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Geographic information — Referencing by coordinates

Information géographique — Système de références par coordonnées

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Contents

Page

Foreword ..... **v**
Introduction ..... **vii**
1 Scope **1**
2 Normative references **1**
3 Terms, definitions, symbols and abbreviated terms **2**
3.1 Terms and definitions 2
3.2 Symbols 11
3.3 Abbreviated terms 11
4 Conformance requirements **12**
5 Conventions **13**
5.1 Unified Modeling Language notation 13
5.2 Attribute status 13
6 Referencing by coordinates — Data model overview **14**
7 Coordinates package **15**
7.1 Relationship between coordinates and coordinate reference system 15
7.2 Coordinate reference system identification 16
7.3 Requirements for coordinate metadata 16
7.3.1 Requirements class: Static CRS coordinate metadata 16
7.3.2 Requirements class: Dynamic CRS coordinate metadata 17
7.4 UML schema for the Coordinates package 17
7.5 UML schema for change of coordinates 19
8 Common Classes package **21**
8.1 General attributes 21
8.1.1 Introduction 21
8.1.2 Name and alias 21
8.1.3 Identifier 21
8.1.4 Scope and Domain of Validity 21
8.2 UML schema for the Common Classes package 22
9 Coordinate Reference Systems package **25**
9.1 Coordinate reference system 25
9.1.1 General 25
9.1.2 Principal subtypes of coordinate reference system 25
9.2 Derived coordinate reference system 26
9.2.1 General 26
9.2.2 Projected coordinate reference system 26
9.3 Compound coordinate reference system 27
9.3.1 General 27
9.3.2 Spatial compound coordinate reference system 27
9.3.3 Spatio-temporal compound coordinate reference system 27
9.3.4 Spatio-parametric compound coordinate reference system 27
9.3.5 Spatio-parametric-temporal compound coordinate reference system 27
9.4 UML schema for the Coordinate Reference Systems package 27
10 Coordinate Systems package **36**
10.1 Coordinate system — General 36
10.2 Parametric coordinate system 37
10.3 Temporal coordinate system 37
10.4 Coordinate system axis 38
10.5 UML schema for the Coordinate Systems package 38
11 Datums (reference frames) package **49**
11.1 Types of datum and reference frame 49

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11.2 Geodetic reference frame 49
11.2.1 Prime meridian 49
11.2.2 Ellipsoid 49
11.3 Dynamic reference frame 50
11.4 Datum ensemble 50
11.5 Temporal datum 50
11.6 UML schema for the Datums package 50
12 Coordinate Operations package 58
12.1 General characteristics of coordinate operations 58
12.2 UML schema for the Coordinate Operations package 59
Annex A (normative) **Abstract test suite 71**
Annex B (informative) **Spatial referencing by coordinates — Geodetic concepts 76**
Annex C (informative) **Spatial referencing by coordinates — Context for modelling 81**
Annex D (informative) **Temporal referencing by coordinates — Context for modelling 95**
Annex E (informative) **Examples 99**
Annex F (informative) **Recommended best practice for interfacing to ISO 19111 ..... 137**
Annex G (informative) **Backward compatibility with ISO 19111:2007 ..... 138**
Bibliography 143

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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).

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights. Details of any patent rights identified during the development of the document will be in the Introduction and/or on the ISO list of patent declarations received (see www.iso.org/patents).

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

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

This document was prepared by Technical Committee ISO/TC 211, *Geographic information/Geomatics,* in close collaboration with the Open Geospatial Consortium (OGC).

This third edition cancels and replaces the second edition (ISO 19111:2007), which has been technically revised. This document also incorporates the provisions of ISO 19111-2:2009, which is cancelled.

The changes in this edition compared to the previous edition are:

— inclusion of applicable modern geodetic terminology;

— extension to describe dynamic geodetic reference frames;

— extension to describe geoid-based vertical coordinate reference systems;

— extension to allow triaxial ellipsoid for planetary applications;

— extension to describe three-dimensional projected coordinate reference systems;

— addition of 'datum ensembles' to allow grouping of related realizations of a reference frame where for lower accuracy applications the differences are insignificant;

— clarification in the modelling of derived coordinate reference systems;

— remodelling of the metadata elements scope and extent;

— addition of requirements to describe coordinate metadata and the relationship between spatial coordinates;

— additional modelling of temporal coordinate reference system components sufficient for spatio-temporal coordinate referencing;

— consolidation of the provisions of ISO 19111-2:2009 (*Spatial referencing by coordinates — Extension for parametric values*) into this document;

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— change in name from 'Spatial referencing by coordinates' to 'Referencing by coordinates', due to the inclusion of the non-spatial coordinate reference system subtypes of parametric (from ISO 19111-2) and temporal;

— the correction of minor errors.

Further details are given in Annex G.

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.

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

Geographic information is inherently four-dimensional and includes time. The spatial component relates the features represented in geographic data to positions in the real world. Spatial references fall into two categories:

— those using coordinates;

— those based on geographic identifiers.

Spatial referencing by geographic identifiers is defined in ISO 19112[5]. This document describes the data elements, relationships and associated metadata required for spatial referencing by coordinates, expanded from a strictly spatial context to include time. The temporal element is restricted to temporal coordinate systems having a continuous axis. The temporal element excludes calendars and ordinal reference systems due to their complexities in definition and in transformation. The context is shown in Figure 1.

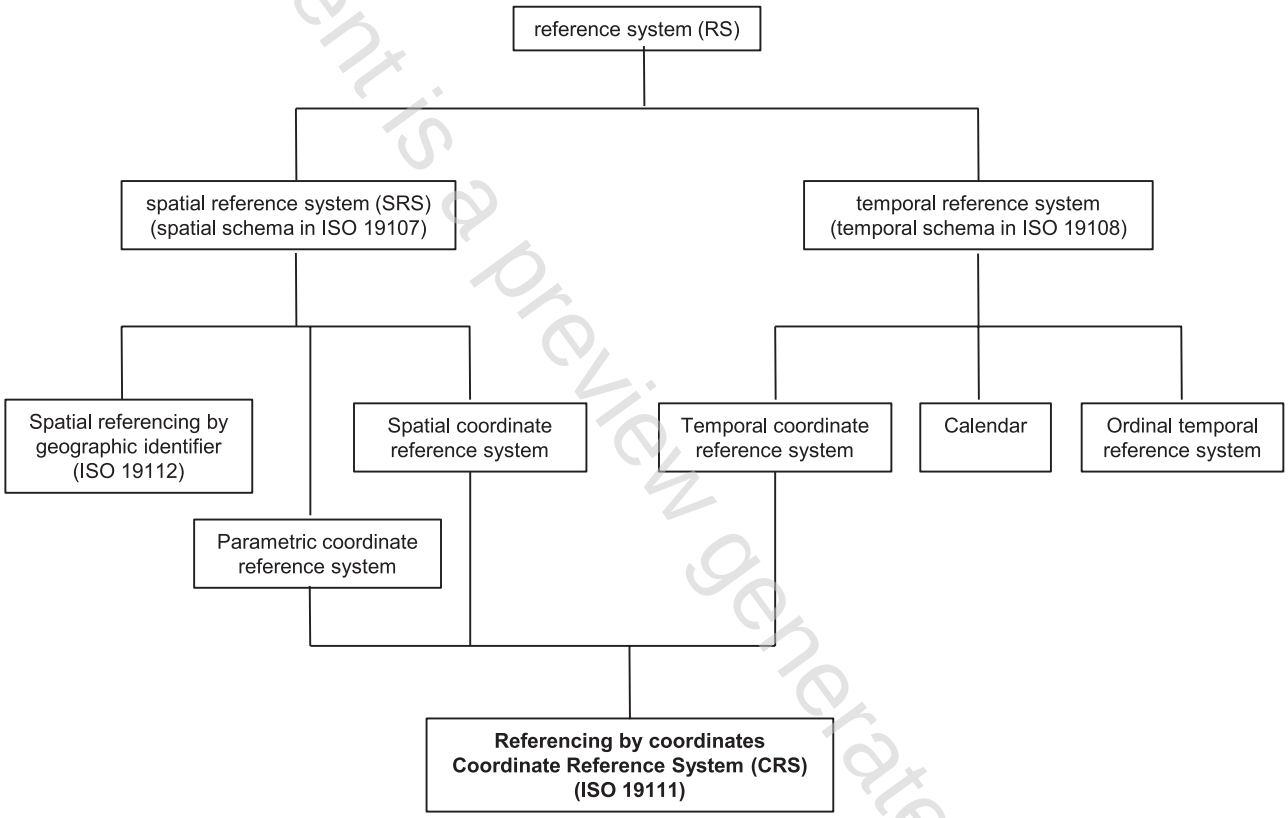


Figure 1 — Context of referencing by coordinates

Certain scientific communities use three-dimensional systems where horizontal position is combined with a non-spatial parameter. In these communities, the parameter is considered to be a third, vertical, axis. The parameter, although varying monotonically with height or depth, does not necessarily vary in a simple manner. Thus conversion from the parameter to height or depth is non-trivial. The parameters concerned are normally absolute measurements and the datum is taken with reference to a direct physical measurement of the parameter. These non-spatial parameters and parametric coordinate reference system modelling constructs were previously described in ISO 19111-2:2009 but have been incorporated into this revision because the modelling constructs are identical to the other coordinate reference system types included in this document.

This document describes the elements that are necessary to fully define various types of coordinate reference systems applicable to geographic information. The subset of elements required is partially dependent upon the type of coordinates. This document also includes optional fields to allow for the

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inclusion of metadata about the coordinate reference systems. The elements are intended to be both machine and human readable.

In addition to describing a coordinate reference system, this document provides for the description of a coordinate operation between two different coordinate reference systems or a coordinate operation to account for crustal motion over time. With such information, spatial data referenced to different coordinate reference systems can be referenced to one specified coordinate reference system at one specified time. This facilitates spatial data integration. Alternatively, an audit trail of coordinate manipulations can be maintained.

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Geographic information — Referencing by coordinates

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1 Scope

This document defines the conceptual schema for the description of referencing by coordinates. It describes the minimum data required to define coordinate reference systems. This document supports the definition of:

— spatial coordinate reference systems where coordinate values do not change with time. The system may:

  — be geodetic and apply on a national or regional basis, or

  — apply locally such as for a building or construction site, or

  — apply locally to an image or image sensor;

  — be referenced to a moving platform such as a car, a ship, an aircraft or a spacecraft. Such a coordinate reference system can be related to a second coordinate reference system which is referenced to the Earth through a transformation that includes a time element;

— spatial coordinate reference systems in which coordinate values of points on or near the surface of the earth change with time due to tectonic plate motion or other crustal deformation. Such dynamic systems include time evolution, however they remain spatial in nature;

— parametric coordinate reference systems which use a non-spatial parameter that varies monotonically with height or depth;

— temporal coordinate reference systems which use dateTime, temporal count or temporal measure quantities that vary monotonically with time;

— mixed spatial, parametric or temporal coordinate reference systems.

The *definition* of a coordinate reference system does not change with time, although in some cases some of the defining parameters can include a rate of change of the parameter. The coordinate values within a dynamic and in a temporal coordinate reference system can change with time.

This document also describes the conceptual schema for defining the information required to describe operations that change coordinate values.

In addition to the minimum data required for the definition of the coordinate reference system or coordinate operation, the conceptual schema allows additional descriptive information - coordinate reference system metadata - to be provided.

This document is applicable to producers and users of geographic information. Although it is applicable to digital geographic data, the principles described in this document can be extended to many other forms of spatial data such as maps, charts and text documents.

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 8601, *Data elements and interchange formats — Information interchange — Representation of dates and times*

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ISO 19103, *Geographic information — Conceptual schema language*

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

3 Terms, definitions, symbols 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 http://www.electropedia.org/

— ISO Online browsing platform: available at https://www.iso.org/obp

3.1.1
affine coordinate system
coordinate system in Euclidean space with straight axes that are not necessarily mutually perpendicular

3.1.2
Cartesian coordinate system
coordinate system in Euclidean space which gives the position of points relative to *n* mutually perpendicular straight axes all having the same unit of measure

Note 1 to entry: *n* is 2 or 3 for the purposes of this document.

Note 2 to entry: A Cartesian coordinate system is a specialisation of an affine coordinate system.

3.1.3
compound coordinate reference system
coordinate reference system using at least two independent coordinate reference systems

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

3.1.4
concatenated operation
coordinate operation consisting of the sequential application of multiple coordinate operations

3.1.5
coordinate
one of a sequence of numbers designating the position of a point

Note 1 to entry: In a spatial coordinate reference system, the coordinate numbers are qualified by units.

3.1.6
coordinate conversion
coordinate operation that changes coordinates in a source coordinate reference system to coordinates in a target coordinate reference system in which both coordinate reference systems are based on the same datum

Note 1 to entry: A coordinate conversion uses parameters which have specified values.

EXAMPLE 1 A mapping of ellipsoidal coordinates to Cartesian coordinates using a map projection.

EXAMPLE 2 Change of units such as from radians to degrees or from feet to metres.

3.1.7
coordinate epoch
epoch to which coordinates in a dynamic coordinate reference system are referenced

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