



JAPANESE
INDUSTRIAL
STANDARD

Translated and Published by
Japanese Standards Association

JIS X 7108 : 2004

(ISO 19108 : 2002)

(APA)

**Geographic information—
Temporal schema**

ICS 35.240.70

Reference number : JIS X 7108 : 2004 (E)

PROTECTED BY COPYRIGHT

Foreword

This translation has been made based on the original Japanese Industrial Standard established by the Minister of Land, Infrastructure and Transport and the Minister of Economy, Trade and Industry through deliberations at the Japanese Industrial Standards Committee according to the proposal of establishing a Japanese Industrial Standard from Association of Precise Survey and Applied Technology (APA), with a draft of Industrial Standard based on the provision of Article 12 Clause 1 of the Industrial Standardization Law.

This Standard has been made based on **ISO 19108 : 2002** *Geographic information—Temporal schema* for the purposes of making it easier to compare this Standard with International Standard; to prepare Japanese Industrial Standard conforming with International Standard; and to propose a draft of an International Standard which is based on Japanese Industrial Standard.

Attention is drawn to the possibility that some parts of this Standard may conflict with a patent right, application for a patent after opening to the public, utility model right or application for registration of utility model after opening to the public which have technical properties. The relevant Minister and the Japanese Industrial Standards Committee are not responsible for identifying the patent right, application for a patent after opening to the public, utility model right or application for registration of utility model after opening to the public which have the said technical properties.

Date of Establishment: 2004-03-25

Date of Public Notice in Official Gazette: 2004-03-25

Investigated by: Japanese Industrial Standards Committee
Standards Board
Technical Committee on Information
Technology

JIS X 7108:2004, First English edition published in 2005-05

Translated and published by: Japanese Standards Association
4-1-24, Akasaka, Minato-ku, Tokyo, 107-8440 JAPAN

In the event of any doubts arising as to the contents,
the original JIS is to be the final authority.

© JSA 2005

All rights reserved. No part of this publication may be reproduced or utilized in any form or by any means, electronic or mechanical, including photocopying and microfilm, without permission in writing from the publisher.

Printed in Japan

PROTECTED BY COPYRIGHT

Contents

	Page
Introduction	1
1 Scope	1
2 Conformance	1
2.1 Conformance classes and requirements	1
2.2 Application schemas for data transfer	1
2.3 Application schema for data with operations	1
2.4 Feature catalogues	1
2.5 Metadata element specifications	2
2.6 Metadata for data sets	2
3 Normative references	2
4 Terms, definitions and abbreviated terms	2
4.1 Terms and definitions	2
4.2 Abbreviated terms	6
5 Conceptual schema for temporal aspects of geographic information	6
5.1 Structure of the schema	6
5.2 Geometry of time	7
5.3 Temporal reference systems	17
5.4 Temporal position	23
5.5 Time and components of geographic information	26
Annex A (normative) Abstract test suite	34
Annex B (informative) Use of time in application schemas	36
Annex C (normative) Describing temporal reference systems in metadata	41
Annex D (informative) Description of calendars	46
Annex E (informative) Bibliography	55

Geographic information— Temporal schema

Introduction This Japanese Industrial Standard has been prepared based on the first edition of **ISO 19108** *Geographic information—Temporal schema* published in 2002 without modifying the technical contents. This Standard is one of Japanese Industrial Standards based on a number of standards for geographic information (hereafter referred to as a set of standards for geographic information) relating to **ISO/TC 211**. The set of standards for geographic information is the standard for the information-processing technology concerning objects or phenomenon directly or indirectly associated with the positions on earth and is applied to digitization of various data about rivers and roads, etc., and sophistication and efficiency of information-processing.

Portions underlined with dots are the matters not stated in the original International Standard (**ISO 19108** *Geographic information—Temporal schema*).

1 Scope This Standard defines concepts for describing temporal characteristics of geographic 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 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.

Remarks : The International Standard corresponding to this Standard is as follows.

In addition, symbols which denote the degree of correspondence in the contents between the relevant International Standard and **JIS** are IDT (identical), MOD (modified), and NEQ (not equivalent) according to **ISO/IEC Guide 21**.

ISO 19108 : 2002 *Geographic information—Temporal schema* (IDT)

2 Conformance

2.1 Conformance classes and requirements This 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 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 schema for data with operations To conform to this 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 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 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 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 standards contain provisions which, through reference in this Standard, constitute provisions of this Standard. If the indication of the year of publication is given to these referred standards, only the edition of the indicated year constitutes the provision of this Standard but the revision and amendment made thereafter do not apply. The normative references without the indication of the year of coming into effect or the year of publication apply only to the most recent edition (including amendments).

JIS X 0301 *Data elements and interchange formats—Information interchange—Representation of dates and times*

NOTE : **ISO 8601** : 2000 *Data elements and interchange formats—Information interchange—Representation of dates and times* is equivalent to the said standard.

JIS Z 8202-1 *Quantities and units—Part 1 : Space and time*

NOTE : **ISO 31-1** : 1992 *Quantities and units—Part 1 : Space and time* is identical with the said standard.

JIS Z 8203 *SI units and recommendations for the use of their multiples and of certain other units*

NOTE : **ISO 1000** : 1992 *SI units and recommendations for the use of their multiples and of certain other units* is identical with the said standard.

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

ISO/TS 19103⁽¹⁾ *Geographic information—Conceptual schema language*

ISO 19107 *Geographic information—Spatial schema*

ISO 19109⁽¹⁾ *Geographic information—Rules for application schema*

ISO 19110⁽¹⁾ *Geographic information—Methodology for feature cataloguing*

ISO 19111 *Geographic information—Spatial referencing by coordinates*

ISO 19115 *Geographic information—Metadata*

Note ⁽¹⁾ To be published.

4 Terms, definitions and abbreviated terms

4.1 Terms and definitions For the purposes of this 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 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 International Bureau of Weights and Measures and the International Earth Rotation Service 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

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.

Information : Although the term of feature originally indicated the concept of natural and artificial objects on earth, this Standard includes other abstract concept for things in the real world.

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.

Information : The term of aggregate in UML does not include the concept of "shrink" and means "collect and combine". "Aggregate" has been chosen here rather than "consolidate".

4.1.9 feature attribute characteristic of a feature (modified **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 (see JIS X 0301)

NOTE : 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

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. On the contrary, for the ratio scale, ratios of values are important. For instance, while the fact that 2 K is twice as high as 1 K has a certain meaning, the absolute temperature is a ratio scale. It is not said that 2 °C is twice as high as 1 °C, so the centigrade temperature is an interval scale. Mass or amount of money is generally expressed in ratio scale. Time is not specified to express in a practical ratio scale.

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 named periods ordered in time

Remarks : A set of the ordinal era may be included as a lower hierarchy.

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 One of temporal reference systems composed of a set of ordinal eras. It is based on ordinal scale.

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 (modified JIS Z 8202-1)

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 (see **ISO 19107**).

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 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 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.

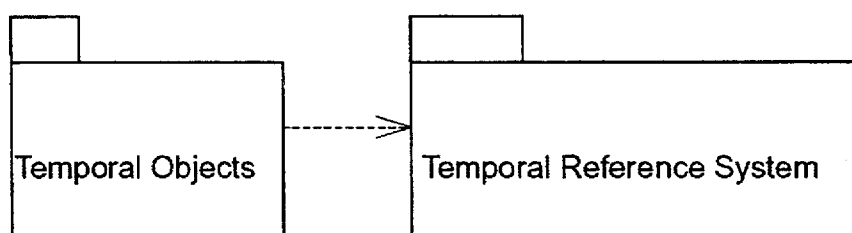


Figure 1 Structure of the temporal schema

The schema consists of two packages (see figure 1). The package Temporal Objects (see 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 (see 5.3 and 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.

Names of UML classes defined in the set of standards for geographic information 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 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.

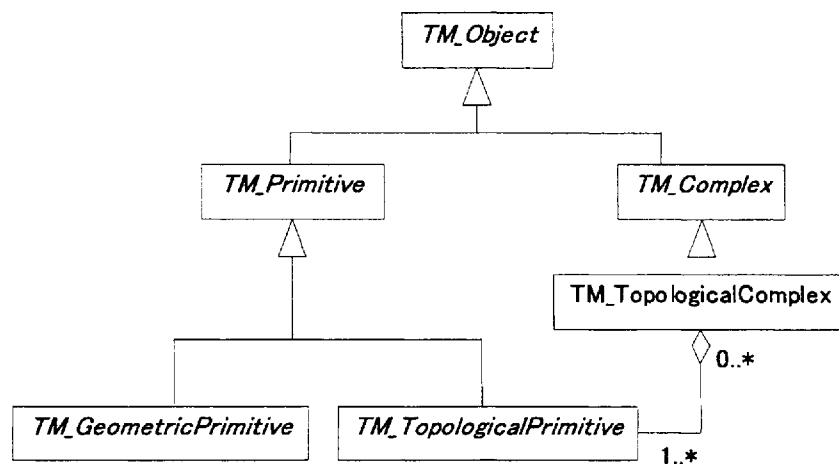


Figure 2 Temporal objects

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* (see 5.2.3) provides information about temporal position. A *TM_TopologicalPrimitive* (see 5.2.4.2) provides information about connectivity in time. A *TM_Complex* is an aggregation of *TM_Primitives*. *TM_TopologicalComplex* (see 5.2.4.5) is the only subclass of *TM_Complex* that is defined in this Standard; it is an aggregation of connected *TM_TopologicalPrimitives*.

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.

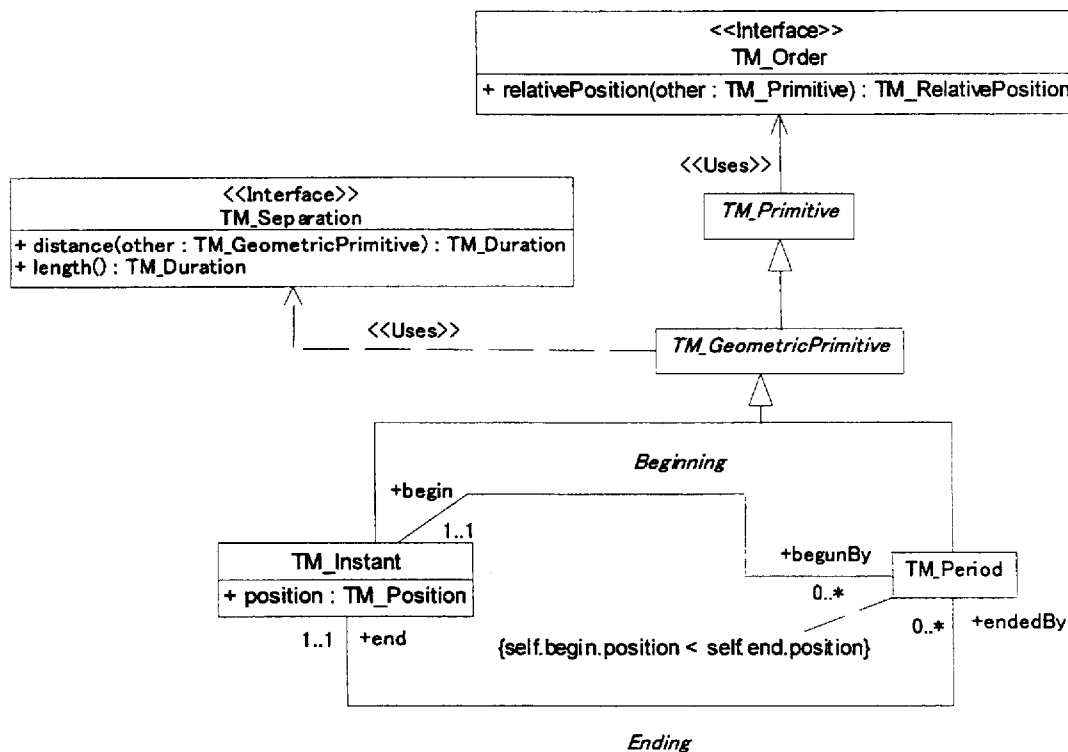


Figure 3 Temporal geometric primitives

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_Position* shall provide the position of this TM_Instant. The TM_Position 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_Position is a data value. The TM_Position of a given TM_Instant may be replaced by an equivalent TM_Position associated with a different temporal reference system.

Associations:

- a) The association *Beginning* associates TM_Period (connected to the edge of the corner point “*begunBy*”) which indicates a period with this TM_Instant.
- b) The association *Ending* associates TM_Period (connected to the edge of the corner point “*endedBy*”) which indicates a period with this TM_Instant.

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 on an ordinal scale. A series of consecutive events must occupy an interval of time, which is a period. The term period is commonly applied to sequences of events that have distinctive characteristics in common.

Associations:

- a) The association *Beginning* associates *TM_Instant* (connected to the edge of the corner point “begin”) which indicates the position of the beginning of the period with this *TM_Period*.
- b) The association *Ending* associates *TM_Instant* (connected to the edge of the corner point “end”) which indicates the position of the beginning of the period with this *TM_Period*.

Constraints:

- a) {self.begin.position < self.end.position} states that the temporal position of the beginning of the period must be less than (i.e. earlier than) the temporal position of the end of the period.

5.2.3.4 TM_Order *TM_GeometricPrimitives* inherit a dependency on *TM_Order* from *TM_Primitive*. *TM_Order* provides an operation for determining the position of this *TM_Primitive* relative to another *TM_Primitive*.

Operation:

- a) *relativePosition(other : TM_Primitive) : TM_RelativePosition* shall accept another *TM_Primitive* as input and return a value for *TM_RelativePosition* as specified in 5.2.3.5.

5.2.3.5 TM_RelativePosition Values for relative positions are provided by the enumerated data type *TM_RelativePosition* (see figure 4) and are based on the 13 temporal relationships identified by Allen (1983). For *TM_Primitives*, the operation *TM_Order.relativePosition* shall return a value of the *TM_RelativePosition* as follows:

- a) If both this *TM_Primitive* and other are *TM_Instant*, the operation shall return a value for *TM_RelativePosition* as follows:

Returns:	If:
Before	self.position < other.position
Equals	self.position = other.position
After	self.position > other.position

- b) If this *TM_Primitive* is a *TM_Period* and other is a *TM_Instant*, the operation shall return a value for *TM_RelativePosition* as follows:

Returns:	If:
Before	<code>self.end.position < other.position</code>
EndedBy	<code>self.end.position = other.position</code>
Contains	<code>self.begin.position < other.position AND self.end.position > other.position</code>
BegunBy	<code>self.begin.position = other.position</code>
After	<code>self.begin.position > other.position</code>

- c) If this `TM_Primitive` is a `TM_Instant` and other is a `TM_Period`, the operation shall return a value for `TM_RelativePosition` as follows:

Returns:	If:
Before	<code>self.position < other.begin.position</code>
Begins	<code>self.position = other.begin.position</code>
During	<code>self.position > other.begin.position AND self.position < other.end.position</code>
Ends	<code>self.position = other.end.position</code>
After	<code>self.position > other.end.position</code>

TM_RelativePosition
+Before : Code
+After : Code
+Begins : Code
+Ends : Code
+During : Code
+Equals : Code
+Contains : Code
+Overlaps : Code
+Meets : Code
+OverlappedBy : Code
+MetBy : Code
+BegunBy : Code
+EndedBy : Code

Figure 4 TM_RelativePosition

- d) If both this `TM_Primitive` and other are `TM_Periods`, the operation shall return a value for `TM_RelativePosition` as follows:

Returns:	If:
Before	<code>self.end.position < other.begin.position</code>
Meets	<code>self.end.position = other.begin.position</code>
Overlaps	<code>self.begin.position < other.begin.position AND self.end.position > other.begin.position AND self.end.position < other.end.position</code>

Begins	<code>self.begin.position = other.begin.position AND self.end.position < other.end.position</code>
BegunBy	<code>self.begin.position = other.begin.position AND self.end.position > other.end.position</code>
During	<code>self.begin.position > other.begin.position AND self.end.position < other.end.position</code>
Contains	<code>self.begin.position < other.begin.position AND self.end.position > other.end.position</code>
Equals	<code>self.begin.position = other.begin.position AND self.end.position = other.end.position</code>
OverlappedBy	<code>self.begin.position > other.begin.position AND self.begin.position < other.end.position AND self.end.position > other.end.position</code>
Ends	<code>self.begin.position > other.begin.position AND self.end.position = other.end.position</code>
EndedBy	<code>self.begin.position < other.begin.position AND self.end.position = other.end.position</code>
MetBy	<code>self.begin.position = other.end.position</code>
After	<code>self.begin.position > other.end.position</code>

This operation shall raise an exception if any input value of `TM_TemporalPosition` is indeterminate.

5.2.3.6 TM_Separation `TM_GeometricPrimitive` also has a dependency on the interface `TM_Separation`, which provides operations for calculating length and distance. `TM_Duration` (see figure 5) is a data type that contains return values for those operations.

- a) *length():TM_Duration* shall return the duration of this `TM_GeometricPrimitive`. The length of a `TM_Instant` is zero by definition. When the `TM_GeometricPrimitive` is a `TM_Period`, the operation shall return the distance between the temporal positions provided by `TM_Period.begin` and `TM_Period.end`. This operation shall raise an exception if the value of either `TM_TemporalPosition` is indeterminate, or if the `TM_TemporalPositions` are referenced to a `TM_OrdinalReferenceSystem`.
- b) *distance(other:TM_GeometricPrimitive):TM_Duration* shall return the distance from this `TM_GeometricPrimitive` to another `TM_GeometricPrimitive`, i.e. the absolute value of the difference between their temporal positions. The distance shall be the distance between the two closest `TM_TemporalPositions` of the two `TM_GeometricPrimitives`. If either `TM_GeometricPrimitive` is connected to, overlaps, or is contained within the other, the operation shall return a value of zero. The operation shall raise an exception if: (1) either of the two `TM_TemporalPositions` is indeterminate, (2) the `TM_TemporalPositions` are not both associated with the same `TM_ReferenceSystem`, or (3) either `TM_TemporalPosition` is associated with a `TM_OrdinalReferenceSystem`.

5.2.3.7 TM_Duration `TM_Duration` (see figure 5) is a data type to be used for describing length or distance in the temporal dimension. It has two subtypes.

`TM_PeriodDuration` uses the format specified by **JIS X 0301** for exchanging information about the duration of a period. It allows duration to be expressed in terms of multiple units of time, specifically years, months, days, hours, minutes, and seconds. Although individual values are optional, a value shall be provided for at least one unit.

Attributes:

- a) *designator*: *CharacterString* = *P* is a mandatory element which designates that the following characters represent the duration of a period.
- b) *years*[0..1]: *CharacterString* is a positive integer, followed by the character “Y” which indicates the number of years in the period.
- c) *months*[0..1]: *CharacterString* is a positive integer followed by the character “M” which indicates the number of months in the period.
- d) *days*[0..1]: *CharacterString* is a positive integer followed by the character “D” which indicates the number of days in the period.
- e) *timeIndicator*[0..1]: *CharacterString* = *T* shall be included whenever the sequence includes values for units of less than a day.
- f) *hours*[0..1]: *CharacterString* is a positive integer followed by the character “H” which indicates the number of hours in the period.
- g) *minutes*[0..1]: *CharacterString* is a positive integer followed by the character “M” which indicates the number of minutes in the period.
- h) *seconds*[0..1]: *CharacterString* is a positive integer followed by the character “S” which indicates the number of seconds in the period.

The value for the rightmost unit may be expressed as a positive decimal fraction rather than as a positive integer.

Example : A duration of five days, four hours, and 30.7 minutes is represented as P5DT4H30.7M.

NOTE : Although this format is defined in **JIS X 0301** for use with dates in the Gregorian calendar and times in UTC, *TM_PeriodDuration* may be used as the data type for expressing length or distance whenever temporal positions are referenced to a calendar that describes dates in terms of years, months and days and a clock that describes times in hours, minutes and seconds.

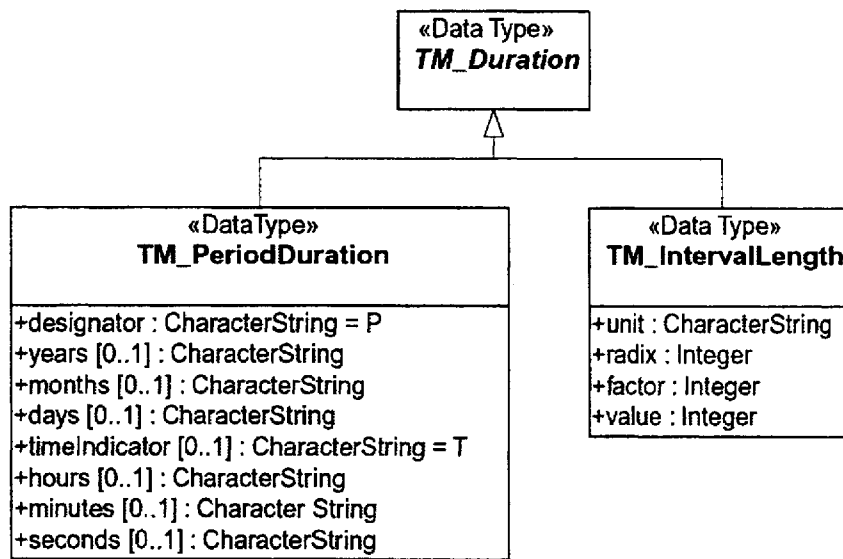


Figure 5 TM_Duration

TM_IntervalLength is a data type specified by **ISO/IEC 11404** for intervals of time, represented here in UML. It supports the expression of duration in terms of a specified multiple of a single unit of time.

Attributes:

- a) *unit:CharacterString* is the name of the unit of measure used to express the length of the interval.
- b) *radix:Integer* is a positive integer that is the base of the multiplier of the unit.
- c) *factor:Integer* is an integer that is the exponent of the base. However, factor cord is reversed. See d).
- d) *value:Integer* is the length of the time interval as an integer multiple of one radix ^(-factor) of the specified unit.

Example : Unit="second," radix=10, factor=3, value=7 specifies a time interval length of 7 ms.

5.2.4 Temporal topological objects

5.2.4.1 Introduction Topology provides information about connectivity between objects in time, and may incidentally provide information about the ordering of objects in time. It does not provide information about temporal position. Topological relationships can often be derived from geometric information. However, data about temporal position is sometimes inadequate for doing this, so topology may need to be described explicitly. Topology may also be used in applications that have a requirement to describe topological relationships explicitly, even though they could be derived.

Example : It may be possible to observe the order of several events or states within a single ordinal era, but the ordinal temporal reference system does not support assignment of distinct temporal positions to these events or states. The order can be described by modelling these events or states with topological primitives.

5.2.4.2 TM_TopologicalPrimitive A topological primitive represents a single non-decomposable element of topology and its relationships to other topological primitives within a topological complex. The two topological primitives relevant for temporal information are the node, which is 0-dimensional, and the edge, which is one-dimensional. In the temporal schema, they are presented by two subclasses of TM_TopologicalPrimitive: TM_Node and TM_Edge (see figure 6). When an application includes information about temporal position as well as connectivity, a TM_TopologicalPrimitive may be associated with a TM_GeometricPrimitive of the same dimension.

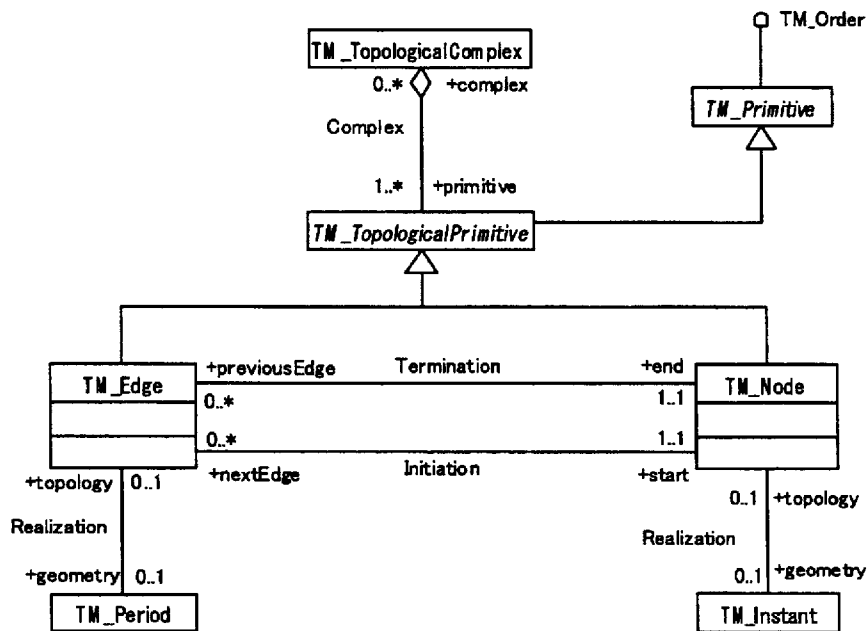


Figure 6 Topology of time

Because topological primitives are intended to provide information about connectivity, their most significant characteristics are the associations that link them to each other. Every TM_TopologicalPrimitive can be a member of TM_TopologicalComplex.

5.2.4.3 TM_Node The TM_Node is the zero dimensional topological primitive in time. Its geometric realization is a TM_Instant.

Associations: TM_Node shall support three associations:

- The association Initiation shall link this TM_Node to the TM_Edge (connected to the edge of the corner point “nextEdge”) for which it is the start.
- The association Termination shall link this TM_Node to the TM_Edge (connected to the end of the corner point “previousEdge”) for which it is the end.
- The association Realization is an optional association that shall link this TM_Node to its corresponding TM_Instant. Only one TM_Node may be associated with a TM_Instant by the geometry in the edge of this association, and only one TM_Instant may be associated with a TM_Node by the topology in the edge of this association.