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Geographic Information — Securing interoperability among heterogeneous city domain information models

Information géographique — Sécuriser l'interopérabilité entre des modèles d'information hétérogènes dans le domaine de la ville

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This document was prepared by Technical Committee ISO/TC 211, *Geographic information*~~.~~, in collaboration with the European Committee for Standardization (CEN) Technical Committee CEN/TC 287, *Geographic Information*, in accordance with the Agreement on technical cooperation between ISO and CEN (Vienna Agreement).

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Introduction

Local governments are actively implementing various smart city services. The heterogeneity of private and public data generated from the smart city services is one of the major concerns standard development organizations (SDOs~~(Standard Development Organizations~~) are actively ~~underway~~proceeding to solve for interoperability. Information modelling fields are moving towards integrated geospatial information environments, such as digital twins, cyber-physical systems~~,~~ and the meta-verse. These trends have produced new needs for standards in both private and public sectors that enable effective information sharing in terms of the geospatial context for smart city services. Building efficient and effective interconnectedness and sharing information between silo data models across domain fields and cities is one of the major concerns to make seamless smart city services operational.

~~The objective of this document is to analyse a feasible way to accommodate interoperability elements for the data component of an SDI and extend the meta-model framework for interoperability (MFI) in securing interoperability among heterogeneous domain information models under smart city context.~~

~~For the feasibility analysis, this document~~

~~a) defines the interoperability issues for city domain information models;~~

~~b) reviews relevant standards and best practices and examines methodologies or solutions to tackle the interoperability issues;~~

~~c) suppose use case for interoperable domain information models under smart city context;~~

~~d) defines technical requirements in concern about how to apply the interoperability elements of the meta model framework to support the interoperability of smart city services;~~

~~e) recommends and suggest the standardization items to be proceeded to secure more interoperability.~~

Geographic Information — Securing interoperability among heterogeneous city domain information models

1 Scope

This document analyses a feasible way to accommodate interoperability elements for the data ~~components~~component of a spatial data infrastructure (SDI) and extend the meta model framework for interoperability (MFI) in securing interoperability among heterogeneous domain information models under the smart city ~~service~~ context.

This document:

a) ~~defines~~outlines the interoperability issues for city domain information models;

b) reviews relevant standards and best practices and examines methodologies or solutions to tackle the interoperability issues;

c) ~~suppose~~supposes a use case and ~~provide~~provides an example to secure interoperability among different domain information models using model registry;

d) ~~defines~~specifies technical requirements in concern about how to apply the interoperability elements of the meta model framework to support the interoperability of smart city services;

e) ~~recommends and suggest~~highlights the standardization items to be ~~proceeded~~developed to secure interoperability.

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 ~~terminological~~terminology databases for use in standardization at the following addresses:

— ISO Online browsing platform: available at ~~http~~https://www.iso.org/obp

— IEC Electropedia: available at https://www.electropedia.org/

Field Code Changed

3.1 Terms and definitions

3.1.1
information model
graphical and textual representation of entities and the relationships between them

Note 1 to entry: May also be known as a data *model* (3.1.5;), a conceptual data model, a logical data model, an entity relationship model, an object class diagram or a database definition.

[SOURCE: ISO/IEC 19763-1:~~2015 4.1.5~~2023, 3.17]

3.1.2
interoperability
capability to communicate, execute programs, or transfer data among various functional units in a manner that requires the user to have little or no knowledge of the unique characteristics of those units

~~[SOURCE: ISO/IEC 2382-1:1993]~~

3.1.3
metadata
information about a resource

[SOURCE: ISO 19115-1:2014, 4.10]

3.1.4
metamodel
model (3.1.5) that explains a set of related models, by defining the language for expressing such models

~~[SOURCE: ISO 14813-5:2010 B.1.84]~~

3.1.5
model
representation of some aspect of a domain of interest using a normative modelling facility ~~andmodel~~and model constructs

Note 1 to entry: ~~models~~Models can be used to express a set of information requirements, processes, services, roles, goals or ~~someother~~some other aspect of a domain of interest.

[SOURCE: ISO/IEC 19763-1:~~2015, 4~~2023, 3.1~~.12]~~

~~**3.1.6**~~
~~**model information**~~
~~representation of some aspect of a domain of interest using a normative modelling facility and model constructs~~

~~Note 1 to entry: In MFI, the model information about a model will be registered using instances of Registered_Item as specified in ISO/IEC 11179-3~~

~~[SOURCE: ISO/IEC 19763-1:2015 4.1.15~~]

~~3.1.7~~3.1.6
model registry
~~registry where~~information system for registering *models* (3.1.5~~are registered~~)

[SOURCE: ISO/IEC 19763-1:~~2015 4.1.16~~2023, 3.10]

~~3.1.8~~3.1.7
model repository
repository (3.1.8) where *models* (3.1.5) are stored

[SOURCE: ISO/IEC 19763-1:~~2015, 4.1.17~~2023, 3.11]

~~3.1.9~~3.1.8
repository
place where, or receptacle in which, things are or may be stored

Note 1 to entry: In meta model framework for interoperability (MFI) and metadata registry (MDR), a repository is recognized as a database that stores actual instances tothat conform to aparticulara particular *metamodel* (3.1.4) or a particular set of *metadata* (3.1.3).

[SOURCE: ISO/IEC 19763-1:2015 4.1.25]

3.1.10
registry summary(RS)
[SOURCE: ISO/IEC 19763-1:2023 3.13 — "things are or can be stored" has been revised to "things are or may be stored," "MDR" has been added and "information system" is revised to "database".]

3.1.9
registry summary is
RS
metadata (3.1.3) which refers to an individual registry system or an aggregate of registry systems

[SOURCE: ISO/IEC 19763-6:2015, 4.1.56 — "(RS)" has been added]

3.1.113.1.10
registry of registries
(RoR)
registry that stores *registry summary* (3.1.9Registry Summary) data showing an individual registry system

[SOURCE: ISO/IEC 19763-6:2015, 4.1.5]

3.2 Abbreviated terms

API	Application Programming Interfaceapplication programming interface
BIM	Building Information Modelingbuilding information modeling
CaLAThe	Cadastre and Land Administration Thesauruscadastre and land administration thesaurus
CRS	Coordinate Reference Systemscoordinate reference systems
EPSG	European Petroleum Survey Groupeuropean petroleum survey group
ETSI	European Telecommunications Standards Instituteeuropean telecommunications standards institute
FAIR	Findable, Accessible, Interoperable, and Reusablefindable, accessible, interoperable, and reusable
GDF	Geographic Data Filesgeographic data files
GIS	Geographic Information Systemsgeographic information systems
GML	Geography Markup Languagegeography markup language
ICT	Information and Communication Technologyinformation and communication technology
INSPIRE	Infrastructureinfrastructure for Spatial Informationspatial information in Europeeurope
IoT	Internetinternet of Thingsthings
JSON	JavaScript Object Notationjavascript object notation
LADM	Land Administration Domain Modelland administration domain model
MDR	Metadata Registrymetadata registry
MFI	Metameta-model Frameworkframework for Interoperabilityinteroperability
MIMs	Minimal Interoperability Mechanismsminimal interoperability mechanisms

NGSI-LD	~~Next Generation Service Interface with Linked Data~~next generation service interface with linked data
OASC	~~Open & Agile Smart Cities~~open & agile smart cities
OGC	~~Open Geospatial Consortium~~open geospatial consortium
RoR	~~Registry~~registry of ~~Registries~~registries
RS	~~Registry Summary~~registry summary
SDI	~~Spatial Data Infrastructures~~spatial data infrastructure
UML	~~Unified Modeling Language~~unified modeling language
WFS	~~Web Feature Service~~web feature service
W3C	~~World Wide Web Consortium~~world wide web consortium
XML	~~eXtensible Markup Language~~extensible markup language
UN	united nations
OMG	object management group

4 Interoperability issues for city domain information models

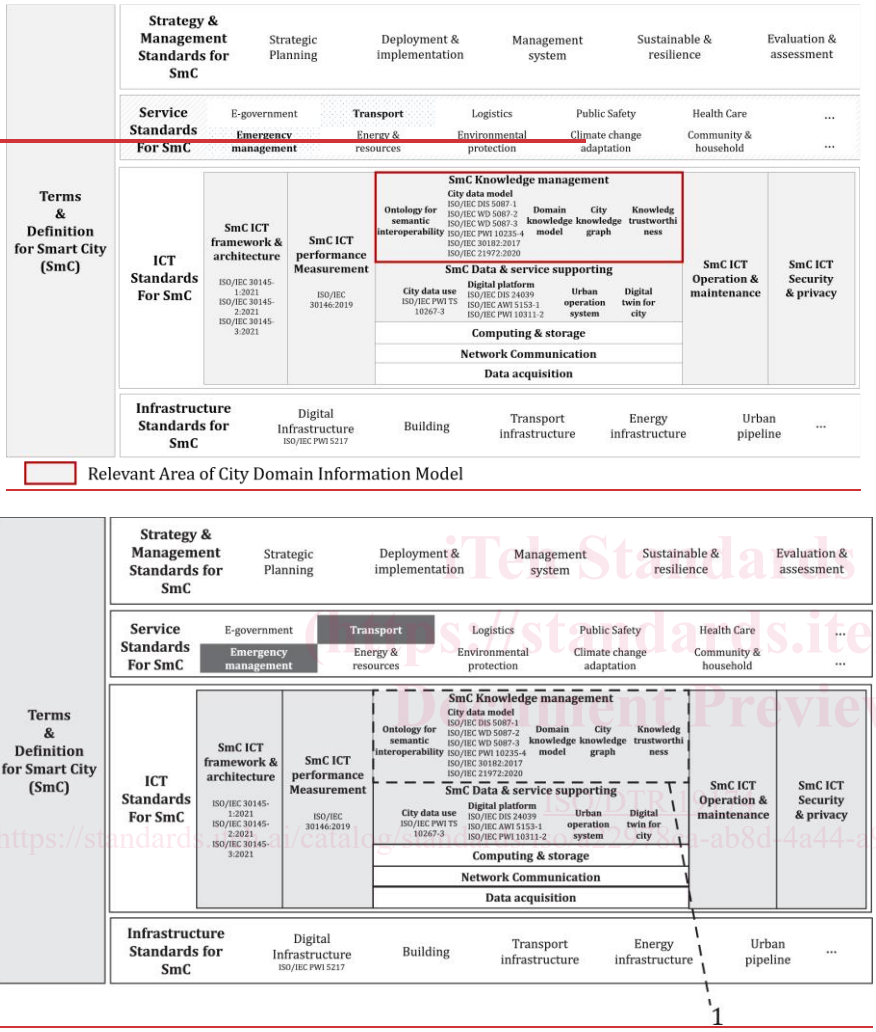
4.1 Overview

Governments and institutions promote ~~"~~open data~~"~~ initiatives, enabling citizens to access and utilize their data via the internet, potentially driving innovation in both public and private sectors. A challenge citizens face is to access, share~~,~~ and interconnect diverse public datasets, which ~~should~~can be analyzed to enhance value through the addition of valuable information and knowledge. The heterogeneity of city domain information models is a critical issue to be addressed for ~~the~~its successful implementation. SDOs actively work to resolve ~~the~~ heterogeneity issues for better interoperability, presenting reference models and guidelines for data exchange and sharing. The complexities of exchanging and sharing city domain information models ~~require~~requires a multifaceted approach to standardization, not confined to a single standard domain. This document explores ~~three domain~~ standards and standardization activities from three domains relevant to the exchange and sharing of city information.

4.2 Smart city standards and standardization activities

— ISO/IEC JTC 1/WG 11 - Smart cities: JTC 1/WG 11 leads JTC 1's ~~Smart Cities~~smart cities standardization program, addressing the need for smart city ICT standards and advancing projects on ~~Smart City~~smart city ICT ~~Reference Architecture, Semantic Interoperability,~~reference architecture, semantic interoperability and ~~Open City Data.~~open city data. The ICT standards developed by JTC 1/WG 11 focus on six topics, ~~with~~including "SmC (Smart City) Knowledge Management" which is closely related to exchanging and sharing city domain information models (see Figure 1~~(See Figure1).~~). The ISO/IEC 5087 series aims to achieve semantic interoperability with three levels: foundation (ISO/IEC 5087-1~~),~~), city (ISO/IEC 5087-2~~),~~), and service (ISO/IEC 5087-~~n).~~:—[1]). This approach ensures integrated and interoperable city data, leveraging existing models and enhancing urban knowledge management. To ensure trustworthy exchange and sharing of city domain information models, smart cities need standards for evaluating the reliability of knowledge used in applications like urban planning and citizen services. The ISO/IEC 30145-~~2:2020 framework~~2framework proposes creating a trustworthiness evaluation framework, methods for data traceability, metrics for trustworthiness attributes, and practical guidelines for domain-specific knowledge (see Figure 2~~(See Figure2).~~).

[1] Under development. Stage at the time of publication: ISO/IEC WD 5087-4:2025.



Key

1 relevant area of city domain information model

Figure 1 — Relevant ~~standard~~standardization area of the city domain information model in JTC1/WG 11 works, mapping into smart city standards landscape and layers[4]