QualityLogic®

PREVENT DER CHAOS:

A Guide to Selecting the Right Communications Protocols for DER Management

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DISCLAIMERS

Why QualityLogic's Recommendations

QualityLogic occupies a unique role in the development and implementation of communications protocols for DER management by vendors and utilities. Developing and supporting test tools for DER protocols provides an unparalleled knowledge of both the technologies and eco-systems working with the technologies.

We have the privilege of advising utilities, vendors, alliances, research labs and regulators on the capabilities and implementation of specific DER protocol standards. We are constantly asked for both training and recommendations for the selection of a standard for specific applications.

The increasing interest in the monitoring and management of DER resources begs for the type of analysis and guidance QualityLogic provides in this Guide.

These Recommendations are a Starting Point

The recommendations contained in this guide are those of QualityLogic and do not represent any other organization, alliance, company or government entity.

The Recommendations should be viewed as a starting point and are based on models for use cases and deployment strategies. For specific applications an independent analysis should be conducted which may yield different results.

The Recommendations also use a "snapshot" of the current state and adoption of protocols which is subject to change over time and may lead to different results than included here.

To find out more about how recommendations were developed, or how to conduct an analyis for your situation contact us at info@qualitylogic.com.

ACKNOWLEDGEMENT

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SELECTING PROTOCOLS THAT MEET YOUR NEEDS, NOT YOUR VENDOR'S

Ask most vendors and they will tell you their smart electronic devices: like smart inverters, thermostats or battery management systems can speak any language you choose. In most cases, that is not entirely true. Devices will often natively speak Modbus, BacNet or CAN bus and then must be converted, at your cost, into some of the newer smart grid protocols like IEEE 2020.5, OpenADR or IEC 61850.

What Do We Mean by Protocol?

In information technology, a "protocol" is simply a way of standardizing how machines communicate with each other. The term protocol may apply at different levels – e.g., WiFi and Zigbee are transport layer protocols that insure that messages get between devices.

For our purposes, we use the term "protocol" to mean an application layer agreement on the information format and meaning that is communicated between two devices. We also call this a "Messaging Protocol" since it carries the information we want to exchange. Think of it as a language: two German speakers understand each other while a Hungarian and a Thai speaker will have trouble communicating. Selecting the right protocol insures that your messages will get to the intended recipients and be properly interpreted.

These protocols can be agreed upon industry standards or vendor specific, proprietary standards. The advantage of industry standards is in the increased number of competitors and options for assembling communications systems. These industry standards are developed and maintained by recognized international standards bodies such as the IEEE, IEC, SAE, ISO, etc.

Standard protocols become useful when there is some form of test and certification program to insure all vendors implement them the same way. Programs by WiFi, Zigbee, Bluetooth, etc, address transport layer protocols while OpenADR, SunSpec, UCA and others address application layer protocols.

DER STANDARD PROTOCOLS THAT PROVIDE *EFFECTIVE LONGEVITY*

We all know the disappointment when a vendor stops supporting a devices' function. One example: your operating system provider notifies you that you must upgrade your operating system to continue technical support and security updates on your laptop. Then you have the scramble and budget for either the updated operating system or replacement laptop.

Smart inverters, battery systems, intelligent thermostats and other smart devices can fall victim to vendors changing their communications standards, especially if they are proprietary protocols. QualityLogic can advise you on the best standards that provide "effective longevity."

Effective longevity provides the maximum in-service lifetime for the device industry and means that you will have the minimum lifetime cost associated with the communication protocol.

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

QualityLogic can assist you with selecting the most appropriate communications protocols for your needs, and then provide testing tools or consulting support to verify your vendor is fully utilizing appropriate protocol standards that will last.

USE-CASE PROTOCOL OPTIMIZATION

DER controls need to be optimized for various use-case applications to provide enough value to justify the application. Also, utility management of smart devices requires the appropriate protocol for reliable communication of operational requirements. Because many new DER applications include battery storage, the system must properly balance the cycles of charging and discharging to maximize the battery system operating lifetime. Typical DER control applications include: Direct SCADA Control; Demand Response, Solar Smoothing, Solar Shaping, Duck Curve Minimization, Black-Start, Frequency Regulation, CA Rule 21 Solar and Storage, and V2G Applications.

Utility Scale Solar/Storage: SCADA Control

Larger solar or storage (or combined solar/storage)

Leading Smart Grid Messaging Protocols

DNP3 (IEEE 1815-2010): Distributed Network Protocol 3 is popular in the US and used for real-time SCADA control of substations and utility controlled DER. The DNP3 Users Group defines testing standards and recently published an Application Note on DER communications.

IEC 61850 is more of a European and Asian standard for substation communications. It has some advantages over DNP3 but also is a complex protocol that does not have a robust certification program for DER applications. The UCAiug designs and manages the test and certification program for IEC 61850.

IEEE 2030.5-2018 has recently been updated to incorporate the CA Rule 21 and IEEE 1547-2018 functionality in the standard. It is an application layer standard based on web services with built-in security and is designed to use the modern internet for transport of its messages between devices. It is emerging as the preferred industry standard for DER communications because it is mandated in California. A network of global test labs conducts a SunSpec certification program for products sold into California which is 50% of the US solar market.

OpenADR (Open Automated Demand Response) protocol was developed in California but has been adopted as an IEC standard and is used in Japan, Korea, the US, Europe and elsewhere for DR program communications. The OpenADR Alliance has a robust certification program for OpenADR devices and systems.

There are other important protocols such as IEEE 1547-2018, UL 1741, OCPP (Open Charge Point Protocol) and ISO 15118 for EV charge management and ICCP (Inter-Control Center Communications Protocol or TASE.2). But the 4 listed above have emerged as the primary Utility-DER messaging protocols as of now.

systems that are under direct SCADA control can be considered as any other real-time controllable resource, except for solar variability. DNP3 and IEC 61850 are currently preferred protocols for direct real-time control. IEEE 2030.5 could be an option in some circumstances.

Demand Response

There are multiple DR use-cases. The emerging use-cases involve battery storage to shift peak loads or store excess power for higher-demand periods. Peak reduction involves storing or time shifting energy when it is abundant or cheap and discharging when in short supply or expensive and is peaking. For demand charge reduction, commercial customers with highly variable loads can have loads flattened, saving the customer money on demand charges while helping with grid optimization. Utility management of these assets is typically done through an aggregator that manages both storage and loads. Battery storage and EV charging times may act in concert with direct load control resources, such as water heater storage, thermostats, lighting and refrigeration equipment. Storage can be both a load and a power resource, expanding the traditional demand response resources by providing both peak reduction capabilities and power consuming ability at times of abundant renewable power. Recommended communication protocols include IEEE 2030.5 if specific device-control is required and OpenADR for more traditional Demand-Response applications. If any DER is included that must meet interconnection requirements, IEEE 2030.5 is most likely a requirement.

QualityLogic develops, markets and supports the official certification test tool for the OpenADR Alliance and the leading test and certification tools for IEEE 2030.5.

Solar Smoothing

With Solar Smoothing a battery system acts to slow rapid ramps of power due to clouds moving between the sun and the PV array so that spikes and troughs of cloud induced variability are reduced. This type of application requires very rapid tracking of solar variances and is accomplished by the battery management system. DNP3 or IEC 61850 would be recommended for this application because of the dominance of inverter control that may need to be coordinated with grid operations. Depending on the kW size or volume of inverters on the distribution feeder, IEEE 2030.5 may provide sufficient management as an alternative to DNP3 or IEC 61850.

Solar Shaping

With Solar Shaping, a battery system stores power at times of solar power availability and holds it in storage until it is needed. Solar shaping can involve time shifting for hours or minutes depending on needs. Solar shaping controls are used in areas where there is abundant solar energy compared to system load in the middle of the day where risk of over-generation is possible. This is a common situation in Hawaii and is developing in other high solar penetration areas. For this application, OpenADR or IEEE 2030.5 would provide the best fit, with DNP3 and IEC 61850 as potential alternatives for larger systems.

Duck Curve Mitigation

By combining elements of solar smoothing, solar shaping and peak time shifting, utilities can offer incentives for duck curve minimization. The California Independent Operator (CAISO) coined the term "duck-curve" that is currently a concern of grid operators in Hawaii and California. Due to the dominance of inverters in this application, IEEE 2030.5 would be the recommended protocol but DNP3 and IEC 61850 may be more applicable in larger systems.

Black Start – Wildfire Prevention Measures

Black-start capability of a battery storage system or standby generator provides enough electric capacity and energy after a system failure to power the in-rush current requirements of transformers on the AC system with enough energy to serve loads for a period. For wildfire prevention measures implemented by utilities, customers may be without grid power for significant periods of time. A black-start energy storage unit combined with solar provides the energy for loads and may be used to help other generator units reduce fuel consumption and to start by providing a reference frequency for synchronization. For this use case, power for communication systems may be intermittent, so the protocol must be robust and available whenever a smart device can connect to a server. And the communications focus will be on insuring correct inverter programming to meet this use-case requirement. For this instance, IEEE 2030.5 may provide the best architecture.

Frequency Regulation

Frequency regulation service is the injection or withdrawal of power by DER capable of responding appropriately to a transmission system's frequency deviations or interchange power imbalance. Both are measured by the Area Correction Error (ACE). ACE has two measures, one the difference between a balancing authority's scheduled and actual interchange, and another measuring the balancing authority's share in correcting the system frequency. Frequency regulation battery resources are sent a signal to charge or discharge their provision of energy. This may be accomplished using an Automatic Generation Control (AGC) or another method selected by the grid operator such as DNP3 or IEC 61850. Both IEEE 2030.5 and OpenADR can in theory be used in this application.

QualityLogic's IEEE 2030.5 Test Tools are being used by the Authorized Test Labs for CA Rule 21 IEEE 2030.5 Certification testing.

CA Rule 21 Solar and Storage

The California PUC has mandated the use of IEEE 2030.5 as the "default" protocol for communications from a utility DERMS to some form of "gateway" to solar and battery inverters. The gateway may be an aggregation system, a microgrid or facility EMS or a local front-end to an inverter. In all cases IEEE 2030.5 must be certified according to CA Rule 21 requirements in order for a gateway and its associated inverters to be interconnected after June 22, 2020. The rulings specifically allow utilities and vendors to use DNP3 or IEC 61850 as alternatives by mutual agreement.

V2G Applications

The standardization of communications protocols for vehicle to grid (V2G) applications is in its infancy. This is a more complex eco-system than stationary solar or storage interconnections There are some aspects becoming clear, however. One is that IEEE 1547.1 and the coming UL 1741-2020 can be applied to both fixed inverters for electric vehicle supply equipment (EVSE) and onboard inverters in a plug in electric vehicle (PEV). In CA, it appears looks like the current CA Rule 21 can be applied to bi-directional EVSE inverters and to onboard PEV inverters with some enhancements. For managing charging behavior, OpenADR is already being used in a number of locations. For managing DER behaviors of multiple interconnected inverters, IEEE 2030.5 is emerging as the primary standard in the US while a combination of OCPP and ISO 15118 are favored in Europe.

REDUCE STARTUP PROBLEMS AND GET MORE FOR YOUR COMMISSIONING DOLLAR

You've selected your architecture and protocol and vendors and need to make sure the actual installation will work as required. The new IEEE 1547 commissioning process includes validating standardized communications operation in the field. A well planned and executed commissioning process can insure that "surprise" interoperability and performance issues don't pop up and add unplanned time and dollars to your DER project.

QualityLogic's engineers and consultants have supported the installations of numerous renewable-energy & DER systems, including solar photovoltaic (PV), biogas - anaerobic digesters, combined heat and power, fuel cell, battery storage, grid paralleled backup generators, geothermal energy systems and complete microgrid systems.

In addition, we are active participants in the development of the new IEEE 1547 commissioning standards. We can assist you with implementing these new commissioning standards to assure a structure that will provide continual costs savings with a standards based approach. These approaches can be documented and the savings quantified. Depending on the DER use-cases you are implementing, commissioning can be monetized.

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Being software developers, we can develop cost effective applications to support your commissioning needs based on the IEEE 1547 commissioning standards. This might include incorporating our IEEE 2030.5 test tool in a custom application that streamlines changes and updates to device control settings across several different smart inverter manufacturers' models.

DNP3 – "DNP3 is an official IEEE standard – IEEE 1815-2012 (https://standards.ieee.org/standard/1815-2012.html) Testing is defined by the DNP3 User's Group (https://www.dnp.org/)".

IEC 61850 – "IEC 61850 is a standard of the IEC (https://en.wikipedia.org/wiki/IEC_61850) and testing and certification are designed and managed by UCAiug (https://iec61850.ucaiug.org/default.aspx)"

IEEE 2030.5 – "IEEE 2030.5-2018 is an IEEE standard (https://standards.ieee.org/standard/2030_5-2018.html) that has been adopted by the CA IOUs for communications with DERs. The SunSpec Alliance has designed and operates the official CA Rule 21 Certification Program (https://sunspec.org/2030-5-csip/)"

OpenADR – "OpenADR was developed and is managed by the OpenADR Alliance which maintains the OpenADR 2.0 Profile and Certification Program (https://www.openadr.org/). It is also now an IEC standard - IEC 62746-10-1"

OCPP – "Open Charge Point Protocol: OCPP 1.6 / OCPP 2.0 is a frequently used open source protocol between EVSEs and central charging management system. It is developed and managed by the Open Charge Alliance (https://www.openchargealliance.org/)"

ISO 15118 – "ISO 15118 (often called Plug & Charge) is a standard for a vehicle to grid communication interface for bi-directional charging/discharging of EVs (https://www.iso.org/standard/69113.html)"