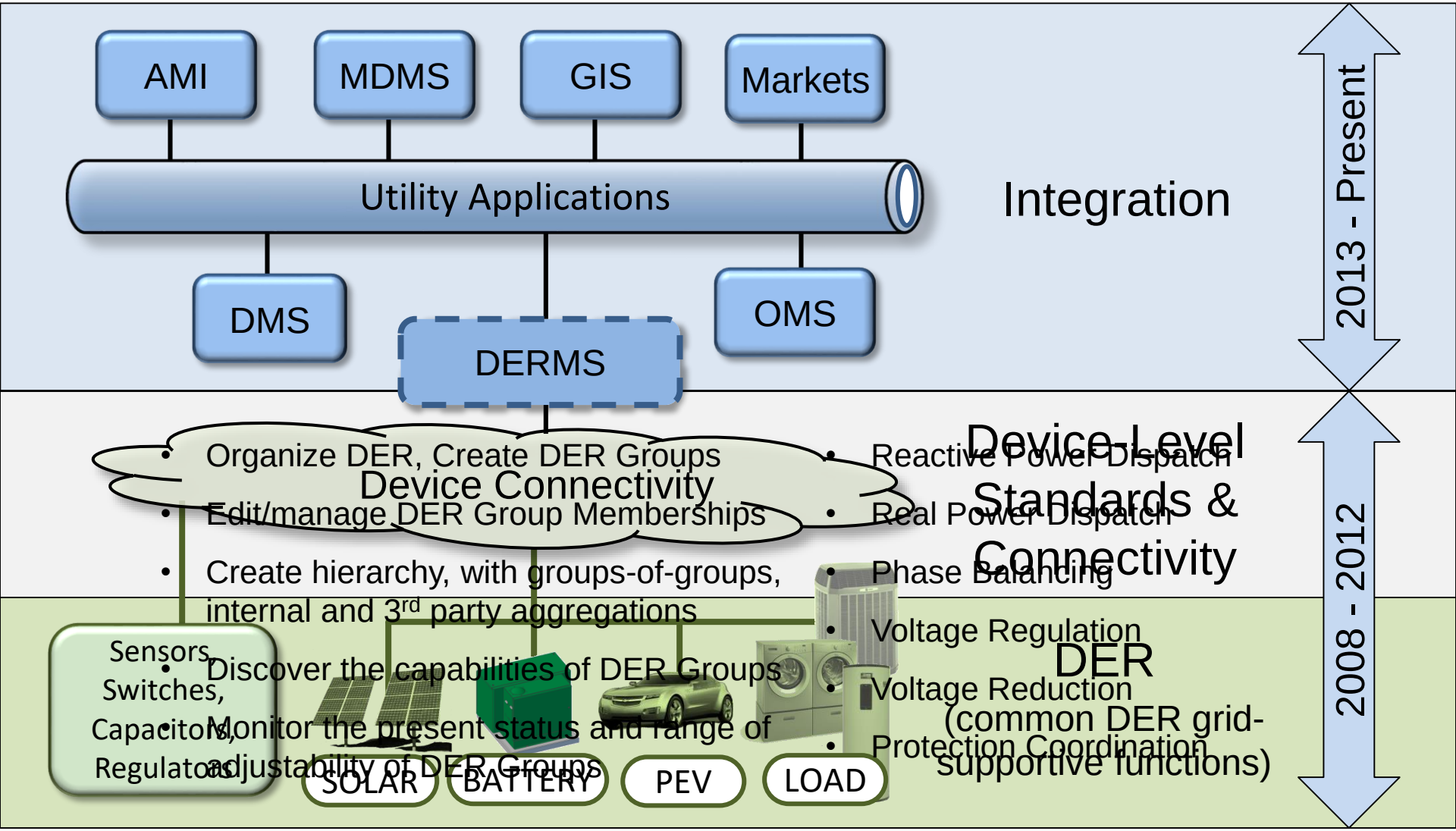
① **Centralized** control of increasing number of DER is ***challenging***



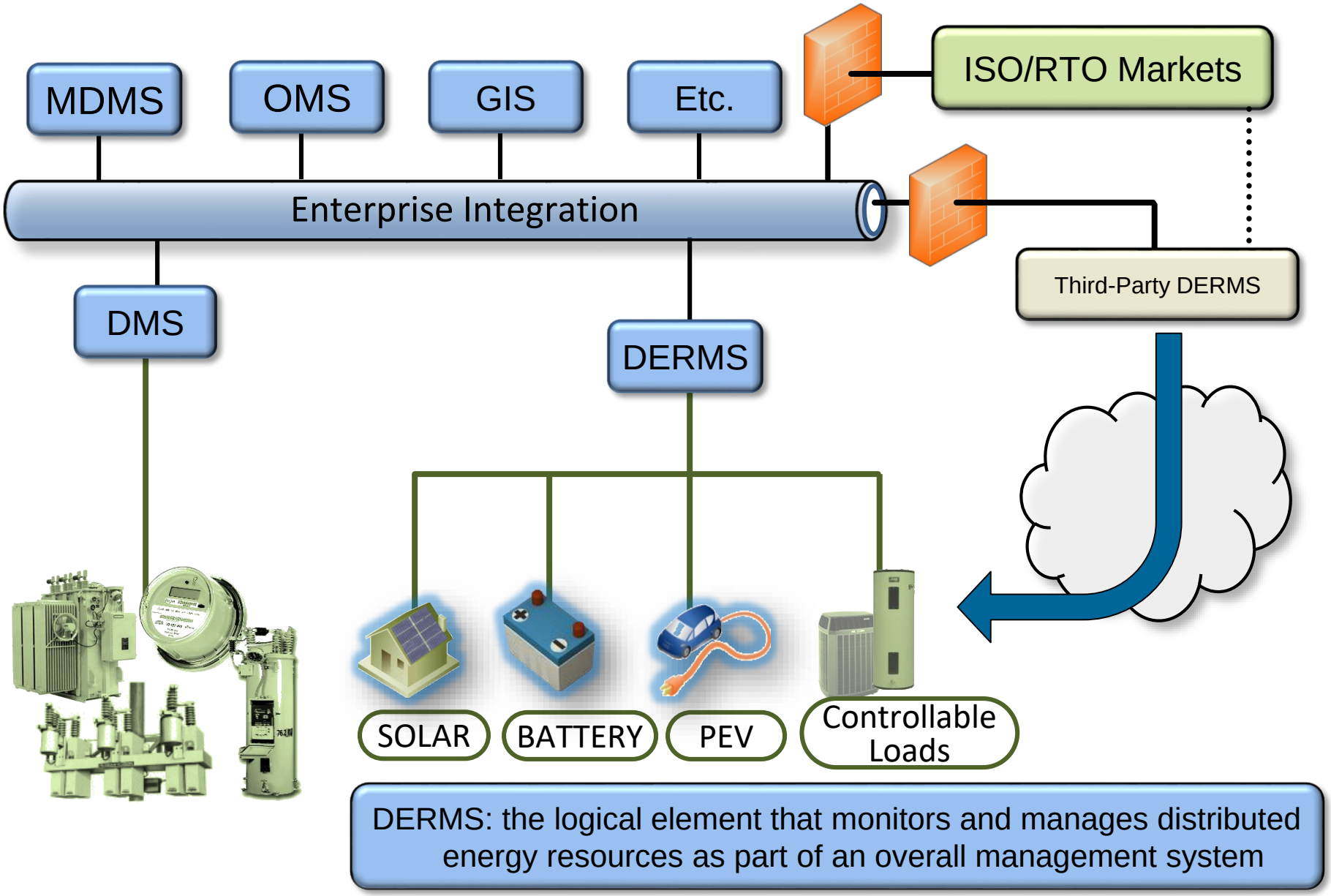
② Utilizing **groups of DER** enables **distributed controls** thereby increasing **scalability**

③ **DERMS** acts as a **management entity** for **individual** as well as **groups of DER.**

The Need for DERMS



What is a "DERMS"



DERMS: the logical element that monitors and manages distributed energy resources as part of an overall management system

What does a DERMS Do?

- **Translate**

  Individual DER may speak different languages, depending on their type and scale. DERMS handle these diverse languages, and present to the upstream calling entity in a cohesive way.

- **Aggregate**

  DERMS take the services of millions of individual DER and present them as a smaller, more manageable, number of aggregated virtual resources that are aligned with the grid configuration.

- **Simplify**

  DERMS provide simplified aggregate services that are useful to distribution operations. Device-level settings, details and iterations are abstracted away as services are achieved and sustained.

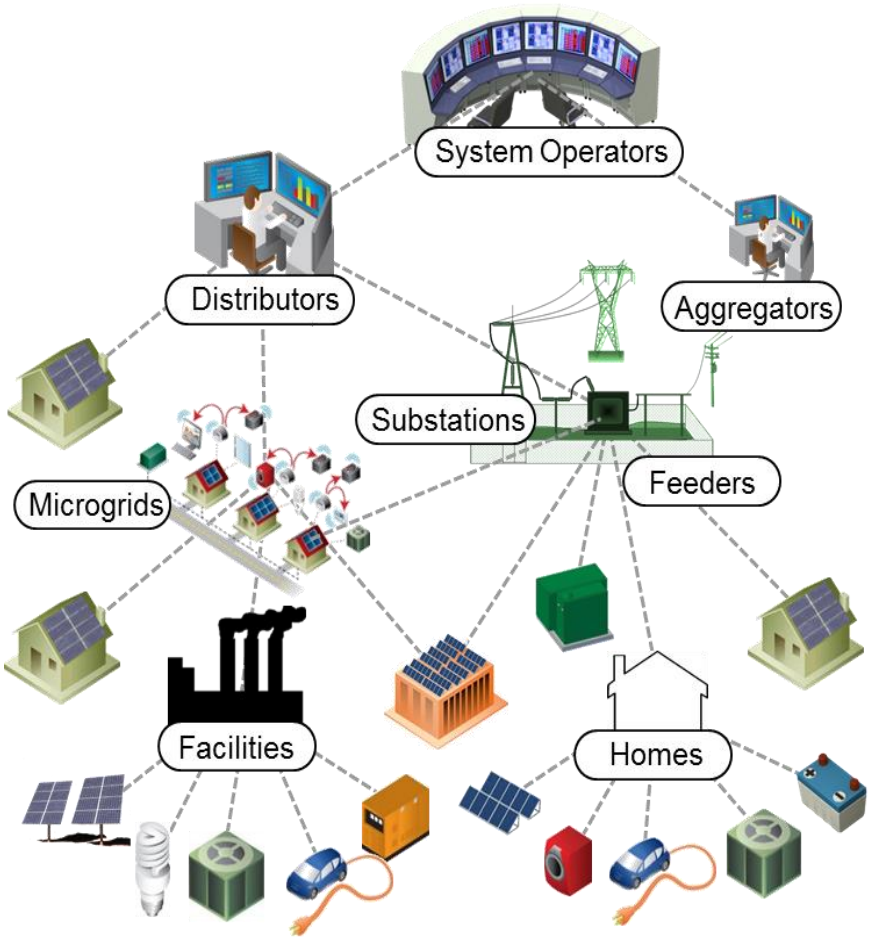
- **Optimize**

  A given service to be provided by a DER groups may be achieved in many ways. Different smart inverter functions may be best at different locations or times. DERMS manage the members of a DER group in the optimal way, saving cost, reducing wear, and optimizing asset value.

System Architecture

DERMS Functionality May Exist at Multiple Levels

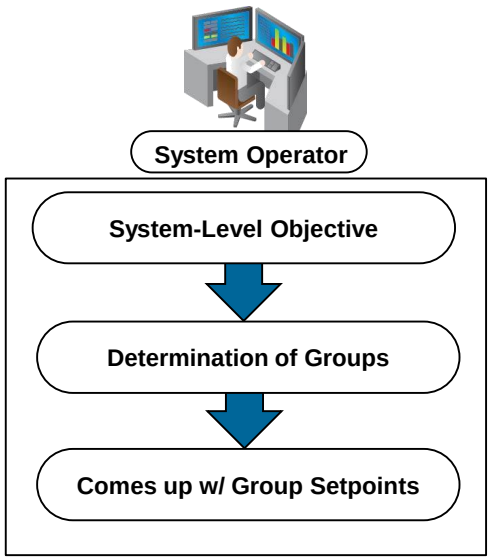
Levels of Control	Example Control Entity
System-Wide Control	ility RMS
Regional Control	Vendor Aggregators
Feeder-Level Control	crogrid trollers
Smart Community Controller	Bldg Energy Management



A DERMS definition that can expand to multiple tiers prepares for the future, enables distributed intelligence and enhances grid resilience

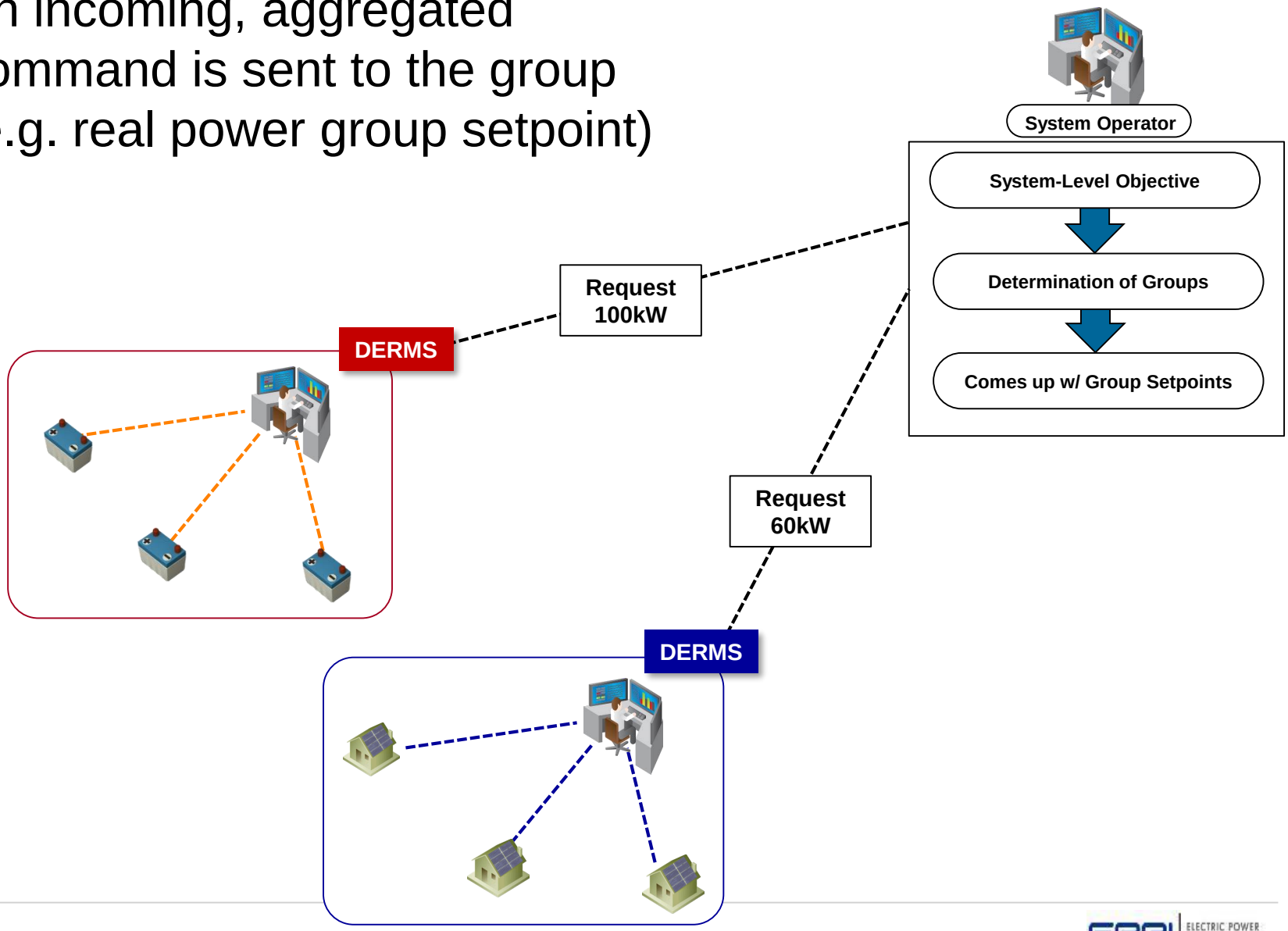
How DER grouping works?

1. Prior to sending the group command, the system operator determines the grouping as well as type of group command that are necessary to achieve the system operator's objective.



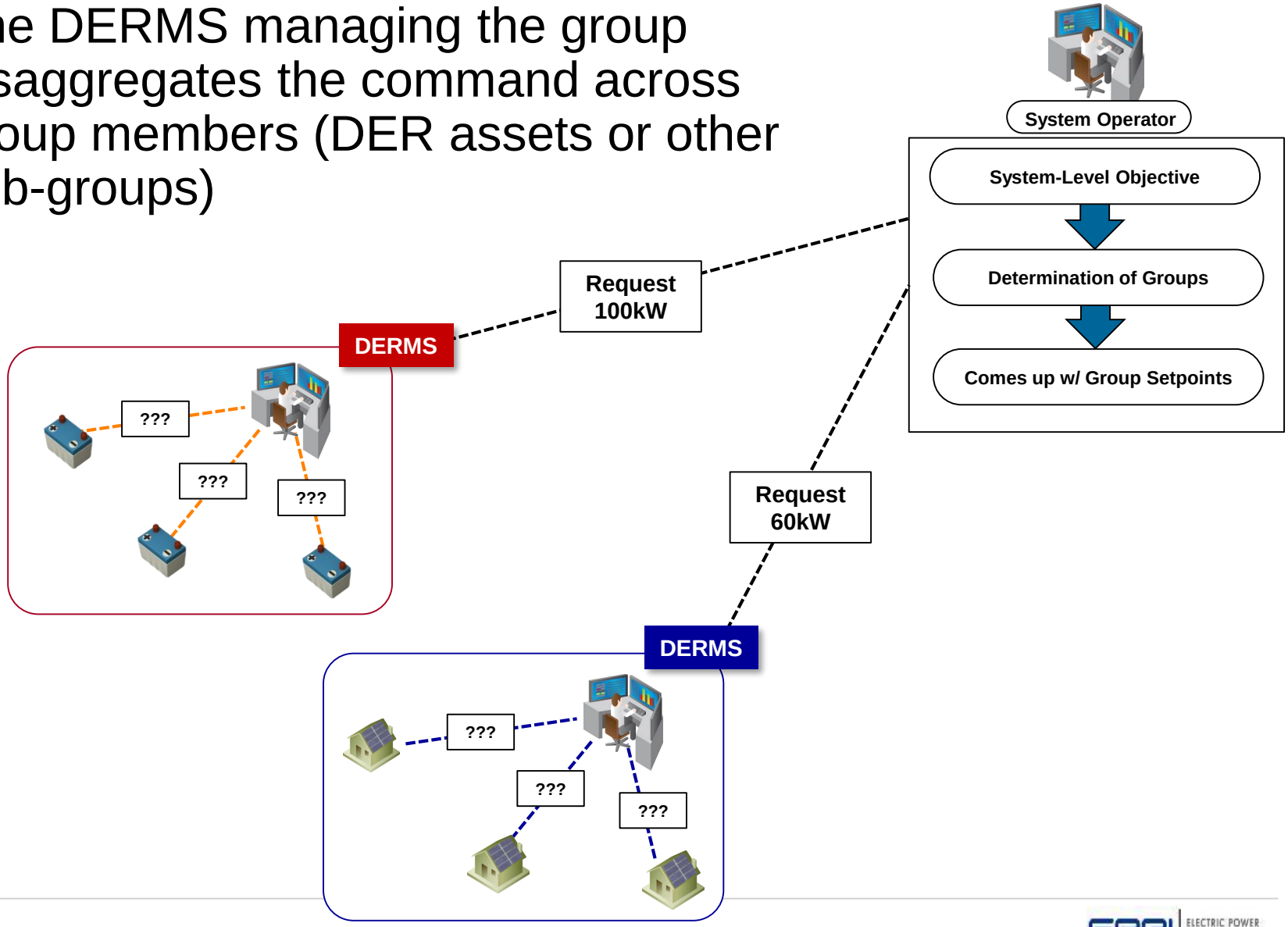
How DER grouping works?

2. An incoming, aggregated command is sent to the group (e.g. real power group setpoint)



How DER grouping works?

3. The DERMS managing the group disaggregates the command across group members (DER assets or other sub-groups)



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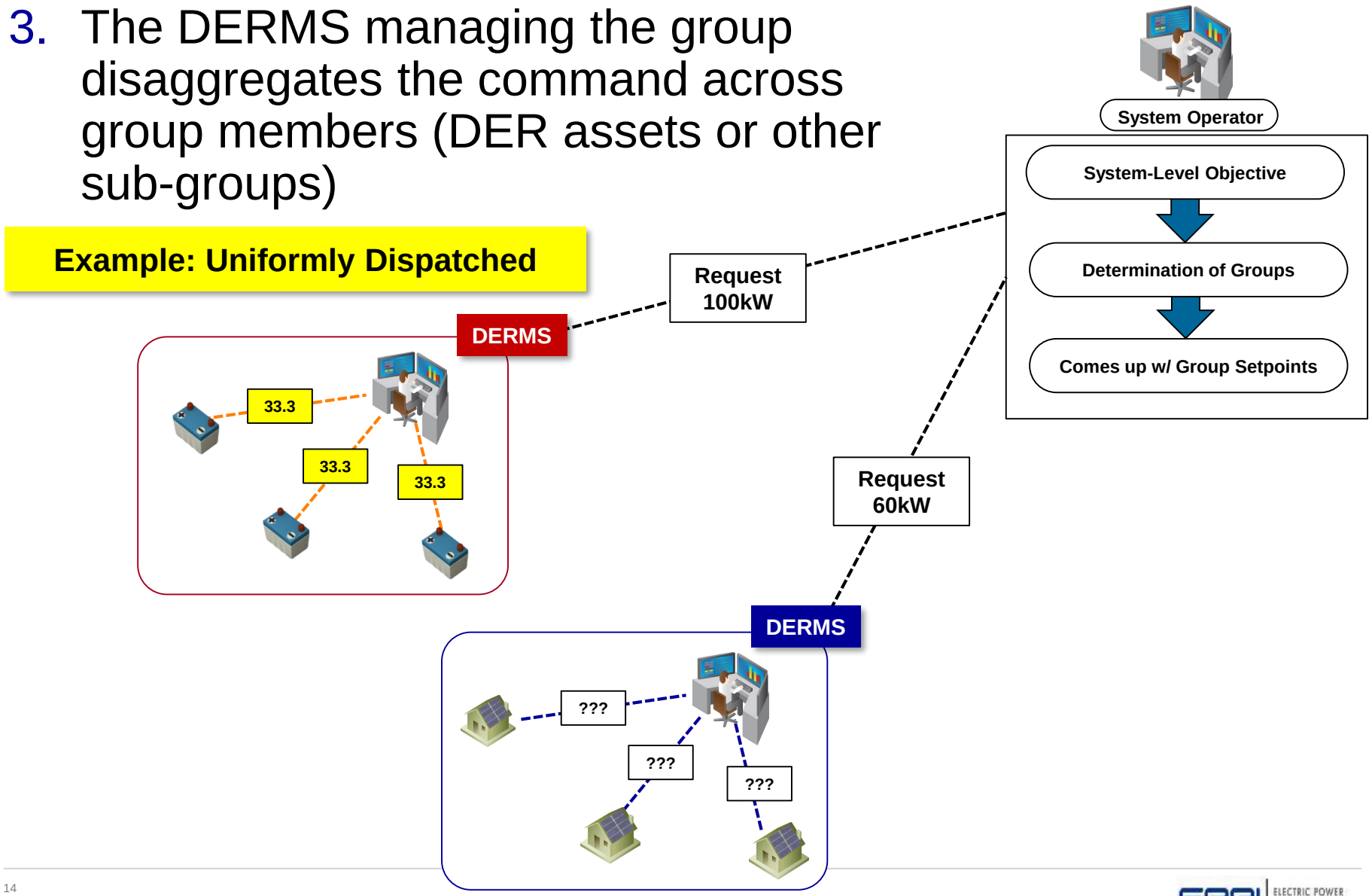
Example: Uniformly Dispatched



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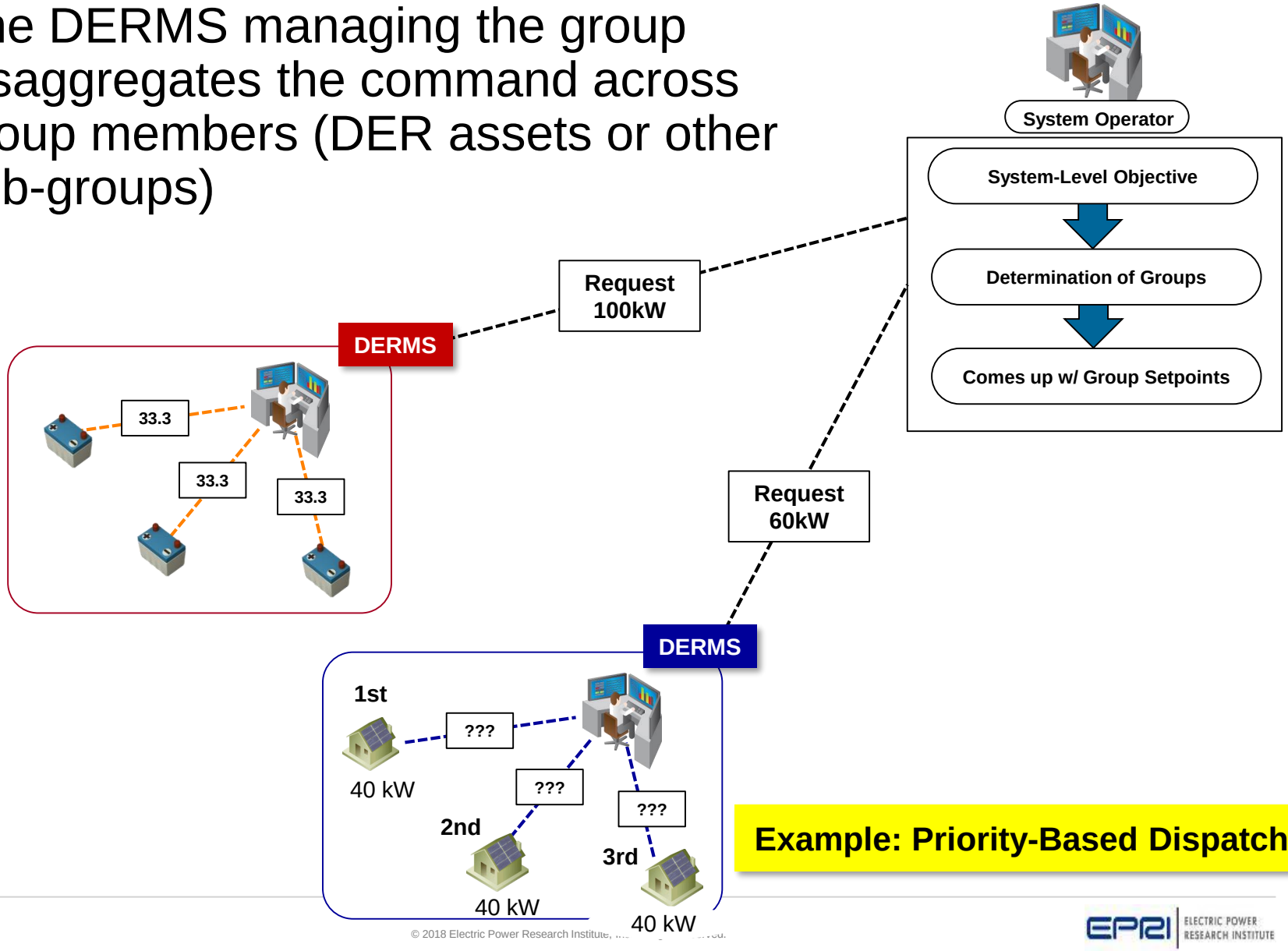

Example: Priority-Based Dispatch

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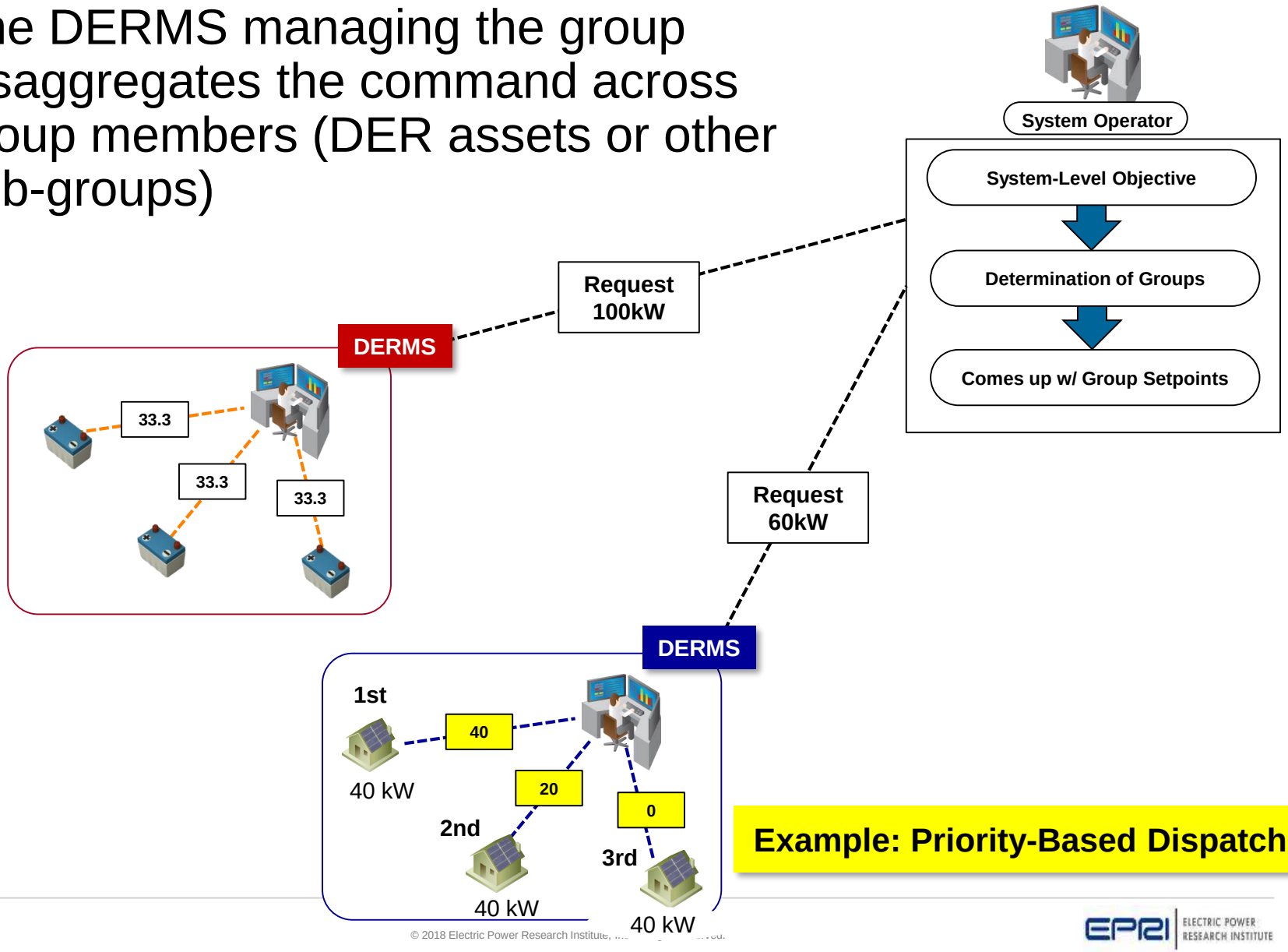

Example: Priority-Based Dispatch

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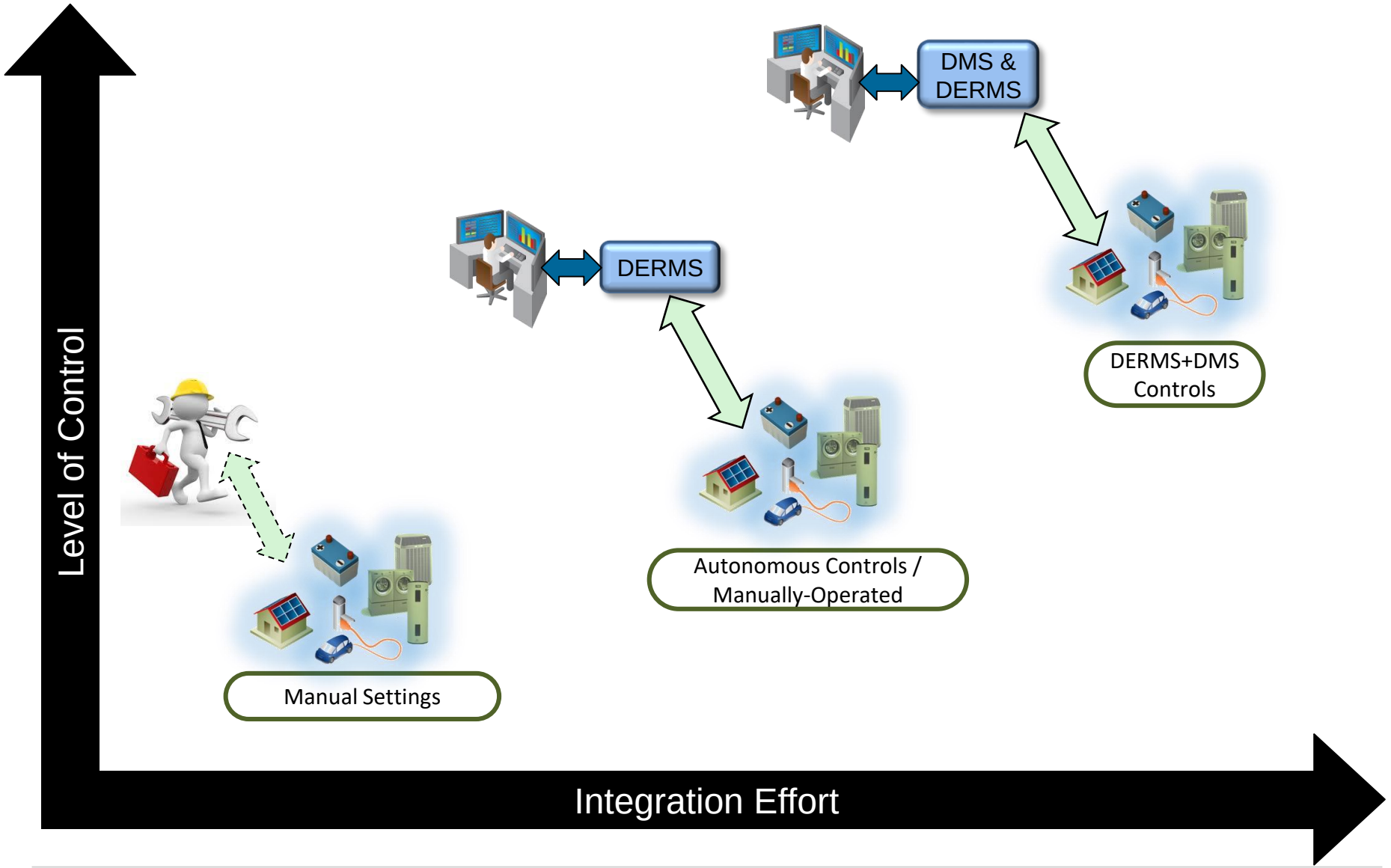
How DER grouping works?

Many other ways for DERMS to Dispatch a Group Command…

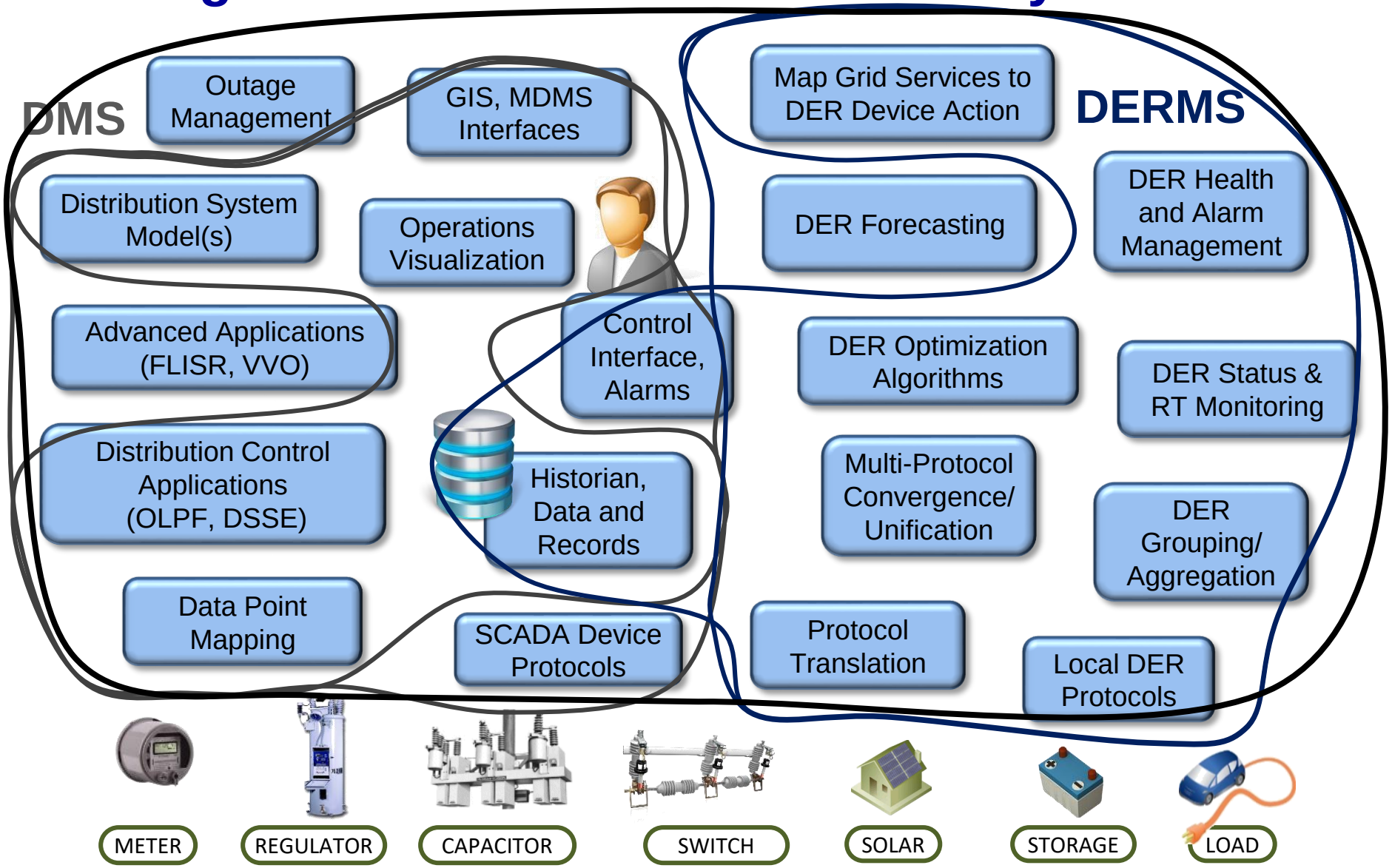
Uniform Distribution	Weighted Distribution in Watts (WDW)	Weighted Distribution by % of Present Capability (WD%)	Priority-Based Dispatch (PBD)	Cost-Based Economic Dispatch (CBED)
• Uniform Distribution in Watts • Uniform Distribution as a percentage of nameplate	• DER type • Grid services provided by the DER • DER capability • DER forecasted confidence • DER ownership • Utilization of assets • Level of commitment (i.e. Binding vs Non-binding dispatch) • Cost • Interconnection date	• DER type • Grid services provided by the DER • DER capability • DER forecasted confidence • DER ownership • Utilization of assets • Level of commitment (i.e. Binding vs Non-binding dispatch) • Cost • Interconnection date • Other factors • Any combination thereof	• DER type • Grid services provided by the DER • DER capability • DER forecasted confidence • DER ownership • Utilization of assets • Level of commitment (i.e. Binding vs Non-binding dispatch) • Cost • Interconnection date • Other factors • Any combination thereof	• Based on DER Cost Curves

EPRI is working on documenting these different reference dispatch methods…

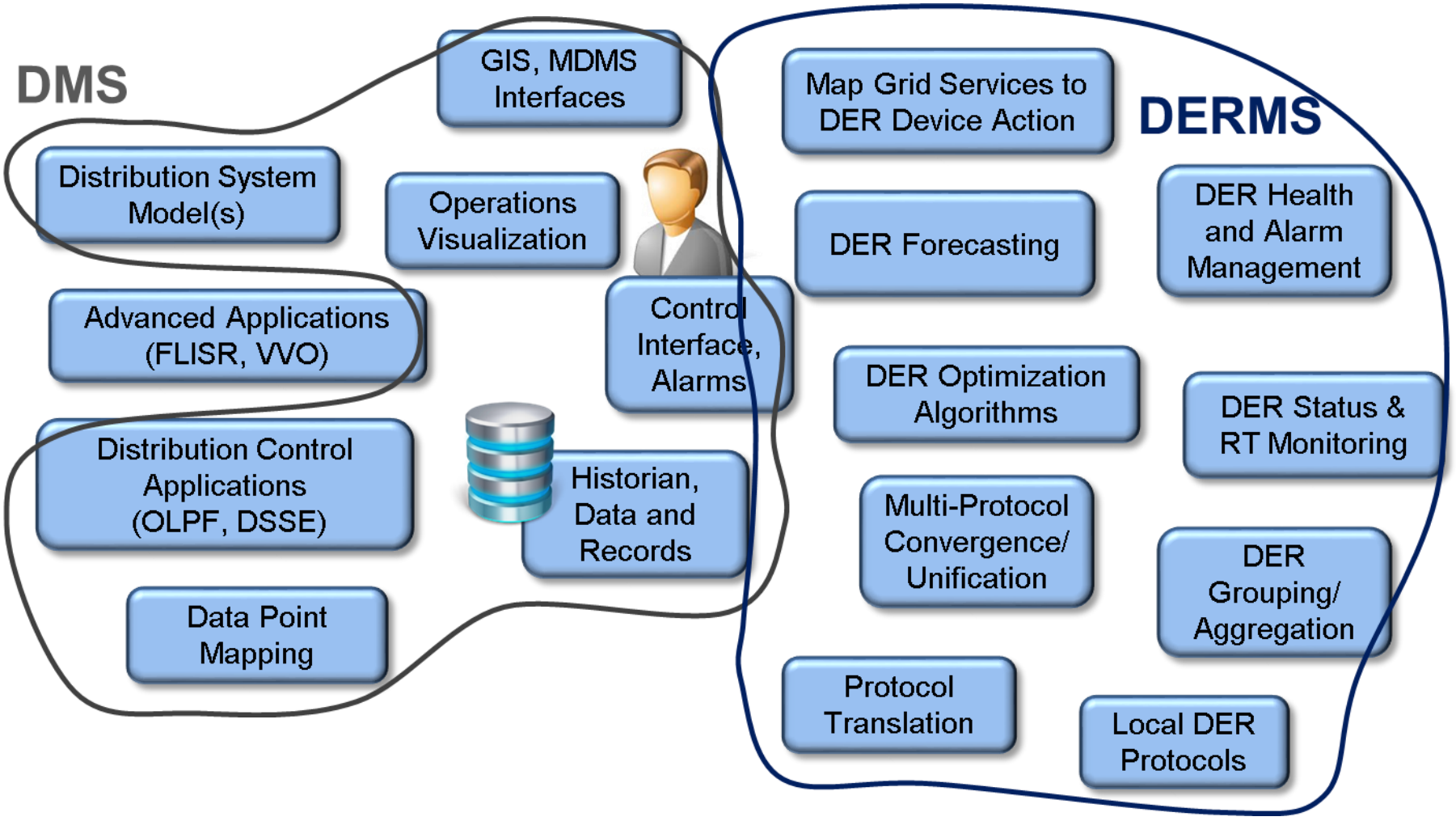
DER Controls vs Integration



Sorting DMS and DERMS Functionality



Architectural Significance of the DMS to DERMS Interface



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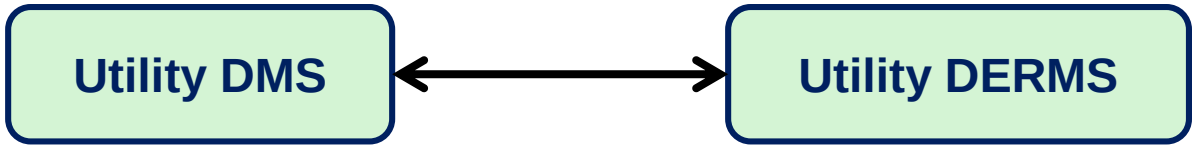

While vendors may offer integrated solutions (e.g. DMS+DERMS), it is important to clearly separate the functions between a DERMS and all other types of systems, to enable system extensibility and interoperability within and beyond the utility.

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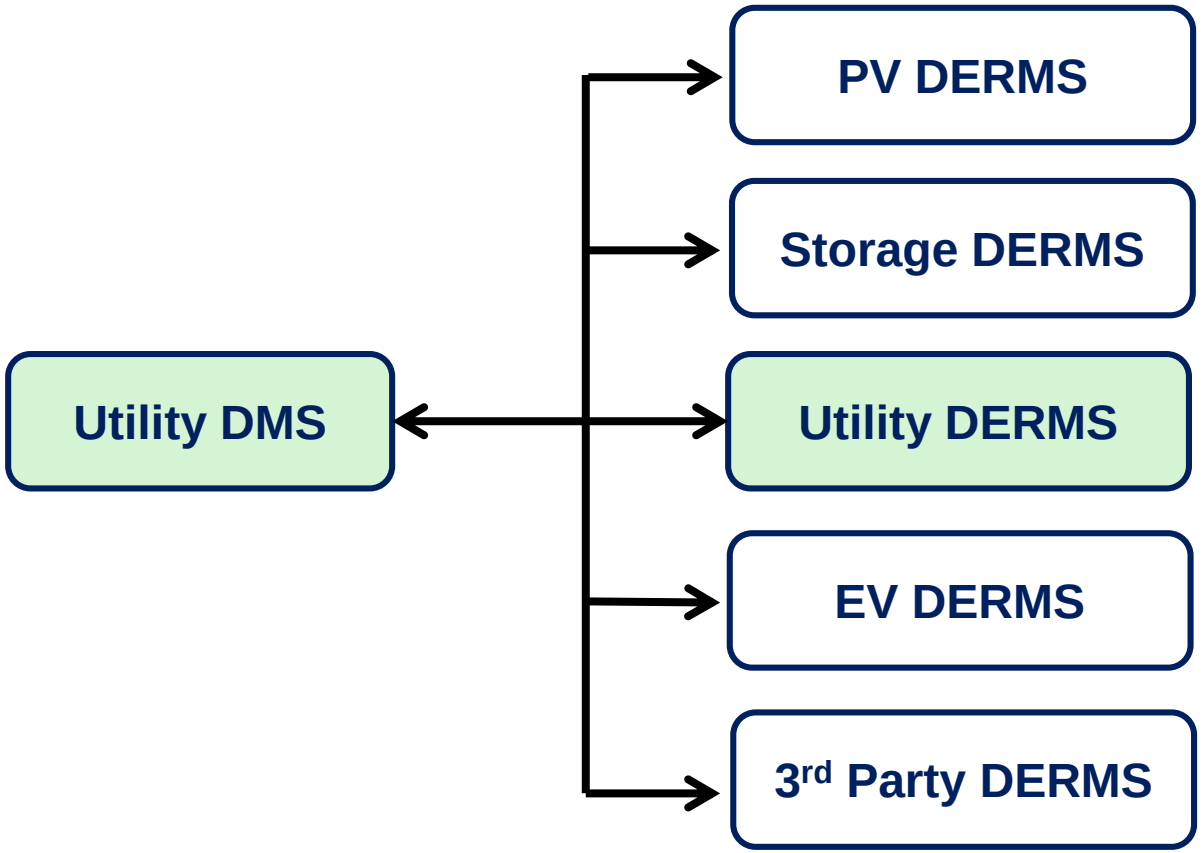

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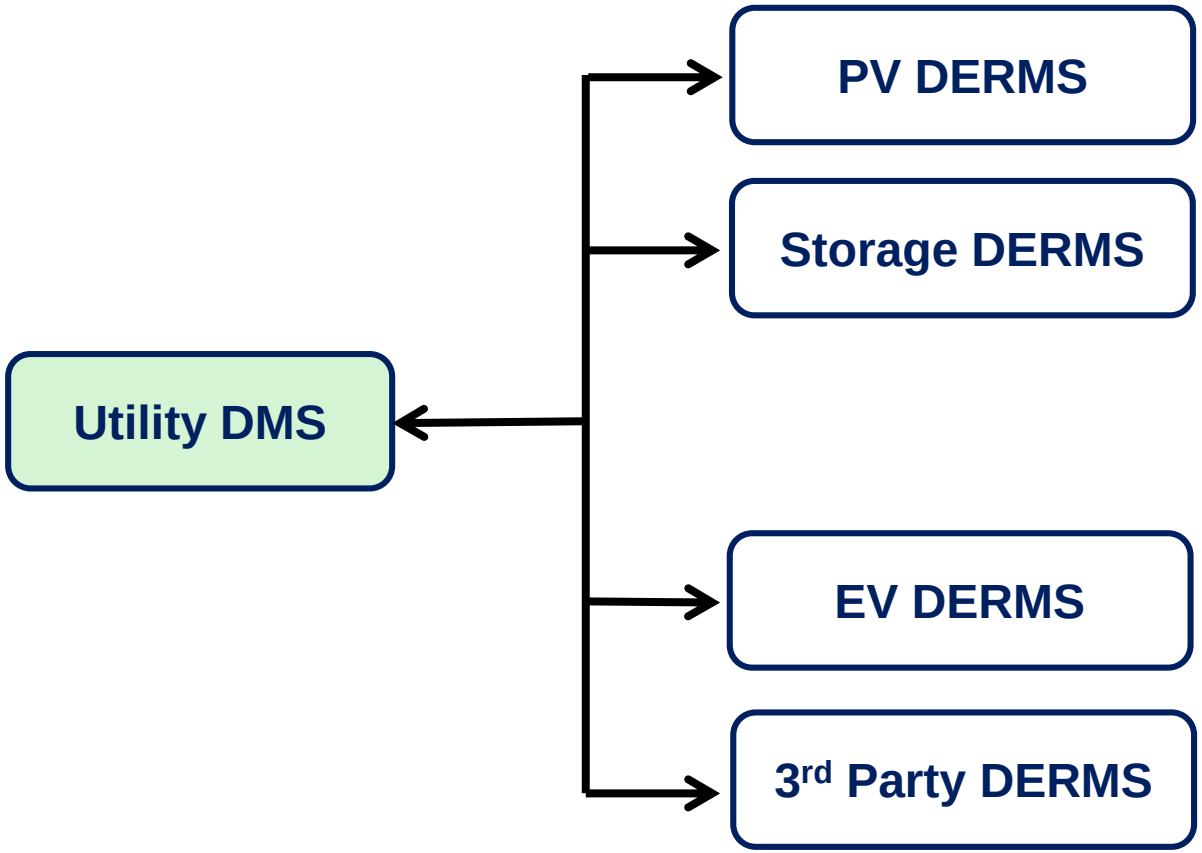

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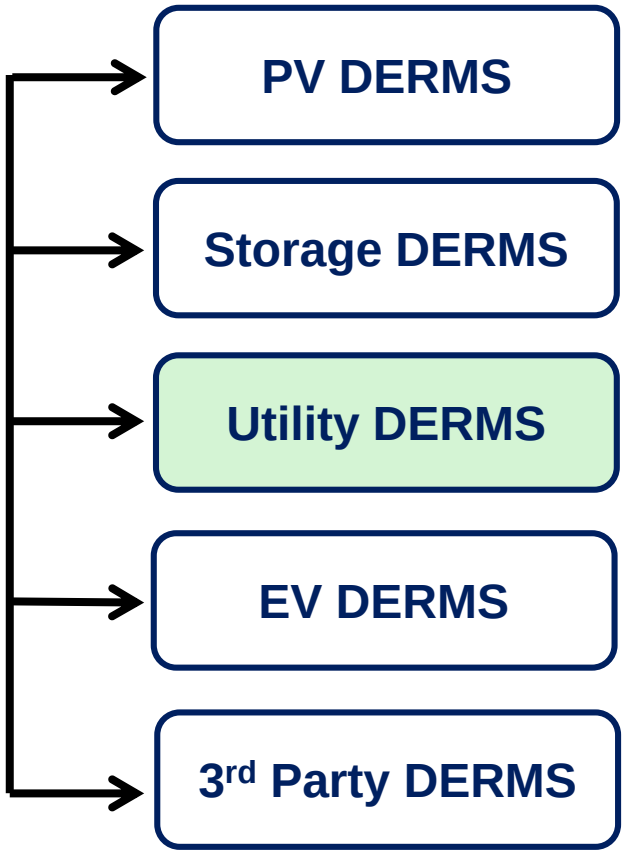

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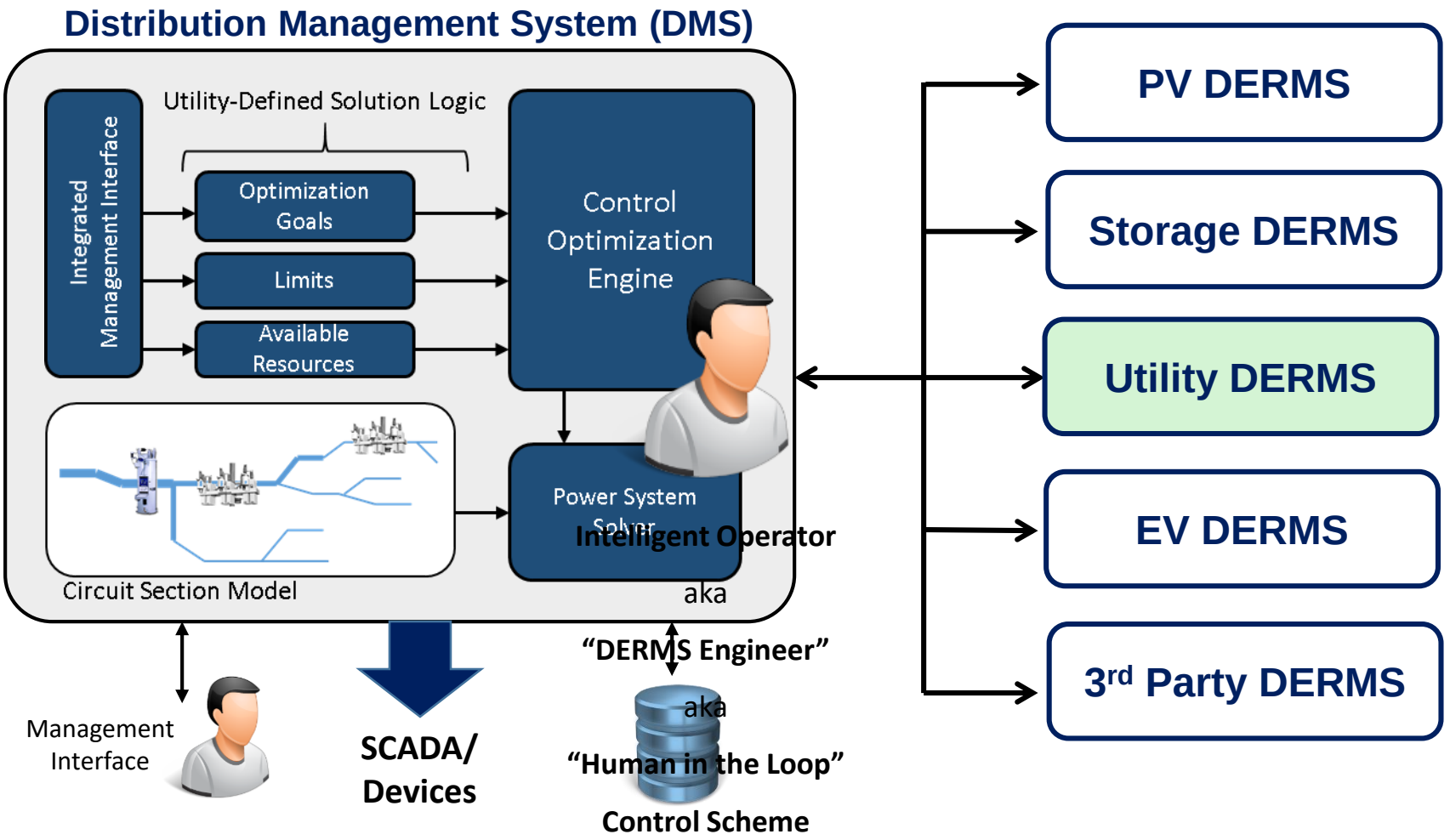
DERMS With & Without a DMS



Functions of DERMS

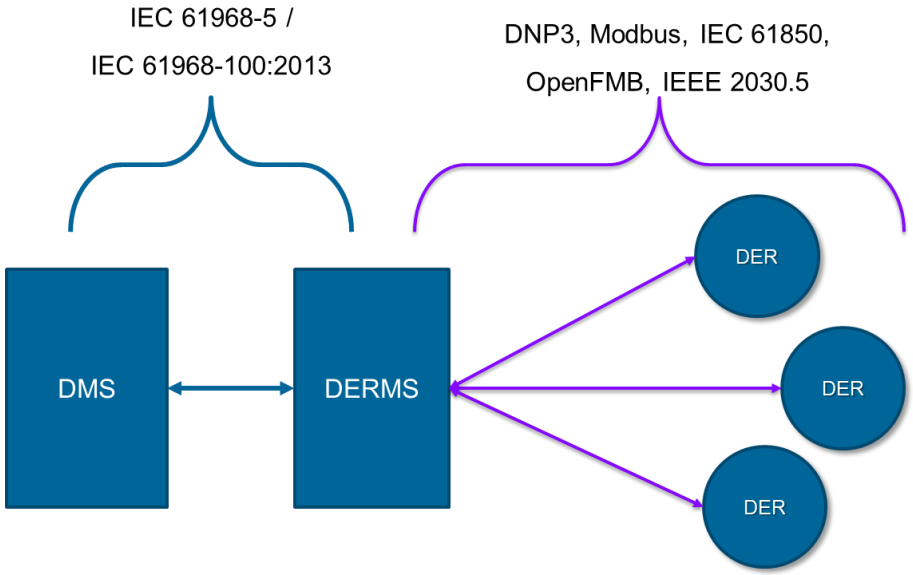
Two Levels of DER Functionality

DER Device-Level

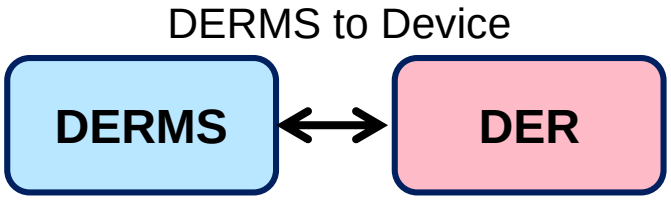
- Device-settings oriented. Function commands are described in a way that tells devices exactly what to do.
- Standards make connectivity practical, create multi-vendor interoperability.

DER Group Level

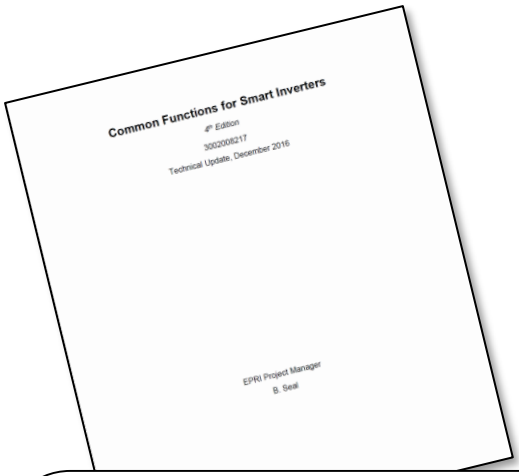
- Grid-need oriented. Service commands are described in terms of what the power system needs. Various techniques may be used to deliver these services.
- Standards make integration with utility operations practical.



Common Functions for Smart Inverters



	Functions
Monitoring & Scheduling	Basic Device Setting & Limits
	Connect/Disconnect Function
	DER Settings to Manage Multiple Grid Configurations (including islanding)
	Status Monitoring Points
	Status Monitoring Log
	Event Logging & Reporting
	Time Adjustment Function
Frequency Support	Frequency-Watt Function
	Low/High Frequency Ride-Through
Real Power Support	Limit DER Power Output
	Dynamic Real Power Support
	Peak Power Limiting
	Load/Generation Following
	Watt-VAR
	Battery Storage: Price-based Charge/Discharge
	Battery Storage: Charge/Discharge Management
	Battery Storage: Coordinated Charge/Discharge
Power Factor Support	Fixed Power Factor
	Volt-VAR
	Watt-Power Factor
Voltage Support	Dynamic Volt-Watt
	Dynamic Reactive Current Support
	Volt-Watt
	Low/High Voltage Ride-Through

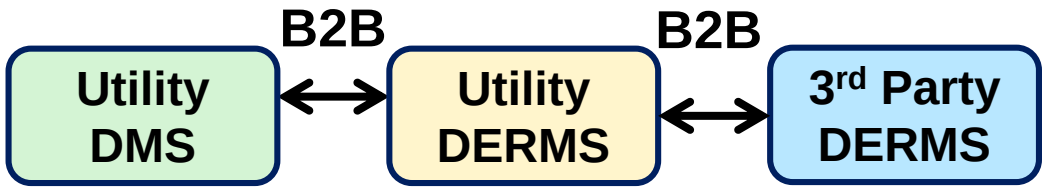


Public EPRI Report
(PID: 3002008215)

Many have been adopted by grid codes like IEEE 1547, Rule 21

Common Functions for DER Group Management

IEC 61968-5 Common Information Model

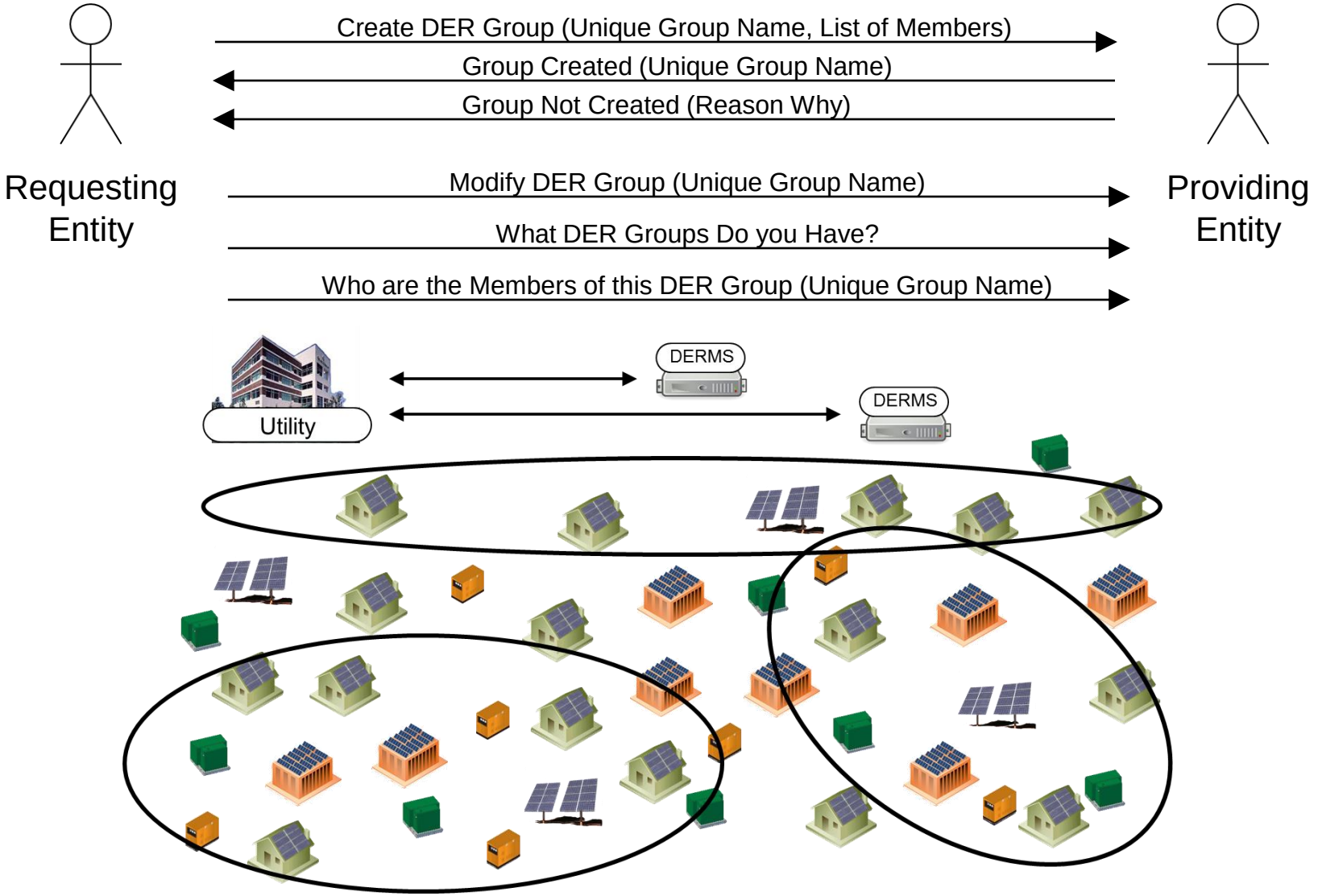


	Group Function
1	Status Monitoring of DER Groups
2	Capability of DER Groups
3	DER Group Output Forecasting
4	DER Group Maximum Real Power Limiting
5	DER Group Ramp Rate Limit Control
6	DER Group Phase Balance Limiting
7	Real Power Dispatch of DER Groups
8	Reactive Power Dispatch of DER Groups
9	DER Group Curve Settings
10	Regulation Function
11	Schedules for DER Services
12	Fast Up-Down Regulation Services
13	Dynamic System Voltage Stabilization Services
14	DER Group Mode Management

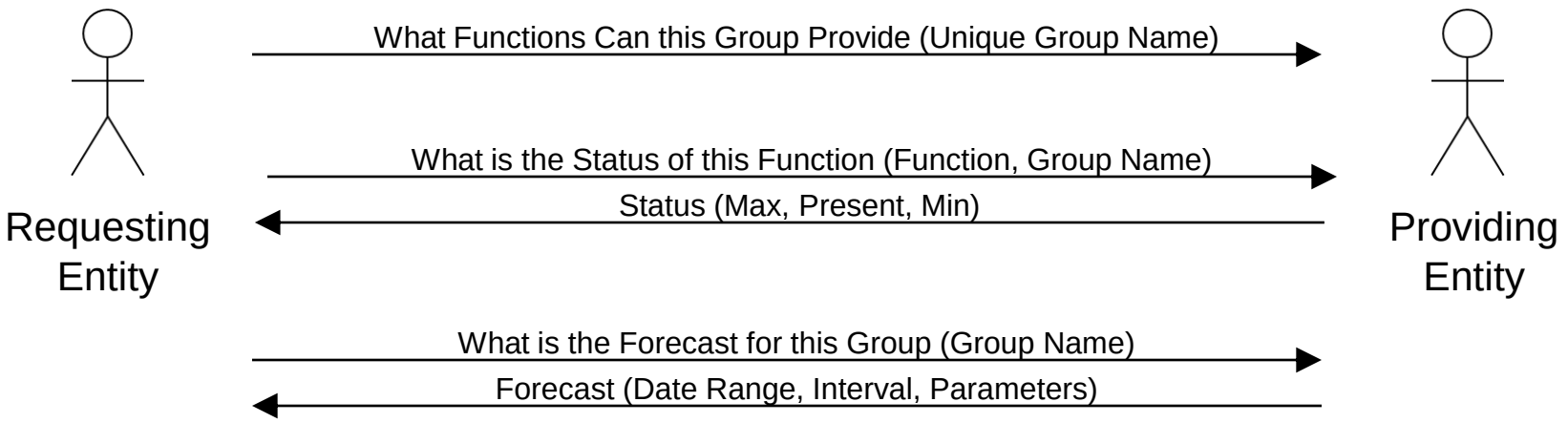
Public EPRI Report
(PID: 3002008215)

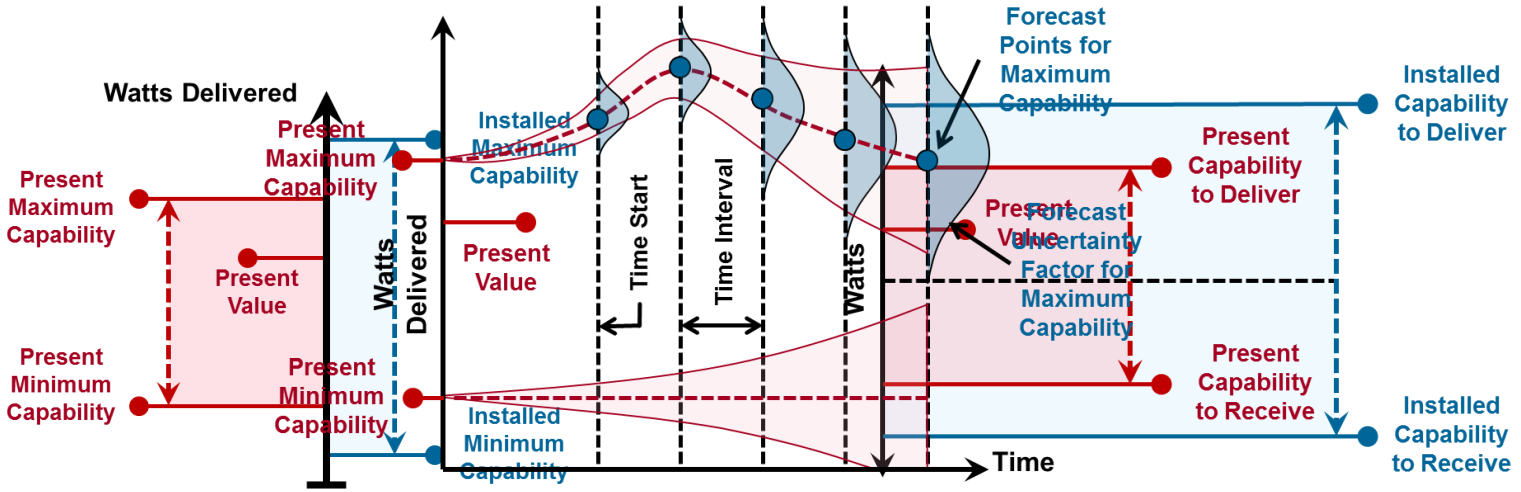
Intended to serve as the information model basis for protocol encodings: IEEE2030.5, OpenADR, OpenFMB

Group Management – Group Creation, Delete, Modify

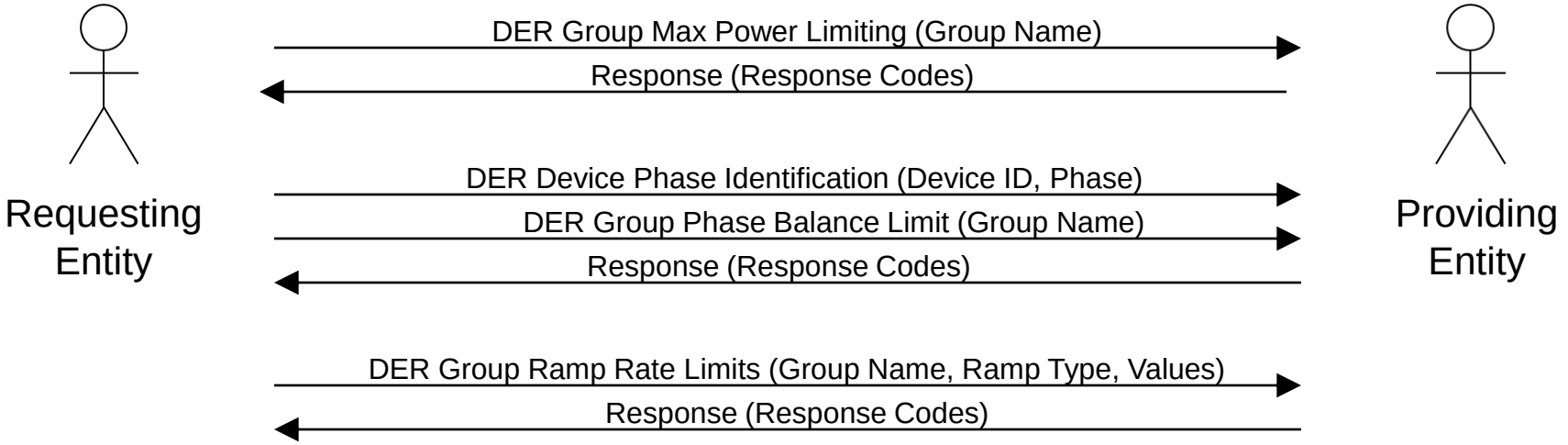


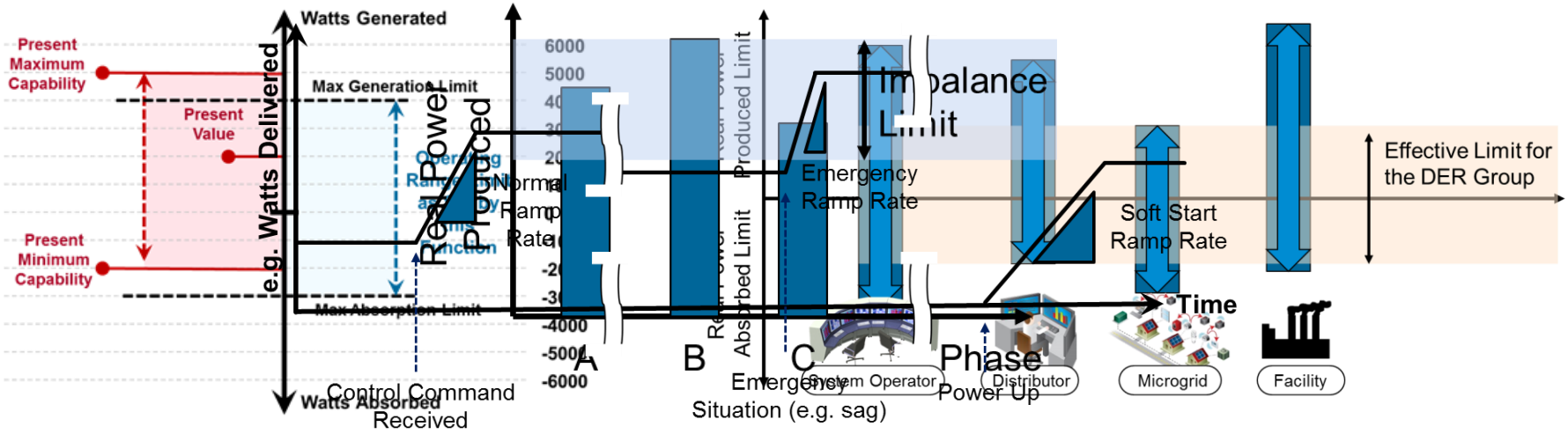
Monitoring, Capabilities, Status



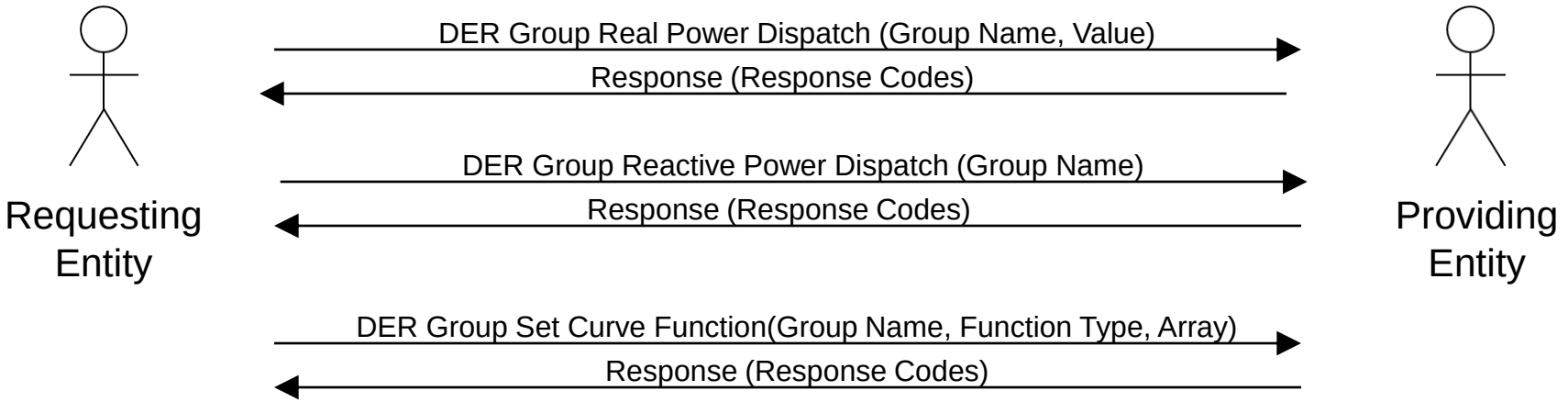


Operational Limits Boundaries

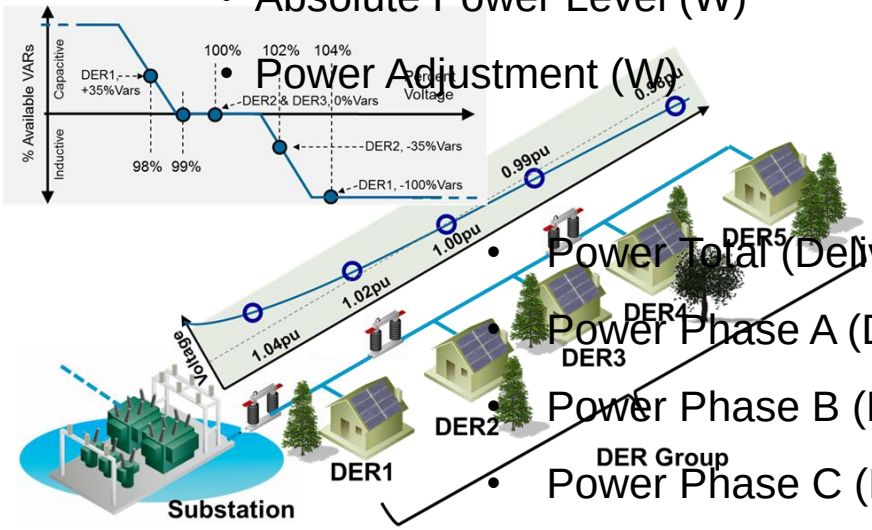


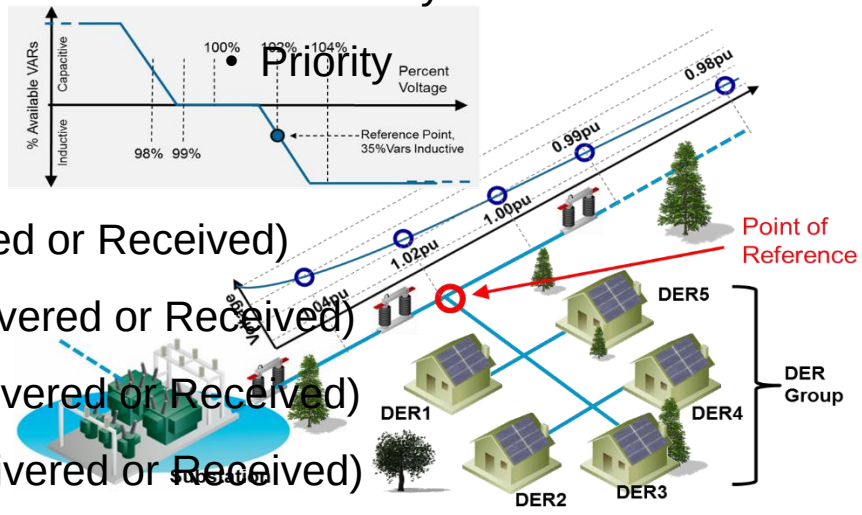


Various Control Functions



- Absolute Power Level (W)
- Power Adjustment (W)
- Power Total (Delivered or Received)
- Power Phase A (Delivered or Received)
- Power Phase B (Delivered or Received)
- Power Phase C (Delivered or Received)
- Effectivity Schedule
- Priority





Communication Protocols for DER Integration

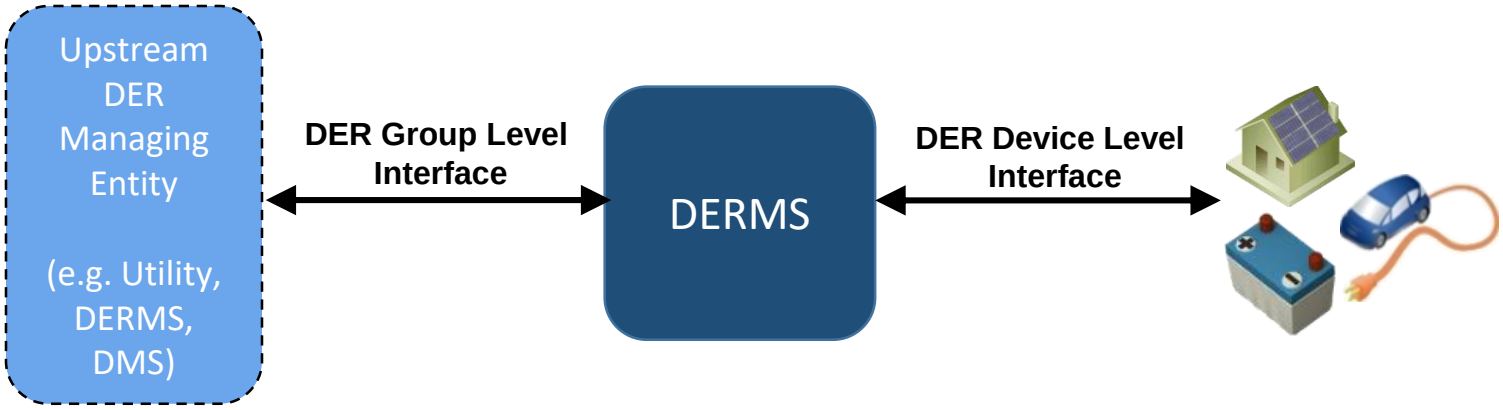
Two Levels of Communication Requirements

DER Group Level

- Fewer groups
- Less frequent interactions
- Device-type agnostic
- Simple settings
- Net results-based

DER Device Level

- Many devices
- Frequent interactions
- Device-type specific
- Complex settings
- Explicit instructions

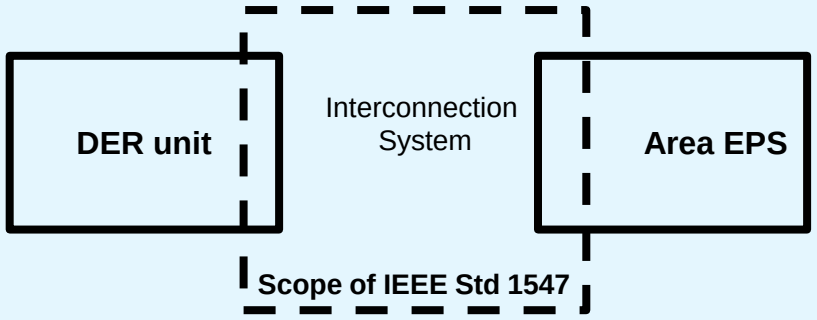


Communication Protocols for DER Integration
Device-Level

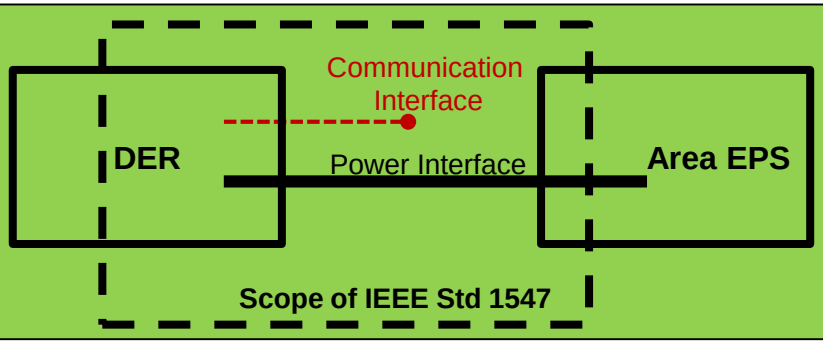
DER-Group Level (DERMS-to-DMS) Interfaces	Device Level (DERMS-to-DER) Interfaces
Standard function definitions and information model are in IEC 61968-5 (Common Information Model for DER)	Standard function definitions - IEC 61850-7-520 Information model - IEC 61850-7-420
Public EPRI report for reference: *Common Functions for DER Group Management, Third Edition*	Public EPRI report for reference: *Common Functions for Smart Inverters, Fourth Edition*
Protocol encodings that can support: • *CIM 61970* • *Multispeak* • *OpenFMB*	Protocol encodings that can support: • *SunSpec Modbus* • *DNP3 AN2013-001, AN2018-001* • *IEEE 2030.5* • *IEC 61850-7*
N/A	DER Grid Code callouts: • IEEE 1547-2018 (specific set of device-level functions required, three protocol options) • CA Rule 21
Testing: UCAIug CIM for DER certification and listing.	Testing: • IEEE 1547.1 – test specification for IEEE 1547. Expected Q1 2019. • UL1741SA - Supports Rule 21, to be updated to support 1547.1
	Certification: SunSpec Alliance

Communication Protocols for DER Integration
Update on IEEE 1547

- Important changes in the scope of IEEE Std 1547



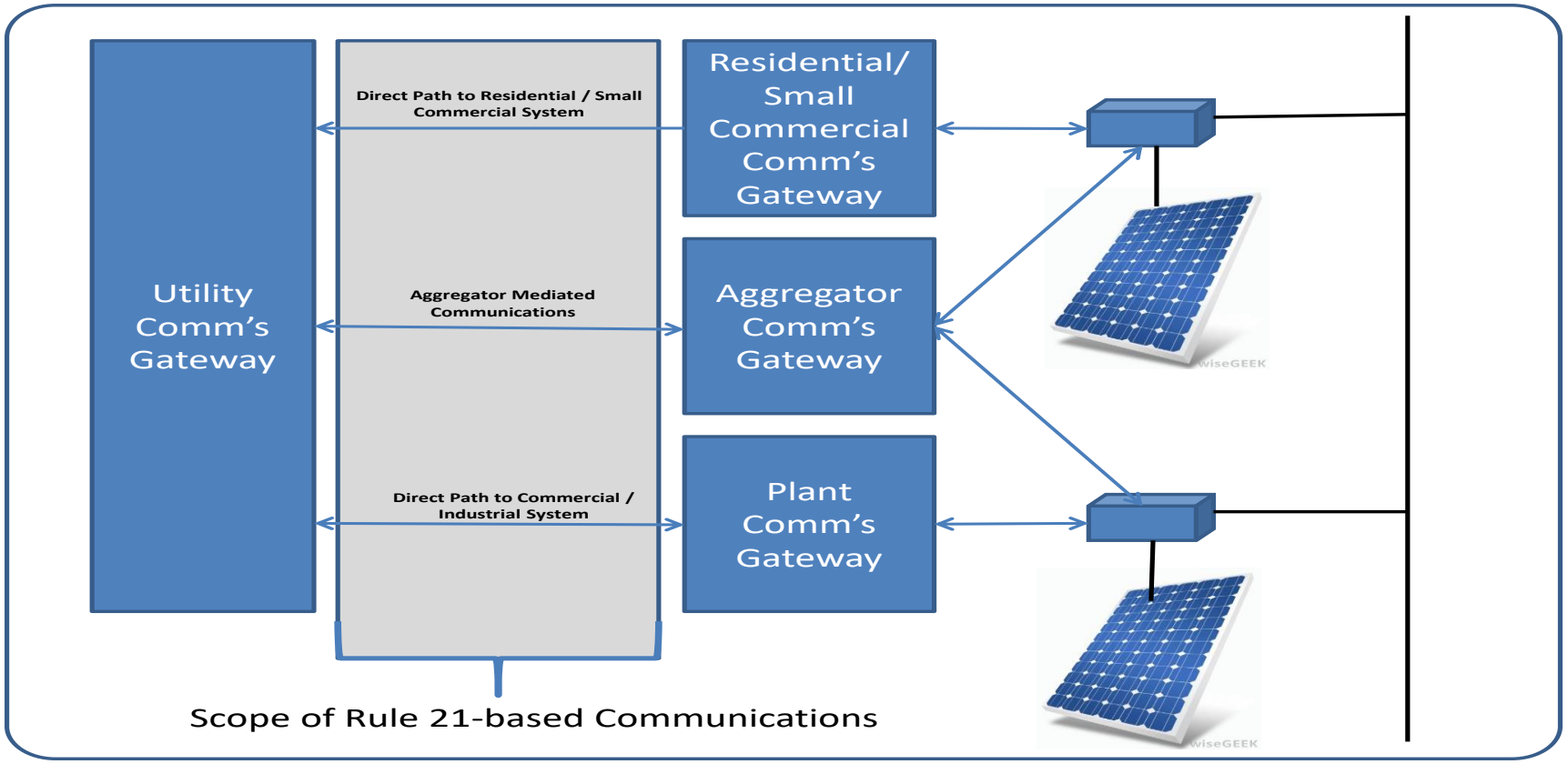
IEEE Std 1547-2003
- Focused on distribution system aspects.
- Specifications for the "interconnection system" sufficiently achieve the standard's objective.
- Meant as DER interconnection standard but mainly used for equipment listing.
- Limited to electrical requirements.



IEEE Std 1547-*revised*
- Focused on distribution and bulk system aspects.
- Specifications encompass the whole DER.
- Can be used for equipment listing as well as plant-level verification.
- **Includes both electrical as well as interoperability/communications requirements.**

Communication Protocols for DER Integration
Update on IEEE 1547

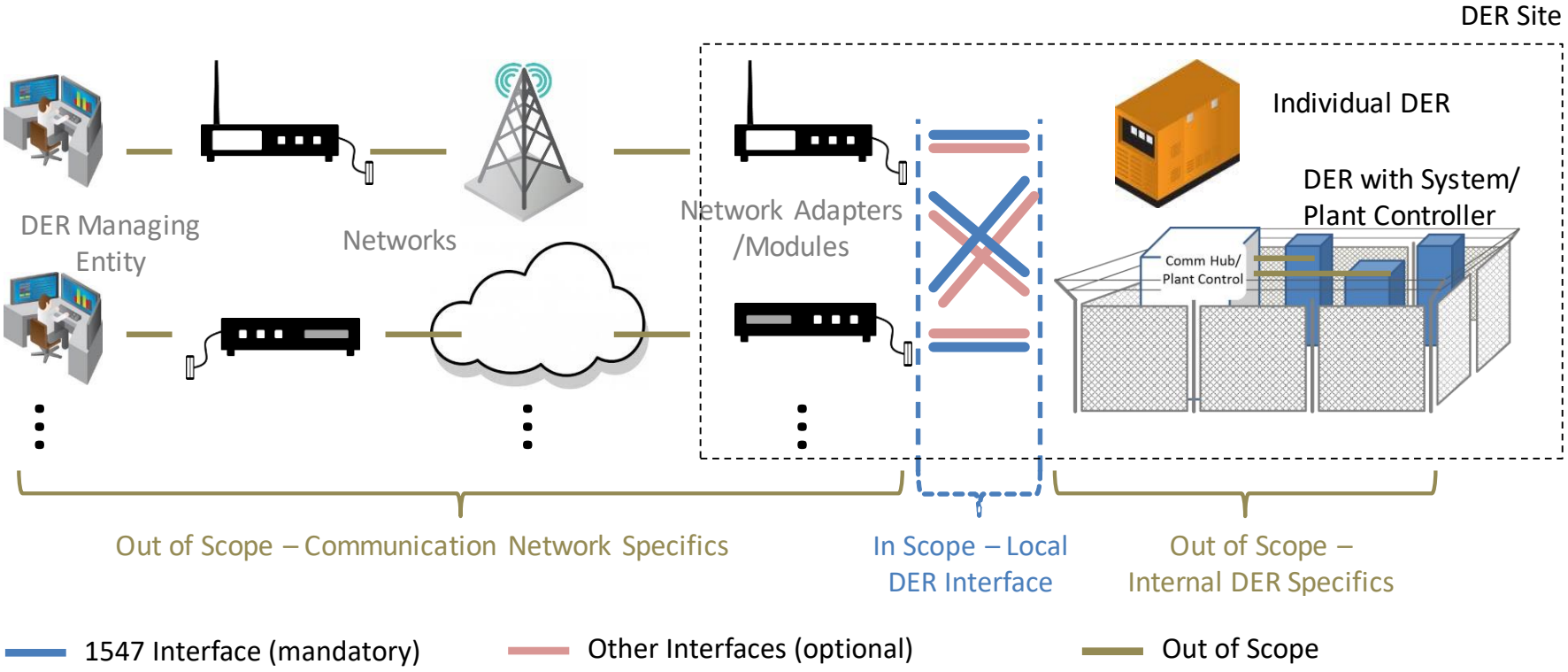
- Example of CA Rule 21 communications requirements



Requirements for IEEE 2030.5 (SEP2) in CA have different scope than IEEE P1547 !

Communication Protocols for DER Integration
Update on IEEE 1547

- Ensuring DER communication *capability* through requirements for standardized protocols and interfaces in IEEE P1547



Requirements in IEEE P1547 are limited to the "Local DER (Communication) Interface"

Communication Protocols for DER Integration
Update on IEEE 1547

- Mandated functions in IEEE P1547 and their corresponding reference in EPRI's Common Functions for Smart Inverters – 4th Edition

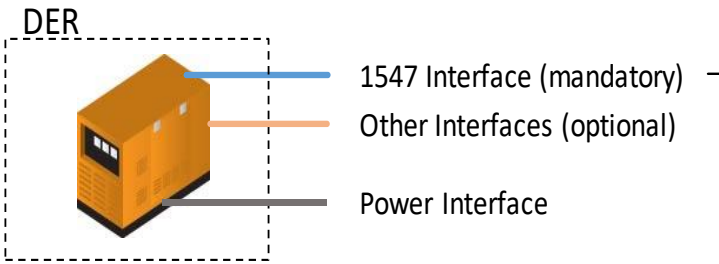
Mandated Communicable Functions in IEEE 1547	Corresponding Function in Common Functions for Smarter Inverters – 4th Edition. (3002008217)
Nameplate Data	Ch 4: Basic Device Settings and Limits
Basic Settings	Ch 4: Basic Device Settings and Limits
Monitoring	Ch 26: Status Monitoring Points
Adjustable constant power factor mode parameters	Ch 10: Fixed Power Factor Function
Voltage - reactive power mode parameters	Ch 11: Volt-VAR Function
Active power – reactive power mode parameters	Ch 24: Watt-Var Function
Adjustable constant reactive power mode parameters	Ch 11: Volt-VAR Function (horizontal curve).
Voltage – active power mode parameters	Ch 12: Volt-Watt Function
Voltage trip parameters	Ch 16: Low/High Voltage Ride-Through Function
Frequency trip parameters	Ch 17: Low/High Frequency Ride-Through Function
Frequency droop parameters	Ch 13: Frequency-Watt Function (modified[1])
Enter service parameters	To be addressed in the 5th edition.
Permit service setting	To be addressed in the 5th edition.
Limit Maximum Active Power	Ch 6: Limit DER Power Output Function

[1] The Frequency Droop function in IEEE 1547 is slightly different from the Frequency-Watt function (Ch 13) in [3] and the new functional needs are being contributed to the IEC to maintain consistency.

Communication Protocols for DER Integration
Update on IEEE 1547

- IEEE P1547-specified communication interface, information models, and protocols

New IEEE P1547 capability requirements



IEEE P1547-approved standard protocols

* Changes based on Working Group meeting in Atlanta prior to balloting

Protocol	Transport	Physical Layer
IEEE 2030.5 (SEP2)	TCP/IP	Ethernet
IEEE 1815 (DNP3)	TCP/IP	Ethernet
SunSpec Modbus	TCP/IP	Ethernet
	N/A	RS-485
~~IEC 61850-8-1 (MMS)~~*	~~TCP/IP~~	~~Ethernet~~
~~IEC 61850-8-2 (XMPP)~~*	~~TCP/IP~~	~~Ethernet~~

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