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Technical Report

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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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Foreword

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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) are actively 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.

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 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 context.

This document:

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

d) 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) highlights the standardization items to be 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 terminology databases for use in standardization at the following addresses:

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

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

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 19763-1:2023, 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

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

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

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

[SOURCE: ISO/IEC 19763-1:2023, 3.1]

3.1.6
model registry
information system for registering *models* (3.1.5)

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

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

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

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 that conform to a particular *metamodel* (3.1.4) or a particular set of *metadata* (3.1.3).

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

[SOURCE: ISO/IEC 19763-6:2015, 4.1.6 — "(RS)" has been added]

3.1.10
registry of registries
RoR
registry that stores *registry summary* (3.1.9) data showing an individual registry system

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

3.2 Abbreviated terms

API	application programming interface
BIM	building information modeling
CaLAThe	cadastre and land administration thesaurus
CRS	coordinate reference systems
EPSG	european petroleum survey group
ETSI	european telecommunications standards institute
FAIR	findable, accessible, interoperable, and reusable
GDF	geographic data files
GIS	geographic information systems
GML	geography markup language
ICT	information and communication technology
INSPIRE	infrastructure for spatial information in europe
IoT	internet of things
JSON	javascript object notation
LADM	land administration domain model
MDR	metadata registry
MFI	meta-model framework for interoperability
MIMs	minimal interoperability mechanisms
NGSI-LD	next generation service interface with linked data
OASC	open & agile smart cities
OGC	open geospatial consortium
RoR	registry of registries
RS	registry summary
SDI	spatial data infrastructure
UML	unified modeling language
WFS	web feature service
W3C	world wide web consortium
XML	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 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 its successful implementation. SDOs actively work to resolve 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 requires a multifaceted approach to standardization, not confined to a single standard domain. This document explores 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 standardization program, addressing the need for smart city ICT standards and advancing projects on smart city ICT reference architecture, semantic interoperability and open city data. The ICT standards developed by JTC 1/WG 11 focus on six topics, including "SmC (Smart City) Knowledge Management" which is closely related to exchanging and sharing city domain information models (see Figure 1). 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:—[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 30145-2framework proposes creating a trustworthiness evaluation framework, methods for data traceability, metrics for trustworthiness attributes, and practical guidelines for domain-specific knowledge (see Figure 2).

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