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The Impact of EPRI's Automated Demand Response Collaborative on Advancing OpenADR Standards

EPRI launched its "Automated Demand Response and Ancillary Services Demonstration Project" in 2012. Since that time it has achieved a number of milestones, which are briefly described in this summary paper. Additional details are available in the reports cited throughout.

The Changing Role of Demand Response

The emerging recognition of the importance of flexible resources in the Intelligent Grid is reflected in increased attention on Demand Response (DR). Formerly considered primarily as an intermittent reliability mechanism (implementing "peak shaving," for example), there is growing interest in using DR as a dispatchable resource capable of operating in shorter time frames and at any hour of the day. In order to accomplish this, information regarding the availability, deployment, and performance of DR resources will be have to be supplied through automated communications.

Proprietary automated load control mechanisms have been used to reduce demand for decades. However, these protocols only provide a one-way communication path that switches loads on or off: no knowledge of the state of the load, either before or after activation of the load control, is directly available to the system operator.

Automated Demand Response

By acting as Virtual Power Plants (VPPs) DR resources can now participate in energy or ancillary services markets in many places. Using this model, the prices and capacity offered by DR resources can be compared with those from traditional generation sources, allowing the DR resources to be selected and dispatched using preexisting frameworks and procedures.

This mode of operation is not possible using traditional load control protocols. For example, positive acknowledgement of the receipt of a deployment signal, as well as real-time telemetry before, during, and after the deployment period, are usually required of resources providing ancillary services. Also, the amount of DR available from a particular resource may depend on it having advance knowledge of pending events (so that it can prepare for the upcoming deployment, such as by pre-cooling a building or performing an orderly shutdown of a manufacturing process).

Open Communication Standards for DR

The DR Research Center (DRRC) at Lawrence Berkeley National Laboratory (LBNL) began working on a protocol for automating DR communications in 2002. By 2007 all three of the IOUs in California had deployed pilot projects using this system, and in 2009 LBNL released a public version of their protocol, naming it "OpenADR 1.0." Widely deployed in California, the DRRC estimates that by 2014 approximately 250 MW of DR were under the control of OpenADR 1.0 across all three California IOUs.

The EPRI Demonstration Project

By 2012 it had become clear that an open standard for two-way DR communications was emerging. Recognizing the potential this offered for making DR a viable resource for ancillary services, EPRI launched its Automated DR and Ancillary Services Demonstration Project. The purpose of this project is to use field demonstrations to assess the capabilities and limitations of emerging standards-based DR communications for ancillary service applications and to advance open standards-based DR and DER communications. The project's first deliverable was a report describing the then-current state of automated DR.[1]

OpenADR 2.0a and 2.0b Specifications

Continuing work on OpenADR is done by an industry consortium, the OpenADR Alliance, in which the EPRI project participates. The Alliance has released two specifications to date. The first, OpenADR 2.0 Profile A (2.0a for short), is similar to OpenADR 1.0 but incorporates EI 1.0 data models and some other requirements from PAP09.

The Alliance is currently working on a DR Program Guide intended to help utilities that are implementing DR programs understand how OpenADR 2.0 can be deployed and applied to support a range of common use cases. The EPRI is assisting in the development of this guide. The project's first deliverable was a report describing the state of automated DR at that time.

Certified Open-Source OpenADR Software

In mid-2013 the Alliance released its specification for Profile B (often referred to as OpenADR 2.0b). This greatly enlarged on Profile A and for the first time provided an open, robust, secure, and standardized protocol capable of fully supporting the two-way communication requirements for loads participating as ancillary services.

In order to accelerate the availability of OpenADR 2.0b testing software, the EPRI project developed open-source implementations the OpenADR Profile 2.0 specifications. Both an OpenADR server (known as a Virtual Top Node or "VTN") and a standalone version of the OpenADR client (known as a Virtual End Node, or "VEN") were created and have been made freely available on SourceForge. Users from around the world have downloaded each implementation nearly 900 times.

In addition, a library of software components that implement the VEN functionality has also been produced and will be released soon. It is intended to be used to develop embedded systems containing the OpenADR VEN functionality

The OpenADR Alliance has established a rigorous procedure whereby implementations can be tested for conformance with the OpenADR specification and be certified by the Alliance. EPRI's open-source VTN and standalone VEN have both achieved this certification (see example in Figure 1).

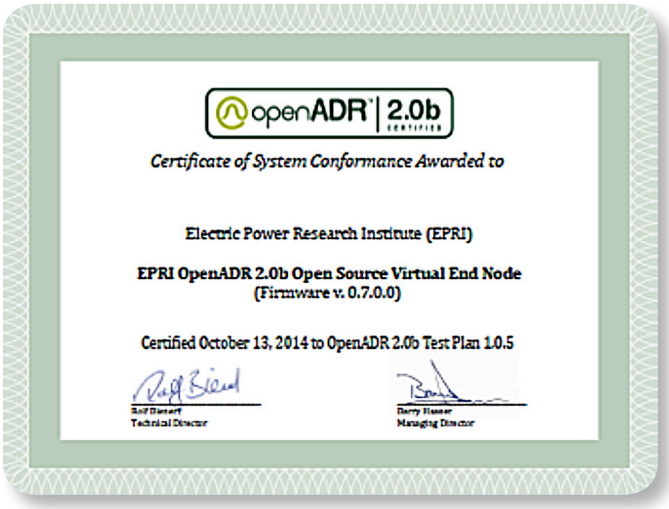

Figure 1 – The OpenADR Alliance's Certificate of Conformance for EPRI's open-source VEN implementation.

An OpenADR-to-Modbus Gateway

Members of the EPRI project were quick to begin applying OpenADR 2.0. Researchers at Électricité de France's (EDF's) Les Renardières laboratory wanted to study the use of industrial equipment for providing DR. As part of the EPRI project, the EDF group decided to try to control a laboratory-scale electric furnace and ceiling lighting via OpenADR communications. Both the EDF furnace and lighting controllers were capable of communicating with Modbus, a control protocol that has a strong presence in industrial processes.

Anticipating the forthcoming release of the Profile B specification, the EPRI project began development of an open-source implementation of OpenADR. When Profile B turned out to take longer to develop than had been anticipated, EDF opted to base their demonstration on a pre-release version of the EPRI software that supported Profile A. The EDF researchers modified the EPRI 2.0a VEN to include a software gateway to translate between OpenADR messages and Modbus commands.[2]

1 *Automated Demand Response Today.* EPRI, Palo Alto, CA: 2012. 1025008.

2 *Automated Demand Response and Ancillary Services Demonstration Project Update: Volume One.* EPRI, Palo Alto, CA: 2014. 3002002782.

Electric Vehicle Telematics for DR

The EPRI project's OpenADR software has also been taken up by other activities at the Institute. For example, the Electric Transportation group created a DR-dispatching capability that uses automobile manufacturer's telematics systems to control electric vehicle (EV) charging. In this application, DR events are sent from the EPRI OpenADR VTN to a central server that then forwards them to systems operated by each EV manufacturer. These systems in turn pass the DR messages to the individual EVs via each manufacturer's proprietary vehicle telematics system.[3] Figure 2 shows some of the EVs taking part in a demonstration of this application that was recently hosted by SMUD; eight different EV manufacturers participated.

Figure 2 – Several of the EVs at the demonstration of telematics-based DR using EPRI's OpenADR VTN.

On-Going EPRI Project Demonstrations

California ISO and Southern Company are proceeding with building controls demos under the EPRI project. The CAISO project will test the operation of the EPRI VTN with a GRIDlink OpenADR 2.0a device interfaced with CAISO's building control systems. Southern Company is testing the integration of EPRI's OpenADR VTN with VENs connected to building control systems from a variety manufacturers.

Irish distribution system operator ESB Networks is developing a demonstration, based on EPRI's OpenADR software, which will enable it to receive advance notice of pending dispatches planned by its transmission operator. These dispatches, which are issued when the system has to absorb rapid upward swings in wind generation, can potentially overload parts of ESB Network's grid. By receiving advance notice of such dispatches, ESB Networks will be able to analyze the impact of such pending actions and inform the transmission operator of any modifications in the dispatch that may be required.

Other EPRI OpenADR Demonstrations

As with the EV demo, other EPRI projects are picking up the project's OpenADR software and using it in their own projects. One example of this is the CEA-2045 demonstration of DR-ready appliances, which is developing a Wi-Fi OpenADR CEA-2045 device control module based on the EPRI software.[4]

Commercial Deployment of the EPRI VTN

Recently a commercial cloud-based test system for OpenADR has been announced by QualityLogic. Based on the EPRI implementation (see Figure 3), subscribers to the system receive access to a dedicated instance of the EPRI VTN they can use to test their own VEN implementations.

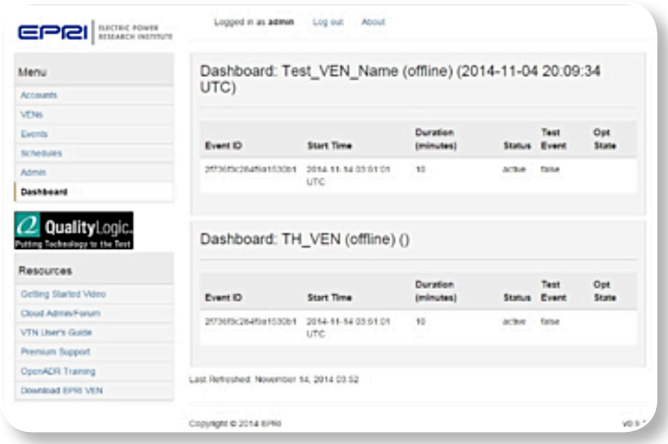

Figure 3 – Screen shot of the EPRI VTN offered as a commercial service by QualityLogic.

3 *Unified Plug-in Electric Vehicle (PEV) to Smart Grid Integration Approach within Automotive and Utility Industries.* EPRI, Palo Alto, CA: 2013. 3002000665.

4 *CEA-2045 Field Demonstrations Project Description.* EPRI, Palo Alto, CA: 2014. 3002004009.

Other OpenADR Developments

OpenADR continues to grow around the world. For example, Japan is experiencing a surge of interest in DR, and Tokyo Electric Power Company (TEPCO), a supporter of the EPRI project, has been working to further the adoption of OpenADR in that country.

OpenADR 2.0 has been included in the Smart Grid Catalog of Standards in the U.S., while the International Electrotechnical Commission (IEC) has accepted OpenADR 2.0b as a Publically Available Specification, a potential first step toward international standardization.

Summary

The EPRI Automated DR and Ancillary Services Demo Project is making an impact across the DR communications space. The project assisted in the development of the OpenADR specifications and is collaborating in the development of the Alliance's upcoming DR Program Guide, it created and freely distributes certified open-source implementations of OpenADR, and the demonstrations and commercial services that are using this software are advancing automated DR communications for the benefit of the grid and public.

Contact Information

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