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Information technology — City data model —

Part 1: Foundation level concepts

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Foreword

ISO (the International Organization for Standardization) and IEC (the International Electrotechnical Commission) form the specialized system for worldwide standardization. National bodies that are members of ISO or IEC participate in the development of International Standards through technical committees established by the respective organization to deal with particular fields of technical activity. ISO and IEC technical committees collaborate in fields of mutual interest. Other international organizations, governmental and non-governmental, in liaison with ISO and IEC, also take part in the work.

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This document was prepared by Joint Technical Committee ISO/IEC JTC 1, *Information technology*.

A list of all parts in the ISO/IEC 5087 series can be found on the ISO and IEC websites.

Any feedback or questions on this document should be directed to the user's national standards body. A complete listing of these bodies can be found at www.iso.org/members.html and www.iec.ch/national-committees.

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Introduction

The intended audience for this document includes municipal information systems departments, municipal software designers and developers, and organizations that design and develop software for municipalities.

Cities today face a challenge of how to integrate data from multiple, unrelated sources where the semantics of the data are imprecise, ambiguous and overlapping. This is especially true in a world where more and more data are being openly published by various organizations. A morass of data is increasingly becoming available to support city planning and operations activities. In order to be used effectively, it is necessary for the data to be unambiguously understood so that it can be correctly combined, avoiding data silos. Early successes in data "mash-ups" relied upon an independence assumption, where unrelated data sources were linked based solely on geospatial location, or a unique identifier for a person or organization. More sophisticated analytics projects that require the combination of datasets with overlapping semantics entail a significantly greater effort to transform data into something useable. It has become increasingly clear that integrating separate datasets for this sort of analysis requires an attention to the semantics of the underlying attributes and their values.

A common data model enables city software applications to share information, plan, coordinate and execute city tasks, and support decision making within and across city services, by providing a precise, unambiguous representation of information and knowledge commonly shared across city services. This requires a clear understanding of the terms used in defining the data, as well as how they relate to one another. This requirement goes beyond syntactic integration (e.g. common data types and protocols), it requires semantic integration: a consistent, shared understanding of the meaning of information.

To motivate the need for a standard city data model, consider the evolution of cities. Cities deliver physical and social services that have traditionally operated as silos. If during the process of becoming smarter, transportation, social services, utilities, etc. were to develop their own data models, the result would be smarter silos. To create truly smart cities, data needs to be shared across these silos. This can only be accomplished through the use of a common data model. For example, "Household" is a category of data that is commonly used by city services. Members of Households are the source of transportation, housing, education and recreation demand. This category represents who occupies a home, their age, their occupations, where they work, their abilities, etc. Though each city service can potentially gather and/or use different aspects of a Household, much of the data needs to be shared with each other.

Supporting this interoperability among city datasets is particularly challenging due to the diversity of the domain, the heterogeneity of its data sources, and data privacy concerns and regulations. The purpose of this document is to support the precise and unambiguous specification of city data using the technology of ontologies[1],[2] as implemented in the Semantic Web[3]. By doing so it will:

— enable the computer representation of precise definitions, thereby reducing the ambiguity of interpretation;

— remove the independence assumption, thereby allowing the world of Big Data, open source software, mobile apps, etc., to be applied for more sophisticated analysis;

— achieve semantic interoperability, namely the ability to access, understand, merge and use data available from datasets spread across the Semantic Web;

— enable the publishing of city data using Semantic Web and ontology standards, and

— enable the automated detection of city data inconsistency, and the root causes of variations.

With a clear semantics for the terminology, it is possible to perform consistency analysis, and thereby validate the correct use of the document.

Figure 1 identifies the three levels of the ISO/IEC 5087 series. The lowest level, defined in ISO/IEC 5087-1 (this document) provides the classes, properties and logical computational definitions for representing the concepts that are foundational to representing any data. The middle level, defined

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in ISO/IEC 5087-2:—[1)], will provide the classes, properties and logical computational definitions for representing concepts common to all cities and their services but not specific to any service. The top level provides the classes, properties and logical computational definitions for representing service domain specific concepts that are used by other services across the city. For example, ISO/IEC TS 5087-3:—[2)], will define the transportation concepts. In the future, additional parts will be added to the ISO/IEC 5087 series covering further services such as education, water, sanitation, energy, etc.

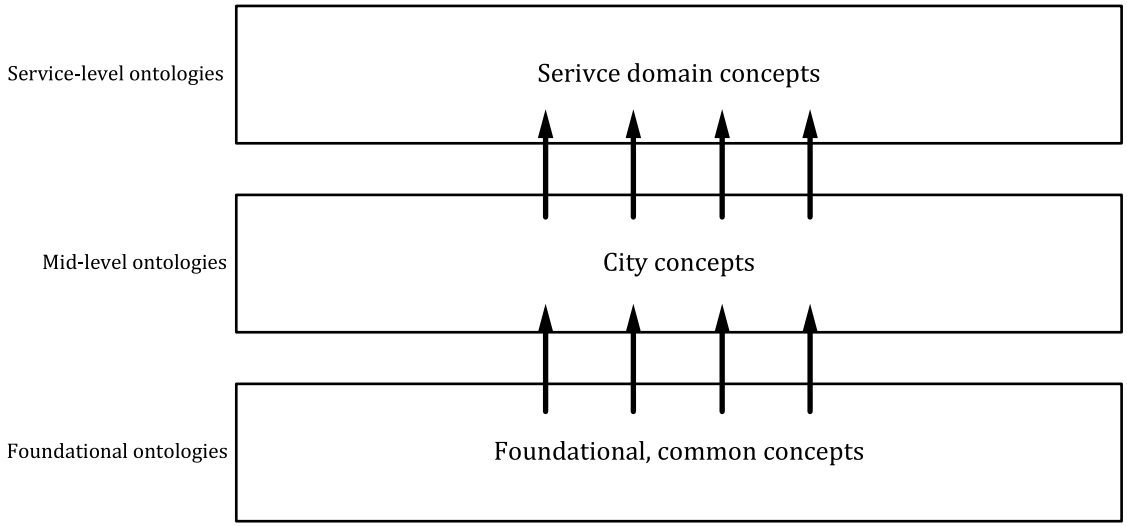


Figure 1 — Stratification of city data model

Figure 2 depicts example concepts for the three levels.

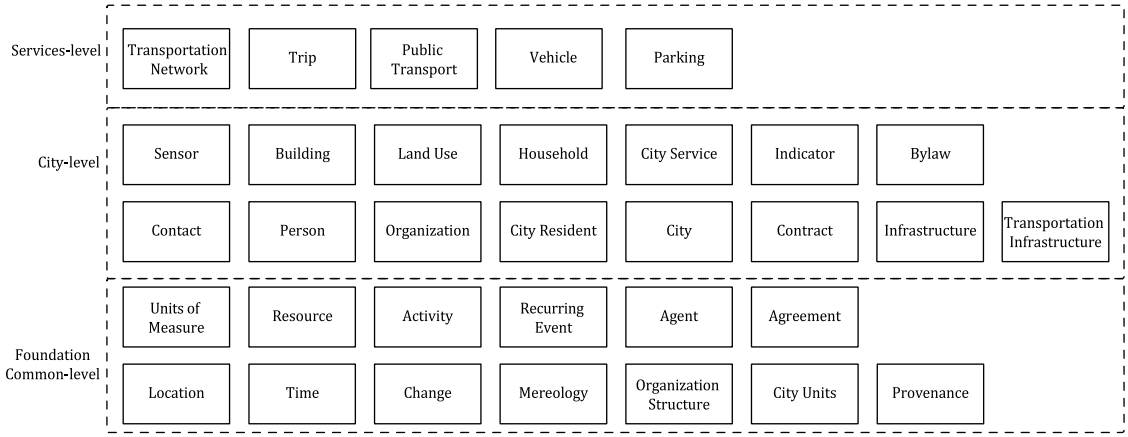


Figure 2 — Example concepts for each level

It is important to distinguish between the ISO/IEC 5087 series and the related, but distinct effort of ISO/IEC 30145-2. As specified in its Scope, ISO/IEC 30145-2:2020 "*specifies a generic knowledge management framework for a smart city, focusing on creating, capturing, sharing, using and managing smart city knowledge. It also gives the key practices which are required to be implemented to safeguard the use of knowledge, such as interoperability of heterogeneous data and governance of multi-sources services within a smart city.*" Figure 3 depicts the smart city knowledge management framework as described in ISO/IEC 30145-2. The smart city domain knowledge model includes a (cross-domain) core concept model and several domain knowledge models. This document defines the foundation level of the core concept model. ISO/IEC 5087-2 is intended to address some of the core concept model and cuts across

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2) Under preparation.

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the domain knowledge models. There is a possibility that subsequent parts of the ISO/IEC 5087 series (not yet defined) will define knowledge models for the services of citizen livelihood, urban management and smart transportation illustrated in the Figure 3.

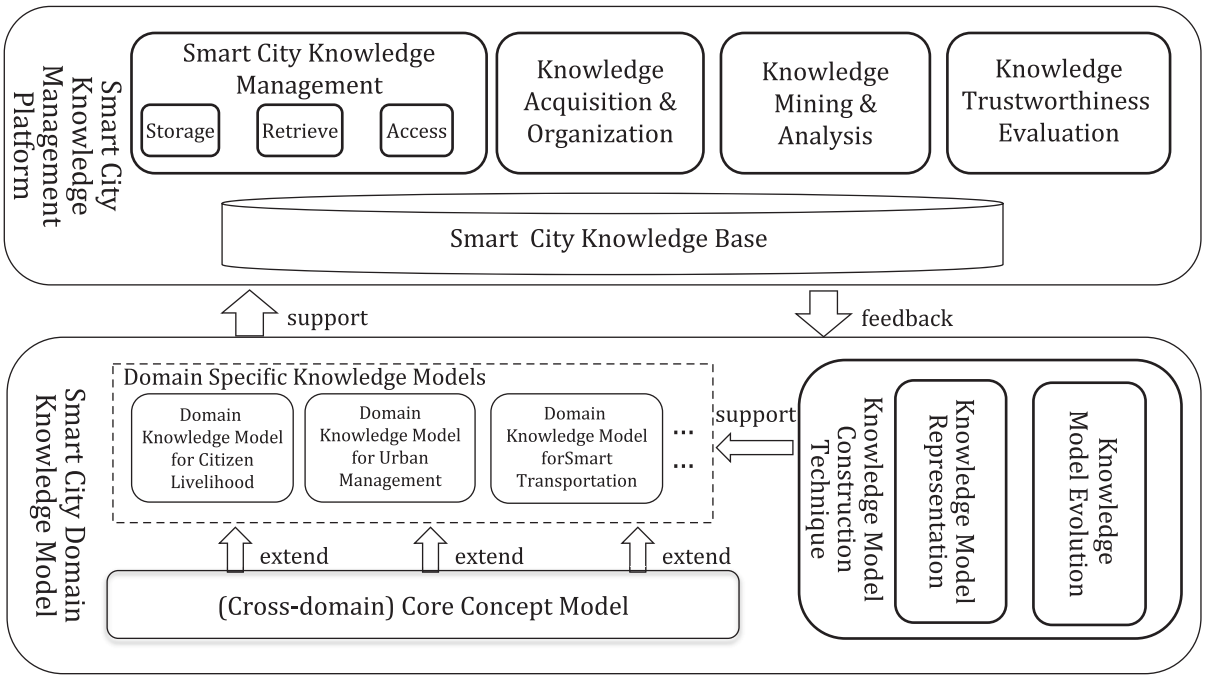


Figure 3 — The framework of smart city knowledge management from ISO/IEC 30145-2:2020

There are other existing standards that overlap conceptually with some of the terms presented in this document. The relationship between ISO/IEC 5087-1 and existing documents that address similar or related concepts is identified in Annex A.

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Information technology — City data model —

Part 1: Foundation level concepts

1 Scope

This document is part of the ISO/IEC 5087 series, which specifies a common data model for cities. This document specifies the foundation level concepts.

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/IEC 21972, *Information technology — Upper level ontology for smart city indicators*

OGC GeoSPARQL, A Geographic Query Language for RDF Data, OGC 11-052r4, Open Geospatial Consortium, 10 September 2012. https://www.ogc.org/standards/geosparql

The Ontology in OWL, W3C Candidate Recommendation 26 March 2020, https://www.w3.org/TR/owl-time/

PROV-O. The PROV Ontology, W3C Recommendation 30 April 2013, https://www.w3.org/TR/prov-o/

The Organization Ontology, W3C Recommendation 16 January 2016, https://www.w3.org/TR/vocaborg/

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
cardinality
number of elements in a set

[SOURCE: ISO/TS 21526:2019, 3.11]

3.2
description logic
DL
family of formal knowledge representation languages that are more expressive than propositional logic but less expressive than first-order logic

[SOURCE: ISO/IEC 21972:2020, 3.2]

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