INTERNATIONAL STANDARD

ISO 19123-1

First edition
2023-06

Geographic information — Schema for coverage geometry and functions —

Part 1: **Fundamentals**

Information géographique — Schéma de la géométrie et des fonctions de couverture —

Partie 1: Principes de base

Reference number
ISO 19123-1:2023(E)

© ISO 2023



COPYRIGHT PROTECTED DOCUMENT

© ISO 2023

All rights reserved. Unless otherwise specified, or required in the context of its implementation, no part of this publication may be reproduced or utilized otherwise in any form or by any means, electronic or mechanical, including photocopying, or posting on the internet or an intranet, without prior written permission. Permission can be requested from either ISO at the address below or ISO's member body in the country of the requester.

ISO copyright office
CP 401 • Ch. de Blandonnet 8
CH-1214 Vernier, Geneva
Phone: +41 22 749 01 11
Email: copyright@iso.org
Website: www.iso.org

Published in Switzerland

© ISO 2023 – All rights reserved

Contents

Page

Foreword ..... **v**
Introduction ..... **vii**
1 Scope **1**
2 Normative references **1**
3 Terms, definitions, abbreviated terms and notation **1**
3.1 Terms and definitions 1
3.2 Abbreviated terms 8
4 Conformance **8**
4.1 Notation 8
4.2 Interoperability and conformance testing 9
4.3 Organization 9
5 Coverages **10**
5.1 Overview 10
5.2 Coverage packages 11
5.3 Probing coverages: evaluate() function 12
5.4 Domain of a coverage 12
5.4.1 Concept 12
5.4.2 Coordinates 13
5.4.3 Mathematical versus physical coordinates 14
5.4.4 Coordinate reference systems and axes 14
5.4.5 Coverage classification along topological dimensions 16
5.5 Range of a coverage 16
5.6 Interpolation 17
5.6.1 Concept 17
5.6.2 Discrete and continuous coverages 18
5.7 Common point rule 19
5.8 Realization variants 19
5.8.1 Overview 19
5.8.2 Geometry/value pair view 19
5.8.3 Domain/range view 20
5.8.4 Partitioned view 21
5.8.5 Functional view 21
5.9 Envelope 21
6 Multi-point coverages **22**
7 Grid coverages **23**
7.1 Overview 23
7.2 Grids 24
7.2.1 Grid definition 24
7.2.2 Grid axis types 27
7.3 Rectified and referenceable grid coverages 30
7.4 Grid cells 31
7.4.1 Grid cell concept 31
7.4.2 Pixel-in-centre, pixel-in-corner 32
7.5 Grid coverage 32
7.6 Further grid coverage types 33
8 Multi-curve coverages **34**
8.1 Overview 34
8.2 General multi-curve coverages 35
8.3 Segmented curve coverages 35
9 Multi-surface coverages **36**
9.1 Overview 36

© ISO 2023 – All rights reserved

9.2 General multi-surface coverages 36
9.3 Further surface coverages 37
9.3.1 General 37
9.3.2 Thiessen polygon coverages 37
9.3.3 Triangulated irregular networks (TINs) 38
10 Multi-solid coverages **39**
Annex A (normative) **Conformance tests** **41**
Annex B (informative) **Interpolation methods** **45**
Annex C (informative) **Sequential enumeration** **49**
Annex D (normative) **Legacy data-centric coverage specification** **60**
Bibliography **77**

© ISO 2023 – All rights reserved

Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular, the different approval criteria needed for the different types of ISO document should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives).

ISO draws attention to the possibility that the implementation of this document may involve the use of (a) patent(s). ISO 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, ISO 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 www.iso.org/patents. ISO shall not be held responsible for identifying any or all such patent rights.

Any trade name used in this document is information given for the convenience of users and does not constitute an endorsement.

For an explanation of the voluntary nature of standards, the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT), see www.iso.org/iso/foreword.html.

This document was prepared by Technical Committee ISO/TC 211, *Geographic information/Geomatics*, 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), in collaboration with the Open Geospatial Consortium (OGC), and in collaboration with the IEEE GRSS Earth Science Informatics Technical Committee.

This first edition cancels and replaces ISO 19123:2005, which has been technically revised.

The main changes are as follows:

— the document has been renamed as “Part 1: Fundamentals”, since a new “Part 2: Coverage Implementation Schema” has been published;

— the text has been simplified for better understanding;

— concepts, while in principle unchanged, have been defined more rigorously and some errors have been corrected;

— the approach to standardization taken in this document has been changed. This edition of the document defines a high-level, generic concept of coverages with an interface definition from which many different (not necessarily interoperable) implementation structures can be derived. The previous edition of this document, ISO 19123:2005, defined a single generic data structure for coverages. The previous model remains valid as one of the many possible data structures that can implement the ISO 19123-1 interface. This data structure, which is defined in Annex D, supports backward compatibility. Standardization targets that referenced ISO 19123 can continue referencing those same classes, although new realizations are not encouraged to do so. It is noted, however, that the coverage definition terms in Clause 3 which are owned by other documents have been updated to refer to newer editions of the documents (including their definitions) where such newer editions are available;

© ISO 2023 – All rights reserved

— all operations except *evaluate*() have been removed, for simplification purposes. ISO 19123-3 now specifies the operations requirements;

— the Scope has been extended to include Mesh;

— the concept of discrete and continuous coverages has been generalized to achieve an improved conceptual basis and to allow for coverages which are discrete along some domain axes and continuous along other domain axes. This is achieved by using the coordinate reference system axes as the basis for the definitions so that any axis individually can be discrete or continuous. Since this is a generalization of the previous concept it is backward compatible. As a side effect, this reworking has greatly simplified the structure of this document;

— updates in ISO 19103 have been reflected, and corresponding adjustments have been made where necessary. The informative Annex on “UML notation” has been deleted since UML notation is now described in ISO 19103;

— all coordinate-related definitions are based on ISO 19111, and corresponding adjustments have been made to this document as necessary;

— the definition of image CRS has been moved from ISO 19111 to this document;

— the definition of interpolation is based on the interpolation definition of ISO 19107 in order to avoid duplicate and diverging definitions;

— the UML diagrams have been redrawn for clarity, in order to correct errors, and to follow the new conventions established in ISO/TC 211;

— the bibliography has been revised to include additional references and has been reformatted.

A list of all parts in the ISO 19123 series can be found on the ISO website.

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.

© ISO 2023 – All rights reserved

Introduction

This document defines, at a high, implementation-independent level, the notion of coverages as digital representations of space-time varying phenomena, corresponding to the notion of a field in physics. Such coverages can be discrete or continuous.

Historically, geographic information has been treated in terms of two fundamental data types called "vector data" and "raster data".

"Vector data" deals with discrete phenomena, each of which is conceived of as a feature. The spatial characteristics of a discrete real-world phenomenon are represented by a set of one or more geometric primitives (points, curves, surfaces or solids). Other characteristics of the phenomenon are recorded as feature attributes. Usually, a single feature is associated with a single set of attribute values. ISO 19107 provides a schema for describing features in terms of geometric and topological primitives.

"Raster data", on the other hand, deals with phenomena that vary over space and time, mathematically described by “fields”. It contains a set of values, each associated with one of the elements in an array of points or cells. Raster data is often associated with a method for interpolating values at spatial positions between the points or within the cells.

The coverage concept, originally adopted from the Abstract Specification of the Open Geospatial Consortium (OGC),[15] generalizes these and further data structures, such as point clouds, into a model for representing phenomena that vary continuously over space and time, and possibly over further dimensions such as spectral bands. Formally, a coverage is a function from a spatial (such as horizontal x and y and vertical height or depth), temporal, other (in ISO 19111:2019 nomenclature: parametric) domain or any combination thereof to values of some data type.

A coverage consists of a set of spatio-temporally extended geometric (often geographic) objects, each with associated attribute values. The spatio-temporal locations with which attribute values are associated are called “direct positions”.

Formally, a coverage itself is a subtype of a feature as defined in ISO 19101-1. The coverage feature is a set of features all sharing some key properties, such as the same attribute definition and coordinate reference system.

NOTE Direct positions can be of different dimensions. For example, in a raster image modelled as a coverage, the direct positions will be the grid points; in a multi-solid coverage a direct position is given by the interior of a 3D solid.

In practice, coverages encompass regular and irregular grids, point clouds and general meshes. Examples include raster data, point clouds, meshes such as triangulated irregular networks and polygon sets. Coverages are multi-dimensional, including examples such as 1D sensor timeseries, 2D satellite images, 3D x/y/t image timeseries and x/y/z geophysical voxel data, and 4D x/y/z/t climate and ocean data. Coordinate axes of such coverages can have spatial, temporal, or any other meaning, and they can be combined freely for *n*-dimensional coverages.

EXAMPLE The electromagnetic spectrum is an example of an axis with neither spatial nor temporal semantics. Such a spectral axis can be defined as a “parametric CRS” as established in ISO 19111.

A coverage which provides values only at the direct positions is called “a discrete coverage”. If interpolation information is added so that values can be obtained also between the coverage’s direct positions, such a coverage is called “a continuous coverage”.

Just as the concepts of discrete and continuous phenomena are not mutually exclusive, their representations as discrete coverages are not mutually exclusive. The same phenomenon can be represented as either a discrete feature or a coverage, depending on the particular context and requirements. A city can be viewed as a discrete coverage that returns a single value for each attribute, such as its name, area and total population, but it can also be represented as a continuous coverage that returns values such as population density, land value or air quality index for each location in the city.

© ISO 2023 – All rights reserved

A coverage, moreover, can be derived by bundling a collection of discrete features sharing a common attribute definition, the values of the coverage at each position being the values of the attributes of the feature located at that position. Conversely, a collection of discrete features can be derived from a coverage by extracting all direct positions with their associated attribute values.

The previous edition of this document, ISO 19123:2005, addressed coverage modelling on both a conceptual and (to some extent) an implementation level, effectively mixing both. Coverage modelling has now been split into two separate, but related documents: ISO 19123-1 (this document), which establishes an abstract, high-level coverage model, and ISO 19123-2, which establishes an implementation-level model ensuring interoperability, based on the concepts of ISO 19123-1. A corresponding high-level processing model for coverages is defined in ISO 19123-3.

© ISO 2023 – All rights reserved

Geographic information — Schema for coverage geometry and functions —

Part 1: Fundamentals

1 Scope

This document defines a conceptual schema for coverages. A coverage is a mapping from a spatial, temporal or spatiotemporal domain to attribute values sharing the same attribute type. A coverage domain consists of a collection of direct positions in a coordinate space that can be defined in terms of spatial and/or temporal dimensions, as well as non-spatiotemporal (in ISO 19111:2019, "parametric") dimensions. Examples of coverages include point clouds, grids, meshes, triangulated irregular networks, and polygon sets. Coverages are the prevailing data structures in a number of application areas, such as remote sensing, meteorology and mapping of depth, elevation, soil and vegetation. This document defines the coverage concept including the relationship between the domain of a coverage and its associated attribute range. This document defines the characteristics of the domain. The characteristics of the attribute range are not defined in this document, but are defined in implementation standards. Consequently, the standardization target of this document consists of implementation standards, not concrete implementations themselves.

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 19103, *Geographic information — Conceptual schema language*

ISO 19107, *Geographic information — Spatial schema*

ISO 19111, *Geographic information — Referencing by coordinates*

3 Terms, definitions, abbreviated terms and notation

3.1 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/

3.1.1
analytical coverage
coverage where the mapping function from domain to range is given by an analytical mathematical function

© ISO 2023 – All rights reserved