The Current Status of OpenADR (Automated Demand Response) Technology and NEC's Approach to the DR Market

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Abstract

Smart Grid progress brought our attention to the importance of Demand Response (DR) as a means of maintaining the power demand and supply balance, and maturation of the DR market is expected. This report introduces OpenADR 2.0b, which is the latest international standard for Automated Demand Response technology, together with details of NEC's approach.

Keywords

Demand Response (DR), OpenADR 2.0b, PPS, EMS, negawatt power

1. Introduction

Interest in Smart Grid technology has increased rapidly on a global level. In Japan, in particular, it has become a pertinent issue, ever since the 2011 Tohoku Earthquake. While the expansion of renewable energies is expected, unpredictable power sources such as solar and wind generation have proven to be unstable, so their increased usage renders the entire power supply system unstable, thereby making the Smart Grid an even more important requirement so as be able to operate all power sources in a stable and efficient manner.

One way to enable the above is to focus more attention on Demand Response (DR), which is an optimum mechanism to control the balance between electricity demand and supply by utilizing ICT. This is now undergoing testing (POC).

DR adjusts the power demand according to the supply and is effective for more efficiently using of power supply resources. It also allows the demand side to consume electricity more efficiently, and with less waste. In cases of urgent power demand, we need to deal with peak demand more quickly than by what power generation plants can produce. As a result, DR is expected to be a clean, economical, and reliable technology that can offer beneficial solutions to both power suppliers and customers. In this paper, we describe OpenADR 2.0b, which is the latest international standard for the Automated Demand Response technology, and we will introduce our ADR platform technology and the DR system that is based on it.

2. Outline and System Configuration of OpenADR 2.0b

Fig. 1 shows the information transfer model of OpenADR 2.0b, specifying the data model and communication protocol for DR information messages among the power providers, aggregators and customers.

The system is modeled based on the VTNs (Virtual Top Nodes) transmitting messages and the VENs (Virtual End Nodes) receiving them, where the power provider is a VTN and the customers are VENs. The aggregators act both as the VEN of the power provider and the VTN for each consumer and multiple number of aggregators can be installed continually.

The VTNs and VENs exchange messages via the In-

ternet, and the PULL type (VEN acquires messages from the VTN by polling) and the PUSH type (VTN sends messages to the VEN) communication models are defined as the transmission mechanism. The use of HTTP and XMPP protocols are also defined. The messages are described in the XML and the payload of each service is also defined. The messages are protected with the TLS and the security is specified using the XML signature.

The power provider (VTN) is configured as a DRAS (Demand Response Application Server) that creates DR events according to the DR program and issues them to the aggregators or customers, and the aggregators and customers (VENs) perform processing based on the DR events received from the VTN. The customers (VENs) are usually implemented in an EMS (Energy Management System) such as BEMS (Building Energy Management System).

Table shows the outline of the service function specifications of OpenADR 2.0b. It consists of four service functions. These are EiRegisterParty (registration), EiEvent (DR event), EiReport (DR report) and EiOpt (opt in/opt out).

To deal with a wide range of energy domains, the DR events include [SIMPLE] for the simple level control, [ELECTRICITY_PRICE] for power price notification, [ENERGY_PRICE] for energy price notification, [LOAD_DISPATCH] for direct demand value specification and [LOAD_CONTROL] for direct load control.

Fig. 2 shows the basic sequences and DR event time chart of OpenADR 2.0b. The scope of application of OpenADR 2.0b is DR sending and measuring, and does not cover the contract scheme.

Fig. 3 shows the software function configuration of the DRAS by taking an aggregator applying OpenADR 2.0b as an example. The aggregator's DRAS is composed of the VEN that receives DR events from the power provider (VTN), the VTN that transmits DR events to

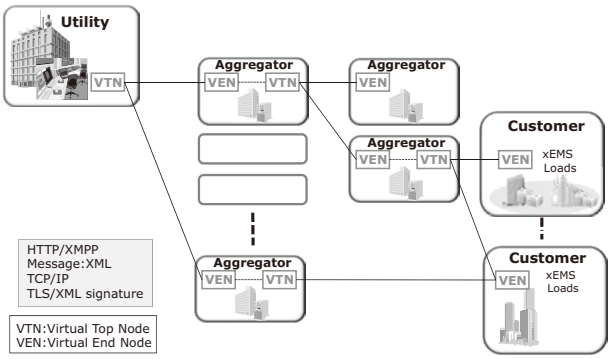


Fig. 1 Information transmission model.

Table Service functions of OpenADR 2.0b.

No.	Service		Description
1	EiRegister Party	Registration	• Registration of new VEN in VTN. • Basic settings for DR information interchange, actual interchange
2	EiEvent	DR event	• DR event notification (VTN→VEN). Definition of price information, load reduction allotment, load control, battery control, etc. • Other: Notification change, cancellation, event expiration period.
3	EiReport	DR report	• Report on momentary and accumulated values of measurements of power consumption, voltage, etc., between VTN and VEN. • Interchange of information on the report capability of each party to enable the above reports.
4	EiOpt	Opt in/ Opt out	Notification from VEN to VTN of DR event opt in/opt out status and planning.

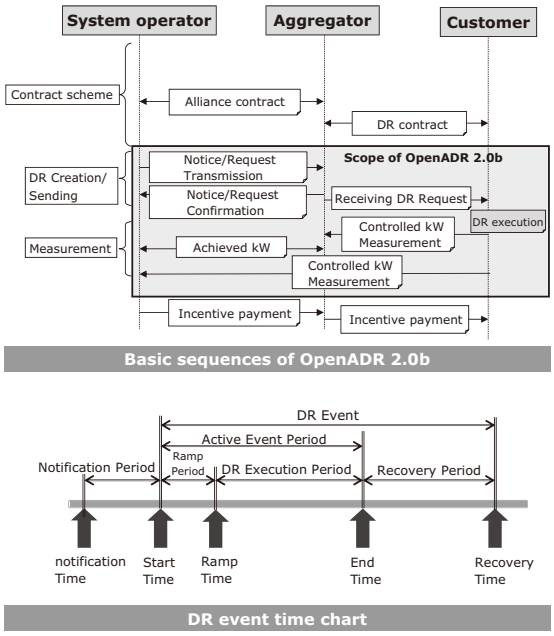


Fig. 2 Sequences of OpenADR 2.0b.

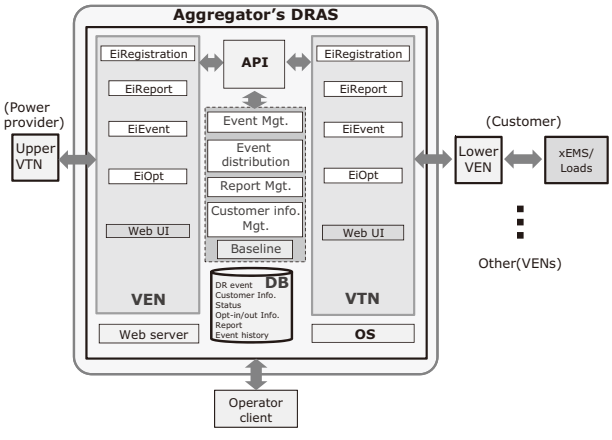


Fig. 3 Function configuration of DRAS software.

the customers, the event management function linked through the API (Application Programming Interface), the applications for event distribution, etc., and the database (DB).

(1) Event management

This function manages the DR events received from the power provider (VTN) and those transmitted to the customers in collaboration with the event distribution function.

(2) Event distribution

According to the contents of a DR event received from the power provider (VTN), this function creates a DR event based on the customer and baseline information and distributes them automatically to the customers (VENs) from the aggregator (VTN). The controlled amounts to be distributed are calculated according to the preset percentages based on the baseline of each customer. The controlled percentages are updated based on past controlled amount achievements and the event acceptance rate of each customer.

(3) Baseline

The baseline refers to the power demand amount estimated assuming that the baseline demand adjustment is not performed. It is the basis for accurate identification of the demand amount resulting from the power adjustment performed by customers according to a DR event. This system determines the baseline according to the past data measured using the averaging technique (High 2 of 10: The data of two days with the highest power consumptions among the latest ten days).

(4) Report management

This function acquires and manages the achievement data (measurements) from customers (VEN), it also transmits the data to the power business (VTN) via the VEN. It additionally checks and analyzes the achievements in order to compile data for use in the auto distribution of DR events.

(5) Customer information management

This function manages the information on the load possessed by each customer and on the baseline and DR event accepted/not-yet accepted status as well as other information.

(6) Web UI

This application handles the user interfaces (UI) of the functions above.

3. Actual Examples of Applications (Use Cases)

This function describes the actual use cases of DR systems and their features.

3.1 Services as a DR Information Send/Receive Infrastructure

Fig. 4 shows the basic configuration of a DR system. It takes the extendibility into consideration because the power provider's DRAS may implement multiple VTNs depending on the scale. The basic DRAS has the VTN(s) and applications including the event management and event distribution (Fig. 3), and linked with the system and functions of the power provided via the API.

This system is intended to provide a service as a DR information send/receive infrastructure using OpenADR 2.0b. It can distribute, transmit and receive DR information between an existing power provider or PPS (Power Producer and Supplier) and customers and perform DR control by means of connections to various EMSs (such as a BEMS) in which VEN is installed or direct connections to the loads and batteries.

The VTN creates a DR event according to the DR program planned by each existing power provider or PPS

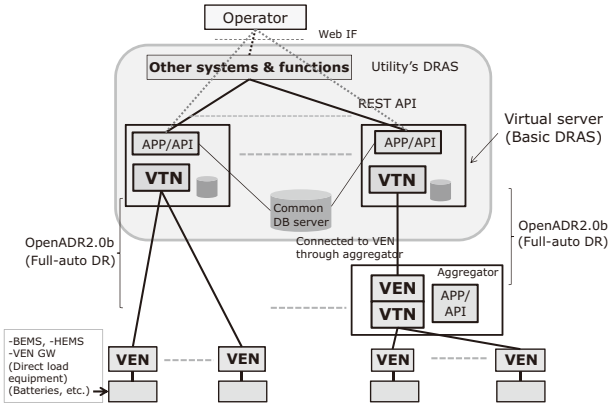
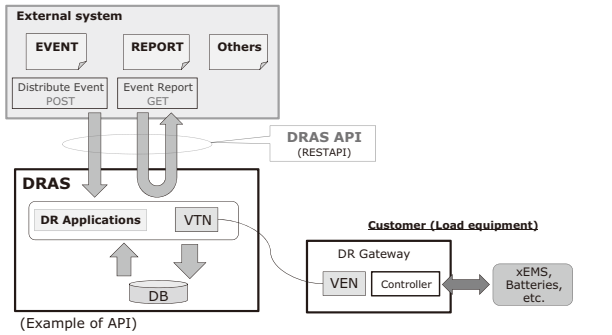


Fig. 4 Basic DR system configuration.



(Example of API)

Function category	Function outline	Acquired information	Service function name	HTTP method
Posting registration	Registration of the event information of DR to be distributed	Possibility of distribution	DistributeEvent	POST
Report acquisition	Acquisition of report on the results of specified DR event	Report information	EventReport	GET

Fig. 5 Outline of API linkage.

and notifies the VENs of the customers of the event.

Fig. 5 shows the linkage with an external system, such as an EMS or a power generation or demand forecasting system. In this example, functions including "POST," which is a DR Event (Distribute Event) function using the HTTP REST, and "GET," which is the Event Report function, are available to facilitate linkages with several external systems.

3.2 Service Solution for DR Aggregator

Fig. 6 shows the configuration of a PPS system.

The system focuses on demand and supply management but also assumes use in power generation and demand forecasting as well as the linkage with DR.

Considering the start of the electricity deregulation in Japan, the PPS should be capable of procuring power of the same amount simultaneously for 30 minutes. In case the 30-minute simultaneous same-amount specification cannot be achieved due to a fault in the power generation or demand forecasting, it is expected that the system should deal with it by means of DR-based power control or power procurement (negawatt power) as one of the power resources. The DR service as a means for reducing the demand and supply management risks is therefore applicable to the PPS system.

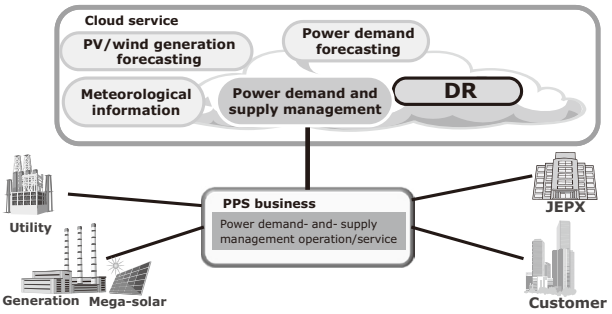


Fig. 6 Configuration of system for PPS.

Fig. 7 Example of a user interface.

Fig. 7 shows an example of a user interface for the DR-based power demand and supply adjustment. (1) receives the DR procurement request from the power demand-and-supply management, and according to the amount requested, summons a DR event to the customers based on the local consumer information and baseline. It also aggregates the DR event acceptance status per time zone and manages the DR control amount. (2) shows the power control values achieved by DR on the target load (building, etc.) to enable understanding of the actual control situation with respect to the baseline.

4. Conclusion

In the above, we introduced OpenADR 2.0b together with actual usage cases of the DR system.

It is expected that OpenADR 2.0b will be updated according to the requirements of the electricity market. At NEC, we aim to continue to support ADR services so that we can contribute to the advancement of businesses in the smart energy domain.

Reference

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