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INTERNATIONAL STANDARD

colour inside

Systems interface between customer energy management system and the power management system –
Part 10-1: Open automated demand response

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SYSTEMS INTERFACE BETWEEN CUSTOMER ENERGY MANAGEMENT SYSTEM AND THE POWER MANAGEMENT SYSTEM –

Part 10-1: Open automated demand response

FOREWORD

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International Standard IEC 62746-10-1 has been prepared by IEC project committee 118: Smart grid user interface.

The text of this International Standard is based on the following documents:

CDV	Report on voting
118/91/CDV	118/96B/RVC

Full information on the voting for the approval of this International Standard can be found in the report on voting indicated in the above table.

This document has been drafted in accordance with the ISO/IEC Directives, Part 2.

A list of all parts in the IEC 62746 series, published under the general title *Systems interface between customer energy management system and the power management system*, can be found on the IEC website.

The committee has decided that the contents of this document will remain unchanged until the stability date indicated on the IEC website under "http://webstore.iec.ch" in the data related to the specific document. At this date, the document will be

- reconfirmed,
- withdrawn,
- replaced by a revised edition, or
- amended.

A bilingual version of this publication may be issued at a later date.

IMPORTANT – The 'colour inside' logo on the cover page of this publication indicates that it contains colours which are considered to be useful for the correct understanding of its contents. Users should therefore print this document using a colour printer.

INTRODUCTION

Development of the demand response (DR) market has resulted in a transition from manual DR to OpenADR (this document) in automated DR programs. DR is defined as an action taken to reduce electricity demand in response to price, monetary incentives, or utility directives so as to maintain reliable electric service or avoid high electricity prices. This document was developed to support common auto-DR programs and energy policy objectives to move toward dynamic markets to improve the economics and reliability of the electricity grid. The recent developments have expanded the use of this document to meet diverse market needs, such as ancillary services, dynamic prices, intermittent renewable resources, supplement grid-scale storage, electric vehicles, and load as generation. For example, with real-time price information, an automated client within the customer facility can be designed to continuously monitor these prices and translate this information into continuous automated control and response strategies.

This document's communication has the following defining features:

- Continuous, secure, and reliable – Provides continuous, secure, and reliable two-way communications where the endpoints at the end-use site receive and acknowledge the receipt of DR signals from the energy service providers.
- Translation – Translates DR event information to internet signals to facilitate DR automation. These signals are designed to interoperate with energy management and control systems, lighting, or other end-use controls.
- Automation – Receipt of the external signal is designed to initiate automation through the use of pre-programmed demand response strategies determined and controlled by the end-use participant.

- Opt-out – Provides opt-out or override function to any participants for a DR event if the event comes at a time when changes in end-use services are not desirable.
- Complete data model – Describes a rich data model and architecture to communicate price, reliability, and other DR activation signals.
- Scalable architecture – Provides scalable communications architecture to different forms of DR programs, end-use buildings, and dynamic pricing.
- Open standards – Open standards-based technology such as internet protocol (IP) and web services form the basis of the communications model.

This document is a communications data model, along with transport and security mechanisms, which facilitate information exchange between two end-points: the electricity service provider or DR program operator, and a customer-side resource. It is not a protocol that specifies "bit-structures" as some communications protocols do, but instead relies upon existing open standards such as Extensible Markup Language (XML) and internet protocol (IP) as the framework for exchanging DR signals. In some references, the term "system," "technology," or "service" is used to refer to the features of this document.

IEC 62746-10-1 is designed to facilitate automation of DR actions at the customer location, whether it involves electric load decreases, load increases, or load shifting for various demand response markets. Many emergency or reliability DR events occur at specific times when the electricity grid is strained. The communications are designed to coordinate such signals with facility control systems (commercial, industrial, and residential). This document is also designed to provide continuous dynamic price signals, such as hourly, day-ahead, or day-of real-time pricing. With such price information, an automated client can be configured to continuously monitor these prices and translate this information into continuous automated control and response within a facility. Several reports present the history of this document and the involved research. This document covers the signalling data models for price and reliability signals to both wholesale and retail markets, and can act as a complementary standard to a CIM-based grid control system.

This document provides the following benefits:

- Open specification – Provides a standardized DR communications and signalling infrastructure using open, non-proprietary, industry-approved data models that can be implemented for both dynamic prices and DR emergency or reliability events.
- Flexibility – Provides open communications interfaces and protocols that are flexible, platform-independent, interoperable, and transparent to end-to-end technologies and software systems.
- Innovation and interoperability – Encourages open innovation and interoperability, and allows controls and communications within a facility or enterprise to build on existing strategies to reduce technology operation and maintenance costs, stranded assets, and obsolescence in technology.
- Ease of integration – Facilitates integration of common energy management and control systems (EMCS), centralised lighting, and other end-use devices that can receive internet signals (such as XML).
- Supports a wide range of information complexity – Can express the information in the DR signals in a variety of ways to allow for systems ranging from simple end devices (e.g. thermostats) to sophisticated intermediaries (e.g. aggregators) to receive the DR information that is best suited for its operations.

This document's purpose is to manage the growing demand for demand-side flexibility – the ability to modify the load profile of the consumers over time. This low-cost communications infrastructure is used to improve the reliability, repeatability, robustness, and cost-effectiveness of DR.

This technology has been field tested for over a decade and deployed in a number of DR programs worldwide. While the scope of this document focuses on signals for DR events and prices, significant supporting research work has been done to study DR strategies and techniques to automate DR within facilities. This document interacts with facility control systems that are pre-programmed to take action based on a DR signal, enabling a response to a DR event or a price to be fully automated, with no manual intervention.

SYSTEMS INTERFACE BETWEEN CUSTOMER ENERGY MANAGEMENT SYSTEM AND THE POWER MANAGEMENT SYSTEM –

Part 10-1: Open automated demand response

1 Scope

This part of IEC 62746-10, OpenADR 2.0 (this document), specifies a minimal data model and services for demand response (DR), pricing, and distributed energy resource (DER) communications. This document can be leveraged to manage customer energy resources, including load, generation, and storage, via signals provided by grid and/or market operators. These resources can be identified and managed as individual resources with specific capabilities, or as virtual resources with an aggregated set of capabilities.

This document specifies how to implement a two-way signaling system to facilitate information exchange between electricity service providers, aggregators, and end users. The DR signalling system is described in terms of servers (virtual top nodes or VTNs), which publish information to automated clients (virtual end nodes, or VENs), which in turn subscribe to the information.

This document provides application-level service communication that can be used to incentivise a response from a customer-owned DER. Price and DR signals over the internet allow indirect control of customer-owned devices that otherwise would not be available.

This document's services are independent of transport mechanisms. For the purposes of interoperability, this document provides basic transport mechanisms and their relevant interaction patterns to address different stakeholder needs. In addition, this document specifies cyber security mechanisms required for data confidentiality, integrity, authentication and message-level security, in order to provide non-repudiation and mitigation of cyber security risks.

The services make no assumption of specific DR electric load control strategies that can be used within a DR resource or of any market-specific contractual or business agreements between electricity service providers and their customers.

This document provides a clear set of mandatory and optional attributes within each of the services to meet broader interoperability, testing and certification requirements. All necessary XML schema are included in Annex E.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO 8601, *Data elements and interchange formats – Information interchange – Representation of dates and times*

INTERNET ENGINEERING TASK FORCE (IETF). RFC 2616: *Hypertext Transfer Protocol – HTTP/1.1* [online]. Edited by R. Fielding et al. June 1999 [viewed 2018-08-02]. available at: http://www.ietf.org/rfc/rfc2616.txt

INTERNET ENGINEERING TASK FORCE (IETF). RFC 3986: *Uniform Resource Identifier (URI): Generic Syntax* [online]. Edited by T. Berners-Lee et al. January 2005 [viewed 2018-08-02]. available at:
http://www.ietf.org/rfc/rfc3986.txt

INTERNET ENGINEERING TASK FORCE (IETF). RFC 5246: The Transport Layer Security (TLS) Protocol Version 1.2 [online]. Edited by T. Dierks et al. August 2008 [viewed 2018-08-02]. available at
https://tools.ietf.org/html/rfc5246

INTERNET ENGINEERING TASK FORCE (IETF). RFC 6120: *Extensible Messaging and Presence Protocol (XMPP): Core* [online]. Edited by P. Saint-Andre. March 2011 [viewed 2018-08-02]. available at:
http://www.ietf.org/rfc/rfc6120.txt

INTERNET ENGINEERING TASK FORCE (IETF). RFC 6121: *Extensible Messaging and Presence Protocol (XMPP): Instant Messaging and Presence* [online]. Edited by P. Saint-Andre. March 2011 [viewed 2018-08-02]. available at:
http://www.ietf.org/rfc/rfc6121.txt

XMPP Standards Foundation. *XEP-0030: Service Discovery* [online]. Edited by J. Hildebrand et al. October 2017 [viewed 2018-08-02]. available at:
http://xmpp.org/extensions/xep-0030.html

3 Terms, definitions and abbreviated terms

3.1 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

- IEC Electropedia: available at http://www.electropedia.org/
- ISO Online browsing platform: available at http://www.iso.org/obp

3.1.1
OpenADR 2.0
specification that provides the basis for this document

3.1.2
PUSH and PULL operations
mode of operation by which this document can be used in either PULL mode (VEN pulling information from VTN) or in a PUSH mode (VTN pushing information to the VEN)

Note 1 to entry: The XMPP transport uses a PUSH model, although VENs can still make requests of the VTN, excluding the use of oadrPoll.

3.1.3
simple HTTP
HTTP implementation that uses HTTP POST over TLS to propagate payloads

3.1.4
virtual end node
VEN
technical role assumed by an actor where the actor is a consumer and/or producer of messages that are defined by this document

Note 1 to entry: A virtual end node (VEN) can be associated with zero or more resources. A VEN can receive messages pushed from a VTN or send requests or events to a VTN. A VEN may communicate with multiple VTNs, where each VTN is part of a different communication domain.

[SOURCE: IEC TS 62746-3:2015, 3.1.15, modified – Note 2 to entry has been omitted.]

3.1.5
virtual top node
VTN
technical role assumed by an actor that is assuming responsibility for the coordination of VENs within a communication domain

Note 1 to entry: This is a special case of a VEN, where a virtual top node (VTN) is effectively a parent of many VENs with the responsibility for coordination of those VENs. A VTN is responsible for pushing to or receiving messages from many VENs. A market operator, grid operator or aggregator are examples of actors which will typically implement a VTN interface.

[SOURCE: IEC TS 62746-3:2015, 3.1.17, modified – Note 2 to entry has been omitted.]

3.1.6
resource
demand-side commodity that is associated with a load profile

3.1.7
party
entity that enters into some sort of business relationship or contract

Note 1 to entry: A more detailed definition can be found in Annex D.

3.1.8
RSA
public-key crypto system placed into the public domain by RSA Data Security, Inc.

3.2 Abbreviated terms

CA	certificate authority
DER	distributed energy resources
DR	Demand Response
ECC	elliptic curve cryptography
EI	energy interoperation
HTTP	Hypertext Transfer Protocol
ISO	independent systems operator
JID	jabber identifier
OpenADR	Open Automated Demand Response
PICS	protocol implementation conformance statement
PKI	public key infrastructure
SASL	Simple Authentication and Security Layer
SOAP	Simple Object Access Protocol
TLS	Transport Layer Security
UCAIug	Utilities Communications Architecture International Users Group
VEN	virtual end node
VTN	virtual top node
XML	Extensible Markup Language
XMPP	XML Messaging and Presence Protocol

4 Overview

4.1 General

Clause 4 gives an overview of the message exchanges, the roles, and actors supported within this document. It contains the following elements that are used to develop test and certification frameworks for smart grid and customer system interoperability:

a) a set of data models that describe information communicated in message payloads;

b) a set of services for performing various functions and operations for the exchange of the data models;

c) a set of transport mechanisms for implementing the services. The transport mechanisms rely upon standard-based IP communications, such as HTTP and XML messaging and presence protocol (XMPP);

d) a set of security mechanisms for securing each of the transport mechanisms;

e) a set of XML schemas (see Annex E).

Integration of IEC 62746-10-1 systems within the IEC's standards framework is done with a CIM adapter that may be produced in accordance with the methodology described in IEC 62746-10-3. Message exchanges in this document support services for communicating information about demand response events. Networks of nodes shall be able to query for active or pending events, register themselves, schedule events, and send reports. The nodes shall also be able to refine and update previously sent information. For instance, a node reporting DR events to nodes downstream shall be able to cancel a previously scheduled event if this becomes necessary.

Nodes in these networks are divided into two groups: nodes that publish and transmit information about events to other nodes (e.g. utilities), and nodes that receive the communications and then respond to that information (e.g. end users). The upstream nodes that publish information about upcoming events are called virtual top nodes (VTNs); the downstream nodes that receive this information are called virtual end nodes (VENs).

These nodes may communicate using a variety of protocols. They may communicate using HTTP in either PUSH mode (where the VTN initiates communication) or in a PULL mode (the VEN requests information from the VTN to begin a series of message exchanges). The VTNs/VENs may also communicate over other transport mechanisms, such as XML messaging and presence protocol (XMPP).

This document supports end devices with a varying degree of capabilities. However, for interoperability, all protocol capabilities are mandatory.

IEC 62746-10-1 specifies the following services:

1) Register: Registration identifies entities in advance of interactions with other parties in various roles such as VEN and VTN.

2) Event: The core DR event functions and information models for price-responsive DR. This service is used to call for performance under a transaction. The service parameters and event information distinguish different types of events: reliability events, emergency events, price events, regulation events and possibly other types in the future.

3) Report: The report service enables feedback to the server in order to provide periodic or one-time information on the state of a resource.

4) Opt: Overrides the EiAvail and addresses short-term changes in availability to create and communicate opt-in and opt-out schedules from the VEN to the VTN.

Table 1 outlines the mandatory and optional implementation of this document.

Table 1 – IEC 62746-10-1 services support

	VTN	VEN	
		Full	(Energy Reporting only)
Services and Functions Support			
EiEvent			
Full Profile	M	M	NA
EiOpt			
Full Profile	M	M	NA
EiReport			
Full Profile	M	M*	M*
EiRegisterParty			
Full Profile	M	M	M
Transport Protocols			
Simple HTTP	M	O-1	O-1
XMPP	M	O-1	O-1
Security Levels			
Standard	M	M	M
High	O	O	O

M Mandatory
O Optional
O-1 Optional, but at least one option shall be supported
NA Not available
* Optional features available

4.2 Node and device types

For any interaction between actors using this document to communicate, one actor is designated the virtual top node and the remainder are the virtual end nodes. All communications are between a VTN and one or more VENs. There is no peer-to-peer communication in this document, i.e. VTNs do not communicate directly with other VTNs, and, likewise, VENs do not communicate directly with other VENs.

The VTN generally acts as the server, providing information to the VEN, which responds to the information. For instance, a VTN would be the entity to announce a DR event; then, VENs hear about DR events and respond. The response can be to reduce power to some devices. The response could also be to propagate the signal further downstream to other VENs. In this case, the VEN would become the VTN for the new interaction (e.g. the aggregator in Figure 1).

For the purpose of device development, the manufacturer should always test the interface between a VTN and a VEN, where either node can be the device under test. Intelligence built into the systems not related to the message exchange is not part of this document.