# Revising ISO-Space and the Role of the Movement Link

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## Abstract

Focusing on the revision of the movement link in the annotation scheme, tagged `<moveLink>`, this paper presents a systematic means of converting the first official edition of ISO-Space to its second edition with revisions required at the specification levels, both abstract and concrete. Even with these changes, the first edition of the ISO-Space standard is expected to be compatible with the second edition, at least at the level of semantics.

## 1 Introduction

The annotation scheme for static and dynamic spatial information, commonly called *ISO-Space*[1], was officially published as part of the first edition of ISO 24617-7:2014 (E) standard. Before the publication of this standard, there were some preliminary working versions such as the ones proposed by Pustejovsky et al. (2010) and Pustejovsky and Yocum  (2013) that had treated event-paths as part of the basic entity types for the spatial annotation scheme. Following these preliminary proposals, the first official edition of ISO-Space (ISO, 2014b), henceforth to be referred to by ISO-Space (2014), also listed event-paths as a basic entity type, but failed to implement them in constructing annotation structures overall.

As Lee (2016) pointed out, this failure made the annotation structures, specified in abstract set-theoretic terms by the first edition of ISO-Space, non-isomorphic to the corresponding structures represented in a concrete markup format. This is a serious mismatch in an annotation scheme between its so-called *abstract syntax* and each of its representation formats, called *concrete syntaxes*, based on the abstract syntax.[2] Pustejovsky and Lee (2017) and Lee (2018) continued to show that the annotation of the movement link, tagged `<moveLink>`, mostly overlapped the task of semantic role annotation, specified in ISO (2014a). Furthermore, the movement link in the first edition failed to conform to the general triplet link structure $<\eta, E, \rho>$, first formulated by Bunt et al. (2016) and then specified as required by another ISO standard 24617-6 Principles of semantic annotation (ISO, 2016). The conformance of the movement link to this triplet structure is basically required to be made interoperable with other parts of the ISO 24617 standard on semantic annotation frameworks such as ISO-TimeML (ISO, 2012), which treats event-based temporal annotation.

Much work has already been done in applying ISO-Space (2014) as an ISO standard to the semantic annotation of raw corpora or the construction of semantic systems. It is thus necessary to make the first edition of ISO-Space compatible with its second edition so that earlier applications still remain valid and can easily be updated according to the second edition if needs arise. This paper aims at showing how the first official edition of ISO-Space (ISO, 2014b) can be made compatible with the revised edition, [3] by:

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[1]See Pustejovsky (2017) for an overview of ISO-Space.

[2]According to Bunt (2010) and Bunt (2011), a semantic annotation scheme consists of an abstract syntax, a set of concrete syntaxes, and a semantics. The abstract syntax defines well-formed annotation structures in set-theoretic terms, while a concrete syntax based on it provides a format for representing annotation structures. The annotation structures defined by the abstract syntax can be represented in different formats which are semantically equivalent, since the semantics specifies the interpretation of the abstract annotation structures.

[3]Following  Bunt et al. (2018), this paper focuses on the compatibility of the original version with a new version in order to save various applications based on the original. The revisions in the new version are required for various independent reasons. The compatibility of a revised version with its original is thus not considered as a necessity, but rather as something desirable.

relating old annotation structures into new ones in a systematic way (sections 4.2 and 4.3) and turning the semantic interpretations of old annotations into those based on event-paths as in the new annotations (section 4.4).

## 2 Specification of `<moveLink>` in ISO-Space (2014)

ISO-Space (2014) has no event-paths implemented in its concrete syntaxes. As a result, the movement link, tagged `<moveLink>` in XML, carries many of the path-related features.[4]

(1) List A.12 Attributes for the `<moveLink>` tag
```
attributes = identifier, [trigger], [source], [goal], [midPoint], [mover],
[ground], [goalReached], [pathID], [motionSignalID], [comment];
identifier = mvl, decimal digit, decimal digit;
   {*The identifier is tagged "xml:id" for XML documents,
   otherwise "id".  Examples are:  mvl3, mvl20*}
trigger = IDREF; {*ID of a <motion> that triggered the link*}
source = IDREF; {*ID of a location/entity/event tag at the
   beginning of the event-path *}
goal = IDREF; {*ID of a location/entity/event tag at the end of the event-path*}
midPoint = IDREFS;
   {*ID(s) of event-path midpoint location/entity/event tags*}
mover = IDREF; {*ID of the location/entity/event tag whose location changes*}
ground = IDREF;
  {*ID of a location/entity/event tag that the @mover participant's motion
   is relative to *}
goalReached = "yes" | "no" | "uncertain";
pathID = IDREF;
  {*ID of a <path> tag that is identical to the event-path of the
   @trigger <motion>*}
motionSignalID = IDREFS;
   {*ID(s) of <motionSignal> tag(s) that contributes path or manner information
   that the @trigger <motion> carries *}
comment = CDATA;
```

The following example shows how the 2014 specification of `<moveLink>` operates:

(2) a. Markables Tagged:

John$_{se1}$ flew$_{m1}$ to$_{ms1}$ Miyazaki$_{pl1}$ through$_{ms2}$ Narita$_{pl2}$ and Haneda$_{pl3}$.

b. Annotated:
```
<moveLink xml:id="mvl1" trigger="#m1" goal="#pl1" midPoint="#pl2,#pl3"
mover="#se1" goalReached="yes" motionSignalID="#ms1,#ms2"/>
```

This specification fails to represent what entities are being related by `<moveLink>`.

## 3 Revised Specifications

### 3.1 Metamodel and Basic Assumptions

Figure 1 presents the metamodel or general structure of revised ISO-Space.

Here we focus on the movement link, tagged `<moveLink>`, only. It is triggered by a motion and then relates a spatial entity to an event-path. This spatial entity is a mover or object which is triggered by a motion to traverse its trajectory, called *event-path*. A case referred to by "An overcrowded bus plunged

---
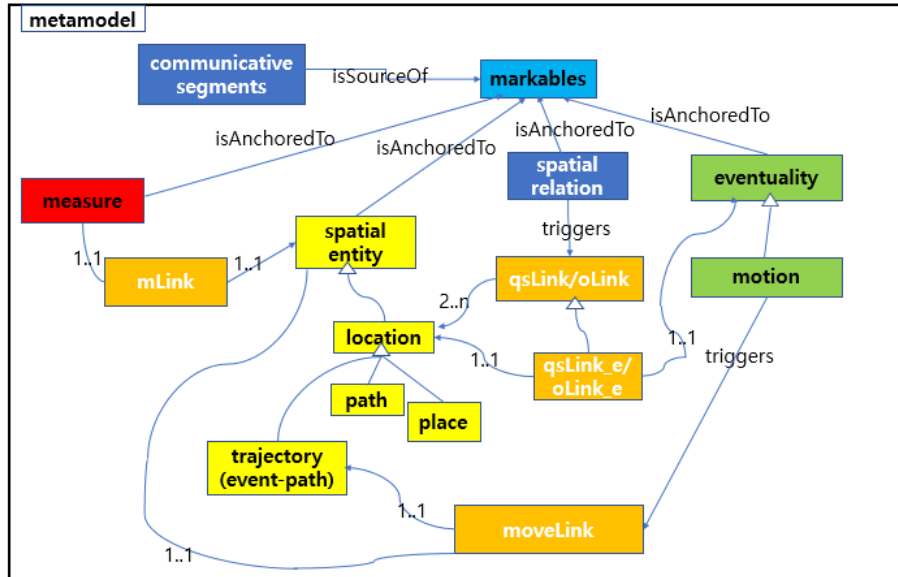
[4]See ISO 24617-7:2014, List A.12.

Figure 1: Metamodel of Revised ISO-Space

off a mountain road into a gorge in northern India" is an example, where the bus is treated as a *spatial entity* and a trajectory from the mountain road down to a gorge is an *event-path*.[5]

There are some basic assumptions according to which the movement link, `<moveLink>`, is reformulated in revised ISO-Space:

(3)   a.  **Axiom**: Every motion-event triggers a trajectory or route, called *event-path*, that a mover traverses: $\forall e[motion(e) \rightarrow \exists\{r,x\}[eventPath(r) \wedge triggers(e,r) \wedge mover(x,e) \wedge traverses(x,r)]]$[6]

   b.  **Definition**: An event-path is a finite directed series of locations.

   c.  **Implementation**: An event-path is represented as a *non-consuming tag*, which is anchored to an empty string of text segments, but uniquely identifiable.

In the revised edition of ISO-Space, the `<moveLink>` is treated as a path-delimiting relation that conveys information about a moving about, traversing a trajectory or event-path. As a genuine but directed finite path, the event-path is understood to have a *start* and an *end* with denumerably many *mid* locations between them. Locations may include points, intervals, paths or (two-dimensional) areas. For a case like an event expressed by "A truck sped off the Massachusetts Turnpike", the truck's speeding off is understood to have started on the Massachusetts Turnpike or some point on that highway (path). Hence, terms such as *begin point* or *endpoint* are replaced by more general terms like *start* or *end*, respectively. These locations delimiting event-paths may not be explicitly mentioned, but they must exist, each being uniquely defined.

## 3.2   Serialization in a Concrete Syntax

In an XML-based concrete syntax, the two elements `<eventPath>` and `<moveLink>` are implemented each with a list of attribute-value specifications. These may be represented in extended BNF (ISO/IEC, 1996), which is found expressively more powerful than DTD (data-type declaration), as follows:

(4)   Attribute-Value Specification for `<eventPath>`

```
attributes = identifier, target, trigger, start, mids, end,
```

---

[5]ISO-Space includes among spatial entities those objects that are not genuinely spatial, but are involved in a spatial relation or in a motion.

[6]Rather than the variable $p$, which is reserved for propositions, the variable $r$ is chosen to represents event-paths, which may also be called *routes*.

```
                            [spatialRelator], [comment];
     {*The attributes in brackets [ ] are opitonal; others are required.*}
   identifier = ep, positive integer;
   target = EMPTY;
   trigger = IDREF; {*ID of a motion*}
   start = IDREF | EMPTY;
     {*ID of a location or EMPTY. A location may include a path or area.*}
   mids = IDREFS | IDREF | EMPTY; {*IDs of locations, ID of a path, or EMPTY*}
   end = IDREF | EMPTY; {*ID of a location or EMPTY*}
   spatialRelator = IDREFS; {*IDs of <spatialRelation>s that delimit an event-path
     with its @start, @end or @mids*}
   comment = CDATA;
```

Each instance of a motion-event triggers an event-path and each event-path is uniquely associated with a motion-event. Such a motion-event is represented by the attribute @trigger with a specific value referring to that motion-event associated with an event-path. As a finite path, every event-path has two ends: one is identified as its start and the other one as its end, because it is directed. Hence, the attributes @start, @mids, and @end are required attributes. Their values are *unspecified* if these locations are not explicitly mentioned.[7]

(5) Attribute-Value Specification for `<moveLink>`

```
   attributes = identifier, figure, ground, relType, [goalReached], [comment];
     {*The attributes in brackets [ ] are optional; others are required.*}
   identifier = mvL, positive integer;
   figure = IDREF; {*ID of a moving object*}
   ground = IDREF; {*ID of an event-path*}
   relType = CDATA | "traverses";
     {*CDATA allows other more specific values such as the motion-event involved
     than the general value "traverses".*}
   goalReached = "yes"|"no";
     {*If @goalReached is uncertain, then it is unspecified.*}
   comment = CDATA;
```

This specification conforms to the general triplet structure $<\eta, E, \rho>$, where $\eta$ is represented by the value of the attribute @figure, $E$ by the value of @ground, and $\rho$ by that of @relType. Optional attributes such as @goalReached or @comment are freely allowed without violating the triplet structure of links.

Here is an example:

(6)  a.  Text: John flew to Miyazaki through Narita and Haneda.

   b.  Markables Tagged:
       John$_{x1}$ flew$_{m1}$ $\emptyset_{ep1}$ pred="fly" to$_{sr1}$ Miyazaki$_{pl1}$ through$_{sr2}$ Narita$_{pl2}$ and Haneda$_{pl3}$.

   c.  Annotated:
```
   <motion xml:id="m1" target="flew" pred="fly" tense="past" goal="#pl1"/>
   <eventPath xml:id="ep1" target="" trigger="#m1" start=""
     end="#pl1" mids="#pl2,#pl3" spatialRelator="#sr1,#sr2"/>
   <moveLink xml:id="mvL1" figure="#x1" ground="#ep1" relType="fly_through"
     goalReached="yes"/>
```

---

[7]Spatial relators such as *from*, *to*, and *through* just define the start, end, and mids of an event-path, without carrying any semantic content. Once the delimiting bounds of an event-path are marked up, the function of spatial relators is discharged.

As shown in (c), the annotation of an event-path, tagged `<eventPath>`, is treated as a complex entity structure referring to other entity structures just like link structures.[8]

## 3.3 Outline of Semantics

The semantics of revised ISO-Space is formulated on the basis of its abstract syntax, but its interpretation rules apply to the semantic interpretations of annotation structures as represented by a concrete syntax. Here is an example for the annotation structures represented in (4c). Each of the annotation structures is interpreted as a Discourse Representation Structure (DRS), as defined in Kamp and Reyle (1993)'s Discourse Representation Theory, through the interpretation function $\sigma$, as shown below:[9]

(7) DRSs:
   Entity: $\sigma(John_{x1}) := [named(x, john), person(x)]$
   Motion: $\sigma(flew_{m1}) := [fly(m_1), past(m_1), goal(\sigma_{pl1}, m_1)]$
   Locations: $\sigma(Miyazaki_{pl1}) := [named(l_1, Miyazaki), airport(l_1)]$,
        $\sigma(Narita_{pl2}) := [named(l_2, Narita), airport(l_2)]$,
        $\sigma(Haneda_{pl3}) := [named(l_3, Haneda), airport(l_3)]$
   Event-path: $\sigma(\emptyset_{ep1}) := [eventPath(r), triggers(m_1, r), endsAt(r, l_1), mids(r, <l_2, l_3>)]$
   Link: $\sigma(mvL1) := [fly\_through(x_1, r), goalReached]$

The entity structures of the entity types *entity, motion, location*, and *event-path* represented in (4c) are each interpreted by $\sigma$ as a DRS. The link structure corresponding to `<moveLink>` is interpreted as a DRS by combining the interpretations of those entity structures. All of the unbound variables are to be interpreted existentially and the commas interpreted as conjunctions. For the movement link, all these DRSs can be compositionally combined.

First, on the basis of neo-Davidsonian event semantics[10], which treats predicates as each applying to an event as an individual entity and with a list of participants in that event, we have the following interpretation of $traverses(x_1, p)$:

(8) Definition 1: $\forall\{x, r\}[traverses(x, r) \rightarrow \exists\{m, x\}[moves(m), mover(x, m), pathOf(r, m)]$

Second, *goalReached* is treated as a truth-value carrying proposition. Its interpretation requires a decomposition to predicates involving spatio-temporal properties:

(9) Definition 2:
   $[goalReached \rightarrow \exists\{m, x, l, t\}[moves(m), mover(x, m), location(l), goal(l, m), time(t), terminatesAt(m, t),$
   $locatedAt(x, <l, t>)]]$

This is interpreted as saying that the motion of moving terminated at the time $t$ and at that time $t$ the mover $x$ was at the location $l$.[11]

*goalReached* may also be defined in terms of an event-path, as shown below:

(10) Definition 3:
   $[goalReached \rightarrow \exists\{m, l, r\}[moves(m), goal(l, m), eventPath(r), triggers(m, r), endsAt(r, l), goal(l, m)]]$

This means that if a goal is reached, then there is a motion-event with a goal that triggers an event-path such that the goal matches the end of the event-path.

The attribute `@goalReached` is optional with its possible values, either `"true"` or `"false"`. Consider:

(11) a. Lee$_{x1}$ climbed$_{m1}$ $\emptyset_{ep1}$ up to$_{sr1}$ [the peak of Mt. Halla]$_{pl1}$, but Kim$_{x2}$ couldn't $\emptyset_{m2}$ $\emptyset_{ep2}$.

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[8] An annotation structure consists of entity structures and link structures. An entity structure is a pair $<m, s>$, where $m$ is a markable and $s$, semantic information, while a link structure is a relation over entity structures, with its relation type specified.

[9] The notation used here can easily be converted into the box notation commonly used in DRT.

[10] See Davidson (1967) and Parsons (1991) and other related works.

[11] See Mani and Pustejovsky (2012) for the spatio-temporal interactions involving motions.

b. 
```
<motion xml:id="m1" target="climbed" pred="climb" tense="past" goal="#pl1"/>
<eventPath xml:id="ep1" trigger="#m1" end="#pl1" spatialRelator="#sr1"/>
<moveLink xml:id="mvL1" figure="#x1" ground="#ep1" relType="climb_to"
goalReached="yes"/>
```

c. 
```
<motion xml:id="m2" target="" pred="climb" tense="past" goal="#pl1"/>
<eventPath xml:id="ep2" trigger="#m2" end=""/>
<moveLink xml:id="mvL1" figure="#x2" ground="#ep2" relType="climb_to"
goalReached="no"/>
```

Lee succeeded in reaching the goal because the end of the event-path triggered by his climbing matched the goal of his climbing. Kim, on the other hand, failed to reach the goal, for the end of his climbing path was unspecified, failing to match the goal.[12]

## 4 Compatible Revision

### 4.1 Overview

As pointed out by Bunt et al. (2018), the notion of compatibility, related to semantic annotation schemes, works at three different levels: abstract syntax, concrete syntax, and semantics. Here we are concerned with compatibility at the semantic level. From an operational point of view, *semantic compatibility* is understood as follows:

(12) Given two versions, $v_1$ and $v_2$, of a semantic annotation scheme,
    $v_1$ is semantically compatible with $v_2$ only if the information annotated by $v_1$ is also annotated by $v_2$ independent of how it is annotated.

Applied to ISO-Space, the compatibility of its first edition with its revised edition means a one-way process can be defined for converting the annotations of the first edition to those according to the second edition. The revision may not invalidate the first edition of ISO-Space (2014) from a theoretical point of view, but when the new edition of an ISO standard is published, the first edition legally loses its status as an ISO standard.

In this paper we focus on the movement link (<moveLink>) and entity structures associated with it in the first edition of ISO-Space, presenting a procedure for reformulating them in the revised edition.[13] There are two steps to the conversion:

(13) i. Rename all of the path-related attributes in the movement link <moveLink> in ISO-Space (2014);
    ii. Move all of the path-related attributes to an <eventPath> restored in the revised version of ISO-Space.

Renaming attributes in a revision only affects the representation of annotation structures in some concrete format, but does not affect the semantics, although the range of attribute values may change. Changing the attribute name @beignPoint to @start, for example, only widens the range of their values from a point to possibly a line or an area. This allows to treat examples like "The car sped off the Massachusetts Turnpike."

### 4.2 Renaming

The proposed renaming process is summarized in Table 1:
With an ID of a motion as value, the attribute @trigger remains the same in both of the versions. In the revised version, the attributes @source and @goal are renamed with path-related terms, @start and @end, respectively. The attribute @midpoint is renamed @mids, a more general term that allows its

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[12]Kim's failure to reach the goal was made certain with the expression of *couldn't*. If it is uncertain, the optional attribute @goalReached is not marked up in <moveLink>.

[13]This procedure should be discussed in abstract terms, independent of representational issues, but is discussed in concrete terms to make it easier to understand what changes are being made.

Table 1: Renaming Attributes for `<moveLink>` in ISO-Space (2014)

| ISO-Space (2014) | Revised | Possible values or Comments |
|---|---|---|
| IDprefix=mvl | IDprefix = "mvL" | |
| trigger | NOT CHANGED | ID of a `<motion>` |
| source | start | ID of a location (place or path) |
| goal | end | ID of a location<br>`@goal` moves to `<motion>` as its attribute |
| midPoint | mids | IDs of locations |
| mover | figure | ID of a moving object |
| ground | NOT CHANGED | Values change to ID of `<eventPath>` |
| goalReached | NOT CHANGED | `"yes"|"no"` |
| pathID | REMOVED | incorporated into `@mids` |
| motionSignalID | REMOVED | incorporated into `<eventPath>` |
| comment | NOT CHANGED | CDATA |

value to be a location which is either a place or a path, or a list of such locations. The attribute `@mover` took a more general name `@figure` as in other links. The attribute `@ground` remains the same, but has the ID of `<eventPath>` as value. The attribute `@goalReached` remains as an optional attribute in revised `<moveLink>` elements with its possible value listed as either `"yes"` or `"no"`. Being optional, `@goalReached` may not be specified; if so, its value is interpreted as being `"uncertain"`. The two attributes, `@pathID` and `motionSignalID`, are removed, but incorporated into `@mids` and `<eventPath>`, respectively.

### 4.3 Reallocation

Having modified the names of some of the attributes in `<moveLink>` in ISO-Space (2014), all of the five path-related attributes, `@trigger`, `@start`, `@end`, `@mids` and `@spatialRelator`, some of which are renamed, are reallocated from `<moveLink>` in the first edition to `<eventPath>` in the revised edition. The remaining four attributes, `@figure`, `@ground`, `@goalReached`, and `@comment` remain in the movement link `<moveLink>` with an additional attribute `@relType` introduced. The three attributes `@figure`, `@ground`, and `@relType` are required to be specified, conforming to the general link structure laid down by the ISO standard 2017-6 Principles of semantic annotation. The attributes `@goalReached` and `@comment` are optional, as licensed by these principles.

Table 2 shows how these attributes are reallocated:

Table 2: Reallocation of Attributes in revised ISO-Space

| ISO-Space (2014) | Revised | | |
|---|---|---|---|
| `<moveLink>` | `<eventPath>` | `<moveLink>` | `<motion>` |
| IDprefix="mvl" | IDprefix="ep" | IDprefix="mvL" | IDprifix="m" |
| [trigger] | trigger | | |
| [source] | [start] | | |
| [goal] | [end] | | [goal] |
| [midPoint] | [mids] | | |
| [mover] | | figure | |
| [ground] | | ground | |
| | | relType | |
| [goalReached] | | [goalReached] | |
| [pathID] | | | |
| [motionSignalID] | [spatialRelator] | | [manner] |
| [comment] | [comment] | [comment] | [comment] |

Note 1: The attributes in `[ ]` are optional.

The right-most column shows how the entity structure representation `<motion>` is modified. There are two attributes `@goal` and `@manner` introduced to it. The attribute @*goal* has an ID of a location as

its possible value. The value @goal may be the same as that of @end for <eventPath>. Then the value of @goalReached for <moveLink> is "yes"; otherwise, it is "no" or uncertain, depending other cues. If reaching the goal is uncertain, then @goal is not specified.

The attribute @manner annotates information on the means of a trans-locational motion-event not through <moveLink>, as in the first 2014 edition of ISO-Space, but directly on the entity structure representation <motion>. This allows the removal of the manner-type <motionSignal> from the first edition. Except for these two newly introduced attributes, the original list of attributes for <motion> remains the same in revised ISO-Space just as in the first edition.

### 4.4 Semantic Compatibility Sketched

For the interpretation of each movement link, tagged <moveLink>, of ISO-Space (2014), we assume the following tuple as standing for a list of basic (discourse) entity types:

(14) $<D, L, m, r>$, where
   $D$ a set of discourse entities that include so-called spatial entities, represented by $x_1$, $x_2$, etc.;
   $L$ a set of locations, $l_1$, $l_2$, etc., or sequences of locations that may include a static path;
   $m$ is a motion;
   $r$ a dynamic route, called *event-path*.

This specifies variables for each of the entity types.

Then, associated with the attribute specification of <moveLink> in the concrete syntax of ISO-Space (2014), we have the following interpretations as DRSs:

(15) a. Given:
```
attributes = identifier, [trigger], [mover], [source], [goal], [midPoint],
[ground], [goalReached], [pathID], [motionSignalID], [comment];
```

   b. For $motion(m_i)$ and $eventPath(r)$,[14]
   $\sigma(\texttt{trigger}_{mi}) := triggers(m_i, r);$
   $\sigma(\texttt{mover}_{sei}) := [mover(x_i, m_i), eventPath(r), traverses(x_i, r)];$
   $\sigma(\texttt{source}_{pli}) := startsAt(r, l_i);$
   $\sigma(\texttt{goal}_{plj}) := [goal(l_j, m_j), endsAt(r, l_j)]$ if goalReached="yes";
   $\sigma(\texttt{goal}_{plj}) := goal(l_j, m_i)$ if goalReached="no" or reaching the goal is uncertain.;
   $\sigma(\texttt{midPoint}_{\{pl_1, pl_2, ...\}}) := mids(r, <l_1, l_2>);$
   $\sigma(\texttt{pathID}_{pi}) := [path(l_i), overlaps(r, l_i)].$

   c. By combining them into one DRS together with $[motion(i), eventPath(r)]$, we obtain the overall DRS $\sigma(mvli)$ of the movement link.

All of the DRSs here reflect Axiom (1a) on event-paths and Definitions (1-3) of $goalReached$. The whole process given above makes the DRSs compatible with revised ISO-Space.

Here is an example:

(16) a. ISO-Space (2014):
   John$_{se3}$ drove$_{m3}$ to$_{ms4}$ Worecester$_{pl3}$ on$_{ss3}$ the [Massachusetts Turnpike]$_{p1}$.

   b. Annotation:
```
<moveLink xml:id="mvl3" trigger="m3" mover="se3" goal="pl3"
   goaReached="true" motionSignalID="ms4" pathID="p1"/>
```

   c. Interpretation of each of the entity structures:
   $\sigma(\texttt{John}_{se3}) := [named(x_3, John), person(x_3)]$

---

[14]The domain of the interpretation function $\sigma$ is a (possibly singleton) set of attribute-value pairs associated with annotation structures.

$$\sigma(\texttt{drove}_{m3}) := [drive(m_3), past(m_3)]$$
$$\sigma(\texttt{Worcester}_{pl3}) := [named(l_3, Worcester), city(l_3)]$$
$$\sigma(\texttt{MassachusettsTurnpike}_{p1}) := [named(l_4, Massachusetts\,Turnpike), highway(l_4)]$$

d. Interpretation of the movement link structure with an event-path variable $r$:
$$\sigma(mvl3) := [[triggers(m_3, r), mover(x_3, m_3), eventPath(r), drives\_through(x_3, r)],$$
$$[goal(l_3, m_3), endsAt(r, l_3), path(l_4), overlaps(l_4, r)]]^{15}$$

The interpretation $\sigma(mvl3)$ of ISO-Space (2014) above is considered as conveying the information obtained jointly from the interpretation of an event-path and that of the revised movement link in its revised edition. This is validated by Axiom (1a) and the interpretation of the proposition $goal\,Reached$.

## 5  Concluding Remarks

Revision should not invalidate all of the costly past work. As discussed by Bunt et al. (2018) in this volume, compatibility is a requirement for revision. Such compatibility, especially as understood at the semantic level, guarantees the preservation of information in the process of revision. This paper has tried to show how such a requirement is a desirable option as compatibility of the first edition of ISO-Space (ISO, 2014b) with its revised edition, by presenting a way of deriving compatible semantic forms on the basis of Axiom (1a) from unrevised annotations. Although we have shown it in this paper, the revision of the movement link (`<moveLink>`) has been required by other independent reasons such as its conformity to and its interoperability with other parts of the ISO 24617 standard on semantic annotation framework, as discussed in Lee (2012), Lee (2016), Pustejovsky and Lee (2017), and Lee (2018).

Modifications other than the reformulation of `<moveLink>` have been made in the revised edition of ISO-Space (ISO, 2014b). The measure link, tagged `<mLink>`, is such a case.[16] The modification of `<mLink>` as well as other parts in ISO-Space is not as complicated as the revision of `<moveLink>`. We thus assume that the conversion of the specifications for other entity and link structures in the first edition into those of its revised edition can be achieved relatively easily.

## Acknowledgements

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[15] `motionSignalID` is not translated.

[16] See Lee (2015), Hao et al. (2017), and Hao et al. (2018).

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