BS ISO 19170-1:2021

BSI Standards Publication

Geographic information — Discrete Global Grid Systems Specifications

Part 1: Core Reference System and Operations, and Equal Area Earth Reference System

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National foreword

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A list of organizations represented on this committee can be obtained on request to its committee manager.

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Geographic information — Discrete Global Grid Systems Specifications —

Part 1: Core Reference System and Operations, and Equal Area Earth Reference System

Information géographique — Spécifications des Systèmes de Grilles Globales Discrètes (DGGS) —

Partie 1: Système de références et opérations de base, et système de référence terrestre à surface équivalente

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Foreword

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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.*

A list of all parts in the ISO 19170 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.

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Introduction

DGGSs (Discrete Global Grid Systems) provide a new way to organize, store and analyse spatio-temporal data. This document contains a normative definition for DGGS and informative annexes. Annex B discusses the theoretical basis for Equal-Area Earth DGGS, and Annex C discusses DGGS's historical background. At the heart of DGGS is a new Reference System (RS). Spatial and temporal RSs described elsewhere by ISO/TC 211 and the OGC (Open Geospatial Consortium) fall into two types:

1) Referencing by coordinates (ISO 19111), and

2) Referencing by identifiers (geographic in ISO 19112 and ordinal era in ISO 19108).

In spatial referencing by identifiers, the only required geometry is an extent, which can be expressed as a simple bounding box. Formal geometry need not be defined and sometimes follows societal whim. Similarly, in ordinal temporal RSs, the topology of the ordinal eras are known, but the start and finish times are often only an estimation and are not required by the data model. DGGSs introduce a third type: referencing by identifiers with structured geometry, illustrated in Figure 1.

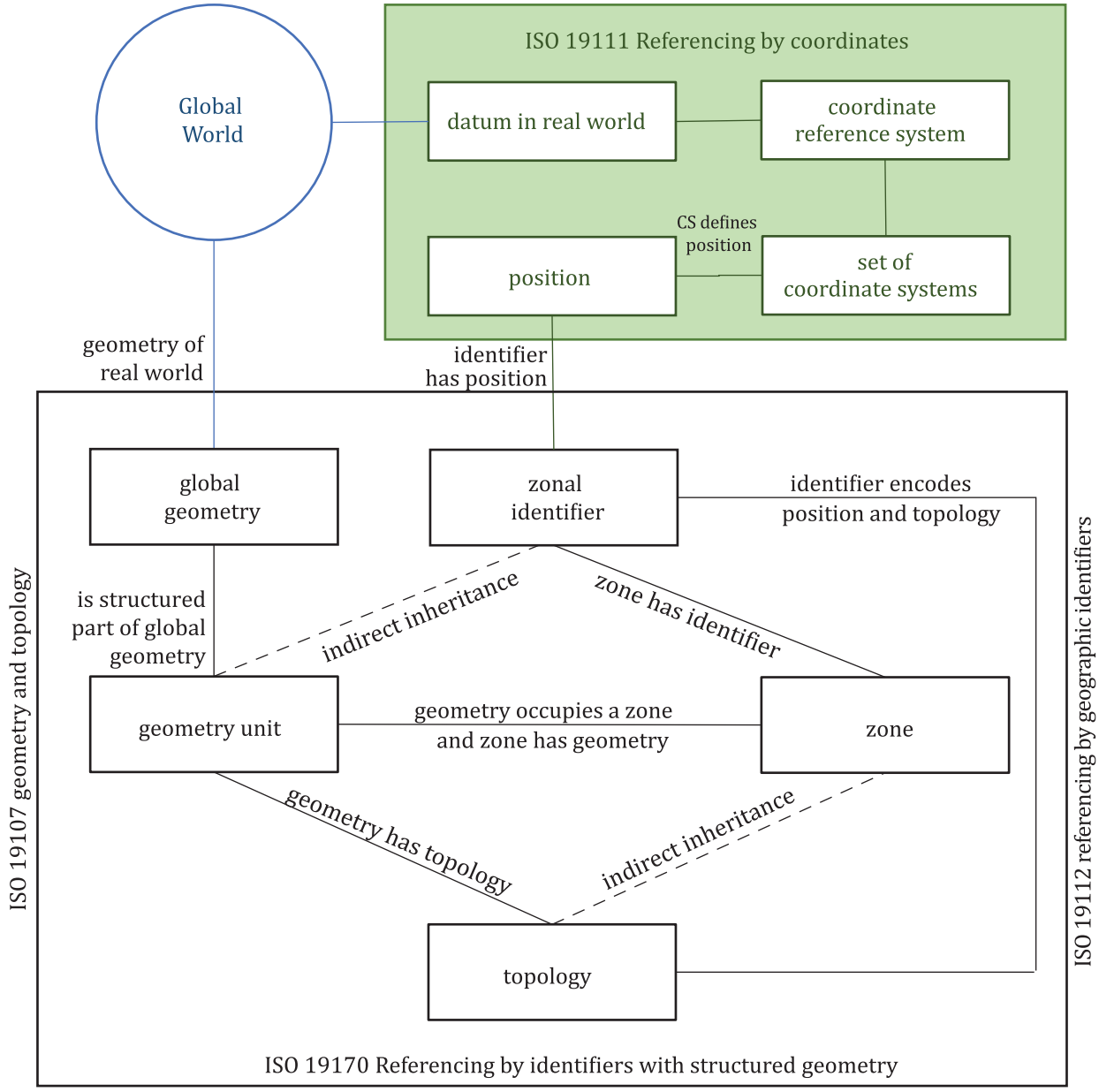

Figure 1 — Referencing by identifiers with structured geometry

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A single parent global geometry is chosen to define the dimensionality and orientation of the region of space-time occupied by the DGGS: it's global world. The structure for the DGGS geometry is provided by a strictly controlled process of recursive tessellation of the parent geometry that creates the DGGS RS's units of geometry. The region occupied by each unit of geometry is called a zone. Each zone is given a unique name, called a zonal identifier. Each zonal identifier is associated with a representative spatio-temporal position in a base CRS (Coordinate Reference System) defined by a datum for the DGGS's global world. Best practice is for a zonal identifier to be an encoding of both its position and its topology. Referencing by identifiers with structured geometry gives rise to RSs using zonal identifiers with structured geometry. Geographic information is inherently four-dimensional and includes time. So, a unified spatio-temporal data model for coordinate systems, geometry, topology, identifiers and RSs using identifiers is a pre-requisite for spatio-temporal DGGSs.

The approach taken in this document to specifying spatio-temporal data classes is to apply the spatio-temporal data model pattern in ISO 19111 to spatial data classes in both ISO 19107 and ISO 19112 to produce their spatio-temporal equivalents. The set of common spatio-temporal classes for geometry, topology, identifiers and RSs using identifiers specified in this document are therefore consistent with spatio-temporal CRS and coordinate systems in ISO 19111. Like ISO 19111, the temporal data model in this document does not reference ISO 19108. The similarities and differences are described in Annex D.

In this document the spatio-temporal scope is constrained to spatial classes that are invariant through all time, and to temporal classes that are invariant throughout space. While this approach excludes certain spatio-temporal situations, it is flexible enough for a very large body of social and environmental modelling. Oceanic, climate and weather modelling often need geometries with a constant mass of gaseous fluid under changing pressure and temperature. These models can be run outside a DGGS. However, the results coming from these environmental models can be stored in a DGGS for efficient later use with other data.

This document specifies data models for a consistent set of common spatio-temporal classes, a DGGS core built on the common spatio-temporal classes, and a DGGS EAERS (Equal-Area Earth RS). The Common Spatio-temporal Classes, DGGS Core, and Equal-Area Earth DGGS packages each have their own conformance classes with their associated specifications and requirements.

The DGGS Core package comprises an RS and functions for quantization, topological query and interoperability.

The DGGS Core RS is an RS using zonal identifiers with structured geometry located in its real world by coordinates in a base CRS. The DGGS Core RS is designed to support:

— temporal, surface, volumetric and spatio-temporal DGGS,

— DGGSs with different grid constraints,

— DGGSs with different refinement strategies, and

— DGGSs referencing either the Earth or other celestial bodies.

The RS in Equal-Area Earth DGGSs is a specialization of the DGGS Core RS. It describes an RS, comprising:

— a base unit polyhedron,

— a discrete hierarchical sequence of global grids,

— global grids with equal-area zones each with a unique identifier, and

— located in a geodetic CRS, that is typically also a geographic CRS.

This document does not prescribe any specific Earth surface model, base polyhedron or class of polyhedra, but is intended to allow for a range of options that produce DGGSs with compatible and interoperable functional characteristics.

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Future additions to the ISO 19170 series are intended to cover:

— Part 2: Three-dimensional and equal-volume Earth RS.

— Part 3: Spatio-temporal Earth RS.

— Part 4: Axis-aligned RS with all zone edges parallel to the base CRS's axes.

— Specification for a DGGS-API to formalize client-server, and server-server operations, both between DGGSs and between DGGSs and non-DGGS architectures.

— Creation of a register system for DGGS definitions analogous to the register for CRSs.

— Additions to other specifications, such as for OWS[52], [54] architectures, spatial features and data formats to support DGGS data structures.

This document was prepared in close collaboration with the Open Geospatial consortium (OGC).

In accordance with the ISO/IEC Directives, Part 2, 2018, *Rules for the structure and drafting of International Standards*, in International Standards the decimal sign is a comma on the line. However, the General Conference on Weights and Measures (*Conférence Générale des Poids et Mesures*) at its meeting in 2003 passed unanimously the following resolution: "The decimal marker shall be either a point on the line or a comma on the line." In practice, the choice between these alternatives depends on customary use in the language concerned. In the technical areas of geodesy and geographic information it is customary for the decimal point always to be used, for all languages. That practice is used throughout this document.

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Geographic information — Discrete Global Grid Systems Specifications —

Part 1: Core Reference System and Operations, and Equal Area Earth Reference System

1 Scope

This document supports the definition of:

— A Discrete Global Grid Systems (DGGS) core comprising:

  — an RS using zonal identifiers with structured geometry, and

  — functions providing import, export and topological query,

— Common spatio-temporal classes for geometry, topology, RS using zonal identifiers, zonal identifiers and zones, based on ISO 19111 CRS. The spatio-temporal scope is constrained to:

  — spatial elements that are invariant through all time, and

  — temporal elements that are invariant across all space.

— Equal-Area Earth Reference Systems (EAERSs) for Equal-Area Earth DGGS.

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 19107:2019, *Geographic information — Spatial schema*

ISO 19111:2019, *Geographic information — Referencing by coordinates*

ISO 19112:2019, *Geographic information — Spatial referencing by geographic identifiers*

ISO 19115-1:2014, *Geographic information — Metadata — Part 1: Fundamentals*

ISO 19156:2011, *Geographic information — Observations and measurements*

3 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

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3.1
boundary
set that represents the limit of an entity

Note 1 to entry: Boundary is most commonly used in the context of geometry, where the set is a collection of points or a collection of objects that represent those points. In other arenas, the term is used metaphorically to describe the transition between an entity and the rest of its domain of discourse.

[SOURCE: ISO 19107:2019, 3.6]

3.2
cell
<DGGS> spatial, spatio-temporal or temporal unit of geometry with dimensionality greater than 0, associated with a *zone* (3.52)

Note 1 to entry: All cells within a *DGGS* (3.13) share the dimensionality of the DGGS's parent global geometry. DGGSs with dimensionality of 0 are not supported.

Note 2 to entry: Cells are the unit of geometry in a DGGS, and the geometry of the region of space-time occupied by a zone is a cell.

Note 3 to entry: While the terms cell and zone are often used interchangeably, "zone" is the strictly preferred term. Cell is entirely appropriate when specifically discussing a zone's geometry or topology.

3.3
cell refinement
<DGGS> process of subdividing *parent cells* (3.33) into descendant *child cells* (3.4) using a specified *refinement ratio* (3.38) and suite of refinement strategies

Note 1 to entry: Iterative application of cell refinements creates a *hierarchy* (3.26) of descendant *discrete global grids* (3.12).

Note 2 to entry: Cell refinement methods may result in *child cells* (3.4) that each have a single parent or that have multiple parents.

3.4
child cell
child
<DGGS> immediate descendant of a *parent cell* (3.33)

Note 1 to entry: Child cells are either within a single parent cell or overlapped by multiple parent cells

3.5
class
description of a set of objects that share the same attributes, operations, methods, relationships, and semantics

Note 1 to entry: A class may use a set of interfaces to specify collections of operations it provides to its environment. The term was first used in this way in the general theory of object-oriented programming, and later adopted for use in this same sense in UML.

[SOURCE: ISO 19103:2015, 4.7, modified — Note 1 to entry has been added from ISO 19117:2012, 4.2]

3.6
compound coordinate reference system
compound CRS
coordinate reference system (3.7) using at least two independent coordinate reference systems

Note 1 to entry: Coordinate reference systems are independent of each other if coordinate *values* (3.49) in one cannot be converted or transformed into coordinate values in the other.

[SOURCE: ISO 19111:2019, 3.1.3]

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3.7
coordinate reference system
CRS
coordinate system (3.8) that is related to an object by a *datum* (3.10)

Note 1 to entry: Geodetic and vertical datums are referred to as reference frames.

Note 2 to entry: For geodetic and vertical datums, the object is the Earth. In planetary applications, geodetic and vertical reference frames may be applied to other celestial bodies.

[SOURCE: ISO 19111:2019, 3.1.9]

3.8
coordinate system
set of mathematical rules for specifying how coordinates are to be assigned to points

[SOURCE: ISO 19111:2019, 3.1.11]

3.9
data type
specification of a *value* (3.49) domain with operations allowed on values in this domain

EXAMPLE Integer, Real, Boolean, String and Date (conversion of a date into a series of codes).

Note 1 to entry: Data types include primitive predefined types and user-definable types. All instances of a data type lack identity.

[SOURCE: ISO 19103:2015, 4.14, modified — EXAMPLE and Note 1 to entry have been added from ISO 19156:2011, 4.3]

3.10
datum
reference frame
parameter or set of parameters that realize the position of the origin, the scale, and the orientation of a *coordinate system* (3.8)

[SOURCE: ISO 19111:2019, 3.1.15]

3.11
datum ensemble
group of multiple realizations of the same terrestrial or vertical reference system that, for approximate spatial referencing purposes, are not significantly different

EXAMPLE "WGS 84" as an undifferentiated group of realizations including WGS 84 (TRANSIT), WGS 84 (G730), WGS 84 (G873), WGS 84 (G1150), WGS 84 (G1674) and WGS 84 (G1762). At the surface of the Earth these have changed on average by 0.7 m between the TRANSIT and G730 realizations, a further 0.2 m between G730 and G873, 0.06 m between G873 and G1150, 0.2 m between G1150 and G1674 and 0.02 m between G1674 and G1762).

Note 1 to entry: Datasets referenced to the different realizations within a datum ensemble may be merged without coordinate transformation.

Note 2 to entry: 'Approximate' is for users to define but typically is in the order of under 1 decimetre but may be up to 2 metres.

[SOURCE: ISO 19111:2019, 3.1.16]

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3.12
discrete global grid
<DGGS> set of *cells* (3.2) at the same *refinement level* (3.37) that uniquely and completely cover a *globe* (3.24)

Note 1 to entry: The set of cell *zonal identifiers* (3.50) comprising a discrete global grid form a single *Zone* (3.51) *Class* (3.5) with its associated *refinement level* (3.37).

Note 2 to entry: The configuration of the set of cells comprising a discrete global grid satisfy at least one *grid* (3.25) constraint in the DGG_GridConstraint codelist.

3.13
discrete global grid system
DGGS
integrated system comprising a *hierarchy* (3.26) of *discrete global grids* (3.12), *spatio-temporal referencing* (3.42) by *zonal identifiers* (3.50) and functions for *quantization* (3.36), *zonal query* (3.51), and *interoperability* (3.28)

3.14
duration
non-negative quantity of time equal to the difference between the final and initial *instants* (3.29) of a time *interval* (3.30)

Note 1 to entry: The duration is one of the base quantities in the International System of Quantities (ISQ) on which the International System of Units (SI) is based. The term "time" instead of "duration" is often used in this context and also for an infinitesimal duration.

Note 2 to entry: For the term "duration", expressions such as "time" or "time interval" are often used, but the term "time" is not recommended in this sense and the term "time interval" is deprecated in this sense to avoid confusion with the concept of "time interval".

Note 3 to entry: The exact duration of a time scale unit depends on the time scale used. For example, the durations of a year, month, week, day, hour or minute, may depend on when they occur [in a Gregorian calendar, a calendar month can have a duration of 28, 29, 30, or 31 days; in a 24-hour clock, a clock minute can have a duration of 59, 60, or 61 seconds, etc.]. Therefore, the exact duration can only be evaluated if the exact duration of each is known.

Note 4 to entry: This definition is closely related to NOTE 1 of the terminological entry "duration" in IEC 60050-113:2011, 113–01–13.

[SOURCE: ISO 8601-1:2019, 3.1.1.8]

3.15
dynamic coordinate reference system
dynamic CRS
coordinate reference system (3.7) that has a *dynamic reference frame* (3.16)

Note 1 to entry: Coordinates of points on or near the crust of the Earth that are referenced to a dynamic coordinate reference system may change with time, usually due to crustal deformations such as tectonic motion and glacial isostatic adjustment.

Note 2 to entry: Metadata for a dataset referenced to a dynamic coordinate reference system should include coordinate epoch information.

[SOURCE: ISO 19111:2019, 3.1.19]

3.16
dynamic reference frame
dynamic datum
reference frame (3.10) in which the defining parameters include time evolution

Note 1 to entry: The defining parameters that have time evolution are usually a coordinate set.

[SOURCE: ISO 19111:2019, 3.1.20]

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3.17
error budget
<metric> statement of or methodology for describing the nature and magnitude of the errors which affect the results of a calculation

[SOURCE: ISO 19107:2019, 3.35, modified — Note 1 to entry has been removed.]

3.18
feature
abstraction of real-world phenomena

Note 1 to entry: A feature can occur as a type or an instance. In this document, feature instance is meant unless otherwise specified.

[SOURCE: ISO 19101-1:2014, 4.1.11, modified — Note 1 to entry has been added from ISO 19156:2011, 4.6, and modified.]

3.19
feature type
class (3.5) of *features* (3.18) having common characteristics

[SOURCE: ISO 19156:2011, 4.7]

3.20
geodetic coordinate reference system
geodetic CRS
three-dimensional *coordinate reference system* (3.7) based on a geodetic reference frame and having either a three-dimensional Cartesian or a spherical *coordinate system* (3.8)

Note 1 to entry: In this document a coordinate reference system based on a geodetic reference frame and having an ellipsoidal coordinate system is geographic.

[SOURCE: ISO 19111:2019, 3.1.31]

3.21
geographic coordinate reference system
geographic CRS
coordinate reference system (3.7) that has a geodetic reference frame and an ellipsoidal *coordinate system* (3.8)

[SOURCE: ISO 19111:2019, 3.1.35]

3.22
geographic identifier
spatial reference (3.41) in the form of a label or code that identifies a *location* (3.31)

EXAMPLE "Spain" is an example of a label (country name); "SW1P 3AD" is an example of a code (postcode).

[SOURCE: ISO 19112:2019, 3.1.2]

3.23
geometric primitive
<geometry> geometric object representing a single, connected, homogeneous (isotropic) element of space

Note 1 to entry: Geometric primitives are non-decomposed objects that present information about geometric configuration. They include points, curves, surfaces, and solids. Many geometric objects behave like primitives (supporting the same interfaces defined for geometric primitives) but are actually composites composed of some number of other primitives. General collections may be aggregates and incapable of acting like a primitive (such as the lines of a complex network, which is not connected and thus incapable of being traceable as a single line). By this definition, a geometric primitive is topological open, since the *boundary* (3.1) points are not isotropic to the interior points. Geometry is assumed to be closed. For points, the boundary is empty.

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[SOURCE: ISO 19107:2019, 3.50]

3.24
globe
<DGGS> region of space-time enclosing a celestial body

Note 1 to entry: In this document globe is used in its most general form to refer to any celestial body or region of space-time enclosing a celestial body that may be referenced by a *DGGS* (3.13). When a specific body, such as the Earth is referred to, an explicit term is used.

3.25
grid
network composed of two or more sets of curves in which the members of each set intersect the members of the other sets in an algorithmic way

Note 1 to entry: The curves partition a space into grid *cells* (3.2).

[SOURCE: ISO 19123:2005, 4.1.23]

3.26
hierarchy
<DGGS> organization and ranking of successive levels of *cell refinement* (3.3) of *discrete global grids* (3.12)

3.27
initial discrete global grid
<DGGS> *discrete global grid* (3.12) *tessellation* (3.8) created by circumscribing a defined path along the chosen surface model of the Earth between the vertices of the scaled base unit polyhedron

3.28
interoperability
capability to communicate, execute programmes, or transfer data among various functional units in a manner that requires the user to have little or no knowledge of the unique characteristics of those units

Note 1 to entry: In this document, interoperability specifically refers to functions that initiate and process transfers of data from a *DGGS* (3.13).

[SOURCE: ISO/IEC 2382:2015, 2121317, modified—The original domain and Notes to Entry have been deleted. A new Note 1 to entry has been added.]

3.29
instant
<DGGS> temporal geometry primitive representing a point in time

Note 1 to entry: On *temporal coordinate systems* (3.46) as specified in ISO 19107, the temporal *geometric primitives* (3.23) instant and *interval* (3.30) are the equivalent of points and lines as specified in ISO 19107.

3.30
interval
<DGGS> temporal geometry primitive representing a line in time

Note 1 to entry: On *temporal coordinate systems* (3.46) as specified in ISO 19107, the temporal *geometric primitives* (3.23) *instant* (3.29) and interval are the equivalent of points and lines as specified in ISO 19107.

3.31
location
particular place or position

EXAMPLE "Madrid", "SW1P 3AD".

Note 1 to entry: A location identifies a geographic place.

Note 2 to entry: In the context of *DGGS* (3.13), locations have dimension greater than one, and so are not points.

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[SOURCE: ISO 19112:2019, 3.1.3, modified — Note 2 to entry has been added and an additional example provided.]

3.32
observation
act of measuring or otherwise determining the *value* (3.49) of a property

[SOURCE: ISO 19156:2011, 4.11]

3.33
parent cell
parent
<DGGS> *cell* (3.2) in a higher *refinement level* (3.37) of *discrete global grid* (3.12) with immediate descendants

Note 1 to entry: Parent cells either overlap or contain their *child cells* (3.4).

3.34
period
<DGGS> particular era or span of time

Note 1 to entry: Periods are *intervals* (3.30) named with a *period identifier* (3.35).

3.35
period identifier
<DGGS> temporal reference in the form of a label or code that identifies a *period* (3.34)

Note 1 to entry: Period identifiers are the temporal equivalent of *geographic identifiers* (3.22) as specified in ISO 19112.

3.36
quantization
<DGGS> function assigning data from external sources to *cell* (3.2) *values* (3.49)

3.37
refinement level
<DGGS> numerical order of a *discrete global grid* (3.12) in the *tessellation* (3.8) sequence

Note 1 to entry: The tessellation with the smallest number of cells has a refinement level = 0.

3.38
refinement ratio
<DGGS> ratio of the number of *child cells* (3.4) to *parent cells* (3.33)

Note 1 to entry: A positive integer ratio *n* refinement of *DGGS* (3.13) parent cells yield *n* times as many child cells as parent cells.

Note 2 to entry: For a two-dimensional DGGS (as defined for EAERS in this document) this is the surface area ratio.

Note 3 to entry: In DGGS literature[34] the term aperture has been used instead of refinement ratio. Refinement ratio is preferred because it is clearer in meaning to audiences outside the early DGGS community.

3.39
sibling cell
sibling
<DGGS> *cell* (3.2) in a *discrete global grid* (3.12) with the same *parent cell* (3.33)

Note 1 to entry: All the *child cells* (3.4) of a parent cell are each-others' sibling cells.

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3.40
simple
<topology, geometry> homogeneous (all points have isomorphic neighbourhoods) and with a simple *boundary* (3.1)

Note 1 to entry: The interior is everywhere locally isomorphic to an open disc in a Euclidean coordinate space of the appropriate dimension `Dn = {P|□P□ < 1.0}`. The boundary is a dimension one smaller. This essentially means that the object does not intersect nor touch itself. Generally used for a curve that does not cross nor touch itself with the possible exception of boundary points. Simple closed curves are isomorphic to a circle.

[SOURCE: ISO 19107:2019, 3.84]

3.41
spatial reference
description of position in the real world

Note 1 to entry: This may take the form of a label, code or coordinate tuple.

[SOURCE: ISO 19111:2019, 3.1.56]

3.42
spatio-temporal reference
system for identifying position in the real world that may include time

Note 1 to entry: This may take the form of a label, code or coordinate tuple.

3.43
spatio-temporal coordinate reference system
spatio-temporal CRS
compound coordinate reference system (3.6) in which one constituent *coordinate reference system* (3.7) is a spatial coordinate reference system and one is a *temporal coordinate reference system* (3.47)

[SOURCE: ISO 19111:2019, 3.1.59]

3.44
static coordinate reference system
static CRS
coordinate reference system (3.7) that has a *static reference frame* (3.45)

Note 1 to entry: Coordinates of points on or near the crust of the Earth that are referenced to a static coordinate reference system do not change with time.

Note 2 to entry: Metadata for a dataset referenced to a static coordinate reference system does not require coordinate epoch information.

[SOURCE: ISO 19111:2019, 3.1.61]

3.45
static reference frame
static datum
reference frame (3.10) in which the defining parameters exclude time evolution

[SOURCE: ISO 19111:2019, 3.1.62]

3.46
temporal coordinate system
<geodesy> one-dimensional *coordinate system* (3.8) where the axis is time

[SOURCE: ISO 19111:2019, 3.1.64]

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3.47
temporal coordinate reference system
temporal CRS
coordinate reference system (3.7) based on a temporal datum

[SOURCE: ISO 19111:2019, 3.1.63]

3.48
tessellation
partitioning of a space into a set of conterminous subspaces having the same dimension as the space being partitioned

EXAMPLE Graphic examples of tessellations may be found in Figures 11, 13, 20, and 22 of ISO 19123:2005.

Note 1 to entry: 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. Tessellations on curved surfaces cannot be congruent, so all tessellations in DGGS are either semi-regular or irregular.

[SOURCE: ISO 19123:2005, 4.1.39, modified — Note 1 to entry has been modified.]

3.49
value
element of a type domain

Note 1 to entry: A value considers a possible state of an object within a *class* (3.5) or type (domain).

Note 2 to entry: A data value is an instance of a datatype, a value without identity.

Note 3 to entry: A value can use one of a variety of scales including nominal, ordinal, ratio and *interval* (3.30), spatial and temporal. Primitive datatypes can be combined to form aggregate datatypes with aggregate values, including vectors, tensors and images.

[SOURCE: ISO 19156:2011, 4.18]

3.50
zonal identifier
<DGGS> *spatio-temporal reference* (3.42) in the form of a label or code that identifies a *zone* (3.52)

Note 1 to entry: A zonal identifier may be a *geographic identifier* (3.22), *period identifier* (3.35), or a compound of the two.

Note 2 to entry: A zone's ZonalIdentifier provides the coordinates of a representative position for the zone, and spatio-temporal *feature* (3.18) geometry is represented by sets of ZonalIdentifiers.

3.51
zonal query
<DGGS> geometry or topology function using a cell's *zonal identifiers* (3.50) to specify geometry

Note 1 to entry: ISO 19107 specifies a suite of geometry and topology functions in the Query2D and Query3D classes, where geometry elements used in each function's parameters are described by sets of coordinates. In DGGS all geometry can be referenced as sets of *cells* (3.2) represented solely by a list (or set) of their zonal identifiers. This document specifies ZoneQuery to implement the operations in both Query2D and Query3D using zonal identifiers to reference each operation's source and target geometry.

3.52
zone
<DGGS> particular region of space-time

Note 1 to entry: The primitives of zone are spatial *location* (3.31) and temporal *period* (3.34).

Note 2 to entry: A zone may be either a single zonal primitive or a compound zone comprising one spatial location and one temporal period. Zones can be regions of space-time associated with any celestial body.

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Note 3 to entry: Zones are the primary container for storing and retrieving data within a DGGS implementation. DGGSs reference zones by their *zonal identifier* (3.50), for instance in databases or through tile nomenclature.

Note 4 to entry: Each zone's geometry is represented by a *cell* (3.2).

4 Conventions

4.1 Abbreviated terms

DE-9IM	Dimensionally Extended 9-Intersection Model
EAERS	Equal-Area Earth RS
ECEF	earth-centered earth fixed
EC	earth-centered
GEM	Geodesic Elevation Model
GIS	geographic information system
GUID	globally unique identifier
HPC	high-performance computing
HPD	high-performance data
ICT	information and communications technology
ISEA	Icosahedral Snyder Equal Area
ISEA3H	Icosahedral Snyder Equal Area Aperture 3 Hexagon
ISO	International Organization for Standardization
OGC	Open Geospatial Consortium
OWS	OGC Web-Service
QTM	Quaternary Triangular Mesh
rHEALPix	rearanged Hierarchical Equal Area isoLatitude Pixelization
RS	Reference System
UML	Unified Modelling Language
URI	Uniform Resource Identifier

4.2 Uniform Resource Identifiers

The normative provisions in this specification are denoted by the URI:

http://www.opengis.net/spec/dggs/2.0

All requirements and conformance tests that appear in this document denoted by partial URIs are relative to this base.

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4.3 Unified Modelling Language notation

In this document, the conceptual schema for describing DGGSs are presented in UML. ISO 19103 presents the specific profile of UML used in this document.

The UML diagrams in this document refer to classifiers in five other standards. Each standard has been assigned a colour that is used consistently across all UML diagrams. Each diagram has a key listing the standards referred to in that diagram and their colours. Interface names in the figure have the structure <module-name>::<interface-name>. For reference, Table 1 lists all the module names and the standard they belong to. Both colour and module name can be used as quick reference to a classifier's standard.

4.4 Naming conventions

Where possible, when a classifier represents the common behaviour of a set of defined things from the terms defined in Clause 3, the UML classifier generally uses the defined terms as its name. Since classifier names are capitalized and contain no space, and the defined term may contain several words, the classifier name separates words using upper-camel-case concatenations (no spaces but each word beginning with a capital with all other letters in lowercase). Similarly, the name may be some simplified key phrase. This "UpperCamelCase" rule is generally followed but may be violated if clarity or consistency with other standards is improved by minor violations. For example:

— Zone identifier values are represented by the interface ZonalIdentifier or stored using the datatype DirectPosition defined in ISO 19107.

— Instances of primitives realize the interface Primitive in the package Common Spatio-temporal Classes and other interfaces for their specific dimension and interpolation mechanism. For example, Point, Instant, Interval, Line, NodeT, LocationS.

— Any classifier name referenced from another standard retains its original format.

Classifier names for attributes and operations in the UML models may similarly use key phrases in lowerCamelCase (same as UpperCamelCase, but the first word begins in a lowercase letter). For example: parent; child; parentOf; childOf and relatePosition are all used as operation names.

Module and package names can contain spaces. In some situations, a phrase that has an abbreviation is used in its unabbreviated form as a package name. Where a package or module is referred to in the text, both the capitalization and unabbreviated form are preserved. This distinguishes them from a phrase in general use. For example: DGGS Equal-Area Earth Reference System; Zone and Temporal Geometry; and Reference System defined in this standard and Coordinate Reference Systems defined in ISO 19111.

In summary, the use of capitals for a term in the general text indicates a reference to a classifier from the UML.

4.5 Attribute and association role status

In this document, conceptual schema in Clauses 6–8 are defined by tables. In these tables:

— attributes and association roles are given an **Obligation** status:

  — **M:** mandatory — this attribute or association role shall be supplied.

  — **C:** conditional — this attribute or association role shall be supplied if the condition (given in the description) is true. It may be supplied if the condition is false.

  — **O:** optional — this attribute or association role may be supplied.

— the **Maximum Occurrence** column in the tables indicates the maximum number of occurrences of attribute values that are permissible, with * indicating no upper limit.

— non-navigable associations are not included in the UML diagrams or tables.

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The tables provide a summary of the UML diagrams. In particular, association roles, attributes, operations, and constraints that are inherited from another class unchanged are not described in the tables. In the event of any discrepancies between the UML diagrams and text, the UML shall prevail.

5 DGGS specification overview

5.1 Package overview

The specification for DGGSs is described in this document in the form of a UML model with supplementary defining tables and text. The UML data model is organized into three primary packages. The Common Spatio-temporal Classes package contains two UML sub-packages, DGGS Core contains four UML sub-packages, and Equal-Area Earth DGGS is a single UML package, as shown in Figure 2.

a) The Common Spatio-temporal Classes package, containing:

   1) Zone and Temporal Geometry package, comprising temporal and spatio-temporal primitives for geometry and topology,

   2) Zone, Identifier and RS package, comprising temporal and spatio-temporal RS using identifiers and their primitives.

b) The DGGS Core package, containing:

   1) Core RS using zonal identifiers with structured geometry package,

   2) Core Quantization Functions package,

   3) Core Query Functions package,

   4) Core Interoperation Functions package.

c) The Equal-Area Earth DGGS package.

In Figure 2, each box represents a package and contains the package name. Each arrowed line shows the normative dependency of one package upon another package (at the head of the arrow). The Common Spatio-temporal Classes, DGGS Core and Equal-Area Earth DGGS packages shall be normatively dependent on packages in five other ISO standards.

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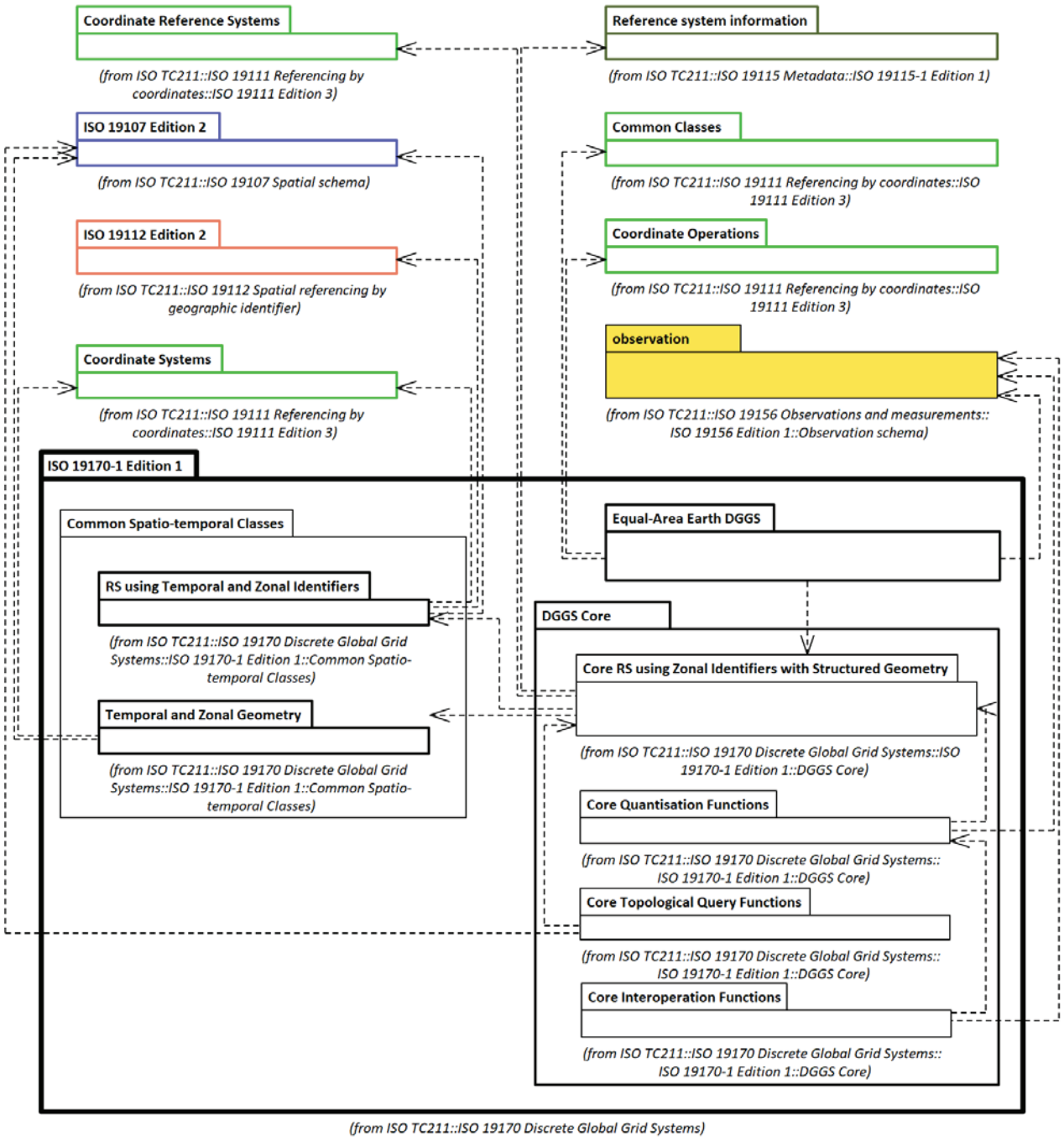

Key

- ISO 19107:2019
- ISO 19111:2019
- ISO 19112:2019
- ISO 19115-1:2014
- ISO 19156:2011
- ISO 19170-1:2021 (this document)

Figure 2 — DGGS package diagram

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Packages are grouped in a hierarchy of sub-packages, with modules containing interfaces at the leaves of the hierarchy. In the UML diagrams that follow, interface names are often shown as <module-name>::<interface-name>. For reference, Table 1 lists all the module names that are referred to in the diagrams and names the International Standard they come from.

Table 1 — Module names used in UML diagrams in this document

Standard name		Module name
ISO 19107:2019 (Spatial Schema, Ed. 2)		Edge
		Geometry
		Node
		Topology
ISO 19111:2019 (Referencing by Coordinates, Ed. 3)		Common Classes
		Coordinates
		Coordinate Operations
		Coordinate Reference System
		Coordinate Systems
ISO 19112:2019 (Spatial referencing by geographic identifier, Ed. 2)		ISO 19112, Edition 2
ISO 19115-1:2014 (Metadata, Ed. 1)		Reference system information
ISO 19156:2011 (Observation and Measurements, Ed. 1)		Observation
ISO 19170-1 (Discrete Global Grid Systems, Ed. 1) [this document]	Common Spatio-temporal Classes	Temporal Geometry and Topology
		Zonal Geometry and Topology
		Temporal RS using Identifiers
		Spatial Location
		Zonal RS using Identifiers
	DGGS Core	Core RS using Zonal Identifiers with Structured Geometry
		Core Quantization Functions
		Core Topological Query Functions
		Core Interoperation Functions
		Interoperation Query
		Interoperation Broadcast
	Equal-Area Earth DGGS	Equal-Area Earth RS
		Equal-Area Tessellation
		Equal-Area Cell

Conformance classes for the modules in the Common Spatio-temporal Classes, DGGS Core, and Equal-Area Earth DGGS packages are described in Annex A.

One product conformance class is also defined for an Equal-Area Earth DGGS product that brings modules together as a system.

6 Common Spatio-temporal Classes package

6.1 Common Spatio-temporal Classes overview

This clause specifies the common spatio-temporal classes to support temporal and spatio-temporal geometry, topology, zones, zonal identifiers, zonal query and RSs using temporal or zonal identifiers.

These classes are defined here in such a way that they can be used in any context which requires an internally consistent set of temporal and spatio-temporal classes for use with spatial classes from

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ISO 19107:2019, ISO 19111:2019 and ISO 19112:2019. They are further specialized in the DGGS Core for use in DGGS. In this restricted model for spatio-temporal systems, the spatio-temporal scope is constrained to spatial classes that are invariant through all time, and to temporal classes that are invariant throughout space.

The Common Spatio-temporal Classes are organized into two packages with five modules:

a) The Temporal and Zonal Geometry package, comprising:

   1) Temporal Geometry and Topology module

   2) Zonal Geometry and Topology module

b) The RS using Temporal and Zonal Identifiers package, comprising:

   1) Spatial Location module

   2) Temporal RS using Identifiers module

   3) Zonal RS using Identifiers module

In each package, separate spatial and temporal classes are defined first, followed by spatio-temporal classes that bring temporal and spatial classes together.

6.2 Temporal and Zonal Geometry package

6.2.1 Temporal Geometry and Topology module

6.2.1.1 Context and data model

Temporal geometry is geometry constrained to one of the temporal coordinate systems, defined by TemporalCS in ISO 19111. Temporal geometry primitives instant and interval implement the temporal analogues of point and line respectively in ISO 19107. All geometry has topology, and the temporal topology primitives nodeT and edgeT implement the temporal analogues of node and edge respectively. These are shown in Figure 3.

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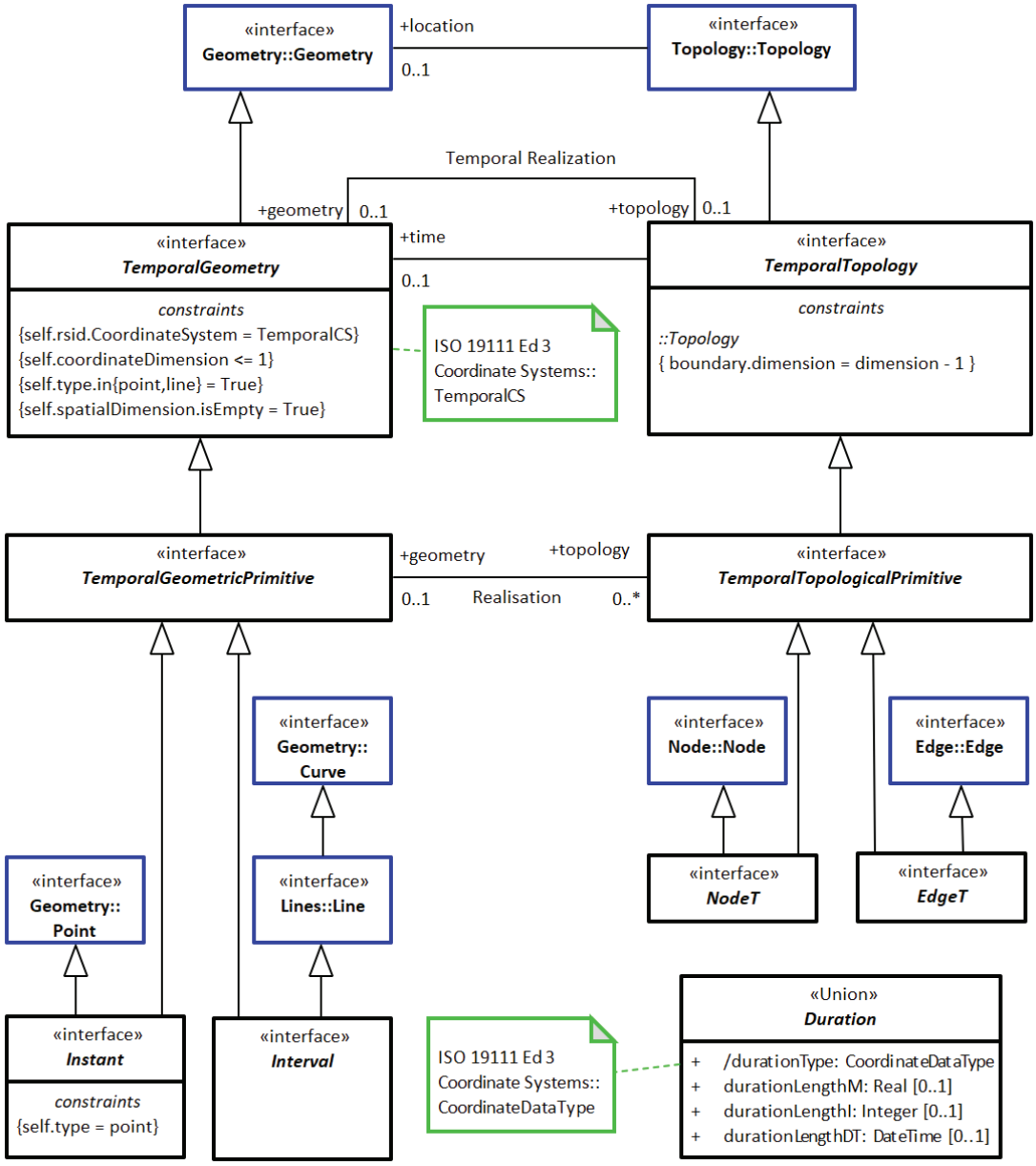

Key

- ISO 19107:2019
- ISO 19111:2019
- ISO 19170-1:2021 (this document)

Figure 3 — Primitives of Temporal Geometry and Topology

Temporal interfaces paralleling the spatial geometry and topology interface structure are built from these temporal primitives. Each temporal interface has the same meaning and semantics as their equivalent spatial interface, with the constraint that all temporal interfaces are constrained to the same coordinate system as their temporal primitives. Figure 4 shows the spatial classes on the left and their temporal equivalents on the right.

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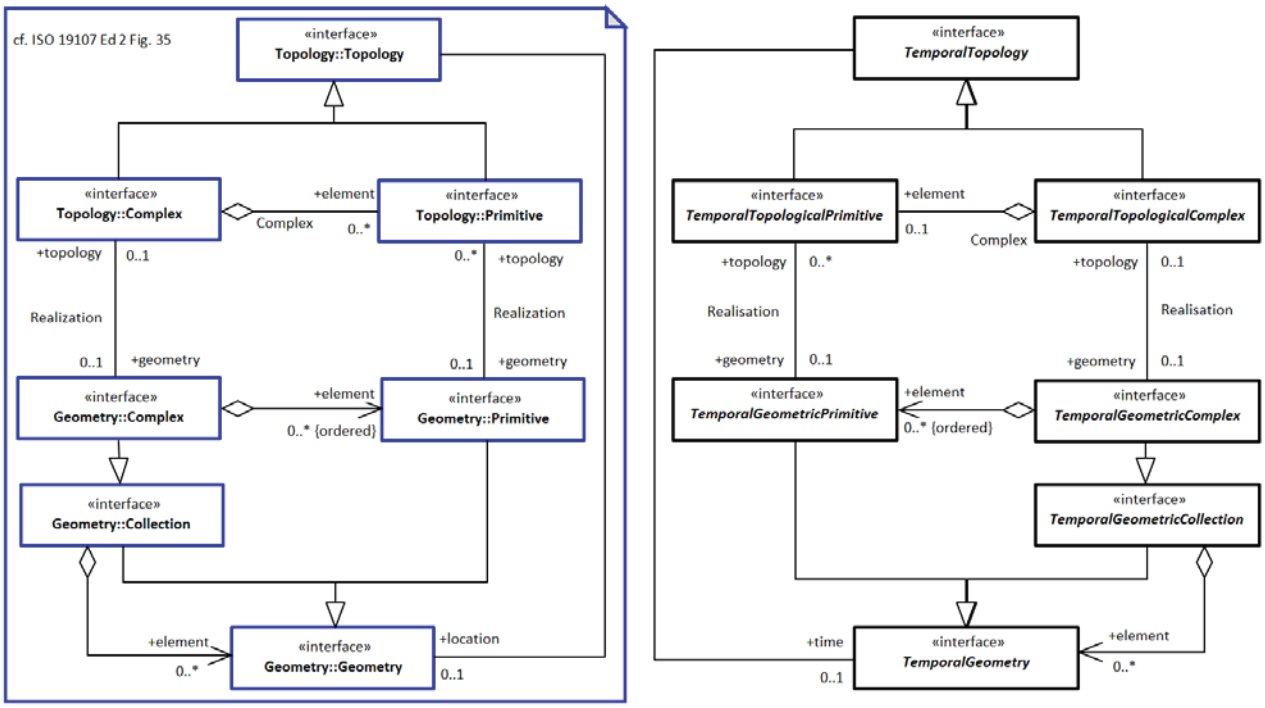

Key

ISO 19107:2019

ISO 19170-1:2021 (this document)

Figure 4 — ISO 19107:2019, Context for Temporal Geometry and Topology

6.2.1.2 Defining tables

a) Table 2 Elements of Temporal Geometry and Topology::Duration

b) Table 3 Elements of Temporal Geometry and Topology::EdgeT

c) Table 4 Elements of Temporal Geometry and Topology::Instant

d) Table 5 Elements of Temporal Geometry and Topology::Interval

e) Table 6 Elements of Temporal Geometry and Topology::NodeT

f) Table 7 Elements of Temporal Geometry and Topology::TemporalGeometricCollection

g) Table 8 Elements of Temporal Geometry and Topology::TemporalGeometricComplex

h) Table 9 Elements of Temporal Geometry and Topology::TemporalGeometricPrimitive

i) Table 10 Elements of Temporal Geometry and Topology::TemporalGeometry

j) Table 11 Elements of Temporal Geometry and Topology::TemporalTopologicalComplex

k) Table 12 Elements of Temporal Geometry and Topology::TemporalTopologicalPrimitive

l) Table 13 Elements of Temporal Geometry and Topology::TemporalTopology

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Table 2 — Elements of Temporal Geometry and Topology::Duration

Name:	Duration					
Definition:	Duration implements Length on a Temporal Coordinate System.					
Stereotype:	Union					
Abstract:	true					
Associations:	(none)					
Public attributes:	*Name*	*Definition*	*Derived*	*Obligation*	*Maximum occurrence*	*Data type*
	durationLengthDT	Length of time for Duration of type DateTime.		C	1	DateTime
	durationLengthI	Length of time for Duration of type Integer count.		C	1	Integer
	durationLengthM	Length of time for Duration of type Real measure.		C	1	Real
	durationType	Type of unit of measure for time.	true	M	1	CoordinateDataType
Constraints:	(none)					

Table 3 — Elements of Temporal Geometry and Topology::EdgeT

Name:	EdgeT
Definition:	Topological temporal edge, one-dimensional topological primitive.
Stereotype:	Interface
Inheritance from:	TemporalTopologicalPrimitive
Abstract:	true
Associations:	(none)
Public attributes:	(none)
Constraints:	(none)

Table 4 — Elements of Temporal Geometry and Topology::Instant

Name:	Instant
Definition:	Instant implements Point geometry on a Temporal Coordinate System.
Stereotype:	Interface
Inheritance from:	TemporalGeometricPrimitive
Abstract:	true
Associations:	(none)
Public attributes:	(none)
Constraints:	self.type = point

Table 5 — Elements of Temporal Geometry and Topology::Interval

Name:	Interval
Definition:	Interval implements Line geometry on a Temporal Coordinate System.
Stereotype:	Interface

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Table 5 *(continued)*

Inheritance from:	TemporalGeometricPrimitive
Abstract:	true
Associations:	(none)
Public attributes:	(none)
Constraints:	(none)

Table 6 — Elements of Temporal Geometry and Topology::NodeT

Name:	NodeT
Definition:	Topological temporal node, zero-dimensional topological primitive, its boundary being empty.
Stereotype:	Interface
Inheritance from:	TemporalTopologicalPrimitive
Abstract:	true
Associations:	(none)
Public attributes:	(none)
Constraints:	(none)

Table 7 — Elements of Temporal Geometry and Topology::TemporalGeometricCollection

Name:	TemporalGeometricCollection			
Definition:	Temporal Geometric Collection implements geometric Collection for Temporal Geometry.			
Stereotype:	Interface			
Inheritance from:	TemporalGeometry			
Generalization of:	TemporalGeometricComplex			
Abstract:	true			
Associations:	*Association with:*	*Obligation*	*Maximum occurrence*	*Provides:*
	TemporalGeometry (feature type)	C	*	element
Public attributes:	(none)			
Constraints:	(none)			

Table 8 — Elements of Temporal Geometry and Topology::TemporalGeometricComplex

Name:	TemporalGeometricComplex			
Definition:	Temporal Geometric Complex implements geometric Complex for Temporal Geometry.			
Stereotype:	Interface			
Inheritance from:	TemporalGeometricCollection			
Abstract:	true			
Associations:	*Association with:*	*Obligation*	*Maximum occurrence*	*Provides:*
	TemporalGeometricPrimitive (feature type)	C	*	element
	TemporalTopologicalComplex (feature type)	C	1	topology
Public attributes:	(none)			
Constraints:	(none)			

Table 9 — Elements of Temporal Geometry and Topology::TemporalGeometricPrimitive

Name:	TemporalGeometricPrimitive

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Table 9 *(continued)*

Definition:	Temporal Geometric Primitive implements geometric Primitive for Temporal Geometry.					
Stereotype:	Interface					
Inheritance from:	TemporalGeometry					
Generalization of:	Instant, Interval					
Abstract:	true					
Associations:	*Association with:*			*Obligation*	*Maximum occurrence*	*Provides:*
	TemporalTopologicalPrimitive (feature type)			C	*	topology
Public attributes:	*Name*	*Definition*	*Derived*	*Obligation*	*Maximum occurrence*	*Data type*
	spatialDimension	Dimension of its spatial geometry component.		M	1	Integer
	temporalDimension	Dimension of its temporal geometry component.		M	1	Integer
Constraints:	(none)					

Table 10 — Elements of Temporal Geometry and Topology::TemporalGeometry

Name:	TemporalGeometry			
Definition:	Temporal Geometry implements 1D Geometry on a Temporal Coordinate System.			
Stereotype:	Interface			
Inheritance from:	ZoneSimpleGeometry			
Generalization of:	TemporalGeometricCollection, TemporalGeometricPrimitive			
Abstract:	true			
Associations:	*Association with:*	*Obligation*	*Maximum occurrence*	*Provides:*
	TemporalTopology (feature type)	C	1	topology
Public attributes:	(none)			
Constraints:	self.coordinateDimension < = 1			
	self.rsid.CoordinateSystem = TemporalCS			
	self.spatialDimension.isEmpty = True			
	self.type.in{point,line} = True			

Table 11 — Elements of Temporal Geometry and Topology::TemporalTopologicalComplex

Name:	TemporalTopologicalComplex			
Definition:	Temporal Topological Complex implements topological Complex for Temporal Topology.			
Stereotype:	Interface			
Inheritance from:	TemporalTopology			
Abstract:	true			
Associations:	*Association with:*	*Obligation*	*Maximum occurrence*	*Provides:*
	TemporalTopologicalPrimitive (feature type)	C	1	element
	TemporalGeometricComplex (feature type)	C	1	geometry
Public attributes:	(none)			
Constraints:	(none)			

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Table 12 — Elements of Temporal Geometry and Topology::TemporalTopologicalPrimitive

Name:	TemporalTopologicalPrimitive			
Definition:	Temporal Topological Primitive implements topological Primitive for Temporal Topology.			
Stereotype:	Interface			
Inheritance from:	TemporalTopology			
Generalization of:	EdgeT, NodeT			
Abstract:	true			
Associations:	*Association with:*	*Obligation*	*Maximum occurrence*	*Provides:*
	TemporalGeometricPrimitive (feature type)	C	1	geometry
Public attributes:	(none)			
Constraints:	(none)			

Table 13 — Elements of Temporal Geometry and Topology::TemporalTopology

Name:	TemporalTopology			
Definition:	Temporal Topology implements 1D Topology for Temporal Geometry.			
Stereotype:	Interface			
Inheritance from:	ZoneSimpleTopology			
Generalization of:	TemporalTopologicalComplex, TemporalTopologicalPrimitive			
Abstract:	true			
Associations:	*Association with:*	*Obligation*	*Maximum occurrence*	*Provides:*
	TemporalGeometry (feature type)	C	1	geometry
	TemporalGeometry (feature type)	C	1	time
Public attributes:	(none)			
Constraints:	(none)			

The following requirement applies:

Requirement 1: www.opengis.net/spec/DGGS/2.0/req/cc/temporal/geometry

The common classes for temporal geometry and topology shall conform to the data model in Figure 3 and Figure 4 and defining tables in Table 2–Table 13.

6.2.2 Zonal Geometry and Topology module

6.2.2.1 Context and data model

Referring to Figure 5, ZoneGeometry is either a primitive of ZoneSingleGeometry or a compound of two ZoneSingleGeometry primitives — one spatial and one temporal.

Zones exhibit topology of the same spatio-temporal dimension as their geometry.

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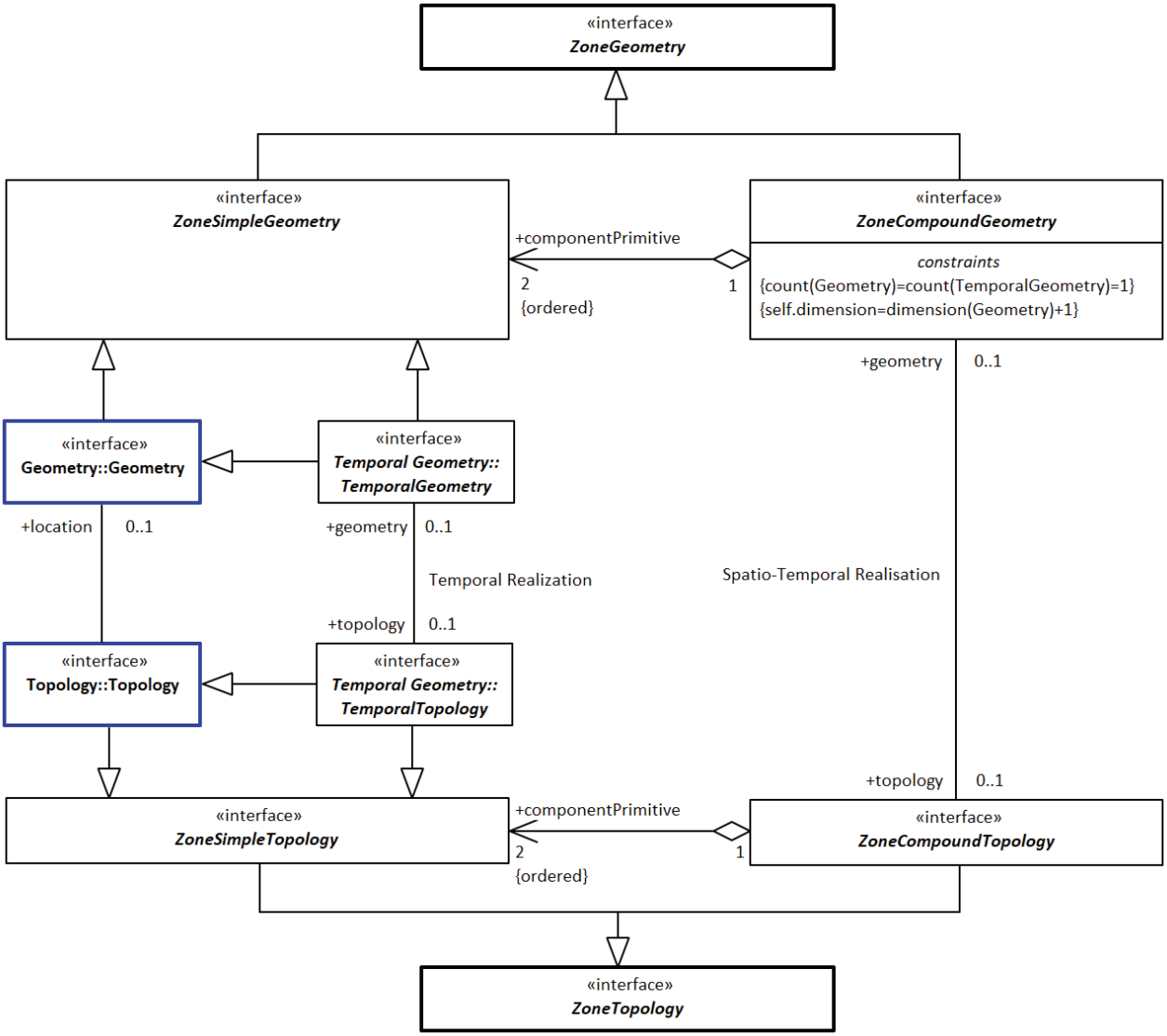

Key

ISO 19107:2019

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Figure 5 — Components of Zonal Geometry and Topology module

6.2.2.2 Defining tables

a) Table 14 Elements of Zonal Geometry and Topology::ZoneCompoundGeometry

b) Table 15 Elements of Zonal Geometry and Topology::ZoneCompoundTopology

c) Table 16 Elements of Zonal Geometry and Topology::ZoneGeometry

d) Table 17 Elements of Zonal Geometry and Topology::ZoneSimpleGeometry

e) Table 18 Elements of Zonal Geometry and Topology::ZoneSimpleTopology

f) Table 19 Elements of Zonal Geometry and Topology::ZoneTopology

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Table 14 — Elements of Zonal Geometry and Topology::ZoneCompoundGeometry

Name:	ZoneCompoundGeometry			
Definition:	ZoneCompoundGeometry is a Compound of two ZoneSimpleGeometry elements, comprising one one-, two- or three-dimensional spatial geometry and one one-dimensional temporal geometry. NOTE This is analogous to an ISO 19111 Compound set of orthogonal space time axes comprising a set of orthogonal spatial axes and one temporal axis orthogonal to the spatial axes. ZoneCompoundGeometry has ZoneCompoundTopology.			
Stereotype:	Interface			
Inheritance from:	ZoneGeometry			
Abstract:	true			
Associations:	*Association with:*	*Obligation*	*Maximum occurrence*	*Provides:*
	ZoneSimpleGeometry (feature type)	M	2	componentPrimitive
	ZoneCompoundTopology (feature type)	C	1	topology
Public attributes:	(none)			
Constraints:	count(Geometry) = count(TemporalGeometry) = 1			
	self.dimension = dimension(Geometry) + 1			

Table 15 — Elements of Zonal Geometry and Topology::ZoneCompoundTopology

Name:	ZoneCompoundTopology			
Definition:	ZoneCompoundTopology exhibits both spatial topology with respect to the spatial component of its geometry and temporal topology with respect to the temporal component of its geometry.			
Stereotype:	Interface			
Inheritance from:	ZoneTopology			
Abstract:	true			
Associations:	*Association with:*	*Obligation*	*Maximum occurrence*	*Provides:*
	ZoneSimpleTopology (feature type)	M	2	componentPrimitive
	ZoneCompoundGeometry (feature type)	C	1	geometry
Public attributes:	(none)			
Constraints:	(none)			

Table 16 — Elements of Zonal Geometry and Topology::ZoneGeometry

Name:	ZoneGeometry
Definition:	ZoneGeometry is a ZoneSimpleGeometry or a ZoneCompoundGeometry. It is the root geometry for all spatio-temporal geometry.
Stereotype:	Interface
Generalization of:	ZoneCompoundGeometry, ZoneSimpleGeometry
Abstract:	true
Associations:	(none)

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Table 16 *(continued)*

	Name	*Definition*	*Derived*	*Obligation*	*Maximum occurrence*	*Data type*
Public attributes:	spatialDimension	Topological dimension of the spatial geometry component.		M	1	Integer
	temporalDimension	Dimension of the temporal geometry component.		M	1	Integer
	topologicalDimension	Sum dimension of topological primitive.		M	1	Integer
Constraints:	(none)					

Table 17 — Elements of Zonal Geometry and Topology::ZoneSimpleGeometry

Name:	ZoneSimpleGeometry
Definition:	ZoneSimpleGeometry is a 1D, 2D or 3D spatial geometry that is invariant over all time, OR a 1D temporal geometry invariant over all space. A ZoneSimpleGeometry has topology appropriate for its geometry.
Stereotype:	Interface
Inheritance from:	ZoneGeometry
Abstract:	true
Associations:	(none)
Public attributes:	(none)
Constraints:	(none)

Table 18 — Elements of Zonal Geometry and Topology::ZoneSimpleTopology

Name:	ZoneSimpleTopology
Definition:	ZoneSimpleTopology is a 1D, 2D or 3D spatial topology that is invariant over all time, OR a 1D temporal topology that is invariant over all space.
Stereotype:	Interface
Inheritance from:	ZoneTopology
Abstract:	true
Associations:	(none)
Public attributes:	(none)
Constraints:	(none)

Table 19 — Elements of Zonal Geometry and Topology::ZoneTopology

Name:	ZoneTopology
Definition:	ZoneTopology is a ZoneSimpleTopology or a ZoneCompoundTopology
Stereotype:	Interface
Generalization of:	ZoneCompoundTopology, ZoneSimpleTopology
Abstract:	true
Associations:	(none)
Public attributes:	(none)
Constraints:	(none)

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The following requirement applies:

Requirement 2: www.opengis.net/spec/DGGS/2.0/req/cc/zone/geometry

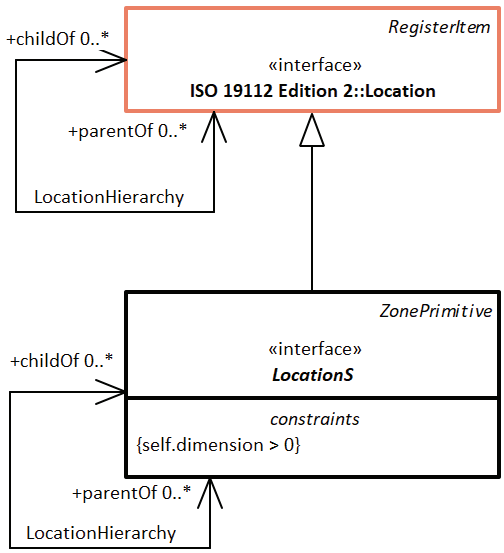
The common classes for zonal geometry and topology shall conform to the data model in Figure 5 and defining tables in Table 14–Table 19.

6.3 Temporal and Zonal RS using Identifiers package

6.3.1 Spatial Location module

6.3.1.1 Context and data model

ISO 19112 describes spatial refencing by geographic identifiers, locations and location classes. The LocationS interface is a specialization of the Location interface from ISO 19112. See Figure 6. In the next subclauses, the Period interface is introduced as the temporal equivalent of LocationS.



Key

ISO 19112:2019

ISO 19170-1:2021 (this document)

Figure 6 — Context for LocationS

6.3.1.2 Defining tables

a) Table 20 Elements of Spatial Location::LocationS

Table 20 — Elements of Spatial Location::LocationS

Name:	LocationS
Definition:	Particular place or position. NOTE Unlike a Location as specified in ISO 19112:2019, all LocationS are owned and defined by their ReferenceSystem and not by an independent authority.
Stereotype:	Interface

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Table 20 *(continued)*

Inheritance from:	ZonePrimitive					
Abstract:	true					
Associations:	*Association with:*			*Obligation*	*Maximum occurrence*	*Provides:*
	LocationS (feature type)			C	*	childOf
	LocationS (feature type)			C	*	parentOf
Public attributes:	*Name*	*Definition*	*Derived*	*Obligation*	*Maximum occurrence*	*Data type*
	coordinateTuple	Point within the extent of the spatial location.		M	1	DirectPosition
	extent	Spatial extent of the location.	true	M	1	EX_Extent
	identifier	Identifier of the spatial location.		M	1	GeographicIdentifier
Constraints:	self.dimension > 0					

The following requirement applies:

Requirement 3: www.opengis.net/spec/DGGS/2.0/req/cc/spatial/location

The common classes for spatial location shall conform to the data model in Figure 6 and defining table in Table 20.

6.3.2 Temporal RS using Identifiers module

6.3.2.1 Context and data model

Semantically, the terms period and zone are defined as the temporal and spatio-temporal equivalents of a location. These are represented in the data model by the interfaces Period and Zone.

Referring to Figure 7 showing the spatial classes on the left and the temporal classes on the right, it is noted that Period is augmented by:

— PeriodIdentifier data-type as the temporal equivalent of GeographicIdentifier,

— Period interface as the temporal equivalent of LocationS, see Figure 6,

— PeriodClass interface as the temporal equivalent of LocationClass, and

— TemporalReferenceSystemusingPeriodIdentifiers interface as the temporal equivalent of SpatialReferenceusingGeographicIdentifiers.

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