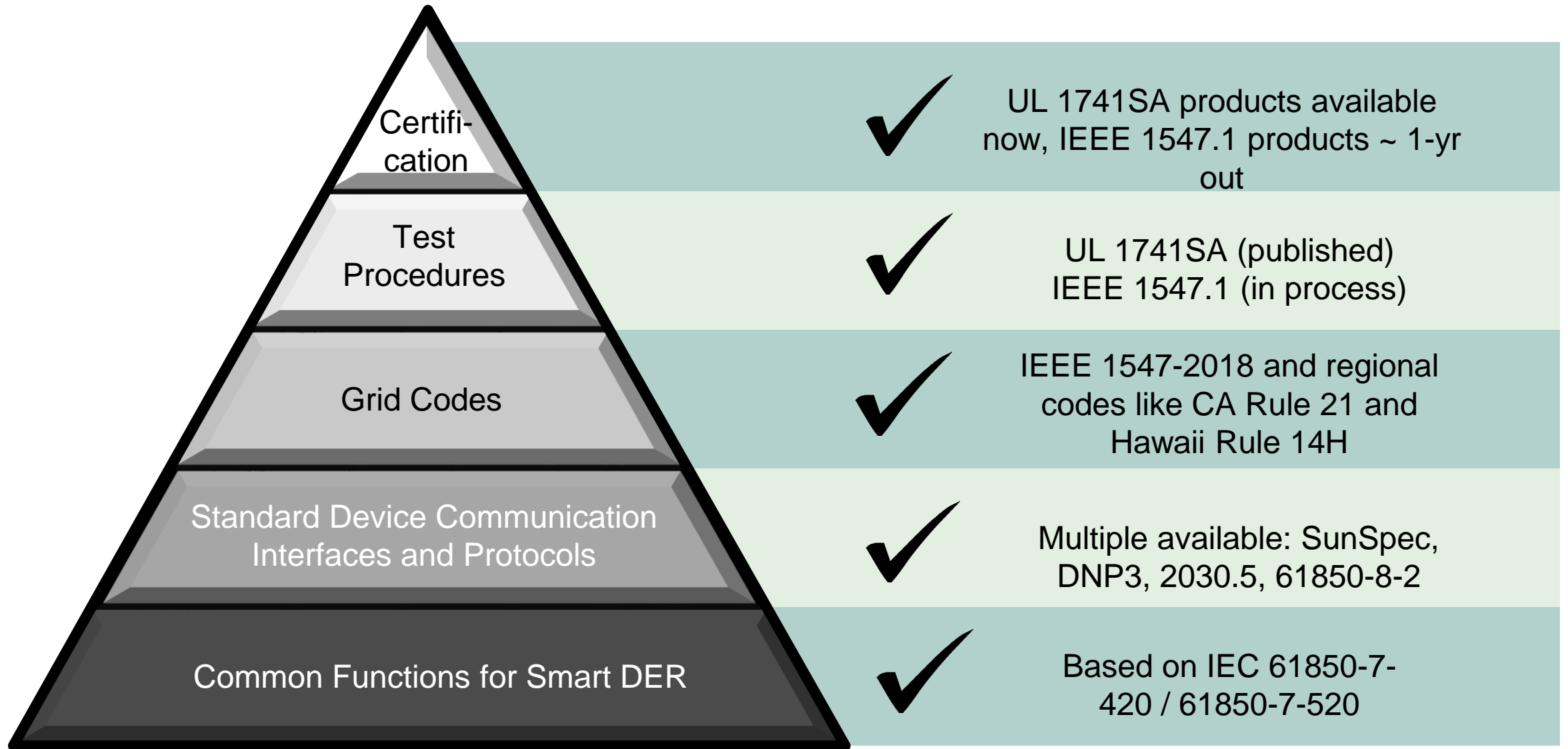# DER Group Management Functions

June 13, 2019
Ajit Renjit
Technical Leader - DERMS
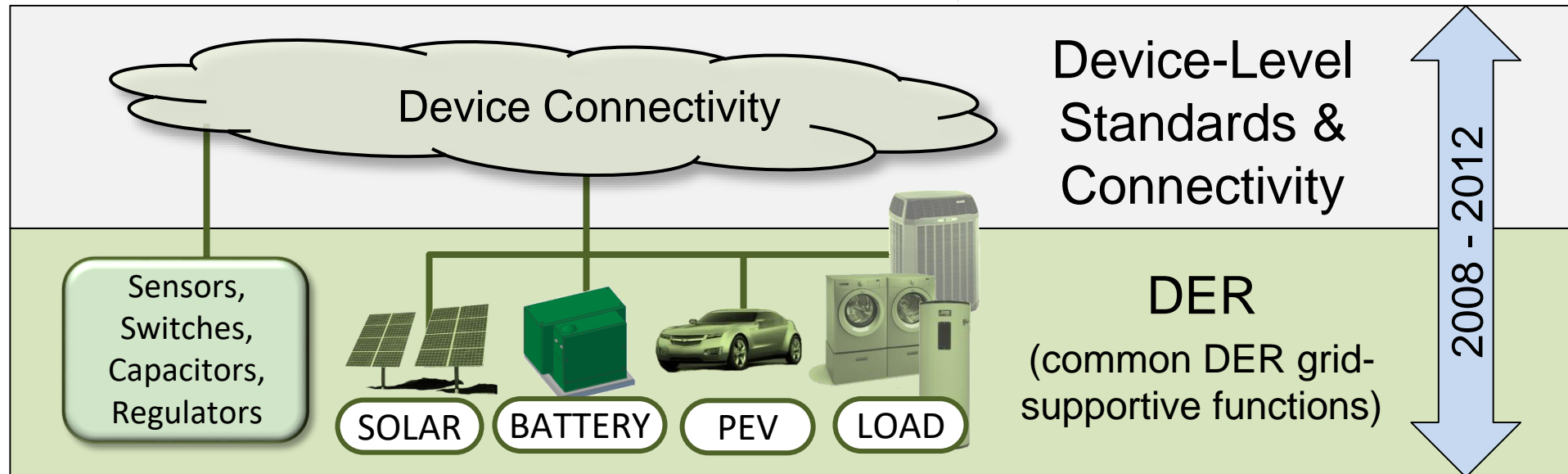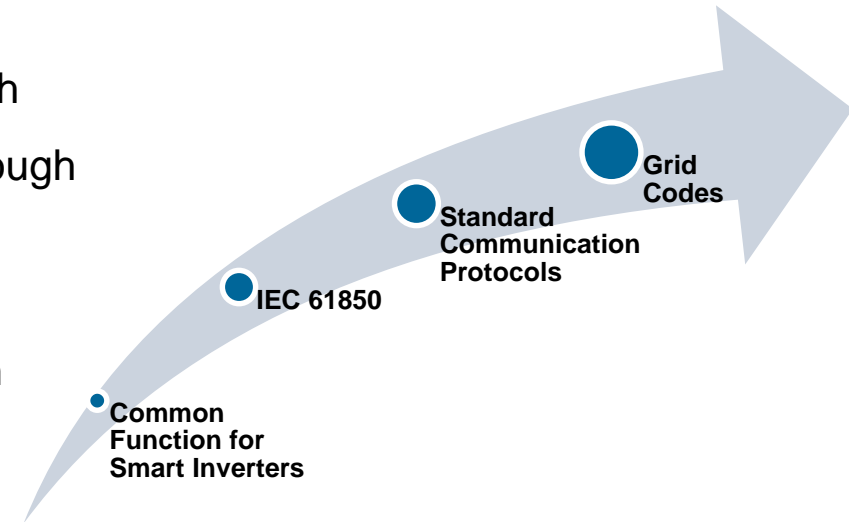EPRI

Framing the discussion: DER Devices are Ready

Certifi-cation
✔ UL 1741SA products available now, IEEE 1547.1 products ~ 1-yr out

Test Procedures
✔ UL 1741SA (published) IEEE 1547.1 (in process)

Grid Codes
✔ IEEE 1547-2018 and regional codes like CA Rule 21 and Hawaii Rule 14H

Standard Device Communication Interfaces and Protocols
✔ Multiple available: SunSpec, DNP3, 2030.5, 61850-8-2

Common Functions for Smart DER
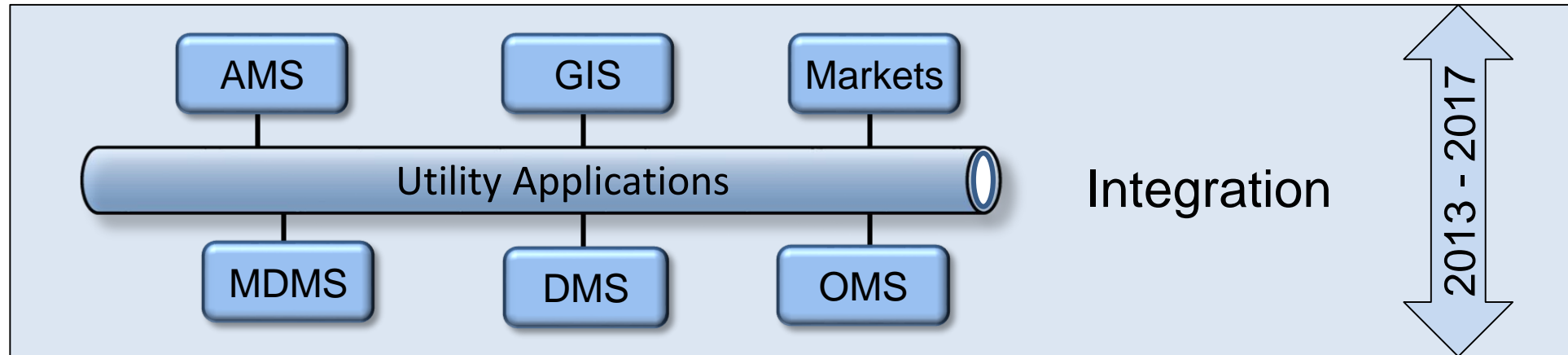✔ Based on IEC 61850-7-420 / 61850-7-520

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What is DER Group Management?

- Volt-Var Function
- Power Factor Control
- Frequency-Watt Function
- Dynamic Reactive Current
- Ramp Rate Control
- Maximum Power Limiting

- Voltage Ride-Through
- Frequency Ride-Through
- Charge/Discharge Management
- Load and Generation Following

Grid Codes

Standard Communication Protocols

IEC 61850

Common Function for Smart Inverters

Device Connectivity

Device-Level Standards & Connectivity

Sensors, Switches, Capacitors, Regulators

SOLAR BATTERY PEV LOAD

DER
(common DER grid-supportive functions)

2008 - 2012

What is DER Group Management?

Need for DER Group Management Functions

|	
Aggregate	Express DER capabilities as manageable resources aligned with the grid configuration (aggregation by substation, feeder, transformer, etc.)
Simplify	Functions at individual inverters are not relevant to the higher level goals of distribution system management.
Optimize	Manage DER members in a group the optimal way, saving cost, reducing wear, and optimizing asset value
Translate	Speak the language spoken by the DER and present to the upstream calling entity in a cohesive way

What is DER Group Management?
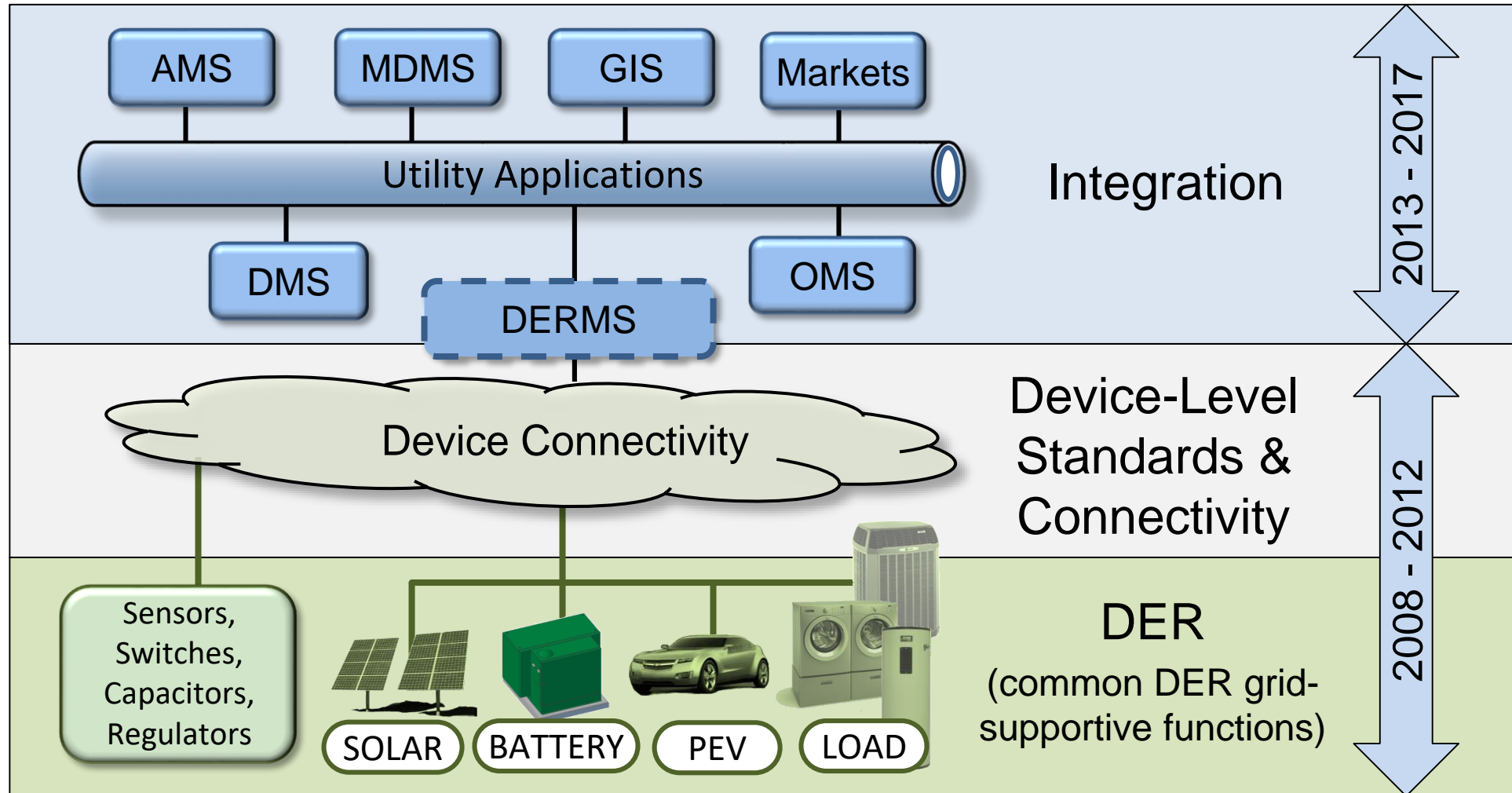
Need for DER Group Management Functions

Device-Oriented Functions are Ready

Grid-Oriented Services are Needed
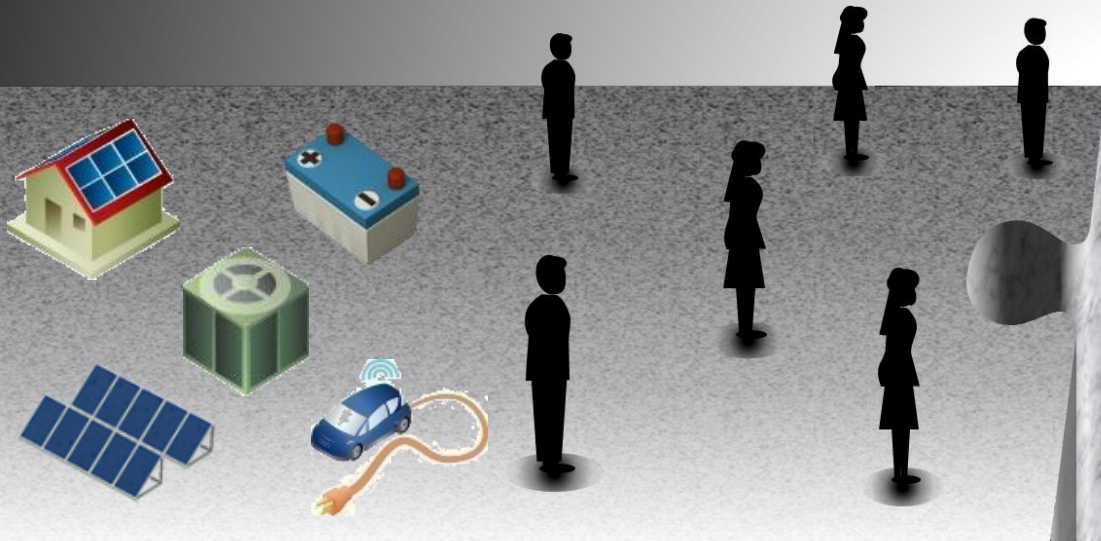
- Many individual devices
- Complex settings
- DER-type-specific interactions

DERMS
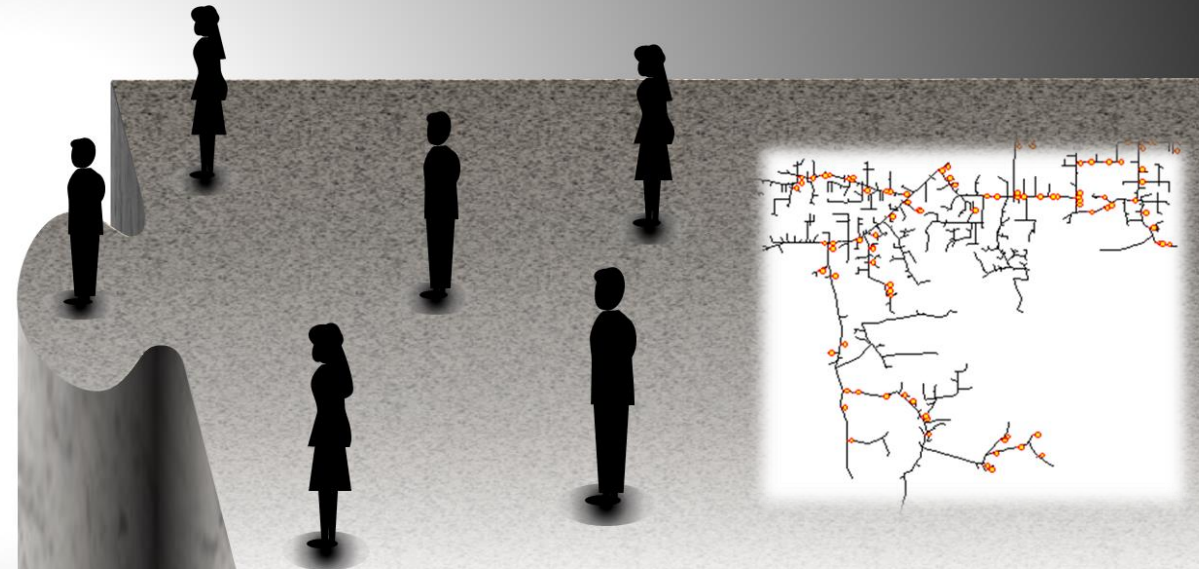
- Grid-aligned DER services
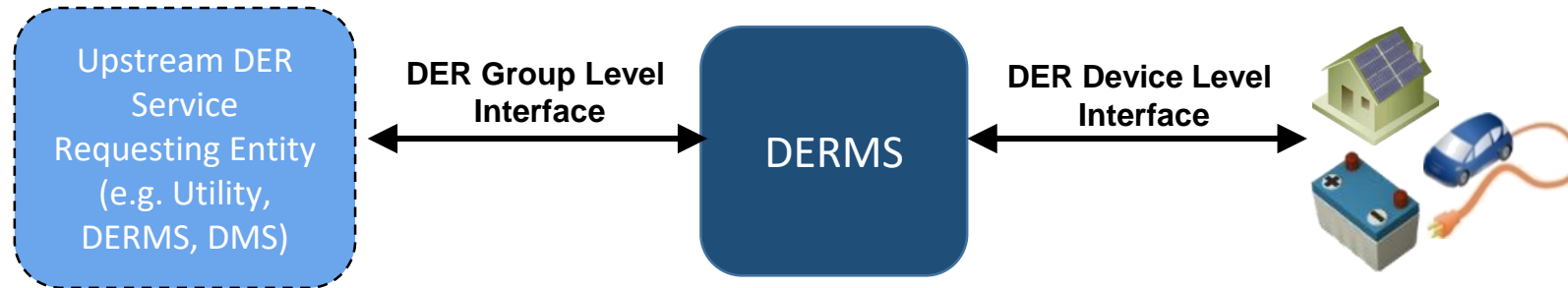- Simple control actions
- Energy-centric interactions

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DER Group vs Device Level Functions
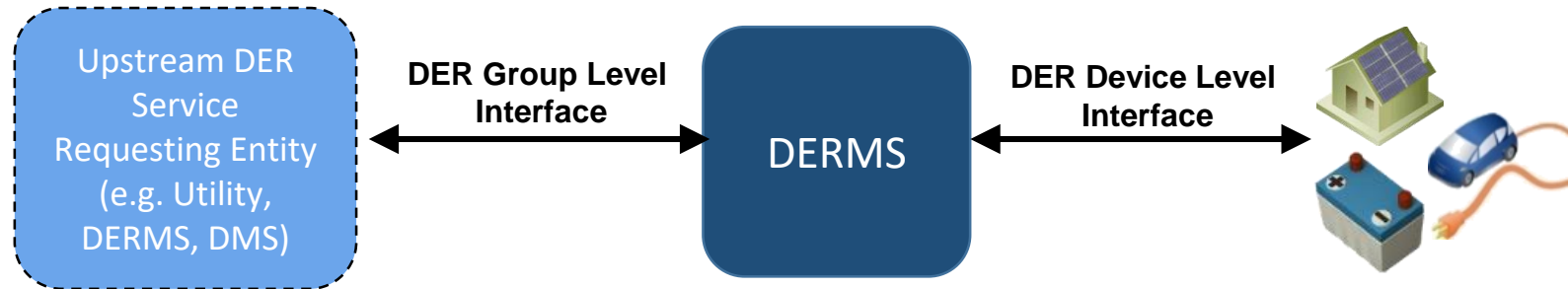
Attribute	Group-Level Interface	Device-Level Interface
Number of Connections	Groups may be fewer in quantity	The number of individual DER is likely to be large
Frequency of Interactions	Group-level interactions may be less frequent.	At the device-level, interactions may happen frequently.
Device-Type Awareness	Group-level services are energy and grid-centric agnostic of the type of downstream DERs	Device-settings oriented. Function commands are described in a way that tells devices exactly what to do
Function Complexity	Group-level services are simple in nature.	Grid support functions at the device-level can be complex and involve a wide range of settings.

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DER Group vs Device Level Functions

Upstream DER Service Requesting Entity (e.g. Utility, DERMS, DMS)

DER Group Level Interface

DERMS

DER Device Level Interface

DER Group Level

- DER Group Status Monitoring
- DER Group Real Power Dispatch
- DER Group Reactive Power Dispatch
- DER Group Voltage Regulation Function
- DER Group Maximum Real Power Limiting
- DER Group Ramp Rate Limit Control
- DER Group Phase Balance Limiting
- Set DER Group Curve Functions
- Provide Price to DER Group
- Manage Power at a Point of Reference
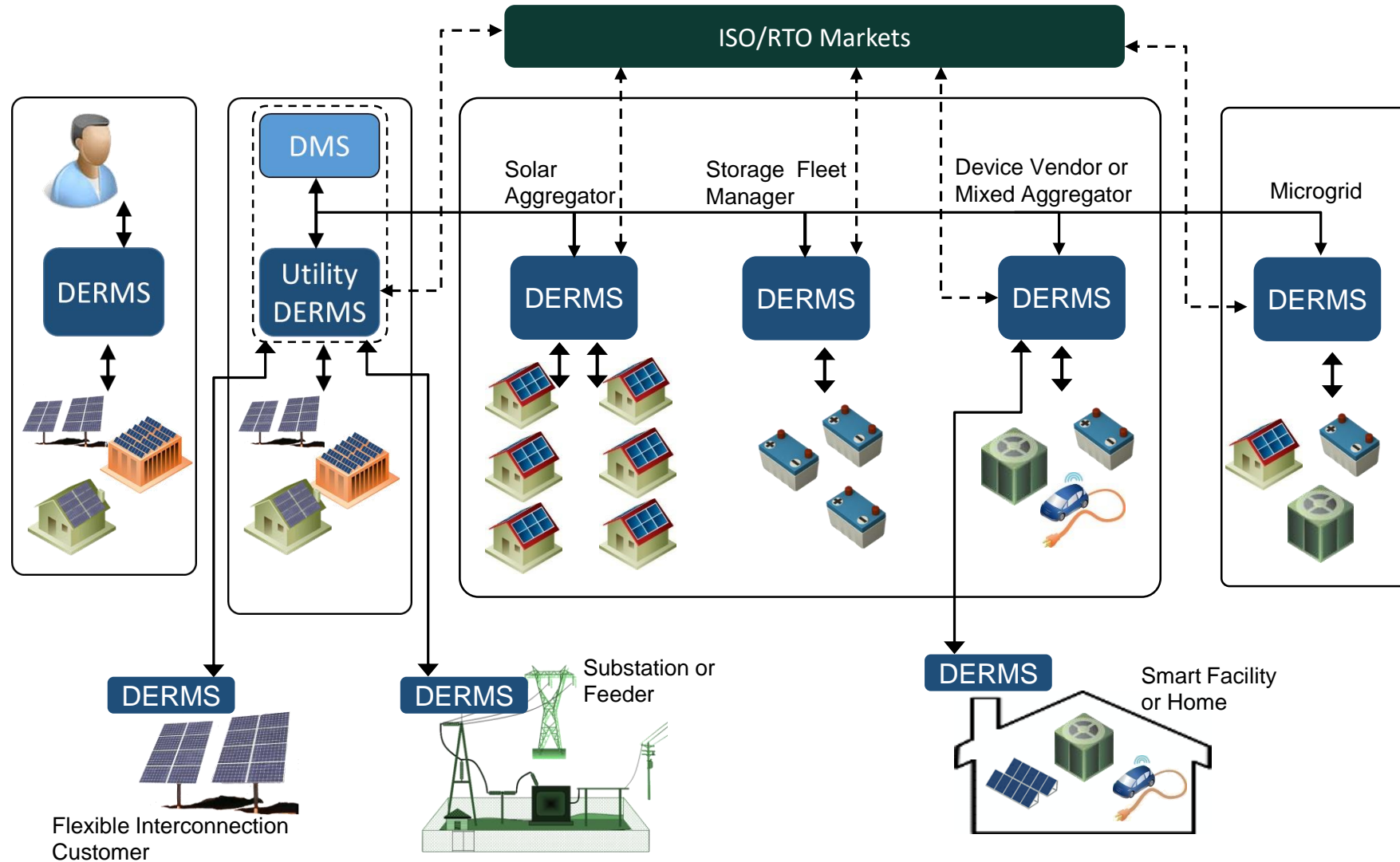- Connect/Disconnect DER Group

DER Device Level

- Status Monitoring Points
- Limit DER Power Output Function
- Fixed Power Factor Function
- Volt-Var Function
- Watt-Var Function
- Volt-Watt Function
- Frequency-Watt Function
- Low/High Voltage Ride-Through Function
- Low/High Frequency Ride-Through Function
- Connect/Disconnect Function

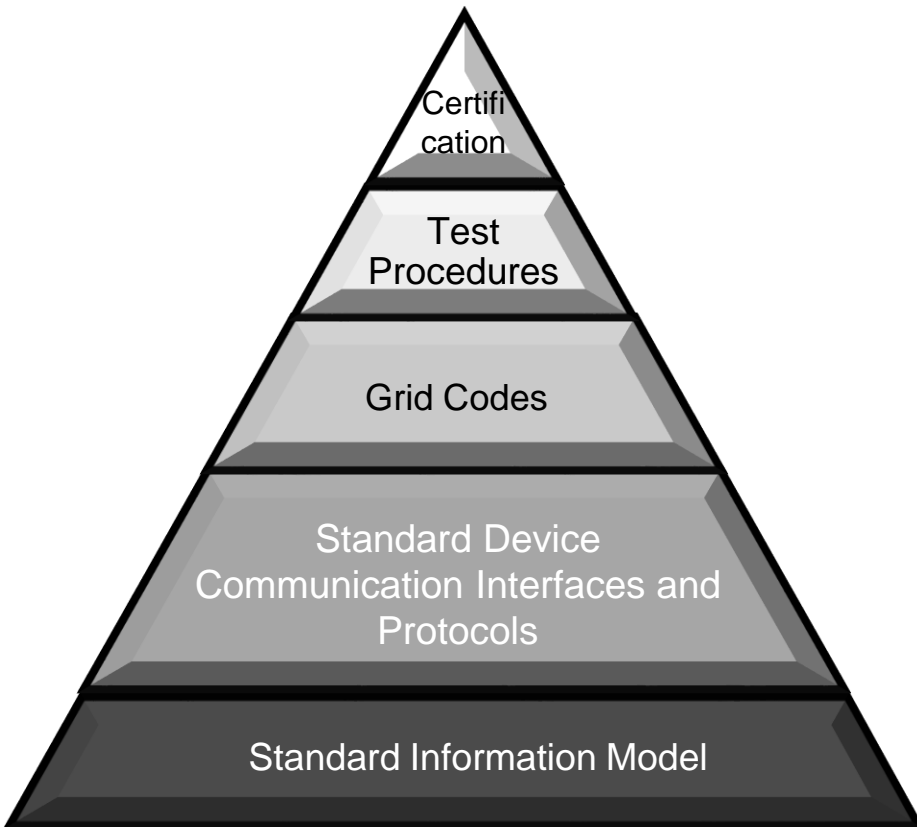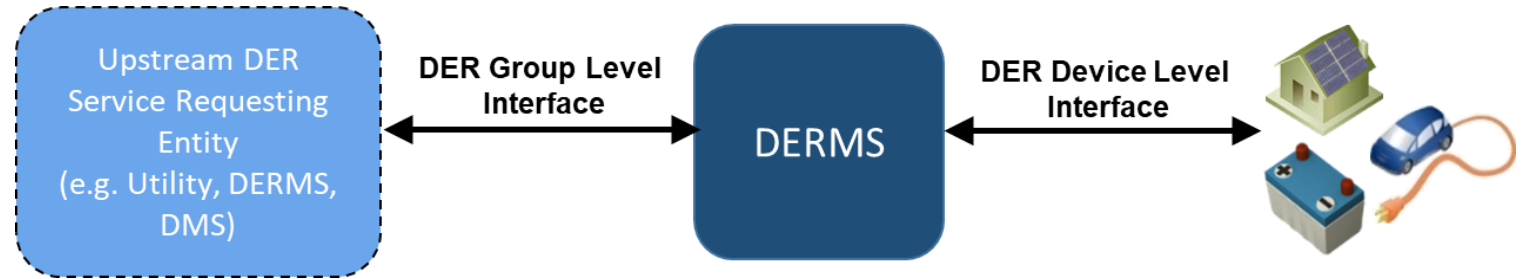# Common Functions for DER Group Management

Common Functions for Smart Inverters: 4th Edition. EPRI, Palo Alto, CA: 2016. 3002008217
Common Functions for DER Group Management, Third Edition. EPRI, Palo Alto, CA 3002008215

# Architectural Extensibility Provided by DER Group Management Functions

Communication Protocols for DER Group Management

Upstream DER Service Requesting Entity (e.g. Utility, DERMS, DMS) ←DER Group Level Interface→ DERMS ←DER Device Level Interface→

UCAI Users Group, CIM for DER certification and listing.	• IEEE 1547.1 • UL1741SA • SunSpec Alliance
UCAI Users Group, CIM for DER compliance testing	• IEEE 1547.1 • UL1741SA • SunSpec Alliance
Not Applicable	• Multiple worldwide, unique by region • IEEE 1547-2018 (specific set) • CA Rule 21 (specific set)
• IEC 61968-100-2013 • Multispeak 5.0 • OpenFMB • OpenADR (mapping considered) • IEEE 2030.5 (mapping considered)	• SunSpec Modbus • DNP3 AN2013-001, AN2018-001 • IEEE 2030.5 • IEC 61850-8-2
IEC 61968-5 (CIM for DER)	IEC 61850-7-420

Pyramid levels (top to bottom):
- Certification
- Test Procedures
- Grid Codes
- Standard Device Communication Interfaces and Protocols
- Standard Information Model

New Industry Wide Interest Group: DER Aggregations/Group Management for Coordinated T&D Interface Operations

Scope

Focus →
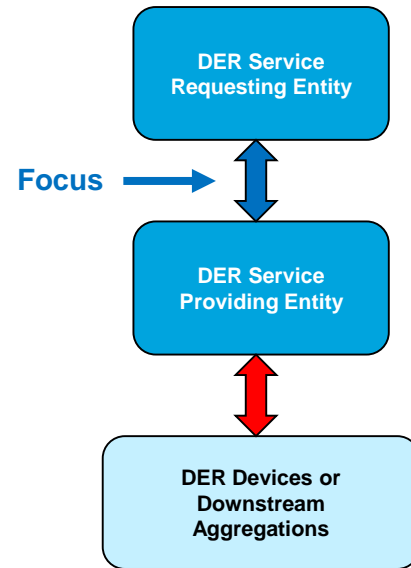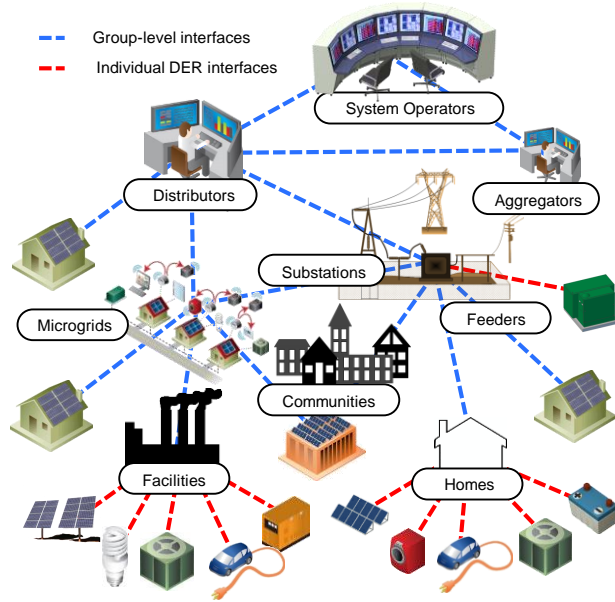
Approach

- Weekly meetings: every Tuesday, 1p-2p ET, 10a-11a PT, 7p-8p CET
- Collaborative, incremental learning and specification of gaps, use cases, functions

Background and Context

- Initiative started in 2012
- Open forum, diverse stakeholders, consensus
- Outputs codified in national and international standards, e.g., IEC CIM 61968-5
- Methods developed thus far have been implemented, tested, and certified in test events and workshops
- Latest report "Common Functions for DER Group Management, 3rd Edition
  - Still lacking in regard to the **TSO/DSO interface**

Report 3002008215
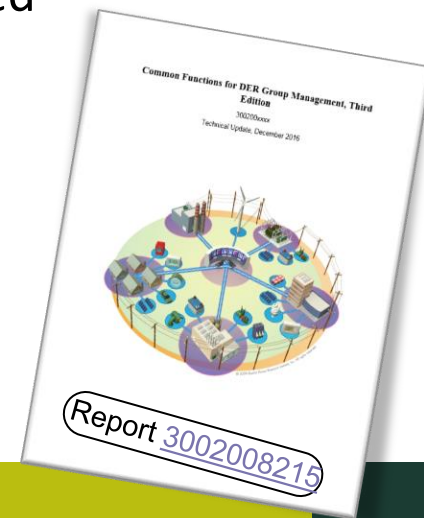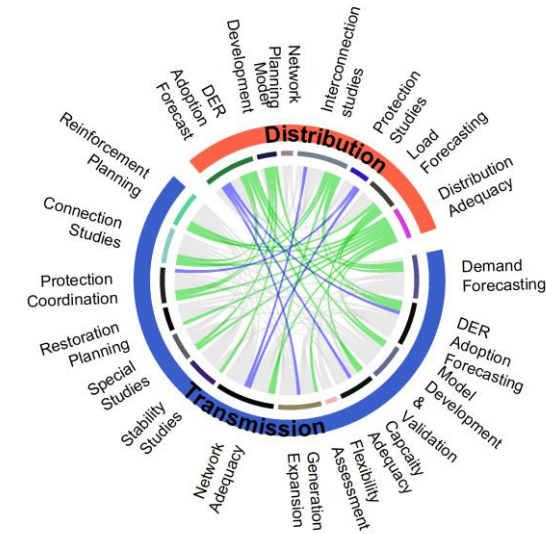
EPRI DERMS Activities

Research Initiatives

- DERMS Working Group
  - 2018: Reference Control Methods for Group-to-Device Interactions
  - 2019: Update to DER Group Management Functions
- DERMS Utility Interest Group
- DERMS Reference RFP for Utilities
- DERMS Testbed & Integration Platform
- Evaluation of DERMS Architecture: Centralized vs Decentralized
- Value of DERMS: Active & Reactive Power Management of DER

Active Projects

- PECO Integrated ADMS/DERMS/Microgrid Project (DOE)
- Tucson Electric Power DERMS Interoperability Demonstration Project
- HydroOne DERMS for Dynamic Management of DER
- DOE ENERGISE (NREL, EPRI, Schneider, Varentec, Xcel Energy, Austin Energy)
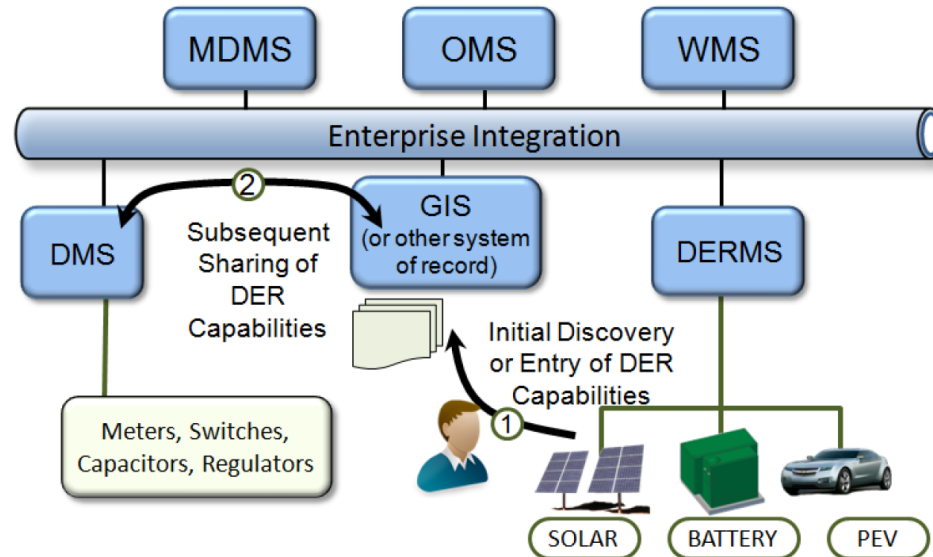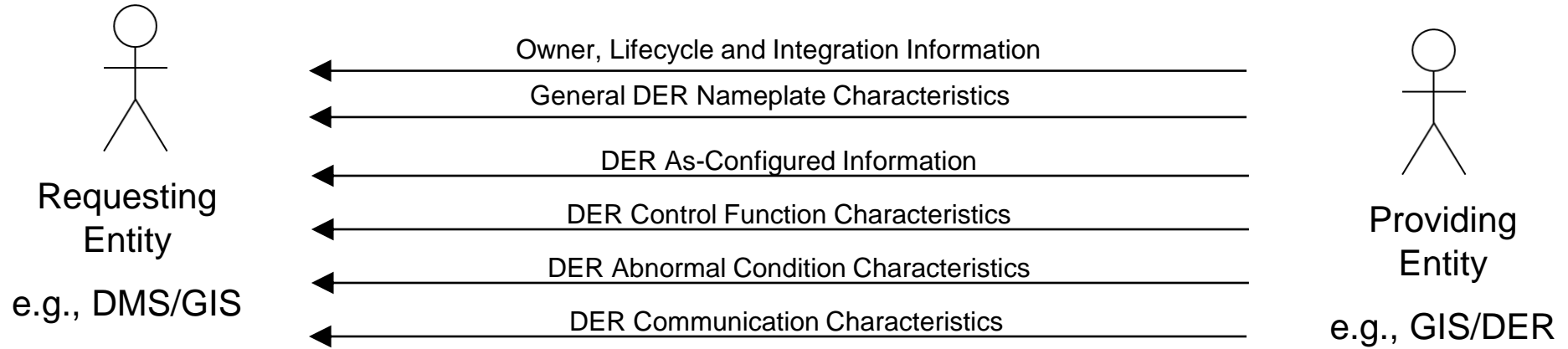
List of DERMS Related Public References

- EPRI, Common Functions for Smart Inverter. 28 December 2016. [Online]. Available: https://www.epri.com/#/pages/product/000000003002008217/?lang=en-US

- EPRI, Common Functions for DER Group Management, Third Edition. 04 November 2016. [Online]. Available: Https://www.epri.com/#/pages/product/000000003002008215/

- EPRI, Understanding DERMS. 13 July 2018. [Online]. Available: https://membercenter.epri.com/abstracts/Pages/ProductAbstract.aspx?ProductId=000000003002013049

- Test Script for IEC 61968-5 Distributed Energy Optimization, Third Edition. [Online]. Available: https://www.epri.com/#/pages/product/000000003002014703/?lang=en-US

- EPRI, Structuring Distribution Management Systems: DMS Applications for Accommodating High Penetrations of Distributed Energy Resources and Microgrids. 05 October 2017. [Online]. Available: https://membercenter.epri.com/abstracts/Pages/ProductAbstract.aspx?ProductId=000000003002009553

- EPRI, A Guidebook to Centralized, Distributed, and Decentralized Intelligence. 31 December 2017. [Online]. Available: https://membercenter.epri.com/abstracts/Pages/ProductAbstract.aspx?ProductId=000000003002010511

- EPRI, Tucson Electric Power Project RAIN: October 2018 Update. 07 November 2018. [Online]. Available: https://www.epri.com/#/pages/product/000000003002014812/?lang=en-US

Thank You

Back-up Slides

DER Registration

Owner, Lifecycle and Integration Information

General DER Nameplate Characteristics

DER As-Configured Information

DER Control Function Characteristics

DER Abnormal Condition Characteristics

DER Communication Characteristics

Requesting Entity

e.g., DMS/GIS

Providing Entity

e.g., GIS/DER

MDMS   OMS   WMS

Enterprise Integration

DMS

② Subsequent Sharing of DER Capabilities

GIS (or other system of record)

DERMS

Meters, Switches, Capacitors, Regulators

Initial Discovery or Entry of DER Capabilities ①

SOLAR   BATTERY   PEV

openADR ALLIANCE

DER Group Setup

Create DER Group (Unique Group Name, List of Members)

Group Created (Unique Group Name)

Group Not Created (Reason Why)

Modify DER Group (Unique Group Name)

What DER Groups Do you Have?

Who are the Members of this DER Group (Unique Group Name)

What is the current version/revision of this DER Group?

Requesting Entity

e.g., DERMS/DMS

Providing Entity

e.g., DERMS

Utility

DERMS

DERMS

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DER Group Setup

Requesting Entity

e.g., DERMS/ DMS

Providing Entity

e.g., DERMS

Create DER Group (Unique Group Name, List of Members)

Group Created (Unique Group Name)

Group Not Created (Reason Why)

Modify DER Group (Unique Group Name)

What DER Groups Do you Have?

Who are the Members of this DER Group (Unique Group Name)

What is the current version/revision of this DER Group?

#	Type	Vendor	kW	kVar	...
1	PV	Tesla	4	3	…
2	Storage	Engie	10	10	…
3	EVSE	ABB	7	0	…
4	Storage	LG	7	7	…
5	…	…	…	…	…

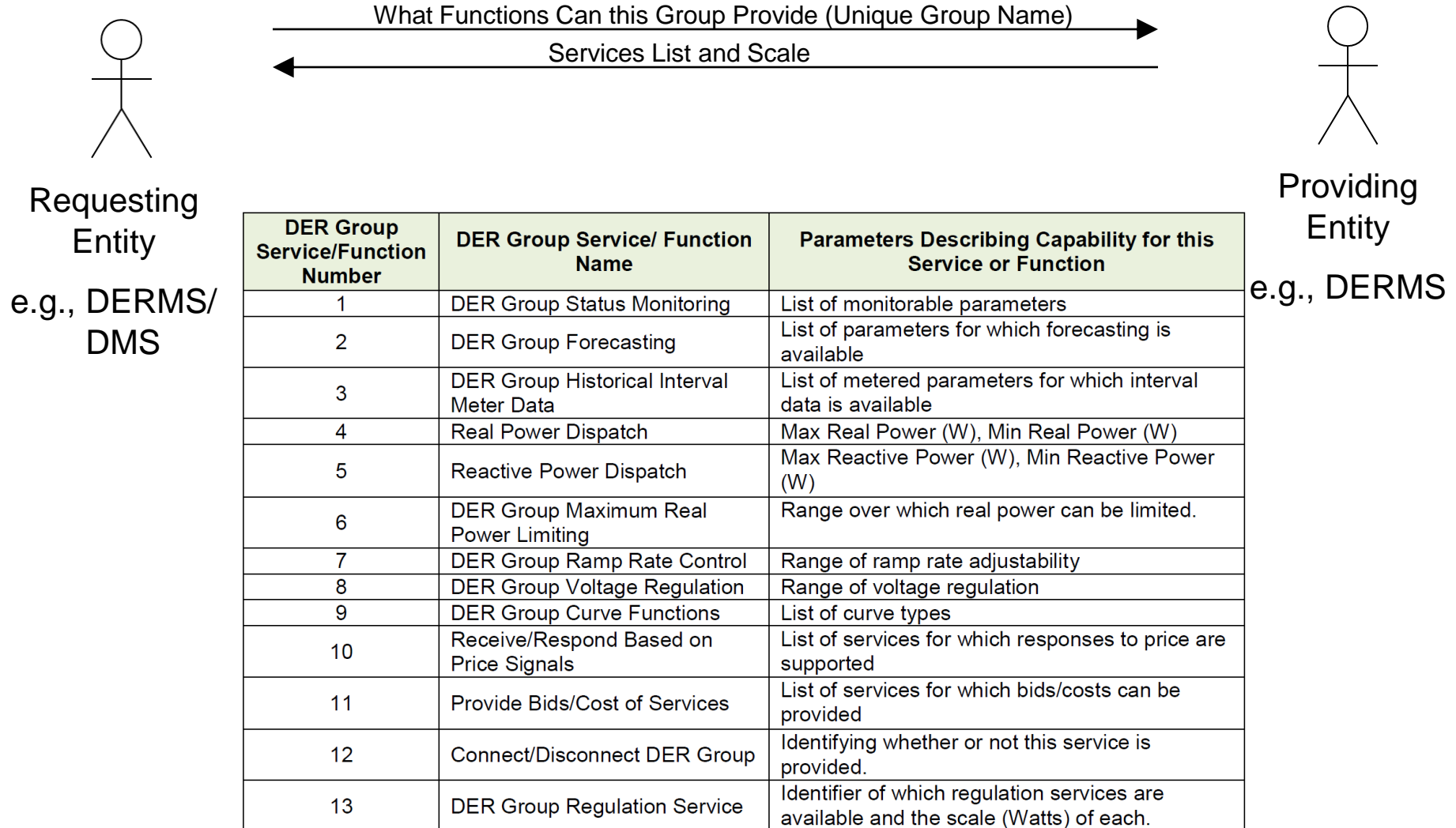| #	Type	Vendor	kW	kVar	...
1	PV	Tesla	4	3	…
2	Storage	Engie	10	10	…
3	EVSE	ABB	7	0	…
4	Storage	LG	7	7	…
5	…	…	…	…	…

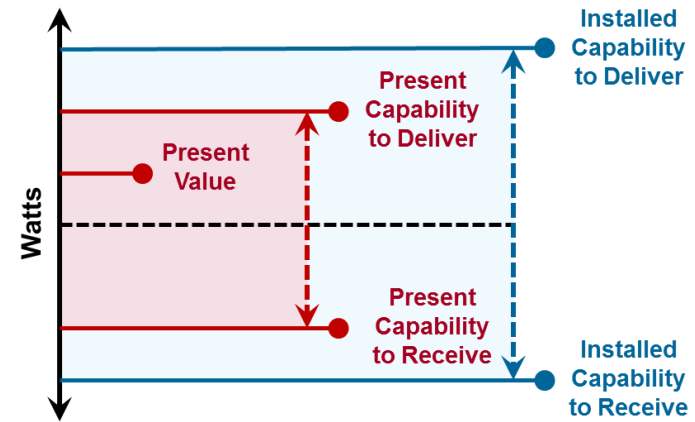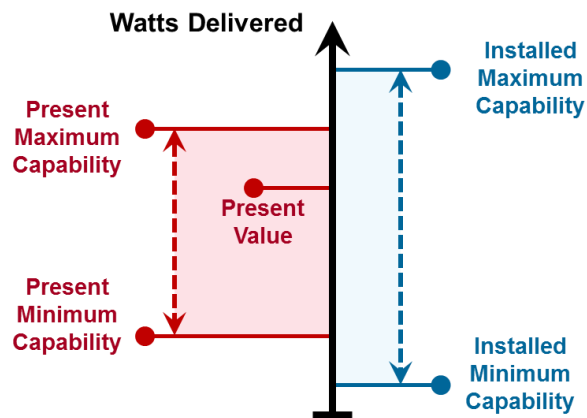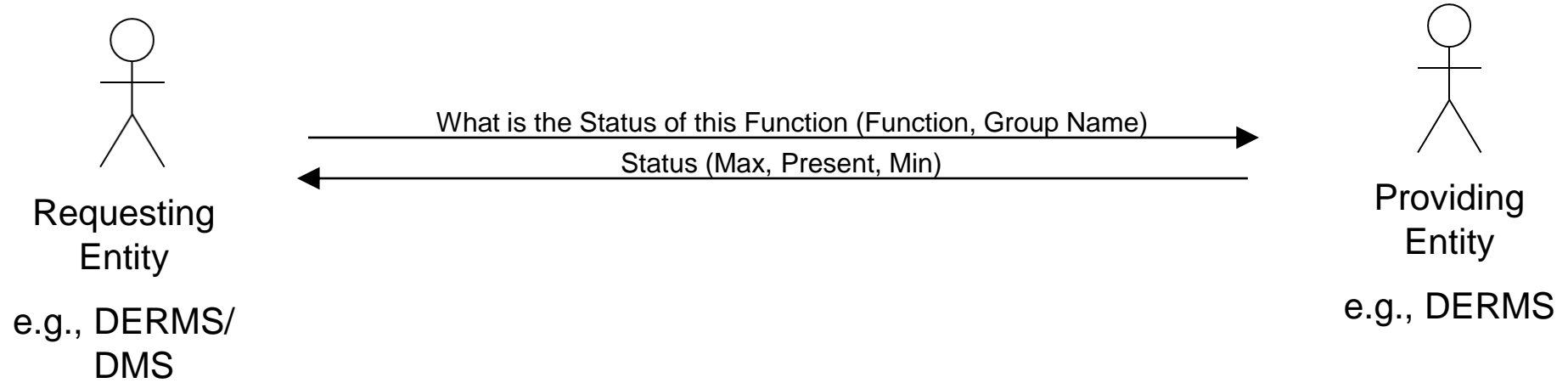# DER Group Setup – DER Group Creation
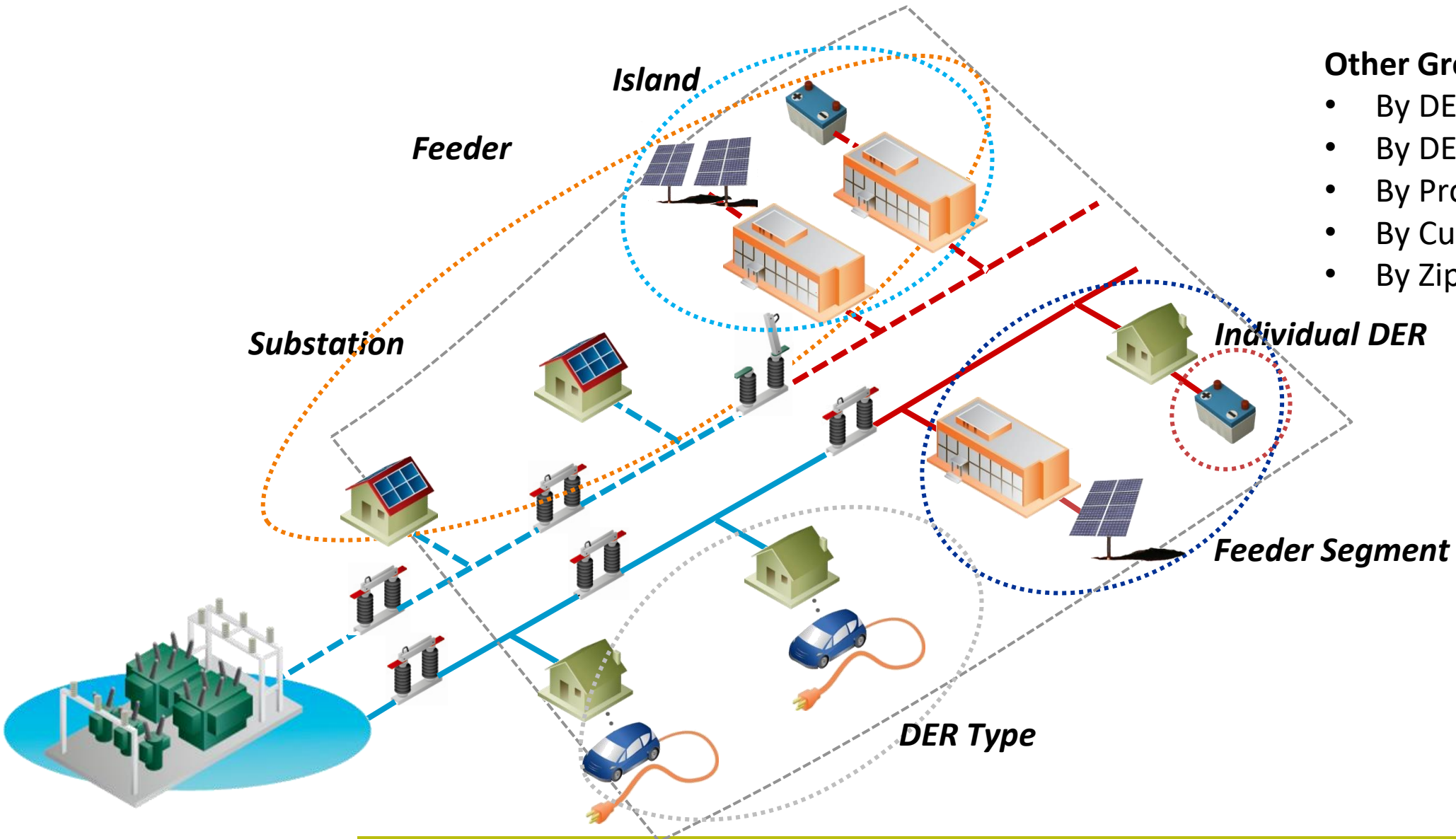
Other Grouping Methods
- By DER Circuit Phase
- By DER Owner
- By Program Enrollment
- By Customer Class
- By Zipcode etc.

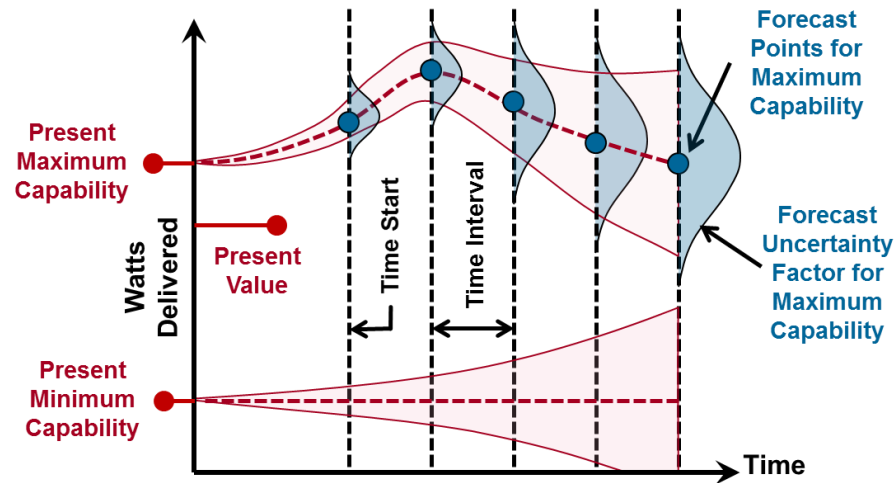Island

Feeder

Substation

Individual DER

Feeder Segment

DER Type

DER Group Monitoring, Capabilities, Status

What Functions Can this Group Provide (Unique Group Name) →

← Services List and Scale

Requesting Entity

e.g., DERMS/ DMS

Providing Entity

e.g., DERMS

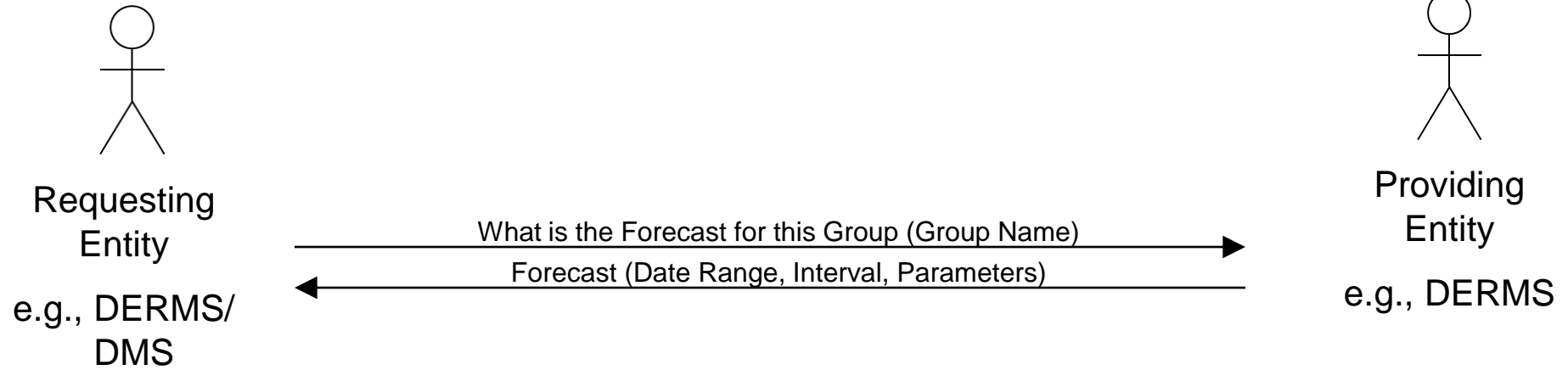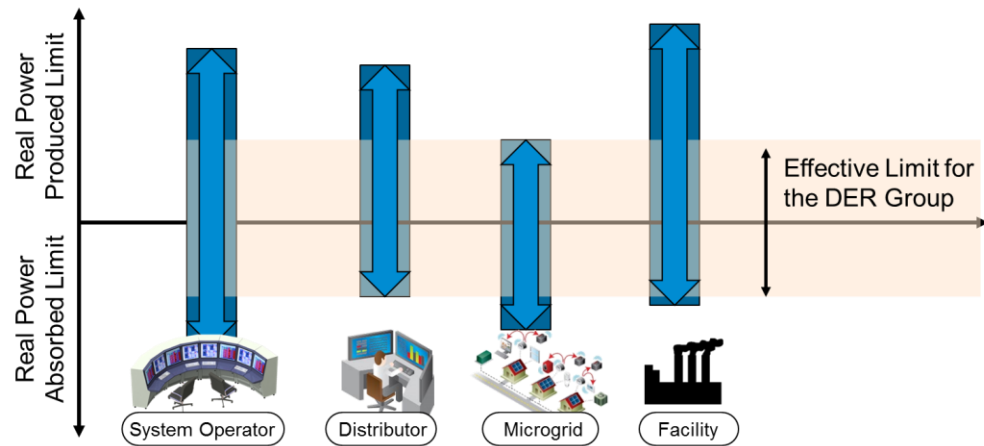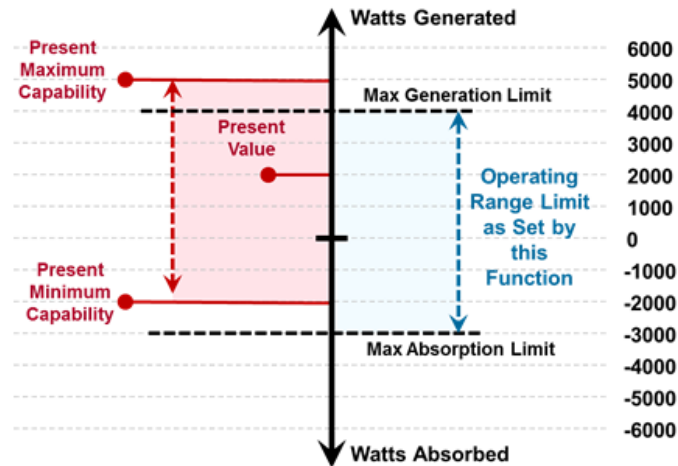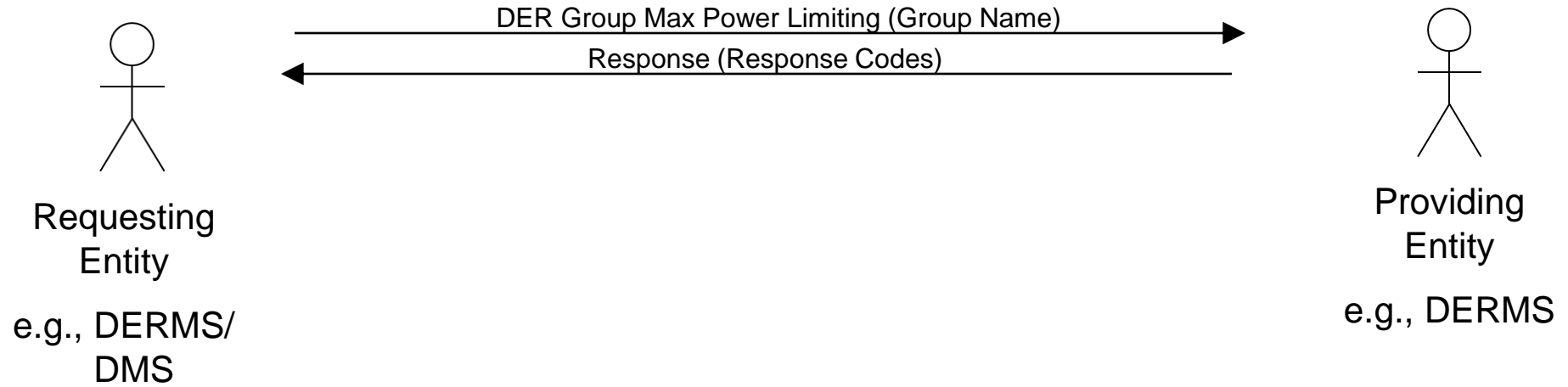| DER Group Service/Function Number	DER Group Service/ Function Name	Parameters Describing Capability for this Service or Function
1	DER Group Status Monitoring	List of monitorable parameters
2	DER Group Forecasting	List of parameters for which forecasting is available
3	DER Group Historical Interval Meter Data	List of metered parameters for which interval data is available
4	Real Power Dispatch	Max Real Power (W), Min Real Power (W)
5	Reactive Power Dispatch	Max Reactive Power (W), Min Reactive Power (W)
6	DER Group Maximum Real Power Limiting	Range over which real power can be limited.
7	DER Group Ramp Rate Control	Range of ramp rate adjustability
8	DER Group Voltage Regulation	Range of voltage regulation
9	DER Group Curve Functions	List of curve types
10	Receive/Respond Based on Price Signals	List of services for which responses to price are supported
11	Provide Bids/Cost of Services	List of services for which bids/costs can be provided
12	Connect/Disconnect DER Group	Identifying whether or not this service is provided.
13	DER Group Regulation Service	Identifier of which regulation services are available and the scale (Watts) of each.

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DER Group Monitoring, Capabilities, Status
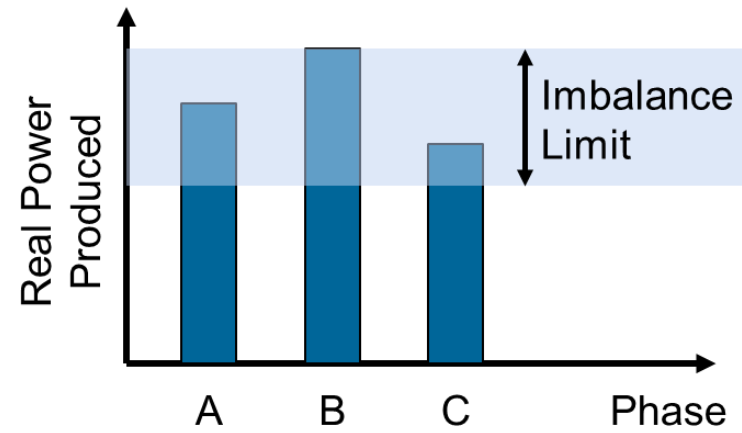
DER Group Monitoring, Capabilities, Status

Requesting
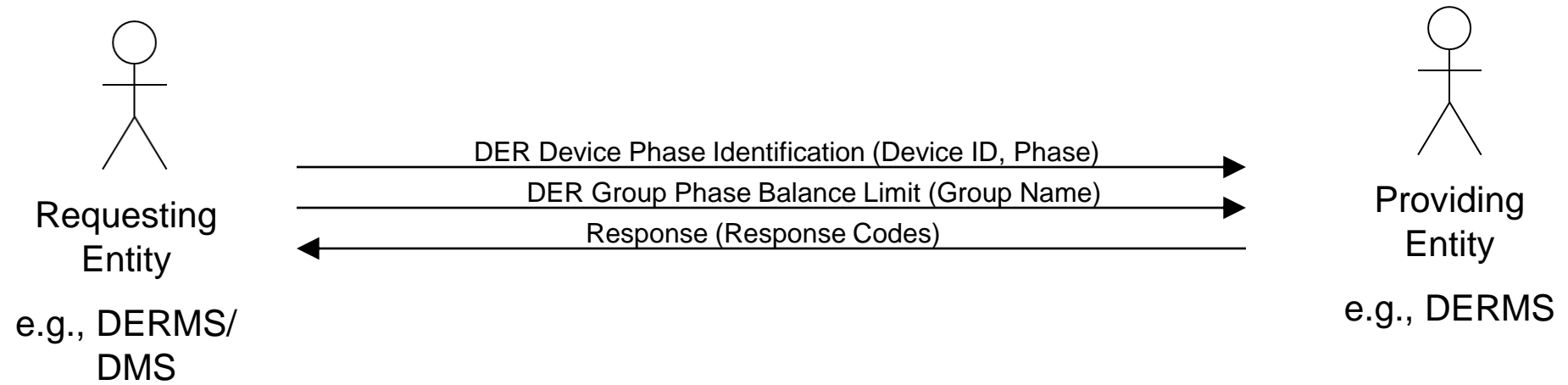Entity

e.g., DERMS/
DMS

What is the Forecast for this Group (Group Name)

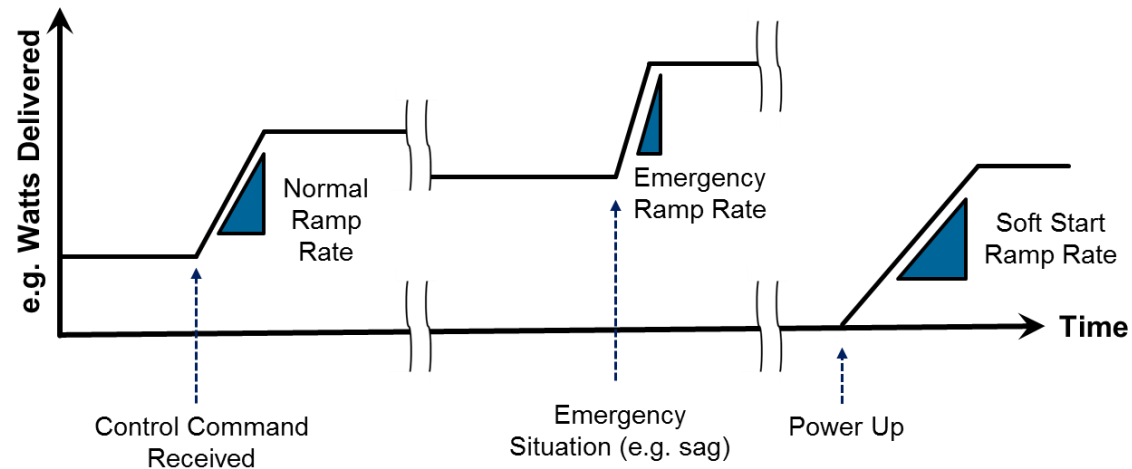Forecast (Date Range, Interval, Parameters)
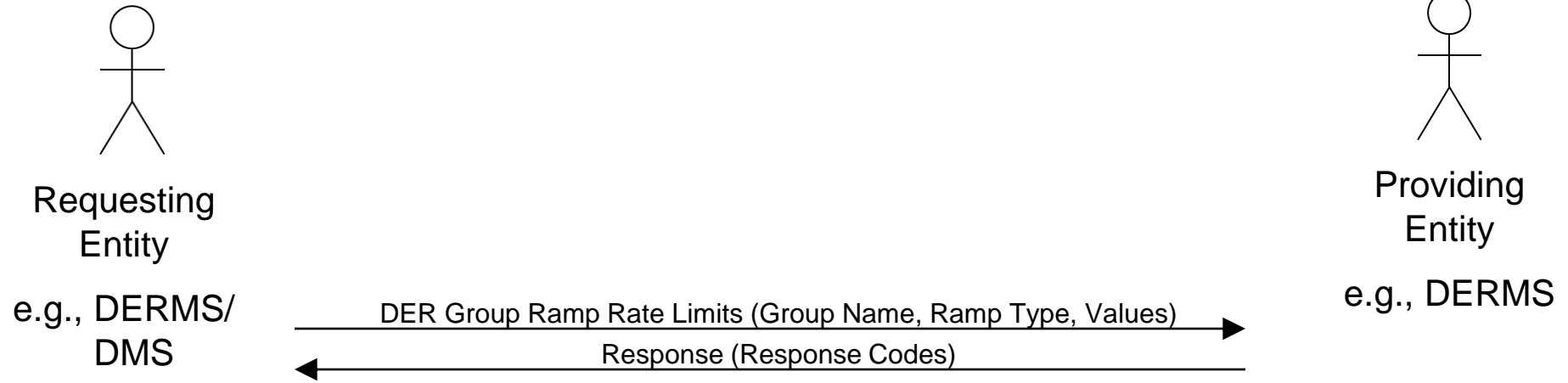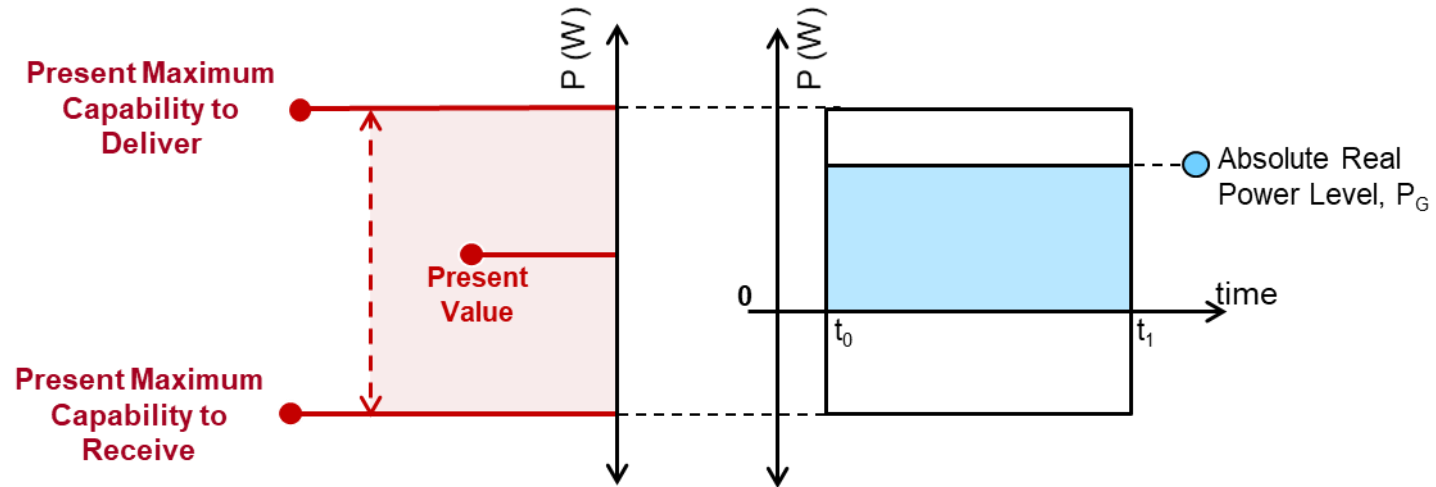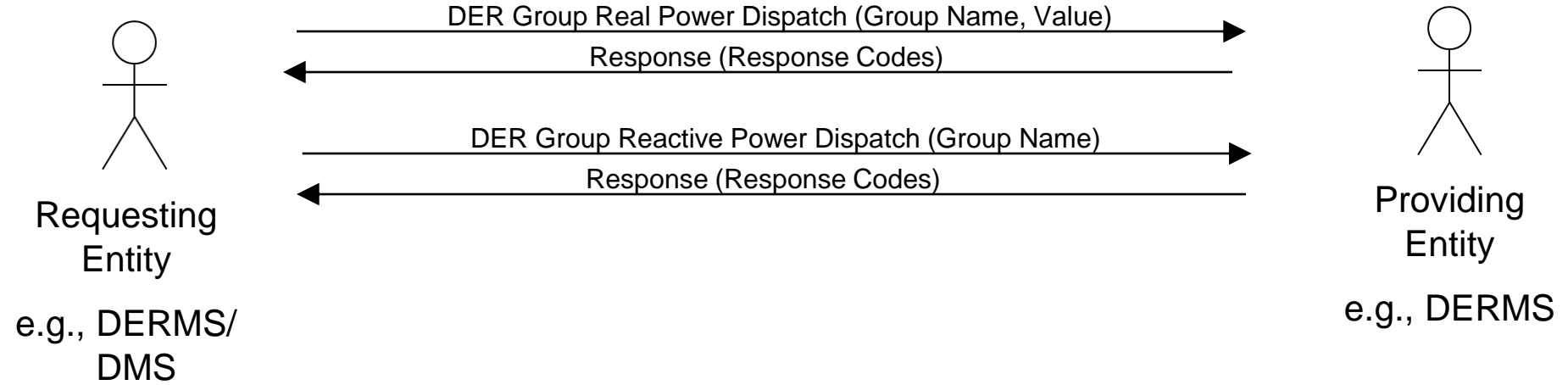
Providing
Entity

e.g., DERMS

DER Group Operational Limits Boundaries

DER Group Operational Limits Boundaries

DER Group Operational Limits Boundaries

Requesting Entity

e.g., DERMS/ DMS

Providing Entity

e.g., DERMS

DER Group Ramp Rate Limits (Group Name, Ramp Type, Values)

Response (Response Codes)

e.g. Watts Delivered

Normal Ramp Rate

Emergency Ramp Rate

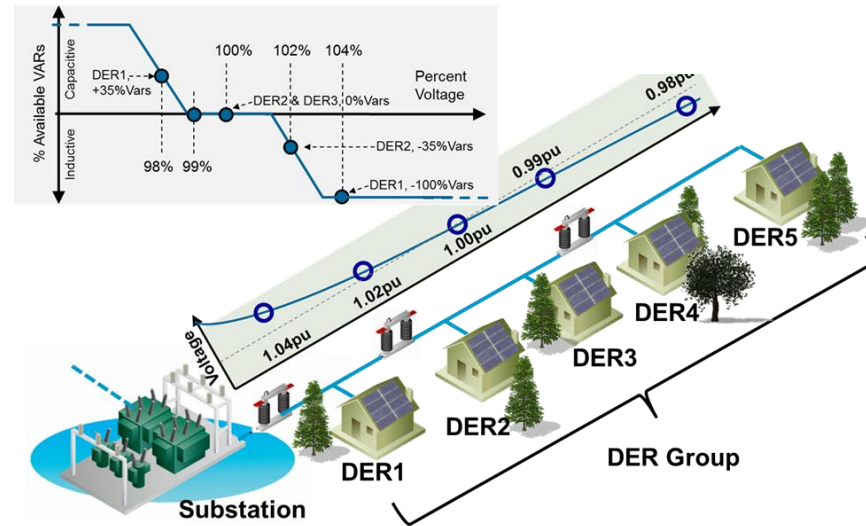Soft Start Ramp Rate

Time

Control Command Received

Emergency Situation (e.g. sag)

Power Up

DER Group Control Functions

DER Group Control Functions

DER Group Regulation Function

Requesting Entity
e.g., DERMS/DMS

Providing Entity
e.g., DERMS

DER Group Assigned Baseline Power(Group Name, Value)

Response (Response Codes)

DER Group ACE Regulation Signal, Ramp Time (Group Name)

Response (Response Codes)

Regulation Capability

Assigned Regulation

Provided Regulation

Baseline

Regulation Power [MW]

Time [Seconds]