

International Standardization for Next-Generation Energy System

Yutaka Arai,
Yasuyuki Hoshi,
Ken'ichi Ito

Keywords Smart grid, Microgrid, BEMS, CEMS, IEC61850, OpenADR2.0b, Dispersed power source

Abstract

Recently, need for microgrids, smart grids, and such next-generation energy systems has increased, as well as need for inter-connections with various power grid facilities by multiple power retail vendors and their management. This reflects the scale expansion and diversity of distributed energy resources and the introduction of Demand Response (DR). Under such circumstances, the significance of international standardization in relation to communication with next-generation energy systems is increasing. According to the trends analysis of the European CEN-CENELEC-ETSI Smart Grid Coordination Group (SG-CG) and American National Institute of Standards and Technology (NIST) they are positively promoting international standardization. IEC is organizing for international standardization and Japanese Japan Smart Community Alliance (JSCA) is catching up to the global trends. Given above, it is possible to identify current situations of each country and their trends. We have recently begun to integrate various kinds of communication protocols based on the XMPP. The XMPP is being investigated for adoption into the transport layer protocol in multiple international communication standards. So far, we have gained the confidence to be able to realize a common communication platform without relying on applications.

1 Preface

Recently, there has been a growing general interest on microgrids, smart grids, and such next-generation energy systems against the background of a need to improve power supply reliability against an increase of renewable energy resources and Combined Heat and Power (CHP) systems. Next-generation energy systems are required to permit inter-connections with various distributed energy resources by multiple power retail vendors and power grid facilities to achieve optimal management. These next-generation energy systems are also required to provide Demand Response (DR) services to secure the regional power stability. This is required in order to inter-connect power grid system (managing regional stability) with electricity aggregators and manage such grid-connected operations.

Following our technical report already released⁽¹⁾ in Japanese, this paper introduces the follow-up status of international standardization works in relation to next-generation energy systems. We also show our recent related R&D program.

2 Updates on Various Countries

2.1 Updates on Europe

In European countries, standardization is promoted to realize the 20-20-20 Target (20% reduction of CO₂, energy saving by 20%, and 20% generation of renewable energy resources by 2020) by the CEN-CENELEC-ETSI Smart Grid Coordination Group (SG-CG) – a joint group by three organizations: CEN (European Committee for Standardization), CENELEC (European Committee for Electrotechnical Standardization), and ETSI (European Telecommunications Standards Institute).

Requirements for this standardization were organized into specifications called the M/400, where conditions are described for building the European common framework. The SG-CG is composed of four working groups: “First Set of Standards,” “Reference Architecture,” “Sustainable Process,” and “Smart Grid Information Security.” Each working group published the following documents:

(1) Framework Document⁽²⁾

The scope of SG-CG is defined and the result

of activities at each working group is summarized.

(2) Reference Architecture⁽³⁾

The Smart Grid Architecture Model (SGAM) was proposed. Based on this three-dimensionally arranged architecture model, European countries are trying to establish European Standards, review the National Institute of Standards and Technology (NIST) specifications (to be discussed later), and act for reasonable promotion to the standard compiling organization.

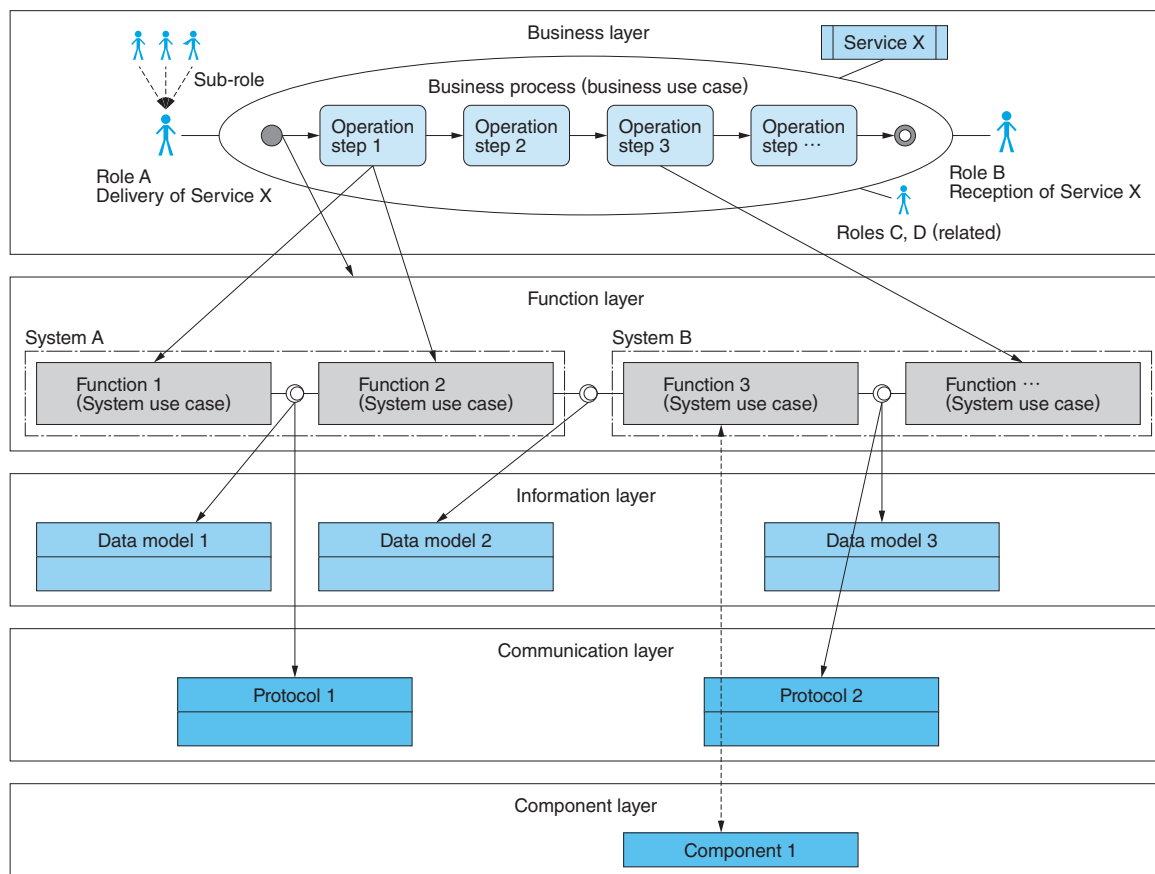
At the same time, there is also a proposal of a method that is mapping on models in the respective layers based on the business use case as shown in Fig. 1. In this manner, the standardization processes and analysis of domain applications are made into rules. This tendency is influencing IEC 62357 (Power systems management and associated information exchange- Reference architecture for object models, services and protocols).

(3) Standardization Processes (Sustainable Processes)⁽⁴⁾

The practical utilization of use cases is described for the standardization of smart grids. Use cases are analyzed to grasp their functions and requirements. This is the basis for the definition of frameworks for smart grids. These processes are classified into the following four items:

- (a) Classification of use cases, gathering, and method of management
- (b) Method of cluster classification for generic use cases obtained based on a concept of gathered use cases
- (c) Use case management tools
- (d) Case study of conceptual models

In particular, generic use cases are important at the time of standardization. The concepts of “Flexibility (power regulation capability)” and “Traffic Light Concept (multi-stage power regulator control



Note: It was drafted based on “SGAM User Manual - Applying, testing & refining the Smart Grid Architecture Model (SGAM) Version 2.0’ (CEN-CENELEC-ETSI Smart Grid Coordination Group).”

Fig. 1 Extraction of Functional and Non-Functional Requirements from Use Case

Based on three-dimensionally arranged architecture models called the SGAM, European countries are promoting rational activities for the establishment of European standard specifications, reviewing the NIST specifications (to be discussed later), and lobbying to standard drafting organizations. Here, a mapping method from a business use case to each layer models is proposed. They regulate on the standardization processes and analytical method for domains and applications. Such progress is influencing IEC 62357 (International Standardization for Standard Smart Grid Architectures).

model)” were introduced for a case study of conceptual models. These concepts were discussed at many standards-related meetings, as the influence is increasing.

(4) First Set of Standards⁽⁵⁾

The definition of SGAM diagrams and SGAM mapping into existing standards are described. The standard mapping can be used as a tool when we examine the applicability of a standard based on an application use case. This list is very convenient.

(5) Information Security

A security guidance is offered and by showing the trend of security for the related persons, it intends to promote the development of smart grids smoothly.

2.2 Updates on the U.S.

The U.S. plays a central role in activities for smart grid standardization. In November 2009, the NIST established the Smart Grid Interoperability Panel (SGIP) and started activities to secure interoperability for smart grids. The SGIP assigned important items regarding smart grids into subworking groups called the Priority Action Plan (PAP) and each group takes actions for standardization according to the roadmap.

A great achievement is the NIST framework. The past three editions of the NIST framework were issued with features as described below.

(1) First edition (Released in January 2010)⁽⁶⁾

- (a) Introduction of high-level conceptual reference models
- (b) Identification of 75 existing standard specifications as the standards relating to smart grids
- (c) Selection of 15 items that need fast solution and formulation of 15 PAPs

(2) Second edition (Released in February 2012)⁽⁷⁾

- (a) Extension of high-level conceptual reference models
- (b) Establishment of SGIP
- (c) Framework formulation guideline for security, testing, and authentication

(3) Third edition (Released in September 2014)⁽⁸⁾

- (a) Conceptual model updating (European SGAM and IEC 62357 were introduced and intermixed models were proposed.)
- (b) Guideline for security, testing, and authentication framework (NISTIR 7628) and standardization
- (c) Positive introduction of microgrid concept effective for recovery from disaster.
- (d) Registration of 59 existing standard speci-

cations as the standard catalogs

(e) 25 PAPs (13 PAPs were already completed.)

(f) Revised standards (OpenADR2.0, SEP2, IEEE1547, NAESB REQ18, UL1741)

The OpenADR is the standardization result⁽⁹⁾ by OpenADR Alliance that is a US-based private organization. It drafted technical specifications on DR and promoted the standardization. The DR means that “when power retail price is high or system reliability is low, the power consumption pattern is controlled to suppress the use of retail power on energy consumer side in response to the retail power price setting or incentive payment scheme.”⁽¹⁰⁾

It is considered that working group work for IEC/TC57 and IEC/PC118 of IEC commenced its coordination work between OpenADR2.0b, IEC power system information model-Common Information Model (CIM) and standard communication protocol of power monitor and control system IEC61850. It seems the movements towards international standardization on DR will become active.

2.3 Updates on IEC

The SG3 is a smart grid strategic group of the International Standard Management Board (SMB). 16 nations are participating. There are 28 technical committees as a subcommittee which are working on more than hundred standards. At the SG3, the smart grid is separately defined in eleven fields. Especially important fields are defined as distribution power systems control, smart home, commercial facilities, industrial facilities, energy consumer side energy management, and power delivery (e-Mobility). A mapping chart was drafted to indicate the related standards of the above eleven fields and has been released to the website.

Meanwhile, the “TC13 Electrical energy measurement and control” now in progress is: the standardization of data transmission from power meters (IEC62056 “DLMS/COSEM” etc.), the standardization of interfaces for watthour data and management systems integrated by the “TC57 Power System Management and associated Information Exchange,” the standardization of interfaces for power systems and energy user systems, and the standardization of information models.

In autumn 2011, the “PC118 Smart Grid User Interface” was established and the standardization activities started to realize DR standardization (OpenADR becoming a IEC standard).

Among such active programs transactions, the

TC57/WG17 attracted particularly high attention. They are working on applying IEC61850, which is a communication standard developed especially for monitor and control of substations of power systems, in order to expand to smart grids. They are working on the development of mapping to the transport layer XMPP (eXtensible Messaging and Presence Protocol) to extend information models to the power user's energy resources (EVs, storage batteries, CHP, renewable energy) or microgrids, and to realize almost real-time standard communication with energy customers over the Internet.

2.4 Updates on Japan

In Japan, a concept of "Smart Community" is featured. In addition to the effective use of electric power, it aims to realize a next-generation energy and social system in a community level. It is a complex combination among a "wide area use" of energy resources like heat and resource recovery, as well as regional traffic system and changes of citizen's lifestyle for energy use. In January 2010, the Ministry of Economy, Trade and Industry (METI) announced "Japan's Roadmap for Going International Standards" and "26 Important Items to be Standardized." In April 2010, the Japan Smart Community Alliance (JSCA) was established. At that time, important items were reviewed for positioning in each field. In December 2012, these important items were changed to 20 items.

Still more, after the occurrence of the Great East Japan Earthquake in 2011, DR received high attention as a tight measure situation of power supply in Japan, and the JSCA began to carry out verification tests in various places such as verification projects in 4 regions. In order to promote the spread of DR, the development of a standard communication interface is imperative. In June 2012, METI launched the Next-Generation DR Technology Standardization Study Group as a sub-organization of the JSCA Smart House and Building Standardization Project Promotion Committee. The Group began studying and in September 2012, the adoption of the OpenADR2.0 was recommended as a standard for DR communications in Japan. Consequently, METI started up the DR Task Force and drafted the communication interface to be used among the power systems, energy aggregators, and energy consumers based on the OpenADR⁽¹¹⁾.

For the Yokohama Smart City Project (YSCP), one of the demonstration projects in 4 regions, we

joined the OpenADR verification testing program and are in co-operation with the project members.

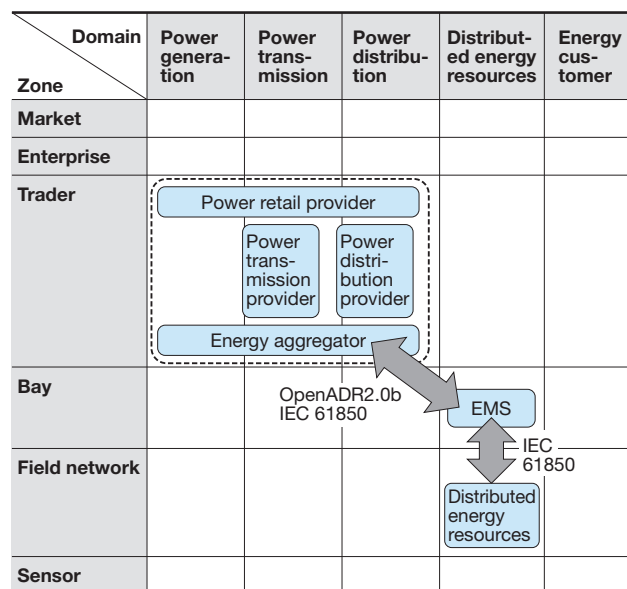
3 Our Programs

For microgrids or smart grids, the communications among power systems, energy aggregators, and energy consumers are vital. As stated above international communication standards are published for each difference in communication purpose and functions. These are not intended for communication of applications with multiple purposes and functions. In order to solve such an issue, we are working to build a common communication platform that is based on the XMPP and independent of any applications with different purposes and functions.

In regard to recent XMPP, these are increasing numbers of applications to apply XMPP to the transport layer in many communication standards in order to realize Internet communication in nearly real-time mode. The OpenADR2.0b and IEC61850-8-2 (Draft) are such cases. These two protocols are for a hierarchical control system [example: Power System Operator (PSO), energy aggregator, EMS, DER that requires a device with two protocols to realize communication between DR application and power monitor and control application of EMS (Table 1). For the OpenADR2.0b and IEC61850, the

Table 1 Communication Layer Model where Two Standard Protocols are Installed in a Single Device

Protocols of OpenADR2.0b and IEC61850-8-2 (Draft) are for hierarchical control systems (example: PSO, aggregator, EMS, DER) and devices having two protocols are needed to realize the communication among DR, application, and EMS.



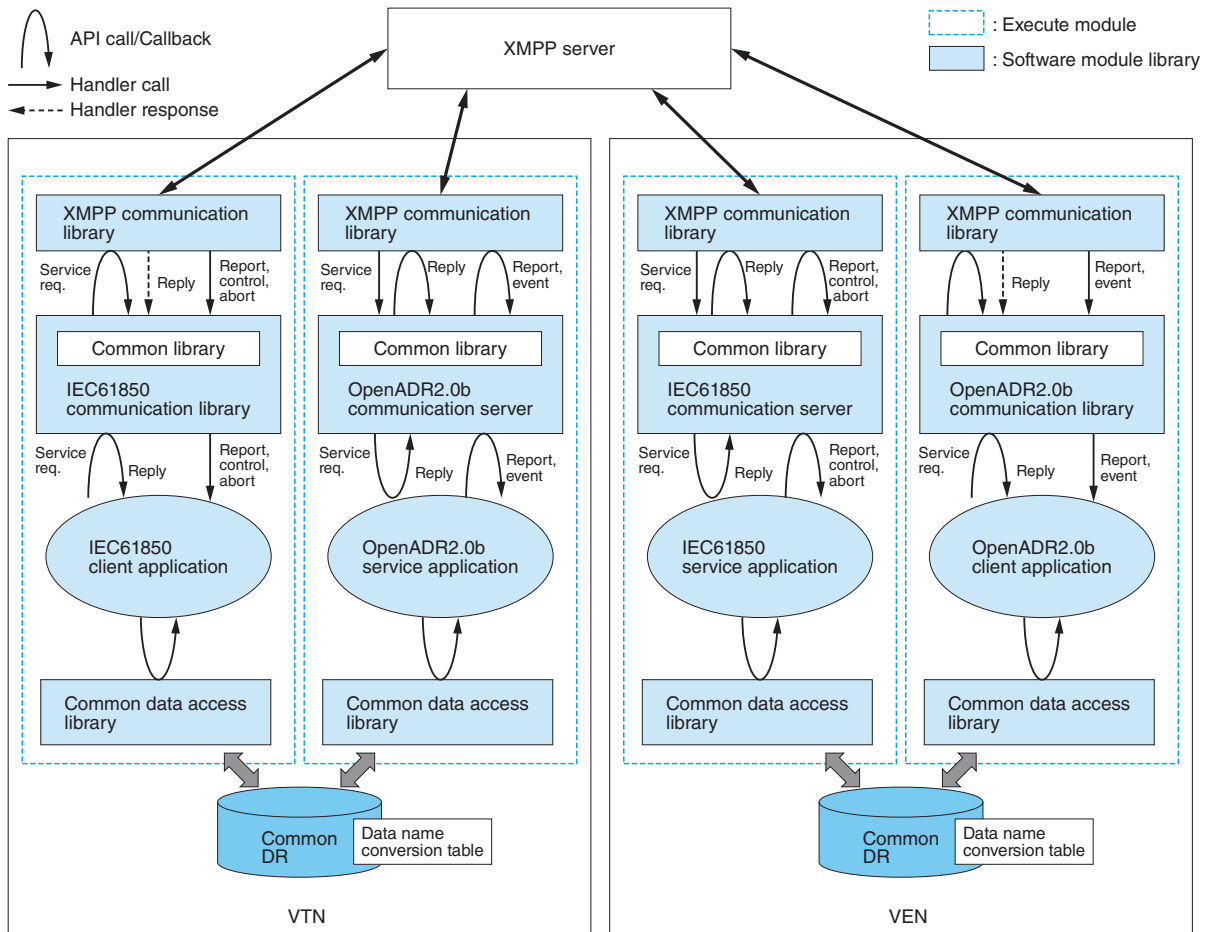


Fig. 2 Common Library, Information Model, and Data Mapping

An example of communication services and information models is shown for applications where communication protocols of OpenADR2.0b and IEC61850 independently installed.

position of the client and server to the upper and lower layers is reversed and therefore, installation of two protocols into the same device is difficult.

As such, we analyzed the behavior of applications installed separately and rearranged the common factors in terms of two protocols, Application Programming Interface (API), and information model (Fig. 2).

As a result, we made the common modules and confirmed the high level of feasibility that we might realize a common platform without relying on an application’s client and server. When application layer services of two communication protocols are properly mapped into common services and a converting table is made available to absorb the difference in information models, it is possible to produce a system without worrying about the said differences for the application programs that use the application layer services of two communication protocols (Fig. 3).

This method will be similarly applicable to IEC

62056 (smart meter) expanding its application range (with due consideration of XMPP), Modbus (instrumentation communication), and DNP3 (IEEE1815.1). In the case of XMPP communication, authentication and stream encryption are indispensable for each application to be used because Joint ID (JID) must be determined in a domain unit. In this manner, the possibility of end-to-end security can be expected. We believe that our approach proposed here is an effective way to harmonize multiple communication protocols in the future.

4 Postscript

There is a recent growing necessity for next-generation energy systems such as microgrids or smart grids. In such systems, standardized ICT technologies help interoperation among products and systems despite there being many kinds of related international communication standards that are in the draft stage. They were organized by clas-

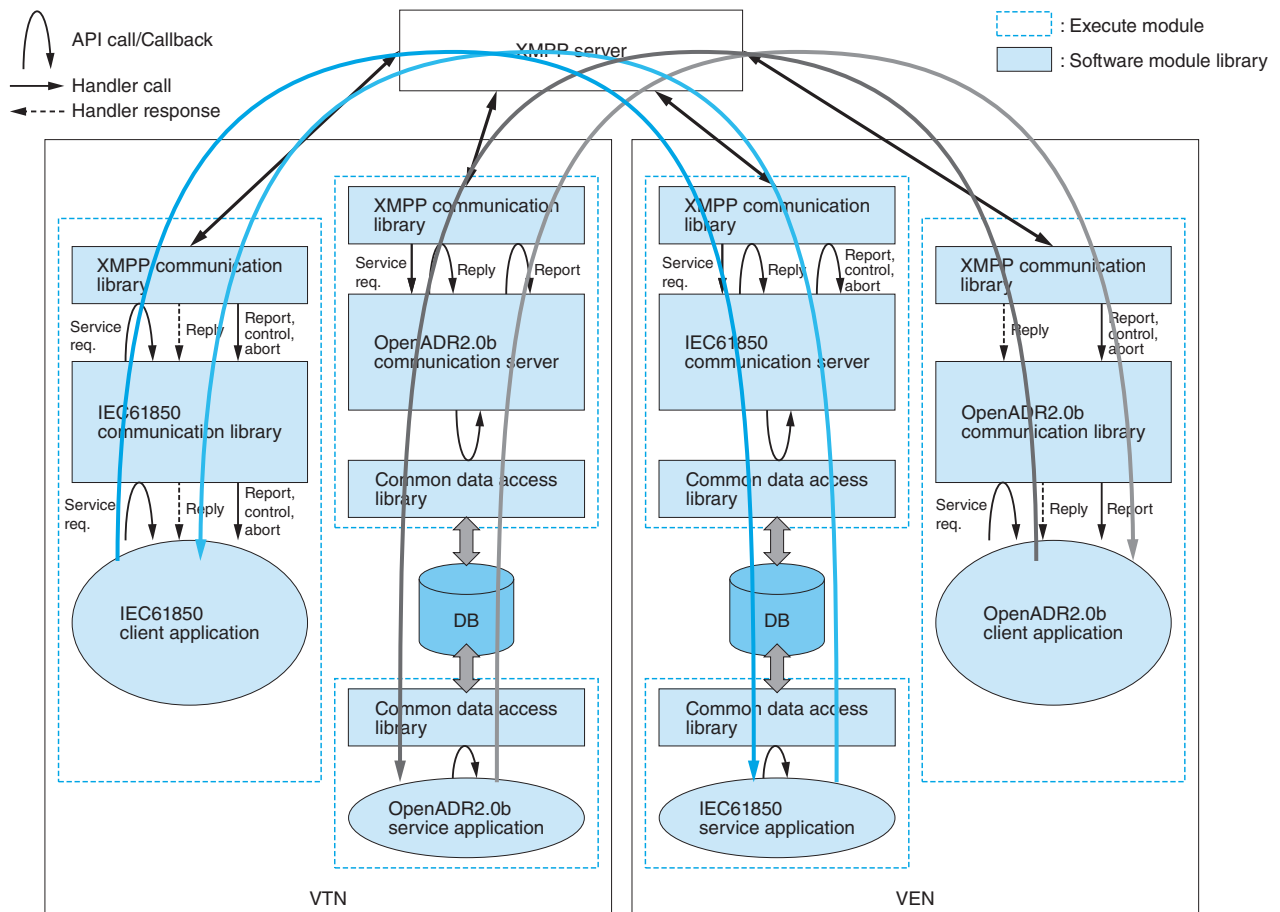


Fig. 3 Installation of Two Standard Protocols in the EMS Using a Common Module

For the OpenADR2.0b and IEC61850, the position of the client and server to the upper and lower layers is reversed and installation into the same device is very difficult. We analyzed the behavior of the applications installed separately and rearranged the common factors among two protocols, API, and an information model.

sification and integration in the drafting work for frameworks and guidelines in western countries. Their guiding policy directions are presently being formulated. Given such information, we have to make an appropriate decision. We are working with standardization reviewing organizations and are asked them to make reasonable choices and amendments. At the same time, we need to develop new systems and equipment. Going forward, we will continue to present our case for optimal standards at home and abroad which will meet the power needs in Japan and its traditional customs in electricity business in Japan while also advancing system development and information gathering.

• All product and company names mentioned in this paper are the trademarks and/or service marks of their respective owners.

《References》

- (1) Yoshimichi Okuno, Yutaka Arai, and Ken'ichi Ito: "International Standardization Relating to Next-Generation Energy Systems," Meiden Jiho No.339, 2013/No.2, pp.20-26 (in Japanese)
- (2) CEN-CENELEC-ETSI Smart Grid Coordination Group – Framework Document, November, 2012
- (3) CEN-CENELEC-ETSI Smart Grid Coordination Group – Smart Grid Reference Architecture, November, 2012
- (4) CEN-CENELEC-ETSI Smart Grid Coordination Group – Sustainable Processes, November, 2012
- (5) CEN-CENELEC-ETSI Smart Grid Coordination Group – First Set of Standards, November, 2012
- (6) NIST Framework and Roadmap for Smart Grid Interoperability Standards, Release 2.0, January, 2010
- (7) NIST Framework and Roadmap for Smart Grid Interoperability Standards, Release 1.0, February, 2012
- (8) NIST Framework and Roadmap for Smart Grid Interoperability Standards, Release 3.0, September, 2014
- (9) OpenADR 2.0 Profile Specification B Profile, September, 2013
- (10) Assessment of Demand Response & Advanced Metering, Federal Energy Regulatory Commission, 2014
- (11) Specifications for DR and Interfaces, Edition 10 (in Japanese)