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**Geographic information –
Schema for coverage geometry and functions –
Fundamentals;
Text in English**

Geoinformationen –
Schema für Coverage und Funktionen –
Grundlagen;
Text Englisch

Information géographique –
Schéma de la géométrie et des fonctions de couverture –
Principes de base;
Texte en anglais

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Foreword

This DIN SPEC has been developed according to the PAS procedure. The development of a DIN SPEC according to the PAS procedure is carried out in workshops and does not require the participation of all stakeholders.

This document has been developed and adopted by the initiator(s) and authors named below:

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Introduction

This DIN SPEC draft in accordance with the PAS procedure was developed within a workshop set up on a temporary basis. The draft was developed and approved by the authors named in the foreword.

This DIN SPEC defines concepts for describing spatio-temporally extended objects where information content depends on (and varies with) the particular coordinate where it is probed. Standardization in this area is the cornerstone for other geographic information design, specification and standardization.

Such space-time varying objects are described as sets of geographic objects (“features”), called *coverages*. The feature objects collected in a coverage define the positions where values are available (called Direct Positions), and the individual values associated with each feature.

NOTE Direct Positions can be of different dimension. For example, in a raster image modelled as a coverage the Direct Positions will be the grid points (topological dimension 0); in a Multi-Solid Coverage a Direct Position is given by the interior of a 3D solid (topological dimension 3).

As the concept of feature collections is already provided with ISO 19107 a coverage can be seen as a special type of feature. However, coverages are not just arbitrary feature collections but impose homogeneity – most importantly, all features contained are of the same type, their coordinates are expressed in the same CRS, and the values associated with the features all have the same type.

In practice, coverages encompass regular and irregular grids, point clouds, and general meshes. Examples include raster data, triangulated irregular networks, point sets and polygon coverages. Coverages are multi-dimensional, including examples like 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. Axes of such coverages can have spatial, temporal, or any other dimension, and they can be combined freely.

EXAMPLE The electromagnetic spectrum is an example for an axis with neither spatial nor temporal semantics. As such a spectral axis can be defined following the rules of ISO 19111-1 it qualifies for a coverage axis.

A coverage which provides values only at the Direct Positions is called “discrete”; if interpolation information is added so that values can be obtained also beyond the coverage’s Direct Positions such a coverage is called “continuous”.

The standard ISO 19123:2007 addresses coverage modelling on both conceptual and (to some extent) physical level. For the next generation, which this document is part of, coverage modelling has been split into two separate, but connected documents: ISO 19123-1 (this document) establishes an abstract, high-level coverage model while ISO 19123-2 establishes a physical, implementation-level model ensuring interoperability, based on the concepts of ISO 19123-1.

1 Scope

This document specifies a conceptual schema for coverages. A coverage is a mapping from a spatial, temporal or spatiotemporal domain to attribute values sharing the same type within the domain. A coverage domain consists of a collection of direct positions in a coordinate space that may be defined in terms of spatial and/or temporal dimensions. Examples of coverages include meshes/grids, triangulated irregular networks, point coverages and polygon coverages. Coverages are the prevailing data structures in a number of application areas, such as remote sensing, meteorology and mapping of bathymetry, elevation, soil and vegetation. This document defines the relationship between the domain of a coverage and an associated attribute range. The characteristics of the domain are defined whereas the characteristics of the attribute range are not part of this standard.

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 19109, *Geographic information — Rules for application schema*

ISO 19111-1, *Geographic information — Spatial referencing by coordinates — Part 1: Fundamentals*

ISO 19115-1, *Geographic information — Metadata — Part 1: Fundamentals*

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 terminological databases for use in standardization at the following addresses:

- ISO Online browsing platform: available at <https://www.iso.org/obp>
- IEC Electropedia: available at <http://www.electropedia.org/>

3.1.1

axis

⟨coordinate geometry⟩ linear feature from which a 1D *coordinate system* is constructed

Note 1 to entry: This definition is established in accordance with ISO 19111-1.

3.1.2

coordinate

one of a sequence of n numbers designating the position of a *point* in n -dimensional space

[SOURCE: ISO 19111-1:2018]

3.1.3

coordinate system

⟨differential geometry, geodesy⟩ set of mathematical rules for specifying how *coordinates* are to be assigned to points

[SOURCE: ISO 19111-1:2018]

3.1.4

coordinate reference system

⟨differential geometry, geodesy⟩ *coordinate* system that is related to an object by a datum

[SOURCE: ISO 19111-1:2018]

3.1.5

coverage

feature that acts as a *function* to return values from its *range* for any *direct position* within its *domain*

3.1.6

(coverage) dimension

(coordinate) dimension

⟨coordinate geometry⟩ number of separate decisions needed to describe a position in a *coordinate system*

Note 1 to entry: An equivalent definition is “the number of axes in the coordinate reference system of the coverage domain set”.

3.1.7

domain (set)

⟨mathematics⟩ well-defined set with all elements being of a given type

3.1.8

direct position

(grid) cell

(grid coverage) cell

⟨geographic information⟩ location, given by a coordinate tuple, where the *coverage* offers a value

[SOURCE: ISO 19107:2003]

3.1.9

external coordinate reference system

coordinate reference system whose datum is independent of the object that is located by it

[SOURCE: ISO 19130-1:2018]

3.1.10

feature

⟨geographic information⟩ abstraction of real-world phenomena or entity

[SOURCE: ISO 19109:2015]

3.1.11

function

⟨mathematics, programming⟩ rule that associates each element from a *domain* (“source domain”, or “domain” of the function) to a unique element in another domain (“target domain”, “co-domain” or “range” of the function)

[SOURCE: ISO 19109:2015]

3.1.12**feature property
feature attribute**

⟨geographic information⟩ potential attribute, quality, or characteristic of a feature

[SOURCE: ISO 19109:2015]

3.1.13**geometric dimension**

⟨geometry, topology⟩ largest number n such that each point in a set of points can be associated with a subset that has that point in its interior and is topologically isomorphic to E^n , Euclidean n -space

[SOURCE: ISO 19109:2015]

3.1.14**geometric object**

⟨geometry, topology⟩ spatial object representing a *geometric set*

[SOURCE: ISO 19109:2015]

3.1.15**geometric set**

⟨geometry⟩ set of points

[SOURCE: ISO 19109:2015]

3.1.16**geometry**

ordered pair composed of a *geometric object* and a value

[SOURCE: ISO 19107:2003]

3.1.17**geometry/value pair**

ordered pair composed of a *geometric object* and a value

3.1.18**grid**

nonempty, ordered set of axes with a set of positions along each axis acting as reference point for connected compact smooth hypersurfaces at whose intersections direct positions are defined

Note 1 to entry: The original definition of ISO 19123:2005 – “network composed of one or more sets of curves in which the members of each set intersect the members of the other sets” – did not cover all cases, (such as 1D). In its intention, both definitions are identical, though.

3.1.19**mesh**

an ISO 19107 Geometry with associated ISO 19107 Topology of topological dimension greater than zero

Note 1 to entry: Mesh examples include curves, TINs, and solids. Points (and point clouds) resemble geometries with topological dimension zero.

3.1.20**native CRS (of a coverage)**

the common *CRS* in which all coordinates of a coverage are expressed

3.1.21

point

geometric object of topological dimension zero, representing a position

3.1.22

range (set)

co-domain

⟨mathematics⟩ acceptable target values of a *function*

[SOURCE: ISO 19109:2015]

3.1.23

raster

grid

Note 1 to entry: “Raster” is the historic term for gridded data, originating from the concept of a regular pixel matrix on a screen. Often raster data are processed to yield regular grids (such as orthorectified imagery), but sometimes irregular grids are of interest as well (such as raw satellite swath data and oblique imagery).

3.1.24

rectified grid

grid for which there is an affine transformation between the grid *coordinates* and the *coordinates* of an external *coordinate reference system*

Note 1 to entry: If the coordinate reference system is related to the earth by a datum, the grid is a georectified grid.

Note 2 to entry: This term, originating from ISO 19123:2005, is deprecated. Its definition is not concise enough and in practice less useful than the axis-based classification defined in this document.

3.1.25

referenceable grid

grid associated with a transformation that can be used to convert grid *coordinate* values to values of coordinates referenced to an external *coordinate reference system*

Note 1 to entry: If the coordinate reference system is related to the earth by a datum, the grid is a georeferenceable grid.

Note 2 to entry: This term, originating from ISO 19123:2005, is deprecated. Its definition is not concise enough and in practice less useful than the axis-based classification defined in this document.

3.1.26

topological dimension

minimum number of free variables needed to distinguish nearby *direct positions* within a *geometric object* from one another

[SOURCE: ISO 19107:2003]

3.1.27

tessellation

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

3.1.28

triangulated irregular network

tessellation composed of triangles

3.2 Abbreviated Terms

GIS	Geographic Information System
TIN	Triangulated Irregular Network
UML	Unified Modelling Language
URI	Uniform Resource Identifier (IETF RFC 3986)

3.3 Notation

The conceptual schema specified in this document is described using the Unified Modelling Language (UML) [12], following the guidance of ISO 19103.

Several model elements used in this schema are defined in other International Standards developed by ISO/TC 211. UML classes defined in this document have the two-letter prefix of CV. Table 2 lists the other standards and packages in which UML classes used in this document have been defined.

Table 1 — Sources of externally defined UML classes

Prefix	International Standard	Package
EX	ISO 19115-1	Extent
GF	ISO 19109	General Feature Model
GM	ISO 19107	Geometry
SC	ISO 19111-1	Spatial Coordinates

Throughout this document, classes defined here are prefixed with “CV_”. While this technique is not common in ISO any longer it is maintained for backwards compatibility with older specifications referring to coverage classes.

4 Conformance

4.1 Interoperability and Conformance Testing

This Document being abstract allows for multiple different implementations does **not** define an interoperable implementation. The abstract concepts herein can be implemented in a variety of ways which normally will not be interoperable, that is: the same abstract coverage represented through two different implementation models will not necessarily be identical in their structure, and services following two different implementation models will not necessarily deliver equivalent results on equivalent queries.

Therefore, no Abstract Test Suite is provided with this standard. Conformance testing is accomplished by manually validating a candidate concretization against all requirements of this Document.

In an implementation standard based on this abstract specification this semantics will normally be cast into a concrete data model (describing data structures to be stored, transferred, ingested, or extracted) and a concrete service model (describing the functionality of a service operating on coverages); such derived models should be designed in an interoperable manner, i.e.: allow concise conformance testing.

This Document has a companion standard, ISO 19123-2 Coverage Implementation Schema (CIS). Based on this ISO 19123-1 standard, ISO 19123-2 defines a concrete coverage model in the sense that interoperability can be guaranteed and interoperability tests (such as the OGC compliance tests on coverages [13]) can be established.

4.2 Organization

The coverage schema is organized into the packages shown in Figure 1 and Table 1; each package establishes one requirements class. Grouping into these requirements classes has been done with a practical perspective in mind: Realizations of this Document should not be forced to address the full breadth of the coverage topic as this may include massive effort. Rather, focus can be set on particular structures, such as grid coverages or point clouds, while ignoring all the other options.

Requirement: Conformant data structures shall be logically equivalent to the default constructor for those interfaces supported by a requirements class.

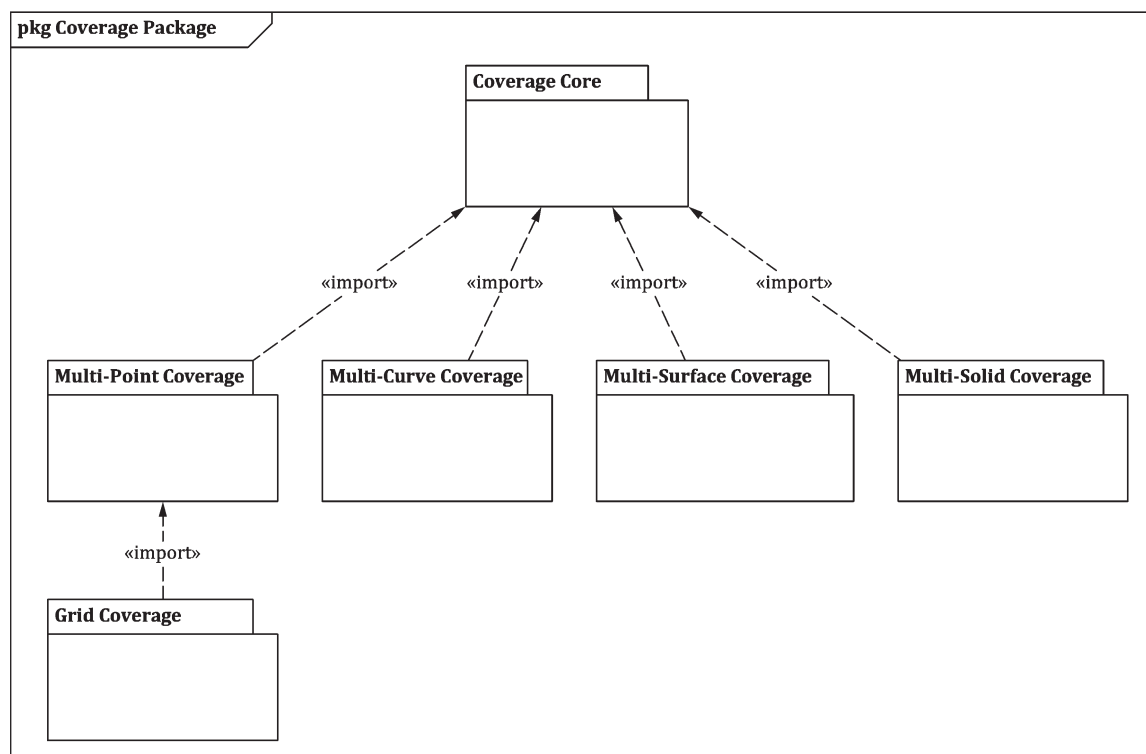


Figure 1 — Packages of the coverage schema

Table 2 — Conformance classes

Conformance class	Clause
Coverage	5
Multi-Point Coverage	6
Grid Coverage	7
Multi-Curve Coverage	8
Multi-Surface Coverage	9
Multi-Solid Coverage	10

5 Coverages

5.1 General

This Clause describes package *CV_Coverage*. It is defined using the concepts of Coordinates and Collections from ISO 19107, as well as those concepts from ISO 19107 and ISO 19111-1 on which these rely in turn.

Requirement 1: An instantiation of package *CV_Coverage* shall have all instances and properties specified for this package, its contents, and its dependencies, contained in the UML model for this package in this Document; item naming may be chosen differently as long as there is no disambiguity or disambiguation is provided.

Requirement 2: An instantiation of package *CV_Coverage* shall make use of ISO 19107 package *Coordinates*.

Requirement 3: A Coverage is an instantiation of ISO 19107 interface *Collection*, with two changes: (i) the elements association is unordered (instead of ordered, as in ISO 19107) and (ii) the code list *GeometryType* for possible geometry types is extended with values provided by the Coverage package.

The set of Direct Positions of a coverage is given by the union of all Direct Positions of its member features.

Requirement 4: For each Direct Position defined in the coverage there shall be exactly one Range Set value provided.

NOTE 1 For the case that no value should be provided for some Direct Position a NULL value should be foreseen in the Range Type.

NOTE 2 This uniqueness criterion for direct positions makes the coordinates amenable to become primary key in databases.

5.2 Coverage Terminology

5.2.1 The Coverage Structure

This Document uses the term *coverage*, adopted from the Abstract Specification of the Open GIS Consortium [1], to refer to any data representation that assigns values directly to spatial and/or temporal positions. Structurally, a coverage can be established from a collection of discrete features with common attributes, the values of the coverage at each position being the values of the attributes of the feature located at that position.

Coverages are multi-dimensional by nature – such as 1-D sensor timeseries, 2-D x/y images, 3-D x/y/t image timeseries and x/y/z geophysical information, and 4-D x/y/z/t atmospheric and oceanographic information. The dimension axes spanning the coverage's can be of spatial, temporal, or “abstract” nature (where abstract is understood in the sense of being neither spatial nor temporal), or any combination of these. As such, a coverage can be described as the digital representation of some space/time varying phenomenon.

EXAMPLE 1 A satellite image timeseries has two spatial and one temporal axis. A geo-statistical datacube may have a temporal axis, spatial extents, and population density.

The set of locations (in a wide, spatio-temporal sense) where a coverage has objects sitting and, hence, has values to offer is called the coverage's *Domain Set*, said locations are called *Direct Positions*. The set of all these values is the coverage's *Range Set*, described by the *Range Type*. Coordinates in a coverage are all expressed in one and the same Coordinate Reference System (CRS), its *Native CRS*. Such a CRS may either be defined directly (such as in the EPSG collection of CRSs [14]) or it may be composed from CRS and axis definitions through the mechanisms defined in ISO 19111-1.

EXAMPLE 2 The CRS of a satellite image timeseries consists of two spatial and one temporal axis, in some given order. Coordinates along each axis are expressed accordingly – horizontal spatial coordinates may be expressed in degrees Lat and Long, laid down in the EPSG:4326 CRS, while time is expressed in seconds since epoch or some calendar, like Gregorian-Proleptic.

In terms of common data structures coverages encompass regular and irregular grids (requirements class *Grid Coverage*), point clouds (requirements class *Multi-Point Coverage*), and general meshes (requirements classes *Multi-Curve Coverage*, *Multi-Surface Coverage*, and *Multi-Solid Coverage*).