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Geographic information — Reference model —

Part 1: **Fundamentals**

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Contents

Page

Foreword

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International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 2.

The main task of technical committees is to prepare International Standards. Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.

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ISO 19101-1 was prepared by Technical Committee ISO/TC 211, *Geographic information/Geomatics*.

This second edition cancels and replaces the first edition (ISO 19101:2002).

ISO 19101 consists of the following parts, under the general title *Geographic information — Reference model*:

— *Part 1: Fundamentals*

— *Part 2: Imagery*

Introduction

Beyond the needs within traditional applications of digital geographic information, users of information technology recognize that indexing by location is fundamental in the organization and the use of digital data. Nowadays, digital data from multiple sources of a wide variety are being referenced to locations and used in various applications. Such data are now extensively distributed and shared over the Web. In fact, the Web is an important source of knowledge in which geographic information plays a significant role. Standardization in the field of geographic information is therefore imperative to support and simplify the sharing and usage of geographic information of different sources, i.e. interoperability.

Standardization in geographic information is a complex task that addresses multiple aspects encompassing the definition of interoperability of geographic information, fundamental data types such as for spatial and temporal information, modelling rules, the semantics of real world phenomena, metadata, services, etc. As such, a reference model is required in order to achieve this task in an integrated and consistent manner. A reference model in geographic information consists of a comprehensive view providing an abstract description of the elements that may compose the field of geographic information and their interrelations. One of the primary goals of this reference model is to define and describe interoperability of geographic information addressing system, syntactic, structural, and semantic levels. The definition of interoperability of geographic information will then serve as the underpinning for standardization in geographic information. It contributes to:

— increase the understanding and usage of geographic information;

— increase the availability, access, integration and sharing of geographic information;

— promote the efficient, effective and economic use of digital geographic information and associated hardware and software systems;

— enable a unified approach to addressing global ecological and humanitarian problems.

This International Standard defines the ISO reference model dealing with geographic information. This reference model provides a guide to structuring geographic information standards in a way that it will enable the universal usage of digital geographic information. It sets out the fundamentals for standardization in geographic information including description, management, and services, and how they are interrelated to support interoperability within the geographic information realm and beyond to ensure interoperability with other information communities. As such, this standard develops a vision for the standardization in geographic information from which it would be possible to integrate geographic information with other types of information and conversely.

The reference model is organized in five parts. The first part (Clause 5) describes interoperability in the context of geographic information from a communication and an e-government perspective. The second part (Clause 6) identifies the foundations of the reference model and sets the scope, (requirements) for the ISO geographic information standardization activities. The third part (Clause 7) identifies the requirement for the abstraction of the real world. The reference model for ISO standardization in geographic information is specified in the fourth part (Clause 8) along with its specific requirements. Finally, profiles related to ISO geographic information standards are introduced in the fifth part (Clause 9).

This International Standard is the first part of the reference model. Additional parts may be developed to address concerns, elements, and structures in distinct areas. As such, the Part 2 of the reference model addresses specific aspects on imagery.

To achieve these goals, standardization of geographic information in the ISO geographic information standards is based on the integration of the concepts of geographic information with those of information technology. The development of standards for geographic information must consider the adoption or

adaptation of generic information technology standards whenever possible. It is only when this cannot be done that the development of geographic information standards becomes required.

This International Standard identifies a generic approach to structuring the ISO geographic information standards. This reference model uses concepts from the Open Distributed Processing – Reference Model (RM ODP) described in ISO/IEC 10746-1 [17] and other relevant ISO standards and technical reports. This International Standard does not prescribe any specific products or techniques for implementing geographic information systems.

This International Standard is intended to be used by information system analysts, program planners and developers of geographic information standards that are related to ISO geographic information standards, as well as others in order to understand the basic principles of this series of standards and the overall requirements for standardization of geographic information.

This edition of the reference model differs from its previous edition by having a specific focus on the semantic aspects related to interoperability of geographic information by the way of ontologies and knowledge. As such, the definition of interoperability has been revisited in the context of communication. Three foundations for interoperability of geographic information are identified. Based on these foundations and the usual four levels of abstraction, a new conceptual framework is introduced to support the organization of the reference model. The architectural aspect of the previous reference model has been removed in this reference model and will be addressed more specifically in a revision of ISO 19119:2005, Geographic information – Services. This version of the reference model has no backward compatibility impact on the ISO geographic information suite of standards.

Geographic information — Reference model —

Part 1:
Fundamentals

1 Scope

This International Standard defines the reference model for standardization in the field of geographic information. This reference model describes the notion of interoperability and sets forth the fundamentals by which this standardization takes place.

The description of the reference model is supported by a conceptual framework. The conceptual framework is a mechanism to structure the scope of the standardization activity in geographic information according to the interoperability description. It identifies the various facets of standardization and the relationships that exist between them.

This reference model settles the role of semantics, how the new technologies such as the Web and many emerging ways of accessing it, and how the Semantic Web can support interoperability in the field of geographic information. It also provides an umbrella under which additional specific reference models on particular facets of geographic information standardization would be required.

Although structured in the context of information technology and information technology standards, this International Standard is independent of any application development method or technology implementation approach.

2 Conformance

General conformance and testing requirements for the ISO geographic information standards are described in ISO 19105.

Any standards and profiles claiming conformance to this International Standard shall satisfy all the requirements described in the abstract test suites in Annex A.

Additional specific conformance requirements are described in individual ISO geographic information standards.

3 Normative reference

This International Standard does not prescribe any normative reference. Specific normative references will be identified as part of each standard developed under this reference model.

4 Terms, definitions and abbreviations

4.1 Terms and definitions

4.1.1
application
manipulation and processing of data in support of user requirements

4.1.2
application schema
conceptual schema (4.1.6) for data required by one or more **applications** (4.1.1)

4.1.3
base standard
ISO **geographic information** (4.1.18) standard or other information technology standard that is used as a source from which a **profile** (4.1.25) may be constructed

[ISO 19106:2004, 4.2]

4.1.4
conceptual formalism
set of modelling concepts used to describe a **conceptual model** (4.1.5)

EXAMPLES UML meta model, EXPRESS meta model.

NOTE One conceptual formalism can be expressed in several **conceptual schema languages** (4.1.7).

4.1.5
conceptual model
model that defines concepts of a **universe of discourse** (4.1.36)

4.1.6
conceptual schema
formal description of a **conceptual model** (4.1.5)

4.1.7
conceptual schema language
formal language based on a **conceptual formalism** (4.1.4) for the purpose of representing **conceptual schemas** (4.1.5)

EXAMPLES UML, EXPRESS, IDEF1X

NOTE A conceptual schema language may be lexical or graphical. Several conceptual schema languages can be based on the same conceptual formalism.

4.1.8
coverage
feature (4.1.11) that acts as a function to return values from its range for any direct position within its spatial, temporal or spatiotemporal domain

EXAMPLE Examples include a **raster** (4.1.28) image, polygon overlay or digital elevation matrix.

NOTE In other words, a coverage is a feature that has multiple values for each attribute type, where each direct position within the geometric representation of the feature has a single value for each attribute type.

[ISO 19123:2005, 4.1.7]

4.1.9
dataset
identifiable collection of data

[ISO 19115:2003, 4.2]

4.1.10
e-government
digital interaction between a government and citizens, government and businesses, and between government agencies

4.1.11
feature
abstraction of real world phenomena

NOTE A feature may occur as a type or an instance. Feature type or feature instance will be used when only one is meant.

4.1.12
feature attribute
characteristic of a **feature** (4.1.11)

EXAMPLE 1 A feature attribute named “colour” may have an attribute value “green” which belongs to the data type “text”.

EXAMPLE 2 A feature attribute named “length” may have an attribute value “82.4” which belongs to the data type “real”.

NOTE 1 A feature attribute has a name, a data type and a value domain associated to it. A feature attribute for a **feature instance** (4.1.14) also has an attribute value taken from the value domain.

NOTE 2 In a **feature catalogue** (4.1.13), a feature attribute may include a value domain but does not specify attribute values for feature instances.

NOTE 3 In UML, attributes, associations and operations are representation types and are not fundamental to the type of a characteristic nor to the type of feature. All three are equally capable of representing the same characteristic of a feature. Every implementation of a characteristic is allowed to use the representation type that is most appropriate and may use several different representations for a single characteristic if required. Feature associations and **feature operations** (4.1.15), therefore, are different types of feature attribute, the distinction between them being based on storage and access mechanisms rather than semantics.

4.1.13
feature catalogue
catalogue containing definitions and descriptions of the **feature types** (4.1.16), **feature attributes** (4.1.12) and feature relationships occurring in one or more sets of geographic data, together with any **feature operations** (4.1.15) that may be applied

4.1.14
feature instance
individual of a given **feature type** (4.1.16) having specified **feature attribute** (4.1.12) values

4.1.15
feature operation
operation that every instance of a **feature type** (4.1.16) may perform

[ISO 19110:2005, 4.5]

EXAMPLE 1 A feature operation upon a “dam” is to raise the dam. The results of this operation are to raise the height of the "dam" and the level of water in a "reservoir".

NOTE Feature operations provide a basis for feature type definition.

4.1.16
feature type
class of **features** (4.1.11) having common characteristics

[ISO 19156:2011, 4.7]

4.1.17
functional standard
existing **geographic information** (4.1.18) standard, in active use by an international community of data producers and data users

NOTE GDF, S-57 and DIGEST are examples of functional standards.

4.1.18
geographic information
information concerning phenomena implicitly or explicitly associated with a location relative to the Earth

4.1.19
geographic information service
service (4.1.34) that transforms, manages, or presents **geographic information** (4.1.18) to users

4.1.20
geographic information system
information system (4.1.22) dealing with information concerning phenomena associated with location relative to the Earth

4.1.21
graphical language
language whose syntax is expressed in terms of graphical symbols

4.1.22
information system
an information processing system, together with associated organizational resources such as human, technical, and financial resources, that provides and distributes information

[ISO/IEC 2382-1:1993, 01.01.22]

4.1.23
lexical language
language whose syntax is expressed in terms of symbols defined as character strings

4.1.24
ontology
formal representation of phenomena of a **universe of discourse** (4.1.36) with an underlying vocabulary including definitions and axioms that make the intended meaning explicit and describe phenomena and their interrelationships

4.1.25
profile
set of one or more **base standards** (4.1.3) or subsets of base standards, and, where applicable, the identification of chosen clauses, classes, options and parameters of those base standards, that are necessary for accomplishing a particular function

[ISO 19106:2004, 4.5]

4.1.26
quality
degree to which a set of inherent characteristics fulfils requirements

NOTE 1 The term "quality" can be used with adjectives such as poor, good or excellent.

NOTE 2 "Inherent", as opposed to "assigned", means existing in something, especially as a permanent characteristic.

[ISO 9000:2005, 3.1.1]

4.1.27
quality schema
conceptual schema (4.1.6) defining aspects of **quality** (4.1.26) for geographic data

4.1.28
raster
usually rectangular pattern of parallel scanning lines forming or corresponding to the display on a cathode ray tube

NOTE A raster is a type of grid.

[ISO 19123:2005, 4.1.30]

4.1.29
reasoning
comprehending, inferring, or thinking especially in orderly rational ways

4.1.30
reference model
framework for understanding significant relationships among the entities of some environment, and for the development of consistent standards or specifications supporting that environment

NOTE A reference model is based on a small number of unifying concepts and may be used as a basis for education and explaining standards to a non-specialist.

[ISO 14721:2003, 1.7.2.63, adapted to conform to standard of terminology layout]

4.1.31
register
set of files containing identifiers assigned to items with descriptions of the associated items

[ISO 19135:2005, 4.1.9]

4.1.32
schema
formal description of a model

4.1.33
Semantic Web
Web (4.1.38) of data with meaning

NOTE The association of meaning allows data and information to be understood and processed by automated tools as well as by people.

4.1.34
service
distinct part of the functionality that is provided by an entity through interfaces

[ISO 19119:2005, 4.1]

4.1.35
tessellation
partitioning of a space into a set of conterminous subspaces having the same dimension as the space being partitioned

NOTE A tessellation composed of congruent regular polygons or polyhedra is a regular tessellation. One composed of regular, but non-congruent polygons or polyhedra is a semi-regular tessellation. Otherwise, the tessellation is irregular.

[ISO 19123:2005, 4.1.39]