
**Language resource management —
Semantic annotation framework —**

**Part 7:
Spatial information**

*Gestion des ressources linguistiques — Cadre d'annotation
sémantique —*

Partie 7: Information spatiale

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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 on the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the WTO principles in the Technical Barriers to Trade (TBT), see [Foreword - Supplementary information](#).

This document was prepared by Technical Committee ISO/TC 37, *Language and terminology*, Subcommittee SC 4, *Language resource management*.

This second edition cancels and replaces the first edition (ISO 24617-7:2014), which has been technically revised. It aims at satisfying the requirements and recommendations laid down in ISO 24617-6.

The main changes compared to the previous edition are as follows.

- Event-paths (<eventPath>), which are triggered by motions, are restored as objects of a basic entity type in concrete syntaxes as well as in the abstract syntax.
- It focuses on spatial relations only, thus tagging them as <sRelation>. There are no <motionSignal> or <measureSignal> as such. Path adjuncts are treated as pathDefining spatial relations, tagged as <sRelation type="pathDefining"/>.
- The movement link (<moveLink>) is very much modified to conform to the general link structure, as specified in ISO 24617-6. This general link structure minimally consists of a relation type and two required arguments, represented by two attribute names, @figure and @ground, which are single entity structures and sets of entity structures, respectively. The addition of optional (implied) attributes such as @trigger (relator) for <moveLink> or @bounds for <mLink> is allowed.
- The measure link (<mLink>) is generalized to accommodate not only spatial measures such as distances but temporal or spatio-temporal measures that include durations, time amounts or speeds. The two optional attributes @endPoint1 and @endPoint2 are also generalized to apply to areas (oceans) or borderlines (rivers, mountain ranges) with a new attribute @bounds, replacing those two attributes.
- As a result, most of the specifications of the attribute-value assignments to each of the entity types and those of the link types, represented in extended BNF, or XML DTD (data type declarations), are revised. The UML figures representing them are also revised or deleted.

- The list of tags associated with entity structures and link structures is presented in a tabular form to make these structures more comparable in a visual way. This list has been given in [Clause 4, Table 1](#).
- To make the document more compact and less burdensome for the readers, [Annex A](#), Guidelines, has been deleted.

A list of all parts in the ISO 24617 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

The automatic recognition of spatial information in natural language is currently attracting considerable attention in the fields of computational linguistics and artificial intelligence. The development of algorithms that exhibit “spatial awareness” promises to add needed functionality to natural language processing (NLP) systems, from named entity recognition to question-answering and text-based inference. However, in order for such systems to reason spatially, they require the enrichment of textual data with the annotation of spatial information in language. This involves a large range of linguistic constructions, including spatially anchoring events, descriptions of objects in motion, viewer-relative descriptions of scenes, absolute spatial descriptions of locations, and many other constructions.

This document provides normative specifications not only for spatial information, but also for information content in motion and various other types of event in language.

In this document, [Clause 8](#) treats the representation of static and dynamic spatial annotations by introducing an XML-based concrete syntax for representing spatial-related or motion-related annotations. This concrete syntax is based on the abstract syntax that is presented in [Clause 7](#) with a metamodel as a part of the specification of the spatial annotation structure. An informative [Annex A](#) is provided with a brief introduction to the annotation and interpretation of quantified spatial entities and eventualities including motions and event-paths.

A formal semantics, based on the abstract syntax, will be provided as part of a future new work item within the semantic annotation framework. This will be coordinated with the temporal semantics and specification of ISO 24617-1, thereby producing a rich semantics that will be directly useable by practitioners in computational linguistics and other communities (see [Clause 6](#)).

Language resource management — Semantic annotation framework —

Part 7: Spatial information

1 Scope

This document provides a framework for encoding a broad range of spatial information and spatiotemporal information relating to motion as expressed in natural language texts. This document includes references to locations, general spatial entities, spatial relations (involving topological, orientational, and metric values), dimensional information, motion events, paths, and event-paths triggered by motions.

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 24617-1, *Language resource management — Semantic annotation framework (SemAF) — Part 1: Time and events (SemAF-Time, ISO-TimeML)*

ISO 24617-6, *Language resource management — Semantic annotation framework — Part 6: Principles of semantic annotation (SemAF Principles)*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 24617-1 and ISO 24617-6, and the following apply.

3.1

document creation location

dcl

unique place or set of places associated with a document that represents the *location* (3.7) in which the document was created

Note 1 to entry: Some collaboratively written documents, such as GoogleDoc¹⁾ documents and chat logs, might refer not only to a single location but also to a set of locations spread out across the world. Besides, for example, the creation place of the Hebrew bible or the creation place of each of the books in it is uncertain. The attribute @dcl will, therefore, have the value "false", understood to mean "unspecified", while the value "true", is understood to mean "specified".

1) GoogleDoc is an example of a suitable product available commercially. This information is given for the convenience of users of this document and does not constitute an endorsement by ISO of this product.

3.2
event
eventuality

something that can be said to obtain or hold true, to happen or to occur

Note 1 to entry: This is a very broad notion of event that includes all kinds of actions, states, processes, etc. It is not to be confused with the narrower notion of event (as opposed to the notion of "state") as something that happens at a certain point in time (e.g. the clock striking two or waking up) or during a short period of time (e.g. laughing). In TimeML, the term "event" is used in a broader sense and is equivalent to the term "eventuality".

[SOURCE: ISO 24617-1:2012, 3.4, modified – The Note 1 to entry has been reworded.]

3.3
event-path
dynamic path
trajectory
dynamic route

directed *path* (3.15) followed by a *mover* (3.12) and coincident with a *motion-event* (3.10)

Note 1 to entry: Unlike (static) paths such as roads or circular tracks, event-paths are each triggered by a specific motion-event, characterized as being finite directed paths each with a start and an end.

3.4
extent

textual segment that is a string of character segments in text to be annotated

EXAMPLE Tokens, words, and non-contiguous phrases (e.g. a complex verb like "look ... up") are extents.

3.5
figure

entity that is considered the focal object, which is related to some reference object

3.6
ground
landmark

entity that acts as reference for a *figure* (3.5)

Note 1 to entry: "landmark" is often used by cognitive semanticists.

3.7
location

point or finite area that is positioned within a *space* (3.19) or a series of such points or areas

Note 1 to entry: *places* (3.16), *paths* (3.15), and *event-paths* (3.3) are subtypes of locations.

3.8
measure

magnitude of a spatial dimension or relation

EXAMPLE Distance is a spatial relation.

3.9
measure relation

link that relates a *measure* (3.8) to an object that is being measured

Note 1 to entry: The bounds of a measured object are sometimes specified for a measure relation. They can be points or areas like a city, or lines like a river or mountain range.

3.10 motion motion-event

action or process involving the translocation of a spatial object, transformation of some spatial property of an object, or change in the conformation of an object

Note 1 to entry: A motion is a particular kind of *eventuality* (3.2).

3.11 movement relation

link that relates a *mover* (3.12) to an *event-path* (3.3) which the *mover* (3.12) traverses

Note 1 to entry: A movement link is triggered by a *motion* (3.10).

3.12 mover moving object

entity that undergoes a change of its location

Note 1 to entry: A mover can either be the agent of a motion as one who walked to the station or one that is simply caused to move like a stone thrown into a well, while the thrower is not considered to be the mover in the sense of the term defined.

3.13 non-consuming tag

tag (3.19) that has no associated *extent* (3.4)

Note 1 to entry: The *extent* (3.4) of a non-consuming tag is a null string.

EXAMPLE In an example, *John ate an apple but Mary a pear*, there are at least two ways of marking up the <event> tag, one with its extent or target filled in with a nonnull string of characters, or audio or visual elements, and the other with an empty string:

- a) John ate_{e1} an apple, but Mary $\emptyset$ _{e2} a pear;
- b) 1) <event xml:id="e1" target="ate"/>
2) <event xml:id="e2" target="" /> (non-consuming <event> tag)

3.14 orientation relation orientational relation directional relation

link that relates one location as a *figure* (3.5) to another location as a *ground* (3.6) that expresses the spatial disposition or direction of a spatial object within a frame of reference

3.15 path static path route

location (3.7) that consists of a series of locations

Note 1 to entry: A spatial object *path* is a location where the focus is on the potential for traversal or which functions as a boundary. This includes common nouns like *road*, *coastline*, and *river* and proper names like *Route 66* and *Kangamangus Highway*. Some nouns, such as *valley*, can be ambiguous. It can be understood as a *path* (3.15) in *we walked down the valley* or as a *place* (3.16) in *we live in the valley*.

Note 2 to entry: A path might be represented as an undirected graph whose vertices are locations and whose edges signify continuity; i.e., unlike an *event-path* (3.3), a path has no inherent directionality.

3.16 place

geographic or administrative entity that is situated at a *location* (3.7)

3.17
qualitative spatial relation
topological link

abstract static relation between *regions* (3.18) or *spaces* (3.19), expressing their connectedness or continuity

3.18
region
connected, non-empty point-set defined by a domain and its boundary points

Note 1 to entry: The term "region" as defined does not refer to a political or administrative region such as "the Canary Islands" or "Hong Kong, SAR", where SAR is the acronym of "Special Administrative Region".

3.19
space
dimensional extent in which objects and *events* (3.2) have a relative position and direction

3.20
spatial entity, non-locational
non-locational spatial entity
object that is situated at a unique *location* (3.7) for some period of time, and typically has the potential to undergo translocation

Note 1 to entry: A non-locational spatial entity, tagged <entity>, as defined, is distinct from genuine spatial entities that consists of three types of locational entities, places, paths, and event-paths. It is an object that participates in a spatial or motional relation. In *John is sitting in a car*, both *John* and *car* could be understood as *spatial entities* or as being the *figure* (3.5) and the *ground* (3.6), respectively, of the sitting-in situation.

Note 2 to entry: In the first edition of this document, non-locational spatial entities were tagged <spatialEntity>. They are now tagged <entity> to allow their use in both spatial and non-spatial contexts, as in: *I left a purse in the car* (spatial context) *that I had rented Φ* (non-spatial context) *last week*.

3.21
spatial relation
segment or series of segments of a text that rebounds to *qualitative spatial relations* (3.17) or *orientational relations* (3.14), or to *movement relations* (3.11) indirectly through the specification of the bounds of *paths* (3.15) or *event-paths* (3.3)

3.22
tag
element name
name associated with textual segments for annotation or for a relation between these segments

Note 1 to entry: The following are three kinds of tag for annotation:

- a) extent tag, which is associated with textual segments referring to basic entities or signals;
- b) link tag, for representing spatial relations; and
- c) root tag, for the closure of annotations.

4 List of tags

See Table 1, where each tag is braced with a pair of angled brackets for the name of an XML element. For other representation formats, the tags have no such brackets. These tags, especially the event-path tag, may be non-consuming tags (see 3.13) having an empty string of characters as @target value, called "extent".

Table 1 — Tags with ID prefixes

Entities	Tags	ID prefixes	Examples	Comments
Basic entities: spatial entities, relations, and eventualities				
place	<place>	pl	<i>Osaka, city</i>	
path	<path>	p	<i>Highway 1, street, river</i>	
non-locational spatial entity	<entity>	x	<i>(in a) car</i>	non-locational entities that are spatially involved
spatial relation	<sRelation>	sr	<i>in, on, north-east, from, to, for, towards</i>	type = "topological" "directional" "topoDirectional" "pathDefining" "goal-defining"
motion	<motion>	m	<i>drive, travel</i>	translocational
non-motional eventuality	<event>	e	<i>live, work</i>	inherited from ISO 24617-1 TimeML
event-path	<eventPath>	ep	<i>empty extent</i>	non-consuming tag, spatio-temporally definable
measure	<measure>	me	<i>500 miles 100 km/h</i>	extendible to spatio-temporal measures
Links: link structures <@figure, @ground, @relType>				
qualitative spatial link	<qsLink>	qsL		Relates one location as a figure to another as a ground
orientational link	<oLink>	oL		Relates one location to another possibly with some point of reference
movement link	<moveLink>	mvL		Relates a mover to an event-path
measure link	<mLink>	meL		Relates a measure to an object, possibly with the specification of its bounds
Root element				
spatial annotation	<spatial>	sp		closure of spatial annotation

5 Overview

Human languages impose diverse linguistic constructions for expressing concepts of space, of spatially-anchored events, and of spatial configurations that relate in complex ways to the situations in which they are used. One area that deserves further development regarding the connection between natural language and formal representations of space is the automatic enrichment of textual data with spatial annotations. There is a growing demand for such annotated data, particularly in the context of the semantic web. Moreover, textual data routinely make reference to objects moving through space over time. Integrating such information derived from textual sources into a geosensor data system can enhance the overall spatiotemporal representation in changing and evolving situations, such as when tracking objects through space with limited image data. It follows that verbal subjective descriptions of spatial relations need to be translated into metrically meaningful positional information. A central research question currently hindering progress in interpreting textual data is the lack of a clear separation of the information that can be derived directly from linguistic interpretation and further information that requires contextual interpretation. In order to avoid building incorrect deductions into the annotations themselves, mark-up schemes should avoid over-annotating the text. Solutions to the language-space mapping problem and its grounding in geospatial data are urgently required for this purpose.

There are many applications and tasks that would benefit from a robust spatial mark-up language, such as the one specified in this document.

These applications and tasks include the following:

- a) creating a visualization of objects from a verbal description of a scene;
- b) identifying the spatial relations associated with a sequence of processes and events from a news article;
- c) determining an object location or tracking a moving object from a verbal description;
- d) translating viewer-centric verbal descriptions into other relative descriptions or absolute coordinate descriptions;
- e) constructing a route given a route description;
- f) constructing a spatial model of an interior or exterior space given a verbal description;
- g) integrating spatial descriptions with information from other media.

The goal of this document is not to provide a formalism that fully represents the complexity of spatial language, but rather to capture these complex constructions in text in order to provide an inventory of how spatial information is presented in natural language. For example, many texts have no explicit frame of spatio-temporal reference, thus making it impossible to annotate such an unspecified frame of reference. The interpretation of spatial prepositions, such as *on* in *a book on the desk* vs *a picture on the wall* requires a handbook of its own dealing with different senses or uses of spatial prepositions beyond a set of annotation guidelines. Any detailed classification of motion verbs in English alone is again beyond the scope of this document.

All of the examples in the current document have been taken from English datasets. The specification language for spatial annotation proposed in this document can be seen as a version for English only and its applicability to other languages is still pending.

6 Motivation and requirements

This document aims to formulate the requirements for static and dynamic spatial annotation standards. It considers ISO 24612, which requires standoff annotation, and ISO 24617-6, which provides a set of basic guidelines to formulate annotation structures for semantic interpretation, and builds on previous work, including ISO 24617-1 and other spatial representations and calculi, especially Reference [10].

Natural language abounds with descriptions of motion. Our experience of our own motion, together with our perception of motion in the world, have given human languages substantial means to verbally express many different aspects of movement, including its temporal circumstances, spatial trajectory and manner. In every natural language, verbalizations of motion can specify changes in the spatial position of an object over time. In addition to when and where the motion takes place, languages additionally characterize how the motion takes place (e.g., its path, its manner, and how it was caused). In particular, the path of motion, called “event-path” in this document, involves conceptualizations of the various spatial relationships that an object can have to other objects in the space in which it moves. An understanding of such spatial information in natural language is necessary for many computational linguistics and artificial intelligence applications.

Any specification language for spatial information in language needs to support the following computational tasks:

- identification of the appropriate topological configuration between two regions or objects (e.g. containment, identity, disjointedness, connectedness, overlap, and closure over these relations, when possible);
- identification of directional and orientational relations between objects and regions, including the distinction between frames of reference;
- identification of metric properties of objects and metric values between regions and objects, when possible (e.g. distance, height and width);

- identification of the motion of objects through space and time and a characterization of the nature of this movement;
- provision of clear interoperable interfaces to existing representations and geo-databases (e.g. GeoNames, ArcGIS, and Google Earth²⁾).

NOTE 1 Texts are often completely unspecified for frames of reference (texts are, so to speak, "not situated") and therefore it appears that the annotation of a frame of reference cannot be provided for many texts.

NOTE 2 Measure expressions, such as *20 miles*, have two attributes, numeric @value "20" and @unit "miles", but expressions like *near* and *far* have no unit specified. The annotation scheme proposed in this document can only state that they are measure-related expressions only with its attribute @value specified, say with "near" or "far". As will be seen, many of the annotation cases are left underspecified.

7 Specification of the spatial annotation scheme

7.1 Overview: annotation vs. representation

As with other areas of work on semantic annotation, each of the annotation schemes that are specified in ISO 24617 draws a fundamental distinction between the concepts of annotation and representation, as is required by ISO 24612. The term "annotation" is used to refer to the process of adding information to segments of language data or to refer to that information itself. This notion is independent of the format in which this information is represented. The term "representation" is used to refer to the format in which an annotation is rendered (for instance, in XML) independent of its content. As is required by ISO 24612, annotations are the proper level of standardization, not representations. This document, therefore, defines a specification language for annotating documents with information about spatial entities and spatial relations at the level of annotations and then for representing these annotations in a specific way, either with XML or with a predicate logic-like format.

Following ISO 24617-6:2016 principles, the spatial annotation scheme of this document is introduced in two steps: (1) Construction of a metamodel and (2) Formulation of the abstract syntax. The metamodel provides a UML-based conceptual frame of establishing the abstract syntax, which lays down a set-theoretic basis of implementing concrete syntaxes as well as a formally definable semantics.

The semantic annotation scheme consists of an abstract syntax, a semantically equivalent set of concrete syntaxes, which is structurally isomorphic to the abstract syntax, and a semantics. The abstract syntax defines in set-theoretic terms annotation structures which consist of entity structures and link structures. Each entity structure is anchored to a markable carrying some information. Entity structures are also typed, each referring, for instance, to a place, path, event-path, eventuality, motion, spatial entity or measure which is involved in spatial information. Link structures relate these entity structures with each other.

7.2 Metamodel

The metamodel of the spatial annotation scheme depicted by [Figure 1](#) represents the general conceptual frame of spatial annotation. It consists of the following five components:

- 1) a collection of datasets, called "communicative segments";
- 2) a nonempty set of markable expressions, called "markables", the source of which is the communicative segments;
- 3) a list of four entity types, each of which is anchored to a markable:
 - a) **spatial entity** with three **locational** subtypes: **place**, **path**, and **trajectory (event-path)**,

2) GeoNames, ArcGIS, and Google Earth are examples of a suitable products available commercially. This information is given for the convenience of users of this document and does not constitute an endorsement by ISO of these products.

- b) **spatial relation** of various types,
 - c) **eventuality**, with its subtype **motion**, and
 - d) **measure**;
- 4) a list of four link types, each of which relates a pair of entity structures, generated by the abstract syntax:
- a) **qualitative spatial link**, tagged <qsLink> or <qsLink_e>,
 - b) **orientation link**, tagged <oLink> or <oLink_e>,
 - c) **movement link**, tagged <moveLink>, and
 - d) **measure link**, tagged <mLink>;
- 5) a list of specifications of attribute-value assignments associated with each of the basic entity types and the link types.

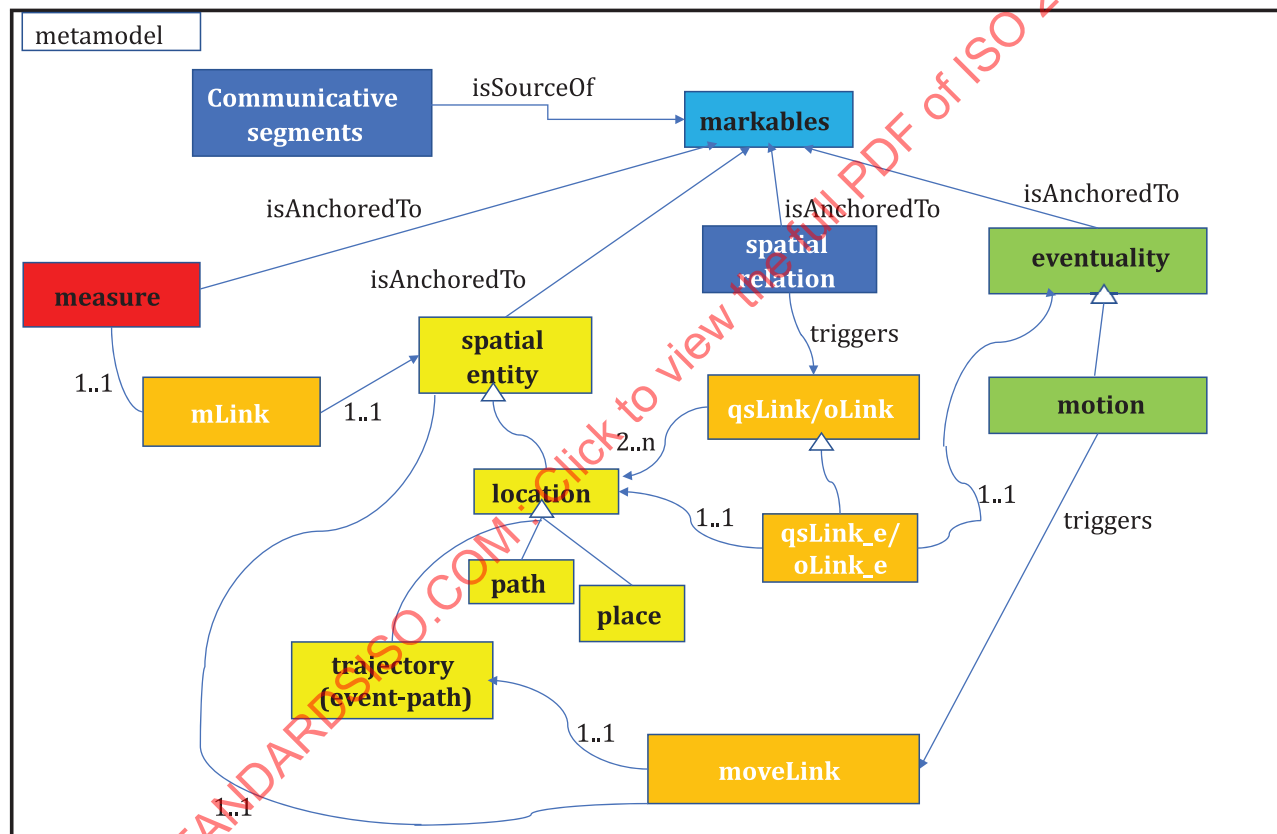


Figure 1 — Metamodel of the spatial annotation scheme

Figure 1 lists only the four components without specifying attribute-value assignments. Communicative segments carry information in the form of text or visual images. Such information may also include contextual or background information that is conveyed by various discourse situations. Each of the entity structures associated with one of the major basic entity types and their subtypes is anchored to a markable which is being annotated.

There are two subtypes of the qualitative spatial link and the orientation link. One type, tagged <qsLink> or <oLink>, relates at least two locational spatial entities with each other. The other, tagged <qsLink_e> or <oLink_e>, relates an eventuality-type entity structure to a locational spatial entity.

NOTE In concrete syntaxes, only the tags <qsLink> and <oLink> are used, while the other tags, <qsLink_e> and <oLink_e>, are not used. They are differentiated in the way how their relations operate.

The movement link, tagged <moveLink>, relates a non-locational spatial entity which is caused to move by a motion to a trajectory, called “event-path”. The measure link, tagged <mLink>, relates a measure to an entity in general and to a spatial entity in particular.

7.3 Abstract syntax

An abstract syntax provides a theoretical basis for deriving various versions of a concrete syntax. In this document, the abstract syntax is schematically represented by the UML-based metamodel (Figure 1), which specifies an annotation scheme for spatial information. It is then formulated in set-theoretic terms.

Given a non-empty set C of communicative segments, the abstract syntax presented in this document for the annotation of C can be formulated as a tuple $\langle C, M, B, L, @ \rangle$, where

M is a set of markables,

B is a set of basic element types,

L is a set of links, and

$@$ is a list of specifications of possible attribute-value assignments to each member of B or L .

NOTE 1 The form of C can be either textual, spoken, visual, or multimodal in general such that even gestures can be included in the set of communicative segments.

Each of the components of the abstract syntax is further specified or subclassified as below.

- a) M is a set of subsets of C , each of which is delimited by B .
- b) B is partitioned to S , R , E , and Q such that
 - 1) S includes locational entities such as places, paths, and motional trajectories (event-paths) and non-locational entities that are involved in spatial relations R or eventualities E ,
 - 2) R consists of spatial relations of various types, topological, directional, topo-directional, path-defining or goal-defining,
 - 3) E includes both motions and non-motions,
 - 4) Q includes both quantitative measures and non-quantitative measures.
- c) L consists of four types,
 - 1) qualitative spatial link with the two subtypes, as listed in Figure 1,
 - 2) orientational link with two subtypes, as listed in Figure 1,
 - 3) movement link, and
 - 4) measure link.

Each of these links is structured to be a triplet $\langle \eta, E, \rho \rangle$,

where η is an entity structure,

E is a non-empty set of entity structures, and

ρ is a type of relation over them.

- d) Each of the specification in @ can be formally represented by DTD or BNF but in general terms.

NOTE 2 An entity structure is a tuple $\langle m, a \rangle$, where m is a markable in M and a is the annotation of m as specified by a specific assignment @ of attribute-values to m . For the semantic annotation of m , the annotation a is semantic information.

8 Representation of spatial annotations

8.1 XML-based concrete syntax: outline

8.1.1 Overview

The abstract syntax proposed in 8.3 allows a variety of semantically equivalent concrete syntaxes for the representation of spatial annotations. Each of these concrete syntaxes is structurally isomorphic to the abstract syntax from which it is derived. An XML-based concrete syntax is the most conventionally accepted one. It serializes spatial annotation structures in XML, consisting of *basic element types* (see 8.1.2) and *links* (see 8.1.3).

8.1.2 Basic element types

As introduced in the abstract syntax (7.3), there are four types of basic elements B :

- 1) spatial entity S with three locational subtypes, “place”, “path”, and “event-path”,
- 2) spatial relation R ,
- 3) eventuality E , and
- 4) measure Q .

In the XML-based concrete syntax, they are tagged as:

- 1) <entity> with its three locational subtypes, <place>, <path>, <eventPath>,
- 2) <sRelation>,
- 3) <event> with its subtype “motion”, tagged <motion>, and
- 4) <measure>, respectively.

NOTE 1 ISO 24617-7:2014 treated spatial relations as signals. In this second edition, there is no basic element called “signal” or tagged <SIGNAL>.

NOTE 2 In ISO 24617-7:2014, non-locational spatial entities used to be tagged <spatialEntity>. It is now simply tagged <entity> because its spatial involvement can be deduced by the context of its use.

The three subtypes are subsumed by spatial entities, tagged <entity>, meaning that they carry more specific information than spatial entities in general. Hence, those entities that are tagged <entity> are understood as referring to spatial entities other than those of the three subtypes, while carrying less specific information than these subtypes.

The type of eventualities has a subtype called “motion”. This is tagged <motion>. Non-motion eventualities are tagged <event>.

The type of spatial relations, tagged <sRelation>, has several subtypes: topological, directional, topodirectional, pathDefining, or goalDefining relations. These subtypes are differentiated with the attribute @type with a different value being assigned to each of them.

EXAMPLE 1 topological: "in", "at";
 directional: "in front of", "north of";
 topodirectional: "on";
 pathDefining: "from", "to", "through";
 goalDefining: "for", "towards".

8.1.3 Links

The abstract syntax introduces four types of links: the **qualitative spatial link**, the **orientation link**, the **movement link**, and the **measure link**. In the XML-based concrete syntax they are tagged respectively as: <qsLink>, <oLink>, <moveLink>, and <mLink>.

NOTE 1 In concrete syntaxes, <qsLink_e> and <oLink_e> are merged into <qsLink> and <oLink>, respectively. Hence, <qsLink> and <oLink> represent two types of relations: one relates a spatial entity to other spatial entities, whereas the other relates an eventuality to one or more spatial entities.

8.1.4 Root element

Each bundle of XML elements forms a tree-like structure called an "XML document". This XML document has a single element called a "root element" that encloses all the other elements in the document.

For each collection of spatial annotation structures conformant to the specifications of this XML document, its root element is tagged <spatial> with its ID prefix "sp".

EXAMPLE 1 <spatial xml:id="spN">
 <CONTENT of spatial annotations/>
 </spatial>
 where N in "spN" is a natural number.

8.2 Conventions for tagging

8.2.1 Naming conventions

Naming conventions can be quite complex. The following are four basic guidelines.

- a) This document follows medial capitalization, also called "CamelCase", thus avoiding the use of the hyphen "-" or the underscore "_" in concatenating more than two words.

EXAMPLE 1 <sRelation> or <qsLink> instead of <S-Relation> or <QS_Link>

- b) This document also avoids the use of uppercase unless it is conventionally required (e.g. acronyms such as "XML" and UML class names like "Entity" as a class).

EXAMPLE 2 <motion> or <qsLink> instead of <MOTION> or <QSLINK>.

- c) This document therefore allows both lowerCamelCase and UpperCamelCase, although the XML serialization of the abstract syntax for spatial annotation presented adopts lowerCamelCase for the representation of element names and tags.

- d) The values of the various ID attributes are specified as beginning with one or more lowercase alphabetical characters, followed by a positive integer. This scheme is mandated by the syntax of XML.

EXAMPLE 3 <event xml:id="e12".../>, <place xml:id="pl23".../>

NOTE 1 "pl23" is a valid XML ID, but "23" without an alphabetical prefix is not. Each ID begins with some alphabetical characters.

Names for elements, attributes, and their values might be mentioned or listed in the documents. Where this occurs, the following mentioning conventions are followed:

- Element names are braced with a pair of angled brackets;

EXAMPLE 4 <place>, <motion>, and <sRelation>

- Attribute names are prefixed with @;

EXAMPLE 5 @value, @referencePt, and @frameType.

NOTE 2 @ is not part of attribute names.

- Values of attributes are in double quotes.

EXAMPLE 6 birthPlace="Boston" and xml:id="e1".

NOTE 3 Some attribute values might refer to an ID value that occurs somewhere in the annotation, i.e. an IDREF value. In cases such as this, the "#" symbol is prefixed to it.

EXAMPLE 7 <word xml:id="w2" pos="verb" lemma="run" tense="past"/>
<motion xml:id="m1" target="#w2" .../>

8.2.2 Convention for inline tagging extents

For illustration, extents in a sample text are often inline tagged with their identifiers or some other tag names. The following are some conventions for such tagging:

- a) Style guides generally do not recommend boldface text for providing emphasis. Hence, the use of boldface is discouraged.

EXAMPLE 1 Tsingtao beer is produced in **Qingdao**_{tok6}.

Boldface is not recommended in actual tagging.

- b) The end of each extent is marked with a unique ID in subscript.

EXAMPLE 2 Tsingtao beer is produced in Qingdao_{tok6}.

- c) If an extent consists of more than one token, then it is enclosed by a pair of square brackets and an ID is placed outside of the closing bracket.

EXAMPLE 3 John hopped_m [out of]_{sr1} the room_{pl1}.

- d) If an extent is a non-contiguous sequence of more than one token, then each non-contiguous token is bracketed and marked with an identical ID.

EXAMPLE 4 Mia looked_{e1} me up_{e1}.

- e) If an extent is an empty string (non-consuming tag), then it is represented with the empty set symbol Φ .

EXAMPLE 5 We camped Φ _{pl1} near the temple.

Here, Φ _{pl1} indicates the actual place of camping.

8.3 Specification of attributes for basic entity tags

8.3.1 <entity> for no-locational spatial entities

Spatial entities have three subtypes: places <place>, paths <path>, and event-paths <eventPath>. Places and paths are understood to be locational entities, whereas event-paths are trajectories created by motions. There are entities other than these locational or trajectorial entities that function like spatial

entities or involve motions. These non-locational entities are tagged as <entity> with its ID prefix “x” in this document.

EXAMPLE 1 John left his purse in a car_{x1}.

```
<entity xml:id="x1" target="car" type="vehicle" form="nom"/>
```

EXAMPLE 2 John_{x2} drove to Toronto.

```
<entity xml:id="x2" target="John" type="person" form="nam"/>
```

Such an entity is generally anything that is spatially relevant, but which does not fit into either the <place> or the <path> category. To be considered spatially relevant, the entity should both (1) be located in real-space and (2) participate in a link. In practice, moving objects and objects that have the potential to move are most commonly tagged as <entity>s. For example, vehicles are designed potentially to move but they are not considered to be inherently places or paths and are therefore marked up as <entity>s.

List of attributes for the <entity> tag

```
<!ELEMENT entity (#PCDATA) >
<!ATTLIST entity id ID prefix="x" #REQUIRED >
<!ATTLIST entity target(IDREF | CDATA) #REQUIRED >
<!ATTLIST entity type (facility | vehicle | person | dynamicEvent | artefact | CDATA) #REQUIRED >
<!ATTLIST entity form (nam | nom) #IMPLIED >
<!ATTLIST entity cardinality (REAL) #IMPLIED >
<!ATTLIST entity countable (yes | no) #IMPLIED >
<!ATTLIST entity comment CDATA #IMPLIED >
```

EXAMPLE 3 Two cars_{x3} are parked on the street.

```
<entity xml:id="x3" target="#token2" type="vehicle" form="nom"/>
```

NOTE Two optional attributes, @cardinality and @countable, are also allowed for finer-grained annotation.

EXAMPLE 4 Two cars_{x3} are parked on the street.

```
<entity xml:id="x3" target="#token2" type="vehicle" form="nom" cardinality="2" countable="yes"/>
```

8.3.2 <place>

The <place> tag is inherited from SpatialML (see Reference [11]) with some additions and modifications. This tag is used to annotate geographic entities like lakes and mountains, as well as administrative entities like towns and counties. With the exception of implicit, non-consuming tags, a <place> tag should be directly linked to an explicit span of text.

NOTE 1 SpatialML refers to MITRE’s annotation scheme, see Reference [11]. It treats only topological and directional relations. Beyond the annotation of these two spatial relations, the annotation scheme presented in this document treats movement and measure links involving motions, spatial entities, and measures.

The list of attributes for the <place> tag is specified below.

List of attributes for the <place> tag

```
<!ELEMENT place (#PCDATA) >
<!ATTLIST place id ID prefix="pl" #REQUIRED >
<!ATTLIST place target (IDREF | CDATA) #REQUIRED >
<!ATTLIST place type (water|celestial|civil|country|grid|latLong|mtn|mts
|postalCode|postBox|ppl|ppla|pplc|rgn|state|UTM) #IMPLIED >
<!ATTLIST place dimensionality (point|line|area|volume) #IMPLIED >
<!ATTLIST place form (nam | nom) #IMPLIED >
<!ATTLIST place continent (AF|AN|AI|AU|GO|LA|NA|PA|SA) #IMPLIED >
<!ATTLIST place country CDATA #IMPLIED >
<!ATTLIST place state CDATA #IMPLIED >
<!ATTLIST place province CDATA #IMPLIED >
<!ATTLIST place county CDATA #IMPLIED >
<!ATTLIST place ctv (city | town | village) #IMPLIED >
<!ATTLIST place gazref CDATA #IMPLIED >
<!ATTLIST place latLong CDATA #IMPLIED >
<!ATTLIST place elevation CDATA #IMPLIED >
<!ATTLIST place mod CDATA #IMPLIED >
<!ATTLIST place dcl (true | false) #IMPLIED "false" >
<!ATTLIST place comment CDATA #IMPLIED >
```

The ATTLIST can specify that an attribute can be any of the following (this list is not exhaustive).

- ID should start with an alphabetic character and may not contain spaces. An ID value should be unique within the document. The name of the attribute @id may take a prefix "xml:" for XML documents.
- IDREF should be a value that is used as an ID somewhere in the document or in the annotation.
- IDREFS is a plural of IDREF.
- CDATA is any parsed character data.
- "#REQUIRED" is for required attributes, whereas "#IMPLIED" is for optional ones, allowing no value to be specified.

NOTE 2 The attribute @state can be replaced by @province or some other name, depending on the administrative division policy of each country.

NOTE 3 A value for the attribute @latLong attribute is provided automatically and it is therefore not usual for it to be manually specified.

The <place> tag attributes are largely inherited from Reference [11]. For example:

- the value "mtn" stands for mountain;
- the value "mts" for mountain range;
- the value "ppl" stands for populated place;
- the value "ppla" stands for a capital of a sub-country (populated area), such as a state or a province;
- the value "pplc" stands for a capital of a country (populated place);
- the value "rgn" stands for a (non-political or non-administrative) region, such as a desert.

For places that have known latitude and longitude values, the @latLong attribute can be used to allow for mapping to other resources such as Google Maps³⁾.

NOTE 4 For further details, see ISO 3166-1:2013, Tables 1, 2 and 4, and ISO 3166-2:2013, Table 1, as well as other parts of the standards as a whole.

Adopting standoff annotation, this document requires an attribute @target to refer to a markable in a tokenized text or an extent in the given text. It also includes a document creation location or @dcl attribute, which is a special location that serves as the “narrative location”. If the document includes a @dcl, it is generally specified at the beginning of the text, in rather the same way that a document creation time is specified in ISO 24617-1. If a place is the DCL, the special @dcl attribute is annotated as “true” and all other location tags have the default @dcl value of “false”.

NOTE 5 The default value for the attribute @dcl is “false”. This means that a document creation location is not specified.

NOTE 6 It is worth remembering that, by convention, the tag names such as <place> and the value of each attribute are no longer represented in uppercase, but in lowercase (unless they are acronyms), while the name of each attributes such as **latLong** is followed by the prefix @, thus being represented as @latLong. This convention is adopted throughout the whole document.

The values for the @type attribute are identical to those for the SpatialML <place> tag, although there are exceptions, such as “vehicle”, which is a spatial entity, tagged <entity> in this document, and “road”, which is a <path> in this document. The tag <place> can be in the form of proper names (*New York*) or nominals (*town*); these are marked with the @form attribute as “nam” or “nom” respectively. For applications to countries other than the U.S., this document also adds “province” both as a value for the attribute @type or replaces “state” with it and as an attribute for the element <place>.

EXAMPLE Tsingtao beer is produced in Qingdao_{tok6}.
 <place xml:id="pl01" target="#tok6" form="nam" type="ppl" ctv="city" province="Shandong" country="CN"/>

NOTE 7 For its value, the attribute @target can refer to a token in a tokenized text. However, in this document, it takes a) an extent directly out of the text as its value to make examples more readable or b) a token or word ID. It follows that, in the above example, the value “_{tok6}” of the @target can be replaced with “Qingdao” or use them interchangeably.

NOTE 8 Although this document describes the full spatial annotation language, many of the example annotations provided show the result of human annotation but do not include elements (e.g. attributes and/or attribute values) that can be introduced by later processing components (e.g. the closure tool).

The @mod attribute is intended to capture cases like “tall building”, “long trail”, and “the higher observation deck” where “tall”, “long”, and “higher” do not constrain the location of the entity but do add spatial information. The @mod attribute is substantially different from its counterpart in SpatialML, where it was used for modifiers like “bottom of the well”, “Burmese border”, “near Harvard”, “northern India”, and “the right side of the building”. In many cases, these modifiers are deemed necessary in SpatialML because SpatialML focuses on annotating gazetteer entries. In this document, these cases are analyzed in one of two ways:

a) the SpatialML modifier is a spatial relation, <sRelation>, in this second edition:

SpatialML: <PLACE type="RGN" mod="N" form="NAM">northern India</PLACE>

Second edition: northern_{sRelation} India_{place},

where the entire phrase is understood as a northern part of India.

or

3) Google Maps is an example of a suitable product available commercially. This information is given for the convenience of users of this document and does not constitute an endorsement by ISO of these products.

- b) the entire phrase may be treated as a <place>, as in SpatialML.

Second edition: [northern India]_{place}

Given this discrepancy with SpatialML, it is likely that the annotator will have to perform some “clean-up” of the <place> elements that are inherited from a SpatialML annotation.

Sometimes, it is necessary to capture location information of places without explicit extents in the text. In such cases, this document allows for creation of non-consuming <place> tags. For example, a non-consuming <place> tag would be necessary in the case of *John climbed to 9 000 feet*, where the elevation *9 000 feet* indirectly references a location that is not associated with any extent in the text. Once a non-consuming <place> tag is created, the identifier of a <measure> can be supplied to the @elevation attribute for the <place>; either the <place> tag's identifier can be supplied to attributes of other tags, or else the <place> can be related to other entities via links.

The attribute @comment introduces any relevant remarks on the content of the tag itself.

8.3.3 <path>

The spatial entity <path> is a location where the focus is on the potential for traversal or else it functions as a boundary. This spatial entity includes common nouns like *road*, *coastline*, and *river* and proper names like *Route 66* and *Kangamangus Highway*.

The <path> tag typically has @start and @end attributes, although these attributes might not be referred to explicitly in the text. Although traversals of <path>s are inherently directional, <path>s themselves are not, and the choice between what is the start and what is the end is therefore, arbitrary. The start and end of a path may not be a point. They can be paths or areas. The attribute @mids may have more than one value.

The <path> tag attributes are a subset of the attributes of the <place> tag, but with the additional @start, @end, and @mids attributes.

List of attributes for the <path> tag

```
<!ELEMENT path (#PCDATA) >
<!ATTLIST path id ID prefix="p" #REQUIRED >
<!ATTLIST path target (IDREF | CDATA) #REQUIRED >
<!ATTLIST path start IDREF #IMPLIED >
<!ATTLIST path end IDREF #IMPLIED >
<!ATTLIST path mids IDREFS #IMPLIED >
<!ATTLIST path dimensionality (line | area | volume) #IMPLIED >
<!ATTLIST path form (nam | nom) #IMPLIED >
<!ATTLIST path gazref CDATA #IMPLIED >
<!ATTLIST path latLong CDATA #IMPLIED >
<!ATTLIST path elevation CDATA #IMPLIED >
<!ATTLIST path mod CDATA #IMPLIED >
<!ATTLIST path dcl (true | false) #IMPLIED "false" >
<!ATTLIST path comment CDATA #IMPLIED >
```

"point" is not listed as a possible value for the attribute @dimensionality of <path> because a path is understood to be a location of more than one dimensionality.

EXAMPLE 1 The railroad_{token2} between Boston_{p1} and New York_{p2}

```
<path xml:id="p1" target="railroad" start="#p1" end="#p2" form="nom"/>
```

EXAMPLE 2 We descended into a long valley_{token6}.

```
<path xml:id="p2" target="valley" form="nom" mod="long"/>
```

Here, the noun *valley* is annotated as a path. In a different context, such as in *John lives in a valley*, it can be annotated as a place.

8.3.4 <eventPath> for event-paths

An event-path, tagged <eventPath>, is a trajectory traversed by a moving object, which is triggered by a motion to move. Such a path is finite, having a start, an end, and an indefinite number of mids between them. Unlike a path, tagged <path>, an event path is directional. Hence, the two terminals of each event-path are either the start or end, although they may not be mentioned explicitly.

The <eventPath> is a non-consuming tag, having a null string as its @target value. The attributes of <eventPath> and their possible value ranges are specified below.

List of attributes for the <eventPath> tag

```
<!ELEMENT eventPath (#PCDATA) >
<!ATTLIST eventPath id ID prefix="ep" #REQUIRED >
<!ATTLIST eventPath target NULL #REQUIRED >
<!ATTLIST eventPath trigger IDREF #REQUIRED >
  <!-- ID of a motion that triggers an event-path --!>
<!ATTLIST eventPath start IDREF #REQUIRED >
<!ATTLIST eventPath end IDREF #REQUIRED >
<!ATTLIST eventPath mids IDREFS #IMPLIED >
<!ATTLIST eventPath gazref CDATA #IMPLIED >
<!ATTLIST eventPath latLong CDATA #IMPLIED >
<!ATTLIST eventPath elevation CDATA #IMPLIED >
<!ATTLIST eventPath comment CDATA #IMPLIED >
```

EXAMPLE John_{x1} drove_{m1} $\emptyset_{ep1}$ from Boston_{pl1} to [New York]_{pl2}.

```
<eventPath xml:id="ep1" target="" trigger="#m1" mover="#x1" begin="#pl1" end="#pl2"/>
```

8.3.5 <motion>

A <motion> is a TimeML event that involves a change of location of some entity. Since <motion> events are inherently spatial, they play a special role in the spatial annotation scheme. When a TimeML eventuality, tagged <event>, has been identified as a <motion>, it is re-annotated with the <motion> tag that has additional attributes.

List of attributes for the <motion> tag

```
<!ELEMENT motion (#PCDATA) >
<!ATTLIST motion id ID prefix="m" #REQUIRED >
<!ATTLIST motion target (IDREF | CDATA) #REQUIRED >
<!ATTLIST motion motionType (manner | path | comopound) #IMPLIED >
<!ATTLIST motion motionManner CDATA #IMPLIED>
<!ATTLIST motion motionGoal CDATA #IMPLIED>
<!ATTLIST motion motionClass (move | moveExternal | moveInternal | leave | reach
  | cross | detach | hit | follow | deviate | stay) #IMPLIED >
<!ATTLIST motion motionSense (literal | fictive | intrinsicChange) #IMPLIED>
<!ATTLIST motion mod CDATA #IMPLIED >
<!ATTLIST motion comment CDATA #IMPLIED >
```

The @motionType attribute refers to the two distinct strategies for expressing concepts of motion in language: *path constructions* and *manner of motion constructions* (see Reference [10]). This is illustrated in the sentences in the following example, where *m* indicates a manner verb and *p* indicates a path. In the first sentence, the motion verb specifies a path, whereas in the second one, the motion verb specifies the manner of motion. The motions in these sentences are of the @motionType COMPOUND since they supply both path and manner information.

EXAMPLE 1 a. John arrived_p [by foot]_m.

b. John hopped_m [out of the room]_p.

A new attribute @motionManner is introduced in this second edition of this document. Example 1a), for instance, is annotated as below.

EXAMPLE 2 John [arrived by foot]_{m1}.

```
<motion xml:id="m1" target="arrived" tense="past" motionType="compound" motionManner="by foot"/>
```

The path adjunct, in contrast, is annotated as referring to a spatial relation: e.g., “John hopped_{m1} [out of]_{sr1} the room_{pl1}.” See [clause 8.3.7](#) for spatial relations, tagged <sRelation>. Example 1b) is then annotated as below.

EXAMPLE 3 John hopped_{m1} [out of]_{sr1} the room_{pl1}. Φ_{ep1}

```
<motion xml:id="m1" target="#w2" pred="hop" tense="past" motionType="compound"/>
<sRlation xml:id="sr1" target="#w3 #w4" type="pathDefining" value="start"/>
<eventPath xml:id="ep1" target="" trigger="#m1" start="#pl1"/>
```

The attribute @goal is reallocated from <moveLink> and placed in <motion> while it is renamed @motionGoal.

EXAMPLE 4 John hiked_{m1} [towards]_{sr1} the peak of the mountain_{pl1}. Φ_{ep1}

```
<motion xml:id="m1" target="#w2" pred="hike" tense="past" motionGoal="#pl1"
motionType="compound"/>
<sRlation xml:id="sr1" target="#w3" type="goalDefining"/>
<eventPath xml:id="ep1" target="" trigger="#m1" start="" end=""/>
```

Motion classes are associated with a spatial event structure that specifies the spatial relations between the arguments of the motion verb at different phases of the event.

The @motionSense attribute distinguishes between the following different kinds of interpretation of motion-events.

- The *literal* sense covers motion-events where the mover participant's location changes over time.
- The *fictive* sense covers cases where the event involves an atemporal, experiential change in an extrinsic, spatial property (e.g. elevation or location).
- The *intrinsic change* sense covers motion verbs that describe change in some intrinsic, spatial characteristic (e.g. height, width, length, or shape). This attribute disambiguates motion examples such as “the balloon rose above the building” from “the river rose above the levee”; in the latter case, a *literal* interpretation (i.e. the river's elevation increased) is inappropriate.
- The @motionSense attribute also captures *fictive* motion interpretations such as “the mountain rises above the valley”, where there is no temporal interpretation (the mountain's elevation increasing over time) but rather a purely spatial, atemporal interpretation predicating spatial characteristics of the mountain over some region.

8.3.6 <event> for non-motion eventualities

An <event> for a non-motion eventuality is a TimeML <event> as per ISO 24617-1, that does not involve a change of location, but it is directly related to another element in the spatial annotation scheme of this document by way of a link. Eventualities are inherited directly from a TimeML annotation and require no further specification in the spatial annotation scheme of this document, except that the tag <event> is changed to <motion> and its ID prefix “e” is changed to “m”. But note that there are additional attributes for this <event> in the spatial annotation scheme to be specified, as shown below.

List of attributes for the <event> tag

```
<!ELEMENT event ( #PCDATA ) >
<!ATTLIST event id ID prefix="e" #REQUIRED >
<!ATTLIST event target (IDREF | CDATA) #REQUIRED >
<!ATTLIST event latLong CDATA #IMPLIED >
<!ATTLIST event elevation CDATA #IMPLIED >
<!ATTLIST event mod CDATA #IMPLIED >
<!ATTLIST event comment CDATA #IMPLIED >
```

EXAMPLE John grew_{token2} up_{token3} in Boston.

```
<event xml:id="e1" target="#token2 #token3" pred="grow" tense="past"/>
```

In TimeML, the element <event> has no attributes such as @latLong, @elevation or @mod. These are added to associate <event>s for non-motion events in the spatial annotation scheme of this document with other spatial entities in general. An earthquake, for instance, is an event and its exact location can be specified with the attributes @latLong and @elevation. The attributes @pred, @pos, @tense, and @aspect were inherited from the element <event> in TimeML.

8.3.7 <sRelation> for various types of spatial relations

In this revised edition of this document, the two tags, <motionSignal> and <spatialSignal>, are merged into a single tag <sRelation>. These “signals” are no longer called as such, but they are understood to be referring to spatial relations. Various spatial relations are differentiated by the attribute @type, having different values.

List of attributes for the <sRelation> tag

```
<!ELEMENT sRelation (#PCDATA) >
<!ATTLIST sRelation id ID prefix="sr" #REQUIRED >
<!ATTLIST sRelation target (IDREF | CDATA) #REQUIRED >
<!ATTLIST sRelation type (topological | directional | topoDirectional | pathDefining | goalDefining) #REQUIRED >
<!ATTLIST sRelation cluster CDATA #IMPLIED >
<!ATTLIST sRelation value CDATA #IMPLIED >
<!ATTLIST sRelation comment CDATA #IMPLIED >
```

The attribute @type is required for the element <sRelation>. The attribute @type should be specified for the <sRelation> element by one of the five possible values: topological, directional, topoDirectional, pathDefining, and goalDefining. The topological, directional, and topo-directional types of <sRelation>s trigger topological or qualitative spatial relations <qsLink>, orientational relations <oLink>, or both topological and orientational relations. The pathDefining type of <sRelation> defines the begin-point, endpoint or midpoints of a path or an event-path, very often related to <moveLink>. The goalDefining type of <sRelation> is associated with the “intended” goal of a motion. See the subsequent clauses concerning these links.

If the type of <sRelation> is topological, then its value is one of RCC+8 values. (See [Table 3](#) and Reference [12]). If the type of <sRelation> defines a path or an event-path, then its value can be either its start, end or mid-points. See [Table 2](#).

Table 2 — Types of Spatial Relation <sRelation>

Types	Possible values	Examples	Associated with
topological	RCC+8	“in”, “at”	<qsLink>
directional		“in front of”, “north of”	<oLink>
topoDirectional		“on”	<qsLink> or <oLink>
pathDefining	“start”, “end”, “mids”	“from”, “to”, “through”	<path> or <eventPath>
goalDefining		“for”, “towards”	<motion>

EXAMPLE 1 John lives **in**_{sr1} Boston.

```
<sRelation xml:id="sr1" target=="in" type="topological" value="IN"/>
```

EXAMPLE 2 Danielle was headed **west-northwest**_{sr2} at near 17 mph (28 kmph).

```
<sRelation xml:id="sr3" target=="west-northwest" type="directional"/>
```

EXAMPLE 3 The cup is **on**_{sr3} the table.

```
<sRelation xml:id="sr3" target="on" type="topoDirectional" cluster="on-1"/>
```

EXAMPLE 4 John walked **to**_{sr4} the store.

```
<sRelation xml:id="sr4" target=="to" type="pathDefining" value="end"/>
```

EXAMPLE 5 John walked **from**_{sr5} Boston all the way **to**_{sr6} Waltham **through**_{sr7} Newton.

```
<sRelation xml:id="sr5" target="from" type="pathDefining" value="start"/>
<sRelation xml:id="sr6" target="to" type="pathDefining" value="end"/>
<sRelation xml:id="sr7" target="through" type="pathDefining" value="mids"/>
```

EXAMPLE 6 John headed_{m8} for_{sr8} Seoul_{pl8}.

```
<motion xml:id="m8" target="headed" pred="head" tense="past" motionType="path"
motionGoal="#pl8"/>
<sRelation xml:id="sr8" target="for" type="goalDefining" value="goal"/>
```

8.3.8 <measure>

The <measure> tag plays its role in measurement relations, providing quantitative information on the dimensions (e.g. length and height) of spatial entities or their relations (e.g. distances). The attributes @value and @unit are two attributes required for the element <measure>, as shown below.

List of attributes for the <measure> tag

```
<!ELEMENT measure (#PCDATA) >
<!-- ATTLIST measure id ID prefix="me" #REQUIRED -->
<!-- ATTLIST measure target (IDREF | CDATA) #REQUIRED -->
<!-- ATTLIST measure value (REAL | CDATA) #REQUIRED -->
<!-- REAL for real numbers; CDATA allows non-quantitative measure expressions such as "far" and "near". -->
<!-- ATTLIST measure unit CDATA #IMPLIED -->
<!-- ATTLIST measure mod CDATA #IMPLIED -->
<!-- ATTLIST measure comment CDATA #IMPLIED -->
```

EXAMPLE 1 John walked for [about 5 miles]_{me1}.

```
<measure xml:id="me1" target="about 5 miles" value="5" unit="miles" mod="approx"/>
```

Following ISO 24617-6:2016, 8.3 principles, a measure relation, tagged <mRelation>, may be introduced to annotate mathematical relation such as “greater than or equal to”.

EXAMPLE 2 John walked for ϕ_5 more than_{mr1} [5 miles]_{me1}.

```
<measure xml:id="me1" target="" value="" />
<measure xml:id="me2" target="5 miles" value="5" unit="miles" />
<mRelation xml:id="mr1" target="more than" value="greaterThan" />
<mLink xml:id="meL1" relType="greaterThan" figure="#me1" ground="#me2" trigger="#mr1"/>
```

In contrast, non-mathematical modifiers such as “about” are annotated with the attribute @mod.

EXAMPLE 3 John walked for [about 5 miles]_{me1}.

```
<measure xml:id="me1" target="about 5 miles" value="5" unit="miles" mod="approx"/>
```

The name of the attribute @value for <measure> allows non-quantitative measures, referred to by expressions such as “near” and “far”.

EXAMPLE 4 The city hall is very near_{mes2}.

```
<measure xml:id="me2" target="very near" value="near" mod=="very"/>
```

List of attributes for the <mRelation> tag

```
<!ELEMENT mRelation (#PCDATA) >
<!ATTLIST mRelation id ID prefix="mr" #REQUIRED >
<!ATTLIST mRelation target (IDREF | CDATA) #REQUIRED >
<!ATTLIST mRelation value CDATA #REQUIRED >
  <!-- Values are mathematical relations. -->
<!ATTLIST measure comment CDATA #IMPLIED >
```

8.4 Link tags

8.4.1 <qsLink>

The tag <qsLink> is used to annotate topological relationships between two or three targeted elements in the annotation.

List of attributes for the <qsLink> tag

```
<!ELEMENT qsLink EMPTY >
<!ATTLIST qsLink id ID prefix="qsl" #REQUIRED >
<!ATTLIST qsLink relType (DC | EC | PO | TPP | ITPP | NTPP | INTPP | EQ | IN) #REQUIRED >
<!ATTLIST qsLink figure IDREF #REQUIRED >
  <!-- There are two types: one relates a spatial entity to other spatial entities and the other, an event to other spatial entities. -- !>
<!ATTLIST qsLink ground IDREF #REQUIRED >
<!ATTLIST qsLink trigger IDREF #IMPLIED >
<!ATTLIST qsLink comment CDATA #IMPLIED >
```

Table 3 — RCC8+ relations

Value	Description
DC	disconnected
EC	externally connected
PO	partial overlap
EQ	equal
TPP	tangential proper part
TPPi	tangential proper part inverse
NTPP	non-tangential proper part
NTPPi	non-tangential proper part inverse
IN	disjunction of TTP and NTPP

The @relType attribute values come from an extension to the RCC8 set of relations that was first used by SpatialML (see [Table 1](#)). The spatial annotation scheme of this document also uses the Region Connection Calculus (RCC) (see Reference [12]) as the basis for its qualitative spatial relationships. RCC is concerned with how regions (spatial objects) are *connected* to each other. RCC8, a variant of RCC that consists of eight basic relations, is used as a basis for the possible relationships between the objects in this document. RCC8 along with the “IN” value are referred to as RCC8+. [Table 1](#) defines the different relationships that RCC8+ captures, and [Figure 2](#) provides an abstract example of the RCC8 relations.

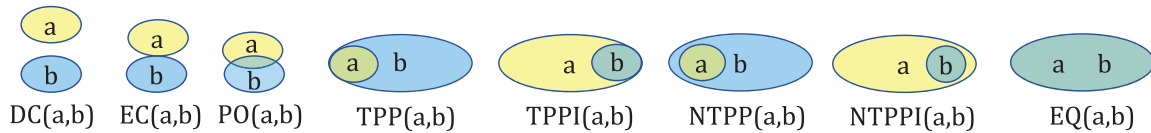


Figure 2 — RCC8+ figures

The objects participating in a spatial relation with one another are typically referred to as either the @figure or @ground. The @figure is the object *being related* to the @ground while the @ground is what the @figure is *being related to*. It is not a universal rule, but the @figure is often a movable object while the @ground tends to be more static.

It is worth noting that while the <qsLink> tag is used exclusively for capturing topological relationships (they are only possible between two regions), the @figure and @ground attributes can accept IDs for both <place>s and <path>s (these are more traditional regions), as well as for <entity> tags and <event> tags. In the case of these two types of tag, it is the region of space associated with the location of the entity or event that participates in the <qsLink> tag; in other words, the entity or event is coerced to a region for the purposes of interpreting this link.

In practice, a <qsLink> is triggered by an <sRelation> with a @type of *topological* or *topoDirectional*. This is shown in the following examples.

- EXAMPLE 1 [The book]_{x1} is **on**_{sr1} [the table]_{x2}.
 <sRelation xml:id="sr1" target="on" cluster="on-1" type="topoDirectional"/>
 <qsLink xml:id="qsL1" relType="EC" figure="#x1" ground="#x2" trigger="#sr1"/>
- EXAMPLE 2 [The light switch]_{x3} is on_{sr2} [the wall]_{x4}.
 <sRelation xml:id="sr2" target="on" cluster="on-2" type="topoDirectional"/>
 <qsLink xml:id="qsL2" relType="PO" figure="#x3" ground="#x4" trigger="#sr2"/>
- EXAMPLE 3 John_{x5} lived_{e1} in_{sr3} Boston_{pl1}.
 <sRelation xml:id="sr3" target="in" type="topological"/>
 <qsLink xml:id="qsL3" relType="IN" figure="#x5" ground="#pl1" trigger="#sr3"/>
 <qsLink xml:id="qsL4" relType="IN" figure="#e1" ground="#pl1" trigger="#sr3"/>

It is assumed that all of the five spatial entities have been annotated with their IDs as shown with the subscripts, so that they can be referred to. The event of Joh's living annotated with its ID "e1" is also linked to the place "Boston_{pl1}" because of the particular property of the event referred to by the verb "lived" that requires a fixed place where that event occurs.

8.4.2 <oLink>

Orientation links describe directional or relative relationships between basic entities. An <sRelation> with a directional @type triggers such a link. In contrast to qualitative spatial relations, <oLink> relations are built around a specific frame of reference type and a reference point. The attributes for <oLink> are as follows.

List of attributes for the <oLink> tag

```
<!ELEMENT oLink EMPTY >
<!ATTLIST oLink id ID prefix="oL" #REQUIRED >
<!ATTLIST oLink relType CDATA #REQUIRED >
<!ATTLIST oLink figure IDREF #REQUIRED >
<!ATTLIST oLink ground IDREF #REQUIRED >
<!ATTLIST oLink trigger IDREF #IMPLIED >
<!ATTLIST oLink frameType (absolute | intrinsic | relative | unspecified) #IMPLIED >
<!ATTLIST oLink referencePt CDATA #IMPLIED >
<!ATTLIST oLink projective (true | false) #IMPLIED >
<!ATTLIST oLink comment CDATA #IMPLIED >
```

The @referencePt value depends on the @frameType of the link. The *absolute* frame type stipulates that the @referencePt is a cardinal direction. For *intrinsic* <oLink>s, the @referencePt is the same identifier that is given in the @ground attribute. For *relative* <oLink>s, the identifier for the viewer should be provided relative to the @referencePt. For *unspecified* <oLink>s or where the viewer is not explicit in the text, the special value *viewer* should be used for the attribute @referencePt.

The @projective attribute is a Boolean that determines whether the <oLink> should have a projective interpretation. This information generally depends on which spatial signal triggered the <oLink>. Projective interpretations add an additional spatial dimension, against which the oLink value is evaluated (e.g., going from a 1-D to a 2-D reading for a preposition).

EXAMPLE 1 Boston_{pl1} [north of]_{sr1} [New York City]_{pl2}.
 <oLink xml:id="oL1" relType="north" figure="#pl1" ground="#pl2" trigger="#sr1"
 frameType="absolute" referencePt="north" projective="true"/>

<oLink> tags also capture projective information. Consider the sentences in the following examples:

- EXAMPLE 2 a) The helicopter_{e1} is above_{sr1} the town_{pl1}.
 b) The hill_{pl2} is above_{sr2} the town_{pl3}.
 c) The [city of Boston]_{pl4} is [north of]_{sr3} [Stoughton, MA]_{pl5}.
 d) The [city of Boston]_{pl6} is [north of]_{sr4} [New York City]_{pl7}.

Both examples a) and b) in EXAMPLE 2 above use the same <sRelation> word, “above”. However, in EXAMPLE 2a), the likely interpretation is that the “helicopter” is located directly above the “town”. This is not the most salient interpretation for EXAMPLE 2b); hills usually do not fly or hover above towns. To distinguish between these two interpretations, the <oLink> in EXAMPLE 2b) has a projective interpretation in which it is imagined that the region associated with the town projects outwards beyond its normal limits. It is this projected region, which is associated with the town that the hill is located above. It follows that both of these sentences should have nearly identical <oLink> tags created for them, except that the @projective attribute value for the link for EXAMPLE 2b) will be flagged as *true* and it is *false* for EXAMPLE 2a).

The issue of projectivity might also arise for <oLink> tags involving any of the four cardinal directions. In EXAMPLE 2c), the relation between Boston and Stoughton would not be projective because Boston is directly north of Stoughton, but the relation in EXAMPLE 2d) would be projective because Boston is indirectly north of New York City. The actual relationship in EXAMPLE 2d) could be described with a @relType of *northeast*, although this information is not directly accessible from the language; that kind of world-knowledge would have to be looked up from a gazetteer entry. The above examples include annotations that illustrate this distinction in further detail.

8.4.3 <moveLink>

The specification of the <moveLink> tag is drastically modified in this document respect to its previous edition. The basic frame of <moveLink> is motivated by Reference [8] and supported by Reference [7] and Reference [8], conforming to ISO 24617-6 principles. Like the other link structures in this document, the structure of <moveLink> is treated as a triple < η , E , ρ >, as is stated in Reference [5], such that

- a) η is an entity structure of the spatial entity type functioning as the mover of a motion-event and also as its figure,
- b) E is a singleton containing an entity structure of the event-path type functioning as a ground, and
- c) ρ is a relation over η and E triggered by a motion-event.

List of attributes for the <moveLink> tag

```
<!ELEMENT moveLink EMPTY >
<!ATTLIST moveLink id ID prefix="mvL" #REQUIRED >
<!ATTLIST moveLink relType (traverse | CDATA) #REQUIRED >
  <!-- relation type of motion, defaults to traverse or motion class -->
<!ATTLIST moveLink figure IDREF #REQUIRED >
  <!-- identifier of the entity that moves along the path -->
<!ATTLIST moveLink ground IDREF #REQUIRED >
  <!-- identifier of the event-path of the motion -->
<!ATTLIST moveLink trigger IDREF #IMPLIED >
  <!-- identifier of the motion event that triggered the link -->
<!ATTLIST moveLink comment CDATA #IMPLIED
```

<moveLink> is typically triggered by a path-type motion, accompanied by an event-path. In the abstract syntax, the value of @relType is specified as CDATA, allowing any possible values, but in the concrete syntax it is specified as "traverse" or a motion class. The two attributes, @figure and @ground, are based on Talmy's suggestions, see Reference [10]. The moving object of a motion is understood to be a *figure* and an event-path created by that motion is the *ground* which the mover follows.

EXAMPLE 1 The past week has been a long ride_{m1} through_{sr1} northern Baja_{pl1}. $\emptyset$ _{x1} $\emptyset$ _{ep1}.
 <motion xml:id="m1" target="ride" motionClass="moveInternal" motionSense="literal"/>
 <place xml:id="pl1" target="Baja" form="nam"/> <sRelation xml:id="sr1" target="through"
 type="pathDefining" value="mids"/>
 <entity xml:id="x1" target="" form="nom"/>
 <eventPath xml:id="ep1" target="" start="" end="" mids="#pl1"/>
 <moveLink xml:id="mvL1" relType="traverse" figure="#x1" ground="#ep1" trigger="#m1"/>

EXAMPLE 2 John_{x2} swam_{m2} around_{sr2} the lake_{pl2}. $\emptyset$ _{ep2}.
 <motion xml:id="m2" target="swam" motionClass="moveInternal" motionSense="literal"/>
 <place xml:id="pl2" target="lake" form="nom"/>
 <sRelation xml:id="sr2" target="around" type="topological" value="IN"/>
 <entity xml:id="x2" target="John" type="person" form="nom"/>
 <eventPath xml:id="ep2" target="" start="#pl2" end="#pl2" mids="#pl2"/>
 <moveLink xml:id="mvL2" relType="traverse" figure="#x2" ground="#ep2" trigger="#m2"/>

EXAMPLE 3 John_{x3} walked_{m3} around_{sr3} the lake_{pl3}. $\emptyset$ _{ep3}.
 <motion xml:id="m3" target="swam" motionClass="moveExternal" motionSense="literal"/>
 <place xml:id="pl3" target="lake" form="nom"/>
 <sRelation xml:id="sr3" target="around" type="topological" value="EC???" />
 <entity xml:id="x3" target="John" type="person" form="nom"/>
 <moveLink xml:id="mvL3" relType="traverse" figure="#x3" ground="#ep3" trigger="#m3" />

8.4.4 <mLink>

Measurement relationships are captured with the <mLink> tag. This tag can describe either the relationship between two spatial objects or the dimensions of a single object.

List of attributes for the <mLink> tag

```
<!ELEMENT mLink EMPTY >
<!ATTLIST mLink id ID prefix="meL" #REQUIRED >
<!ATTLIST mLink relType (distance | length | width | height | generalDimension |
  CDATA) #REQUIRED >
  <!-- CDATA allows any measure value types other than the ones listed here such as speed or weight. -->
<!ATTLIST mLink figure IDREF #REQUIRED >
  <!-- The value of @figure is the ID of the tag <measure>. -->
<!ATTLIST mLink ground IDREF | unspecified #REQUIRED >
  <!-- The value of @ground is a list of the IDs of entities to which the measure value applies. -->
<!ATTLIST mLink bounds IDREFs #IMPLIED >
  <!-- The value of @bounds is a list of the IDs of bounds that together define the object to which the measure
  value applies. -->
<!ATTLIST mLink comment CDATA #IMPLIED >
```

Where there is a measure of a distance or some other type of dimension between or among a number of spatial objects in a figure-ground configuration, the value of <measure> becomes the @figure, while the @ground attribute lists those spatial objects to which the measurement applies possibly with its bounds specified. The specification of the bounds can be omitted if they are marked up in the measured object.

- EXAMPLE 1 John_{x1} is 180 cm_{me1} tall.
 <entity xml:id="x1" target="John" type="person" form="nam"/>
 <measure xml:id="me1" target="180 cm" value="1.80" unit="meters"/>
 <mLink xml:id="meL1" relType="height" figure="#me1" ground="#x1"/>
- EXAMPLE 2 We camped $\emptyset$ _{pl1} [three hundred meters]_{me1} from the temple_{pl2}.
 <place xml:id="pl1" target="" comment="camp ground"/>
 <place xml:id="pl2" target="temple" form="nom"/>
 <measure xml:id="me2" target="three hundred meters" value="300" unit="miles"/>
 <mLink xml:id="meL2" relType="distance" figure="#me2" ground="#pl1, #pl2"/>

Distances always require two @ground values. A distance is a spatial relation between two places or from one place to another.

- EXAMPLE 3 The Empire State Building_{x1} has a roof_{x2} height of 1,250 feet_{me31} (380 m) and stands a total of 1,454 feet_{me32} (443,2 m) tall, including its antenna_{x3}.
 (Copied from https://en.wikipedia.org/wiki/Empire_State_Building)
 <entity xml:id="x1" target="Empire State Building" type="building" form="nam"/>
 <place xml:id="pl1" target="" comment="ground level"/>
 <entity xml:id="x2" target="roof" form="nom"/>
 <entity xml:id="x3" target="antenna" form="nom" comment="tip of the antenna"/>
 <measure xml:id="me31" target="1,250 feet" value="1250" unit="feet"/>
 <measure xml:id="me32" target="1,454 feet" value="1454" unit="feet"/>
 <mLink xml:id="meL21" relType="height" figure="#me31" ground="#x1" bounds="#pl1, #x2"/>
 <mLink xml:id="meL22" relType="height" figure="#me32" ground="#pl1" bounds="#pl1, #x3"/>

8.5 Root tag: <spatial>

All well-formed XML documents should have a single root node: in this document, it is <spatial>; for example, a sample, partially-annotated document might look like as follows.

```
<?xml version="1.0" encoding="UTF-8"?>
<text>
<title> Empire State Building - Wikipedia </title>
<source>https://en.wikipedia.org/wiki/Empire\_State\_Building</source>
<![CDATA[
The Empire State Building is a 102-story Art Deco skyscraper in Midtown Manhattan, New York City. De-
signed by Shreve, Lamb & Harmon and completed in 1931, the building has a roof height of 1,250 feet (380 m)
and stands a total of 1,454 feet (443,2 m) tall, including its antenna. Its name is derived from "Empire State", ...
]]></text>
<spatial xml:id="sp1">
<entity xml:id="x1" target="Empire State Building" type="building" form="nam"/>
<entity xml:id="x2" target="skyscraper" type="building" form="nom"/>
<sRelation xml:id="sr1" target="in" type="topological" value="IN"/>
<place xml:id="pl1" target="New York City" type="PPL" ctv="city" form="nam" state="NY" country="USA"/>
<entity xml:id="x3" target="building" type="building" form="nom"/>
<entity xml:id="x4" target="roof" form="nom" comment="tip of the antenna"/>
<qslink xml:id="qsl1" relType="IN" figure="#x1" ground="#pl1" trigger="#sr1"/>
<entity xml:id="x2" target="roof" form="nom"/>
<entity xml:id="x3" target="antenna" form="nom" comment="tip of the antenna" />
<measure xml:id="me31" target="1,250 feet" value="1250" unit="feet"/>
<measure xml:id="me32" target="1,454 feet" value="1454" unit="feet"/>
<mLink xml:id="meL21" relType="height" figure="#me31" ground="#x1" bounds="#pl1, #x2"/>
<mLink xml:id="meL22" relType="height" figure="#me32" ground="#pl1" bounds="#pl1, #x3"/>
</spatial>
```