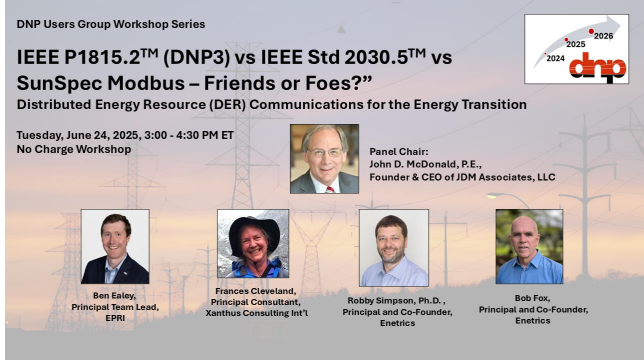


Workshop on DER Communications: "IEEE P1815.2 (DNP3) vs IEEE Std 2030.5 vs SunSpec Modbus – Friends or Foes?"

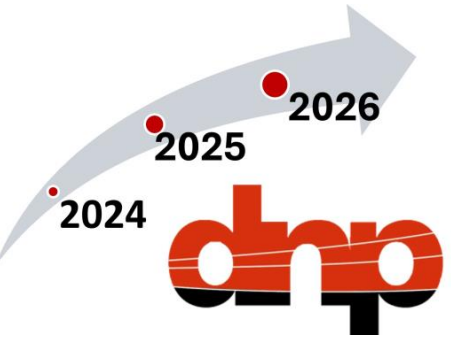
June 24, 2025

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- Please remain muted unless you are speaking.
- We are recording the workshop and using the ZOOM AI Companion. The recording will be available as soon as possible.
- The recording and notes for our last workshop are available now on our website
- Questions and discussion:
  - Use the chat feature at any time to ask your questions.
  - When speaking please introduce yourself and turn your camera on.
  - Please hold on your verbal questions until John McDonald (Panel Chair) invites discussion.
- Survey:
  - We would really appreciate your feedback and ideas.
  - Please let us know your suggestions at membership@dnp.org



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- The following presentations are the opinion of the presenters and/or their affiliations and does not necessarily reflect that of IEEE, IEEE SA, IEC or the applicable IEEE committees and working groups.
- Each of the standards discussed is quite large and this presentation is not intended to be comprehensive. As always, the standard itself should be considered authoritative.

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Agenda

- Introductions
- John McDonald (Chair)
- Ben Ealey, EPRI
- Frances Cleveland, Xanthus, MESA
- Robby Simpson, Enetrics
- Bob Fox, Enetrics
- Open Q&A



Refer to the Workshop Announcement for Speaker Bios

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DNP Users Group Workshop Series

IEEE P1815.2™ (DNP3) vs IEEE Std 2030.5™ vs SunSpec Modbus – Friends or Foes?"

Distributed Energy Resource (DER) Communications for the Energy Transition

Tuesday, June 24, 2025, 3:00 - 4:30 PM ET
No Charge Workshop



Panel Chair:
John D. McDonald, P.E.,
Founder & CEO of JDM Associates, LLC



Ben Ealey,
Principal Team Lead,
EPRI



Frances Cleveland,
Principal Consultant,
Xanthus Consulting Int'l



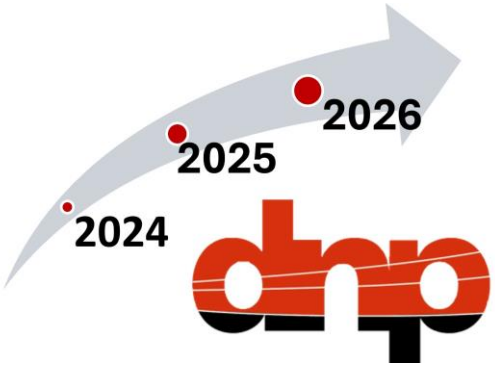
Robby Simpson, Ph.D. ,
Principal and Co-Founder,
Enetrics



Bob Fox,
Principal and Co-Founder,
Enetrics

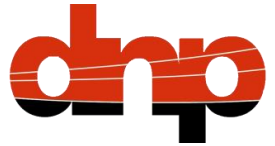
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Workshop Session Chair

John D. McDonald, P.E.
IEEE Life Fellow
Member of National Academy of Engineering
CIGRE Honorary Member
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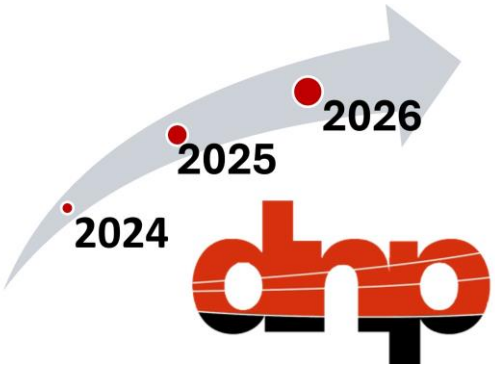


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IEEE Std.1547™-2018

Ben Ealey,
Electric Power Research Institute (EPRI)
Principal Team Lead, DER Communication and Data Integratic
bealey@epri.com



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IEEE 1547-2018

IEEE Standard for Interconnection and Interoperability of Distributed Energy Resources with Associated Electric Power Systems Interfaces

- IEEE Standard 1547™ is the de-facto basis for interconnection standards for DER in the United States.
- Paradigm shift from 1547-2003 to 1547-2018.
- A new section on interoperability was added to define communications requirements.
- IEEE 1547 has no authority until it is referenced by a state or federal law.
- IEEE 1547 was approved on February 15, 2018 and published April 6th, 2018.
- No cyber security requirements

Comparison of IEEE 1547-2003 and IEEE 1547-2018	
2003	Focused on distribution system aspects.
2018	Focused on distribution and bulk system aspects.
2003	Specifications for the "interconnection system" sufficiently achieve the standard's objective.
2018	Specifications encompass the whole DER.
2003	Meant as DER interconnection standard but mainly used for equipment listing.
2018	Can be used for equipment listing as well as plant-level verification.
2003	Limited to electrical requirements.
2018	Includes both electrical as well as interoperability/communications requirements.

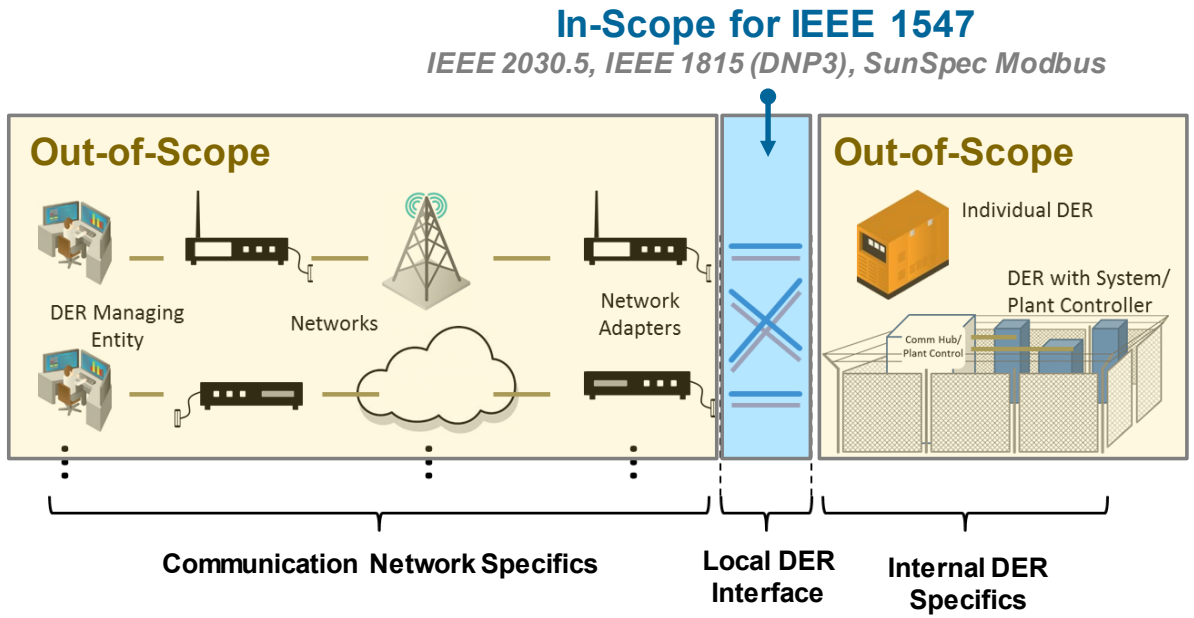
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IEEE 1547-2018 Protocol Options

- IEEE 1547 focuses on interoperability by including both electrical as well as interoperability and communications requirements

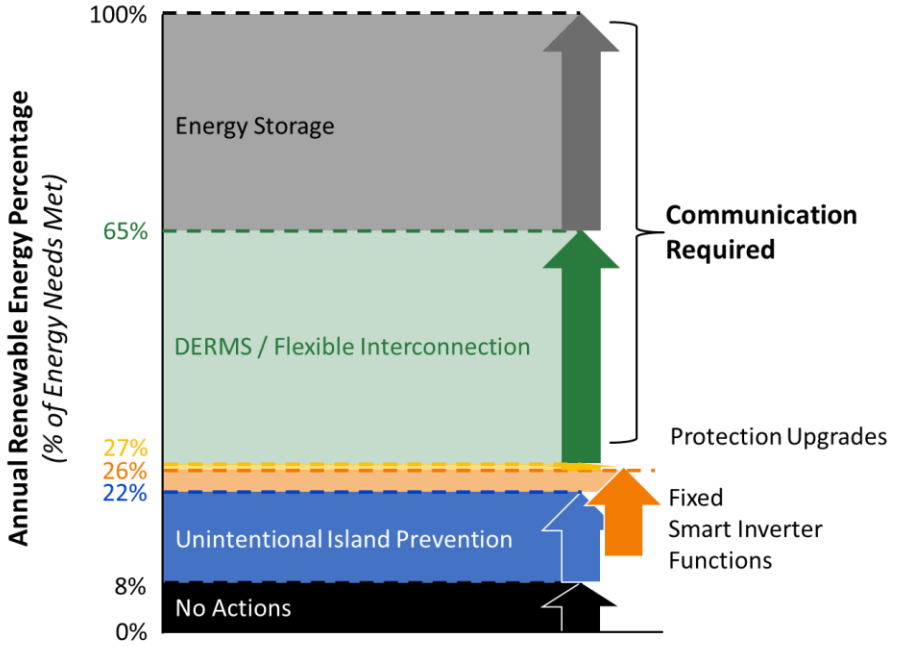
- Defines the LDERCI (local DER communication interface)



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Interoperability is Assumed in Today's Hosting Capacity Analysis

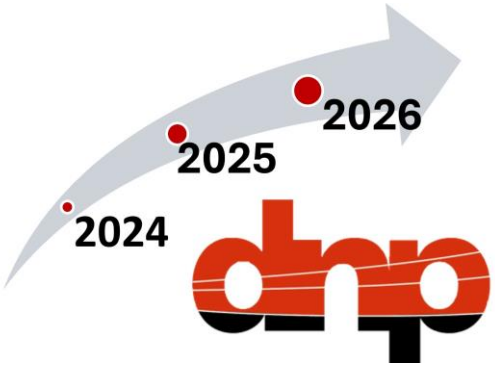
- Industry working to make DER more grid supportive
- The Centerpiece is IEEE 1547 – the basis for utility interconnection requirements
- Communication-connectivity and active management is required for today's hosting capacity assumptions
- This expectation has changed hosting capacity approaches and been factored into power system planning, telecom network designs, and software architecture including DMS and DERMS



Maximizing Distributed Energy Resource Value Through Grid Modernization. https://www.epri.com/research/products/3002023235

In short, the utility industry is counting on DER interoperability

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IEEE Std P1815.2™

Frances Cleveland, President of Xanthus Consulting International
Technical Consultant to MESA
Vice Chair of IEEE 1815.2
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MESA
Open Standards for Energy Systems

IEEE 1815.2 DNP3 Profile for DER

IEEE 1815.2 Supporting IEEE 1547 Functions, Energy Storage Systems, Cybersecurity, and Scheduling



Frances Cleveland – fcleve@xanthus-consulting.com

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History of IEEE 1815.2 – DER Profile for DNP3



Includes CA Rule 21 Functions

Includes Semantics and functions

MESA specification and spreadsheet

Maps 61850-7-420 data objects to specific DNP3 data points

International standard!!

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What is IEEE 1815.2?

- IEEE 1815.2 establishes a **Standard Profile for Communications with Distributed Energy Resources (DERs) using IEEE Std 1815™ [Distributed Network Protocol (DNP3)]**
- **DNP-UG App Note AN2018-001 was used as the source of IEEE 1815.2**
- The purpose of defining this standardized profile is **interoperability** to make it easier for a utility (or other entity) to communicate with a variety of DNP3 outstations supplied by many different DER manufacturers and to make it easier for manufacturers to build systems that can interoperate with various utility systems.
- **It specifies the data objects needed for many DER functions and IBR functions**, including those in IEEE 1547-2018 and IEEE 2800, as well as additional functions needed for storage systems. These are based on selected data objects from IEC 61850-7-420 Ed2 2021 data model, mapped to a fixed list of DNP3 data points, thus providing interoperability across utilities and across DER implementations.
- It provides **complete cybersecurity**, using DNP3's SAv5 (eventually SAv6)
- It provides **full scheduling capabilities**, including for export and import limiting.
- **After successfully balloted, final publication by IEEE is expected before the end of 2025**
- **Remains backward compatible with the DNP3 Application Note 2018**, since there have been **several implementations**
- **IEEE 1815.2 will be the reference for the DNP3 requirements in the IEEE 1547.1 amendment currently underway and the revision to IEEE 1547**

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IEEE 1815.2 – 21 Functions

IEEE 1547 and Rule 21 Functions

- Monitor Key DER Data (Currently one-way telemetry only)
- DER Disconnect/ Reconnect (Trip or Cease to Energize/Enter service)
- Limit Maximum Active Power (Export Limiting)
- Set Active power
- Low/High Voltage Ride-Through
- Low/High Frequency Ride-Through
- Dynamic Volt-Watt Function
- Frequency-Watt
- Volt-Watt
- Constant VArs Function
- Fixed Power Factor Function
- Volt-VAr Control Function
- Watt-VAr Function
- Dynamic Reactive Current Support
- Scheduling (simple)

Additional IEEE 1815.2 (MESA-DER) Functions

- Charge/Discharge Function
- Coordinated Charge/Discharge Function
- Peak Power Limiting Function
- Generation Following Function
- Load Following Function
- Automatic Generation Control (AGC) Function
- Active Power Smoothing Function
- Frequency-Watt “Curve” Function, used for:
  - Advanced Frequency-Watt Function with Snapshot and Hysteresis
  - Fast Frequency Response (FFR)
  - Artificial Inertia (experimental)
  - Frequency smoothing
- Advanced Volt-Watt Function (experimental)
- Power Factor Correction Function
- Scheduling (more capable)

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MESA Standards and the DNP User Group

- **MESA Standards Activities:**
  - MESA supported the development of the original DNP3 Application Note (aka MESA-DER), and now IEEE 1815.2, as they were implemented by various utilities since 2018
  - MESA's mission is to accelerate the interoperability of DER through the development of open and non-proprietary communication standards
  - MESA's focus is to define the DER-specific functions for ensuring a capable and safe smart grid based on existing standards
  - MESA is currently developing the testing requirements for the new IEEE 1815.2 functions, particularly the new functions needed by Energy Storage Systems
  - **MESA Standards | Open Standards for Energy Systems**
- **DNP User Group (DNP-UG) Activities**:
  - Development of new and updates to the existing standards with an overall objective to maximize interoperability
  - Member training, SME technical support, application notes and industry workshops
  - Promotion and industry engagement including an MOU with MESA
  - **DNP Users Group - Innovative Technology for Reliable and Secure OT Communications**
- **DNP-UG Technical Committees:**
  - New cybersecurity specifications (SAv6 and AMP)
  - On-going standards updates and support via application notes, discussion forum and SME access
  - Conformance Certification Program and Test Procedure Committee

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IEEE 1815.2 Testing and Certification Process

MESA, in Partnership with UL Solutions, Testing and Certification Program for IEEE P1815.2 DER and/or Plant Control Systems

IEEE 1815.2 Profile Semantics Test → IEEE 1815.2 Functional Testing per IEEE 1547.1 → Commissioning

IEEE 1815.2 Profile Semantics Test:
Verifies Semantic Protocol Conformance of Vendor's Spreadsheet:

- **Requires**: Passing the PNNL's test tool (*based on Triangle Microworks' MESA-DER test tool*) : Conversion of spreadsheet to JSON; Mandatory points plus specific Modes and Functions called out in vendor's PICS
- **Recommended**: DNP3 protocol and cybersecurity certification, initially for SAv5 and eventually SAv6

IEEE 1815.2 Functional Test of IEEE 1547 functions:
Verifies Functional Performance:

- **Prerequisite**: IEEE 1815.2 Profile Semantics Certification
- **Requires**: IEEE 1815.2 Functional Testing per IEEE 1547.1/UL 1741 SB
  - **Verifies**: 1547.1 Functions using DNP3 with IEEE 1815.2 Profile:
  - **Requires**: Passing 1547.1/UL 1741 SB NRTL test using DNP3

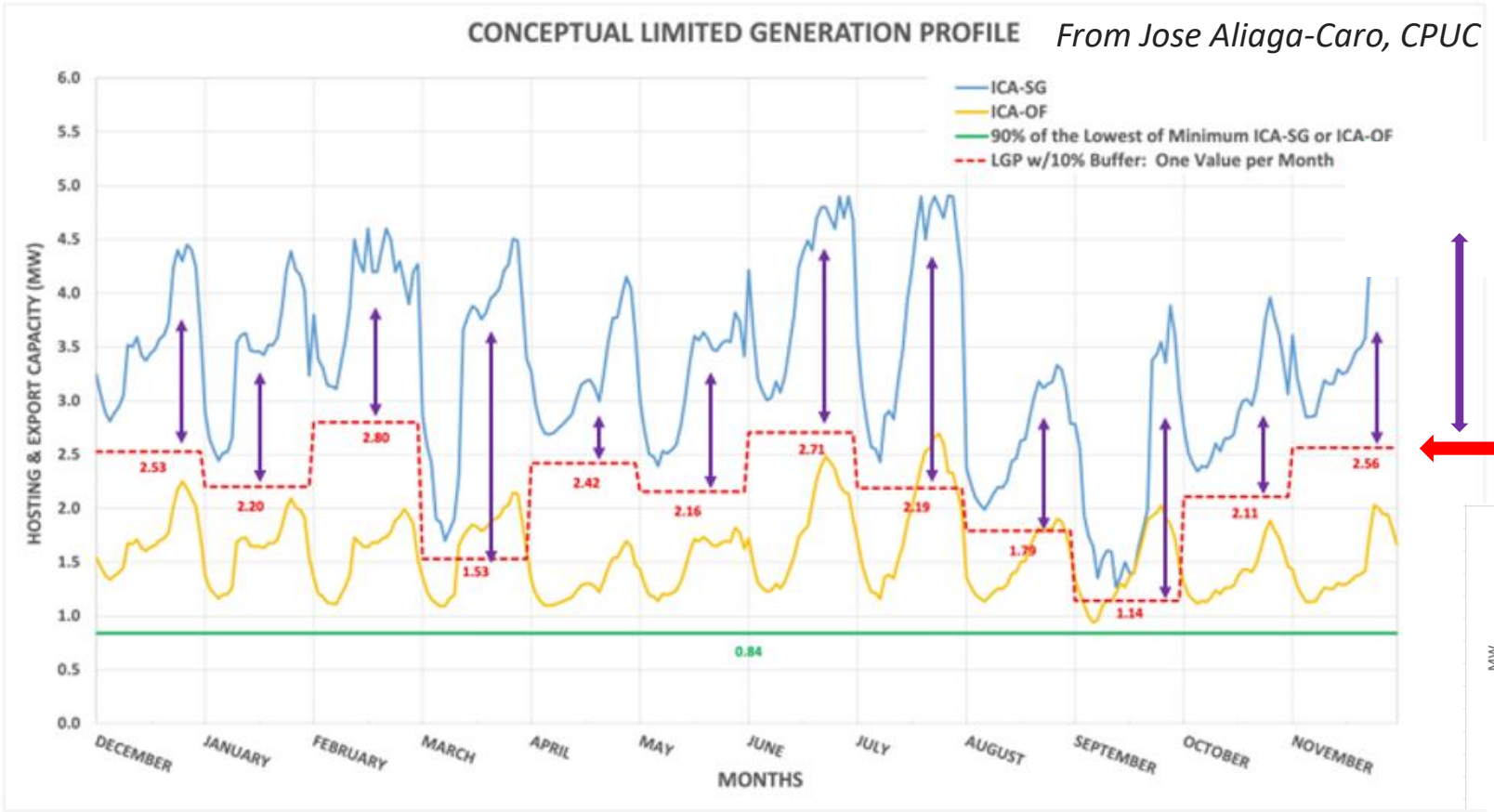
IEEE 1815.2 Factory Acceptance Testing (FAT)/Commissioning Test:
These evaluations shall be performed on-site by qualified personnel as required by Designated Certification Body

- **Prerequisite**: IEEE 1815.2 Profile Semantics Certification
- **Requires**: IEEE 1815.2 Functional Testing per IEEE 1547.1/UL 1741 SB
  - **Verifies**: 1547.1 Functions using DNP3 with IEEE 1815.2 Profile:
  - **Requires**: Passing 1547.1/UL 1741 SB NRTL test using DNP3
  - **Recommended**: Additional IEEE P1815.2 functions beyond those in IEEE 1547-2018

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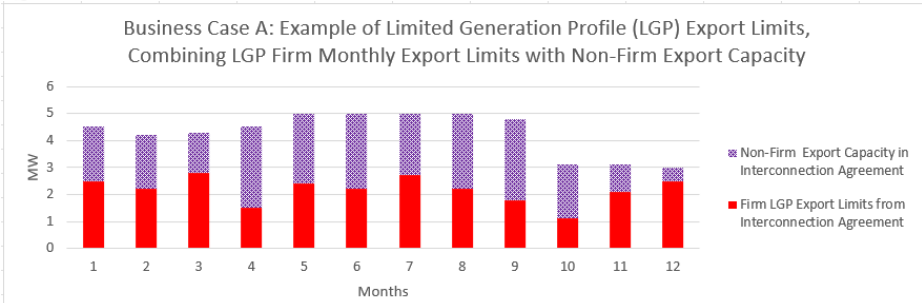
Summary of Strengths of IEEE 1815.2 – DER Profile using DNP3

- DNP3 is widely used by utilities
- Semantics provide complete interoperability of DNP3 for DER
- SCADA performance supports large numbers of DER devices, rapidly, securely, and without loss of data
- Focus is on larger DER and IBR plants
- Scheduling of functions, including for Limited Generation Profile (LGP) Firm and Non-Firm Export

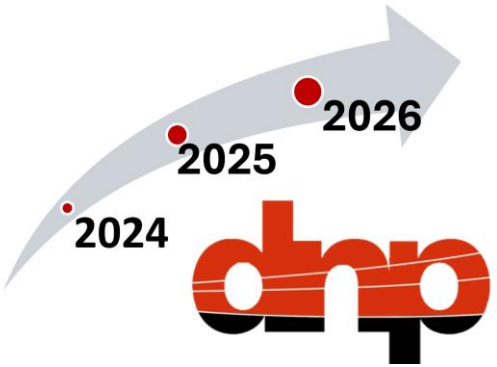


Non-Firm Export as permitted based on utility assessments and DER Site capabilities

Firm Export Limit



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IEEE Std 2030.5™-2023

Dr. Robby Simpson, Enetrics
Principal and Co-Founder, Enetrics
Chair, IEEE P2030.5
Vice Chair, IEEE P2030.5.1
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IEEE 2030.5 – Smart Grid User Interface

- Designed using widely-adopted technologies (“Don’t be weird”) for communications between utilities and outside entities (consumers) – the integration of consumer devices into the grid
- Best-in-class security
- Serves two general purposes:
  - Inform the consumer (e.g., energy usage, pricing)
  - Request actions to assist the grid (e.g., PV inverter controls, EV charging, thermostat changes)
- Focus on communications related to efficiency, energy usage, price, DER, EVs, demand response and load control, and service provider messages
- An IoT “profile”
- Range of backhaul technologies
- Optimized for embedded and battery-powered devices
- RESTful polling as well as Subscription/Notification

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IoT Profile – “Don’t be Weird”

- Internet Protocol (IP) – *multiple link layers*
- RESTful HTTP – *long life and robust*
- TLS – *secure*
- XML and/or EXI – *extensible*
- mDNS & DNS-SD – *plug and play device and service discovery*



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IEEE 2030.5 and DER

- Supports communications with individual DER
- Supports aggregation and proxying
- Support for both generation and storage (IEEE 1547 requirements plus much more)
- Support DER controls, curves, ratings, settings
- Many other function sets useful:
  - Pricing
  - Energy usage (monitoring/metering/telemetry)
- Ability to target groups or individual DER without exposing grid topology
- In addition to remote monitoring and control, allows increased customer engagement and information
- One of three communications protocols in IEEE 1547-2018
- Working group aligned DER information model with IEEE 1547, IEC 61850, SunSpec Modbus (IEEE 1815.2 had not been published)

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A Robust and Growing Ecosystem

- Common Smart Inverter Profile (CSIP)
  - Originally developed under an order from the California Public Utilities Commission (CPUC)
  - Now in the process of standardization as IEEE 2030.5.1
- Testing and Certification of CSIP
  - Can be performed by Nationally Recognized Testing Laboratories (NTRLs)
  - Can be performed by SunSpec Alliance Authorized Test Laboratories (ATLs)
  - Approximately 100 product lines CSIP certified!
- CSIP-AUS
  - CSIP + extensions for the Australian market
  - Standardized by Standards Australia
  - Testing and Certification program established

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Cybersecurity – A Critical Component

- Security and privacy concerns paramount
- Cybersecurity attacks on the grid can have significant consequences in the physical world
- Design must operate with minimal consumer intervention (e.g., commissioning, firewalls)
- Grid-Customer Interface may be one piece of consumer's network
  - Cannot be weak link
  - Rest of consumer network may be insecure or actively hostile
- Little to no physical protection
- Devices need to last decades
- Many governments and jurisdictions have cybersecurity guidelines and requirements
- IEEE 2030.5 underwent an independent security audit by CMU

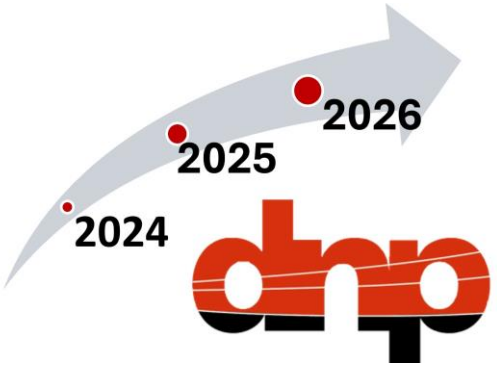
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Five Strengths of IEEE 2030.5

- ✓ Internet Native
- ✓ Highly Secure
- ✓ Supports a Variety of Applications and Functions
- ✓ Utilizes Well-Known Protocols and Technologies
- ✓ Robust Global Ecosystem

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SunSpec Modbus

Bob Fox, Enetrics
Principal and Co-Founder, Enetrics
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Enetrics

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Modbus/SunSpec Modbus Introduction

- **Modbus**
  - Modbus was introduced as an industrial automation protocol in 1979 by Modicon which now a part of Schneider Electric.
  - In 2004 the Modbus Organization was established and responsibility for Modbus protocol maintenance was transferred from Schneider.
  - The Modbus protocol has been broadly adopted as a communications interface for devices in many different industries.
  - All Modbus specification are freely available at modbus.org.
- **SunSpec Modbus**
  - The SunSpec Alliance was founded in 2009 with a mission to create a standardized interface for renewable energy related devices using the Modbus protocol.
  - SunSpec has developed information models for different categories of devices such as inverters, meters, environmental measurement, string combiners, panels, trackers, DER, and storage.
  - In 2017, SunSpec published an updated specification for DER devices that fully supported the IEEE 1547-2018 standard.
  - The SunSpec Modbus DER specification is one of the three protocols specified in IEEE 1547-2018 for interoperability compliance.
  - SunSpec information model specifications are developed by work groups in the SunSpec Alliance. All SunSpec specifications are free to download and use.

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Modbus Protocol

- **Modbus**
  - The Modbus protocol provides the ability to read or write values in an address space consisting of single bit or 16-bit elements.
  - The Modbus protocol does not assign any meaning to the content of the address space made available by a Modbus implementation.
  - A Modbus implementation defines the information contained in the Modbus address space and publishes the Modbus mapping for users of the device.
  - The individual information elements in the Modbus address space may be larger than 16 bits and would span multiple 16-bit addresses.
  - Modbus can be used over TCP/IP networks or serial communications. Serial implementations typically use RS-485.
- **SunSpec Modbus**
  - SunSpec Modbus uses the standard Modbus protocol specifications as a basis for the SunSpec Modbus specifications.
  - Each SunSpec information model contains a set of related elements for a specific logical block of device information.
  - Each SunSpec information model is assigned a unique numeric ID. Information models IDs are assigned in numeric ranges based on the category of information they represent.

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Modbus Application to DER Communications

- **Modbus**
  - Most DER devices support Modbus as a method of exchanging information over a communications interface.
  - A DER device may support a manufacturer specific Modbus implementation, a SunSpec Modbus implementation, or both.
- **SunSpec Modbus**
  - Early in Sunspecs' development, information models for inverter telemetry and control were developed and used by a number of inverter manufacturers. The original inverter models are in the 1xx model ID range.
  - In 2017, an updated set of DER information models were created based on lessons learned and specific requirements in the IEEE 1547 specification. The updated 1547 compliant DER models are in the 7xx ID range.
  - The DER information models consist of: AC Measurement (701), DER Capacity (702), Enter Service (703), AC Controls (704), Volt-Var (705), Volt-Watt (706), Low Voltage Trip (707), High Voltage Trip (708), Low Frequency Trip (709), High Frequency Trip (710), Frequency Droop (711), Watt-Var (712), Storage Capacity (713), DC Measurement (714), DER Control (715).
  - The SunSpec DER model contents are a superset of the IEEE 1547-2018 requirements. SunSpec has published an IEEE 1547-2018 profile that specifies the elements that are required for 1547 compliance using the DER information models.
  - SunSpec has also developed information models to support storage devices. The storage model IDs are in the 8xx range and are also used by the Modular Energy System Architecture (MESA) Standards Alliance as part of the MESA-Device specification.

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Modbus/SunSpec Standards Activities and Users Group Support

- **Modbus**
  - The Modbus Organization manages the Modbus specifications.
  - In general, the Modbus specifications have been stable for decades. An additional security specification was added more recently.
  - For more information about standards activities see modbus.org.
- **SunSpec Modbus**
  - The SunSpec Alliance manages the SunSpec Modbus specifications.
  - The SunSpec Alliance runs a SunSpec Modbus work group to develop updates to the SunSpec Modbus specifications.
  - Some corrections were recently added to the SunSpec Modbus specifications that relate to general usage as well as IEEE 1547-2018 usage.
  - Addressing security considerations for SunSpec Modbus is an upcoming activity in the SunSpec Modbus work group.
  - For more information about the SunSpec Alliance and SunSpec Modbus activities see sunspec.org.

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Modbus Cybersecurity and Test & Certification

- **Cybersecurity**
  - Modbus
    - Most devices that support Modbus run with unencrypted network traffic. Each device may have implementation specific security features.
    - The Modbus Organization has published a Modbus/TCP Security specification that utilizes X.509v3 certificates and TLS to supply more standardized security features.
  - SunSpec Modbus
    - Currently, SunSpec Modbus does not specify any specific cybersecurity requirements.
    - It would be possible to mandate the functionality in the Modbus/TCP Security specification for Modbus TCP without any additional activity from the SunSpec Alliance. There is currently no equivalent for Modbus serial (RTU).
    - The SunSpec Alliance is planning to address cybersecurity requirements in future SunSpec Modbus work groups.
- **Test & Certification**
  - The SunSpec Alliance publishes SunSpec Modbus compliance test procedures that can be used by test labs to perform SunSpec Modbus protocol conformance testing.
  - IEEE Std 1547.1 contains testing requirements and procedures for interoperability compliance testing including device functional verification. These tests are required for UL 1741 SB/IEEE Std 1547-2018 compliance and can be performed by a qualified Nationally Recognized Testing Laboratory (NRTL).

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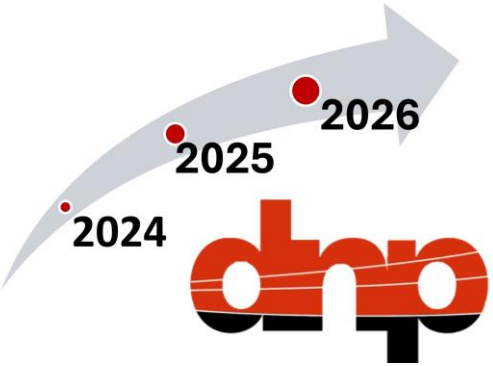
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Modbus/SunSpec Modbus Top Five Strengths

- Modbus is well understood and broadly deployed in DER devices
- Modbus is relatively easy and inexpensive to implement
- Modbus supports both TCP and serial communications (RTU) options
- SunSpec Modbus profile for IEEE 1547-2018 has been widely adopted in DER devices
- Modbus and SunSpec Modbus standards are freely available to all

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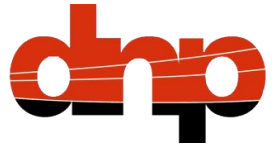
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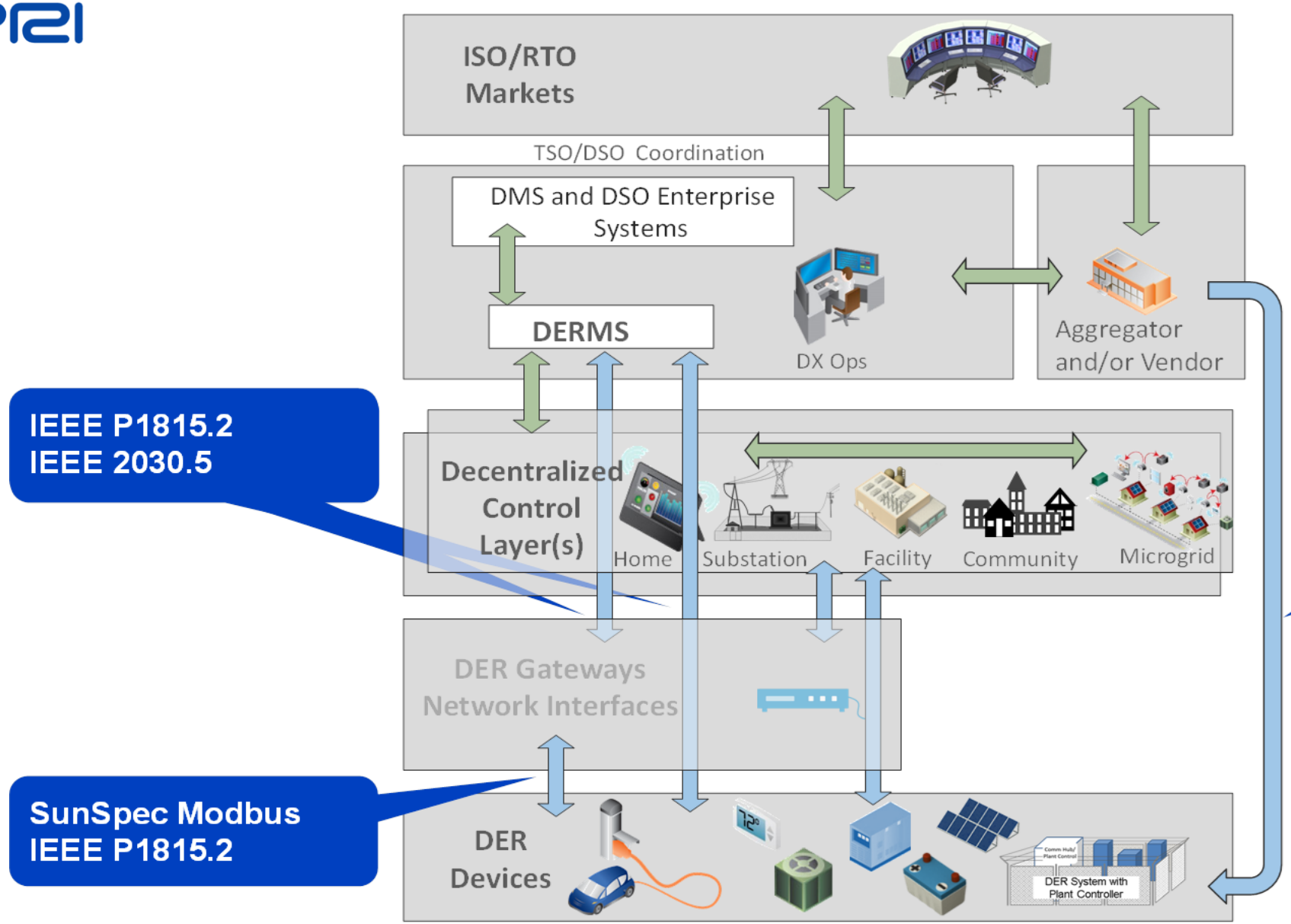
Summary – Friends or Foes?

Thoughts on Architecture and Strengths

Ben Ealey,
Electric Power Research Institute (EPRI)
Principal Team Lead, DER Communication and Data Integration
bealey@epri.com



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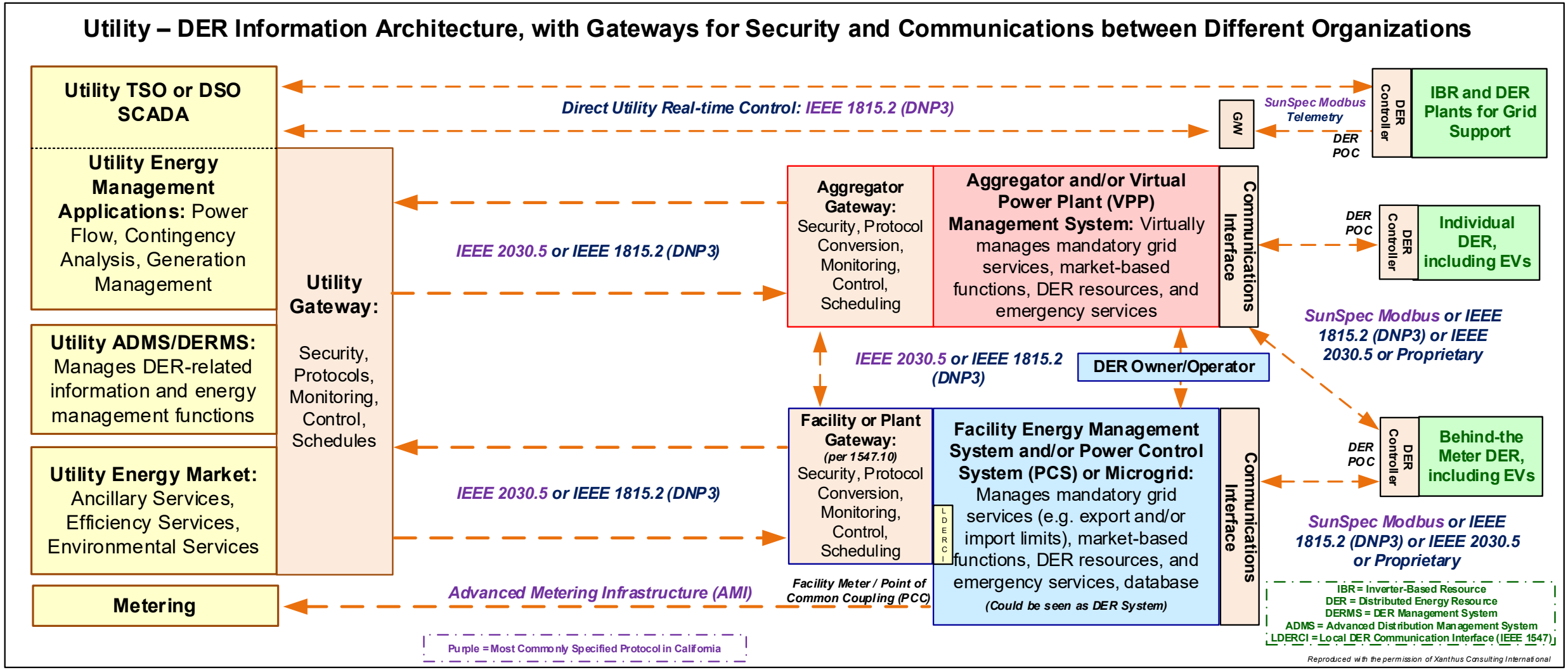


IEEE 1547 is being revised and protocols such as IEC 61850 are being considered for inclusion.

The information above reflects common use, but each protocol can be used in more applications than shown.

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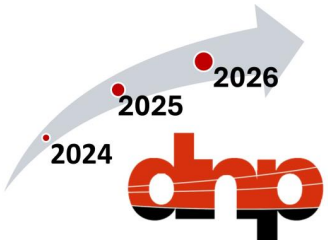
Information Exchanges in Utility and DER Architecture, Including the Communication Protocols Identified in IEEE 1547



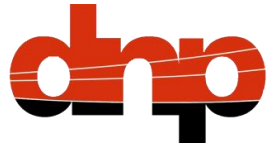
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MESA Open Standards for Energy Systems

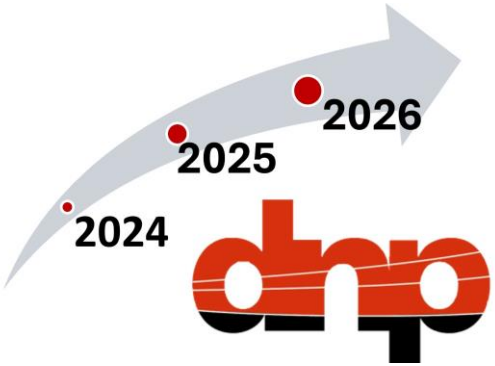
Top Five Strengths



IEEE P1815.2	IEEE Std 2030.5	SunSpec Modbus
DNP3 is widely used by utilities	Internet Native	Well understood and broadly deployed in DER devices
Semantics provide complete interoperability of DNP3 for DER	Highly Secure	Relatively easy and inexpensive to implement
SCADA performance supports large numbers of DER devices, rapidly, securely, and without loss of data	Supports a Variety of Applications and Functions	Supports both TCP and serial communications (RTU) options
Focus is on larger DER and IBR plants	Utilizes Well-Known Protocols and Technologies	Widely adopted in DER devices
Scheduling of functions, including for Limited Generation Profile (LGP) Firm and Non-Firm Export	Robust Global Ecosystem	Standards are freely available to all

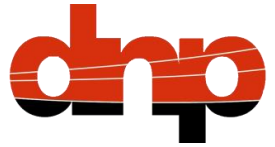


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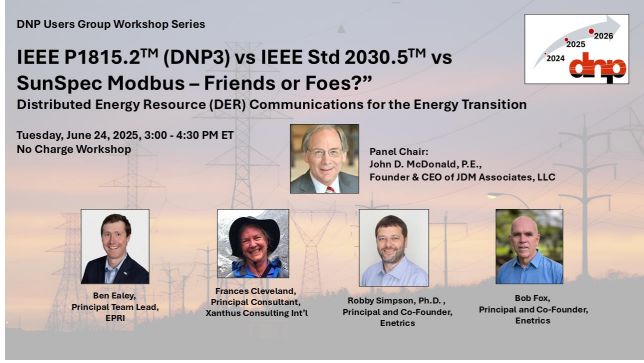


Open Q&A

Please introduce yourself and turn on your camera as you ask your question. Thank you!



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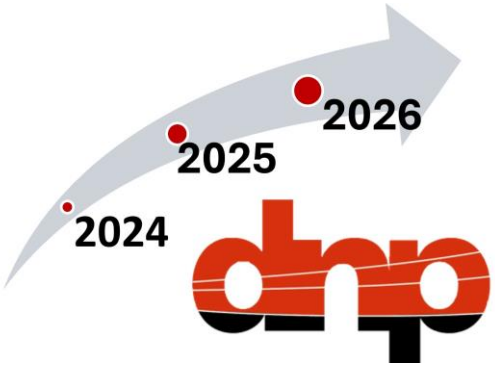


Thank you for attending!

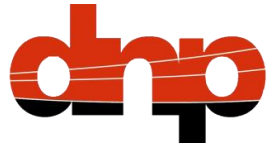
Workshop on DER Communications: "IEEE P1815.2 (DNP3) vs IEEE Std 2030.5 vs SunSpec Modbus – Friends or Foes?"

For more information contact Sara at membership@dnp.org

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Back-up Material



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Questions

- Ben Ealey
  1. A couple of you mentioned “information models”, what is an information model and what value does it provide in the DER space?
  2. How many protocols should utilities be prepared to support in the future? Can they pick one? Or should they prepare to support more?
- Frances Cleveland
  1. Why was the decision made to include full scheduling capabilities?
  2. If a utility already uses DNP3, what changes do they need to make to be conformant with IEEE 1815.2?
- Robby Simpson
  1. You stated that the IEEE 2030.5 working group had an unofficial motto of "Don't be weird." What are the perceived benefits of using well-known protocols and technologies?
  2. What are the benefits of having profiles of IEEE 2030.5, such as CSIP
- Bob Fox
  1. Modbus is usually characterized as an insecure protocol. Can you comment on this view?
  2. What are the biggest challenges in implementing SunSpec Modbus for 1547?

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