

SYSTEMS REFERENCE DELIVERABLE



Smart city system ontology –
Part 1: Gap analysis



THIS PUBLICATION IS COPYRIGHT PROTECTED
Copyright © 2024 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.

IEC Secretariat
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 corrigendum or an amendment might have been published.

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 It also gives information on projects, replaced and withdrawn publications.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 once a month by email.

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.

IEC Products & Services Portal - products.iec.ch

Discover our powerful search engine and read freely all the publications previews, graphical symbols and the glossary. With a subscription you will always have access to up to date content tailored to your needs.

Electropedia - www.electropedia.org

The world's leading online dictionary on electrotechnology, containing more than 22 500 terminological entries in English and French, with equivalent terms in 25 additional languages. Also known as the International Electrotechnical Vocabulary (IEV) online.



SYSTEMS REFERENCE DELIVERABLE



Smart city system ontology –
Part 1: Gap analysis

INTERNATIONAL
ELECTROTECHNICAL
COMMISSION

ICS 13.020.20

ISBN 978-2-8322-8976-1

Warning! Make sure that you obtained this publication from an authorized distributor.

CONTENTS

FOREWORD.....	5
INTRODUCTION.....	7
1 Scope.....	8
2 Normative references	8
3 Terms and definitions	8
4 Foundations of concept system building for smart city systems.....	11
4.1 Methods of ISO 704:2022	11
4.2 Core concepts and the characteristics of smart city by different SDOs	11
4.3 System of systems view on smart city system in IEC SRD 63235:2021	11
4.4 Methodology framework for smart city system concept in IEC SRD 63235:2021	15
4.5 Descriptive framework of city in ISO 37105:2019	16
5 Existing ontology definitions from different SDOs	16
5.1 Existing ontology definitions from different sources	16
5.2 Methodology for identification of concepts and concept relations	16
5.3 Concept and concept relations about ontology	18
6 Existing ontology standards deliverables and activities in different SDOs	21
6.1 General.....	21
6.2 Ontology-related standardization activities in ISO	21
6.2.1 ISO/TC 46/SC 4.....	21
6.2.2 ISO/TC 184/SC 4.....	21
6.2.3 ISO/TC 211	22
6.2.4 ISO/IEC JTC 1/WG 11	22
6.2.5 ISO/IEC 30182:2017, Smart city concept model (SCCM) for data interoperability.....	25
6.2.6 ISO/IEC JTC 1/SC 29	26
6.2.7 ISO/IEC JTC 1/SC 32	27
6.2.8 ISO/IEC JTC 1/SC 38	28
6.2.9 ISO/IEC JTC 1/SC 41	29
6.2.10 ISO/IEC JTC 1/SC 42	29
6.3 Ontology-related standardization activities in IEC	30
6.3.1 IEC TC Smart Energy	30
6.3.2 IEC TC 3/SC 3D	31
6.3.3 IEC SyC Smart Cities	31
6.4 Ontology-related standardization activities in ITU-T	33
6.4.1 ITU-T Study Group 20.....	33
6.5 Ontology-related standardization activities in IEEE	33
6.5.1 IEEE Robotics and Automation Society.....	33
6.5.2 IEEE Consumer Technology Society.....	34
6.6 Ontology-related standardization activities in W3C OGC	34
6.7 Ontology-related standardization activities in ETSI SmartM2M.....	37
6.8 Ontology related standardization activities elsewhere	37
6.9 Types of ontology standardization issues and concerns	38
6.10 Processes and activities of ontology building	39
6.11 Framework for generating and constructing ontologies.....	40
6.12 Stakeholders and concerns about ontology standards.....	42
6.13 Ontology standard scenarios mapping with IEC SRD 63235:2021	42

7	Gap analysis and recommendations for future work	45
7.1	Limitation of ontology definitions and concepts for smart city systems	45
7.2	Lack of harmonization of ontology concepts for smart city systems	46
7.3	Lack of integrated ontology framework for smart city systems	46
7.4	Recommendations for future work	48
7.4.1	Potential new work items	48
7.4.2	Recommendations from the international virtual seminar on ontology	48
7.4.3	Future collaboration	50
Annex A (informative)	A survey of shared understandings on smart city	51
Annex B (informative)	Existing definitions of ontology from SDOs and authoritative sources	56
Annex C (informative)	A survey of understandings about ontology concepts for smart cities and smart city systems	59
	Bibliography	65
	Figure 1 – An integrated concept system on smart city	14
	Figure 2 – Concept views of smart city systems	15
	Figure 3 – A methodology framework for building smart city system concept	16
	Figure 4 – Basic process for identification of concepts and their relations	17
	Figure 5 – A continuum thinking about ontology standards development	20
	Figure 6 – Framework to demonstrate certain indicators of ontology work	23
	Figure 7 – Framework of the ISO/IEC 5087 series formed by three levels of ontologies	24
	Figure 8 – Example concepts for the three levels of ontologies according to the ISO/IEC 5087 series	25
	Figure 9 – Smart city levels of insight	26
	Figure 10 – Framework decomposition in packages and dependencies	41
	Figure 11 – Scope of MFI ontology registration	41
	Figure 12 – A harmonized ontology concept system for smart city systems	45
	Figure 13 – An ontology continuous model mapping with ontology concepts	46
	Figure 14 – Gaps in ontology standards for smart city systems	47
	Table 1 – Core concepts and the characteristics of smart city from different SDOs	12
	Table 2 – Three types of concept relation	18
	Table 3 – Types of ontology concept relation	19
	Table 4 – ISO/TC 46/SC 4 ontology deliverables	21
	Table 5 – ISO/TC 184/SC 4 ontology deliverables	21
	Table 6 – ISO/TC 211 ontology deliverables	22
	Table 7 – ISO/IEC JTC 1/WG 11 ontology deliverables	22
	Table 8 – ISO/IEC JTC 1/SC 29 ontology deliverables	27
	Table 9 – ISO/IEC JTC 1/SC 32 ontology deliverables	28
	Table 10 – ISO/IEC JTC 1/SC 38 ontology deliverables	28
	Table 11 – ISO/IEC JTC 1/SC 41 ontology deliverables	29
	Table 12 – ISO/IEC JTC 1/SC 42 ontology deliverables	30
	Table 13 – IEC SyC Smart Energy ontology deliverables	30
	Table 14 – IEC TC 3/SC 3D ontology deliverables	31

Table 15 – IEC SyC Smart Cities SCRAM deliverables	32
Table 16 – ITU-T Study Group 20 ontology deliverables	33
Table 17 – IEEE Robotics and Automation Society ontology deliverables.....	34
Table 18 – IEEE Consumer Technology Society ontology deliverables.....	34
Table 19 – W3C OGC ontology deliverables	35
Table 20 – ETSI SmartM2M ontology deliverables	37
Table 21 – Ontology deliverables elsewhere	37
Table 22 – Common processes and activities in ontology building	39
Table 23 – Existing ontology standards mapping with IEC SRD 63235:2021	42

Currently in preview, click buy full version

INTERNATIONAL ELECTROTECHNICAL COMMISSION

SMART CITY SYSTEM ONTOLOGY –

Part 1: Gap analysis

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) IEC draws attention to the possibility that the implementation of this document may involve the use of (a) patent(s). IEC takes no position concerning the evidence, validity or applicability of any claimed patent rights in respect thereof. As of the date of publication of this document, IEC had not received notice of (a) patent(s), which may be required to implement this document. However, implementers are cautioned that this may not represent the latest information, which may be obtained from the patent database available at <https://patents.iec.ch>. IEC shall not be held responsible for identifying any or all such patent rights.

IEC SRD 63476 has been prepared by IEC systems committee Smart Cities: Electrotechnical aspects of Smart Cities. It is a Systems Reference Deliverable.

The text of this Systems Reference Deliverable is based on the following documents:

Draft	Report on voting
SyCSmartCities/322/DTS	SyCSmartCities/334/RVDTS

Full information on the voting for its approval can be found in the report on voting indicated in the above table.

The language used for the development of this Systems Reference Deliverable is English.

This document was drafted in accordance with ISO/IEC Directives, Part 2, and developed in accordance with ISO/IEC Directives, Part 1 and ISO/IEC Directives, IEC Supplement, available at www.iec.ch/members_experts/refdocs. The main document types developed by IEC are described in greater detail at www.iec.ch/publications.

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

- reconfirmed,
- withdrawn, or
- revised.

IMPORTANT – The "colour inside" logo on the cover page of this document 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

Ontology is becoming a key subject in the world of big data, AI, IoT, and smart city system standards. The following benefits of ontology are recognized as important with respect to interoperability, connectivity, traceability of digital content, particularly machine readability, executability and interpretability of digital content for decision making and actions.

- Increase interoperability across domains.
- Enable machine-readable code for computational reasoning and decision making.
- Create semantic linkages between data, information and knowledge systems.
- Build accessible APIs and semantic linkages between web-based data objects.
- Link data domains with shared concepts or canonical data models.
- Connect shared data concepts and definitions between domains.

However, ontology has a variety of definitions in different international standards. How to understand different meanings of ontology and select the right definition for the right stakeholders' concerns for the right purposes is a big challenge for effective integration of business, data, information, knowledge and decision making, across disciplines, domains, systems, platforms and applications in smart cities. Moreover, how to deal with the grand challenges of interoperability of many and various ontologies to satisfy the demands from artificial intelligence and big data analytics are gaps to be filled in the area of smart city systems. How to develop digital content that is machine readable, executable and interpretable, working in the system without human effort for a smart city system are emerging needs to be studied. There are significant demands for better communication, coordination, cooperation, collaboration and connectivity of existing ontology standards to smart cities practical sectors. This document aims:

- to identify existing ontology standards from different Standards Development Organizations (SDOs) and to provide best practice examples and considerations of ontology standards development and maintenance for smart city systems;
- to identify gaps in existing ontology standards for smart city systems and the opportunities and challenges in ontology standards development taking into account multi-dimensional and multi-domain stakeholders' concerns city wide, and to provide recommendations for ontology standards development and maintenance to enable integration, interoperability, efficiency and effectiveness of smart city systems.

SMART CITY SYSTEM ONTOLOGY –

Part 1: Gap analysis

1 Scope

This document provides a gap analysis on ontology relevant standards for smart city systems to be used as a base document for mapping, developing and maintaining a set of ontology standards for smart city systems.

2 Normative references

There are no normative references in this document.

3 Terms and definitions

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

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

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

3.1

characteristic

abstraction of a *property* (3.8)

Note 1 to entry: Characteristics are used to describe concepts.

[SOURCE: ISO 1087:2019, 3.2.1, modified – The EXAMPLE has been deleted.]

3.2

concept

unit of knowledge created by a unique combination of *characteristics* (3.1)

[SOURCE: ISO 1087:2019, 3.2.7, modified – The Notes to entry have been deleted.]

3.3

definition

representation of a concept by an expression that describes it and differentiates it from related concepts (3.2)

[SOURCE: ISO 1087:2019, 3.3.1]