

INTERNATIONAL STANDARD

NORME INTERNATIONALE



**Systems interface between customer energy management system and the power management system –
Part 10-3: Open automated demand response – Adapting smart grid user interfaces to the IEC common information model**

**Interface entre le système de gestion de l'énergie côté client et le système de gestion de puissance –
Partie 10-3: Réponse à la demande automatisée ouverte – Adaptation des interfaces utilisateur de réseau intelligent au modèle d'information commun de l'IEC**



THIS PUBLICATION IS COPYRIGHT PROTECTED

Copyright © 2018 IEC, Geneva, Switzerland

All rights reserved. Unless otherwise specified, no part of this publication may be reproduced or utilized in any form or by any means, electronic or mechanical, including photocopying and microfilm, without permission in writing from either IEC or IEC's member National Committee in the country of the requester. If you have any questions about IEC copyright or have an enquiry about obtaining additional rights to this publication, please contact the address below or your local IEC member National Committee for further information.

Droits de reproduction réservés. Sauf indication contraire, aucune partie de cette publication ne peut être reproduite ni utilisée sous quelque forme que ce soit et par aucun procédé, électronique ou mécanique, y compris la photocopie et les microfilms, sans l'accord écrit de l'IEC ou du Comité national de l'IEC du pays du demandeur. Si vous avez des questions sur le copyright de l'IEC ou si vous désirez obtenir des droits supplémentaires sur cette publication, utilisez les coordonnées ci-après ou contactez le Comité national de l'IEC de votre pays de résidence.

IEC Central Office
3, rue de Varembe
CH-1211 Geneva 20
Switzerland

Tel.: +41 22 919 02 11
info@iec.ch
www.iec.ch

About the IEC

The International Electrotechnical Commission (IEC) is the leading global organization that prepares and publishes International Standards for all electrical, electronic and related technologies.

About IEC publications

The technical content of IEC publications is kept under constant review by the IEC. Please make sure that you have the latest edition, a corrigenda or an amendment might have been published.

IEC Catalogue - webstore.iec.ch/catalogue

The stand-alone application for consulting the entire bibliographical information on IEC International Standards, Technical Specifications, Technical Reports and other documents. Available for PC, Mac OS, Android Tablets and iPad.

IEC publications search - webstore.iec.ch/advsearchform

The advanced search enables to find IEC publications by a variety of criteria (reference number, text, technical committee,...). It also gives information on projects, replaced and withdrawn publications.

IEC Just Published - webstore.iec.ch/justpublished

Stay up to date on all new IEC publications. Just Published details all new publications released. Available online and also once a month by email.

Electropedia - www.electropedia.org

The world's leading online dictionary of electronic and electrical terms containing 21 000 terms and definitions in English and French, with equivalent terms in 16 additional languages. Also known as the International Electrotechnical Vocabulary (IEV) online.

IEC Glossary - std.iec.ch/glossary

67 000 electrotechnical terminology entries in English and French extracted from the Terms and Definitions clause of IEC publications issued since 2002. Some entries have been collected from earlier publications of IEC TC 37, 77, 86 and CISPR.

IEC Customer Service Centre - webstore.iec.ch/csc

If you wish to give us your feedback on this publication or need further assistance, please contact the Customer Service Centre: sales@iec.ch.

A propos de l'IEC

La Commission Electrotechnique Internationale (IEC) est la première organisation mondiale qui élabore et publie des Normes internationales pour tout ce qui a trait à l'électricité, à l'électronique et aux technologies apparentées.

A propos des publications IEC

Le contenu technique des publications IEC est constamment revu. Veuillez vous assurer que vous possédez l'édition la plus récente, un corrigendum ou amendement peut avoir été publié.

Catalogue IEC - webstore.iec.ch/catalogue

Application autonome pour consulter tous les renseignements bibliographiques sur les Normes internationales, Spécifications techniques, Rapports techniques et autres documents de l'IEC. Disponible pour PC, Mac OS, tablettes Android et iPad.

Recherche de publications IEC - webstore.iec.ch/advsearchform

La recherche avancée permet de trouver des publications IEC en utilisant différents critères (numéro de référence, texte, comité d'études,...). Elle donne aussi des informations sur les projets et les publications remplacées ou retirées.

IEC Just Published - webstore.iec.ch/justpublished

Restez informé sur les nouvelles publications IEC. Just Published détaille les nouvelles publications parues. Disponible en ligne et aussi une fois par mois par email.

Electropedia - www.electropedia.org

Le premier dictionnaire en ligne de termes électroniques et électriques. Il contient 21 000 termes et définitions en anglais et en français, ainsi que les termes équivalents dans 16 langues additionnelles. Egalement appelé Vocabulaire Electrotechnique International (IEV) en ligne.

Glossaire IEC - std.iec.ch/glossary

67 000 entrées terminologiques électrotechniques, en anglais et en français, extraites des articles Termes et Définitions des publications IEC parues depuis 2002. Plus certaines entrées antérieures extraites des publications des CE 37, 77, 86 et CISPR de l'IEC.

Service Clients - webstore.iec.ch/csc

Si vous désirez nous donner des commentaires sur cette publication ou si vous avez des questions contactez-nous: sales@iec.ch.

INTERNATIONAL STANDARD

NORME INTERNATIONALE



**Systems interface between customer energy management system and the power management system –
Part 10-3: Open automated demand response – Adapting smart grid user interfaces to the IEC common information model**

**Interface entre le système de gestion de l'énergie côté client et le système de gestion de puissance –
Partie 10-3: Réponse à la demande automatisée ouverte – Adaptation des interfaces utilisateur de réseau intelligent au modèle d'information commun de l'IEC**

INTERNATIONAL
ELECTROTECHNICAL
COMMISSION

COMMISSION
ELECTROTECHNIQUE
INTERNATIONALE

ICS 33.200

ISBN 978-2-8322-5788-3

**Warning! Make sure that you obtained this publication from an authorized distributor.
Attention! Veuillez vous assurer que vous avez obtenu cette publication via un distributeur agréé.**

CONTENTS

FOREWORD.....	4
INTRODUCTION.....	6
1 Scope.....	7
2 Normative references	7
3 Terms and definitions	8
4 Abbreviated terms	10
5 Connecting facility management and grid operations	10
5.1 Business and functional requirements for the adapter	10
5.2 Adapter benefits.....	10
5.3 Interoperation overview.....	11
5.3.1 General	11
5.3.2 Grid operations standards.....	11
5.3.3 Customer facility standards.....	11
5.3.4 Smart grid user interface (SGUI).....	11
5.3.5 Role of the bridge and adapter	12
5.4 Interaction model for interoperability	13
5.5 Adapter deployments	14
6 Constructing the adapter	15
6.1 General considerations	15
6.2 Adapter protocol and message type	17
6.3 Namespace and version management.....	17
6.4 Subjects of the adapter	17
6.5 Implementing the adapter	18
6.5.1 General	18
6.5.2 Step one: Determine information model for SGUI end	18
6.5.3 Step two: Determine information model for grid operations end	18
6.5.4 Step three: Build XML schema for CIM DR profile.....	18
6.5.5 Step four: Build XML transformation between grid operations and SGUI	18
6.5.6 Step five: Develop, test and deploy the adapter	19
6.5.7 Changing the adapter implementation to use the UML-to-UML-first path	19
7 Example transformation (informative)	19
7.1 General.....	19
7.2 Notes on transformation.....	20
7.2.1 General	20
7.2.2 Transformation functions that do not draw on the CIM DR schema	21
7.2.3 Transformation functions that draw on business and implementation context	21
7.2.4 Transformation functions for detailed signal name, type, and ID	22
7.2.5 Transformation function that converts CIM date time intervals to the equivalent SGUI bridge standard intervals	22
7.2.6 Other information mapping issues.....	22
Annex A (informative) XML artefacts for standard adapters.....	23
A.1 General.....	23
A.2 Adapter example CIM XML artefacts	23
A.3 Adapter example OpenADR XML artefacts.....	23
A.4 XSLT transform xml artefact.....	23

Annex B (informative) Details for mapping and adaptation	24
B.1 Time interval mapping function	24
B.2 Mapping functions related to mRIDs.....	24
B.3 Business context mapping functions	24
B.4 Other mapping functions	24
Annex C (informative) Considerations for adapter implementers	25
C.1 Overview.....	25
C.2 Notes on information model for CIM endpoint.....	25
C.3 Notes on information model for SGUI-facing endpoint	25
C.4 Interfaces and protocols.....	25
C.5 Service requests and verbs in IEC 61968-100 and SGUI standards	25
Bibliography.....	27
 Figure 1 – The smart grid user interface (SGUI) as a blue bar between grid operations and customer facility management and control.....	12
Figure 2 – Adapter and IEC 62746-10-1 as an example SGUI bridge	13
Figure 3 – Actors in grid, adapter, and facility domains, using IEC 62746-10-1 as the SGUI bridge standard	14
Figure 4 – Grouping adapters with grid actor (left hand side) or with a facility actor (right hand side)	15
Figure 5 – Two transformation paths from CIM DR profile (upper left) to SGUI bridge standard (lower right).....	16
Figure 6 – Transforming CIM DR model profiles into XML schema	17
Figure 7 – Graphical XSLT mapping between CIM ResourceDeployment sample message based on IEC 62325-301:2018 and IEC 62746-10-1 EiEvent.....	20
 Table 1 – Actors and key standards	13
Table C.1 – Verbs comparison (source: OASIS Energy Interoperation 1.0)	26
Table C.2 – Message type comparison	26

INTERNATIONAL ELECTROTECHNICAL COMMISSION

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

Part 10-3: Open automated demand response – Adapting smart grid user interfaces to the IEC common information model

FOREWORD

- 1) The International Electrotechnical Commission (IEC) is a worldwide organization for standardization comprising all national electrotechnical committees (IEC National Committees). The object of IEC is to promote international co-operation on all questions concerning standardization in the electrical and electronic fields. To this end and in addition to other activities, IEC publishes International Standards, Technical Specifications, Technical Reports, Publicly Available Specifications (PAS) and Guides (hereafter referred to as "IEC Publication(s)"). Their preparation is entrusted to technical committees; any IEC National Committee interested in the subject dealt with may participate in this preparatory work. International, governmental and non-governmental organizations liaising with the IEC also participate in this preparation. IEC collaborates closely with the International Organization for Standardization (ISO) in accordance with conditions determined by agreement between the two organizations.
- 2) The formal decisions or agreements of IEC on technical matters express, as nearly as possible, an international consensus of opinion on the relevant subjects since each technical committee has representation from all interested IEC National Committees.
- 3) IEC Publications have the form of recommendations for international use and are accepted by IEC National Committees in that sense. While all reasonable efforts are made to ensure that the technical content of IEC Publications is accurate, IEC cannot be held responsible for the way in which they are used or for any misinterpretation by any end user.
- 4) In order to promote international uniformity, IEC National Committees undertake to apply IEC Publications transparently to the maximum extent possible in their national and regional publications. Any divergence between any IEC Publication and the corresponding national or regional publication shall be clearly indicated in the latter.
- 5) IEC itself does not provide any attestation of conformity. Independent certification bodies provide conformity assessment services and, in some areas, access to IEC marks of conformity. IEC is not responsible for any services carried out by independent certification bodies.
- 6) All users should ensure that they have the latest edition of this publication.
- 7) No liability shall attach to IEC or its directors, employees, servants or agents including individual experts and members of its technical committees and IEC National Committees for any personal injury, property damage or other damage of any nature whatsoever, whether direct or indirect, or for costs (including legal fees) and expenses arising out of the publication, use of, or reliance upon, this IEC Publication or any other IEC Publications.
- 8) Attention is drawn to the Normative references cited in this publication. Use of the referenced publications is indispensable for the correct application of this publication.
- 9) Attention is drawn to the possibility that some of the elements of this IEC Publication may be the subject of patent rights. IEC shall not be held responsible for identifying any or all such patent rights.

International Standard IEC 62746-10-3 has been prepared by IEC project committee 118: Smart grid user interface.

This publication contains attached files in the form of XML artefacts. These files are intended to be used as a complement and do not form an integral part of the publication.

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

FDIS	Report on voting
118/94/FDIS	118/98/RVD

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.

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

The IEC common information model (CIM), comprised of IEC 61968-11, IEC 61970-301, and IEC 62325-301, contains the core IEC standards used by applications that govern the electric grid systems. On the other hand, customer facility management and control is enabled by over twenty non-CIM-based interoperation protocols.

One challenge facing IEC is to flexibly bridge the CIM-based portions of the electric grid domain to the non-CIM customer facility domain. IEC TR 62939-1 presents interface principles, requirements and use case analysis to help bridge the domains, and identifies existing standards that serve use case requirements for the customer facility domain.

This part of IEC 62746 defines a methodology for defining adapters to carry out core transformations to enable interoperation between

- CIM-based utility systems using CIM profiles supporting CIM demand response and distributed energy resources (that is, CIM DR profiles), and
- smart grid user interface (SGUI) bridge standards that bridge to the customer facility domain.

This document provides a standard method to achieve interoperability for the semantics and mapping of message payloads, and does not address broader system issues including but not limited to transport protocols, message envelopes, cybersecurity and business model differences.

Business and market presentation requirements are out of scope as they are syntactic rather than the semantic information exchange described in this document. In the enterprise software world, specific presentation requirements are typically implemented with XSLT transforms.

Adapters may not be required when the relevant business models as well as the CIM versions and profiles used by the respective actors in the grid and the facility domain are the same.

An informative example is included showing how this document can be applied to define interoperation between a specific CIM DR profile and the SGUI bridge standard IEC 62746-10-1. Such interoperation is two-way: the example shows a DR event produced by a CIM-based system communicated by means of an adapter to the virtual end node.

Applying a conformant adapter, a facility system may present itself to grid systems as if it implemented CIM demand response; likewise, a CIM system may present itself to facility systems as if it implemented an SGUI bridge standard.

This work is aligned with a gap identified in IEC TR 63097:2017.

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

Part 10-3: Open automated demand response – Adapting smart grid user interfaces to the IEC common information model

1 Scope

This part of IEC 62746 defines and describes methods and example XML artefacts that can be used to build a conformant adapter to enable interoperation between a utility distributed automation or demand response (DR) system based on the IEC common information model (CIM) and a utility smart grid user interface (SGUI) bridge standard (e.g., IEC 62746-10-1) to a customer facility. A conformant adapter

- 1) defines mappings for the payloads of request and response messages to pass between the SGUI bridge standard and grid operation systems,
- 2) requires minimal information sharing between grid operation systems and customer facility management and control systems, and
- 3) permits independent evolution of necessary standards and technologies used in grid systems and customer facility systems.

The scope is restricted to a method to define payload mappings between any specific CIM profile that contains DR/DER information models and the SGUI bridge standards including IEC 62746-10-1.

NOTE This document addresses a standard method to achieve interoperability for the semantics of message payloads, and does not address broader system issues including but not limited to transport protocols, message envelopes, cybersecurity, presentation, and business model differences. A complete software implementation addresses those broader system issues and, for the grid management side, IEC 62561 and other relevant standards apply.

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.

IEC 62325-301:2018, *Framework for energy market communications – Part 301: Common information model (CIM) extensions for markets*

IEC 62325-450:2013, *Framework for energy market communications – Part 450: Profile and context modelling rules*

IEC 62361-100:2016, *Power systems management and associated information exchange – Interoperability in the long term – Part 100: CIM profiles to XML schema mapping*

IEC 62746-10-1, *Systems interface between customer energy management system and the power management system – Part 10-1: Open automated demand response – OpenADR 2.0 profile specification*¹

¹ Under preparation. Stage at the time of publication: IEC/DECFDIS 62746-10-1:2018.

3 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

adapter

set of technologies necessary to bridge between CIM-based applications and SGUI bridge standard applications

3.2

bridge pattern

architectural design pattern describing how to connect independently evolved and independently evolving technologies

Note 1 to entry: The purpose is to achieve interoperation between two or more established technologies.

Note 2 to entry: See [1].

3.3

CIM DR profile

profile of IEC CIM related to demand response, based on IEC common information model that includes extensions for DR and DER in IEC 62325-301

Note 1 to entry: The CIM demand response profiles are not published. Only the CIM profiles for European markets based on IEC 62325-450 are standard profiles.

Note 2 to entry: IEC 62325-301:2018 defines DER interactions. The Annex A example CIM DR profile includes the transitive closure of the IEC 62325-301 DR/DER model elements, and so can serve as an example to address any CIM profile that includes DR/DER. That example CIM DR profile includes all information elements used for communication with an SGUI standard-based DR system.

3.4

CIM endpoint

communications endpoint using CIM DR

3.5

CIM-facing endpoint

endpoint of an adapter that faces and connects to the grid management actor CIM DR endpoint

3.6

CIM profile

profile of IEC 61968 (all parts), IEC 61970 (all parts), and/or IEC 62325 (all parts), defined according to IEC 62325-450:2013, Clause 4

3.7

DR

demand response, including DER as described in IEC 62325-301

Note 1 to entry: This note applies to the French language only.

3.8

facility management

shorthand for customer facility management and control

3.9**payload****message payload**

portion of a transmitted message that is the actual intended message, excluding any headers or metadata sent to facilitate payload delivery

Note 1 to entry: This definition is consistent with the use in IEC 61968-100, with W3C recommendations, and with general use in communications (see IEC 61968-100:2013, 6.2.4).

3.10**service-oriented architecture****SOA**

paradigm for organizing and utilizing distributed capabilities that can be under the control of different ownership domains

Note 1 to entry: In SOA, services are the mechanism by which needs and capabilities are brought together [3].

Note 2 to entry: This definition is consistent with the use in IEC 61968-100 and IEC TR 62357-1.

Note 3 to entry: This note applies to the French language only.

3.11**smart grid user interface**

logical, abstract, cross-domain interface that supports appropriately secure communications of information between an entity within the customer domain (e.g., home or building energy management system, electrical load, energy storage system or generation source) and an external service provider (e.g., utility, aggregator, market or customer energy service provider)

3.12**SGUI bridge standard**

standard including IEC 62746-10-1 that functionally bridges a grid management system with a facility management system or other non-grid management system

3.13**SGUI endpoint**

communications endpoint implementing an SGUI bridge standard

3.14**SGUI-facing endpoint**

adapter endpoint that faces and connects to the SGUI endpoint

3.15**transformation**

actor or technology that takes information expressed in one model and conveys the same information in another model

Note 1 to entry: XSL transformations are used as input to automated tools that transform XML artefacts valid under one set of schemas to XML artefacts valid under another set of schemas.

3.16**virtual end node**

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 deleted.]

3.17

virtual top node

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.

Note 2 to entry: The term is used in IEC 62746-10-1 (OpenADR 2.0).

[SOURCE: IEC TS 62746-3:2015, 3.1.17, modified – Note 2 to entry has been replaced by a new note.]

4 Abbreviated terms

CIM	IEC common information model
DER	distributed energy resource
DR	demand response
OpenADR	open automated demand response
SGUI	smart grid user interface
SOA	service-oriented architecture
UML	unified modeling language
VEN	virtual end node
VTN	virtual top node
WSDL	Web services description language
XML	extensible markup language
XSLT	extensible stylesheet language transformations

5 Connecting facility management and grid operations

5.1 Business and functional requirements for the adapter

The adapter implementation shall meet certain business requirements (see IEC TR 62939-1:2014, 2.4), including scalability and decoupling, support the bridge pattern for interoperation between grid management systems and facility management systems, and connect to existing bridge standard deployments (e.g., OpenADR 2.0 and IEC 62746-10-1).

Use of SOA techniques and technology allows independent evolution of the grid and customer facility domain standards so that these are not tightly coupled. The bridge pattern, with a minimal information model bridge, limits the shared information and reduces interactions to a small message set. This in turn supports scalability to millions of nodes and hundreds to thousands of grid operators. Bridging allows interoperation of distinct and different domains, effectively harmonizing the operation of actors in the domains. Decoupled interaction is necessary since each domain has its own information models, communication protocols and execution models.

5.2 Adapter benefits

A conformant adapter provides the following benefits for CIM-based systems:

- It enables applications using CIM DR to use CIM-based interactions to interoperate with existing and new non-CIM customer facility applications.

- It enables CIM-based smart grid systems to easily interoperate with the facility systems and/or devices, aggregators, etc., for DR services.
- It adapts to SGUI standards, which in turn are designed to connect to a plurality of customer domain automation and control environments.
- It leverages the widespread use of IEC 62746-10-1. It is separate from CIM, but conforms at the CIM endpoint to CIM demand response profiles.
- Its clear and limited purpose makes an adapter simple to maintain and extend.
- It enables runtime integration between CIM-based smart grid systems and common customer facility applications, leveraging the presence of OpenADR in the facility space.
- The adapter decouples and allows independent and asynchronous evolution of the CIM and of the customer domain standards.

For the customer facility application side, with the following similar benefits:

- Facility applications use the SGUI which allows interoperation with embedded systems.
- The SGUI is long-term stable and does not depend on user-defined profiles – it is a fixed integration point.
- Facilities can more easily participate in CIM-based DR events and programs without change.
- As CIM DR evolves, facilities implementing the ISO 17800 facility smart grid information model can share additional information such as curtailable load.
- Facilities and grid management all benefit from cooperation between distributed resources and grid management.
- The adapter decouples and allows independent and asynchronous evolution of the CIM and of the customer domain standards. The customer domain standards may evolve independently from the CIM.

5.3 Interoperation overview

5.3.1 General

Subclause 5.3 describes the role of the adapter and its relationship to standards used in grid management systems and the SGUI bridge standards.

5.3.2 Grid operations standards

Grid operation applications use the IEC CIM for describing objects that are subjects for interaction. The CIM standards are information models expressed in UML. Many profiles of CIM are in use, with applications using both standardized profiles (for European markets based on IEC 62325-450) and non-standardized profiles. In addition, message payloads are expressed in XML schema, according to IEC 62361-100.

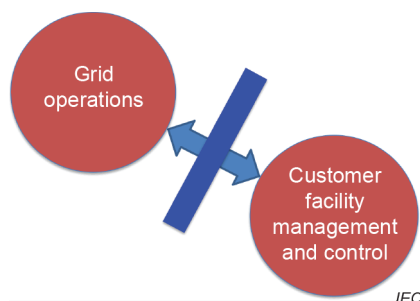
5.3.3 Customer facility standards

There are many facility management and control standards in use for systems and devices. IEC TR 62939-1 lists more than twenty ISO, IEC, and ISO/IEC facility standards. Examples included ISO 16484-5 BACnet, ISO/IEC 14543-3 KNX and ISO/IEC TR 14543-4 ECHONET. Each of these has an underlying information model that represents the systems and devices, and management of customer facilities. Commercial and industrial facility management functions include occupancy and process scheduling, and provision of occupant comfort, lighting, transport, life safety, and other local services that are fundamentally different and decoupled from grid management.

5.3.4 Smart grid user interface (SGUI)

The SGUI connects grid operations and customer facilities. Deploying the adapter creates a flexible connection to CIM-based grid operations actors.

Figure 1 shows the SGUI as a blue bar between grid operations and customer facility management and control. The grid operations and facility management domains shall interoperate and cooperate for effective grid operations and facility management. Interactions go through the SGUI, and are bidirectional.



[SOURCE: IEC TR 62939-1:2014, Figure 1]

Figure 1 – The smart grid user interface (SGUI) as a blue bar between grid operations and customer facility management and control

SGUI bridge standards implement the bridge pattern, serving as a stable interoperability point with a simple data model and small set of services as required for the SGUI. The SGUI bridge decouples the grid operations domain from the customer facility domain, allowing independent and asynchronous evolution of standards on both ends of the bridge.

5.3.5 Role of the bridge and adapter

Figure 2 shows how an adapter shall be used between

- grid operations including portions defined by IEC 62325-301:2018,
- customer facility management and control defined by standards and specifications including those listed in IEC TR 62939-1, and
- the SGUI bridge (blue bar) which applies the bridge pattern to connect the grid operations domain to the customer facility domain.

NOTE 1 The bridge pattern is applied to connect two different domains that have evolved and can evolve separately.

A complete adapter implementation effects a protocol transform and associated message transformations from CIM to SGUI bridge protocol. This specification provides the method to transform message payloads, along with an example CIM-OpenADR transform. The power of the adapter plus bridge is that a grid operations system application developer does not need to know or interact with details of the numerous facility management standards, but only the adapter.

NOTE 2 A single DER or aggregation presents the same interface and exposes the same information model in an SGUI bridge standard such as IEC 62746-10-1 and in CIM DR (see IEC TS 62746-3:2015). The VTN-VEN architecture allows for either a single DER or aggregation. One can deploy any actor presenting the VEN services. Thus, both CIM DR and IEC 62746-10-1 are agnostic to the implementation and nature of an actor presenting the VEN services.

NOTE 3 IEC 62746-10-1 defines an information model for message payloads, interaction patterns, and interoperation semantics to enable DR between utilities and facilities. Normative definitions use XML schema and WSDL.

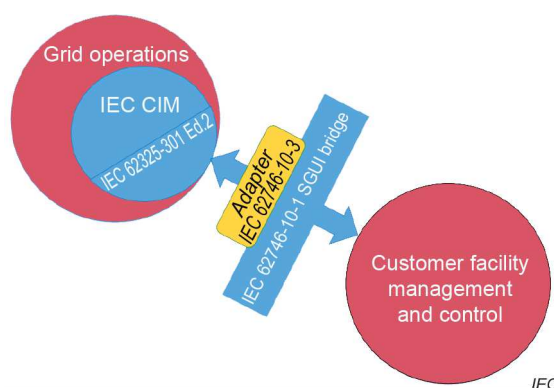


Figure 2 – Adapter and IEC 62746-10-1 as an example SGUI bridge

In summary, the adapter conforms to and interoperates with CIM DR profile messages on the one end while the other end conforms to and interoperates with OpenADR. This document provides a standard method to specify the adapter along with an example CIM-OpenADR adapter.

5.4 Interaction model for interoperability

The interactions between grid operators and customer facilities can be described as a series of message exchanges between actors. Actors are presented along with their contexts in Table 1 and in Figure 3.

Table 1 – Actors and key standards

Actor domain	Actor's information model includes	Notes
Grid	CIM	Interactions to and from a grid operations actor connect at the CIM endpoint, implementing messages specific to a CIM DR profile.
Adapter	CIM and SGUI bridge standards	The adapter uses CIM DR profile schemas to communicate with the grid actor via the CIM-facing endpoint, and uses SGUI standard schemas to communicate with the facility actor via the SGUI-facing endpoint. Internally, the adapter uses transformations between the CIM DR profile messages (based on CIM DR XML schemas) and SGUI standard messages (based on SGUI standard XML schemas).
Facility	SGUI bridge standards and relevant facility standards	The facility actor integrates SGUI XML message requests (based on SGUI standard schemas) with internal technologies and standards relevant to the facility with which it is integrated.

Figure 3 shows an example deployment using IEC 62746-10-1. The SGUI bridge standard provides an information model for the set of minimal information that needs to be communicated across the bridge along with a set of simple messages that satisfy the DR use case requirements of the SGUI (see IEC TR 62939-1).

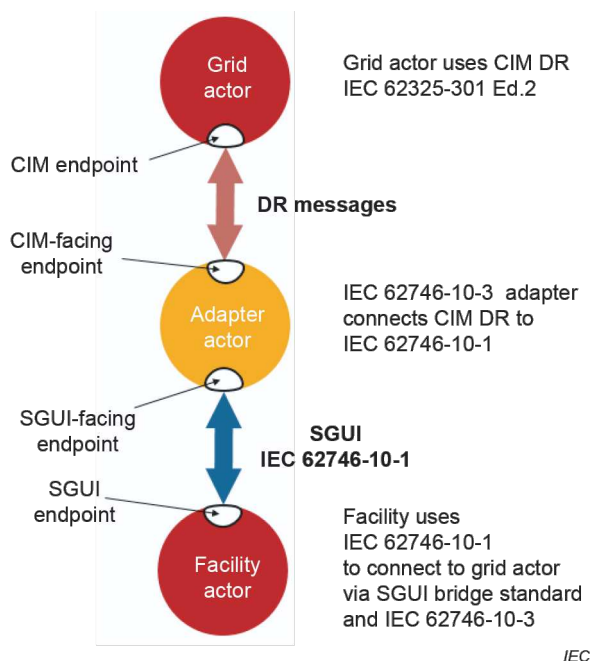


Figure 3 – Actors in grid, adapter, and facility domains, using IEC 62746-10-1 as the SGUI bridge standard

NOTE Figure 3 uses the UML-to-XML-first path as described in 6.1.

In Figure 3, the endpoints and actors in a DR use case interaction are shown. The grid actor uses CIM-based DR messages as appropriate to its purpose and implementation. The adapter actor applies the XSLT and protocol transformation code to map between CIM DR profile messages and IEC 62746-10-1 messages. The facility actor uses facility standards and communicates with the adapter using IEC 62746-10-1.

5.5 Adapter deployments

The adapter can be grouped with grid operations or facility management in two standard ways as shown in Figure 4.

- 1) The adapter is hosted by the grid actor in a grid operations deployment, for example a utility or system operator (left hand side of Figure 4). In this case, the facility actor communicates with the grid actor that presents as an OpenADR VTN. The grid actor deploys an OpenADR DR management system and the adapter is internal to the utility or system operator systems.
- 2) The adapter is hosted by the facility actor in a facility management deployment or an aggregator system (right hand side of Figure 4). In this case, the facility actor (or aggregator) uses the adapter so that it presents as a CIM DR endpoint to the grid actor.

NOTE A complete software adapter implementation includes the payload mapping defined in this document, as well as addressing broader issues including but not limited to transport protocols, message envelopes, cybersecurity, presentation, and business model differences. On the grid management side, IEC 62561 and other relevant standards can be applied.

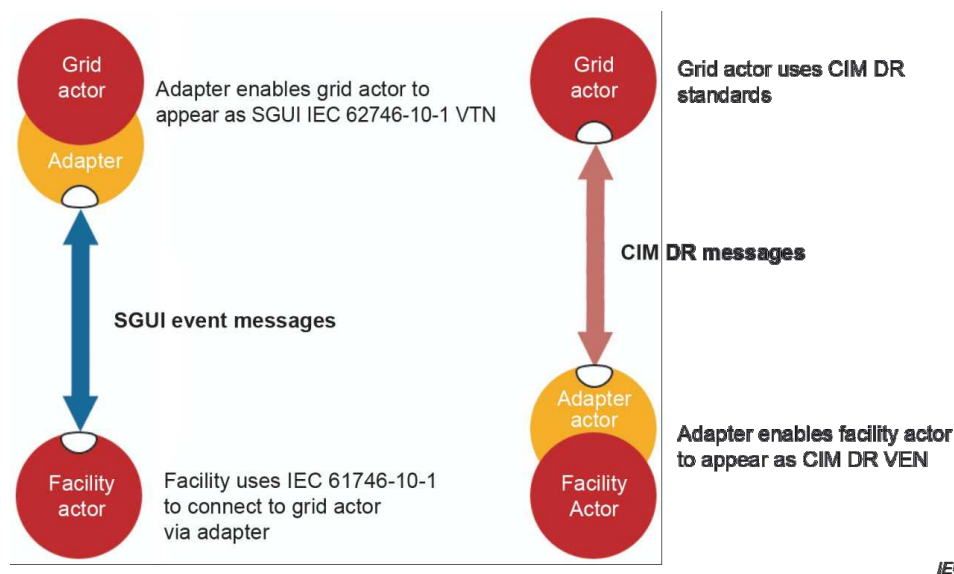


Figure 4 – Grouping adapters with grid actor (left hand side) or with a facility actor (right hand side)

6 Constructing the adapter

6.1 General considerations

CIM is an abstract model expressed using UML. Messages exchanged when using OpenADR are described using XML schema, as are CIM profiles used in message payload description.

Figure 5 shows the two models that shall be adapted as well as intermediate nodes on two possible paths. Bold Italic text indicates standards for the nodes and the arrows.

- The upper left node is CIM DR (IEC 62325-301:2018) expressed in UML.
- The lower right node is OpenADR (IEC 62746-10-1) expressed in XML schema.
- The upper right node is non-standard UML for the IEC 62746-10-1 payloads.
- The lower left node is XML schema produced from a CIM DR UML profile generated in accordance with IEC 62361-100.

The labelled arrows indicate standards used to move from one node to another; only the lower and left arrows are defined by standards. The upper arrow indicates a UML to UML transformation (the "UML-to-UML-first" path), for which there are no deployed standards. The left arrow indicates a UML to XSD transformation (the "UML-to-XSD-first" path) which is governed by the IEC 62361-100 standard. The right arrow indicates a non-standard transformation between the IEC 62746-10-1 XML schema model (standard) and a corresponding UML model (included in part in ISO 17800). The lower arrow is the W3C XSL Transformation standard.

NOTE 1 There are no standard transformations between IEC 62746-10-1 XML schema and ISO 17800 payload UML models. This is because the IEC 62746-10-1 XML schema is normative and idiomatic for XML experts and ISO 17800 UML is normative and idiomatic for UML experts.

NOTE 2 W3C calls their standardized documents "Recommendations".

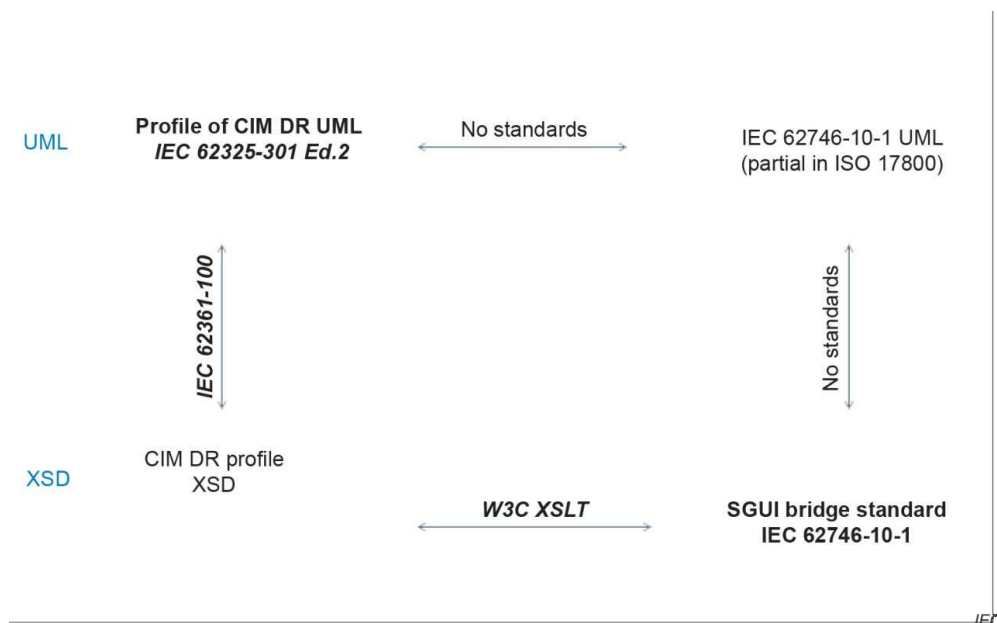


Figure 5 – Two transformation paths from CIM DR profile (upper left) to SGUI bridge standard (lower right)

Adaptation is performed via the horizontal paths, either by the upper UML-UML path or the lower XSD-XSD path. The UML-to-UML transformation is possible, but is not standards-based. The associated right-side UML-XSD transformation is also not standards-based, as the idiomatic XML in IEC 62746-10-1 and its standards bases are not supported by any automated tooling.

There are two paths between CIM DR UML and SGUI bridge standard XSD:

- the UML-to-XSD-first path takes the left arrow based on IEC 62361-100, followed by the bottom arrow based on XSLT;
- the UML-to-UML-first path takes the top arrow, followed by the right arrow.

NOTE 3 Tools to perform repeatable and standard UML-to-UML transformation are not available.

NOTE 4 There are no tools to perform transformation between idiomatic XML and idiomatic UML, that is, between XML reasonably structured for an XML expert and UML reasonably structured for a UML expert.

The left-side UML-to-XML transformation applies tooling for generating a CIM profile in UML and then transforms that profile to XML schema according to IEC 62361-100. The associated lower transformation to IEC 62746-10-1 XML schema is performed using W3C XSLT. The standards-based path applies IEC 62361-100 on a CIM UML profile with second step W3C XSLT transformation to SGUI bridge standard XSD.

Figure 6 indicates in yellow the standards path from upper left (CIM DR model) to lower right (SGUI bridge standard XSD). Adapter transformation tools shall be able to support bidirectional interaction between the CIM DR XML schema profile and IEC 62746-10-1. For example, a history report will have time intervals, time stamps, and identification of programs and resources, all of which can be transformed into a CIM-based application message (when defined).

NOTE 5 By using the XML schema(s) for the SGUI standards, one can provide an adapter that can communicate with any facility endpoint via ISO 17800 or non-standard means. This effectively decouples CIM-based messages from customer facility protocol messages that will change over time, and/or which can be contained in embedded systems that typically have constraints on firmware updates.

NOTE 6 Payloads in IEC 62746-10-1 are consistent with those in facility smart grid information model, ISO 17800:2017.

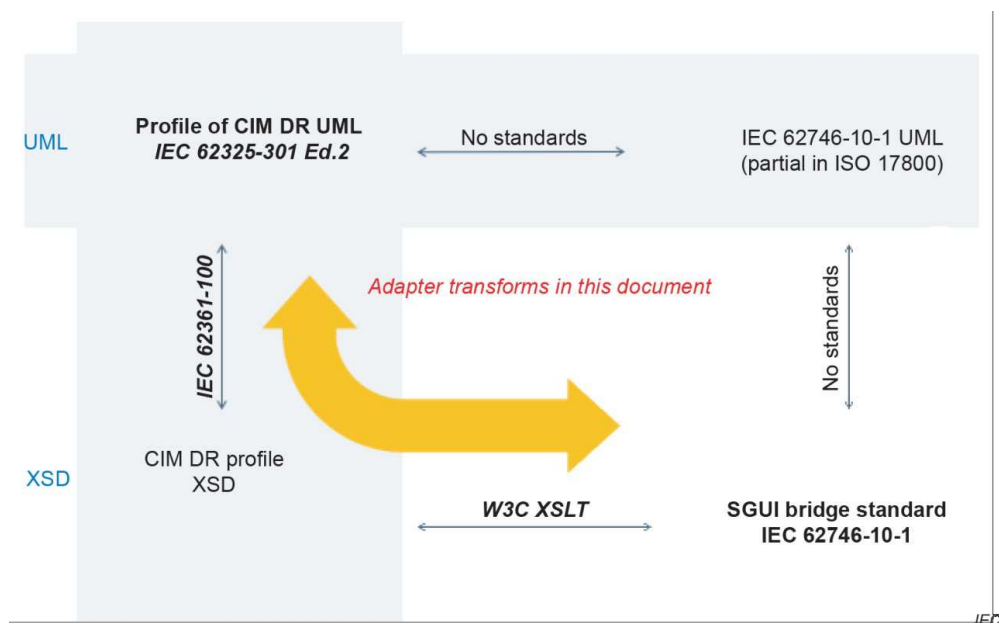


Figure 6 – Transforming CIM DR model profiles into XML schema

6.2 Adapter protocol and message type

The protocols and messages are as defined in the respective normative standards and profiles.

6.3 Namespace and version management

New versions of the grid operations and SGUI facing endpoints will be manifested by changes in the respective profiles and XML schemas.

The target namespace for CIM-based schemas shall be determined according to IEC 62361-100:2016.

NOTE 1 The namespaces used for the CIM profile are not established by this document, and do not affect conformance of an adapter.

The target namespace for SGUI schemas is defined in the SGUI bridge standard determined in 6.5.2 below.

NOTE 2 The namespaces used for the SGUI bridge standard are not established by this document, and do not affect conformance of an adapter.

The conformance statement for an adaptor shall include a version indication and a descriptive reference to the adapted endpoint standard(s).

6.4 Subjects of the adapter

The adapter effects a protocol transform and the accompanying message transformations. The message payloads received are transformed to one or more message payloads transmitted for each interaction. Interoperation is defined with respect to message payloads for a set of specific messages. As shown in Figure 3, the ends exist and communicate in different environments and information models.