MESA-DER Workshops: DNP3 for IEEE 1547 and Integration into IEEE 1815.2

April 25, 2023

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MESA

Contents

MESA

1. Introduction to MESA Alliance, MESA-DER, and Integration into IEEE 1815.2

The **Modular Energy System Architecture (MESA) Standards Alliance** is an industry association comprised of electric utilities and technology suppliers dedicated to providing interoperable communications for DER systems and DER devices.

MESA Membership

MESA Members 2022-23

A full listed of members and partners is available at www.mesastandards.org/members

MESA's Mission

MESA's mission is to accelerate the interconnection of Distributed Energy Resources (DER) through the development of interoperable communication specifications, based on well-established standards that meet the specific needs of utilities and DER integrators.

MESA specifications support safe, affordable, and scalable DER communications with the following benefits:

	UTILITIES	DEVELOPERS	INDUSTRY
▲ Meet all DER interoperability requirements for IEEE 1547 DER interconnection and interoperability standard	✓	✓	✓
▲ Use international communication standards, including IEEE 1815 (DNP3), IEC 61850, and SunSpec Modbus	✓	✓	✓
▲ Streamline deployments and meet customer timelines	✓	✓	✓
▲ Focus resources on implementing market-based functions for improved efficiency and revenue streams	✓	✓	✓
▲ Reduce costs of technology development and deployment	✓	✓	
▲ Reduce risk by enabling supplier flexibility	✓	✓	
▲ Simplify long-term maintenance and system upgrades	✓	✓	
▲ Efficiently scale DER deployments	✓	✓	
▲ Reduce training and compliance testing costs	✓	✓	✓
▲ Provide products designed for integration with other MESA-compliant products		✓	✓
▲ Increase the array of available partners for projects			✓

Energy Storage Systems (ESS) as Essential Technology for the Future Electric Grid

- MESA-DER started as MESA-ESS because energy storage was seen as critical to the High DER Future Electric Grid, even though regulatory requirements and standards had not yet addressed ESS:

❖ "Economical grid-scale and distributed storage has the potential of completely transforming the electric industry. Planning processes, operations, markets and the role of utilities will all be impacted by large-scale deployment of storage."

➢ *Steve Berberich, President and Chief Executive Officer for the California Independent System Operator (CAISO), one of the world's largest transmission organizations*

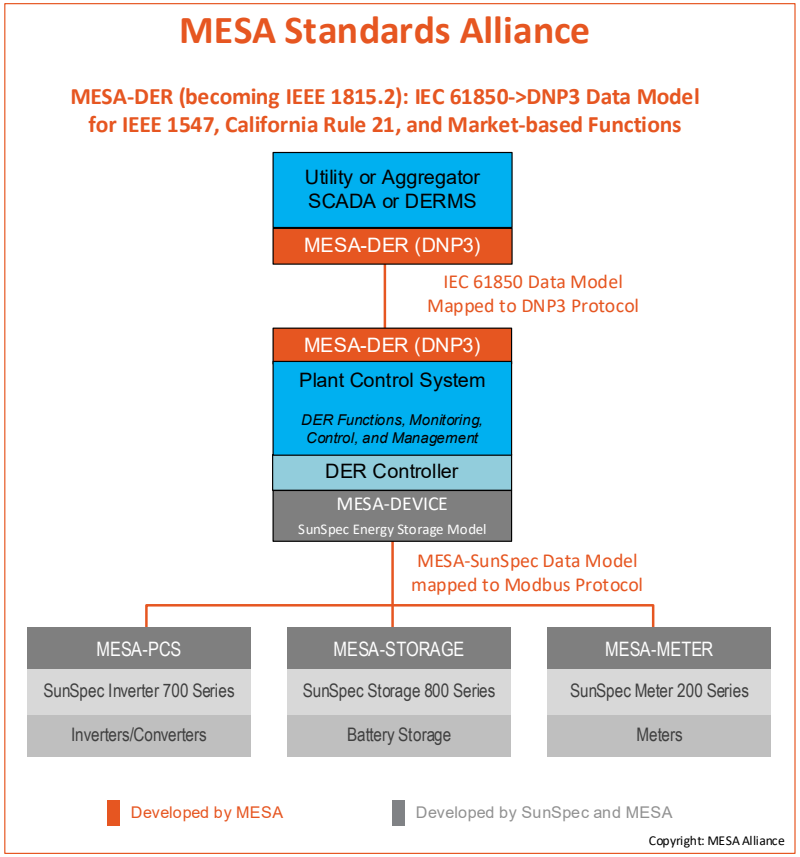
❖ "With economic and technical (r)evolutions, storage will be the game-changer which is needed for the acceleration of the successful energy transition. Our company is already incorporating energy storage and its usage as a source of flexibility in our grid planning and operation. We also actively develop solutions for a higher utilization of our grids enabled by fast reacting storage assets as well as long-term storage solutions like power-to-gas."

➢ *Manon van Beek, Chair of the Executive Board and Chief Executive Officer of TenneT Holding B.V*

❖ "Global warming and the explosive growth of humanity's demand for ecological resources call for a resolute action to drive a profound (r)evolution of the entire energy system. The electrical system has a crucial and central role as an enabler of such a transformation; in order to ensure the quality of service and security of supply, storage systems and flexibility resources are key "ingredients" of the energy transition, both for frequency regulation services and for the containment of structural overgeneration from renewables."

➢ *Luigi Ferraris, Chief Executive Officer and General Manager of Terna – the company responsible for managing the Italian high-voltage transmission grid*

Overview of MESA Specifications



- **MESA-DER Specifications: IEC 61850 Data Model Mapped to DNP3**
  - ❖ IEEE 1547 Mandatory Functions
  - ❖ Operational Management of DER Plant and/or Facility
  - ❖ Monitoring and Control of DER units
  - ❖ Power Market Functions
  - ❖ Scheduling of Functions
  - ❖ Priority Management of Multiple Co-Existing Functions

- **MESA-Device Specifications: SunSpec Models providing Modbus for inverters and battery storage devices**
  - ❖ MESA-PCS: Power Conversion Systems
  - ❖ MESA-Storage: Batteries
  - ❖ MESA-Meter: Meters

MESA-DER: 21 Functions

IEEE 1547.1 Functions (Via NRTL Test Tools)

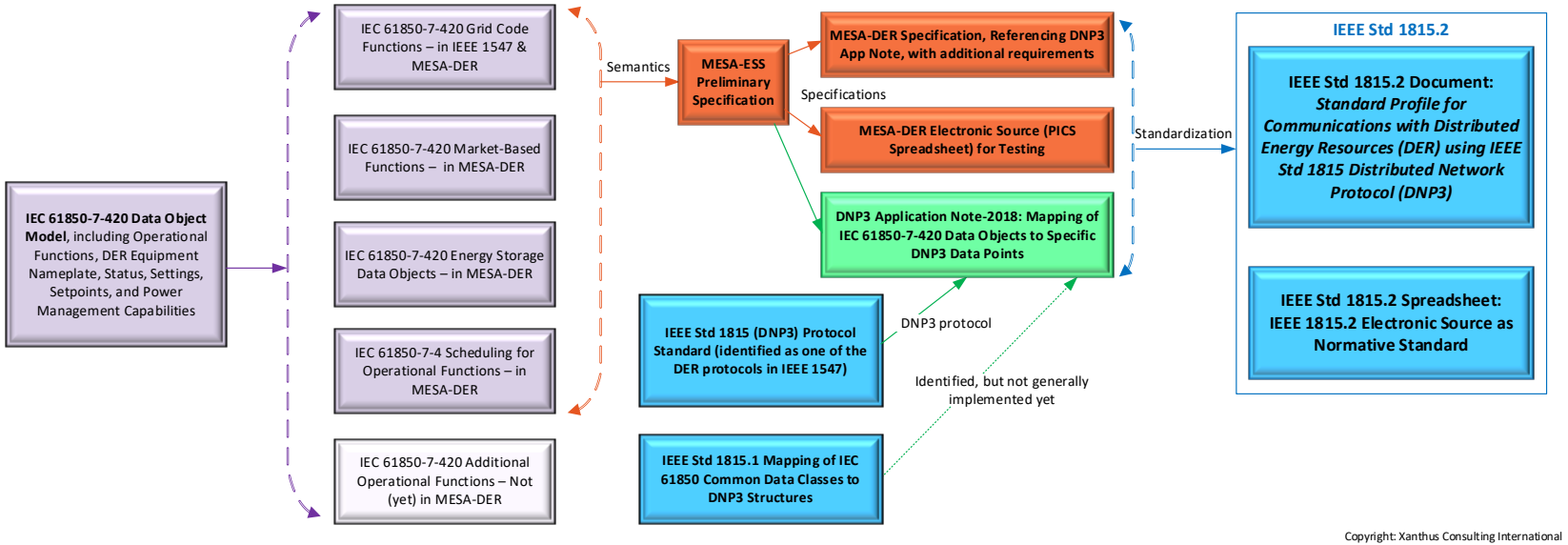
- Low/High Voltage Ride-Through
- Low/High Frequency Ride-Through
- Dynamic Volt-Watt Function
- Frequency-Watt Function (Droop)
- Limit Active Power Function
- Volt-Watt Function
- Constant VArs Function
- Fixed Power Factor Function
- Volt-VAr Control Function
- Watt-VAr Function
- Dynamic Reactive Current Support

Additional MESA Functions

- Charge/Discharge Function (Set Active Power)
- Coordinated Charge/Discharge Function
- Active Power Response Function #1 (Peak Power Limiting)
- Active Power Response Function #2 (Generation Following)
- Active Power Response Function #3 (Load Following)
- Automatic Generation Control (AGC) Function
- Active Power Smoothing Function
- Frequency-Watt “Curve” Function (Artificial Inertia, Fast Frequency Response, etc.)
- Power Factor Correction Function
- Pricing Function
- Scheduling

Status 2023: Integration into IEEE 1815.2

IEC 61850-7-420 Semantics, MESA-DER Specification, MESA-DER Spreadsheet, and DNP3 Application Note Integration into IEEE 1815.2



- IEEE PSCC P15 WG, with major support by MESA, DNP User Group, and EPRI, is developing the draft IEEE 1815.2
- Draft has been reviewed by the P15 WG
- Next Step is Balloting – probably around September 2023

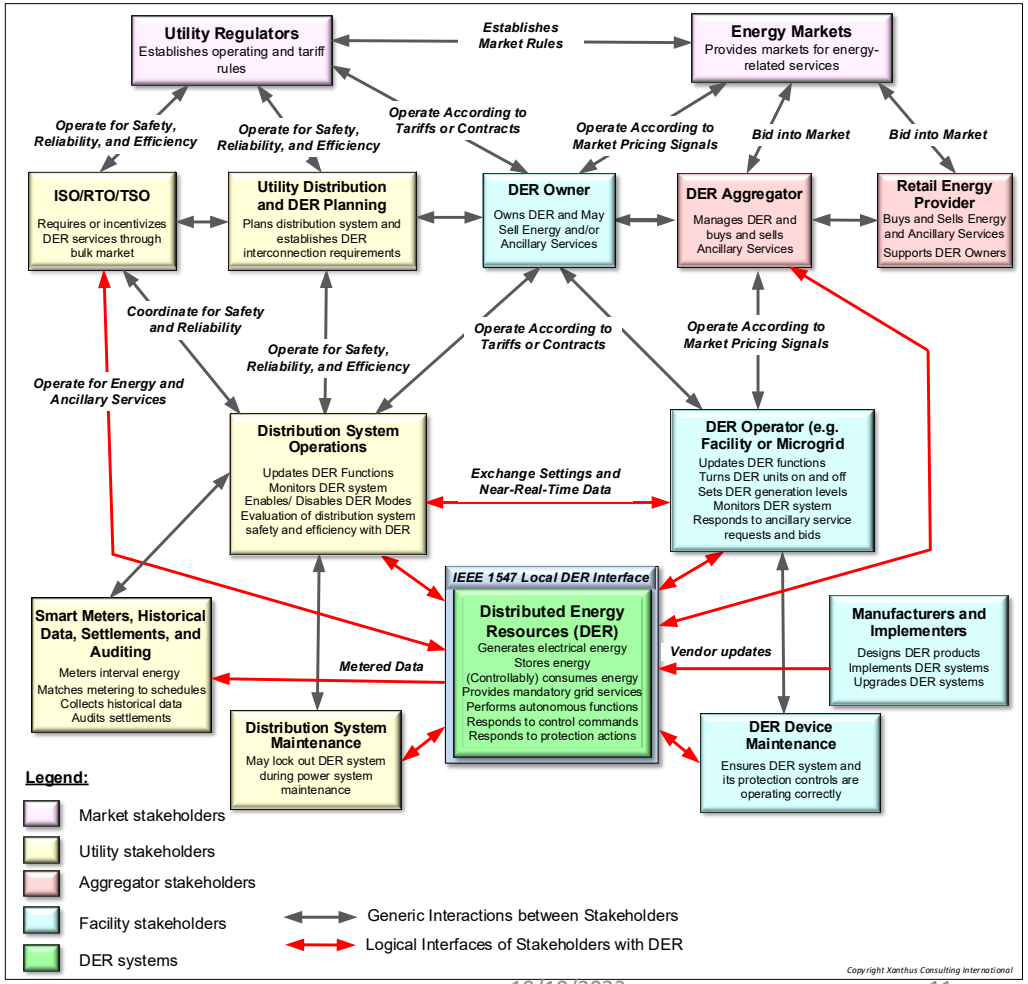
2. DER Architectures and Interoperability Concepts

Communication concepts required for **Interoperability** (*the ability of computer systems or software to exchange and make use of information. "interoperability between devices made by different manufacturers“)*

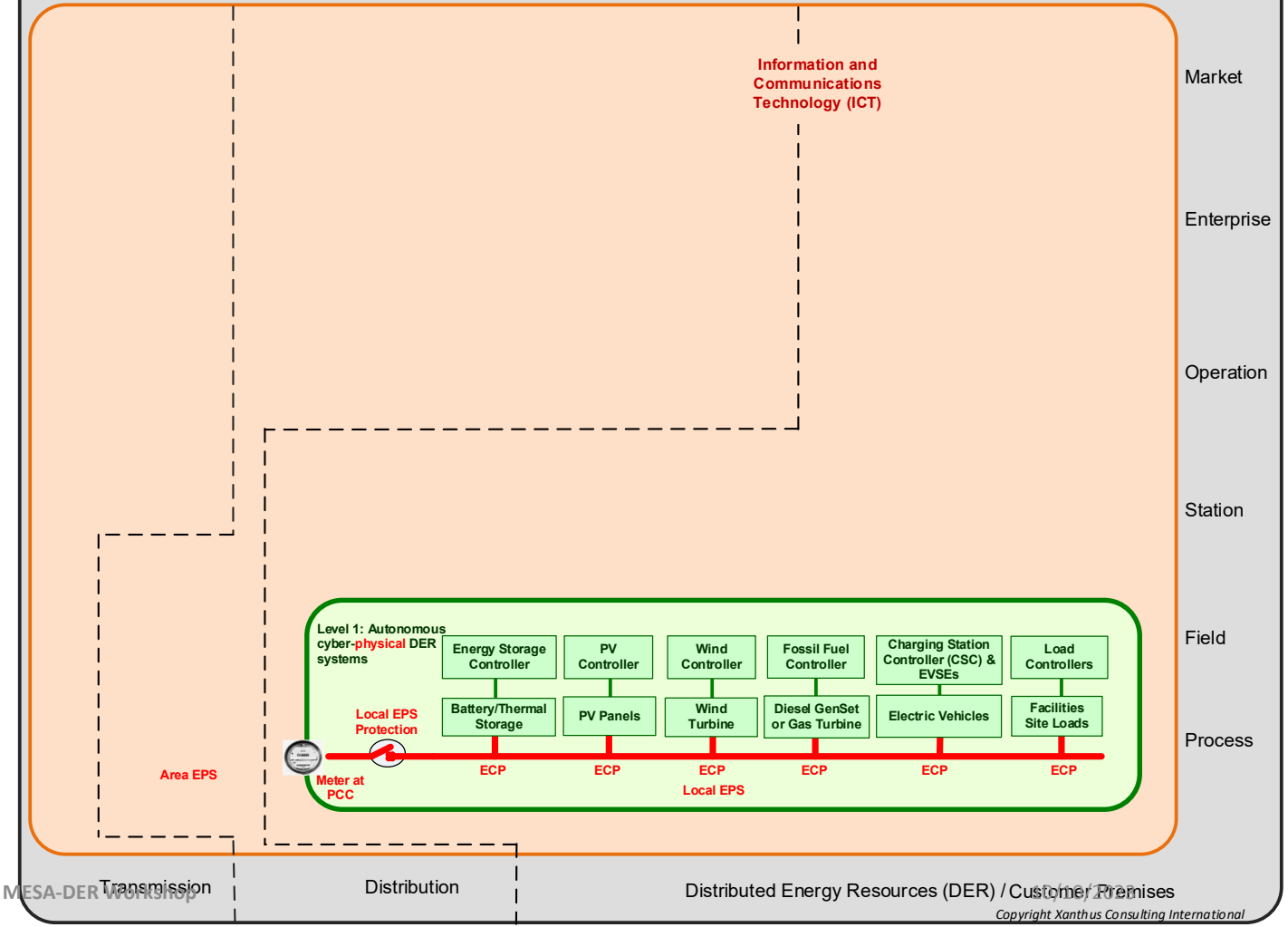
For instance, English is often used as the **Interoperable Business Language** in meetings among different countries

Many Diverse DER Stakeholders

- Multiple business purposes
- Multiple types of contractual arrangements
- Multiple levels and requirements for communication interactions
- Different needs for the capabilities of the communication protocols
- Meeting mandatory DER grid codes
- Deciding on which market-based DER functions provide optimal return on investment
- **Need a standardized Interoperable Communications Language for Data Exchanges between the Stakeholders' computer systems**



Hierarchical DER System Five-Level Architecture, Mapped to the Smart Grid Architecture Model (SGAM)



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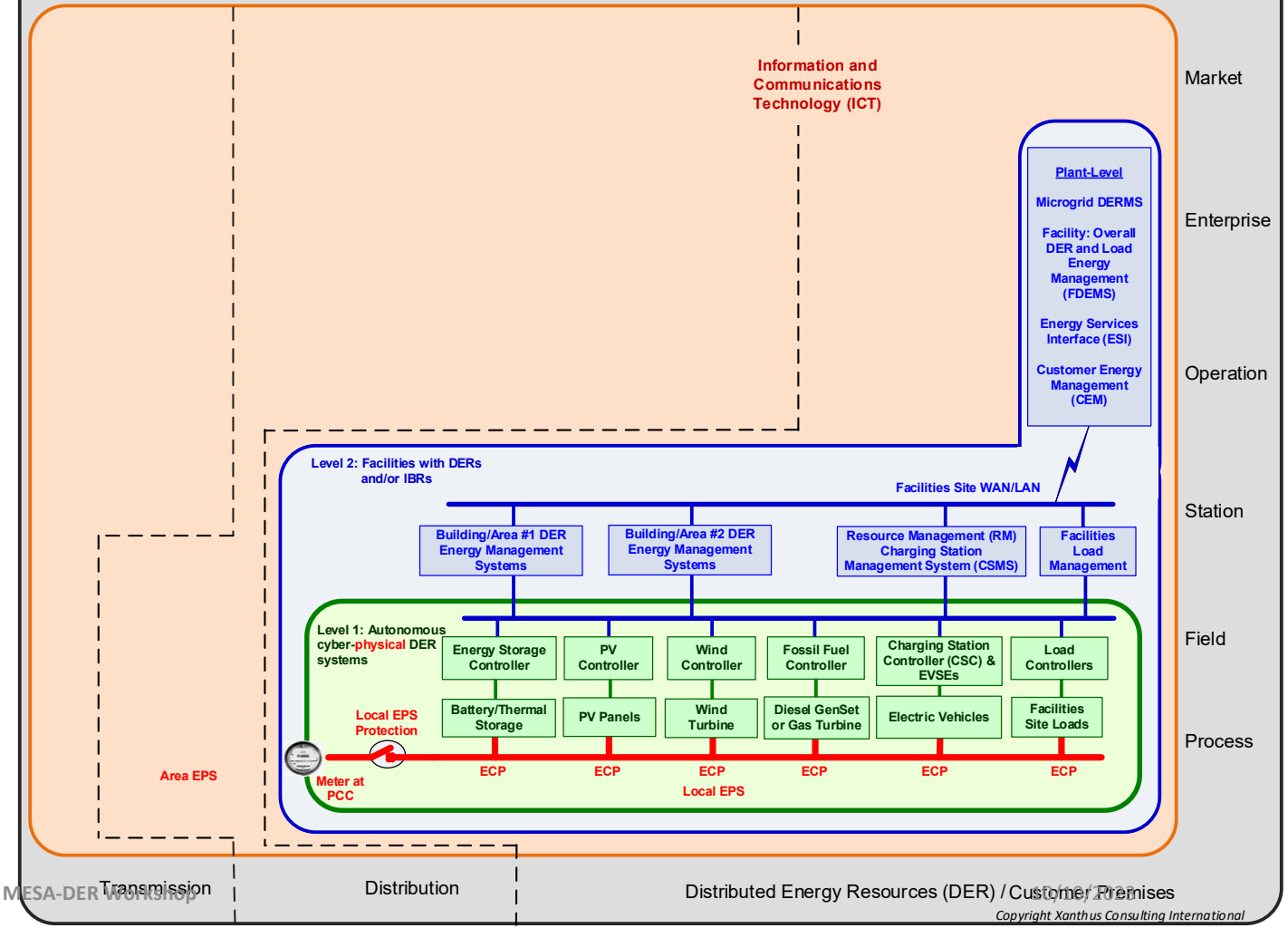

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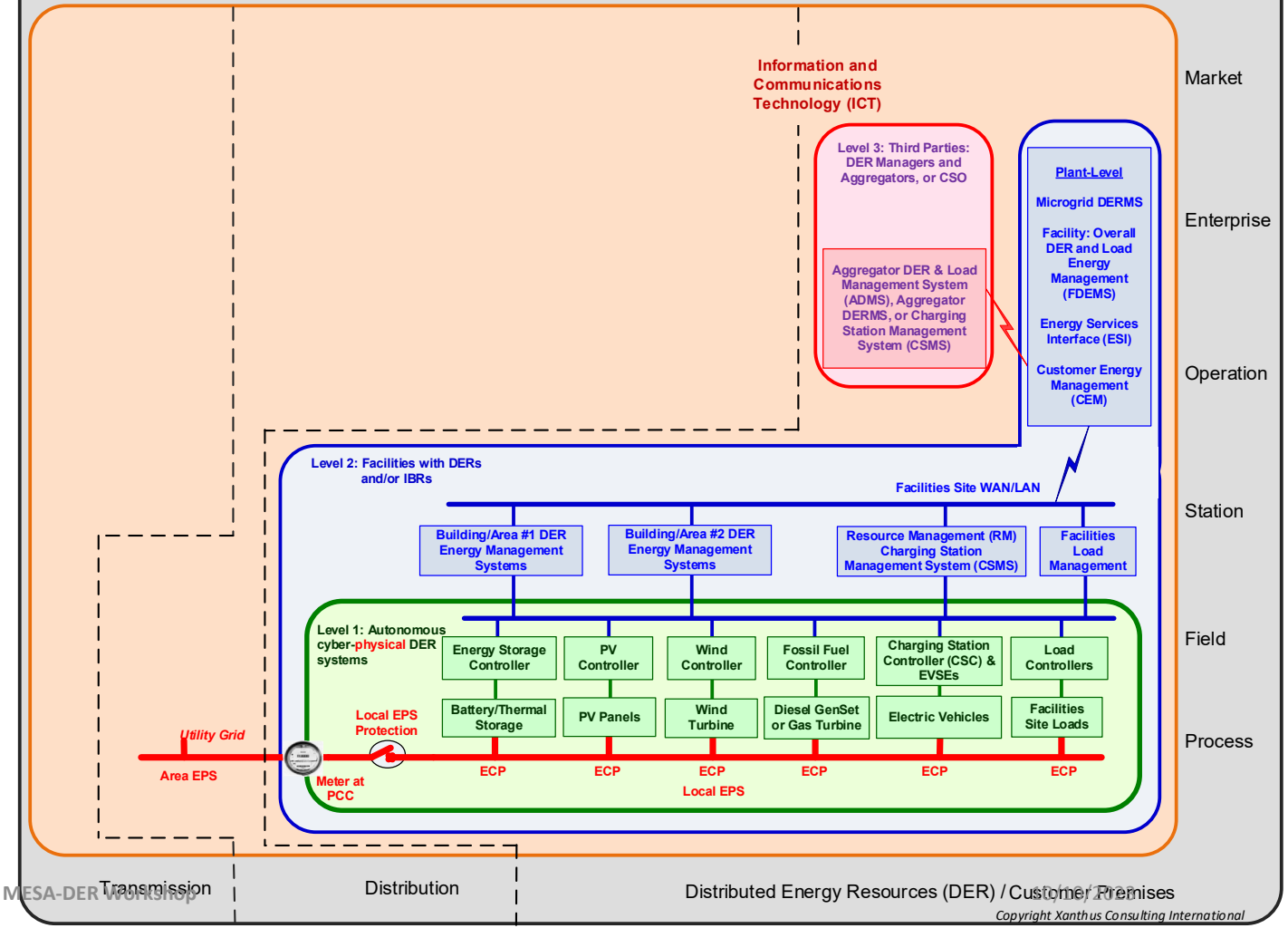

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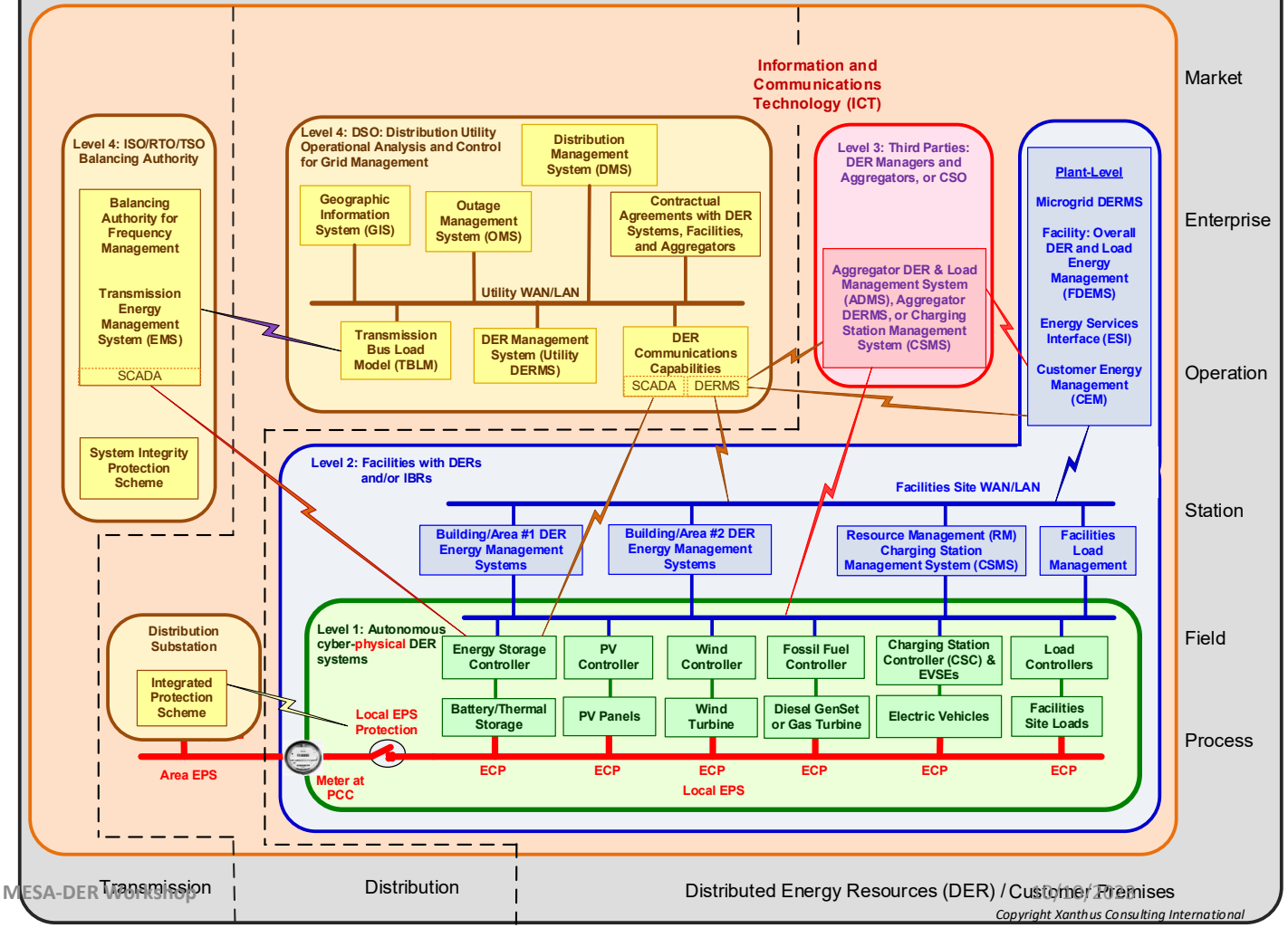

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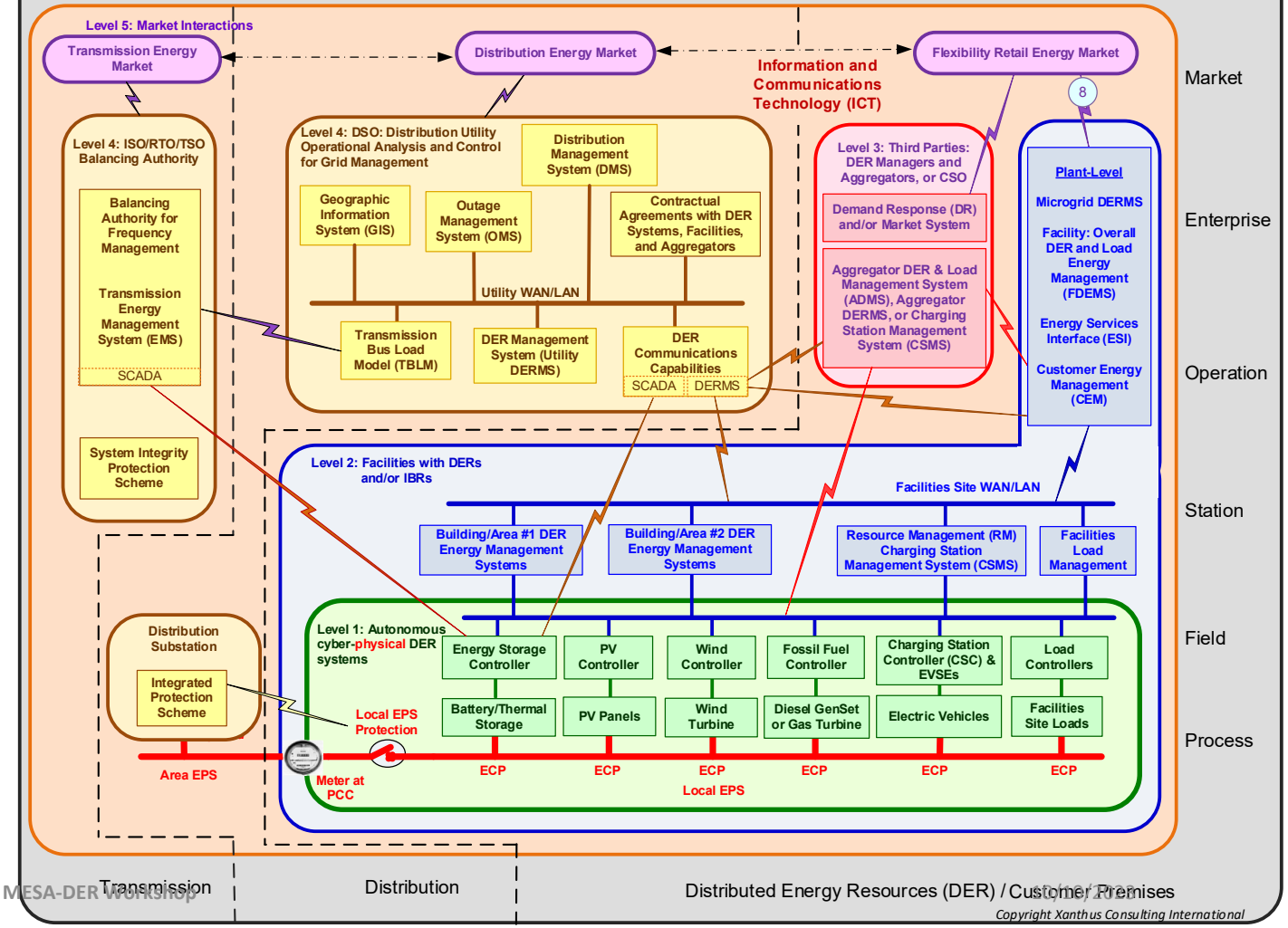
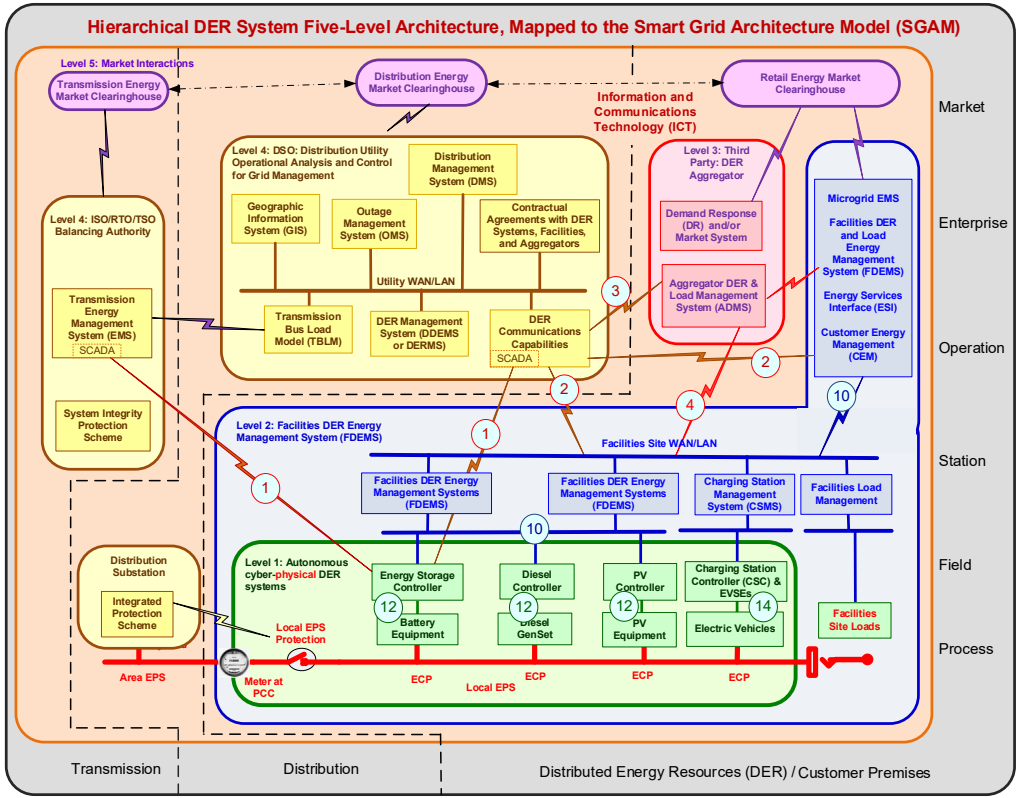


MESA-DER Focus on Interface #1, #2, #4, & #10 (DNP3 for SCADA) and MESA-Device/SunSpec on Interface #12 (Modbus for Storage Devices)



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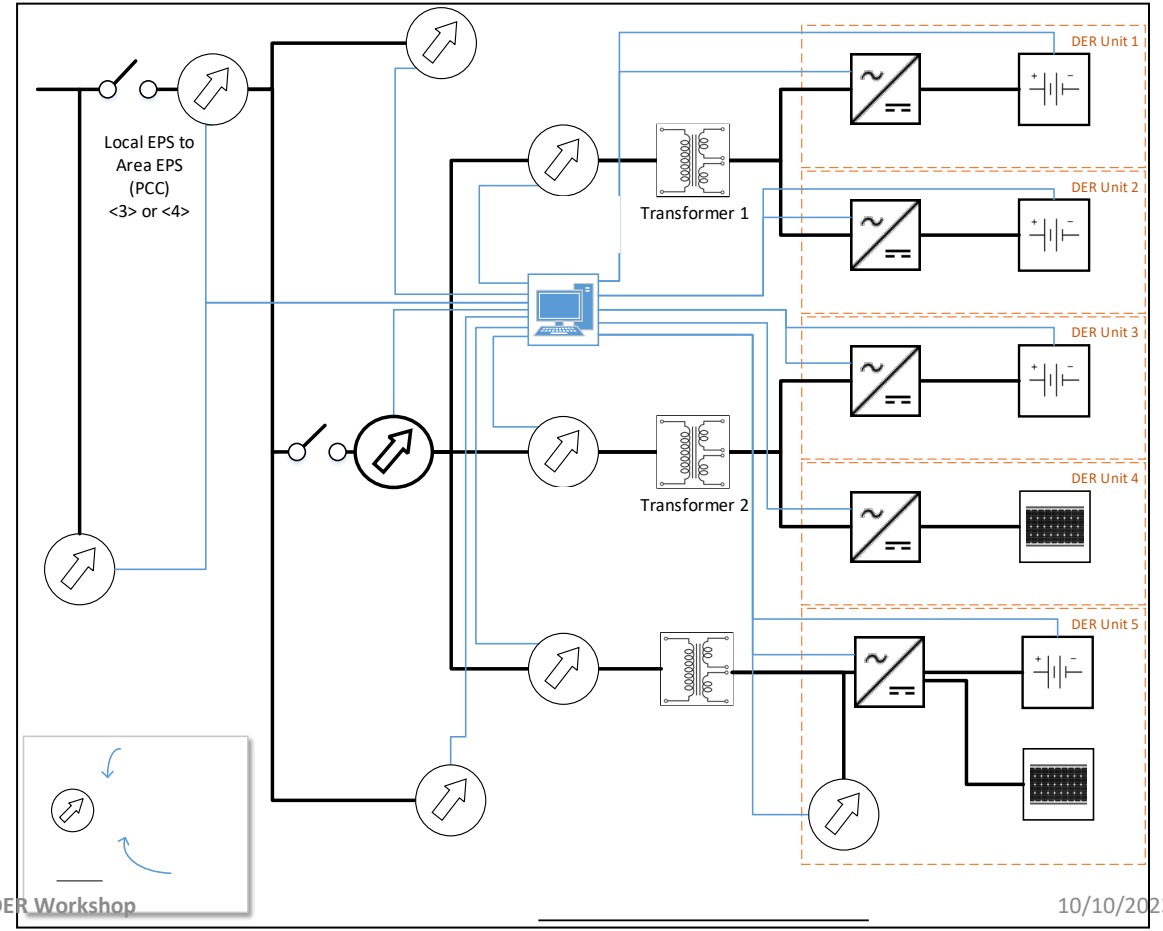
MESA-DER Specification

The MESA-DER Specification provides *standardized* and *interoperable* communications language using the IEC 61850 information Model mapped to specific DNP3 (IEEE 1815) data points, thus ensuring both utilities and DER vendors have precisely the same understanding of the meaning of these data points.

This MESA-DER Specification meets the IEEE 1547 functional and interoperability requirements and is specified in IEEE 1547.1 for the interoperability testing of DNP3. MESA-DER also supports many additional functions, such as AGC, Generation Following, Load Following, Set Active Power (base load), Peak Power Limiting, Operational Reserve, and Coordinated Charge/Discharge for storage.

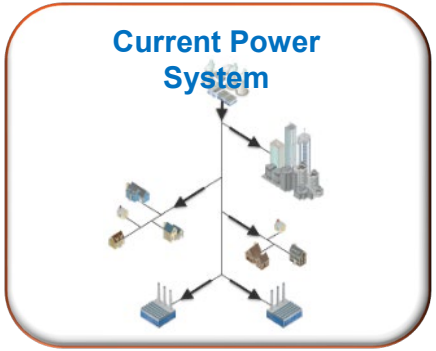
MESA-DER can be used for interactions among the various "stakeholders", including the SCADA system (distribution and/or transmission) operator, the balancing authority, DER facility energy management systems, interactions between DERs within a facility, response to power market requirements, inter-DER markets (e.g., generation following of a PV plant by a storage plant), virtual DER plants, microgrids, etc.).

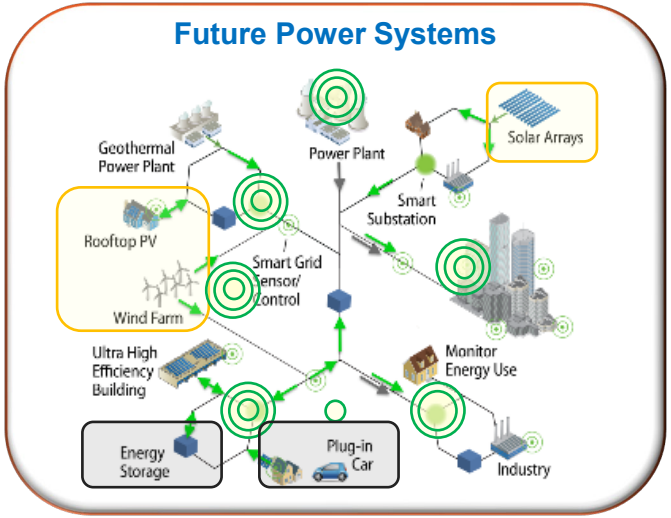
Details within a Site with PV-plus-Storage



3. IEEE Std 1547-2018 DER Functional and Interoperability Requirements

Background to Development of IEEE 1547-2018: Evolution of the Grid





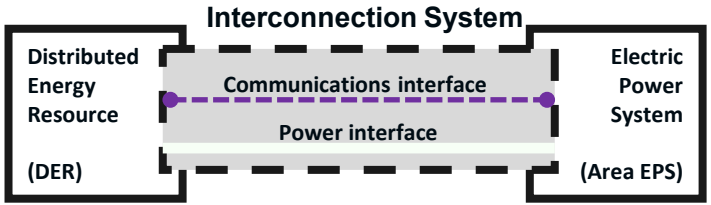
New Challenges

- New energy technologies and services
- Penetration of variable renewables in grid (High DER Future)
- New communications and controls (e.g., Smart Grids)
- Electrification of transportation
- Integration of distributed energy storage
- Regulatory requirements
- Cybersecurity

IEEE 1547-2018 Scope and Purpose

Title: ***Standard for Interconnection and Interoperability of Distributed Energy Resources with Associated Electric Power Systems Interfaces***

Scope: *This standard establishes criteria and requirements for interconnection of distributed energy resources (DER) with electric power systems (EPS), and associated interfaces.*



Purpose*: This document provides a uniform standard for the interconnection and interoperability of distributed energy resources (DER) with electric power systems (EPS).*

It provides requirements relevant to the interconnection and interoperability performance, operation, and testing, and safety, maintenance and security considerations.

- *Interconnection system: The collection of all interconnection equipment and functions, taken as a group, used to interconnect DERs to an area EPS. Note: In addition to the power interface, DERs should have a communications interface.*
- *Interface: A logical interconnection from one entity to another that supports one or more data flows implemented with one or more data links.*

IEEE 1547-2018: 11 Functional Capabilities

- Low/High Voltage Ride-Through
- Low/High Frequency Ride-Through
- Dynamic Reactive Current Support
- Dynamic Volt-Watt Function
- Frequency-Watt (Droop) Function
- Limit Active Power Function
- Volt-Watt Function
- Constant VArs Function
- Constant Power Factor Function
- Volt-VAr Function
- Watt-VAr Function

Abnormal Grid Conditions: Voltage Ride-Through

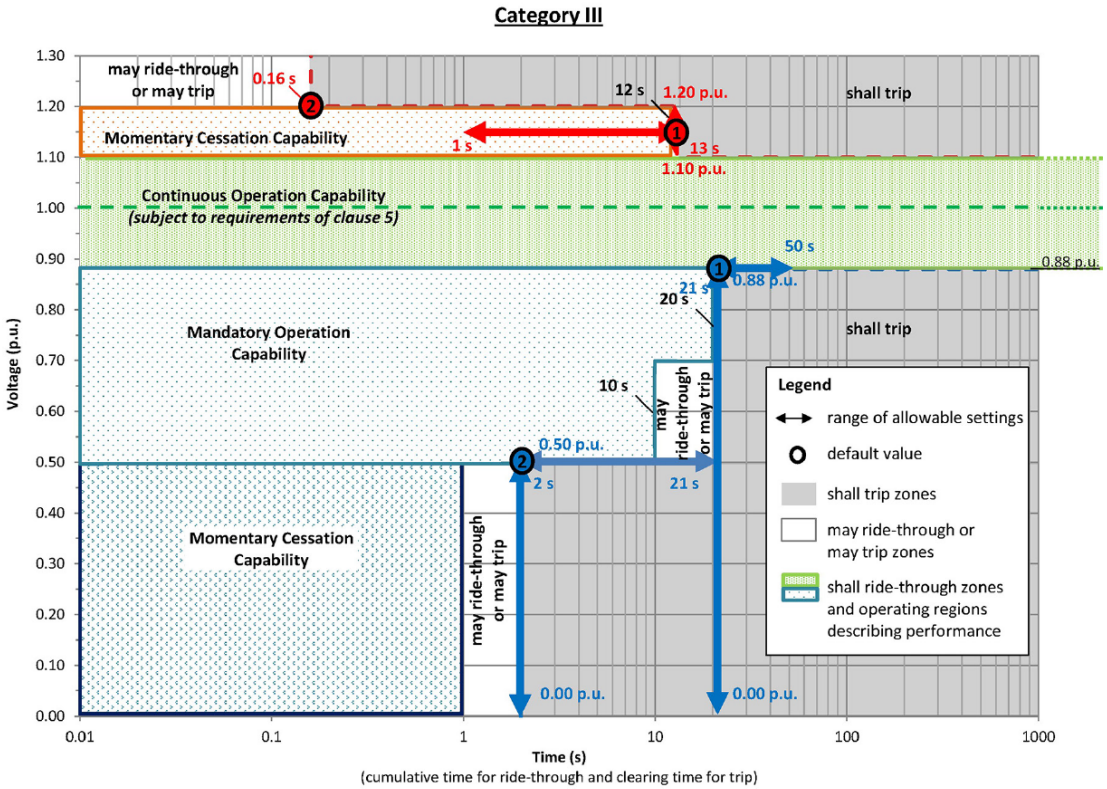


Figure H.9—DER response to abnormal voltages and voltage ride-through requirements for DER of abnormal operating performance Category III

Abnormal Grid Conditions: Frequency Ride-Through

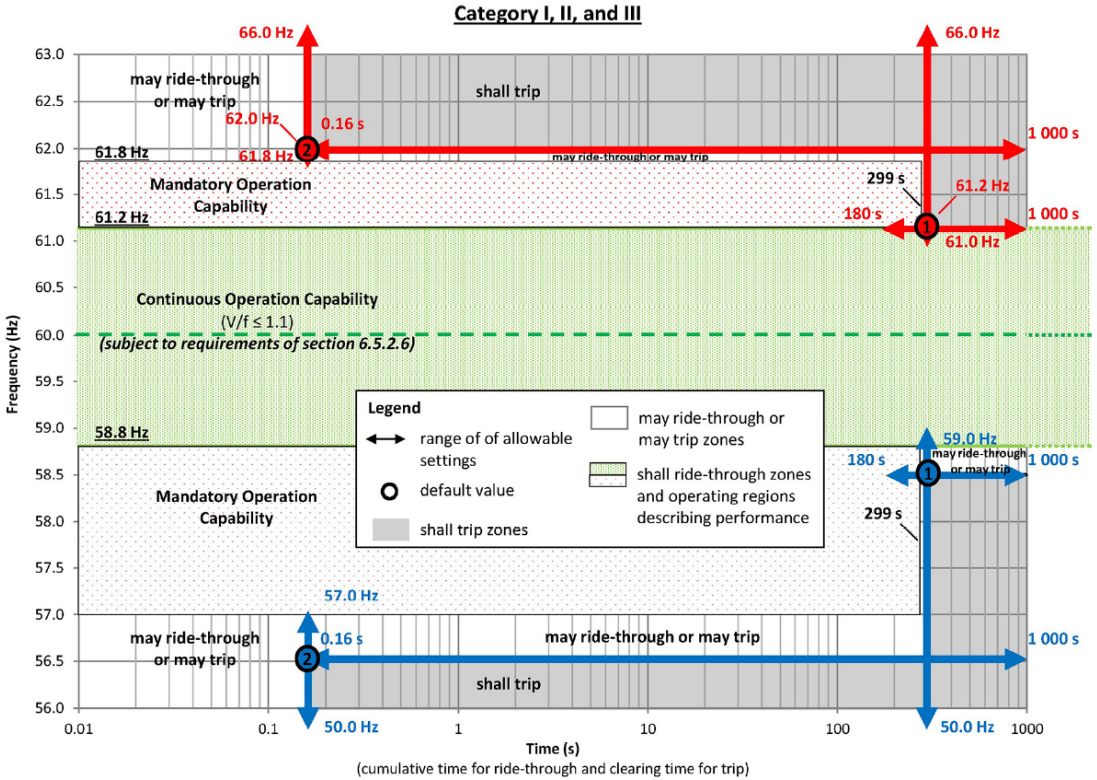


Figure H.10—DER default response to abnormal frequencies and frequency ride-through requirements for DER of abnormal operating performance Category I, Category II, and Category III

Voltage-Reactive Power (Volt/VAr) Function

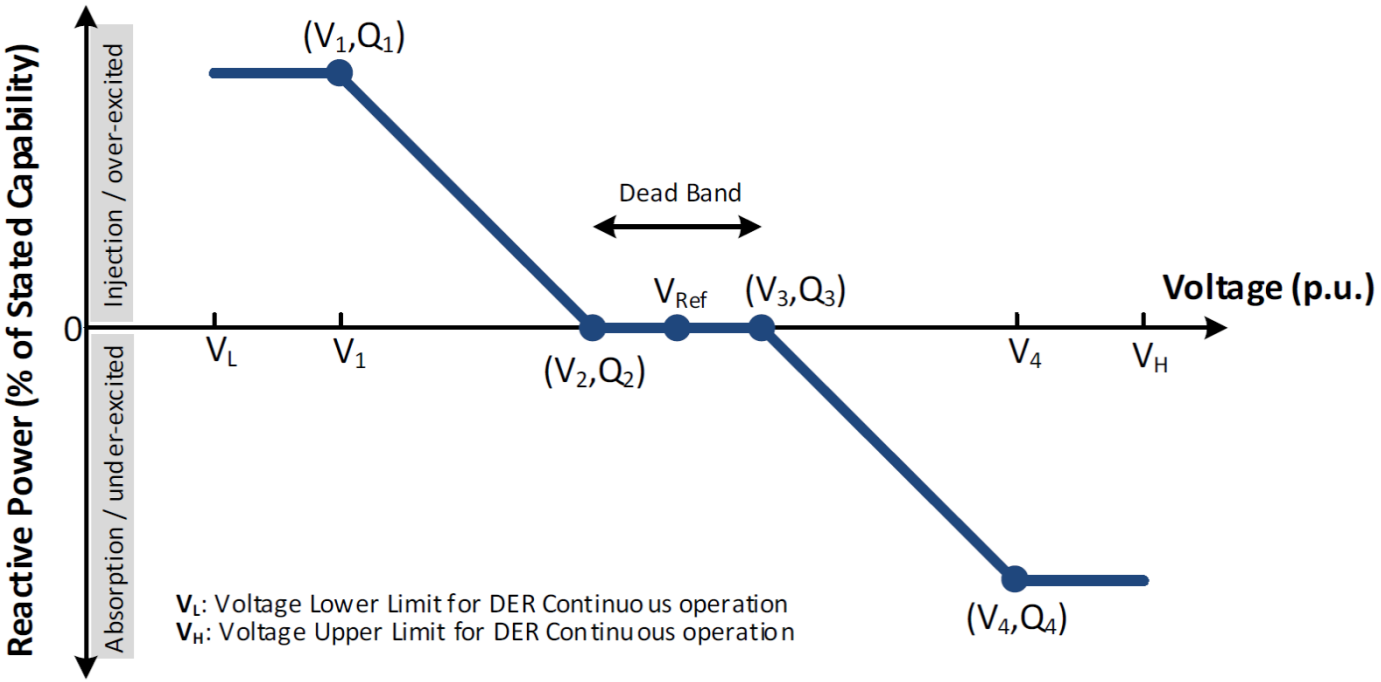


Figure H.4—Example voltage-reactive power characteristic

Active Power – Reactive Power (Watt/VAr) Function

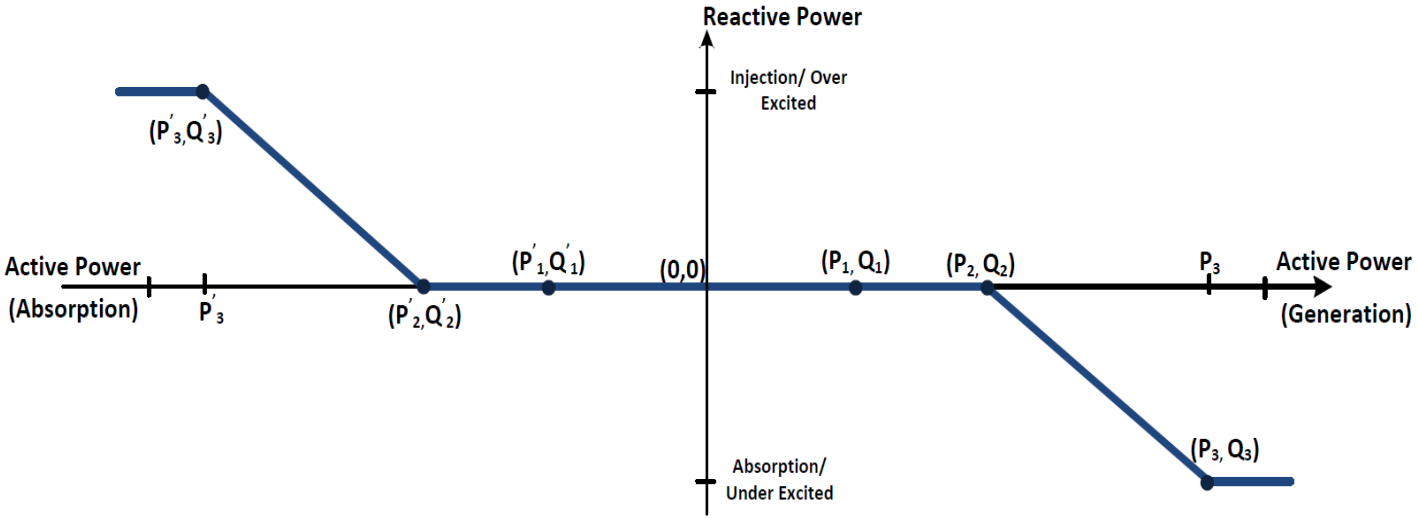


Figure H.5—Example active power-reactive power characteristic

Frequency-Active Power (Frequency-Watt or Droop) Function

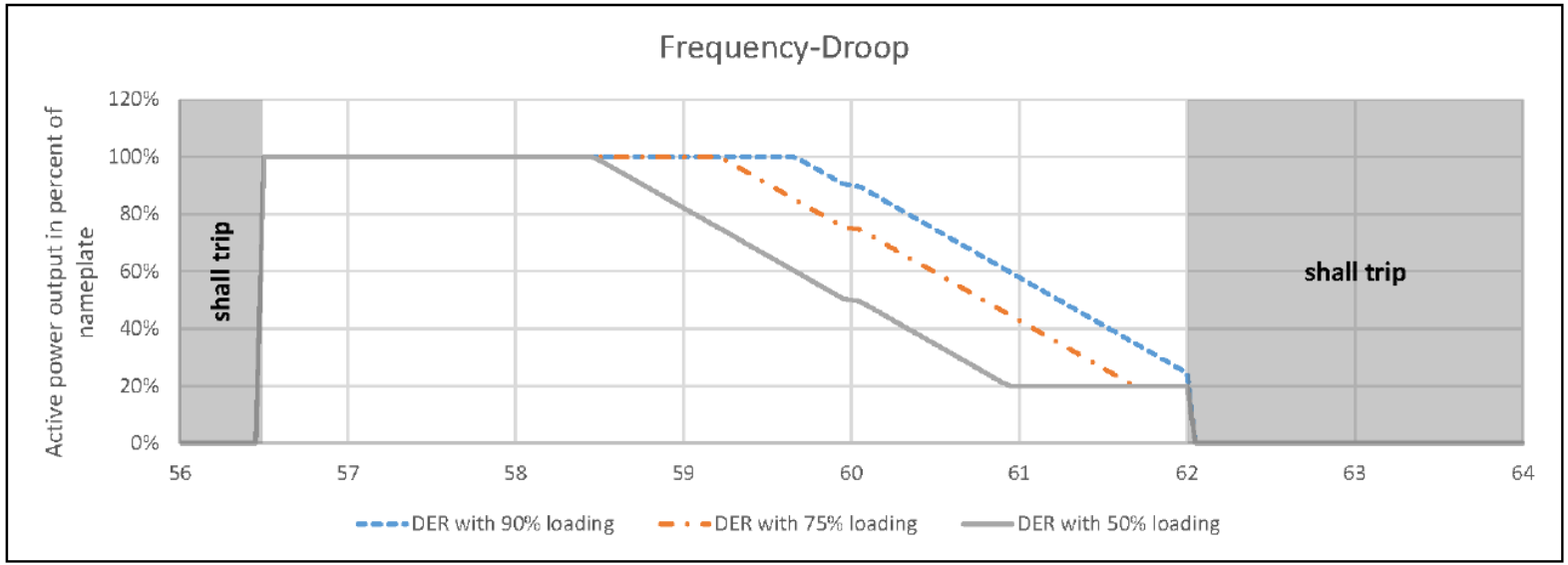
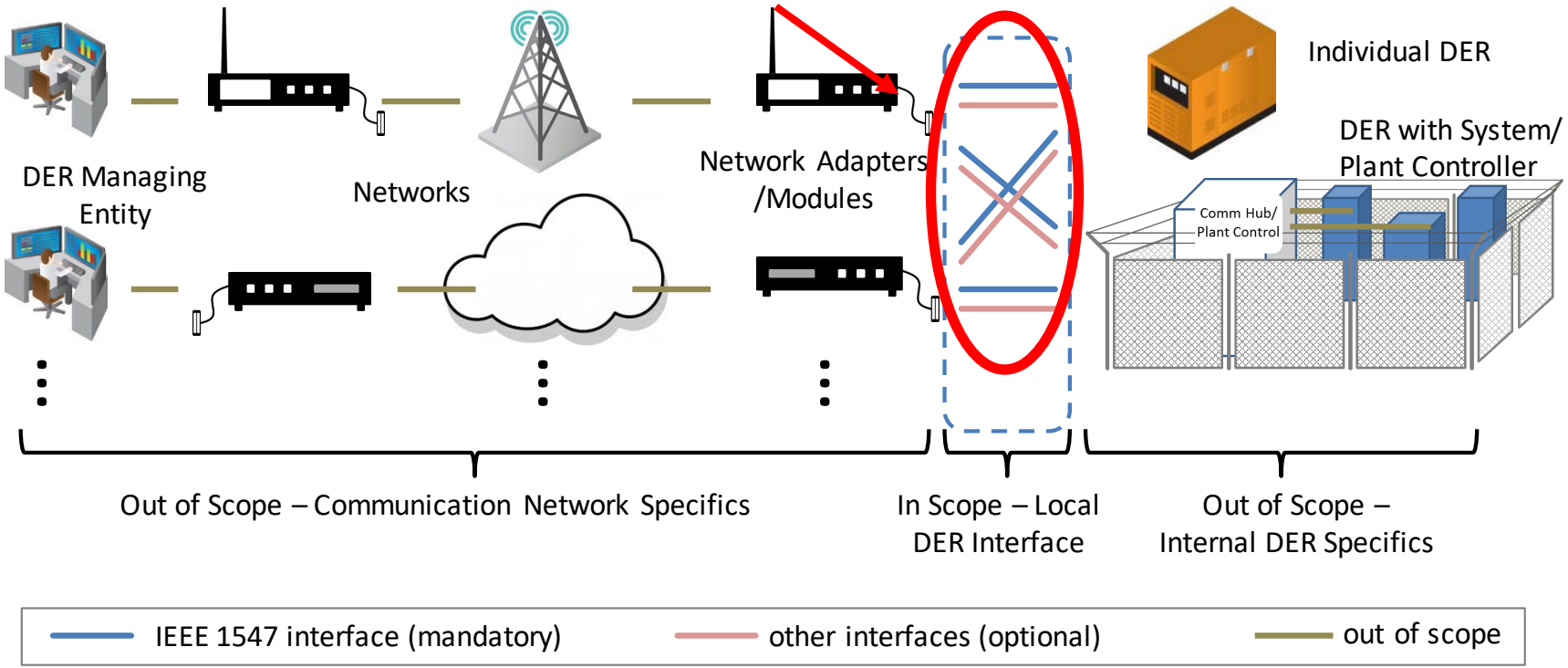


Figure H.11—Example of a three frequency-droop function curves with a 5% droop, 36 mHz deadband, and 20% minimum active power output for DER operating at different pre-disturbance levels of nameplate rating (50%, 75%, and 90%)

IEEE 1547 Interoperability (Communications)



Source: 1547-2018 Approved Draft

IEEE 1547-2018 Interoperability Requirements

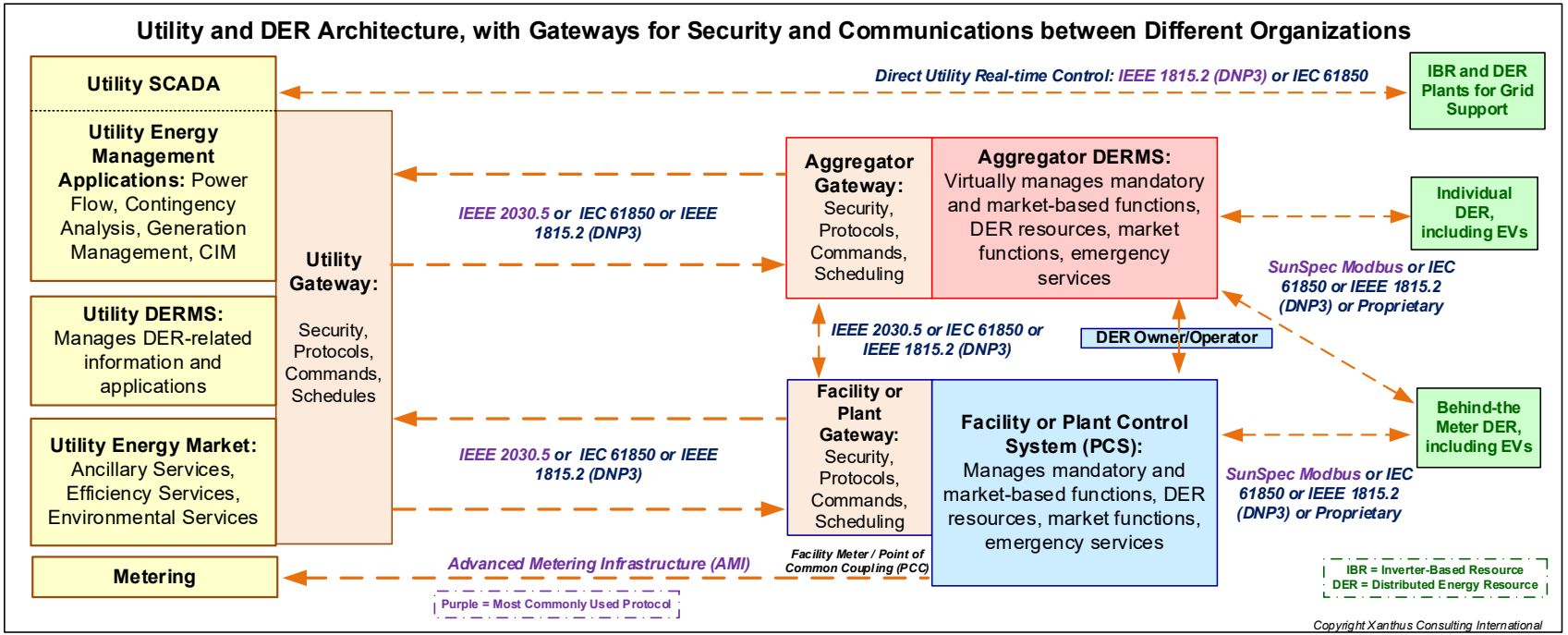
*The capability of two or more networks, systems, devices, applications, or components to **externally exchange and readily use information securely and effectively** (IEEE 2030).*

- **Mandatory communications capability**
  - A DER **shall have provisions for** a local DER interface capable of communicating…
- **Information to be exchanged:**
  - **Nameplate**: as-built characteristics of the DERs (read)
  - **Configuration**: present capacity and ability of the DERs to perform functions (read/write)
  - **Monitoring**: present operating conditions of the DERs (read)
  - **Management**: information to update the functional and function settings for the DERs (read/write)
- **Communication performance requirements:**
  - **Availability of communication** (DER is operating in continuous or mandatory operation region)
  - **Information read response times** (≤ 30 secs, maximum amount of time to respond to read requests)
- **Communication protocol requirements:**
  - **Shall support** at least one of these protocols …(IEEE Std 2030.5, IEEE Std 1815, SunSpec, Modbus)

Table of the Four Protocols for IEEE 1547 Interoperability Data Objects – Volt-Var Function

Voltage-reactive power (volt-var) function	IEC 61850 Data Objects (LN.DO)	IEEE 1815.2 (DNP3) Uses IEC 61850 Names	IEEE 2030.5	SunSpec Modbus
Voltage-Reactive Power Function Enable	DVVR.ModEna	DVVR.ModEna BI81	Active Event	1xx.Ena
V_{Ref} Reference Voltage	DECP.VRef	DECP.VRef AI29 - AI30	DERCurve::vRef	1xx.VRef
Autonomous V_{Ref} Adjustment Enable	DECP.VRefOfs	DECP.VRefOfs BI93	DERCurve::autonomousVRefEnable	1xx.VRefAuto
V_{Ref} Adjustment Time Constant	DVVR.VRefTmms	DVVR.VRefTmms AI300	DERCurve::autonomousVRefTimeConstant	1xx.VRefTms
V/Q Curve Points	DVVR.VVArCrv	DVVR.VVArCrv AI303	DERControl::opModVoltVar::CurveData	1xx.VoltVar.Crv.Pt
Open Loop Response Time	DVVR.OpnLoopMax	DVVR.OpnLoopMax AI298 - AI299	DERControl::opModVoltVar::openLoopTms	1xx.RspTms

Information Exchanges in Utility and DER Architecture, Plus the Communication Protocols Identified in IEEE 1547

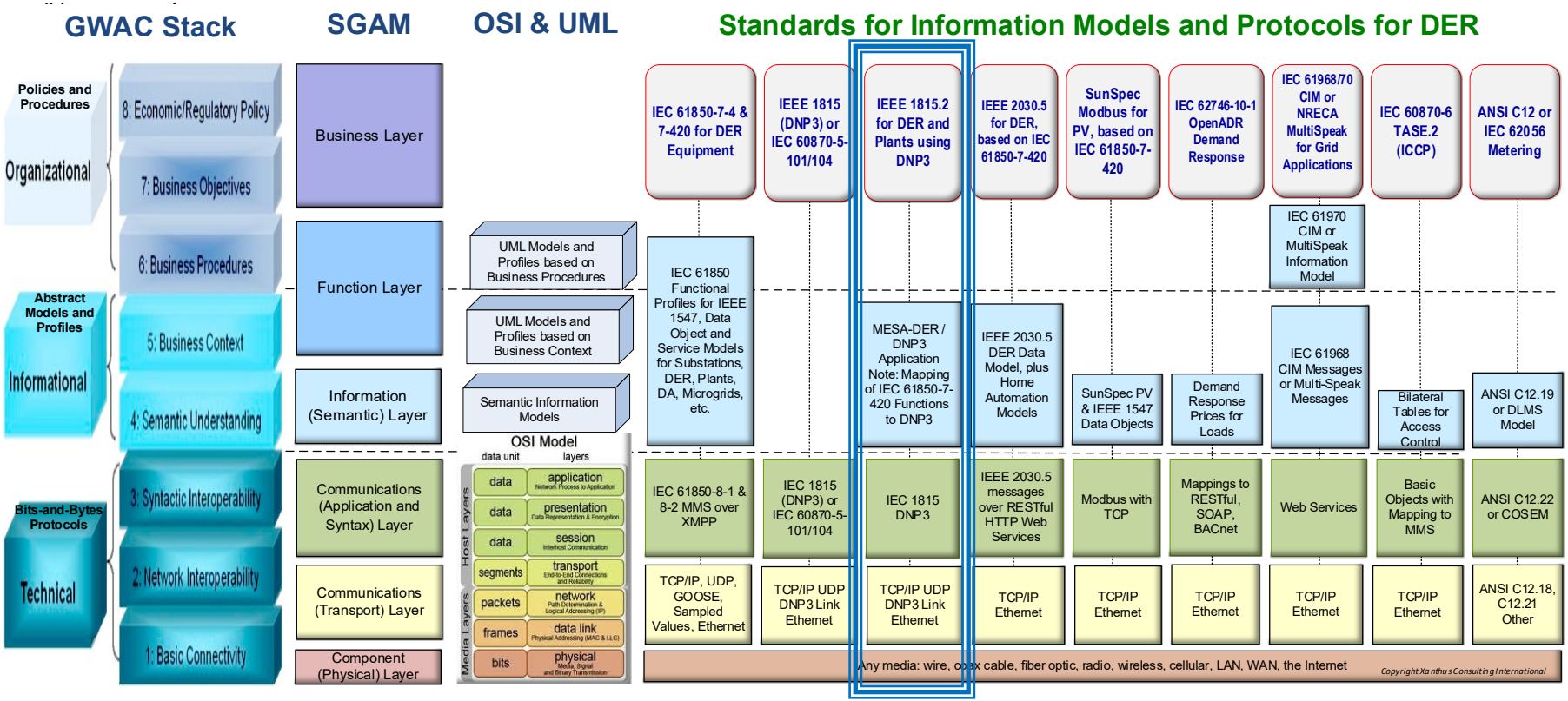


IEEE 1547 Revision – Maybe Published in 2025?

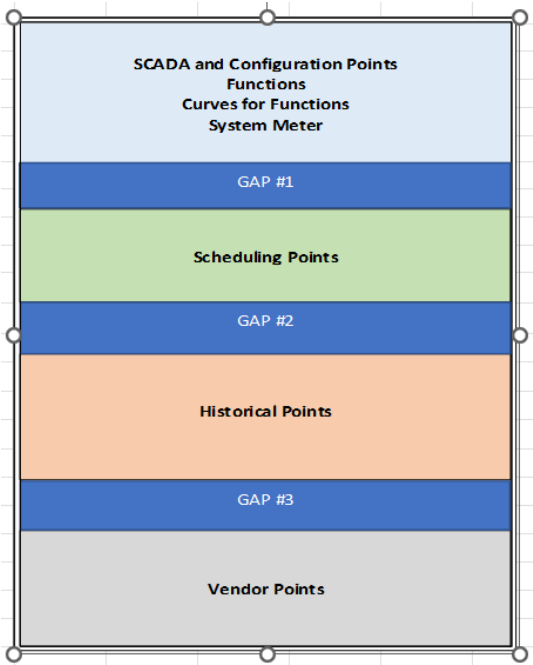
- Revision of IEEE 1547 is just starting. First virtual and F2F meetings in 2023
- The revision process will review the many desired updates, including a “Wish List” of:
  - Storage (including when charging)
  - Electric vehicles as DER (and when charging)
  - Additional DER functions (fast frequency response, etc.)
  - Additional communication protocols (IEC 61850)
  - Cybersecurity requirements (based on IEEE 1547.3 Guide)
  - Power management systems for facilities
  - Gateways (1547.10)
  - ????

4. MESA-DER Capabilities for Interoperable Communications

DER Communications: Comprised of Layers, Including Semantic, Syntax, Application, and Transport Layers



MESA-DER Implementation Levels and Indexing in IEEE 1815.2



DNP3 Points		Index	BO	BI	AO	AI
Configuration & Control Points		0	0	0	0	0
Functions		x	12	31	22	71
Curves		x	-	107	244	328
System Meter		x	-	94	449	533
Extensions in IEEE 1815.2-2024		x	42	108	461	569
Gap #1	*Reserved for Future Extensions*	x	44	111	476	586
Schedules (SCH)		2000	2000	2000	2000	2000
Gap #2	*Reserved for Future Extensions*					
Historical Points						
HM	Start of historical meter points.	5000	5000	5000	5000	5000
HDU	Start of historical DER unit points.	x	5000	5026	5024	5074
HI	Start of historical inverter points.	x	5000	5038	5024	5116
HB	Start of historical battery points.	x	5000	5178	5072	5248
Gap #3	*Reserved for Future Extensions*					
Vendor Points (VP)		50000	50000	50000	50000	50000
Index Points	Used for Optional Auto Discovery	65000	65000	65000	65000	65000
Maximum Index Value		65535				

Overview of MESA-DER Functions in IEEE 1815.2

Function	Brief Description	Document Section	DNP3 Points Range
Monitored Data			
Nameplate data	Factory-related DER data	See Table 2 for details	AI0-AI23;
Configuration data	Configuration of DER Which functions are supported	-	AI24-AI31; AO0-AO2 BI31-BI51;
Operational Settings	Installation-related DER data Which functions are enabled Enable functions commands	See Table 2 for details	AI32-AI49; AI62-AI68; AO3-AO6; AO18-AO19; BI64-BI85; BO12-BO33;
Counters	Counters for meters		AI69-AI70; AO20-AO21;
Alarms	Alarms from DER		BI0-BI9; BI94-BI106;
State	State of DER		BI10-BI30; BO0; BO3-BO11;
Protection			BI52-BI63;
Basic Functions		**Section 6.3**	
Connect/Disconnect	Cause the DER to electrically connect or disconnect at the DER's Point of Connection (PoC) or at the facility's Point of Common Coupling (PCC).	Section 6.3.1	AI60-AI61; AO16-AO17;
Cease to Energize/Return to Service	Cause the cessation of active power delivery, used primarily in voltage or frequency ride-through situations. Return to service allows the DER to start active power delivery, if permission is granted.	Section 6.3.2	AI50-AI59; AO6-AO15; BO1-BO2;
Voltage Ride-Through	Allows voltage excursions from the normal range to be tolerated for specific voltage excursion levels over specific lengths of time.	Section 6.3.3	AI71-AI76; AO22-AO26;
Frequency Ride-Through	Allows frequency excursions from the normal range to be tolerated for specific frequency excursion levels over specific lengths of time.	Section 6.3.4	AI77-AI82; AO27-AO31;
Active Power Functions		**Section 6.4**	
Charge/Discharge (Set Active Power)	Manages the charging and discharging DER, typically storage, by setting specific active power outputs or inputs for the DER.	Section 6.4.1	AI150-AI162; AO89-AO101; BI90; BO38;
Active Power Limit	Active power generation and/or consumption are limited. Usually, this limit is applied at the Point of Common Coupling (PCC) although it may be applied at any DER's Point of Connection (PoC).	Section 6.4.2	AI142-AI149; AO82-AO88;
Frequency-Watt	Active power is modified based on frequency. Usually used for imitating the "droop" of mechanical generators or motors, but can be used for other purposes, depending on the settings.	Section 6.4.3	AI115-AI141; AO57-AO81; BI86-BI87; BO34-BO35;

MESA-DER's Scheduling Capabilities Meet California's and Hawaii's Requirements for Export Limiting, Plus More ….

Schedule Index (S+1)	Schedule ID (S+2)	Schedule Priority (S+3)	Schedule type (S+4)	Start Date (S+5) and Time (S+6)	Repetition interval (S+7)	Repetition units (S+8)	Number of schedule entries (S+11)	Day of the week for repetition (Binary S+2 thru S+8)	Paired entries: Time Offset (X-Value) in seconds for each schedule point (S+12), Schedule Value (Y-Value) for each schedule point (S+13) { TimeOffset : "X-Value", ScheduleValue : "Y-Value"}
3	1	Priority = 1 (Lowest possible)	Meaning = 13 (Active Power Limiting - Generation)	July 11, 2021 00:00 (Sunday midnight) (Start date and time updated every week)	Repeats every 7 days	Unit= Week=5	1	{Sun = "F", Mon = "T", Tue = "T", Wed = "T", Thu = "T", Fri = "T", Sat = "F" } Execute only on weekdays	[{{TimeOffset: 00:00 am, SchedValue: AI 149 = 100}, = Disable},] Default, Fallback schedule
4	29	Priority = 30 (Higher than Sched Id #68 to ensure function is enabled and disabled according to contractual agreements)	Meaning = 13 (Active Power Limiting - Generation)	July 11, 2021 00:00 (Sunday midnight) (Start date and time updated every week)	Repeats every 7 days	Unit= Week=5	2	{Sun = "F", Mon = "T", Tue = "T", Wed = "T", Thu = "T", Fri = "T", Sat = "F" } Execute only on weekdays	[{TimeOffset: 10:00 am, SchedValue: BI69 = Enable}, {TimeOffset: 5:30 pm, SchedValue: BI69 = Disable},] At 10:00 am, enable Active Power Limiting At 5:30, disable Active Power Limiting, due to contractual obligations
5	16	Priority = 20 (Medium)	Meaning = 13 (Active Power Limiting - Generation)	July 11, 2021 00:00 (Sunday midnight) (Start date and time updated every week)	Repeats every 7 days	Unit= Week=5	4	{Sun = "F", Mon = "T", Tue = "T", Wed = "T", Thu = "T", Fri = "T", Sat = "F" } Execute only on weekdays	[{TimeOffset: 09:30 am, SchedValue: AI 149 = 100}, { TimeOffset : 12:00 pm, SchedValue : AI 149 = 80 }, { TimeOffset : 4:00 pm, SchedValue : AI 149 = 70 }, {TimeOffset: 5:00 pm, SchedValue: AI 149 = 100}] At 09:30, set limit to 100% to ensure no limit when enabled. At 10:00 am, enable Active Power Limiting (See Sched ID=29) At noon, limit active power to 80% of WMax. At 4 pm, limit active power to 70% of WMax, At 5 pm, limit active power to 100%, effectively disabling active power limiting as default, but able to receive a command or higher priority schedule for a different limit At 5:30, disable Active Power Limiting, due to contractual obligations (See Sched ID=29)

Market-based Functions (Ancillary Services) beyond Grid Codes

- **Reduce (increase) Energy Demand based on Price:** The DER reduces energy demand by either reducing load or by increasing generation (or vice versa)
- **Peak Power Limiting operational function**: The DER limits the load at the Referenced ECP after it exceeds a threshold target power level
- **Load Following operational function**: The DER counteracts the load by a percentage at the Referenced ECP, after it starts to exceed a threshold target power level
- **Generation Following operational function**: The consumption and/or production of the DER counteracts generation power at the Referenced ECP.
- **Dynamic Active Power Smoothing operational function**: The DER produces or absorbs active power in order to smooth the changes in the power level at the Referenced ECP.
- **Rate of Change of Power – dW/dt**: Frequency-Active Power Primary Control operational function. The DER changes its watt output or input to provide frequency support to maintain frequency within normal limits
- **Automatic Generation Control (AGC) operational function**: The DER responds to raise and lower power level requests to provide frequency regulation support
- **Operating Reserve (Spinning Reserve) operational function**: The DER provides operating reserve
- **Synthetic or Artificial Inertia Frequency-Active Power operational function**: The DER responds to the rate of change of frequency (ROCOF) by changing its watt output or input to minimize spikes and sags
- **Coordinated Charge/Discharge Management operational function**: The DER determines when and how fast to charge or discharge so long as it meets its target state of charge level obligation by the specified time *(focus is on Electric Vehicle consumption)*
- **Frequency-Active Power Smoothing operational function**: The DER responds to changes in frequency at the Referenced ECP by changing its consumption or production rate based on frequency deviations from nominal, as a means for countering those frequency deviations Df/dt
- **Power Factor Limiting (Correcting) operational function**: The DER supplies or absorbs Reactive power to hold the power factor at the Referenced ECP within the PF limit
- **Delta Power Control Function:** Decrease active power output to ensure there remains spinning reserve amount that was bid into the market
- **Power Ramp Rate Control**: The power increase and decrease is limited by specified maximum ramp rates.
- **Dynamic Volt-Watt Function**: Dynamically absorb or produce additional watts in proportion to the instantaneous difference from a moving average of the measured voltage
- **Microgrid Separation Control (Intentional Islanding)**
- **Provide Black Start Capability**
- **Provide Backup Power**

5. MESA-DER Testing per IEEE 1547.1 and UL 1741 Supplement B

Press Release:
UL Solutions and MESA Standards Alliance Launch Testing and Certification Service to Help Standardize Distributed Energy Communications

- **San Francisco, CA – Feb. 14, 2023** – UL Solutions, a global leader in applied safety science, and the Modular Energy System Architecture (MESA) Standards Alliance, a leader in standardizing communications between utility systems and distributed energy resources (DER), announced an alliance to provide testing and certification of the MESA-DER profile.
- This profile is proposed to be incorporated into the IEEE P1815.2 standard, Standard Profile for Communications with Distributed Energy Resources, using IEEE 1815, Standard for Electric Power Systems Communications – Distributed Network Protocol (DNP3).
- Utilities in the U.S. commonly utilize DNP3, a set of communications protocols used between components in process automation systems, for their Supervisory Control and Data Acquisition System (SCADA).
- The MESA-DER profile organizes DER data in a standard structure to allow many types of distributed energy installations to be easily integrated and understood by utility SCADA systems. Electric utilities or aggregators can utilize MESA-DER to significantly lower their integration and implementation costs for large energy storage systems, microgrids, solar inverter power plants and other grid-scale DER.

MESA-DER (IEEE P1815.2) Testing and Certification Process

A "one-stop-shopping" MESA-DER (IEEE P1815.2) Testing and Certification Program for DER and/or Plant Control Systems

MESA-DER Profile Communications → MESA-DER Functional Testing per IEEE 1547.1 → Commissioning

MESA-DER (IEEE P1815.2) Profile Communication Test:

Verifies Communications Protocol Conformance:

- Requires: Passing the Triangle Microworks' MESA-DER test tool: Mandatory MESA points plus specific Modes and Functions called out in PICS
- Recommended: DNP3 protocol certification

MESA-DER (IEEE P1815.2) Functional Test of IEEE 1547 functions:

Verifies Functional Performance:

- Prerequisite: MESA-DER Profile Communications Certification
- Requires: MESA-DER Functional Testing per IEEE 1547.1/UL 1741 SB
  - Verifies: 1547.1 Functions using DNP3 with MESA-DER Profile:
  - Requires: Passing 1547.1/UL 1741 SB NRTL test using DNP3

MESA-DER Factory Acceptance Testing (FAT)/Commissioning Test:

These evaluations shall be performed on-site by qualified personnel as required by Designated Certification Body

- Prerequisite: MESA-DER Profile Communications Certification
- Requires: MESA-DER Functional Testing per IEEE 1547.1/UL 1741 SB
  - Verifies: 1547.1 Functions using DNP3 with MESA-DER Profile:
  - Requires: Passing 1547.1/UL 1741 SB NRTL test using DNP3
  - Recommended: Additional MESA-DER (IEEE P1815.2) functions beyond those in IEEE 1547-2018

MESA-DER (IEEE 1815.2) PICS for Protocol Testing – Frequency-Watt

DNP3 Point Index	Name / Description	IEC 61850	For Phase 1 Conformance Testing				EUT Capabilities
		UniqueString	Assoc. AO	Mandatory: Yes or specific	Purpose/Mode/Function	1547-2018	Supported by EUT? (Mark "x")
System Analog Inputs							
AI115	**Frequency-Watt Mode Priority**	DHFW1.ModPrio	**AO57**	Yes	Freq-Watt		
AI116	**Frequency-Watt Enabling Time Window**	DHFW1.WinTms			Freq-Watt		
AI117	**Frequency-Watt Enabling Ramp Time**	DHFW1.RmpTms			Freq-Watt		
AI118	**Frequency-Watt Reversion Timeout Period**	DHFW1.RvrtTms			Freq-Watt		
AI119	**Frequency-Watt Signal Meter ID**	DHFW1.EcpRef		Yes	Freq-Watt		
AI120	**Frequency-Watt Frequency Reference Input.** Frequency measurement read from the meter and used as an input to the mode.	MMXU3.Hz		Yes	Freq-Watt		
AI121	**Frequency-Watt High Starting Frequency.** Delta frequency between start frequency and nominal grid frequency for high frequency events.	DHFW1.HzStr		Yes	Freq-Watt	Yes	
AI122	**Frequency-Watt High Stopping Frequency.** Delta frequency between stop frequency and nominal grid frequency for high frequency events.	DHFW1.HzStop		Yes	Freq-Watt	Yes	
AI123	**Frequency-Watt High Discharging / Generating Gradient**	DHFW1.WGra	**AO64**	Yes	Freq-Watt	Yes	
AI124	**Frequency-Watt High Charging Gradient**	DHFW1.WChaGra	**AO65**	For Storage	Freq-Watt	Yes	

IEEE 1547 Interconnection Testing Standards

IEEE 1547

Interconnection System and Test Requirements

- Voltage Regulation
- Ride-through
- Interoperability
- Islanding
- ….

IEEE 1547.1

Conformance Test Procedures

- Utility interactive tests
- Islanding
- Reconnection
- O/U Voltage and Frequency
- Synchronization
- DC injection
- ….

UL 1741 SA, SB, SC, SD, SE, ..

Interconnection Equipment Safety, Performance Certification

- **California Rule 21 (SA)**
- **Interoperability Testing (SB)**
- **V2G of AC Electric Vehicles (SC)**
- **Power Control System (PCS) for Limiting Power Exports at PCC (SE)**
- **Scheduling of Functions (SE)**
- **…**

NFPA70 (NEC 2020 Edition)

Installation Code

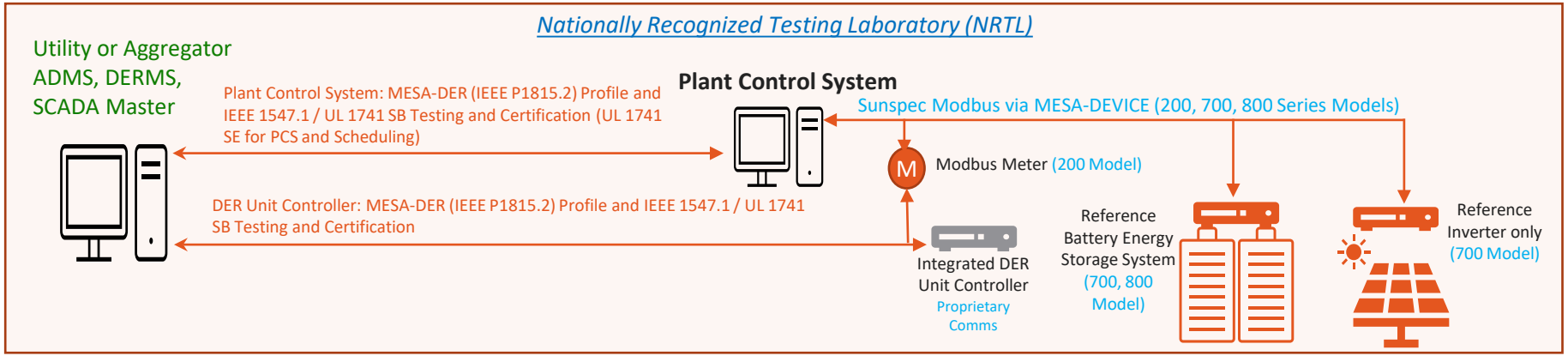
- 690,691 Solar PV
- 692 Fuel Cells
- 694 Wind Turbines
- 700-702 Emergency / Standby Systems
- 705 Interconnected Power Production Sources
- 706 Energy Storage Systems
- 710 Stand alone or Islanded
- UL3001 Systems

(NEC info. Based on NEC 2018 First Revision)

Local interconnection processes and procedures

MESA-DER (IEEE P1815.2) Testing Communications/Functions for Plant Control Systems & DER Unit Controllers

Plant Control Systems will use lab specified "Reference" Battery Energy Storage System, Inverter, and Meter which are MESA-Device compliant
DER Unit Controller is tested at the NRTL or facility integrated as it will be delivered to market.



- Triangle Microworks, Inc. (TMW)
- QualityLogic, Inc. (QL)
- Nationally Recognized Testing Laboratory (NRTL)
- Underwriters Laboratories (UL)

- *Note: Reference BESS, inverter, and meter will be MESA DEVICE Compliant. Translation may be used if SunSpec Modbus 200, 700 & 800 Models are not currently available for the device at the time of testing.*
- *Since Plant Control Systems may communicate with many inverter types with different protocols, we require they at minimum communicate via SunSpec Modbus/MESA-Device internal to the "plant".*

MESA-DER (IEEE P1815.2) Certification Entities

MESA CERTIFIED	Test Description	Vendor Self Attestation	DNP User Group	UL-managed NRTL Testing or Witness Testing	Utility & Vendor FAT and/or Site Testing
IEEE 1815 DNP3 (DNP UG*)	Basic DNP3 protocol certification	✓	✓		
MESA-DER (IEEE P1815.2) Profile Communication	MESA-DER (IEEE P1815.2) profile communications conformance testing using Triangle Microwork's test tool			✓	
IEEE 1547.1/UL 1741-SB*	IEEE 1547-2018 functional and interoperability lab testing			✓	✓
MESA-DER (IEEE P1815.2) Functional Certification	Lab testing of MESA-DER (IEEE P1815.2) functions based on PICS: ❖ Plant Controller Energy Storage ❖ Plant controller with IBR ❖ Integrated DER Unit Controller			✓	
MESA-DER (IEEE P1815.2) Commissioning	MESA-DER (IEEE P1815.2) Functional Test of Plant Control System and all DER units (FAT/Commissioning)				✓

MESA Membership

MESA Membership

Membership Fee:

- ✓ Offers entry into working groups and committees
- ✓ Members can be elected to the Board of Directors

2023 Membership Options:

Standard (Companies with revenue > $1M): $5,000

Small Business (Companies with revenue ≤ $1M): $3,000

MESA/SunSpec Joint Modbus Membership: $9,000

Individual/Strategic Partner: $1,000

Student: $350

Read more about MESA's membership options at
http://mesastandards.org/membership/

Discretionary Allocation to Technical Priorities:

- ✓ Variable depending on organizational technical priorities
- ✓ Fees can be directed toward a specific project

2023 Technical Allocation:

A min $5,000 per company (depends on available funds) focused on MESA-DER certification program development

Questions?