INTERNATIONAL STANDARD

ISO 19108

First edition
2002-09-01

Geographic information — Temporal schema

Information géographique — Schéma temporel

Reference number
ISO 19108:2002(E)

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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.

International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 3.

The main task of technical committees is to prepare International Standards. Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.

Attention is drawn to the possibility that some of the elements of this International Standard may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights.

ISO 19108 was prepared by Technical Committee ISO/TC 211, *Geographic information/Geomatics.*

Annexes A and C form a normative part of this International Standard. Annexes B and D are for information only.

Introduction

This International Standard defines the standard concepts needed to describe the temporal characteristics of geographic information as they are abstracted from the real world. Temporal characteristics of geographic information include feature attributes, feature operations, feature associations, and metadata elements that take a value in the temporal domain.

The widespread application of computers and geographic information systems has led to the increased analysis of geospatial data within multiple disciplines. Geographic information is not confined to a three-dimensional spatial domain. Many geographic information systems require data with temporal characteristics. A standardized conceptual schema for temporal characteristics will increase the ability of geographic information to be used for certain types of applications such as simulations and predictive modelling.

As a fundamental physical reality, time is of interest to the whole range of scientific and technical disciplines. Many of the concepts described in this International Standard are applicable outside of the field of geographic information. ISO/TC 211 does not intend to develop independent standards for the description of time, but the technical committee believes that it is necessary to standardize the way to describe the temporal characteristics of geographic data sets and features. Geographic information system and software developers and users of geographic information will use this schema to provide consistently understandable temporal data structures.

Historically, temporal characteristics of features have been treated as thematic feature attributes. For example, a feature "Building" may have an attribute "date of construction". However, there is increasing interest in describing the behaviour of features as a function of time. This can be supported to a limited extent when time is treated independently of space. For example, the path followed by a moving object can be represented as a set of features called "way point", each of which is represented as a point and has an attribute that provides the time at which the object was at that spatial position. Behaviour in time may be described more easily if the temporal dimension is combined with the spatial dimensions, so that a feature can be represented as a spatiotemporal object. For example, the path of a moving object could be represented as a curve described by coordinates in x, y and t. This International Standard has been prepared in order to standardize the use of time in feature attributes. Although it does not describe feature geometry in terms of a combination of spatial and temporal coordinates, it has been written to establish a basis for doing so in a future standard within the ISO 19100 series.

Geographic information — Temporal schema

1 Scope

This International Standard defines concepts for describing temporal characteristics of geographic information. It depends upon existing information technology standards for the interchange of temporal information. It provides a basis for defining temporal feature attributes, feature operations, and feature associations, and for defining the temporal aspects of metadata about geographic information. Since this International Standard is concerned with the temporal characteristics of geographic information as they are abstracted from the real world, it emphasizes valid time rather than transaction time.

2 Conformance

2.1 Conformance classes and requirements

This International Standard defines five conformance classes, which depend upon the nature of the test item.

2.2 Application schemas for data transfer

To conform to this International Standard, an application schema for data transfer shall satisfy the requirements of A.1 of the Abstract Test Suite in annex A.

2.3 Application schemas for data with operations

To conform to this International Standard, an application schema that supports operations on data shall satisfy the requirements of A.2 of the Abstract Test Suite in annex A.

2.4 Feature catalogues

To conform to this International Standard, a feature catalogue shall satisfy the requirements of A.3 of the Abstract Test Suite in annex A.

2.5 Metadata element specifications

To conform to this International Standard, a metadata specification shall satisfy the requirements of A.4 of the Abstract Test Suite in annex A.

2.6 Metadata for data sets

To conform to this International Standard, metadata for a data set shall satisfy the requirements of A.5 of the Abstract Test Suite in annex A.

3 Normative references

The following normative documents contain provisions which, through reference in this text, constitute provisions of this International Standard. For dated references, subsequent amendments to, or revisions of, any of these publications do not apply. However, parties to agreements based on this International Standard are encouraged to investigate the possibility of applying the most recent editions of the normative documents indicated below. For undated references, the latest edition of the normative document referred to applies. Members of ISO and IEC maintain registers of currently valid International Standards.

ISO 31-1:1992, *Quantities and units — Part 1: Space and time*

ISO 1000:1992, *SI units and recommendations for the use of their multiples and of certain other units*

ISO 8601:2000, *Data elements and interchange formats — Information interchange — Representation of dates and times*

ISO/IEC 11404:1996, *Information technology — Programming languages, their environments and system software interfaces — Language-independent data types*

ISO/TS 19103:—[1)], *Geographic information — Conceptual schema language*

ISO 19107:—[1)], *Geographic information — Spatial schema*

ISO 19109:—[1)], *Geographic information — Rules for application schema*

ISO 19110:—[1)], *Geographic information — Methodology for feature cataloguing*

ISO 19111:—[1)], *Geographic information — Spatial referencing by coordinates*

ISO 19115:—[1)], *Geographic information — Metadata*

4 Terms, definitions and abbreviated terms

4.1 Terms and definitions

For the purposes of this International Standard, the following terms and definitions apply.

4.1.1
calendar
discrete **temporal reference system** that provides a basis for defining **temporal position** to a resolution of one **day**

4.1.2
calendar era
sequence of **periods** of one of the types used in a **calendar**, counted from a specified **event**

4.1.3
UTC
Coordinated Universal Time
time scale maintained by the Bureau International des Poids et Mesures (International Bureau of Weights and Measures) and the International Earth Rotation Service (IERS) that forms the basis of a coordinated dissemination of standard frequencies and time signals [ITU-R Rec.TF.686-1 (1997)]

4.1.4
day
period having a **duration** nominally equivalent to the **periodic time** of the Earth's rotation around its axis

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1) To be published.

4.1.5
edge
one-dimensional **topological primitive** [ISO 19107]

NOTE The geometric realization of an edge is a curve. The boundary of an edge is the set of one or two nodes associated to the edge within a topological complex.

4.1.6
event
action which occurs at an **instant**

4.1.7
feature
abstraction of real world phenomena [ISO 19101]

NOTE A feature may occur as a type or an instance. Feature type or feature instance should be used when only one is meant.

4.1.8
feature association
relationship between features [ISO 19109]

NOTE 1 A feature association may occur as a type or an instance. Feature association type or feature association instance is used when only one is meant.

NOTE 2 Feature associations include aggregation of features.

4.1.9
feature attribute
characteristic of a **feature** [Adapted from ISO 19110]

NOTE A feature attribute has a name, a data type, and a value domain associated to it.

4.1.10
feature division
feature succession in which a previously existing **feature** is replaced by two or more distinct **feature** instances of the same **feature** type

EXAMPLE An instance of the feature type "land parcel" is replaced by two instances of the same type when the parcel is legally subdivided.

4.1.11
feature fusion
feature succession in which two or more previously existing instances of a **feature** type are replaced by a single instance of the same **feature** type

EXAMPLE Two instances of the feature type "pasture" are replaced by a single instance when the fence between the pastures is removed.

4.1.12
feature operation
operation that every instance of a **feature** type may perform [ISO 19110]

EXAMPLE An operation upon a "dam" is to raise the dam. The results of this operation are to raise the height of the "dam" and the level of water in a "reservoir".

NOTE Feature operations provide a basis for feature type definition.

4.1.13
feature substitution
feature succession in which one **feature** instance is replaced by another **feature** instance of the same or different **feature** type

EXAMPLE An instance of feature type “building” is razed and replaced by an instance of feature type “parking lot”.

4.1.14
feature succession
replacement of one or more **feature** instances by other **feature** instances, such that the first **feature** instances cease to exist

4.1.15
geometric primitive
object representing a single, connected, homogeneous element of space [ISO 19107]

NOTE Geometric primitives are non-decomposed objects that present information about geometric configuration. They include points, curves, surfaces, and solids.

4.1.16
Gregorian calendar
calendar in general use; first introduced in 1582 to define a year that more closely approximated the tropical year than the Julian **calendar** [adapted from ISO 8601:2000]

NOTE 1 The introduction of the Gregorian calendar included the cancellation of the accumulated inaccuracies of the Julian year. In the Gregorian calendar, a calendar year is either a common year or a leap year; each year is divided into 12 sequential months.

4.1.17
instant
0-dimensional **geometric primitive** representing position in time

NOTE The geometry of time is discussed in 5.2.

4.1.18
interval scale
scale with an arbitrary origin which can be used to describe both ordering of values and distances between values

NOTE Ratios of values measured on an interval scale have no meaning.

4.1.19
Julian date
Julian day number followed by the decimal fraction of the **day** elapsed since the preceding noon

4.1.20
Julian day number
number of **days** elapsed since Greenwich mean noon on 1 January 4713 BC, Julian proleptic calendar

4.1.21
life span
period during which something exists

NOTE Valid-time life span is the period during which an object exists in the modelled reality. Transaction-time life span is the period during which a database object is current in the database.

4.1.22
month
period approximately equal in **duration** to the **periodic time** of a lunar **cycle**

NOTE The duration of a month is an integer number of days. The number of days in a month is determined by the rules of the particular calendar.

4.1.23
node
0-dimensional **topological primitive** [ISO 19107]

NOTE The boundary of a node is the empty set.

4.1.24
ordinal era
one of a set of named **periods** ordered in time

4.1.25
ordinal scale
scale which provides a basis for measuring only the relative position of an object

4.1.26
ordinal temporal reference system
temporal reference system composed of **ordinal eras**

4.1.27
period
one-dimensional **geometric primitive** representing extent in time

NOTE A period is bounded by two different temporal positions.

4.1.28
periodic time
duration of one **cycle** [adapted from ISO 31-2:1992]

4.1.29
point
0-dimensional **geometric primitive**, representing a position [ISO 19107]

NOTE The boundary of a point is the empty set.

4.1.30
temporal coordinate
distance from the origin of the **interval scale** used as the basis for a **temporal coordinate system**

4.1.31
temporal coordinate system
temporal reference system based on an **interval scale** on which distance is measured as a multiple of a single unit of time

4.1.32
temporal feature association
feature association characterized by a reference to time or to a temporal constraint

4.1.33
temporal feature operation
feature operation specified as a function of time

4.1.34
temporal position
location relative to a **temporal reference system**

4.1.35
temporal reference system
reference system against which time is measured

4.1.36
topological complex
collection of **topological primitives** that is closed under the boundary operations [ISO 19107]

NOTE Closed under the boundary operations means that if a topological primitive is in the topological complex, then its boundary objects are also in the topological complex.

4.1.37
topological primitive
topological object that represents a single, non-decomposable element [ISO 19107]

NOTE A topological primitive corresponds to the interior of a geometric primitive of the same dimension in a geometric realization.

4.1.38
transaction time
time when a fact is current in a database and may be retrieved [Jensen et al. (1994)]

4.1.39
valid time
time when a fact is true in the abstracted reality [Jensen et al. (1994)]

4.2 Abbreviated terms

For the purposes of this International Standard, the following abbreviations apply.

AD Anno Domini

BC Before Christ

GPS Global Positioning System

TOW Time of Week

UML Unified Modeling Language

UTC Coordinated Universal Time

WN Week Number

5 Conceptual schema for temporal aspects of geographic information

5.1 Structure of the schema

This clause presents a conceptual schema for describing temporal aspects of geographic information. The schema is specified in the Unified Modeling Language (UML) [Object Management Group (1999)]. ISO/TS 19103 describes the way in which UML is used in this family of standards. The three primary aspects of a UML class are attributes, operations, and associations. This schema uses all three. This schema is an abstract model; to conform to this International Standard, an implementation shall provide the capabilities described by these elements of the abstract model, but it need not implement them in the same way.

The schema consists of two packages (see Figure 1). The package Temporal Objects (described in 5.2) defines temporal geometric and topological objects that shall be used as values for the temporal characteristics of features and data sets. The temporal position of an object shall be specified in relation to a temporal reference system. The package Temporal Reference System (5.3, 5.4) provides elements for describing temporal reference systems. Subclause 5.5 describes how the concepts specified in 5.2 through 5.4 shall be used in the context of geographic information.

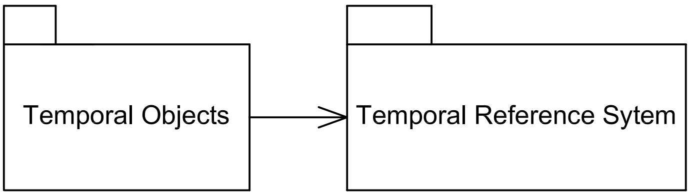

Figure 1 — Structure of the temporal schema

Names of UML classes defined in the ISO 19100 series of standards begin with a two-letter prefix followed by an underscore to identify the specific standard, and possibly the package, in which they are defined. TM_ is used to identify classes defined in this International Standard.

5.2 Geometry of time

5.2.1 Time as a dimension

Time is a dimension analogous to any of the spatial dimensions. Like space, time has geometry and topology. A point in time occupies a position that can be identified in relation to a temporal reference system. Distance can be measured. Unlike space, however, time has a single dimension — temporal reference systems are analogous to the linear referencing systems that are used to describe spatial position for some kinds of applications. Although time has an absolute directionality — movement in time is always forward — time can be measured in two directions.

NOTE Although time always has geometry and topology at a conceptual level, sometimes it is possible or desirable to describe geometry alone, or topology alone.

Time is measured on two types of scales, ordinal and interval. An ordinal scale provides information only about relative position in time, while an interval scale offers a basis for measuring duration.

5.2.2 Temporal objects

Temporal geometric and topological objects shall be used as values for the temporal characteristics of features and data sets. See 5.5 and annex B for an explanation and examples. TM_Object (see Figure 2) is an abstract class that has two subclasses. TM_Primitive is an abstract class that represents a non-decomposed element of geometry or topology of time. There are two subclasses of TM_Primitive. A TM_GeometricPrimitive (5.2.3) provides information about temporal position. A TM_TopologicalPrimitive (5.2.4.2) provides information about connectivity in time. A TM_Complex is an aggregation of TM_Primitives. TM_TopologicalComplex (5.2.4.5) is the only subclass of TM_Complex that is defined in this International Standard; it is an aggregation of connected TM_TopologicalPrimitives.

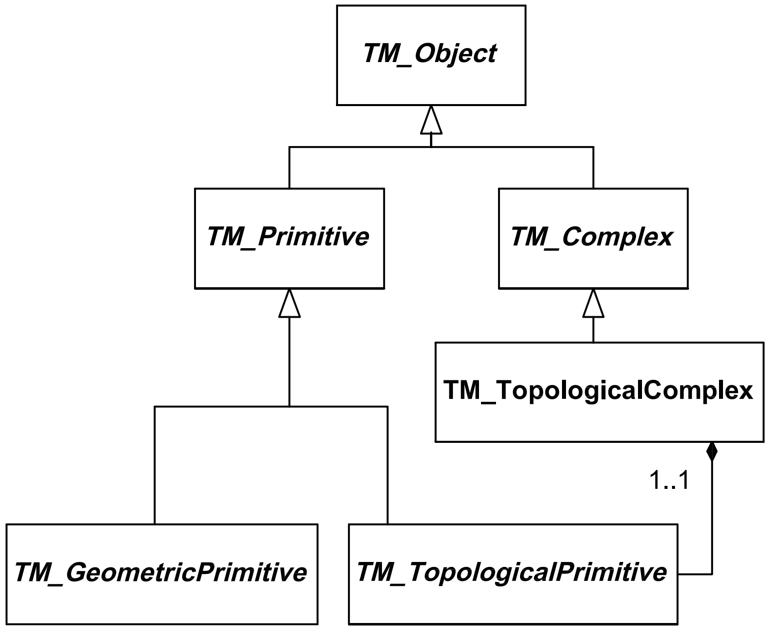

Figure 2 — Temporal objects

5.2.3 Temporal geometric primitives

5.2.3.1 Temporal geometric primitive classes

The two geometric primitives in the temporal dimension are the instant and the period. These primitives are defined analytically in the case of time measured on an interval scale, and analogically in the case of time measured on an ordinal scale. TM_GeometricPrimitive is an abstract class with two subclasses, TM_Instant represents an instant and TM_Period represents a period (see Figure 3). TM_GeometricPrimitive inherits from TM_Primitive a dependency on the interface TM_Order, and also has a dependency on the interface TM_Separation. The «uses» stereotype on the dependency means that the class may support any of the operations defined for the interface, but need not support all of them.

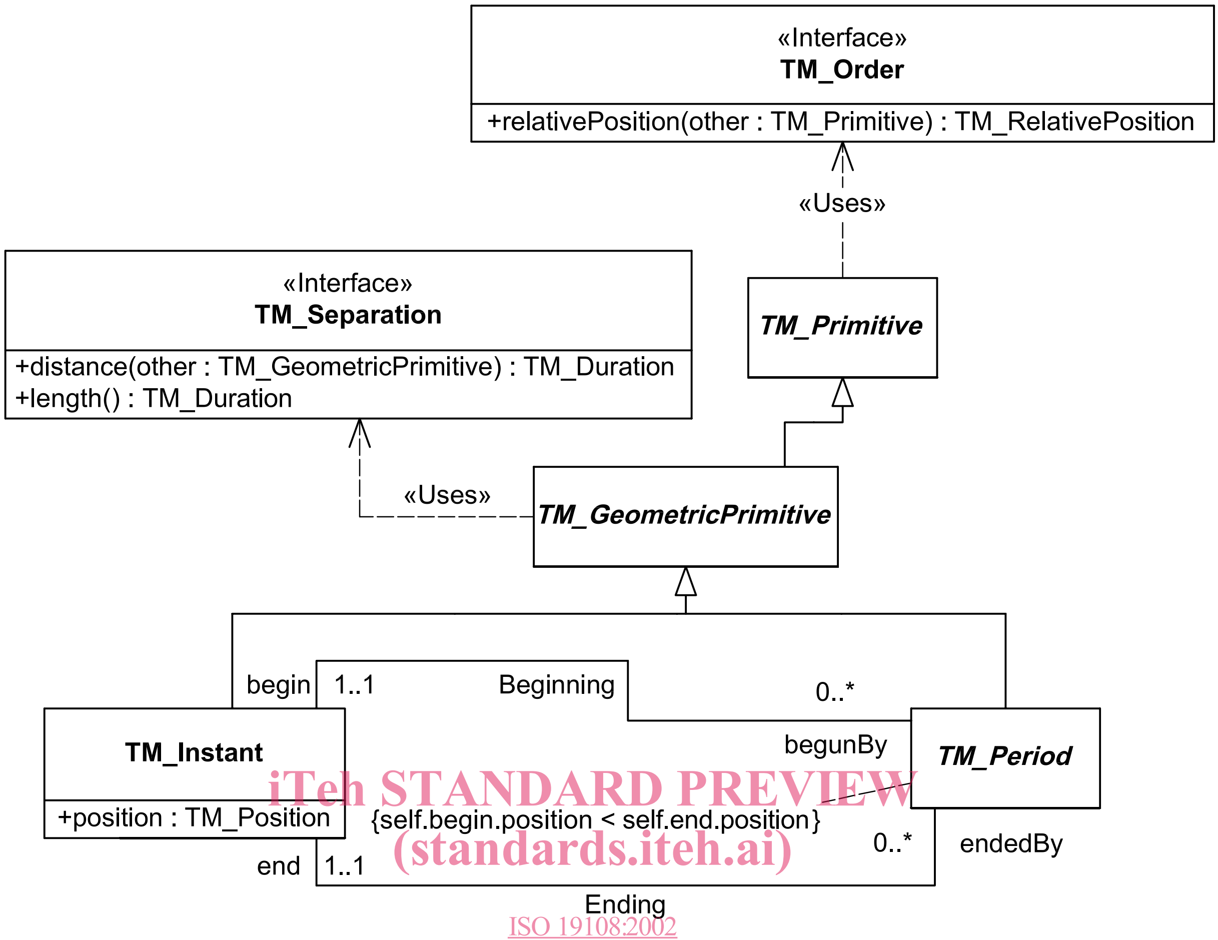

Figure 3 — Temporal geometric primitives

5.2.3.2 TM_Instant

An instant is a zero-dimensional geometric primitive that represents position in time. It is equivalent to a point in space. In practice, an instant is an interval whose duration is less than the resolution of the time scale.

Attributes:

TM_Instant has one attribute.

a) *position: TM_TemporalPosition* shall provide the position of this TM_Instant. The TM_TemporalPosition shall be associated with a single temporal reference system, as specified in 5.3. An instance of TM_Instant is an identifiable object, while an instance of TM_TemporalPosition is a data value. The TM_TemporalPosition of a given TM_Instant may be replaced by an equivalent TM_TemporalPosition associated with a different temporal reference system.

5.2.3.3 TM_Period

The period is a one-dimensional geometric primitive that represents extent in time. The period is equivalent to a curve in space. Like a curve, it is an open interval bounded by beginning and end points (instants), and has length (duration). Its location in time is described by the temporal positions of the instants at which it begins and ends; its duration equals the temporal distance between those two temporal positions.

Since it is impossible to measure duration on an ordinal scale, an instant cannot be distinguished from a period on this basis. In practice, the time at which a single event occurs can be considered an instant when time is measured