Trends Concerning Standardization of OpenADR

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Abstract

Automated demand response (ADR) technology is drawing worldwide attention alongside renewable energy technologies as a countermeasure against global warming and rising energy costs. In Japan, standardization of ADR has progressed rapidly as a promising power-saving measure since the Great East Japan Earthquake of March 2011, and Demand Response Interface Specification Version 1.0 was adopted by the JSCA (Japan Smart Community Alliance) Smart House/Building Standardization and Business Promotion Study Group organized by METI (Ministry of Economy, Trade and Industryof Japan) in May 2013. This article describes OpenADR 2.0, the international standard that forms the basis of the above-mentioned Japanese specification.

Keywords: automated demand response, smart community, OpenADR

1. Introduction

Demand response (DR) is defined as the practice of reducing peak power consumption based on utilities' demands for power saving and electricity users' (consumers') responses to them. For example, utilities or aggregators*1 notify consumers of power saving incentives or temporary increases in electricity prices in accordance with the peak power demand. Then consumers restrain their power usage during peak times or shift it to off-peak times (**Fig. 1**). This helps to reduce power consumption during peak times.

Because the cost of storing electricity is very high, it is not practical to store electricity for peak time use, and utilities must therefore keep preliminary power generators to prepare for peak time power usage. Thus, from the standpoint of utilities, reducing peak power consumption by using DR has the same effect as cutting back on power-generation facilities and reducing fuel costs. In the United States, DR has been subjected to large-scale field tests around the country since the mid-2000s as a result of power shortages that have occurred because of restrictions on the construction of new power plants imposed by environmental regulations. These tests have confirmed that DR can reduce electricity demand by roughly 10–20%. In particular, automated demand response (ADR), whereby messages are exchanged between systems electronically and devices are controlled automatically using energy-management systems (EMSs), has been recognized as being more effective than manual DR, whereby notifications of DR events are sent to users via email, and consumers then control their devices manually. OpenADR 1.0 was developed as a message-exchange protocol for ADR by the Lawrence Berkeley National Laboratory in the USA. After some field tests and commercialization activities by several California power utilities, it was made public in 2009 (see **Fig. 2**).

2. Steps toward standardization of OpenADR

OpenADR 1.0 was originally just a local standard in the USA. However, it took a step closer to being an international standard after it was recommended by NIST (the National Institute of Standards and Technology) in the USA as one of the standards that should be complied with to achieve interoperability of smart grids. In 2009, NIST established the Smart Grid Interoperability Panel (SGIP) as a body

*1 Aggregator: a business operator acting as an intermediary between power utilities and groups of consumers that aggregates the amounts of megawatt power, namely the reducible power demand saved by consumers in exchange for incentives.

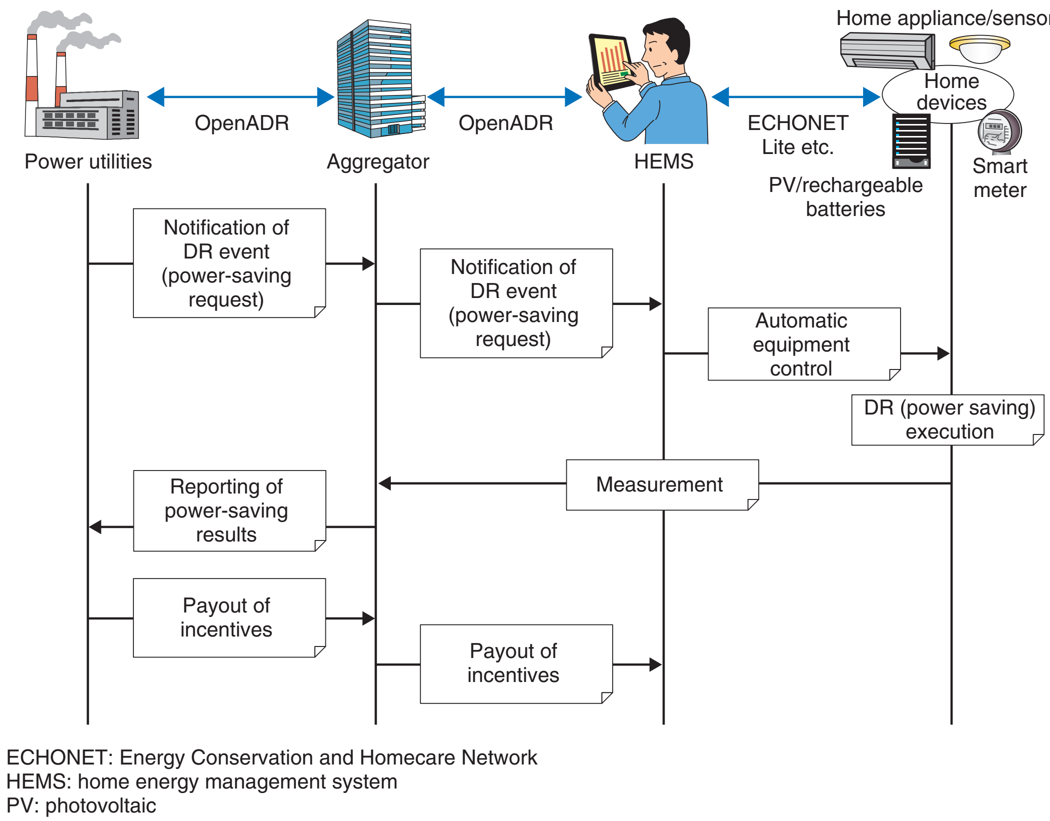

Fig. 1. Example of an ADR sequence.

promoting the standardization of smart grids, and at the behest of SGIP, the Organization for the Advancement of Structured Information Standards (OASIS*2) started developing standards for ADR. Referring to previously investigated documents such as the OpenADR 1.0 System Requirement Specifications by the Utility Communication Architecture International Users Group (UCAIug) and the results of investigations by the North American Energy Standards Board (NAESB), OASIS drew up two specifications—EI 1.0 (Energy Interoperation 1.0) and EMIX 1.0 (Energy Market Information Exchange 1.0)—as new international standards. Although these specifications can be applied to ADR as well as a wide range of business transactions in the electric industry, they are not necessarily sufficient from the viewpoint of implementation. Under those circumstances, the OpenADR Alliance was established in 2010 as an international standardization body for developing and promoting a practical ADR standard (namely, OpenADR 2.0) and providing certification to approved products. The OpenADR Alliance established an interoperable standard by extracting specifications required by ADR from EI 1.0 and EMIX 1.0 and supplemented insufficient points regarding implementation. A set of specifications of this kind is called a Profile. OpenADR 2.0 Profile A (2.0a), which targets control of relatively simple devices such as intelligent thermostats, was made public in August 2012, and OpenADR 2.0 Profile B (2.0b), which targets full-blown ADR services offered by aggregators, was made public in July 2013. Profile 2.0b incorporates 2.0a and offers higher functionality than its predecessor. Therefore, this article focuses on 2.0b.

3. Overview of OpenADR 2.0

OpenADR stipulates data models for message exchange and communication protocols needed when

*2 OASIS: an international non-profit organization promoting standardization of XML (extensible markup language) based electronic transactions between businesses.

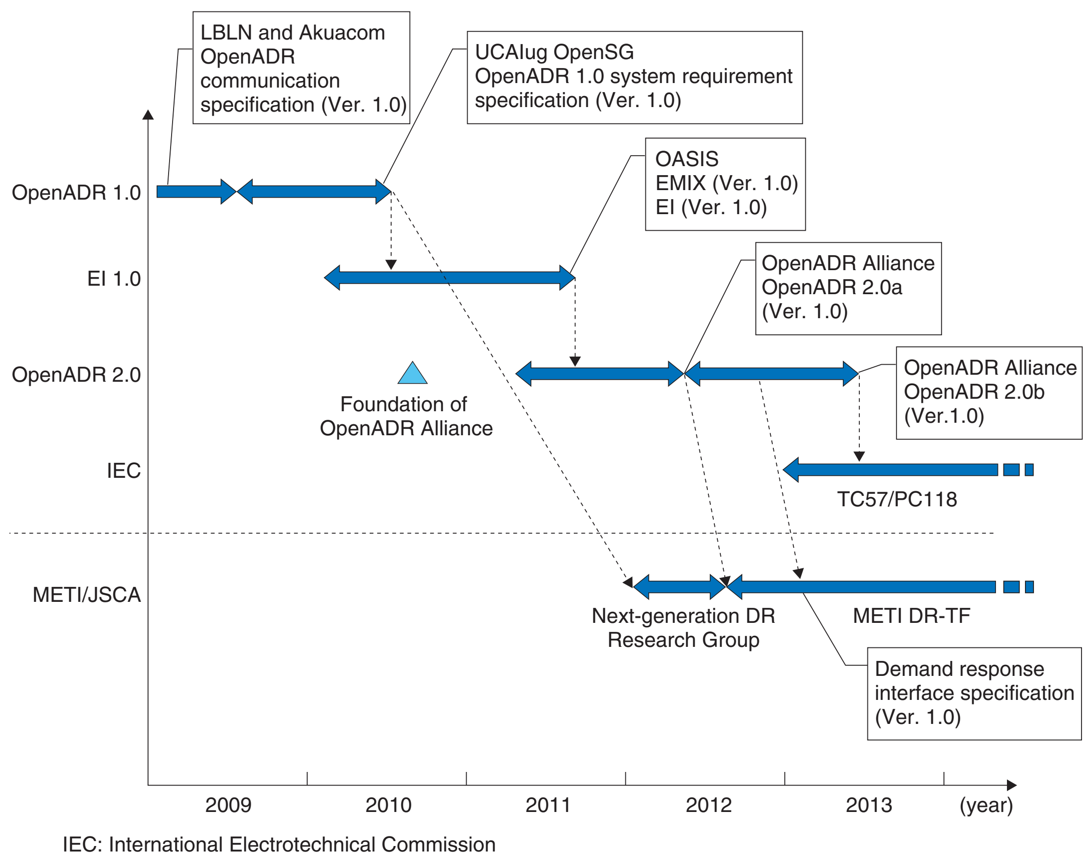

Fig. 2. Steps involved in standardization of OpenADR.

information is exchanged between *actors*, namely business entities such as power utilities and consumers, involved in ADR services. As shown in **Fig. 3**, the actors are modeled in the form of virtual top nodes (VTNs), which send messages, and virtual end nodes (VENs), which receive messages. Power utilities and consumers correspond to VTNs and VENs, respectively. Aggregators are actors that double as VTNs for consumers and VENs for utilities; they can be set up in multiple stages. A VTN is generally implemented as a server system called a demand response automation server (DRAS), while a VEN usually corresponds to "x energy management systems" (xEMSs), for example, a BEMS (business EMS) or HEMS (home EMS), and devices such as smart meters.

VTNs and VENs are assumed to exchange messages via the Internet (IP (Internet protocol) network). The transport mechanism is defined as either of two types of communication models, namely *Pull* and *Push*. In a Pull model, a VEN polls a VTN periodically and receives messages from it. By contrast, messages are sent from a VTN to a VEN in the Push model. The protocols that support these models are standard HTTP for the former, and XMPP (extensible messaging and presence protocol), which enables bidirectional communication used for instant messaging, for the latter. Messages are defined in XML, and their data structure is defined in XSD (XML schema definition). In addition, a standard level of security using TLS (transport layer security) and a high level of security combining an XML signature are prescribed for securing messages.

The services provided by OpenADR 2.0b are listed in **Table 1.** Four services are prescribed: EiRegisterParty, which reciprocally registers the VTNs and VENs that become communication parties; EiEvent, which transmits details of DR events; EiReport, which sends measured and recorded data related to DR events, for example, power consumption; and EiOpt, which manages acceptances and refusals concerning DR events. Meanwhile, in OpenADR 2.0b, an extremely wide range of required and optional

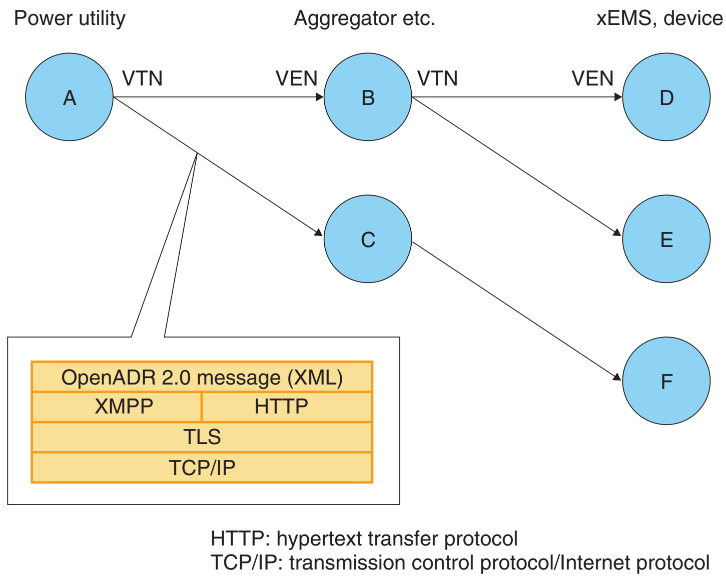

Fig. 3. Communication model for OpenADR 2.0.

Table 1. Services provided by OpenADR2.0.

Service	Summary
EiRegisterParty (Registration)	VTN and VEN are mutually registered; information required for reciprocating messages is mutually exchanged.
EiEvent (DR events)	VTN notifies VEN of DR events, updates notification contents, and cancels notifications. Valid period of events and event contents are shown. Various event contents (such as price information, assignment of load reductions, load control, and rechargeable-battery control) are defined.
EiReport (Reporting/feedback)	Instantaneous and accumulated values of measurement results (such as power consumption and voltage at VEN) are reported. Prior to the reporting, information concerning respective reporting capabilities is mutually exchanged.
EiOpt (Acceptance/modification)	Schedules of acceptances and rejections regarding DR events are transmitted from VEN to VTN.
(Remarks)	Although services such as registration of resource equipment controlled by ADR (EiEnroll), management of available resources (EiAvail), and cooperation with markets (EiMarketContext) were initially going to be defined in OpenADR2.0, they were omitted from Profile B since the present specifications were judged sufficient for actual usage.

parameters are defined so that a variety of ADR services can be created. When installing OpenADR 2.0b, it is necessary to set each parameter in line with the contents and operation of services.

Although it was initially planned that OpenADR 2.0 would evolve into Profile C, hearings conducted with various power utilities indicated that the current specifications are sufficiently practical, so Profile C was halted. It is possible, however, that services not covered by Profile B will be added in the future, for example, management of devices that provide DR resources and coordination with markets.

4. Status of standardization concerning ADR in Japan

In contrast to the worldwide boom in smart grids that was triggered by the energy policies promoted by President Obama in the USA, some skepticism towards this worldwide trend was initially exhibited in Japan, where the energy supply was considered to be stable. However, following the Great East Japan Earthquake of March 2011, DR started to draw attention as a promising countermeasure to power shortages. Consequently, proving tests and test services—

starting with field tests in four regions of Japan performed by the Japan Smart Community Alliance (JSCA)—were started in various regions. These tests were, however, limited to manual DR or cooperation with systems through independent communication protocols. To apply ADR as a genuine social infrastructure, the standardization of an interface between business operators (utilities and aggregators) and consumers was urgently required.

Given those issues, METI set up the Next-generation Demand Response Technical Standardization Research Group under the JSCA Smart House/Building Standardization and Business Promotion Study Group in June 2012, and surveys on use cases of DR in Japan and technical investigations on OpenADR were carried out. In their final report in September 2012, this research group confirmed the validity of adopting OpenADR 2.0 as the basis of ADR standards in Japan.

On the basis of this report, METI then set up the Demand Response Task Force (DR-TF) under the above-mentioned study group, and the DR-TF drew up the technical specifications required for DR communications between energy suppliers (power utilities) and energy users (consumers and aggregators) in Japan. This specification was adopted in May 2013 and is called Demand Response Interface Specification Version 1.0.

This specification became somewhat transitional in various ways in order to ensure that it was ready for application in the summer of 2013. For example, the specification is applied only to the interface between the power utilities and the aggregators. The interface between aggregators and xEMSs was deferred, even though it would be more effective to standardize it. Moreover, the specification should be called a *minimum subset* of 2.0b, since it consists of 2.0a and a very small part of version 2.0b because of the considerable delay in formulating specification OpenADR 2.0b itself. However, ADR services themselves are still in the earliest stages of development throughout the world, and there is a lot of room to improve them by refining them through actual use. METI is at the point of thoroughly reviewing Version 1 of the specification in light of the results of verification tests and service applications implemented in 2013.

5. OpenADR at NTT R&D (Research and Development)

At NTT Network Technology Laboratories, studies on the *Smart Community* have been ongoing since the autumn of 2011, and R&D on a Smart Community Platform (SCPF) is now underway. From the early stage of development, ADR has been viewed as a fundamental technology, and OpenADR 1.0 was adopted for SCPF Ver. 1.0, which was developed in October 2012. It appears more than likely that SCPF Ver. 1.0 was the initial implementation of OpenADR 1.0 in Japan. SCPF Ver. 1.0 was applied to a field test on ADR carried out from March to August 2013 at a company house of NTT EAST. In parallel with this development, as well as joining the OpenADR Alliance in September 2012, NTT Network Technology Laboratories joined the above-mentioned research group and DR-TF organized by METI, and has been contributing knowhow based on the experience gained in implementing the SCPF. Smart Community Platform Ver. 1.6 (SCPF Ver. 1.6) was developed in June 2013 as a B2B2C (business-to-business-to-consumer) platform for power utilities and aggregators; it can provide ADR services via the cloud based on OpenADR 2.0 (**Fig. 4**). SCPF Ver. 1.6 was certified by the OpenADR Alliance to conform to OpenADR 2.0a in July 2013 and to conform to OpenADR 2.0b in October 2013. It is the first OpenADR 2.0 certified product in Japan. In the meantime, SCPF Ver. 1.6 is being implemented in accordance with Demand Response Interface Specification Version 1.0, which was recommended by METI as mentioned previously, and it has been adopted as a core system for ADR verification tests at Waseda University. This test is subsidized by METI and is being conducted by Waseda University in order to verify the feasibility and interoperability of the Demand Response Interface Specification by applying it to ADR communications between actual power utility and aggregators' ADR systems.

6. The future of OpenADR

As described in the above sections, OpenADR 2.0 is being adopted in Japan and other countries as an international standard for implementing ADR and is being verified through proving tests in those countries. At the present time, OpenADR 2.0 is being positioned as the de facto or forum standard. However, it has been decided by committees TC57 and PC118 of the IEC (International Electrotechnical Commission) that work will commence on harmonizing the IEC's common information model IEC61850, namely, a power-system information model, with OpenADR 2.0b. It can thus be said that OpenADR is on its way to becoming the de jure standard. This

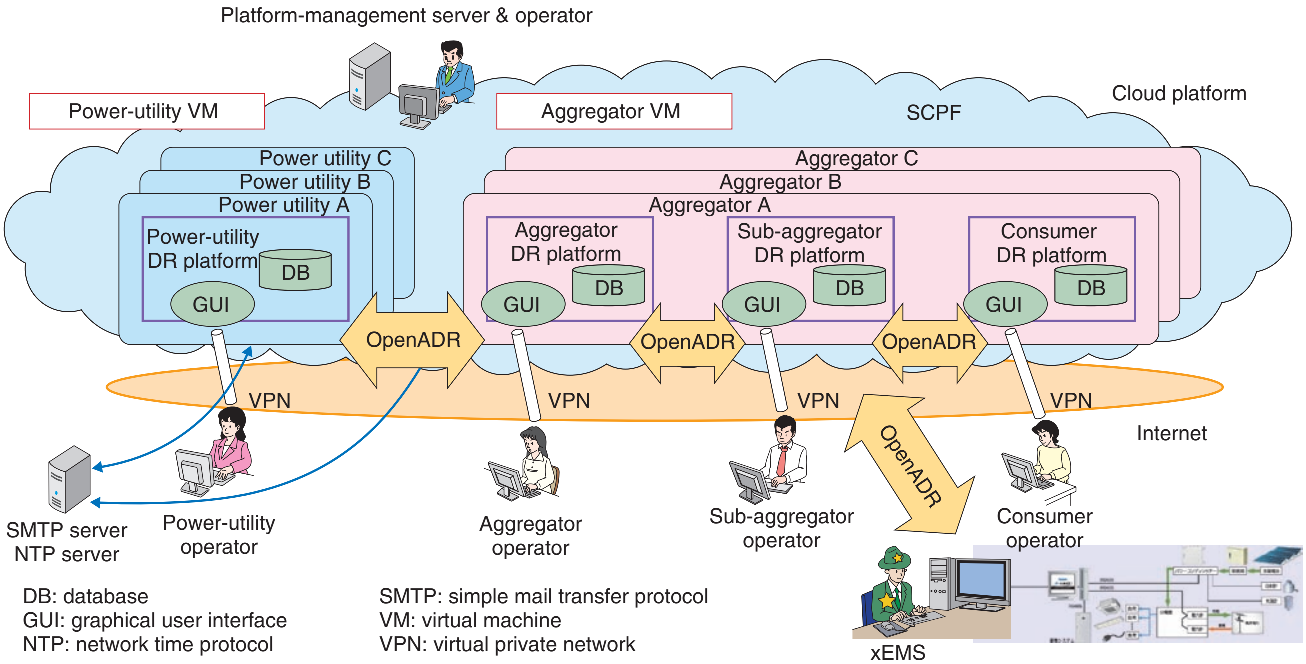

Fig. 4. Overview of Smart Community Platform (Ver. 1.6).

standardization work is predicted to take several years, so in the meantime, OpenADR 2.0b is being positioned as a PAS (publicly available specification).

Moreover, if we look into the future, ADR is not simply a way of providing power-saving services. Essentially, it is about reinventing the electricity infrastructure by incorporating power-saving activities and renewable energy on the consumer side into conventional power distribution, which has been a one-way street from power utility to consumer. From that viewpoint, it is sufficient to say that OpenADR 2.0b will be upgraded and expanded from now on as that reinvention continues.

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He received the M.S. degree in coordinated science from the University of Tokyo in 1987. After joining NTT Communications and Information Processing Laboratories in 1987, he engaged in R&D of dialogue systems using speech recognition technology, computer telephony integration systems for call centers, and a network-based management platform for multi-application smart cards, which was deployed for the Basic Resident Registration Card in Japan. He was a General Manager in the Platform Services Department and the Innovative Financial Systems Department of NTT Communications from 2005 to 2010. Since 2011 he has been engaged in R&D of the Smart Community Platform using Automated Demand Response technology at NTT Network Technology Laboratories.