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This draft standard is based on national and international discussions. Your comments on this draft are invited and will assist in the preparation of the consequent standard.

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1	2	(3)	4	5	(6)	7
MB	Clause No./ Subclause No./Annex (e.g. 3.1)	Paragraph/ Figure/Table/Note	Type of comment	Comment (justification for change) by the MB	Proposed change by the MB	Secretariat observations on each comment submitted
	3.1	Definition 1	ed	Definition is ambiguous and needs clarifying.	Amend to read '...so that the mains connector to which no connection...'	
	6.4	Paragraph 2	te	The use of the UV photometer as an alternative cannot be supported as serious problems have been encountered in its use in the UK.	Delete reference to UV photometer.	



DRAFT International Standard

ISO/DIS 19123-2

Geographic information — Schema for coverage geometry and functions —

Part 2: Coverage implementation schema

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

Partie 2: Schéma de la mise en place de la couverture

ICS: 35.240.70

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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 documents 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).

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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), under participation of the IEEE GRSS Earth Science Informatics (ESI) Technical Committee, and derived from the Open Geospatial Consortium (OGC) standards CIS 1.0 and CIS 1.1 with permission.

A list of all the 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 iso.org/members.html.

Introduction

This 19123-2 Coverage Implementation Schema (CIS) specifies an interoperable, conformance-testable information schema for coverages. As defined in ISO 19123-1:2023^[10] (which is equivalent to OGC Abstract Topic 6.1), coverages serve as digital representations of space-time varying phenomena, corresponding to the notion of a “field” in physics. Such coverages can be discrete or continuous. Common examples include 1-D time series, 2-D imagery, 3-D x/y/t image time series and x/y/z geophysical voxel models, as well as 4-D x/y/z/t atmospheric and ocean data. Coverages are independent from service definitions and, therefore, can be accessed through a variety of web based service types, such as the OGC Web Coverage Service (WCS) Standard,^[6] and through service instantiations realizing ISO 19123-3.

CIS is a compliant standardization target of ISO 19123-1:2023 relying on its concepts, terms, definitions, and interfaces to establish a logical schema (via UML) implementing the interfaces defined there. Additionally, this document defines related physical coverage schemas (via format encodings) for the single logical schema. Thus, both standards together establish an abstraction hierarchy:

- conceptual level: ISO 19123-1 defining abstract interfaces;
- logical level: [Clauses 5](#) – 0 of this document, defining data as object classes with attributes;
- physical level: [Clause 12](#) of this document, plus further separate coverage encoding standards, defining the mapping of the logical-level data to byte streams (such as GeoTIFF, NetCDF, JPEG2000, etc.).

The main changes of this document over its predecessor version ISO 19123-2:2018 are as follows:

- The document is adjusted to the structure established in ISO 19123-1. Among others, a clear separation of logical level (UML structures) and physical level (encodings, such as XML) is established.
- Use of terminology is adjusted to ISO 19123-1.
- Coverage type `GeneralGridCoverage` is integrated from OGC CIS 1.1^[18] as an additional coverage structure which generalizes and simplifies grid coverage modelling. It adds comprehensive definitions for all possible types of irregular grids, including `RectifiedGridCoverage` and `ReferenceableGridCoverage` as special cases.
- `RectifiedGridCoverage` and `ReferenceableGridCoverage` have been moved into a (normative) annex as their specification follows a different logic which does not easily fit into the structuring given by the Coverage Fundamentals (ISO 19123-1). They form a legacy and will be deprecated in the next version as `GeneralGridCoverage` covers these cases while simpler in structure.
- Structure and nomenclature are adjusted to new ISO requirements.
- The UML schema is updated to reflect the above adjustments.
- Complement the XML coverage encoding with equivalent JSON encodings.

Note The RDF encoding of OGC CIS 1.1 has not been included at this time and is left for future work.

Technically, this document implements the following improvements over the previous version:

- More general grid identifiers (with punctuation, national character sets, etc.).
- Mixed regular and non-regular grids.
- Added support for non-regularly gridded sensor models.
- Clear regulation for interpolation methods associated with grid coverages, thereby also clarifying a long-standing confusion between discrete and continuous grid coverages.
- Distinction between grid dimension and CRS dimension.
- Introduction of `EnvelopeByAxis`, an envelope type which allows for a convenient handling of any type of coordinates.

- Partitioned (“tiled”) coverages, allowing – among others – “interleaved representations” of coverages and datacubes tiled for efficient subsetting.
- Removal of a namespace ambiguity in `ReferenceableGridCoverage` (resolved by introduction of `GeneralGridCoverage`).
- Some GML schema definitions whose generality complicates coverage understanding unnecessarily have been extracted and condensed into the pertaining XML schema. This remedies an often heard complaint about the complexity not of the coverage model, but the underlying GML. As a consequence, the XML encoding of this document is not a GML application schema any longer, but a compact, freestanding definition. Nevertheless, by keeping with the coverage types inherited from 19123-2:2018 it is possible for implementers to remain in the realm of a GML application schema.

Geographic information — Schema for coverage geometry and functions —

Part 2: Coverage implementation schema

1 Scope

This document specifies a concrete¹⁾, implementable, conformance-testable coverage structure based on the abstract schema for coverages defined in the ISO 19123-1 coverage fundamentals. This document defines a concrete data structure that is suitable for encoding in many formats.

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 19123-1:2023, *Geographic information — Schema for coverage geometry and functions — Part 1: Fundamentals*

ISO 19136-1:2020, *Geographic information — Geography Markup Language (GML) — Part 1: Fundamentals*

OGC 08-094r1, *OGC® SWE Common Data Model Encoding Standard, version 2.0*

3 Terms, definitions, and abbreviated terms

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:

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

3.1.1

coverage CRS

<coverage> CRS (as per 19111:2019) in which domain set coordinates of a given coverage are expressed

3.1.2

displaced grid

<coverage> grid whose direct positions are topologically aligned to a grid, but whose geometric positions can vary arbitrarily

3.1.3

irregular grid

<coverage> grid whose direct positions have individual distances along each grid's axis

1) “concrete” is used here as a contrast to “abstract” in the sense described in the Introduction.

3.1.4**partition**

<coverage> separately stored coverage acting, by being referenced in another coverage, as one of its components

3.1.5**regular grid**

<coverage> grid whose direct positions have a constant distance along each grid's axis

3.1.6**transformation grid**

<coverage> grid whose direct positions are given by a transformation algorithm not further specified in this document

Note 1 to entry: This definition is adapted from OGC 08-094r1.

3.2 Abbreviated terms

CIS	Coverage Implementation Schema
CRS	Coordinate Reference System
EPSG	European Petroleum Survey Group
GeoTIFF	Geo Tagged Image File Format
GML	Geography Markup Language
JSON	JavaScript Object Notation
netCDF	network Common Data Format
OGC	Open Geospatial Consortium
RDF	Resource Description Framework
SWE	Sensor Web Enablement
TIN	Triangulated Irregular Network
UoM	Unit of Measure
UML	Unified Modeling Language
WCS	Web Coverage Service
WCPS	Web Coverage Processing Service

4 Conformance**4.1 Notation**

Schemas are presented using the Unified Modeling Language (UML) as defined in the ISO 19103:2024 Conceptual Schema Language^[40].

4.2 Interoperability and conformance testing

The term “coverage”, together with related terms, is used as defined in ISO 19123-1:2023.^[10] This Coverage Implementation Schema standard realizes Clauses 5 through 10 of ISO 19123-1:2023 (Annex D is realized by

normative [Annex B](#) of this document). In other words, the data structures defined in the UML schema form an implementation of the interfaces established in ISO 19123-1:2023.

This document defines testable conformance classes which correspond to the requirements in [Clause 5](#) onwards. These conformance classes, together with the corresponding conformance tests, are described in [Annex A](#). Any implementation claiming conformance with this document must conform to the abstract conformance class *coverage* and, in addition, at least one of the conformance classes *xml*, *json*, *multipart*.

4.3 Organization

The coverage schema is organized into the packages shown in [Figure 1](#). Each package establishes one requirements class. [Figure 1](#) show the requirements class dependencies depicted as a UML package diagram; each package represents one class, the *depends-on* relationship represents the requirements class dependency relationship. Packages have been grouped along practical implementation considerations, in particular to maximize modularity ([Figure 1](#)):

- The core class *coverage* (in red). This is the only abstract class – it establishes the basic framework, while the concrete conformance classes listed below define how concrete coverage instances can be built.
- The grid coverage classes (in green):
 - Class *grid-regular* establishes multi-dimensional unreferenced and regular referenced grids; in particular, *GridCoverage* and *RectifiedGridCoverage* are provided here for backwards compatibility with version 1.0 of this standard.
 - Class *grid-irregular* establishes multi-dimensional irregular referenced grids.
 - Class *grid-transformation* establishes multi-dimensional referenced grids defined by algorithmic transformations.
- The non-gridded coverage classes (in blue):
 - Class *pointcloud* establishes point clouds, a class kept separately as it frequently appears standalone in practice.
 - Class *mesh* establishes general multi-dimensional geometric meshes with curves, surfaces, and solids.
- The format encoding classes (in yellow):
 - Class *xml-coverage* establishes XML encoding of coverages.
 - Class *json-coverage* establishes JSON encoding of coverages.
 - Class *multipart* establishes a multipart encoding of coverages.
- Class *partitioning* (in grey) establishes coverages composed from several sub-coverages.

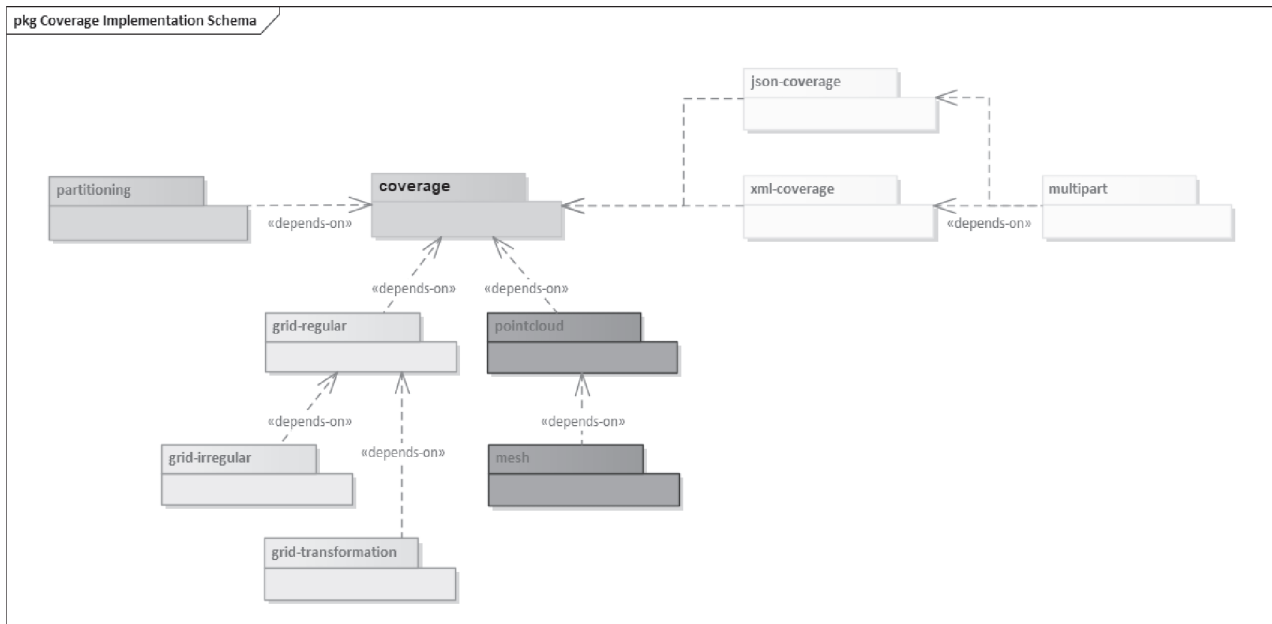


Figure 1 — The Coverage class hierarchy as UML package diagram

Requirement 1: <https://standards.iso211.org/19123/-/2/req/coverage/conformance>

An implementation of this CIS standard, in order to be compliant, **shall** comply with:

- the core conformance class *coverage* plus
- at least one of the *grid-regular*, *grid-irregular*, *grid-transformation*, *pointcloud*, and *mesh* conformance classes plus
- at least one of the encoding conformance classes *xml-coverage* and *json-coverage*.

All requirements-classes and conformance-classes described in this document are owned by the standard(s) identified.

The URIs in this standard have a stem of <https://standards.iso211.org/19123/-/2/2/> which corresponds to the OGC URI stem <https://www.opengis.net/spec/CIS/1.1/>, except that the numbering (such as of requirements) has changed sometimes.

Table 1 — Package URIs established in this standard

Class	Description and URI
<i>coverage</i>	General, abstract coverage class, implementing ISO 19123-1:2023 https://standards.iso211.org/19123/-/2/2/coverage
<i>pointcloud</i>	Coverage specialization for Multi-Point Coverages (point clouds) https://standards.iso211.org/19123/-/2/2/pointcloud
<i>grid-regular</i>	Coverage specialization for regular Grid Coverages https://standards.iso211.org/19123/-/2/2/grid-regular
<i>grid-irregular</i>	Coverage specialization for irregular Grid Coverages https://standards.iso211.org/19123/-/2/2/grid-irregular
<i>grid-transformation</i>	Coverage specialization for transformation Grid Coverages https://standards.iso211.org/19123/-/2/2/grid-transformation
<i>mesh</i>	Coverage specialization for curve, surface, and solid coverages https://standards.iso211.org/19123/-/2/2/mesh
<i>partitioning</i>	Partitioned representation of coverages https://standards.iso211.org/19123/-/2/2/partitioning

Table 1 (continued)

Class	Description and URI
<i>xml-coverage</i>	Coverage encoding in XML https://standards.iso211.org/19123/-2/2/xml-coverage
<i>json-coverage</i>	Coverage encoding in JSON https://standards.iso211.org/19123/-2/2/json-coverage
<i>multipart</i>	Multi-part representation of coverages https://standards.iso211.org/19123/-2/2/multipart

This Coverage Implementation Schema consists of the UML diagrams and textual requirements classes established in this document as well as an external file bundle consisting of the corresponding schema files, plus example coverage files. The URL root

The name and contact information of the maintenance agency for this document can be found at www.iso.org/maintenance_agencies.

5 Coverages

5.1 Overview

Conformance class *coverage* lays the foundation for the Coverage Implementation Schema. It is the abstract core class, meaning it does not allow creating coverage instances itself, but rather provides the fundament for the further classes which define various specializations of coverage instances.

Following ISO 19123-1:2023^[10] coverages are sorted along the topological dimension of the elements they contain (Figure 2), visible in their respective domain set structure:

- 0D point sets, known as Multi-Point Coverages for irregular point agglomerations (see Subclause 6) and General Grid Coverages for points sitting on some regular or irregular grid (see Subclause 7);
- 1D curve bundles, known as Multi-Curve Coverages (see Subclause 8);
- 2D surface bundles, known as Multi-Surface Coverages (see Subclause 9);
- 3D solid bundles, known as Multi-Solid Coverages (see Subclause 0).

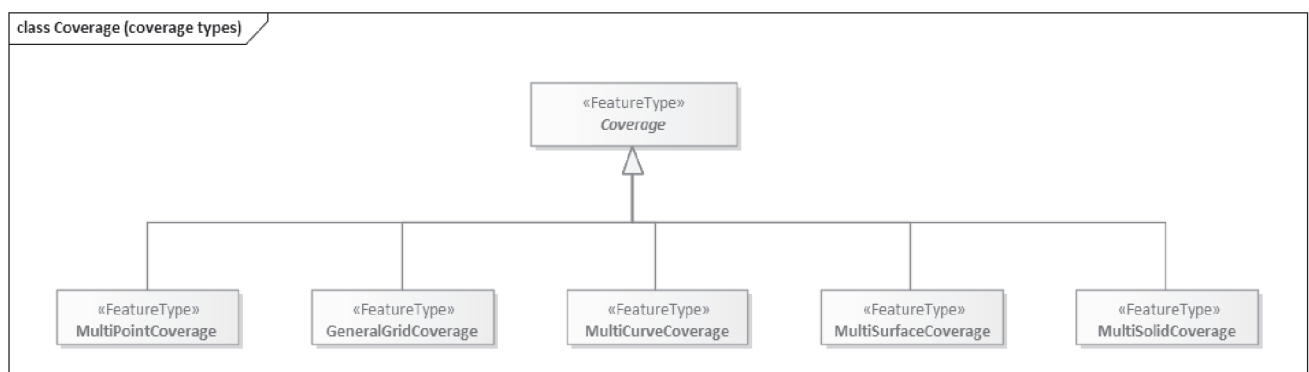


Figure 2 — Coverage subtypes defined in CIS (overview)

Requirement 2: <https://standards.iso211.org/19123/-2/2/req/coverage/subtypes>

A coverage **shall** be one of: MultiPointCoverage, GeneralGridCoverage, MultiCurveCoverage, MultiSurfaceCoverage, MultiSolidCoverage.

NOTE This structuring, adopted from ISO 19123-1:2023, is different from the previous edition of this standard.

5.2 Terminology

The following terms used are imported from other standards, mainly ISO 19123-1:2023, and used in addition to those defined in [Clause 3](#).

3.1.1

axis

<coordinate geometry> tuple of axis name, axis abbreviation, axis direction, axis unit, and further information as specified in ISO 19123-1

[SOURCE: ISO 19123-1:2023, 3.1.2]

[SOURCE: ISO 19123-1:2023, 3.1.2]

3.1.2

coordinate

<coverage> one of a sequence of measures designating the position of a point

Note 1 to entry In a coordinate reference system, the coordinate numbers are usually qualified by units. Some coordinates may use a unit representation, for example date/time conformant with ISO 8601-1. When coordinates are an index (ordinal coordinates) they are unitless (which possibly can be represented by a unit of 1).

[SOURCE: ISO 19123-1:2023, 3.1.5]

3.1.3

coordinate reference system

coordinate system that is related to an object by a datum

[SOURCE: ISO 19123-1:2023, 3.1.6]

3.1.4

coordinate tuple

tuple composed of coordinates

Note 1 to entry The number of s in the coordinate tuple equals the dimension of the coordinate system; the order of coordinates in the coordinate tuple is identical to the order of the axes of the coordinate system.

[SOURCE: ISO 19123-1:2023, 3.1.8]

3.1.5

coverage

<coverage> function which returns values from its range type for any direct position within its domain

[SOURCE: ISO 19123-1:2023, 3.1.9]

3.1.6

direct position

<coverage> position inside one of the geometric objects in a coverage described by a coordinate tuple within the coverage coordinate reference system

Note 1 to entry A direct position is described by an ordered sequence of coordinates. The number of elements in a direct position is established by the number of axes of the coverage CRS.

[SOURCE: ISO 19123-1:2023, 3.1.14 – Note 2 removed]

3.1.7

domain

<coverage> set of geometric objects

Note 1 to entry Examples of such geometric objects are points, lines, faces, and solids. All elements within a domain (set) are of a single given type.

[SOURCE: ISO 19123-1:2023, 3.1.16]

3.1.8

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 $\mathbb{E}^n$, Euclidean n -space

[SOURCE: ISO 19123-1:2023, 3.1.22]

3.1.9

georectified

corrected for positional displacement with respect to the surface of the Earth

Note 1 to entry This term is kept only for backwards compatibility and is not fundamental to the coverage definition of this document.

[SOURCE: ISO 19123-1:2023, 3.1.25 adopted from ISO 19115-2:2019, 3.11]

3.1.10

georeferenceable

associated with a geopositioning information that can be used to convert grid coordinate values to values of coordinates referenced to an external coordinate reference system related to the Earth by a datum

Note 1 to entry This term is kept only for backwards compatibility and is not fundamental to the coverage definition of this document.

[SOURCE: ISO 19123-1:2023, 3.1.26]

3.1.11

grid

<coverage> covering of a multi-dimensional region using quadrilateral shapes (in the 2D case) or their n -dimensional generation (in the n -D case) with no overlaps and gaps

Note 1 to entry The term grid originates historically from a 2D view: In 19123:2005 a grid consists of a network composed of one or more sets of curves in which the members of each set intersect the members of the other sets. Meantime, n D grids (including 1D) are known and in use. The “covering” of a region is also known as a tessellation in mathematics.

Note 2 to entry The 19123:2005 definition is equivalent to the revised definition of this document.

[SOURCE: ISO 19123-1:2023, 3.1.28]

3.1.12

index coordinate reference system

index CRS

<coverage> coverage CRS in which all axes are Cartesian

[SOURCE: ISO 19123-1:2023, 3.1.35]

3.1.13

mesh

<coverage> coverage consisting of a collection of curves, surfaces, or solids, respectively

[SOURCE: ISO 19123-1:2023, 3.1.36]

3.1.14

point coverage

<coverage> coverage that has a domain composed of points

[SOURCE: ISO 19123-1:2023, 3.1.39]

3.1.15

range (set)

<coverage> set of values associated by a function, the coverage, with the domain of a coverage

Note 1 to entry This is consistent with the more generic definition of range in ISO 19107:2019.

Note 2 to entry Coverage range types and values correspond to the notion of feature attribute types and values.

[SOURCE: ISO 19123-1:2023, 3.1.41]

3.1.16

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 is kept only for backwards compatibility and is not used in nor fundamental to the coverage definition of this document.

[SOURCE: ISO 19123-1:2023, 3.1.43]

3.1.17

referenceable grid

grid with an external coordinate reference system whose type is either geodetic or projected

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 is kept only for backwards compatibility and is not used in nor fundamental to the coverage definition of this document.

[SOURCE: ISO 19123-1:2023, 3.1.44]

3.1.18

sensor model

description of the radiometric and geometric characteristics of a sensor

[SOURCE: ISO 19101-2:2018, 3.37]

3.1.19

solid

geometric set with three spatial dimensions

Note 1 to entry This is consistent with the definition in ISO 19107:2019

Note 2 to entry A solid may have further dimensions, such as time.

[SOURCE: ISO 19123-1:2023, 3.1.45]

3.1.20**transformation grid**

<coverage> grid whose direct positions are given by a transformation algorithm not further specified in this document

Note 1 to entry This definition is adapted from OGC 08-094r1.

5.3 General coverage structure

A coverage consists of the following main components ([Figure 3](#)):

- *Domain set*: “where are values available?” Coordinate positions for which values are stored in the coverage are called *direct positions*.
- *Range set*: “what is the value at a particular position?” (often referred to as “pixels” or “voxels”). Such values can be atomic (such as in grayscale images) or record structures (such as in color or hyperspectral images). Record components are known as bands, channels, and variables in different disciplines.
- *Range type*: “what do these values mean?” Such a type often consists of one or more fields (also referred to as bands or channels or variables – not to be confused with the physics field a coverage represents). For this description of the semantics, coverages in this document make use of OGC SWE Common^[16].
- *Metadata*: “what else do we know about this coverage?” This item is added in this document over ISO 19123-1:2023.

Technically, all coverage types are derived from abstract class `Coverage`. This structure contains a `DomainSet` describing the coverage’s domain and a `RangeSet` component containing the range value consisting of one or more record fields. The `RangeType` element describes the coverage’s range data structure. Its structure description is based on the OGC SWE Common [OGC 08-094r1] `DataRecord`, so that the semantics description from upstream sensor acquisitions into downstream services is carried over seamlessly.

In conformance class *coverage*, this domain/range representation is used; requirements class *coverage-partitioning* (Clause 0) adds partitioning and position/value pair list as alternatives. This is why coverage subtype `CoverageByDomainAndRange` is introduced in [Figure 3](#); while it may seem artificial in this requirements class, it will allow modelling the alternative representations later in this document.

[Figure 3](#) contains the complete coverage structure with all variants allowed; in the subsequent subclauses, all parts are successively described in detail.

NOTE OGC Web Coverage Processing Service (WCPS)^[39] defines a coverage-specific query language based on this coverage standard allowing extraction, recoding, fusion, derivation of coverages and general analytics, currently on multi-dimensional grid coverages aka geo datacubes.

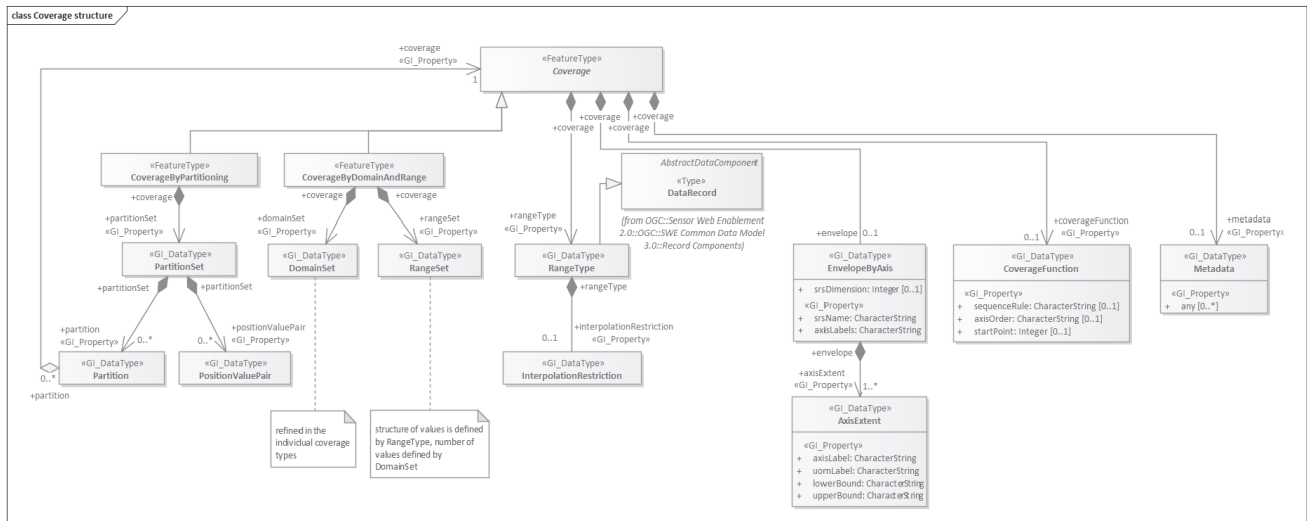


Figure 3 — The Coverage structure (overview)

5.4 Domain/range based coverage structure

The coverage structure defined normatively in this class *coverage* is CoverageByDomainAndRange.

Requirement 3: <https://standards.iso211.org/19123/-/2/req/coverage/domain+range>

A coverage instantiating class *coverage* **shall** conform with Figure 4 and Table 2.

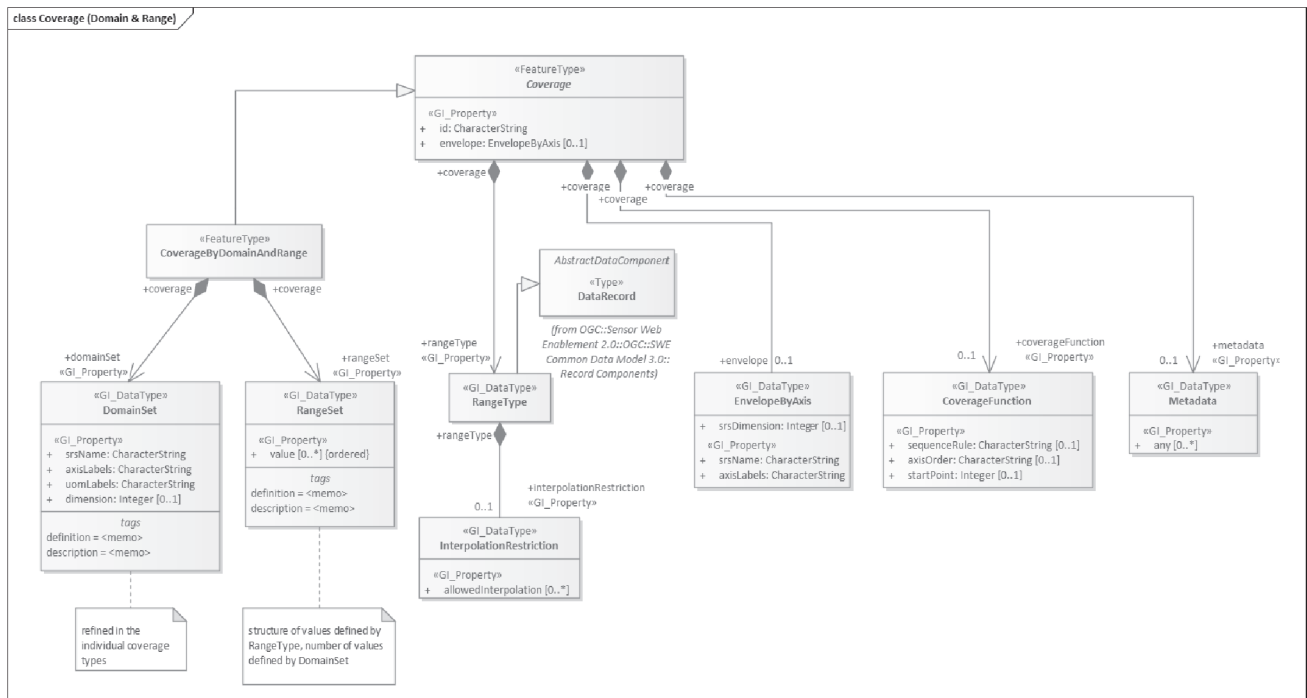


Figure 4 — The Coverage domain/range structure