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Title: **Report of CE on Semantic DS**
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1 Introduction

The Semantic DS allows describing the world depicted by the AV content and interpreting that world, i.e., the "about" of the AV content or depicted narrative reality, which sometimes is imaginary. This document reports on the core experiment on the Semantic DS [6]. The CE originally started at the Maui meeting in December 1999 [3]. Progress reports of the CE were provided at the Geneva meeting [1] and at the Beijing meeting [2]. In Beijing, some components of the Semantic DS were promoted to the XM: Semantic DS, Object DS, PersonObject DS, Event DS, State DS, MediaOccurrence DS, SemanticTime DS, SemanticLocation DS, UsageLabel D, and some semantic relations.

The main tasks of this core experiment have been the following:

1) To refine the specification of the Semantic DS by solving identified issues,
2) To define the Conceptual DSs,
3) To recommend the standardization of more semantic relations,
4) To investigate the use of membership functions to describe the strength of relations,
5) To generate simple and complex semantic descriptions of multimedia material,
6) To implement a retrieval and browsing application/s that uses the generated descriptions and that shows the functionality of the UsageLabel D, the Conceptual DSs, the State DS, and membership functions for relations, especially,
7) To recommend changes and additions to the Semantic DS based on the results of the experiment.

The retrieval application that the CE has accomplished two objectives: (1) to show the utility of the components of the Semantic DS in a retrieval scenario, and (2) to be the software for the MPEG-7 XM platform.

2 Work Plan

The experiment started after the Beijing meeting in July 2000 and has generated a report of results at the La Baule meeting in October 2000. The experiment has also provided the software for XM integration.

2.1 Parties

The participants of this core experiment are listed in the following table.

Name	Company
Ana Benitez	Columbia University, USA
Hawley Rising	Sony, USA
Corinne Joergensen	Univ. at Buffalo, State Univ. of New York, USA
Riccardo Leonardi, Alessandro Bugatti	Univ. of Brescia, Italy
Koiti Hasida	Electrotechnical Lab, Japan

2.2 Context

The context of the experiment is a retrieval application of multimedia material based on associated semantic descriptions.

2.3 Input

The input material of this core experiment is multimedia material from the MPEG-7 content set and preexisting textual descriptions of this or other multimedia material.

The multimedia material for the experiment will be selected from the following MPEG-7 content:

1) CD 14, CD 18, CD 20, CD 28: Sporting event videos
2) CD 14, CD 15: News videos
3) CD 28: Documentaries
4) Melbourne Photo Database (http://www.cre.canon.co.uk/mpeg7/melbourne_photo_database.htm)

2.4 Output

The output of this core experiment has been a refined and more complete specification of the Semantic DS (in particular, the Conceptual DSs), and an application/s that retrieves and browses multimedia material based on semantic descriptions. The retrieval application has demonstrated the functionality of the components of the Semantic DS in a retrieval and browsing scenario.

Some of the identified initial issues in the specification of the Semantic DS are listed below:

- Whether object and event should be derived from a common root type.
- The definition of the Conceptual DSs (Abstraction, MediaAbstraction, Abstract, and Property).
- The specification of normative relations among semantic entities.
- How to describe the strength of relations using membership relations and states.

2.5 Measurement

The experiment has demonstrated the descriptive power of the Semantic DS to express preexisting textual descriptions and to encode new descriptions of multimedia material. The experiment has tried to find descriptions that could not be expressed using the current Semantic DS as an indication of the limit of its descriptive power. The experiment has also demonstrated the functionality provided by the components of the Semantic DS in a retrieval and browsing scenario.

2.6 Breakdown of Tasks

The tasks to be accomplished by this core experiment can be broken down into the following:

1) Refinement of the specification of the Semantic DS by solving identified issues.
2) Definition of the Conceptual DSs.
3) Define how to use of memberships functions and states within the Graph DS to describe changing strength of relations.
4) Investigate the methodology to evaluate the use of membership functions to describe changing weights of relations and determine any measures that could be used to demonstrate the added functionality (e.g. descriptive power, compactness, and usability).
5) Recommendations to standardize a set of relations among semantic entities. The relations identified by the CE on Structured Textual Description [7] will be a good starting point for this work.
6) Selection and description of suitable image, video, and audio material from the MPEG-7 content set.
7) Selection of preexisting textual descriptions for multimedia material.
8) Generation of XML descriptions for the selected content and preexisting descriptions instantiating the Semantic DS. These descriptions should be shared among all the participants.
9) Implementation of a retrieval application that uses the XML descriptions.
10) Implementation of a browsing application (maybe in combination with retrieval applications) that uses the descriptions of membership functions and states to browse multimedia material.
11) Assess the functionality of the Semantic DS in a retrieval application. In special, the utility of the UsageLabel D, the State DS, the Conceptual DSs, and membership functions for relations should be demonstrated to justify their presence or introduction in the MDS XM. The retrieval application will make use of an existing ontology, for example, WordNet.
12) Recommendations to change and extend the Semantic DS based on the results of the experiment.
13) Report of the results of the core experiment.

2.7 Time Table

The time table for this core experiments is shown in the following table.

<table>
<tr><th>July 30, 2000</th><th>August 30, 2000</th><th>October 15, 2000</th></tr>
<tr><td>Select multimedia material and preexisting description of multimedia material
Define Conceptual DSs
Define the use of membership functions to describe strength of relations</td><td colspan="2"></td></tr>
<tr><td colspan="2">Refine specification of Semantic DS
Recommend to standardize relations among semantic entities
Generate XML description of multimedia material or encode preexisting descriptions using Semantic DS
Implement retrieval and browsing application</td><td></td></tr>
<tr><td colspan="2"></td><td>Show the functionality of the Semantic DS and components in retrieval scenario
Report of results of the experiment</td></tr>
</table>

2.8 Monitoring

The core experiment has been monitored by the Ad Hoc Group on MPEG-7 MDS Core Experiments.

3 Experiment Results

This section reports on the results of the CE on the Semantic DS since the Beijing meeting: a refined and more complete specification of the Semantic DS, example descriptions of the Semantic DS, and the implementation of two applications that retrieve and browse multimedia material based on semantic descriptions.

3.1 Specification of the Semantic DS

The specification of the Semantic has been refined and further completed since the Beijing meeting. The updated syntax, semantic, and some examples of the Semantic DS and its components are included in Annex A. The major changes with respect the output of the Beijing meeting are the following:

- Addition of semantic root type, SemanticEntity DS, that defines the common elements and attributes of the basic semantic description elements such as the Object DS, the Event DS, the SemanticState DS, the Concept DS, etc.
- The SemanticTime DS and the LocationObject DS has been made stand alone entities derived from SemanticEntity DSs too. The Location Object DS has been derived by extension from Object DS to include the Place DS.
- Regarding the Conceptual DSs, definition of the Properties DS, the Concept DS, and the UsageLabel D. The Properties DS is a list of qualities of a semantic entity. The Concept DS represents a non-perceivable entity result of the interpreation of one or more objects and events. The UsageLabel D allows describing the level of abstraction of semantic entity descriptions.
- Specification of relations between semantic entities and between semantic entities and segment entities. In particular, general relations among semantic entities, object/event relations, event/event relations, time/event relations, and semantic/segment reatlions are being recommended for standardization.
- Addition of an attribute to MediaOccurrence DS to distinguish between perceivable (e.g. picture that shows Bill Clinton) and symbolic (e.g., picture whose theme is Bill Clinto but he does not appear in the picture) occurrences of objects, events, and concepts in the media.

- Description of the strength of relations using using membership functions, relations, the Semantic State DS, and the Properties DS.

3.2 Examples of the Semantic DS

Several examples instantiating the Semantic DS and its components were generated during this CE. These can be found in the example section of Annex A and in Annex B. Several open issues raised from generating these examples. These and other issues pointed out by several reviewers are included in Annex C.

Four video shots were selected from the soccer game of the video program in CD 18 and semantic descriptions were generated for them. The semantic descriptions of these video shots, which are included in Annex B, exemplify the instantiation of the following components of the Semantic DS: Semantic DS, Object DS, PersonObject DS, LocationObject DS, Event DS, SemanticTime DS, MediaOccurrence DS, SemanticGraph DS, object/event relations, and event/event relations. In Annex B, there is also a description of an imaginary love scene between two lovers that instantiates the same Semantic DSs. An example on how to describe the strength of relations using membership functions and the SemanticState DS is included in Annex B too.

Examples that instantiate the other parts of the Semantic DS such as the SemanticState DS, the Properties DS, the Concept DS, and the UsageLabel DS were also generated during this experiment. These have been included in the example sections of the corresponding DSs in Annex A.

3.3 Demonstrations of the Semantic DS

Two applications demostrating the usage of the Semantic DS have been implemented during this CE. The first application is an application that allows user to retrieve multimedia material based on semantic descriptions. This application was developed within the MPEG-7 XM platform. The second application is an application that allows used to browse multimedia material based on instantiations of membership functions and the SemanticState DS. This application also demonstrates the usage of relation rules.

3.3.1 Retrieval Application based on Semantic Descriptions for the MPEG-7 XM Platforms

The software provided for the MPEG-7 XM platform was written to formulate queries and responses using the Semantic DS. First, query semantic entity descriptions are matched to semantic entity description of the same type in the DB by matching the keywords of the Label field. Then, the relations between semantic entities specified in the query are matched to the relations between semantic entities for the descriptions in the DB. A ranked list of matching semantic descriptions is returned using the following criteria.

In matching the Label descriptions for two semantic entities, the following stop words and symbols are removed: “.”, “:”, “;”, “,”, “(“, “)”, “/”, “the”, “and”, “of”, “on”, “in”, “with”, “without”, “'s”, “at”, “as”, “from”, “to”, and “only”. Then, the keywords in the query Label description are compared to the ones in the database as follows.

Query Label String Q: keywordQ1, keywordQ2, keywordQ3, …, keywordQn
Matching Label String M: keywordM1, keywordM2, keywordM3, …, keywordMm

There are several possibilities:

(1) Strings M and Q are of the same length
(2) String M is longer than string Q
(3) String Q is longer than string M
(4) All of the keywords in Q are in M
(5) Only some of the keywords in Q are in M

To account for these possibilities in a simple way, the following score is assigned to matching strings:

distance (Q, M) = Match(Q,M) / max(Size(Q), Size(M))

where Size(Q) = Number of keyword in String Q,
Match(Q, M) = Number of common keyworld in Q and M, and
max(a, b) = a > b ? a : b;

[Matching a group of semantic entities to another group of semantic entities and matching semantic relations among semantic entities is still work in progress]

The program is executed by running the following command:

```
XMWinExe.exe -a SemanticClient -l sem_infiles.txt -b Semantic.xml -q sem.xml -n 4
```

The format of this command is as follows:

XMWinExe.exe	-a	application_name (always SemanticClient for this code)
	-l	database_name
	-b	name_of_elements_in_DB
	-q	query_description
	-n	number_of_retrieved_results

The following files are used:

- sym_infiles.txt contains the names of the directories in which the semantic descriptions in the DB can be found. The format of the content of this file is as follows:

  ```
  ../../inputdata/Semnatic/semantic1
  ../../inputdata/Semantic/semantic2
  ../../inputdata/Semantic/semantic3
  ../../inputdata/Semantic/semantic4
  ```

  Which means that the semantic descriptions in the DB have the following paths when combined with the name of the elements in the database provided in the command above:

  ```
  ../../inputdata/Semnatic/semantic1.dir/Semantic.xml
  ../../inputdata/Semantic/semantic2.dir/Semantic.xml
  ../../inputdata/Semantic/semantic3.dir/Semantic.xml
  ../../inputdata/Semantic/semantic4.dir/Semantic.xml
  ```

- The descriptions in the DB and the query description (sem.xml) have the format outlined by the examples in section 6.1. Only the FreeTerm form of the Label field is supported at the moment.

3.3.2 Browsing Application based on Membership Functions, Semantic States, and Relation Rules

[Work in progress]

3.4 Conclusions

3.5 Summary of Results

This experiment has validated the different aspects of the Semantic DS. The results of the different part of the experiment follow:

- Refined and more complete specification of the Semantic DS and its components.
- Instantiations of the Semantic DS and its components.
- Two demonstrations of the usage of semantic descriptions of multimedia content: a retrieval application for the MEPG-7 XM platform and a browsing application.

3.6 Recommendations

The recommendations of this CE are the following:

- Promotion of the Semantic DS, SemanticEntity DS, Event DS, Object DSs, SemanticTime DS, MediaOccurrence DS, and the semantic relations because software for the XM has been provided by the experiment.
- Promotion of SemanticState DS, Properties DS, Concept DS, UsageLabel D, and membership functions to XM.
- That the MediaLocator DS supports the localization of a spatial and spatio-temporal regions in multimedia content.

3.7 Open Issues and Future Work

Some open issues on the specification of the Semantic DS is include in Annex A. The main remaining issues are the following:

- Improve definition of perceivable and abstract object/scenes and concepts. Clearly detailing what exist in the narrative world and how it is perceived in or interpret from the media.
- Definition of media occurrence as stand alone
- Description of connotations of AV content using the Semantic DS, which is partly supported by Concept DS
- Clearly differenciate between State DS and the Properties DS

4 References

[1] AHG on MPEG-7 Semantic information representation, "Report of the CE on the Semantic DS", ISO/IEC JTC1/SC29/WG11 MPEG00/M6062, Geneva, Switzerland, May/June 2000.

[2] Alessandro Bugatti, Ana Benitez, Rajiv Mehrotra, Koiti Hasida, Hawley Rising, Corinne Joergensen, Riccardo Leonardi, Ed Hartley, Murat Tekalp, "Report of CE on Semantic DS", ISO/IEC JTC1/SC29/WG11 MPEG00/M6355, Beijing, July 2000.

[3] MDS Group, "Core Experiment on the Semantic DS", ISO/IEC JTC1/SC29/WG11 MPEG99/N3123, Maui, Hawaii, December 1999.

[4] MDS Group, "Workplan for CE on Semantic DS", ISO/IEC JTC1/SC29/WG11 MPEG00/N3263, Noordwijkerhout, The Netherlands, March 2000.

[5] MDS Group, "Workplan for CE on Semantic DS", ISO/IEC JTC1/SC29/WG11 MPEG00/N3424, Geneva, Switzerland, May/June, 2000.

[6] MDS Group, "Workplan for CE on Semantic DS", ISO/IEC JTC1/SC29/WG11 MPEG00/N3474, Beijing, China, July, 2000.

[7] Masahiro Shibata, Audrey Tam, Clement Leung, Koiti Hasida, Ana Benitez, Alejandro Jaimes, "Report of CE on Structured Textual Description", ISO/IEC JTC1/SC29/WG11 MPEG00/M6240, Beijing, July 2000.

5 Annex A: Specification of Semantic DS

This section specifies the tools to describe the semantics of AV content. The main semantic description tools are the Semantic DS, the Semantic Entity DSs, semantic feature Ds/DSs, and semantic relations. These are defined in the following table. Figure 1 shows some of the relationship between the semantic description tools.

Name	*Definition*
Semantic DS	Allows representing the world depicted by AV content such as an image or a video segment as a set of semantic entities and relations among them.
SemanticEntity DSs	Allows representing entities that exist or take place in the narrative world – perceivable entities-, and abstractions, attributes, and interpretations of the perceivable entities. Objects, person objects, location, objects, events, properties, concepts, semantic states, and semantic times are types of semantic entities.
Semanticfeature DSs/Ds	Allows representing features of the semantic entities such as the UsageLabel D and the MediaOccurrence DS. The UsageLabel D specifies the level abstraction of a segment entity description. The MediaOccurrence DS describes the appearance in the media of a semantic entity.
Semantic Relations	Allows representing semantic relations among semantic entities. Some relations between segments and semantic entities are also defined.

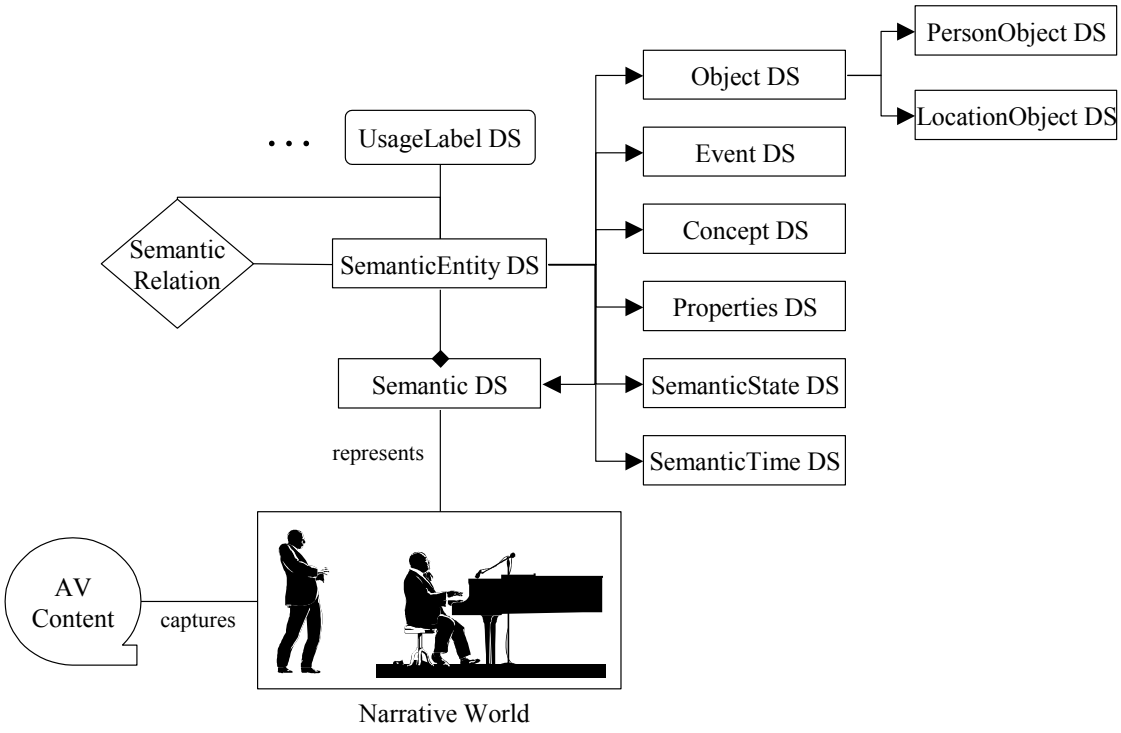

Figure 1: Relation among semantic description tools.

5.1 Semantic DS

The Semantic DS allows describing the world depicted by the AV content and interpreting that world, i.e., the "about" of the AV content or depicted narrative reality, which sometimes is imaginary. The Semantic DS is a

specialized type of SemanticEntity DS representing the four dimensional spatio-temporal world that AV content depicts, including objects and events that exist or take place in within that world.

5.1.1 Semantic DS Syntax

```
<!-- ################################################ -->
<!-- Definition of Semantic DS                        -->
<!-- ################################################ -->

<element name="Semantic" type="mpeg7:SemanticType"
         equivClass="mpeg7:SemanticEntity"/>
<complexType name="SemanticType" base="SemanticEntityType"
             derivedBy="extension">
      <element ref="mpeg7:SemanticEntity"
               minOccurs="0" maxOccurs="unbounded"/>
      <element name="SemanticGraph" type="mpeg7:GraphType"
               minOccurs="0" maxOccurs="unbounded"/>
      <element name="Graph" type="mpeg7:GraphType"
               minOccurs="0" maxOccurs="unbounded"/>
</complexType>
```

5.1.2 Semantic DS Semantics

The Semantic DS inherits all the elements and attributes from the SemanticEntity DS with the same syntax and semantics.

Name	*Definition*
Semantic	World depicted by AV content such as an image or a video segment. The term narrative world is used to refer to this world.
SemanticEntity	Semantic entities that exist or take place in the narrative world – perceivable entities, or abstractions, attributes, and connotations of the perceivable entities.
SemanticGraph	Graph structure describing semantic relations among semantic entities such as objects and events in this and other narrative worlds described by the Semantic DSs.
Graph	Graph structure describing relations among the semantic entities in the world and other content description elements such as audio segments and images.

5.2 Semantic Entities

This section describes DSs that represent semantic entities that exist or take place in the world depicted by AV content – perceivable entities-, or abstractions, attributes, and interpretations of perceivable entities. The SemanticEntity DS represents any semantic entity defines the common properties of the specialized SemanticEntity DSs, which are listed and defined in the following table (except for the Semantic DS). The relations among the specialized SemanticEntity DSs and examples of semantic entities are shown in Figure 2.

SemanticEntity DS	*Definition*
Object DS	Allows representing an entity that exists in the narrative world with temporal and spatial extent – perceivable object (e.g. Tom's piano)-, or an abstraction of a perceivable object – abstract object (e.g., any piano). Abstraction is the process of disassociating an object from any specific instances of the object in the world.
PersonObject DS	Allows representing an object that is a person – an individual, an organization, or a group of people (e.g. Tom Daniels).
LocationObject DS	Allows representing an object that is a location (e.g., Carniege Hall).
Event DS	Allows representing a dynamic relation involving one or more objects occurring in a region in time and space of the narrative world – perceivable event (e.g., Tom playing the piano) -, or an abstraction of a perceivable event – abstract event (e.g., anyone playing the piano). An event

SemanticEntity DS	*Definition*
	represents a change in the (combined) state for one or more objects.
Concept DS	Allows representing a non-perceivable entity result of the interpretation or connotation of one or more objects and events in the narrative world (e.g. harmony and freedom). A concept is usually represented by a group of objects and events, metaphor and abstractions, and blending of several abstract concepts together. They can also usually be described as a collection of properties. An object can also act as the interpretation or connotation of perceivable entities (e.g., Tom playing the piano in memory of his tutor Jim Higgins). This object is different from concept in that it has the capability of being perceived in the world.
Properties DS	Allows representing qualities associated with a semantic entity (e.g. short/tall).
SemanticState DS	Allows representing semantic attributes of a semantic entity at a given time or spatial location in the narrative world, or in a given location in the media (e.g. height and weight).
SemanticTime DS	Allows representing time in the narrative world (e.g., 7pm-8pm, on October 14, 1998).

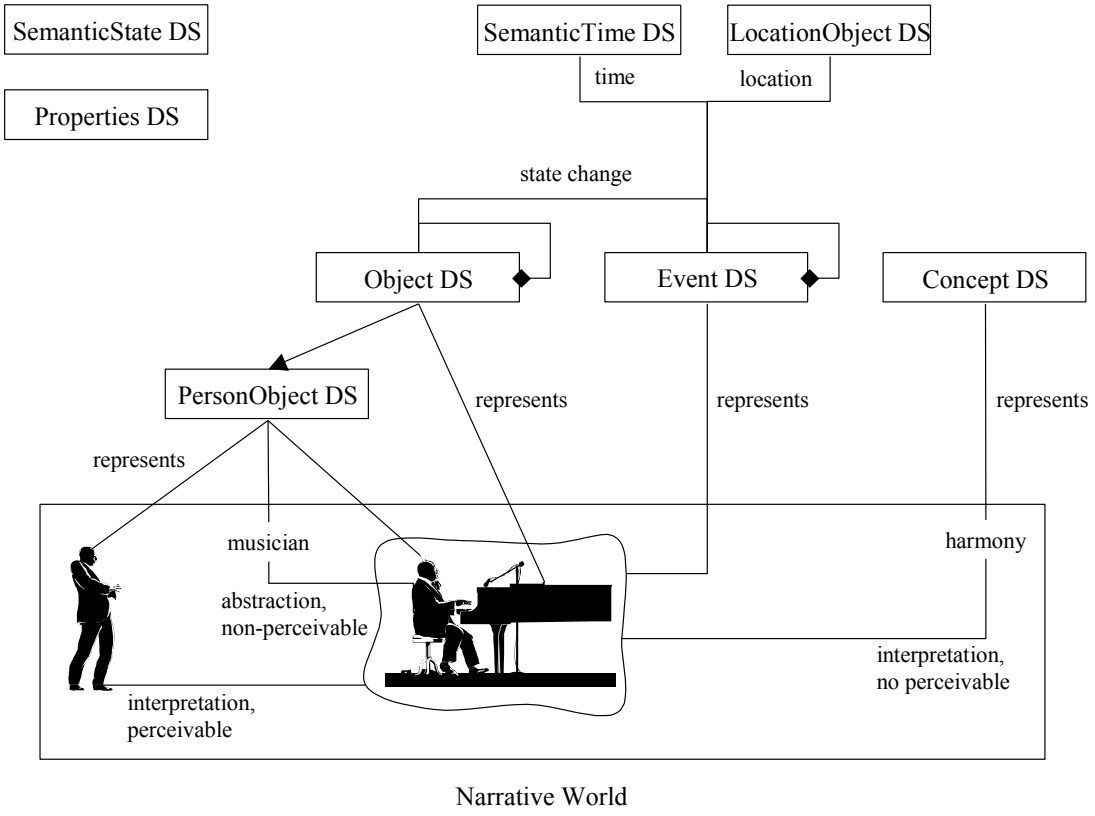

Figure 2: Relations among specialized Semantic DSs and examples of semantic entities.

5.2.1 SemanticEntity DS

The SemanticEntity DS allows representing semantic entities that exist or take place in the world depicted by AV content – perceivable entities-, or abstractions, attributes, and interpretations of perceivable entities. Its role is to define the common properties of the specialized DSs: Semantic DS, Event DS, Object DS, ObjectPerson DS, ObjectLocation DS, Concept DS, Properties DS, SemanticState DS, and SemanticTime DS. References to instances of the SemanticEntity DSs can be described using the SemanticEntityRef DS.

A semantic entity could be either perceivable or abstract. A perceivable semantic entity is one which represents one or more specific instances in the world or the media. An abstract semantic entity is created from a concrete semantic entity by abstraction, that is, by replacing one or more attributes of the semantic entity by variables. The UsageLabel D indicated if abstraction has been performed (see section 5.3.2 on UsageLabel D).

5.2.1.1 SemanticEntity DS Syntax

```
      <!-- ################################################ -->
      <!-- Definition of SemanticEntity DS                  -->
      <!-- ################################################ -->

      <element name="SemanticEntity" type="mpeg7:SemanticEntityType"/>
      <complexType name="SemanticEntityType">
            <element name="UsageLabel" type="mpeg7:UsageLabelType"
                     minOccurs="0" maxOccurs="1"/>
            <element name="Label" type="mpeg7:TermType"
                     minOccurs="1" maxOccurs="unbounded"/>
            <element name="Definition" type="mpeg7:TextAnnotationType"
                     minOccurs="0" maxOccurs="1"/>
            <element                              name="SemanticRelationLink"
type="mpeg7:RelationLinkType"
                     minOccurs="0" maxOccurs="unbounded"/>
            <element name="RelationLink" type="mpeg7:RelationLinkType"
                     minOccurs="0" maxOccurs="unbounded"/>
            <attribute name="id" type="ID" use="required"/>
      </complexType>


      <!-- ################################################ -->
      <!-- Definition of SemanticEntityRef DS               -->
      <!-- ################################################ -->

      <element name="SemanticEntityRef"
type="mpeg7:SemanticEntityRefType"/>
      <complexType name="SemanticEntityRefType" base="mpeg7:ReferenceType"
                   derivedBy="restriction">
            <attribute name="idref" type="IDREF"
                       refEltName=" mpeg7:SemanticEntity"/>
      </complexType>
```

5.2.1.2 SemanticEntity DS Semantics

Semantics of the SemanticEntity DS:

Name	*Definition*
SemanticEntity	Entity that exists or takes place in the world depicted by AV content.
id	Unique identifier of an instantiation of the SemanticEntity DS.
UsageLabel	Indication of the kind of abstraction performed in an instantiation of the SemanticEntity DS. The UsageLabel D is optional. When it is not present, then the description is concrete and references the AV content. If it is present, some kind of abstraction has been performed (see section 5.3.2 on UsageLabel D).
Label	Term descriptor identifying the type of the semantic entity.
Definition	Text annotation describing the semantic entity.
SemanticRelationLink	Relation link describing a relation between the semantic entity and other semantic entities.
RelationLink	Relation link describing a relation between the semantic entity and other content description entities such as still regions and video programs.

Semantics of the SemanticEntity DS:

Name	*Definition*
SemanticEntityRef	Reference to an instance of the SemanticEntity DS.

The label is what is known in Library and Information Science as a "descriptor" or "index term". It is a type used for classifying or retrieving the semantic entity. A semantic entity can have multiple labels, one for each “index term”. The labels can be used to retrieve all the semantic entities sharing the same label(s).

5.2.1.3 SemanticEntity DS Examples (Informative)

The example below describe a semantic entity “apple”

```
<SemanticEntity id="apple">
      <Label>
            <FreeTerm> Apple </FreeTerm>
      </Label>
      <Definition>
            <FreeText>
                  The fleshy usually rounded and red, yellow, or green
edible pome fruit of a tree (genus Malus) of the rose family
            </FreeText>
      </Definition>
</SemanticEntity>
```

5.2.2 Object DS

The Object DS allows describing a perceivable or abstract object. A perceivable object is an entity that exists in the narrative world with temporal and spatial extent – perceivable object (e.g. Tom Daniels). An abstract object is the result of applying abstraction to a perceivable object (e.g. any man). Abstraction is the process of disassociating an object from any specific instances of the object in the world. Essentially, this generates a template of the object in question.

5.2.2.1 Object DS Syntax

```
      <!-- ################################################ -->
      <!-- Definition of Object DS                        -->
      <!-- ################################################ -->

      <element name="Object" type="mpeg7:ObjectType"
               equivClass=“mpeg7:SemanticEntity”/>
      <complexType name="ObjectType" base=”mpeg7:SemanticEntityType”
                   derivedBy=”extension”>
            <element                                  name="MediaOccurrence"
type="mpeg7:MediaOccurrenceType"
                     minOccurs="0" maxOccurs="unbounded"/>
            <element            ref="mpeg7:Object"            minOccurs="0"
maxOccurs="unbounded"/>
      </complexType>
```

5.2.2.2 Object DS Semantics

The Object DS inherits all the elements and attributes from the SemanticEntity DS with the same syntax and semantics.

Name	*Definition*
Object	Entity that exists in the narrative world with temporal and spatial extent – perceivable object (e.g. Tom’s piano)-, or an abstraction of a perceivable object – abstract object (e.g. any piano).
MediaOccurrence	Field specifying the segment of media being described with a media locator and/or a set of

Name	*Definition*
	descriptor values. If the description requires more information, the object can be linked to a segment using the represents/isRepresentedBy relation (see section 5.3.1 on MediaOccurrence DS and section on segment relation of the MDS WD).
Object	Objects resulting from the decomposition of the parent object. The Object DS can be recursive. The decomposition of an object into sub-objects could be a component decomposition (e.g. table/leg), a substance decomposition, (e.g. martini/gin), or a member decomposition (e.g. fleet/ship). The object recursion allows forming sets of objects to use them as semantic units.

The object recursion specified in Object is specifically to support convenient matching with a region tree in the Segment DSs. Object decomposition in trees is not the only way to create new objects. The graph could be used to represent lattices to create new objects.

5.2.2.3 Object DS Examples (Informative)

The example below describes a table object that is decomposed into one tabletop object and four leg objects, i.e., a component type of decomposition. The table is depicted in an image. The value of the color histogram is provided for the image using the MediaOccurrence DS.

```
<Object id="table-object">
      <Label>
            <FreeTerm/>
                  <Label> Table </Label>
            </FreeTerm>
      </Label>
      <Definition>
            <FreeText xml:lang="en-us">
                  Piece of furniture consisting of a smooth flat slab
                  fixed on legs
            </FreeText>
      </Definition>
      <MediaOccurrence>
            <MediaLocator>
                  <MediaURI> http://www.table.gif </MediaURI>
            <MediaLocator>
            <Descriptor size="1">
                  <ElementDescriptorValue>
4617 11986 938 2628 458 1463 5178 2258 444 134 69 456 9300 2810 121 21 14
18 48 107 277 53 47 1926 8281 793 38 11 0 5 201 28 0 1 1 2 23 252 122 6 3
433 1517 46 1 1 0 0 0 0 0 0 0 0 2 55 13560 3326 678 221 1610 5602 916 32 8
1 21 58 11 1 0 0 2 61 331 179 14 7 2388 6213 51 0 0 0 0 0 0 0 0 0 2 337
243 0 0 220 194 0 0 0 0 0 0 0 0 0 0 0 383 3172 1072 51 20 91 128 0 0 0 0
0 2 4 0 0 0 0 89 757 694 0 0 217 39 0 0 0 0 0 0 0 0 0 0 0 912 210 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0 0 55
                  </ElementDescriptorValue>
                  <DescriptorName> ColorHistogram </DescriptorName>
            </Descriptor>
      </MediaOccurrence>
      <Object id=”tabletop-object”>
            <Label> <FreeTerm> Table top </FreeTerm> </Label>
      </Object>
      <Object id=”Leg1-object”>
            <Label> <FreeTerm> Leg </FreeTerm> </Label>
      </Object>
      <Object id=”Leg2-object”>
            <Label> <FreeTerm> Leg </FreeTerm> </Label>
      </Object>
      <Object id=”Leg3-object”>
```

```
            <Label> <FreeTerm> Leg </FreeTerm> </Label>
      </Object>
      <Object id=”Leg4-object”>
            <Label> <FreeTerm> Leg </FreeTerm> </Label>
      </Object>
</Object>
```

The example below describes a fleet that is decomposed into different three ships, i.e., a membership type of decomposition.

```
<Object id="fleet-object">
      <Label>
            <FreeTerm/>
                  <Label> Fleet </Label>
            </FreeTerm>
      </Label>

      <Object id=”ship1-object”>
            <Label> <FreeTerm> Ship “Von Vogage” </FreeTerm> </Label>
      </Object>
      <Object id=”ship2-object”>
            <Label> <FreeTerm> Ship “La Sirena” </FreeTerm> </Label>
      </Object>
      <Object id=”ship3-object”>
            <Label> <FreeTerm> Ship “The Winner“</FreeTerm> </Label>
      </Object>
</Object>
```

5.2.3 PersonObject DS

The PersonObject DS is a specialized Object DS representing an individual, an organization (e.g. company), or a group of people (e.g. soccer team). It encapsulates the Person DS within the Object DS.

5.2.3.1 PersonObject DS Syntax

```
      <!-- ################################################ -->
      <!-- Definition of PersonObject DS                    -->
      <!-- ################################################ -->

      <element name="PersonObject" type="mpeg7:PersonObjectType"
               equivClass=“mpeg7:Object"/>
      <complexType name="PersonObjectType" base="mpeg7:ObjectType"
                   derivedBy="extension">
            <element name="Person" type="mpeg7:PersonType"
                     minOccurs=”1” maxOccurs=”1”/>
      </complexType>
```

5.2.3.2 PersonObject DS Semantics

The PersonObject DS inherits all the elements and attributes from the Object DS with the same syntax and semantics.

Name	*Definition*
PersonObject	Object that is an individual, an organization, or a group of people.
Person	Person described by the object.

5.2.3.3 PersonObject DS Examples (Informative)

The example below describes a person who is a Spanish soccer player named Javier Morientes. Javier Morientes is the agent of the goal event whose description is in the section on Event DS Examples.

```
<PersonObject id="Morientes-object">
      <Label>
            <ControlledTerm CSLocation="http://www.CSs.com/Sports"
                        CSTermId="60">
                  <Label xml:lang="en-us"> Soccer player </Label>
            </ControlledTerm>
      </Label>
      <Definition>
            <FreeText xml:lang="en-us">
                  Spanish soccer player named Javier Morientes
            </FreeText>
      </Definition>
      <SemanticRelationLink name="agentOf" target="Goal-event"/>
      <Person xsi:type="Individual">
            <Name>
                  <GivenName> Javier </GivenName>
                  <FamilyName> Morientes </FamilyName>
            </Name>
      </Person>
</PersonObject>
```

5.2.4 LocationObject DS

The LocationObject DS is a specialized Object DS representing a location. It encapsulates the Place DS within the Object DS. There are two ways to use the LocationObject DS. First, a location, specified by filling the fields of the Place DS can be given. Second, if the description of the location is complex, semantic relation links are provided to relate the location object to the other semantic entities such as objects and events needed to fully describe it. For example, the location "at the Eiffel Tower in the same spot where we were engaged last year" requires a location object to give the Eiffel Tower, an event representing the engagement, a semantic time specifying "last year", a semantic relation "locationOf" from the location object to the engagement event, and a semantic relation "timeOf" from the semantic time to the engagement event.

5.2.4.1 LocationObject DS Syntax

```
      <!-- ################################################ -->
      <!-- Definition of LocationObject DS                  -->
      <!-- ################################################ -->

      <element name="LocationObject" type="mpeg7:LocationObjectType"
               equivClass="mpeg7:Object">
      <complexType                                  name="LocationObjectType"
base="mpeg7:SemanticEntityType"
                  derivedBy="extension">
            <element name="Place" type="mpeg7:PlaceType"
                     minOccurs="0" maxOccurs="1"/>
      </complexType>
```

5.2.4.2 LocationObject DS Semantics

The LocationObject DS inherits all the elements and attributes from the Object DS with the same syntax and semantics.

Name	*Definition*
LocationObject	Object that is a location.
Place	Place represented by the object.

5.2.4.3 LocationObject DS Examples (Informative)

The example below describes a soccer stadium in Spain.

```
<LocationObject id="stadium-location">
      <Label>
            <FreeText> Soccer stadium </FreeText>
      </Label>
      <Place>
            <Name xml:lang='en'> Santiago Bernabeu </Name>
            <Planet> Earth </Planet>
            <Country> Spain </Country>
            <PostalAddress>
                  <AddressLine>
                        C/Fabregas No. 26, Barcelona
                  </AddressLine>
                  <PostingIdentifier> E-64200 </PostingIdentifier>
            </PostalAddress>
      </Place>
</LocationObject>
```

See below the description of the location "at the Eiffel Tower in the same spot where Cri and Ale were engaged last year". The event "Cri and Ale were engaged last year" is described in the Semantic DS description with id "semantic1". The new location object ("sem2-loc") can be defined as equivalent to the semantic time description of the event "engagement-event" – semantic relation link "equivalentTo" to semantic location "Eiffel-loc" - or as being the time when that event happened – semantic relation link "locationOfInv" (inverse relation to "timeOf") to event "engagement-event".

```
<Semantic id="Semantic2">
      <LocationObject id="sem2-loc">
            <Label> <FreeTerm> Location </FreeTerm> </Label>
            <!--  This is a possibility  -->
            <SemanticRelationLink name="equivalentTo" target="Eiffel-loc"/>
            <!--  This is another  -->
            <SemanticRelationLink name="locationToInv"
                                  target="engagement-event"/>
      </LocationObject>
</Semantic>

<Semantic id="Semantic1">
      <LocationObject id="Eiffel-loc">
            <Label>  <FreeTerm>  Spot  at  the  Eiffel  Tower  </FreeTerm>
</Label>
            <Definition>
                  <FreeText>
                        Near the ticket office at North pillar of Eiffel
Tower
                  </FreeText>
            </Definition>
            <Place>
                  <Planet> Earth </Planet>
                  <Country> France </Country>
            </Place>
      </LocationObject>
```

```
      <Event id="engagement-event">
            <Label>
                  <FreeTerm xml:lang="en-us"> Engagement </FreeTerm>
            </Label>
            <Definition>
                  <FreeText>
                        Engagement of two lovers, Cri and Ale,
                        at the Eiffel Tower in Paris
                  </FreeText>
            </Definition>
            <SemanticRelationLink name="locationOf" target="Eiffel-loc"/>
            <SemanticRelationLink name="timeOf" target="lastyear-time"/>
      </Event>

      <SemanticTime id=”lastyear-time”>
            <Label> <FreeTerm> Last year </FreeTerm> </Label>
            <SemanticRelativeTime TimeOrigin="Now" TimeUnit="Year"
                                  Instant="-1"/>
      </SemanticTime>
</Semantic>
```

5.2.5 Event DS

The Event DS allows describing perceivable and abstract events. A perceivable event is a dynamic relation involving one or more objects occurring in a region in time and space of the narrative world (e.g., Tom playing the piano). An abstract event is the resulting entity of applying abstraction to a perceivable event (e.g., anyone playing the piano). An event represents a change in the (combined) state for one or more objects.

5.2.5.1 Event DS Syntax

```
      <!-- ################################################ -->
      <!-- Definition of Event DS                           -->
      <!-- ################################################ -->

      <element name="Event" type="mpeg7:EventType"
               equivClass=“mpeg7:SemanticEntity”/>
      <complexType name="EventType" base=”mpeg7:SemanticEntityType”
                   derivedBy=”extension”>
            <element                                  name="MediaOccurrence"
type="mpeg7:MediaOccurrenceType"
                     minOccurs="0" maxOccurs="unbounded"/>
            <element             ref="mpeg7:Event"             minOccurs="0"
maxOccurs="unbounded"/>
      </complexType>
```

5.2.5.2 Event DS Semantics

The Event DS inherits all the elements and attributes from the SemanticEntity DS with the same syntax and semantics.

Name	*Definition*

Name	*Definition*
Event	dynamic relation involving one or more objects occurring in a region in time and space of the narrative world – perceivable event (e.g., Tom playing the piano) -, or an abstraction of a perceivable event – abstract event (e.g., anyone playing the piano). The place where an event takes place can be described by a semantic relation *locationOf* to the ObjectLocation DS representing that place. The time when an event happens can be described by a semantic relation *timeOf* to the SemanticTime DS representing that time.
MediaOccurrence	Field specifying the segment of media being described with a media locator and/or a set of descriptor values. If the description requires more information, the event can be linked to a segment using the represents/isRepresentedBy relation (see section 5.3.1 on MediaOccurrence DS and section on segment relation of the MDS WD).
Event	Events resulting from the decomposition of the parent event. The Event DS can be recursive. The decomposition of an event into sub-event could be a feature/activity decomposition (e.g., paying/shopping).

Events can be recursive because sub-events may not need to be defined outside the parent event. The recursion specified in Event is specifically intended to be used to match the tree structures that occur in Segment. Event decomposition in trees is not the only way to create new events. The graph could be used to represent lattices to create new events.

Events are continuous in the narrative world or semantic time, but not necessarily in the media. They are therefore not persistent, unlike objects. As descriptions, however, they have the same life span as objects, one description of a particular event is sufficient (but not necessary) for one media document, or one collection.

5.2.5.3 Event DS Examples (Informative)

The example below describes the event of a goal in a soccer game. A RelationLink DS is used to describe the goal event as the result of an event representing a play in the soccer game. The goal event is depicted a video segment; this is described with a "isRepresentedBy" relation to the video segment (see definition of "isRepresentedBy" in the MDS WD document).

```
<Event id="Goal-event">
      <Label>
            <ControlledTerm CSLocation="http://www.CSs.com/Sports"
                            CSTermId="43">
                  <Label xml:lang="en-us"> Goal </Label>
            </ControlledTerm>
      </Label>
      <Definition>
            <FreeText xml:lang="en-us">
                  The act or action of causing a ball or puck to go
                  through or into such a goal
            </FreeText>
      </Definition>
      <SemanticRelationLink name="eventResultOf" target="Play-event"/>
      <RelationLink name="isRepresentedBy" target="videosegment"/>
</Event>

<Event id="Play-event">
      <Label>
            <FreeTerm> Soccer play </FreeTerm>
      </Label>
</Event>
```

5.2.6 Properties DS

The Properties DS contains a set of qualities associated with a semantic entity such as an object and a concept. A property corresponds to an essential and peculiar character or inherent feature of an entity. As an example, a banana can have a property of ripeness.

5.2.6.1 Properties DS Syntax

The Properties DS inherits all the elements and attributes from the SemanticEntity DS with the same syntax and semantics.

```
<!-- ################################################ -->
<!-- Definition of Properties D                       -->
<!-- ################################################ -->

<complexType name="Properties" base="mpeg7:SemanticEntityType"
             derivedBy="extension">
      <element name="Property" type="mpeg7:TermType" minOccurs="1"
               maxOccurs="unbounded"/>
</complexType>
```

5.2.6.2 Properties DS Semantics

Name	*Definition*
Properties	Set of qualities associated with a semantic entity.
Property	Quality of semantic entity.

5.2.6.3 Properties DS Examples (Informative)

The example below describes the colors of sunsets using a Properties DS.

```
<Properties id="sunset-pt">
      <Label> <FreeTerm> Sunset color properties </FreeTerm> </Label>
      <Property> <FreeTerm> Blue </FreeTerm> </Property>
      <Property> <FreeTerm> Pink </FreeTerm> </Property>
      <Property> <FreeTerm> Orange </FreeTerm> </Property>
      <Property> <FreeTerm> Yellow </FreeTerm> </Property>
</Properties>
```

5.2.7 Concept DS

The Concept DS allows describing a non-perceivable entity result of the interpretation or connotation of one or more entities in the narrative world (e.g. harmony and freedom). A concept is usually represented by a group of objects and events, with metaphor and abstractions, and blending several abstract concepts together. They can also usually be described as a collection of properties.

5.2.7.1 Concept DS Syntax

```
<!-- ################################################ -->
<!-- Definition of Concept D                          -->
<!-- ################################################ -->

<complexType name="Concept" base="mpeg7:SemanticEntityType"
             derivedBy="extension">
      <element name="Properties" type="mpeg7:PropertiesType"
```

```
                minOccurs="0" maxOccurs="unbounded"/>
      <element name="MediaOccurrence" type="mpeg7:MediaOccurrenceType"
                minOccurs="0" maxOccurs="unbounded"/>
</complexType>
```

5.2.7.2 Concept DS Semantics

The Concept DS inherits all the elements and attributes from the SemanticEntity DS with the same syntax and semantics.

Name	*Definition*
Concept	Non-perceivable entity result of the interpretation or connotation of one or more objects and events in the narrative world.
Properties	Collection of properties used to define the Abstract.
MediaOccurrence	Field specifying the segment of media being described with a media locator and/or a set of descriptor values.

5.2.7.3 Concept DS Examples (Informative)

The example below describes the abstract entity "freedom" as the qualities of being open, outspoken, and frank. The concept description links to an image of the Statue of Liberty that represents "freedom".

```
<Concept id="freedom">
      <Label> <FreeTerm> Freedom </FreeTerm> </Label>
      <Properties>
            <Property> <FreeTerm> Open </FreeTerm> </Property>
            <Property> <FreeTerm> Outspoken </FreeTerm> </Property>
            <Property> <FreeTerm> Frank </FreeTerm> </Property>
      </Properties>
      <MediaOccurrence type="symbol">
            <MediaLocator> <MediaURI>
                  http:://wwww.Statue.Of.Liberty.gif
            </MediaURI> </MediaLocator>
      </MediaOccurrence>
</Concept>
```

The example below describes the abstract entity "happiness" as the qualities of well being, contentment, pleasure, and satisfaction.

```
<Concept id="happiness">
      <Label> <FreeTerm> Happiness </FreeTerm> </Label>
      <Properties>
            <Property> <FreeTerm> Well being </FreeTerm> </Property>
            <Property> <FreeTerm> Contentment </FreeTerm> </Property>
            <Property> <FreeTerm> Pleasure </FreeTerm> </Property>
            <Property> <FreeTerm> Satisfaction </FreeTerm> </Property>
      </Properties>
</Concept>
```

5.2.8 SemanticState DS

The SemanticState DS identifies semantic properties of the entity at a given time, in a given spatial location, or in a given media location (e.g., height and weight). It is a set of numerical and verbal attributes that can be attached to semantic entities such as objects and events and other semantic elements such as semantic relationship graphs.

5.2.8.1 SemanticState DS Syntax

```
      <!-- ################################################ -->
      <!-- Definition of SemanticState DS                   -->
      <!-- ################################################ -->

      <element name="SemanticState" type="mpeg7:SemanticStateType"/>
      <complexType name="SemanticStateType" base="mpeg7:SemanticEntityType"
                   derivedBy="extension">
            <element name="AttributeValuePair"
                     type="mpeg7:AttributeValuePairType"
                     minOccurs="0" maxOccurs="unbounded"/>
            <element ref="mpeg7:SemanticTime" minOccurs="0" maxOccurs="1"/>
            <element       ref="mpeg7:LocationObject"       minOccurs="0"
maxOccurs="1"/>
            <element name="MediaLocator" type="mpeg7:MediaLocatorType"
                     minOccurs="0" maxOccurs="unbounded"/>
      </complexType>

      <complexType name="AttributeValuePairType">
            <element name="Attribute" type="mpeg7:TextualType"
                     minOccurs="1" maxOccurs="1"/>
            <choice minOccurs="1" maxOccurs="1">
                  <element name="BooleanValue" type="boolean"/>
                  <element name="IntegerValue" type="integer"/>
                  <element name="FloatValue" type="float"/>
                  <element name="IntegerVectorValue"
                           type="mpeg7:IntegerVectorType"/>
                  <element name="FloatVectorValue"
                           type="mpeg7:FloatVectorType"/>
                  <element name="IntegerMatrixValue"
                           type="mpeg7:IntegerMatrixType"/>
                  <element name="FloatMatrixValue"
                           type="mpeg7:FloatMatrixType"/>
                  <element name="TextValue" type="mpeg7:TextualType"/>
                  <element name="TextAnnotationValue"
                           type="mpeg7:TextAnnotationType"/>
                  <element name="ControlledTermValue"
                           type="mpeg7:ControlledTermType"/>
            </choice>
      </complexType>
```

Editor's Note: The definition of value elements using <any/> is under investigation.

5.2.8.2 SemanticState DS Semantics

Semantics of the SemanticState DS:

The State DS inherits all the elements and attributes from the SemanticEntity DS with the same syntax and semantics.

Name	*Definition*
SemanticState	Semantic attributes of an entity at a given time or spatial location in the narrative world, or in a given media location.
AttributeValuePair	Description scheme that contains a pair formed by an attribute and a value being the value one of a series of types (e.g. Boolean, integer, real, matrix, string, and controlled text).
SemanticTime	Semantic time information associated with the state.
LocationObject	Semantic location information associated with the state.

Name	*Definition*
MediaLocator	Locator to the portion of media depicting the state.

Semantics of the AttributeValuePair DS:

Name	*Definition*
AttributeValuePair	Description scheme that contains a pair formed by an attribute and a value being the value one of a series of types (e.g. boolean, integer, real, matrix, string, and controlled text).
Attribute	Textual description that specifies the name of the pair's attribute
BolleanValue	Specifies the value of the attribute. The type of the element is Boolean.
IntegerValue	Specifies the value of the attribute. The type of the element is integer.
FloatValue	Specifies the value of the attribute. The type of the element is float.
IntegetVectorValue	Specifies the value of the attribute. The type of the element is integer vector.
FloatVectorValue	Specifies the value of the attribute. The type of the element is float vector.
IntegerMatrixValue	Specifies the value of the attribute. The type of the element is integer matrix.
FloatMatrixValue	Specifies the value of the attribute. The type of the element is float matrix.
TextValue	Specifies the value of the attribute. The type of the element is Text DS.
TextAnnotationValue	Specifies the value of the attribute. The type of the element is TextAnnotation DS.
ControlledTermValue	Specifies the value of the attribute. The type of the element is ControlledTerm DS.

5.2.8.3 SemanticState DS Examples (Informative)

The example below describes a sunset. The sunset is represented by an event; the sunset event is described using a semantic state. As a side note, a sunset is considered as an event because it can be nominalized: "The sunset is beautiful".

```
<Semantic id="state-example">
      <Label> <FreeTerm> Sunset </FreeTerm> </Label>
      <Event id="sunset-event">
            <Label> <FreeTerm> Sunset </FreeTerm> </Label>
            <Definition>
                  <FreeText xml:lang="en-us">
                        Phenomenon of the sun setting down
                  </FreeText>
            </Definition>
      </Event>

      <SemanticState id=”sunset-state”>
            <Label> <FreeTerm> State of sunset </FreeTerm> </Label>
            <AttributeValuePair>
                  <Attribute> Blue </Attribute>
                  <IntegerValue> 90 </Integervalue>
            </AttributeValuePair>
            <AttributeValuePair>
                  <Attribute> Pink </Attribute>
                  <Integervalue> 9 </Integervalue>
            </AttributeValuePair>
            <AttributeValuePair>
                  <Attribute> Orange </Attribute>
                  <Integervalue> 50 </Integervalue>
            </AttributeValuePair>
            <AttributeValuePair>
                  <Attribute> Yellow </Attribute>
                  <Integervalue> 45 </Integervalue>
            </AttributeValuePair>
      </SemanticState>
```

```
      <SemanticGraph>
            <!--  Link sunset and its state  -->
            <Edge name="stateOf"
                  source="sunset-event" target="sunset-state"/>
      </SemanticGraph>
</Semantic>
```

5.2.9 SemanticTime DS

The SemanticTime DS is a specialized SemanticEntity DS representing a time in the narrative world. It encapsulates the Time DS within the SemanticEntity DS. There are two ways to use the SemanticTime DS. First, a time, specified by filling the fields of the Time or the SemanticRelativeTime DS can be given. Second, if the description of the time is complex, relation links are provided to relate the time to the semantic entities such as objects and events needed to fully describe it. For example, the time "in the year 2000 at the same time when the earthquake happened in San Francisco" requires a semantic time to give the year 2000, an event representing the earthquake, a location object describing San Francisco, a semantic relation “timeOf” from the earthquake event to the semantic time, and a semantic relation “locationOf” from the earthquake event to the location object.

5.2.9.1 SemanticTime DS Syntax

```
      <!-- ################################################ -->
      <!-- Definition of SemanticTime DS                    -->
      <!-- ################################################ -->

      <element name="SemanticTime" type="mpeg7:SemanticTimeType"
               equivClass=”mpeg7:SemanticEntity”>
      <complexType name="SemanticTimeType" base=”mpeg7:SemanticEntityType”
                   derivedBy=”extension”>
            <element name="Time" type="mpeg7:TimeType" minOccurs="0"
                     maxOccurs="1"/>
            <element name="SemanticRelativeTime"
                     type="mpeg7:SemanticRelativeTimeType"
                     minOccurs="0" maxOccurs="1"/>
      </complexType>

      <complexType name="SemanticRelativeTimeType">
            <attribute name="TimePoint" type="string" use="required"/>
            <attribute name="Duration" type="string" use=”optional”/>
            <attribute name="TimeOrigin" type="string" use="optional"/>
            <attribute name="TimeUnit" type="string" use="optional"/>
      </complexType>
```

5.2.9.2 SemanticTime DS Semantics

Semantics of the SemanticTime DS:

The SemanticTime DS inherits all the elements and attributes from the SemanticEntity DS with the same syntax and semantics.

Name	*Definition*
SemanticTime	A time in the narrative world.
Time	Field for expressing the time being described.
SemanticRelativeTime	Field for expressing the time with semantic attributes.

Semantics of the SemanticRelativeTime DS:

Name	*Definition*
SemanticRelativeTime	Semantic attributes representing time.
TimePoint	String specifying a point in time in the narrative world. It is a time point defined in semantic terms, e.g., "third week of October 1998". If the TimeOrigin attribute is provided, it specifies a time point that is relative to the time origin. If the TimeUnit attribute is provided, it specifies a time point as the number of time units. It may contain fractions of time units.
Duration	String specifying a temporal duration. If the TimeUnit attribute is provided, it specifies a temporal duration as the number of time units. It may contain fractions of time units.
TimeOrigin	String specifying the time origin. It is a time point defined in semantic terms, e.g., "the day before yesterday".
TimeUnit	String specifying the time unit. It is a time unit defined in semantics terms, e.g., "clock cycle" and “day”.

The free text description of the SemanticTime DS is discouraged because it increases the difficulty of retrieving semantic descriptions based on time information.

5.2.9.3 SemanticTime DS Examples

The example below describes the time “3 minutes starting at 14:13:00 hours, 12 November, 1899”.

```
<SemanticTime id=”3m1899-time”>
      <Label>
            <FreeTerm>
                  3 minutes starting at 14:13:00 hours, 12 November, 1899
            </FreeTerm>
      </Label>
      <Time>
            <TimePoint> 1899-11-12T14:13:00 </TimePoint>
            <Duration> PT3M </Duration>
      </Time>
</SemanticTime>
```

The example below describes the time “last year”.

```
<SemanticTime id=”lastyear-time”>
      <Definition> <FreeText> Last year </FreeText> </Definition>
      <SemanticRelativeTime         TimePoint="-1"         TimeOrigin="Now"
TimeUnit="Year"/>
</SemanticTime>
```

The example below describes the time “the third and fourth day in April”.

```
<SemanticTime id=”lastyear-time”>
      <Definition> <FreeText> Two days in April </FreeText> </Definition>
      <SemanticRelativeTime TimePoint="3” Duration=”2”
                           TimeOrigin="April" TimeUnit="Day"/>
</SemanticTime>
```

Find below the description for the time “in the year 1899 at the same time when the earthquake happened in San Francisco”. The event “Earthquake in San Francisco in 1988” is described in the Semantic DS description with id “semantic2”. The new semantic time (“sem3-time”) can be defined as equivalent to the semantic time description of the event “earthquake-event” – semantic relation link “equivalentTo” to semantic time “3m1899-time” - or as being the time when that event happened – semantic relation link “timeOfInv” (inverse relation of “timeOf”) to event “earthquake-event”.

```
<Semantic id=”semantic1”>
      <SemanticTime id=”sem3-time”>
            <Label> <FreeTerm> Time </FreeTerm> </Label>
            <!—  This is a possibility  -->
            <SemanticRelationLink    name=”equivalentTo”    target=”3m1899-
time”/>
            <!—  This is another  -->
            <SemanticRelationLink name=”timeToInv”
                                    target=”earthquake-event”/>
      </SemanticTime>
</Semantic>

<Semantic id=”semantic2”>
      <SemanticTime id=”3m1899-time”>
            <Label>
                  <FreeTerm>
                        3 minutes starting at 14:13:00 hours, 12 November,
1899
                  </FreeTerm>
            </Label>
            <Time>
                  <TimePoint> 1899-11-12T14:13:00 </TimePoint>
                  <Duration> PT3M </Duration>
            </Time>
      </SemanticTime>

      <Event id="earthquake-event">
            <Label> <FreeTerm> Earthquake </FreeTerm> </Label>
            <Definition>
                  <FreeText>   The   big   earthquake   in   San   Francisco
</FreeText>
            </Definition>
            <SemanticRelationLink name=”timeOf” target="3m1899-time">
            <SemanticRelationLink name="locationOf" target="sanfran-loc"/>
      </Event>

      <LocationObject id="sanfran-loc">
            <Label> <FreeTerm> San Francisco </FreeTerm> </Label>
            <Place>
                  <Name> San Francisco </Name>
                  <Planet> Earth </Planet>
                  <Country> United States of America </Country>
            </Place>
      </LocationObject>
</Semantic>
```

5.3 Semantic Features

This section specifies DSs/Ds that allow representing features of semantic entities and are not defined in other sections of the MDS document. These are summarized in the following table.

Name	*Definition*	*Semantic Entities*
MediaOccurrence DS	Allows representing one appearance of an object or an event in the media.	Object DS and Event DS
UsageLabel D	Allows indicating that abstraction has been performed in a description of a semantic entity.	SemanticEntity DSs

5.3.1 MediaOccurrence DS

The MediaOccurrence DS allows representing one appearance of an object or an event in the media with a media locator and/or a set of descriptor values. The purpose of this description scheme is to provide access to the same media information as the Segment DS, but without the hierarchy and without extra temporal and spatial information. There are some applications for which this information, location in media, and the descriptor values at that location, is sufficient. If the description requires more information or access to the media, it should use the Segment DS instead.

5.3.1.1 MediaOccurrence DS Syntax

```
<!-- ################################################ -->
<!-- Definition of MediaOccurrence DS                 -->
<!-- ################################################ -->

<simpleType name=”mediaOccurrenceType” base=”string”
            derivedBy=”retriction”>
      <enumeration value=”perceivable”/>
      <enumeration value=”symbol”/>
</simpleType>

<complexType name="MediaOccurrenceType">
      <element name=”MediaLocator" type="mpeg7:MediaLocatorType"
               minOccurs="1" maxOccurs="1"/>
      <element                                          name="Descriptor"
type="mpeg7:DescriptorCollectionType"
               minOccurs="0" maxOccurs="1"/>
      <attribute name=”type” type=”mpeg7:mediaOccurrenceType”
                 use=”required” default=”perceivable”/>
</complexType>
```

5.3.1.2 MediaOccurrence DS Semantics

Semantic of the mediaOccurrenceType datatype:

Name	*Definition*
mediaOccurrence Type	Enumeration of the possible types of occurrence in the media of a semantic entity. The possible types are “perceivable” and “symbol”, which are defined as follows: • Perceivable: The semantic entity is perceivable in the media with a spatial and/or temporal extent (e.g., Bill Clinton is perceivable in a picture of him). • Symbol: The semantic entity is symbolized in the media with a spatial and/or temporal extent (e.g., Bill Clinton is a symbol in a news reports about him but that does not show an image of him).

Semantic of the MediaOccurrence DS:

Name	*Definition*
MediaOccurrence	Record of the appearance in the media of a semantic entity.
type	String specifying the type of media occurrence. The possible types of media appearance are “perceivable” and “symbol”, which are defined as follows: • Perceivable: The semantic entity is perceivable in the media with a spatial and/or temporal extent (e.g., Bill Clinton is perceivable in a picture of him). • Symbol: The semantic entity is symbolized in the media with a spatial and/or temporal extend (e.g., Bill Clinton is a symbol in a news reports about him but that does not show an image of him). The default value of this attribute is “perceivable”.
MediaLocator	A locator to the physical instance of the semantic object/event.

Name	*Definition*
Descriptor	A set of descriptors describing the features of the media at the location pointed to by the media locator.

The descriptor field gives properties of the media where it is pointed to by the MediaLocator field. For instance, if it contains a color histogram and shape descriptor, the values in these descriptors are the values in the media at that point. If the locator points, for example, to a part of a scene taking place in a red room, one expects the color histogram values to reflect the red color.

Examples of MediaOccurrenced DS descriptions can be found in the Examples section of the Object DS, the Event DS, and the Concept DS.

Editor's Note: The specification of the MediaOccurrence DS assumes that the MediaLocator (or derived types) are capable of locating still regions and moving regions in audio-visual content. This is currently not implemented in the MDS XM/WD documents.

5.3.2 UsageLabel D

The UsageLabel D allows indicating that some kind of abstraction has been performed in a description. When it is not present in the description, then the description is concrete – it describes the world depicted by AV content and references the AV content (e.g., through a MediaOccurrence DS or a relation to a Segment DS). If it is present in the description, an abstraction is in place - description that contains variables or is a template for other descriptions. The degree or dimension of the abstraction is indicated by the dimension attribute. A dimension of zero indicates a media abstraction, since this is still a specific description but does not reference the media, i.e., the AV content and could be use as a template for other descriptions. A dimension of one indicates a standard abstraction, and can be thought of as a first order lambda abstraction, where one or more attributes of the description have been replaced by a variable in the description. Higher values indicate that it is an abstraction of abstractions usually indicating that the graph relations are the relevant parts of the descriptions.

5.3.2.1 UsageLabel D Syntax

```
<!-- ################################################ -->
<!-- Definition of UsageLabel D                       -->
<!-- ################################################ -->

<complexType name="UsageLabelType">
      <element name="Defines" type="mpeg7:TermType"
               minOccurs="0" maxOccurs="1"/>
      <attribute name="dimension" type="nonNegativeInteger"/>
</complexType>
```

5.3.2.2 UsageLabel D Semantics

Name	*Definition*
UsageLabel	DS indicating the level of abstraction of a description.
dimension	Positive integer giving the level of abstraction of the description that contains it. A value of 0 indicates a media abstraction – no references to the media. A value of 1 indicates a standard abstraction – a description that contains variables. Higher values indicate abstractions of abstractions - the graph relations are the relevant parts of the description.
Defines	Term pointing to the dictionary entry defined by the abstraction.

Editor's Note: Defines field required further work: a justification, improved semantics, and examples.

5.3.2.3 UsageLabel D Examples (Informative)

The example below describes “Jim and Jane know each other and walk to high school together”, the semantics of the first 10 seconds of the movie being described. “Jim”, “Jane”, and “high school” are represented by objects in the Semantic DS descriptions; “know” and “walk” as events. “Jane” and “Jim” appear in the first 10 seconds of the movie; “high school appears at second 8 for 2 seconds; and “know” and “walk” events happen during the 10 first seconds of the movie two. The description below does not contain a UsageLabel D description because it is describing the AV content (see left part of Figure 3).

```
<Semantic id="ConcreteDescription">
      <!--  Description of AV content: no usage label  -->
      <Label> <FreeTerm>
            Jane knows Jim. Jane and Jim walk to high school together.
      </FreeTerm> </Label>
      <PersonObject id="Jane">
            <Label> <FreeTerm> Jane </FreeTerm> </Label>
            <MediaOccurrence>
                  <MediaLocator>
                        <MediaURI> http://www.video.mpg </MediaURI>
                        <MediaTime>
                              <MediaTimePoint> T0:0:0 </MediaTimePoint>
                              <MediaDuration> PT10S </MediaDuration>
                        </MediaTime>
                  </MediaLocator>
            </MediaOccurrence>
            <Person xsi:type="Individual">
                  <Name>
                        <GivenName>Jane</GivenName>
                        <FamilyName>Wood</FamilyName>
                  </Name>
            </Person>
      </PersonObject>
      <PersonObject id="Jim">
            <Label> <FreeTerm> Jim </FreeTerm> </Label>
            <MediaOccurrence>
                  <MediaLocator>
                        <MediaURI> http://www.video.mpg </MediaURI>
                        <MediaTime>
                              <MediaTimePoint> T0:0:0 </MediaTimePoint>
                              <MediaDuration> PT10S </MediaDuration>
                        </MediaTime>
                  </MediaLocator>
            </MediaOccurrence>
            <Person xsi:type="Individual">
                  <Name>
                        <GivenName>Jim</GivenName>
                        <FamilyName>Sky</FamilyName>
                  </Name>
            </Person>
      </PersonObject>
      <Object id="highschool">
            <Label> <FreeTerm> High School </FreeTerm> </Label>
            <MediaOccurrence>
                  <MediaLocator>
                        <MediaURI> http://www.video.mpg </MediaURI>
                        <MediaTime>
                              <MediaTimePoint> T0:0:8 </MediaTimePoint>
                              <MediaDuration> PT2S </MediaDuration>
                        </MediaTime>
                  </MediaLocator>
            </MediaOccurrence>
```

```
      </Object>

      <Event id="know">
            <Label> <FreeTerm> Jane know Jim </FreeTerm> </Label>
            <MediaOccurrence>
                  <MediaLocator>
                        <MediaURI> http://www.video.mpg </MediaURI>
                        <MediaTime>
                              <MediaTimePoint> T0:0:0 </MediaTimePoint>
                              <MediaDuration> PT10S </MediaDuration>
                        </MediaTime>
                  </MediaLocator>
            </MediaOccurrence>
      </Event>
      <Event id="walk">
            <Label> <FreeTerm>
                  Jim and Jane walk to high school together
            </FreeTerm> </Label>
            <MediaOccurrence>
                  <MediaLocator>
                        <MediaURI> http://www.video.mpg </MediaURI>
                        <MediaTime>
                              <MediaTimePoint> T0:0:0 </MediaTimePoint>
                              <MediaDuration> PT10S </MediaDuration>
                        </MediaTime>
                  </MediaLocator>
            </MediaOccurrence>
      </Event>

      <SemanticGraph>
            <!--  Jane knows Jim  -->
            <Edge name="agentOf" source="know" target="jane"/>
            <Edge name="accompanierOf" source="know" target="jim"/>

            <!--  Jane and Jim walk to high school together  -->
            <Edge name="agentOf" source="walk" target="jane"/>
            <Edge name="agentOf" source="walk" target="jim"/>
            <Edge name="destinationOf" source="walk" target="highschool"/>
      </SemanticGraph>
</Semantic>
```

The description below is a media abstraction created from the description above. The links to the media in the description have been removed and a usage label of value zero has been added (see Figure 3). Media abstractions can be used as templates for descriptions of the media.

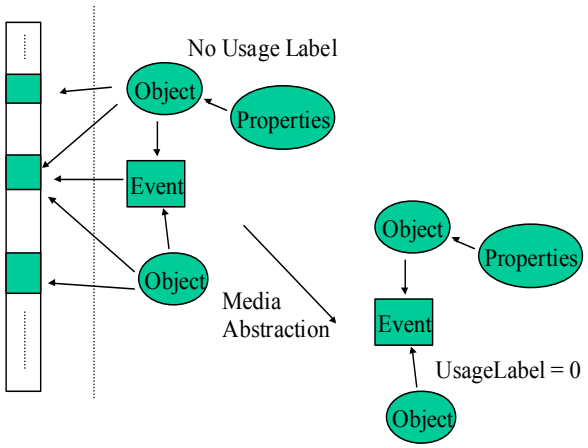

Figure 3: Relation between description of media and media abstraction description.

```
<Semantic id="MediaAbstractionDescription">
      <!--  Abstraction of media: usage label = 0  -->
      <UsageLabel dimension=”0”/>
      <Label> <FreeTerm>
            Jane knows Jim. Jane and Jim walk to high school together.
      </FreeTerm> </Label>
      <PersonObject id="Jane">
            <Label> <FreeTerm> Jane </FreeTerm> </Label>
            <Person xsi:type="Individual">
                  <Name>
                        <GivenName>Jane</GivenName>
                        <FamilyName>Wood</FamilyName>
                  </Name>
            </Person>
      </PersonObject>
      <PersonObject id="Jim">
            <Label> <FreeTerm> Jim </FreeTerm> </Label>
            <Person xsi:type="Individual">
                  <Name>
                        <GivenName>Jim</GivenName>
                        <FamilyName>Sky</FamilyName>
                  </Name>
            </Person>
      </PersonObject>
      <Object id="highschool">
            <Label> <FreeTerm> High School </FreeTerm> </Label>
      </Object>

      <Event id="know">
            <Label> <FreeTerm> Jane knows Jim </FreeTerm> </Label>
      </Event>
      <Event id="walk">
            <Label> <FreeTerm>
                  Jim and Jane walk to high school together
            </FreeTerm> </Label>
      </Event>

      <SemanticGraph>
            <!--  Jane knows Jim  -->
            <Edge name=“agentOf” source="know" target="jane"/>
            <Edge name="accompanierOf" source="know" target="jim"/>

            <!--  Jane and Jim walk to high school together  -->
            <Edge name=“agentOf” source="walk" target="jane"/>
            <Edge name=“agentOf” source="walk" target="jim"/>
            <Edge name="destinationOf" source="walk" target="highschool"/>
      </SemanticGraph>
</Semantic>
```

The description below is a formal abstraction created from the description above. Jane has been modified to be a variable now, woman, in the description and a usage label of value one has been added to the semantic and woman description (see Figure 4).

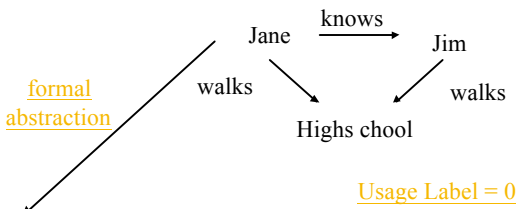

Figure 4: Relation between media abstraction description and abstraction description.

```
<Semantic id="AbstractionDescription">
      <!--  Formal abstraction: usage label = 1 -->
      <UsageLabel dimension=”1”/>
      <Label> <FreeTerm>
            Woman knows Jim. Jane and Jim walk to high school together.
      </FreeTerm> </Label>
      <PersonObject id="woman">
            <UsageLabel dimension=”1”/>
            <Label> <FreeTerm> woman </FreeTerm> </Label>
      </PersonObject>
      <PersonObject id="Jim">
            <Label> <FreeTerm> Jim </FreeTerm> </Label>
            <Person xsi:type="Individual">
                  <Name>
                        <GivenName>Jim</GivenName>
                        <FamilyName>Sky</FamilyName>
                  </Name>
            </Person>
      </PersonObject>
      <Object id="highschool">
            <Label> <FreeTerm> High School </FreeTerm> </Label>
      </Object>

      <Event id="know">
            <Label> <FreeTerm> Woman knows Jim </FreeTerm> </Label>
      </Event>
      <Event id="walk">
            <Label> <FreeTerm>
                  Jim and woman walk to high school together
            </FreeTerm> </Label>
      </Event>

      <SemanticGraph>
            <!--  Woman knows Jim  -->
            <Edge name=“agentOf” source="know" target="woman"/>
            <Edge name="accompanierOf" source="know" target="Jim"/>

            <!--  Woman and Jim walk to high school together  -->
            <Edge name=“agentOf” source="walk" target="woman"/>
            <Edge name=“agentOf” source="walk" target="Jim"/>
            <Edge name="destinationOf" source="walk" target="highschool"/>
      </SemanticGraph>
</Semantic>
```

The example below demonstrates how could an abstraction description be used in other descriptions.

```
<Semantic id="sem1">
      <Label> <FreeTerm> man </FreeTerm> </Label>
      <Object id="man">
            <!--  Formal abstraction: usage label = 1  -->
            <UsageLabel dimension=”1”/>
            <Label> <FreeTerm> man </FreeTerm> </Label>
      </Object>
</Semantic>

<Semantic id="sem2">
      <Label> <FreeTerm> Jim </FreeTerm> </Label>
      <PersonObject id="Jim">
            <!--  Description of media: no usage label  -->
            <Label> <FreeTerm> Jim </FreeTerm> </Label>

            <!--  Jim is instance of Man: using exampleOf  -->
            <SemanticRelationLink name=“exampleOf” target="man"/>

            <MediaOccurrence>
                  <MediaLocator>
                        <MediaURI> http://www.video.mpg </MediaURI>
                        <MediaTime>
                              <MediaTimePoint> T0:0:0 </MediaTimePoint>
                              <MediaDuration> PT10S </MediaDuration>
                        </MediaTime>
                  </MediaLocator>
            </MediaOccurrence>
            <Person xsi:type="Individual">
                  <Name>
                        <GivenName>Jim</GivenName>
                        <FamilyName>Sky</FamilyName>
                  </Name>
            </Person>

      </PersonObject>
</Semantic>
```

5.4 Semantic Relations

Although hierarchical structures such as the trees provided by the Object DS and the Event DS are adequate for efficient access and retrieval, some relations cannot be expressed using such structures. The Graph DS and the RelationLink D add flexibility in describing more general relations among semantic entities and other content descriptions entities (e.g., Segment DS). The Graph DS in the Semantic DS can be used to represent a graph of semantic entities and other content description entities, and relations among them. The RelationLink D in the SemanticEntity DS can also be used to represent relations among semantic entities and other content description entities. Some relations between semantic entities are normative.

5.4.1 Normative Semantic Relations

The normative semantic relations between semantic entities are defined in this section. Examples are provided for each relation.

5.4.1.1 Generic Relations

The table below defines normative semantic relations between semantic elements in general. It also includes informative examples of each relation.

Relation	*Inverse Relation*	*Definition*	*Participating Entities*	*Informative Examples*
isAKindOf	isAKindOfInv	Item A is a kind or specialization in meaning of item B.	Between SemanticEntity DSs of same type	Object “dog” *is a kind of* object “mammal”.
similarTo	similarTo	Item A has the same or almost the same meaning as item B (i.e., synonymy).	Between SemanticEntity DSs of same type	Object "man" is *similar to* object "human". Object "car" is *similar* to object "auto".
oppositeTo	oppositeTo	.Item A is opposite in meaning to item B.	Between SemanticEntity DSs of same type	Object “white” is *opposite to* object “black”.
stateOf	stateOfInv	Item A is the state of item B.	From Object DS or Event DS to SemanticState DS	State “brown=0.5” is the *state of* object “banana”.
propertyOf	propertyOfInv	Adjectival quality of an object, an event, or an abstract entity.	From Object DS, Event DS, and Concept DS to Properties DS	“ripeness” is the *property of* object “banana”.
exampleOf	exampleOInvf	Item A is an example of item B. The distinction between *kindOf* and *exampleOf* is the following: *kindOf* is used between types and *exampleOf* is used between a type and an instance.	From Object DS to Object DS From Event DS to Event DS	Object “Bill Clinton” is an *example of* object “man”.
equivalent	equivalent	Item A is the same as item B.	Between SemanticEntity DSs of same type	Object “Bill Clinton 1” is equivalent to object “Bill Clinton 2”.

5.4.1.2 Object/Object Relations

The table below defines normative semantic relations between objects. It also includes informative examples of each relation.

Relation	*Inverse Relation*	*Definition*	*Participating Entities*	*Informative Examples*
partOf	partOfInv	Item A is a part of item B.	From Object DS to Object DS	Any of the examples for the three relations below.
componentOf	componentOfInv	Item A is a component part of item B. Component parts are separable from the whole.	From Object DS to Object DS	Object “wheel” is a *component of* object “car”.
memberOf	memberOfInv	Item A is a member part of item B.	From Object DS to Object DS	Object “player” is a *member of* object “team”.
substanceOf	substanceOfInv	Item A is a substance part of item B. Substance parts are not separable from the whole.	From Object DS to Object DS	Object “gin” is a *substance of object* “martini”. Object “cellulose” is a *substance of* object “paper”.

5.4.1.3 Object/Event Relations

The table below defines normative semantic relations between objects and events. It also includes informative examples of each relation.

Relation	*Relation*	*Definition*	*Participating Entities*	*Informative Examples*
agentOf	agentOfInv	Object that performs or initiates an event. The agent is animate, intentional, and volitional.	From Event DS to Object DS	In the description "Peter gives the book to Mary", object "Peter" is the *agent of* event "give".
patientOf	patientOfInv	Object whose state is affected by an event.	From Event DS to Object DS	In the example above, object "book" is the *patient of* event "Give". In the description, "The chicken died", object "chicken" is the *patient of* event "die".
experiencerOf	experiencerOfInv	Object that perceives or experiences a stimulus or sensation. The experiencer is involved in a passive capacity.	From Event DS to Object DS	In the description "John hates pizza", object "John" is the *experiencer of* event "hate". In the description, "The boy sees the dog", object "boy" is the *experiencer of* event "see". However, in the description "John watches a movie", object "John" is an *agent of* event "watch".
stimulusOf	stimulusOfInv	Object perceived/experienced by an experiencer.	From Event DS to Object DS	In the description, "The boy sees the dog", object "dog" is the *stimulus of event* "see".
causerOf	causerOfInv	Object does causes an event but it is not an agent. The causer is non-intentional and non-volitional.	From Event DS to Object DS	In the description "Lightening strikes the tree", object "lightening" is the *causer of* event "strike".
sourceOf	sourceOfInv	Object that is the starting point for a transfer or motion event.	From Event DS to Object DS	In the example "John moved the box from the floor to table", "the floor" is the *source of* event "move".
destinationOf	destinationOfInv	Object that is the finishing point for a transfer or motion event.	From Event DS to Object DS	In the description "Mary receives a flower", object "Mary" is the *destination of* event "Receive". In the description, "Mary moved from California to Toronto", "Toronto" is the *destination of* event "move".
benificiaryOf	benificiaryOfInv	Object for which an action is performed.	From Event DS to Object DS	In the description "John baked a cake for Mary", object "Mary" is the *beneficiary of* event "bake".
themeOf	themeOfInv	Object that gets acted on or the topic of the event. The theme is more or less unaffected by the event.	From Event DS to Object DS	In the description "the boy calls the dog", object "dog" is the *theme of* event "call".
objectResultOf	objectResultOf	Object resulting from an event.	From Event DS to Object DS	In the description "John baked a cake", object "cake" is the *result of* event "bake".
instrumentOf	instrumentOfInv	Object employed by an agent in an event.	From Event DS to Object DS	In the descriptions, "Mary cut the salami with a knife" and

				"The knife cut the salami", object "knife" is the *instrument of* event "cut".
locationOf	locationOfInv	Location of an event.	From Event DS to Object DS	In the description "Mary climbed the Butte", object "Butte" is the *location of* event "climb".
pathOf	pathOfInv	A route along which an entity travels in the Event.	From Event DS to Object DS	In the description "The train traveled along the track", "Object "track" is the *path of* event "travel".
accompanierOf	accompanierOfInv	Object which joint agent in event, but does not initiate the event.	From Event DS to Object DS	In the description, "John traveled to France with Mary", "Mary" is the *accompanier of* event "travel".

5.4.1.4 SemanticTime/Event Relations

The table below defines normative semantic relations between semantic time and events. It also includes informative examples of each relation.

Relation	*Inverse Relation*	*Definition*	*Participating Entities*	*Informative Examples*
timeOf	timeOfInv	Time of an event.	From Event DS to SemanticTime DS	In the description "Mary was born for Christmas", SemanticTime "Christmas" is the *time of* event "be born".

5.4.1.5 Event/Event Relations

The table below defines normative semantic relations between events. It also includes informative examples of each relation.

The 13 normative relations for describing temporal relations between segments in the media time can also be used to describe temporal relations among events in the narrative world time, i.e., the semantic time (e.g., "Event 1 is *before* Event 2"). Note that temporal relations between events in the narrative world time may not be the same as the temporal relations of the segments where they appear in the media time (in "Event 1 is *before* Event 2" does not necessarily mean that Event 1 appears before Event 2 in the media).

Relation	*Inverse Relation*	*Definition*	*Participating Entities*	*Informative Examples*
eventResultOf	eventResultOf	Event resulting from another event.	From Event DS to Event DS	In the description "Tom is gone, so I am alone", event "be alone" is the *result of* event "be gone".
summaryOf	elaborationOf	Event being a summary of another event.	From Event DS to Event DS	In the description "Tom is gone. John escaped", event "be gone" is the *summary of* event "escape".
elaborationOf	summaryOf	Event being an elaboration or a more detail account of another event. This relation is the inverse of summary.	From Event DS to Event DS	In the description "Tom is gone. John escaped", event "escape" is the *elaboration of* event "be gone".
entailmentOf	entailmentOf	Event causing or involving by necessity or as a consequence of another Event. The	From Event DS to Event DS	Event "Marry" is an *entailment of* event "Divorce".

		entailed event could be a backward presupposition, a		
mannerOf	mannerOf	Event being a particular manner or way of achieving the same result of another event.	From Event DS to Event DS	Event "Run" is a *manner of* event "Walk".
CauseOf	causeOfInv	Event brings about the other event. *Note: This relation seems to have some overlap with entailment.*	From Event DS to Event DS	Event "Killing" is the *cause of* the Event "dying".

5.4.1.6 Segment/Semantic Relations

The table below defines normative relations between segments and semantic entities. It also includes informative examples of each relation.

Relation	*Inverse Relation*	*Definition*	*Participating Entities*	*Informative Examples*
mediaPerceptionOf	mediaPerceptionOfInv	Segment in which a semantic entity is perceived.	From Event DS to Segment DS	An image that shows Bill Clinton is a *media perception of* Object "Bill Clinton".
mediaSymbolOf	mediaSymbolOfInv	Segment in which a semantic entity is symbolized.	From Event DS to Segment DS	A video program that talks about Bill Clinton but does not shown a picture of him is a *media symbol of* "Bill Clinton".

5.4.2 Semantic Relation Examples (Informative)

Consider expressing the relation that object A is the agent of event B, the example below uses the Graph DS in the Semantic DS to accomplish that.

```
<Semantic id="example1">
      <Object id="objectA"> … </Object>
      <Event id="eventB"> … </Event>

      <SemanticGraph>
            <Node id="nodeA" idref="objectA"/>
            <Node id="nodeB" idref="eventB"/>
            <!-- Edge from a->b -->
            <Edge name="agentOf" source="nodeB" target="nodeA"/>
      </SemanticGraph>
</Semantic>
```

For cases in which the graph is extremely simple, e.g. —consisting of a single relation between two semantic entities—, the RelationLink D within SemanticEntity DS can be used.

```
<Semantic id="example2">
      <Object id="objectA"> … </Object>
      <Event id="eventB">
            <SemanticRelationLink name="agentOf" target="objectA"/>
      </Event>
</Semantic>
```

Other examples of semantic graphs are included in section **Error! Reference source not found.** and the section of Examples of the Event DS, the Object DS, the LocationObject DS, and the SemanticTime DS, among others.

6 Annex B: Instantiations of the Semantic DS

This section includes instantiations of the Semantic DS.

6.1 Soccer Game - CD 18

6.1.1 Interview

Figure 5 shows the key frame of a video shot capturing an interview of a soccer coach by a sports reporter. In the video shot, the coach of the Spanish soccer team is talking about the soccer game between the Spanish soccer team and the Swedish soccer team. In particular, it is explaining how tough the soccer game is going to be for the Spanish soccer team because the Swedish soccer team is very strong and the Spanish soccer team is tired physically.

The entire video shot could be described by an event (Event DS) with id "Interview-ev". The talk, coach, and soccer game event could be represented by sub-event with id "Talk-ev", “Coach-ev”, and "Game-ev". The video objects corresponding to the sports reporter, the coach, the Spanish soccer team, and the Swedish soccer team could be described by objects (Object DS) with ids "Reporter-ob", “Clemente-ob”, "SpanishTeam-ob", and "SwedishTeam-ob", respectively.

Figure 5: Key frame of a video shot depicting an interview.

Once these events and objects are defined using the Event and Object DSs, the Semantic Graph DS could be used to describe relations among them. Some examples of semantic relations among these elements follow. The “Clemente-ob” and "SpanishTeam-ob" are the agent and the patient of “Coach-ev”, repectively. The "Reporter-ob" and “Clemente-ob” objects participate in the "Interview-ev" as agent and patient, respectively. The “Clemente-ob” object and "Game-ev" event participate in the "Talk-ev" as the agent and the subject, respectively. The "SpanishTeam-ob" and "SwedishTeam-ob" are objects participating in the "Game-ev" as the home team and the visiting team, respectively.

The semantic description for the example below is included below. Fictional locations, times, and occurrence properties describe the objects and the events in the description.

```
<Semantic id="S1">
      <PersonObject id="Clemente-ob">
            <Label>
                  <FreeTerm xml:lang="en-us"> Soccer Coach </FreeTerm>
            </Label>
            <Definition>
                  <FreeText xml:lang="en-us">
                  Coach of the Spanish soccer team whose name is Javier
Clemente
                  </FreeText>
            </Definition>
            <MediaOccurrence>
```

```
                  <MediaLocator>
                        <MediaTime>
                              <MediaTimePoint> T0:7:57 </MediaTimePoint>
                              <MediaDuration> PT15S </MediaDuration>
                        </MediaTime>
                  </MediaLocator>
            </MediaOccurrence>
            <Person xsi:type="IndividualType">
                  <Name>
                        <GivenName>Javier</GivenName>
                        <FamilyName>Clemente</FamilyName>
                  </Name>
            </Person>
      </PersonObject>
      <PersonObject id="Reporter-ob">
            <Label>
                  <ControlledTerm CSLocation="http://www.CSs.com/Sports"
                                  CSTermId="4">
                        <Label xml:lang="en-us"> Sports Reporter </Label>
                  </ControlledTerm>
            </Label>
            <Definition>
                  <FreeText xml:lang="en-us">
                  Sports reporter for the Spanish TV1 whose name is Enrique
Guas
                  </FreeText>
            </Definition>
            <Person xsi:type="IndividualType">
                  <Name>
                        <GivenName>Enrique</GivenName>
                        <FamilyName>Guas</FamilyName>
                  </Name>
            </Person>
            <MediaOccurrence>
                  <MediaLocator>
                        <MediaTime>
                              <MediaTimePoint> T0:7:57 </MediaTimePoint>
                              <MediaDuration> PT15S </MediaDuration>
                        </MediaTime>
                  </MediaLocator>
            </MediaOccurrence>
      </PersonObject>
      <PersonObject id="SpanishTeam-ob">
            <Label>
                  <ControlledTerm CSLocation="http://www.CSs.com/Sports"
                                  CSTermId="60">
                        <Label xml:lang="en-us"> Soccer team </Label>
                  </ControlledTerm>
            </Label>
            <Person xsi:type="PersonGroupType">
                  <Name> Spanish soccer team </Name>
                  <!--  People in the team  -->
                  <Person> </Person>
                  <Person> </Person>
            </Person>
      </PersonObject>
      <PersonObject id="SwedishTeam-ob">
            <Label>
                  <ControlledTerm CSLocation="http://www.CSs.com/Sports"
                                  CSTermId="60">
                        <Label xml:lang="en-us"> Soccer team </Label>
```

```
                  </ControlledTerm>
            </Label>
            <Person xsi:type="PersonGroupType">
                  <Name> Swedish soccer team </Name>
                  <!--  People in the team  -->
                  <Person> </Person>
                  <Person> </Person>
            </Person>
      </PersonObject>

      <Event id="Interview-ev">
            <Label>
                  <FreeTerm xml:lang="en-us"> Interview </FreeTerm>
            </Label>
            <Definition>
                  <FreeText xml:lang="en-us">
                  Interview of coach of Spanish soccer team by sports
reporter
                  </FreeText>
            </Definition>
            <MediaOccurrence>
                  <MediaLocator>
                        <MediaTime>
                              <MediaTimePoint> T0:7:57 </MediaTimePoint>
                              <MediaDuration> PT15S </MediaDuration>
                        </MediaTime>
                  </MediaLocator>
            </MediaOccurrence>
            <Event id="Talk-ev">
                  <Label>
                        <FreeTerm xml:lang="en-us"> Talk </FreeTerm>
                  </Label>
            </Event>
      </Event>

      <LocationObject id="Santberna-ob">
            <Label> <FreeTerm> Santiago Bernabeu </FreeTerm> </Label>
            <Definition>
                  <FreeText xml:lang="en-us">
                  Soccer stadium of Santiago Bernabeu at Barcelona, Spain
                  </FreeText>
            </Definition>
            <Place>
                  <Name xml:lang='en'> Santiago Bernabeu </Name>
                  <Planet> Earth </Planet>
                  <Country> Spain </Country>
                  <PostalAddress>
                        <AddressLine>
                              C/Fabregas No. 26, Barcelona
                        </AddressLine>
                        <PostingIdentifier> E-64200 </PostingIdentifier>
                  </PostalAddress>
            </Place>
      </LocationObject>
      <SemanticTime id="interview-time">
            <Label> <FreeTerm> Saturday </FreeTerm> </Label>
            <Time>
                  <MediaTimePoint> 2000-3-20T20:31:00 </MediaTimePoint>
                  <MediaDuration> PT15S </MediaDuration>
            </Time>
            <SemanticRelativeTime TimePoint="SaturdayNight"/>
```

```
      </SemanticTime>

      <Event id="Game-ev">
            <Label>
                  <FreeTerm xml:lang="en-us"> Soccer Game </FreeTerm>
            </Label>
      </Event>
      <Event id="Coach-ev">
            <Label>
                  <FreeTerm xml:lang="en-us"> Coach </FreeTerm>
            </Label>
      </Event>

      <SemanticGraph>
            <!--  Reporter interviews coach  -->
            <Edge  name="agentOf"  source="Interview-ev"  target="Reporter-
ob"/>
            <Edge  name="patientOf"  source="Interview-ev"  target="Clemente-
ob"/>

            <!--  Coach talks about game  -->
            <Edge name="agentOf" source="Talk-ev" target="Clemente-ob"/>
            <Edge name="themeOf" source="Talk-ev" target="Game-ev"/>

            <!--  The game's home team is the Spanish soccer team  -->
            <Edge  name="homeTeam"  source="Game-ev"  target="SpanishTeam-
ob"/>
            <!--  The game's visiting team is the Swedish soccer team  -->
            <Edge name="visitingTeam" source="Game-ev" target="SwedishTeam-
ob"/>

            <!--  The coach coaches the Spanish soccer team  -->
            <Edge name="agentOf" source="Coach-ev" target="Clemente-ob"/>
            <Edge  name="patientOf"  source="Coach-ev"  target="SpanishTeam-
ob"/>

            <!--  Location and time of events  -->
            <Edge          name="locationOf"          source="interview-ev"
target="Santberna-ob"/>
            <Edge  name="timeOf"  source="interview-ev"  target="interview-
time"/>

      </SemanticGraph>
</Semantic>
```

6.1.2 Goal 1

Figure 5 shows the key frame of a video shot capturing the first goal of the soccer game by Morientes, a forward in the Spanish soccer team and the mistake of the goalkeeper of the Swedish soccer team, Svensson. The entire video shot could be described by an event (Event DS) with id "Goal-ev". The kick, and "make error" events in the video shot could be represented by sub-events with ids "Kick-ev", and "Error-ev" respectively. The video objects corresponding to the goal area, the forward, the goalkeeper, the ball, the Spanish soccer team, and the Swedish soccer team could be described by objects (Object DS) with ids "GoalArea-ob", "Morientes-ob", "Svensoon-ob", "Ball-ob", "SpanishTeam-ob", and "SwedishTeam-ob", respectively.

Figure 6: Key frame of a video shot depicting a soccer goal.

Once these events and objects are defined using the Event and Object DSs, the Semantic Graph DS could be used to describe relations among them. Some examples of semantic relations among these elements follow. The "Morientes-ob", the "Ball-ob", and the "GoalArea-obj" objects participate in the "Kick-ev" event as agent, patient, and destination, respectively. The "Svensoon-ob" participates in the "Error-ev" as the agent.

The semantic description for the example below is included below. Fictional locations, times, and occurrence properties describe the objects and the events in the description.

```
<Semantic id="S2">
      <Label> <FreeTerm> goal </FreeTerm> </Label>
      <PersonObject id="Morientes-ob">
            <Label>
                  <ControlledTerm CSLocation="http://www.CSs.com/Sports"
                                  CSTermId="48">
                        <Label xml:lang="en-us"> Forward player </Label>
                  </ControlledTerm>
            </Label>
            <Definition>
                  <FreeText xml:lang="en-us">
                  Forward player for the Spanish soccer team whose name is
Morientes
                  </FreeText>
            </Definition>
            <MediaOccurrence>
                  <MediaLocator>
                        <MediaTime>
                              <MediaTimePoint> T0:9:54 </MediaTimePoint>
                              <MediaDuration> PT2S </MediaDuration>
                        </MediaTime>
                  </MediaLocator>
                  <Descriptor size="1">
                        <ElementDescriptorValue>
4617 11986 938 2628 458 1463 5178 2258 444 134 69 456 9300 2810 121 21 14
18 48 107 277 53 47 1926 8281 793 38 11 0 5 201 28 0 1 1 2 23 252 122 6 3
433 1517 46 1 1 0 0 0 0 0 0 0 0 2 55 13560 3326 678 221 1610 5602 916 32 8
1 21 58 11 1 0 0 2 61 331 179 14 7 2388 6213 51 0 0 0 0 0 0 0 0 0 2 337
243 0 0 220 194 0 0 0 0 0 0 0 0 0 0 0 0 383 3172 1072 51 20 91 128 0 0 0 0
0 2 4 0 0 0 0 89 757 694 0 0 217 39 0 0 0 0 0 0 0 0 0 0 0 0 912 210 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0 0 55
                        </ElementDescriptorValue>
                  </Descriptor>
                  <DescriptorName> ColorHistogram </DescriptorName>
            </MediaOccurrence>
            <Person xsi:type="IndividualType">
                  <Name>
                        <FamilyName>Morientes</FamilyName>
                  </Name>
```

```
            </Person>
      </PersonObject>
      <Object id="Ball-ob">
            <Label>
                  <ControlledTerm CSLocation="http://www.CSs.com/Sports"
                                    CSTermId="46">
                        <Label xml:lang="en-us"> Soccer Ball </Label>
                  </ControlledTerm>
            </Label>
      </Object>
      <PersonObject id="Svensoon-ob">
            <Label>
                  <ControlledTerm CSLocation="http://www.CSs.com/Sports"
                                    CSTermId="45">
                        <Label xml:lang="en-us"> Goalkeeper player </Label>
                  </ControlledTerm>
            </Label>
            <Person xsi:type="IndividualType">
                  <Name>
                        <FamilyName>Svensson</FamilyName>
                  </Name>
            </Person>
      </PersonObject>
      <Object id="GoalArea-ob">
            <Label>
                  <ControlledTerm CSLocation="http://www.CSs.com/Sports"
                                    CSTermId="65">
                        <Label xml:lang="en-us"> Goal area </Label>
                  </ControlledTerm>
            </Label>
      </Object>
      <PersonObject id="SpanishTeam-ob">
            <Label>
                  <ControlledTerm CSLocation="http://www.CSs.com/Sports"
                                    CSTermId="60">
                        <Label xml:lang="en-us"> Soccer team </Label>
                  </ControlledTerm>
            </Label>
            <Person xsi:type=“PersonGroupType”>
                  <Name> Spanish soccer team </Name>
                  <!--  People in the team  -->
                  <Person> </Person>
                  <Person> </Person>
            </Person>
      </PersonObject>
      <PersonObject id="SwedishTeam-ob">
            <Label>
                  <ControlledTerm CSLocation="http://www.CSs.com/Sports"
                                    CSTermId="60">
                        <Label xml:lang="en-us"> Soccer team </Label>
                  </ControlledTerm>
            </Label>
            <Person xsi:type=“PersonGroupType”>
                  <Name> Swedish soccer team </Name>
                  <!--  People in the team  -->
                  <Person> </Person>
                  <Person> </Person>
            </Person>
      </PersonObject>

      <Event id="Goal-ev">
```

```
            <Label>
                  <ControlledTerm CSLocation="http://www.CSs.com/Sports"
                                  CSTermId="43">
                        <Label xml:lang="en-us"> Goal </Label>
                  </ControlledTerm>
            </Label>
            <Definition>
                  <FreeText xml:lang="en-us">
                  Soccer goal
                  </FreeText>
            </Definition>
            <MediaOccurrence>
                  <MediaLocator>
                        <MediaTime>
                              <MediaTimePoint> T0:9:45 </MediaTimePoint>
                              <MediaDuration> PT2S </MediaDuration>
                        </MediaTime>
                  </MediaLocator>
                  <Descriptor size="1">
                        <ElementDescriptorValue>
4617 11986 938 2628 458 1463 5178 2258 444 134 69 456 9300 2810 121 21 14
18 48 107 277 53 47 1926 8281 793 38 11 0 5 201 28 0 1 1 2 23 252 122 6 3
433 1517 46 1 1 0 0 0 0 0 0 0 0 2 55 13560 3326 678 221 1610 5602 916 32 8
1 21 58 11 1 0 0 2 61 331 179 14 7 2388 6213 51 0 0 0 0 0 0 0 0 0 0 2 337
243 0 0 220 194 0 0 0 0 0 0 0 0 0 0 0 0 0 383 3172 1072 51 20 91 128 0 0 0 0
0 2 4 0 0 0 0 89 757 694 0 0 217 39 0 0 0 0 0 0 0 0 0 0 0 0 0 912 210 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0 0 55
                        </ElementDescriptorValue>
                        <DescriptorName> GoFGoPColor </DescriptorName>
                  </Descriptor>
            </MediaOccurrence>

            <Event id="Kick-ev">
                  <Label xml:lang="en-us"> <FreeTerm> Kick
                  </FreeTerm> </Label>
            </Event>
            <Event id="Error-ev">
                  <Label xml:lang="en-us"> <FreeTerm> Makes an error
                  </FreeTerm> </Label>
            </Event>
      </Event>

      <LocationObject id="Santberna-ob">
            <Label> <FreeTerm> Santiago Bernabeu </FreeTerm> </Label>
            <Definition>
                  <FreeText xml:lang="en-us">
                  Soccer stadium of Santiago Bernabeu at Barcelona, Spain
                  </FreeText>
            </Definition>
            <Place>
                  <Name xml:lang='en'> Santiago Bernabeu </Name>
                  <Planet> Earth </Planet>
                  <Country> Spain </Country>
                  <PostalAddress>
                        <AddressLine>
                              C/Fabregas No. 26, Barcelona
                        </AddressLine>
                        <PostingIdentifier> E-64200 </PostingIdentifier>
                  </PostalAddress>
            </Place>
      </LocationObject>
```

```
      <SemanticTime id=”goal1-time”>
            <Label> <FreeTerm> Saturday </FreeTerm> </Label>
            <Time>
                  <MediaTimePoint> 2000-3-20T20:33:00 </MediaTimePoint>
                  <MediaDuration> PT2S </MediaDuration>
            </Time>
            <SemanticRelativeTime TimePoint="SaturdayNight"/>
      </SemanticTime>

      <SemanticGraph>
            <!--  morientes kicks ball into goal towards the Goal -->
            <Edge name=“agentOf” source="Kick-ev" target="Morientes-ob"/>
            <Edge name="patientOf" source="Kick-ev" target="Ball-ob"/>
            <Edge  name="destinationOf"  source="Kick-ev"  target="GoalArea-
ob"/>

            <!--  Goalkeeper makes an error  -->
            <Edge name=“agentOf” source="Error-ev" target="Svensoon-ob"/>
            <!--  Morientes is a player of the Spanish soccer team  -->
            <Edge           name="memberOf"           source="Morientes-ob"
target="SpanishTeam-ob"/>
            <!--  The goalkeeper is a player of the Swedish soccer team  --
>
            <Edge name="memberOf" source="Svensoon-ob" target="SwedishTeam-
ob"/>

            <!--  Location and time of the goal event  -->
            <Edge  name="locationOf"  source="Goal-ev"  target=“Santberna-
ob”/>
            <Edge name="timeOf" source="Goal-ev" target="goal1-time"/>

      </SemanticGraph>
</Semantic>
```

6.1.3 Running

Figure 7 shows the key frame of a video shot capturing Morientes, a forward player for the Spanish soccer team, and Ingesson, a player for the Swedish soccer team, running on the soccer field. We consider two events with ids "Run1-ev" and "Run2-ev", and three objects with ids "Morientes-ob", "Ingesson-ob", and "Field-ob".

Figure 7: Key frame of a video shot depicting two soccer players running.

Once these events and objects are defined using the Event and Object DSs, the Semantic Graph DS could be used to describe relations among them. Some examples of semantic relations among these elements follow. The

"Morientes-ob" and "Field-ob" objects participate in the "Run1-ev" event as the agent and the location. The "Ingesson-ob" and "Field-ob" objects participate in the "Run2-ev" event as the agent and the location.

The semantic description for the example below is included below. Fictional locations, times, and occurrence properties describe the objects and the events in the description.

```
<Semantic id="S3">
      <PersonObject id="Morientes-ob">
            <Label>
                  <ControlledTerm CSLocation="http://www.CSs.com/Sports"
                                  CSTermId="48">
                        <Label xml:lang="en-us"> Forward player </Label>
                  </ControlledTerm>
            </Label>
            <Definition>
                  <FreeText xml:lang="en-us">
            Forward player for the Spanish soccer team whose name is
Morientes
                  </FreeText>
            </Definition>
            <MediaOccurrence>
                  <MediaLocator>
                        <MediaTime>
                              <MediaTimePoint> T0:14:4 </MediaTimePoint>
                              <MediaDuration> PT3S </MediaDuration>
                        </MediaTime>
                  </MediaLocator>
                  <Descriptor size="1">
                        <ElementDescriptorValue>
4617 11986 938 2628 458 1463 5178 2258 444 134 69 456 9300 2810 121 21 14
18 48 107 277 53 47 1926 8281 793 38 11 0 5 201 28 0 1 1 2 23 252 122 6 3
433 1517 46 1 1 0 0 0 0 0 0 0 0 2 55 13560 3326 678 221 1610 5602 916 32 8
1 21 58 11 1 0 0 2 61 331 179 14 7 2388 6213 51 0 0 0 0 0 0 0 0 0 2 337
243 0 0 220 194 0 0 0 0 0 0 0 0 0 0 0 383 3172 1072 51 20 91 128 0 0 0 0
0 2 4 0 0 0 0 89 757 694 0 0 217 39 0 0 0 0 0 0 0 0 0 0 0 0 912 210 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0 55
                        </ElementDescriptorValue>
                        <DescriptorName> ColorHistogram </DescriptorName>
                  </Descriptor>
            </MediaOccurrence>
            <Person xsi:type="IndividualType">
                  <Name>
                        <FamilyName>Morientes</FamilyName>
                  </Name>
            </Person>
      </PersonObject>
      <PersonObject id="Ingesson-ob">
            <Label>
                  <ControlledTerm CSLocation="http://www.CSs.com/Sports"
                                  CSTermId="49">
                        <Label xml:lang="en-us"> Player </Label>
                  </ControlledTerm>
            </Label>
            <MediaOccurrence>
                  <MediaLocator>
                        <MediaTime>
                              <MediaTimePoint> T0:14:5 </MediaTimePoint>
                              <MediaDuration> PT1S </MediaDuration>
                        </MediaTime>
                  </MediaLocator>
            </MediaOccurrence>
```

```
            <Definition>
                  <FreeText xml:lang="en-us">
                  Player for the Swedish soccer team whose name is Ingesson
                  </FreeText>
            </Definition>
            <Person xsi:type="IndividualType">
                  <Name>
                        <FamilyName>Ingesson</FamilyName>
                  </Name>
            </Person>
      </PersonObject>
      <PersonObject id="SpanishTeam-ob">
            <Label>
                  <ControlledTerm CSLocation="http://www.CSs.com/Sports"
                                  CSTermId="60">
                        <Label xml:lang="en-us"> Soccer team </Label>
                  </ControlledTerm>
            </Label>
            <Person xsi:type="PersonGroupType">
                  <Name> Spanish soccer team </Name>
                  <!--  People in the team  -->
                  <Person> </Person>
                  <Person> </Person>
            </Person>
      </PersonObject>
      <PersonObject id="SwedishTeam-ob">
            <Label>
                  <ControlledTerm CSLocation="http://www.CSs.com/Sports"
                                  CSTermId="60">
                        <Label xml:lang="en-us"> Soccer team </Label>
                  </ControlledTerm>
            </Label>
            <Person xsi:type="PersonGroupType">
                  <Name> Swedish soccer team </Name>
                  <!--  People in the team  -->
                  <Person> </Person>
                  <Person> </Person>
            </Person>
      </PersonObject>

      <Event id="Run1-ev">
            <Label>
                  <FreeTerm xml:lang="en-us"> Run </FreeTerm>
            </Label>
            <MediaOccurrence>
                  <MediaLocator>
                        <MediaTime>
                              <MediaTimePoint> T0:14:4 </MediaTimePoint>
                              <MediaDuration> PT3S </MediaDuration>
                        </MediaTime>
                  </MediaLocator>
                  <Descriptor size="1">
                        <ElementDescriptorValue>
4617 11986 938 2628 458 1463 5178 2258 444 134 69 456 9300 2810 121 21 14
18 48 107 277 53 47 1926 8281 793 38 11 0 5 201 28 0 1 1 2 23 252 122 6 3
433 1517 46 1 1 0 0 0 0 0 0 0 0 2 55 13560 3326 678 221 1610 5602 916 32 8
1 21 58 11 1 0 0 2 61 331 179 14 7 2388 6213 51 0 0 0 0 0 0 0 0 0 0 2 337
243 0 0 220 194 0 0 0 0 0 0 0 0 0 0 0 0 383 3172 1072 51 20 91 128 0 0 0 0
0 2 4 0 0 0 0 89 757 694 0 0 217 39 0 0 0 0 0 0 0 0 0 0 0 0 912 210 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0 0 55
                        </ElementDescriptorValue>
```

```
                  <DescriptorName> GoFGoPColor </DescriptorName>
            </Descriptor>
      </MediaOccurrence>
</Event>
<Event id="Run2-ev">
      <Label>
            <FreeTerm xml:lang="en-us"> Run </FreeTerm>
      </Label>
      <MediaOccurrence>
            <MediaLocator>
                  <MediaTime>
                        <MediaTimePoint> T0:14:5 </MediaTimePoint>
                        <MediaDuration> PT1S </MediaDuration>
                  </MediaTime>
            </MediaLocator>
      </MediaOccurrence>
</Event>

<LocationObject id="Santberna-ob">
      <Label> <FreeTerm> Santiago Bernabeu </FreeTerm> </Label>
      <Definition>
            <FreeText xml:lang="en-us">
            Soccer stadium of Santiago Bernabeu at Barcelona, Spain
            </FreeText>
      </Definition>
      <Place>
            <Name xml:lang='en'> Santiago Bernabeu </Name>
            <Planet> Earth </Planet>
            <Country> Spain </Country>
            <PostalAddress>
                  <AddressLine>
                        C/Fabregas No. 26, Barcelona
                  </AddressLine>
                  <PostingIdentifier> E-64200 </PostingIdentifier>
            </PostalAddress>
      </Place>
</LocationObject>
<SemanticTime id="Run1-time">
      <Label> <FreeTerm> Saturday </FreeTerm> </Label>
      <Time>
            <MediaTimePoint> 2000-3-20T20:37:00 </MediaTimePoint>
            <MediaDuration> PT3S </MediaDuration>
      </Time>
      <SemanticRelativeTime TimePoint="SaturdayNight"/>
</SemanticTime>
<SemanticTime id="Run1-time">
      <Label> <FreeTerm> Saturday </FreeTerm> </Label>
      <Time>
            <MediaTimePoint> 2000-3-20T20:37:00 </MediaTimePoint>
            <MediaDuration> PT1S </MediaDuration>
      </Time>
      <SemanticRelativeTime TimePoint="SaturdayNight"/>
</SemanticTime>

<SemanticGraph>
      <!--  Morientes runs  -->
      <Edge name="agentOf" source="Run1-ev" target="Morientes-ob"/>

      <!--  Ingesson runs  -->
      <Edge name="agentOf" source="Run2-ev" target="Ingensson-ob"/>
```

```
            <!--  Morientes is a player of the Spanish soccer team  -->
            <Edge           name="memberOf"           source="Morientes-ob"
target="SpanishTeam-ob"/>
            <!--  Ingesson is a player of the Swedish soccer team  -->
            <Edge           name="memberOf"           source="Ingensson-ob"
target="SwedishTeam-ob"/>

            <!--  Time and location of events  -->
            <Edge  name="locationOf"  source="run1-ev"  target="Santberna-
ob"/>
            <Edge  name="locationOf"  source="run2-ev"  target="Santberna-
ob"/>
            <Edge name="timeOf" source="run1-ev" target="Run1-time"/>
            <Edge name="timeOf" source="run2-ev" target="Run2-time"/>

      </SemanticGraph>
</Semantic>
```

6.1.4 Goal 2

Figure 8 shows the key frame of a video shot capturing the second goal of the soccer game of Morientes, a forward player for the Spanish soccer team. The goalkeeper for the Swedish team is Svensson. The description of this video shot at the semantic level could be as follows. The entire video shot could be described by an event (Event DS) with id "Goal-ev". The kick, not-catch, and enter events in the video shot could be represented by sub-events with ids "Kick-ev", "Not-Catch-ev", and "Enter-ev" respectively. The video objects corresponding to the goal, the forward, the goalkeeper, the Spanish soccer team, and the Swedish soccer team could be described by objects (Object DS) with ids "GoalArea-ob", "Morientes-ob", "Svensoon-ob", "SpanishTeam-ob", and "SwedishTeam-ob", respectively.

Figure 8: Key frame of a video shot depicting a soccer goal.

Once these events and objects are defined using the Event and Object DSs, the Semantic Graph DS could be used to describe relations among them. Some examples of semantic relations among these elements follow. The "Morientes-ob", the "Ball-ob", and the "GoalArea-obj" objects participate in the "Kick-ev" event. Similarly, the "Ball-ob" and the "Svensoon-ob" objects participate in the "Not-Catch-ev" event and the "Ball-ob" and the "GoalArea-ob" objects participate in the "Not-Catch-ev" event. The "Morientes-ob", the "Ball-ob", and the "GoalArea-ob" objects are the agent, the patient, and the destination of the "Kick-ev" event, respectively. The "Svensoon-ob" and the "Ball-ob" objects are agent and the patient of the "Not-Catch-ev" event, respectively. Again, The "Ball-ob" and the "GoalArea-ob" objects are the agent and the patient of the "Not-Catch-ev" event, respectively.

The semantic description for the example below is included below. Fictional locations, times, and occurrence properties describe the objects and the events in the description.

```
<Semantic id="S4">
```

```
      <PersonObject id="Morientes-ob">
            <Label>
                  <ControlledTerm CSLocation="http://www.CSs.com/Sports"
                                  CSTermId="48">
                        <Label xml:lang="en-us"> Forward player </Label>
                  </ControlledTerm>
            </Label>
            <Definition>
                  <FreeText xml:lang="en-us">
            Forward player for the Spanish soccer team whose name is
Morientes
                  </FreeText>
            </Definition>
            <MediaOccurrence>
                  <MediaLocator>
                        <MediaTime>
                              <MediaTimePoint> T0:15:11 </MediaTimePoint>
                              <MediaDuration> PT2S </MediaDuration>
                        </MediaTime>
                  </MediaLocator>
                  <Descriptor size="1">
                        <ElementDescriptorValue>
4617 11986 938 2628 458 1463 5178 2258 444 134 69 456 9300 2810 121 21 14
18 48 107 277 53 47 1926 8281 793 38 11 0 5 201 28 0 1 1 2 23 252 122 6 3
433 1517 46 1 1 0 0 0 0 0 0 0 0 2 55 13560 3326 678 221 1610 5602 916 32 8
1 21 58 11 1 0 0 2 61 331 179 14 7 2388 6213 51 0 0 0 0 0 0 0 0 0 2 337
243 0 0 220 194 0 0 0 0 0 0 0 0 0 0 0 383 3172 1072 51 20 91 128 0 0 0 0
0 2 4 0 0 0 0 89 757 694 0 0 217 39 0 0 0 0 0 0 0 0 0 0 0 912 210 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0 55
                        </ElementDescriptorValue>
                        <DescriptorName> ColorHistogram </DescriptorName>
                  </Descriptor>
            </MediaOccurrence>
            <Person xsi:type="IndividualType">
                  <Name>
                        <FamilyName>Morientes</FamilyName>
                  </Name>
            </Person>
      </PersonObject>
      <Object id="Ball-ob">
            <Label>
                  <ControlledTerm CSLocation="http://www.CSs.com/Sports"
                                  CSTermId="46">
                        <Label xml:lang="en-us"> Soccer Ball </Label>
                  </ControlledTerm>
            </Label>
      </Object>
      <PersonObject id="Svensoon-ob">
            <Label>
                  <ControlledTerm CSLocation="http://www.CSs.com/Sports"
                                  CSTermId="45">
                        <Label xml:lang="en-us"> Goalkeeper player </Label>
                  </ControlledTerm>
            </Label>
            <Person xsi:type="IndividualType">
                  <Name>
                        <FamilyName>Svensson</FamilyName>
                  </Name>
            </Person>
      </PersonObject>
      <Object id="GoalArea-ob">
```

```
            <Label>
                  <ControlledTerm CSLocation="http://www.CSs.com/Sports"
                                  CSTermId="65">
                        <Label xml:lang="en-us"> Goal object </Label>
                  </ControlledTerm>
            </Label>
      </Object>
      <PersonObject id="SpanishTeam-ob">
            <Label>
                  <ControlledTerm CSLocation="http://www.CSs.com/Sports"
                                  CSTermId="60">
                        <Label xml:lang="en-us"> Soccer team </Label>
                  </ControlledTerm>
            </Label>
            <Person xsi:type="PersonGroupType">
                  <Name> Spanish soccer team </Name>
                  <!--  People in the team  -->
                  <Person> </Person>
                  <Person> </Person>
            </Person>
      </PersonObject>
      <PersonObject id="SwedishTeam-ob">
            <Label>
                  <ControlledTerm CSLocation="http://www.CSs.com/Sports"
                                  CSTermId="60">
                        <Label xml:lang="en-us"> Soccer team </Label>
                  </ControlledTerm>
            </Label>
            <Person xsi:type="PersonGroupType">
                  <Name> Swedish soccer team </Name>
                  <!--  People in the team  -->
                  <Person> </Person>
                  <Person> </Person>
            </Person>
      </PersonObject>

      <Event id="Goal-ev">
            <Label>
                  <ControlledTerm    CSLocation="http://www.CSs.com/Sports"
CSTermId="43">
                        <Label xml:lang="en-us"> Goal </Label>
                  </ControlledTerm>
            </Label>
            <MediaOccurrence>
                  <MediaLocator>
                        <MediaTime>
                              <MediaTimePoint> T0:15:11 </MediaTimePoint>
                              <MediaDuration> PT2S </MediaDuration>
                        </MediaTime>
                  </MediaLocator>
                  <Descriptor size="1">
                        <ElementDescriptorValue>
4617 11986 938 2628 458 1463 5178 2258 444 134 69 456 9300 2810 121 21 14
18 48 107 277 53 47 1926 8281 793 38 11 0 5 201 28 0 1 1 2 23 252 122 6 3
433 1517 46 1 1 0 0 0 0 0 0 0 0 2 55 13560 3326 678 221 1610 5602 916 32 8
1 21 58 11 1 0 0 2 61 331 179 14 7 2388 6213 51 0 0 0 0 0 0 0 0 0 0 2 337
243 0 0 220 194 0 0 0 0 0 0 0 0 0 0 0 0 0 383 3172 1072 51 20 91 128 0 0 0 0
0 2 4 0 0 0 0 89 757 694 0 0 217 39 0 0 0 0 0 0 0 0 0 0 0 0 912 210 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0 0 55
                        </ElementDescriptorValue>
                        <DescriptorName> ColorHistogram </DescriptorName>
```

```
                  </Descriptor>
            </MediaOccurrence>

            <Event id="Kick-ev">
                  <Label>
                        <FreeTerm xml:lang="en-us"> Kick </FreeTerm>
                  </Label>
            </Event>
            <Event id="Not-Catch-ev">
                  <Label>
                        <FreeTerm   xml:lang="en-us">   Does   not   catch
</FreeTerm>
                  </Label>
            </Event>
            <Event id="Enter-ev">
                  <Label>
                        <FreeTerm xml:lang="en-us"> Enter </FreeTerm>
                  </Label>
            </Event>
      </Event>

      <LocationObject id="Santberna-ob”>
            <Label> <FreeTerm> Santiago Bernabeu </FreeTerm> </Label>
            <Definition>
                  <FreeText xml:lang="en-us">
                  Soccer stadium of Santiago Bernabeu at Barcelona, Spain
                  </FreeText>
            </Definition>
            <Place>
                  <Name xml:lang='en'> Santiago Bernabeu </Name>
                  <Planet> Earth </Planet>
                  <Country> Spain </Country>
                  <PostalAddress>
                        <AddressLine>
                              C/Fabregas No. 26, Barcelona
                        </AddressLine>
                        <PostingIdentifier> E-64200 </PostingIdentifier>
                  </PostalAddress>
            </Place>
      </LocationObject>
      <SemanticTime id=”goal2-time”>
            <Label> <FreeTerm> Saturday </FreeTerm> </Label>
            <Time>
                  <MediaTimePoint> 2000-3-20T20:38:00 </MediaTimePoint>
                  <MediaDuration> PT1S </MediaDuration>
            </Time>
            <SemanticRelativeTime TimePoint="SaturdayNight"/>
      </SemanticTime>

      <SemanticGraph>
            <!--  Morientes kicks the ball toward the goal  -->
            <Edge name="agentOf” source="Kick-ev" target="Morientes-ob"/>
            <Edge name="patientOf” source="Kick-ev" target="Ball-ob"/>
            <Edge  name="destinationOf”  source="Kick-ev"  target="GoalArea-
ob"/>

            <!--  Goal keeper does not catch the boal  -->
            <Edge  name="agentOf”  source="Not-Catch-ev"  target="Svensoon-
ob"/>
            <Edge name="patientOf” source="Not-Catch-ev" target="Ball-ob"/>
```

```
            <!--  Ball enters goal  -->
            <Edge name="agentOf" source="Enter-ev" target="Ball-ob"/>
            <Edge name="patientOf" source="Enter-ev" target="GoalArea-ob"/>

            <!--  Morientes is a player of the Spanish soccer team  -->
            <Edge           name="memberOf"           source="Morientes-ob"
target="SpanishTeam-ob"/>
            <!--  The goalkeeper is a player of the Swedish soccer team  --
>
            <Edge name="memberOf" source="Svensoon-ob" target="SwedishTeam-
ob"/>

            <!--  Time and location of goal event  -->
            <Edge name="timeOf" source="Goal-ev" target="goal2-time"/>
            <Edge  name="locationOf"  source="Goal-ev"  target="Santberna-
ob"/>
      </SemanticGraph>
</Semantic>
```

6.1.5 The Soccer Story

The example combines the semantic descriptions of the four previous sections into the story of the game.

```
<Semantic id="TheSoccerStory">
            <Label> <FreeTerm> The soccer story </FreeTerm> </Label>

      <!-- ######################################## -->
      <!-- Object descriptions                      -->
      <!-- ######################################## -->

      <PersonObject id="SpanishTeam-ob">
            <Label>
                  <ControlledTerm CSLocation="http://www.CSs.com/Sports"
                                  CSTermId="60"/>
            </Label>
            <Person xsi:type="PersonGroupType">
                  <Name> Spanish soccer team </Name>
                  <!--  People in the team  -->
                  <Person> </Person>
                  <Person> </Person>
                  <PersonRef idref="Morientes-person"/>
                  <PersonRef idref="Clemente-person"/>
            </Person>
      </PersonObject>
      <PersonObject id="SwedishTeam-ob">
            <Label>
                  <ControlledTerm CSLocation="http://www.CSs.com/Sports"
                                  CSTermId="60"/>
            </Label>
            <Person xsi:type="PersonGroupType">
                  <Name> Swedish soccer team </Name>
                  <!--  People in the team  -->
                  <Person> </Person>
                  <Person> </Person>
                  <PersonRef idref="Ingesoon-person"/>
                  <PersonRef idref="Svensoon-person"/>
            </Person>
      </PersonObject>
      <PersonObject id="Clemente-ob">
```

```
            <Label>
                  <FreeTerm xml:lang="en-us"> Soccer Coach </FreeTerm>
            </Label>
            <MediaOccurrence>
                  <MediaLocator>
                        <MediaURI> http://www.spain.sweeden.mpg </MediaURI>
                        <MediaTime>
                              <MediaTimePoint> T0:7:57 </MediaTimePoint>
                              <MediaDuration> PT15S </MediaDuration>
                        </MediaTime>
                  </MediaLocator>
            </MediaOccurrence>
            <Person xsi:type="IndividualType" id=”Clemente-person”>
                  <Name>
                        <GivenName>Javier</GivenName>
                        <FamilyName>Clemente</FamilyName>
                  </Name>
            </Person>
      </PersonObject>
      <PersonObject id="Reporter-ob">
            <Label>
                  <ControlledTerm CSLocation="http://www.CSs.com/Sports"
                                  CSTermId="4"/>
            </Label>
            <Definition>
                  <FreeText xml:lang="en-us">
                  Sports reporter for the Spanish TV1 whose name is Enrique
Guas
                  </FreeText>
            </Definition>
            <Person xsi:type="IndividualType">
                  <Name>
                        <GivenName>Enrique</GivenName>
                        <FamilyName>Guas</FamilyName>
                  </Name>
            </Person>
            <MediaOccurrence>
                  <MediaLocator>
                        <MediaURI> http://www.spain.sweeden.mpg </MediaURI>
                        <MediaTime>
                              <MediaTimePoint> T0:7:57 </MediaTimePoint>
                              <MediaDuration> PT15S </MediaDuration>
                        </MediaTime>
                  </MediaLocator>
            </MediaOccurrence>
      </PersonObject>
      <PersonObject id="Morientes-ob">
            <Label>
                  <ControlledTerm CSLocation="http://www.CSs.com/Sports"
                                  CSTermId="48"/>
                  </ControlledTerm>
            </Label>
            <MediaOccurrence>
                  <MediaLocator>
                        <MediaURI> http://www.spain.sweeden.mpg </MediaURI>
                        <MediaTime>
                              <MediaTimePoint> T0:9:54 </MediaTimePoint>
                              <MediaDuration> PT2S </MediaDuration>
                        </MediaTime>
                  </MediaLocator>
                  <Descriptor size="1">
```

```
                        <ElementDescriptorValue>
4617 11986 938 2628 458 1463 5178 2258 444 134 69 456 9300 2810 121 21 14
18 48 107 277 53 47 1926 8281 793 38 11 0 5 201 28 0 1 1 2 23 252 122 6 3
433 1517 46 1 1 0 0 0 0 0 0 0 0 2 55 13560 3326 678 221 1610 5602 916 32 8
1 21 58 11 1 0 0 2 61 331 179 14 7 2388 6213 51 0 0 0 0 0 0 0 0 0 2 337
243 0 0 220 194 0 0 0 0 0 0 0 0 0 0 0 0 383 3172 1072 51 20 91 128 0 0 0 0
0 2 4 0 0 0 0 89 757 694 0 0 217 39 0 0 0 0 0 0 0 0 0 0 0 0 912 210 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0 0 55
                        </ElementDescriptorValue>
                  </Descriptor>
                  <DescriptorName> ColorHistogram </DescriptorName>
            </MediaOccurrence>
            <MediaOccurrence>
                  <MediaLocator>
                        <MediaURI> http://www.spain.sweeden.mpg </MediaURI>
                        <MediaTime>
                              <MediaTimePoint> T0:14:4 </MediaTimePoint>
                              <MediaDuration> PT3S </MediaDuration>
                        </MediaTime>
                  </MediaLocator>
                  <Descriptor size="1">
                        <ElementDescriptorValue>
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18 48 107 277 53 47 1926 8281 793 38 11 0 5 201 28 0 1 1 2 23 252 122 6 3
433 1517 46 1 1 0 0 0 0 0 0 0 0 2 55 13560 3326 678 221 1610 5602 916 32 8
1 21 58 11 1 0 0 2 61 331 179 14 7 2388 6213 51 0 0 0 0 0 0 0 0 0 2 337
243 0 0 220 194 0 0 0 0 0 0 0 0 0 0 0 0 383 3172 1072 51 20 91 128 0 0 0 0
0 2 4 0 0 0 0 89 757 694 0 0 217 39 0 0 0 0 0 0 0 0 0 0 0 0 912 210 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0 0 55
                        </ElementDescriptorValue>
                        <DescriptorName> ColorHistogram </DescriptorName>
                  </Descriptor>
            </MediaOccurrence>
            <MediaOccurrence>
                  <MediaLocator>
                        <MediaURI> http://www.spain.sweeden.mpg </MediaURI>
                        <MediaTime>
                              <MediaTimePoint> T0:15:11 </MediaTimePoint>
                              <MediaDuration> PT2S </MediaDuration>
                        </MediaTime>
                  </MediaLocator>
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                        <ElementDescriptorValue>
4617 11986 938 2628 458 1463 5178 2258 444 134 69 456 9300 2810 121 21 14
18 48 107 277 53 47 1926 8281 793 38 11 0 5 201 28 0 1 1 2 23 252 122 6 3
433 1517 46 1 1 0 0 0 0 0 0 0 0 2 55 13560 3326 678 221 1610 5602 916 32 8
1 21 58 11 1 0 0 2 61 331 179 14 7 2388 6213 51 0 0 0 0 0 0 0 0 0 2 337
243 0 0 220 194 0 0 0 0 0 0 0 0 0 0 0 0 383 3172 1072 51 20 91 128 0 0 0 0
0 2 4 0 0 0 0 89 757 694 0 0 217 39 0 0 0 0 0 0 0 0 0 0 0 0 912 210 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0 0 55
                        </ElementDescriptorValue>
                        <DescriptorName> ColorHistogram </DescriptorName>
                  </Descriptor>
            </MediaOccurrence>
            <Person xsi:type="IndividualType" id=”Morientes-person”>
                  <Name>
                        <FamilyName>Morientes</FamilyName>
                  </Name>
            </Person>
      </PersonObject>
      <PersonObject id="Svensoon-ob">
```

```
            <Label>
                  <ControlledTerm CSLocation="http://www.CSs.com/Sports"
                                  CSTermId="45"/>
            </Label>
            <Person xsi:type="IndividualType" id=”Svensoon-person”>
                  <Name>
                        <FamilyName>Svensson</FamilyName>
                  </Name>
            </Person>
            <MediaOccurrence> </MediaOccurrence>
            <MediaOccurrence> </MediaOccurrence>
      </PersonObject>
      <PersonObject id="Ingesson-ob">
            <Label>
                  <ControlledTerm CSLocation="http://www.CSs.com/Sports"
                                  CSTermId="49"/>
            </Label>
            <MediaOccurrence>
                  <MediaLocator>
                        <MediaURI> http://www.spain.sweeden.mpg </MediaURI>
                        <MediaTime>
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                              <MediaDuration> PT1S </MediaDuration>
                        </MediaTime>
                  </MediaLocator>
            </MediaOccurrence>
            <Definition>
                  <FreeText xml:lang="en-us">
                  Player for the Swedish soccer team whose name is Ingesson
                  </FreeText>
            </Definition>
            <Person xsi:type="IndividualType" id=”Ingesson-person”>
                  <Name>
                        <FamilyName>Ingesson</FamilyName>
                  </Name>
            </Person>
      </PersonObject>
      <Object id="Ball-ob">
            <Label>
                  <ControlledTerm CSLocation="http://www.CSs.com/Sports"
                                  CSTermId="46"/>
            </Label>
            <MediaOccurrence> </MediaOccurrence>
            <MediaOccurrence> </MediaOccurrence>
      </Object>

      <!-- ######################################## -->
      <!—- Event descriptions                      -->
      <!-- ######################################## -->

      <Event id="Interview-ev">
            <Label>
                  <FreeTerm xml:lang="en-us"> Interview </FreeTerm>
            </Label>
            <MediaOccurrence>
                  <MediaLocator>
                        <MediaURI> http://www.spain.sweeden.mpg </MediaURI>
                        <MediaTime>
                              <MediaTimePoint> T0:7:57 </MediaTimePoint>
                              <MediaDuration> PT15S </MediaDuration>
                        </MediaTime>
```

```
                  </MediaLocator>
            </MediaOccurrence>
            <Event id="Talk-ev">
                  <Label>
                        <FreeTerm xml:lang="en-us"> Talk </FreeTerm>
                  </Label>
            </Event>
      </Event>
      <Event id="Coach-ev">
            <Label>
                  <FreeTerm xml:lang="en-us"> Coach </FreeTerm>
            </Label>
      </Event>
      <Event id="Game-ev">
            <Label>
                  <FreeTerm xml:lang="en-us"> Soccer Game </FreeTerm>
            </Label>
            <MediaOccurrence>
                  <MediaLocator>
                        <MediaURI> http://www.spain.sweeden.mpg </MediaURI>
                        <MediaTime>
                              <MediaTimePoint> T0:5:00 </MediaTimePoint>
                              <MediaDuration> PT1h35M </MediaDuration>
                        </MediaTime>
                  </MediaLocator>
            </MediaOccurrence>
            <Event id="Goal1-ev">
                  <Label>
                        <ControlledTerm
CSLocation="http://www.CSs.com/Sports"
                                          CSTermId="43">
                        <Label xml:lang="en-us"> Goal </Label>
                        </ControlledTerm>
                  </Label>
                  <Definition>
                        <FreeText xml:lang="en-us">
                        Soccer goal
                        </FreeText>
                  </Definition>
                  <MediaOccurrence>
                        <MediaLocator>
                        <MediaURI> http://www.spain.sweeden.mpg </MediaURI>
                              <MediaTime>
                                    <MediaTimePoint>                T0:9:45
</MediaTimePoint>
                                    <MediaDuration> PT2S </MediaDuration>
                              </MediaTime>
                        </MediaLocator>
                        <Descriptor size="1">
                              <ElementDescriptorValue>
4617 11986 938 2628 458 1463 5178 2258 444 134 69 456 9300 2810 121 21 14
18 48 107 277 53 47 1926 8281 793 38 11 0 5 201 28 0 1 1 2 23 252 122 6 3
433 1517 46 1 1 0 0 0 0 0 0 0 0 2 55 13560 3326 678 221 1610 5602 916 32 8
1 21 58 11 1 0 0 2 61 331 179 14 7 2388 6213 51 0 0 0 0 0 0 0 0 0 0 2 337
243 0 0 220 194 0 0 0 0 0 0 0 0 0 0 0 0 383 3172 1072 51 20 91 128 0 0 0 0
0 2 4 0 0 0 0 89 757 694 0 0 217 39 0 0 0 0 0 0 0 0 0 0 0 0 912 210 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0 0 55
                              </ElementDescriptorValue>
                              <DescriptorName>                  GoFGoPColor
</DescriptorName>
                        </Descriptor>
```

```
                  </MediaOccurrence>
                  <Event id="Kick-ev">
                        <Label xml:lang="en-us"> Kick </Label>
                  </Event>
                  <Event id="Error-ev">
                        <Label xml:lang="en-us"> Makes an error </Label>
                  </Event>
            </Event>
            <Event id="Run1-ev">
                  <Label>
                        <FreeTerm xml:lang="en-us"> Run </FreeTerm>
                  </Label>
                  <MediaOccurrence>
                        <MediaLocator>
                              <MediaURI>       http://www.spain.sweeden.mpg
</MediaURI>
                              <MediaTime>
                                    <MediaTimePoint>                T0:14:4
</MediaTimePoint>
                                    <MediaDuration> PT3S </MediaDuration>
                              </MediaTime>
                        </MediaLocator>
                        <Descriptor size="1">
                              <ElementDescriptorValue>
4617 11986 938 2628 458 1463 5178 2258 444 134 69 456 9300 2810 121 21 14
18 48 107 277 53 47 1926 8281 793 38 11 0 5 201 28 0 1 1 2 23 252 122 6 3
433 1517 46 1 1 0 0 0 0 0 0 0 0 2 55 13560 3326 678 221 1610 5602 916 32 8
1 21 58 11 1 0 0 2 61 331 179 14 7 2388 6213 51 0 0 0 0 0 0 0 0 0 2 337
243 0 0 220 194 0 0 0 0 0 0 0 0 0 0 0 383 3172 1072 51 20 91 128 0 0 0 0
0 2 4 0 0 0 0 89 757 694 0 0 217 39 0 0 0 0 0 0 0 0 0 0 0 912 210 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0 55
                              </ElementDescriptorValue>
                              <DescriptorName>                  GoFGoPColor
</DescriptorName>
                        </Descriptor>
                  </MediaOccurrence>
            </Event>
            <Event id="Run2-ev">
                  <Label>
                        <FreeTerm xml:lang="en-us"> Run </FreeTerm>
                  </Label>
                  <MediaOccurrence>
                        <MediaLocator>
                              <MediaURI> http://www.spain.sweeden.mpg
                              </MediaURI>
                              <MediaTime>
                                    <MediaTimePoint>                T0:14:5
</MediaTimePoint>
                                    <MediaDuration> PT1S </MediaDuration>
                              </MediaTime>
                        </MediaLocator>
                  </MediaOccurrence>
            </Event>
            <Event id="Goal2-ev">
                  <Label>
                        <ControlledTerm
CSLocation="http://www.CSs.com/Sports" CSTermId="43">
                              <Label xml:lang="en-us"> Goal </Label>
                        </ControlledTerm>
                  </Label>
                  <MediaOccurrence>
```

```
                        <MediaLocator>
                        <MediaURI> http://www.spain.sweeden.mpg </MediaURI>
                              <MediaTime>
                                    <MediaTimePoint>                T0:15:11
</MediaTimePoint>
                                    <MediaDuration> PT2S </MediaDuration>
                              </MediaTime>
                        </MediaLocator>
                        <Descriptor size="1">
                              <ElementDescriptorValue>
4617 11986 938 2628 458 1463 5178 2258 444 134 69 456 9300 2810 121 21 14
18 48 107 277 53 47 1926 8281 793 38 11 0 5 201 28 0 1 1 2 23 252 122 6 3
433 1517 46 1 1 0 0 0 0 0 0 0 0 2 55 13560 3326 678 221 1610 5602 916 32 8
1 21 58 11 1 0 0 2 61 331 179 14 7 2388 6213 51 0 0 0 0 0 0 0 0 0 2 337
243 0 0 220 194 0 0 0 0 0 0 0 0 0 0 0 383 3172 1072 51 20 91 128 0 0 0 0
0 2 4 0 0 0 0 89 757 694 0 0 217 39 0 0 0 0 0 0 0 0 0 0 0 912 210 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0 55
                              </ElementDescriptorValue>
                              <DescriptorName>               ColorHistogram
</DescriptorName>
                        </Descriptor>
                  </MediaOccurrence>
                  <Event id="Kick2-ev">
                        <Label>
                              <FreeTerm xml:lang="en-us"> Kick </FreeTerm>
                        </Label>
                  </Event>
                  <Event id="Not-Catch-ev">
                        <Label>
                              <FreeTerm    xml:lang="en-us">    Not    catch
</FreeTerm>
                        </Label>
                  </Event>
                  <Event id="Enter-ev">
                        <Label>
                              <FreeTerm xml:lang="en-us"> Enter </FreeTerm>
                        </Label>
                  </Event>
            </Event>
            <Event id="Win-ev">
                        <Label>
                              <FreeTerm xml:lang="en-us"> Win </FreeTerm>
                        </Label>
                  </Event>
            </Event>
      </Event>

      <!-- ######################################## -->
      <!—- Location object descriptions             -->
      <!-- ######################################## -->

      <LocationObject id=“Santberna-ob”>
            <Label> <FreeTerm> Soccer stadium </FreeTerm> </Label>
            <Place>
                  <Name xml:lang=’en’> Santiago Bernabeu </Name>
                  <Planet> Earth </Planet>
                  <Country> Spain </Country>
                  <PostalAddress>
                        <AddressLine>
                              C/Fabregas No. 26, Barcelona
                        </AddressLine>
```

```
                  <PostingIdentifier> E-64200 </PostingIdentifier>
            </PostalAddress>
      </Place>
      <MediaOccurrence> </MediaOccurrence>
</LocationObject>
<LocationObject id="GoalArea-loc">
      <Label>
            <ControlledTerm CSLocation="http://www.CSs.com/Sports"
                        CSTermId="65">
                  <Label xml:lang="en-us"> Goal object </Label>
            </ControlledTerm>
      </Label>
      <MediaOccurrence> </MediaOccurrence>
      <MediaOccurrence> </MediaOccurrence>
      <Place> <Name> Goal area </Name> </Place>
</LocationObject>

<!-- ######################################## -->
<!-- Semantic time descriptions               -->
<!-- ######################################## -->

<SemanticTime id="interview-time">
      <Label> <FreeTerm> Saturday </FreeTerm> </Label>
      <Time>
            <MediaTimePoint> 2000-3-20T20:31:00 </MediaTimePoint>
            <MediaDuration> PT15S </MediaDuration>
      </Time>
</SemanticTime>
<SemanticTime id="game-time">
      <Label> <FreeTerm> Saturday </FreeTerm> </Label>
      <Time>
            <MediaTimePoint> 2000-3-20T20:32:00 </MediaTimePoint>
            <MediaDuration> PT1H35M </MediaDuration>
      </Time>
</SemanticTime>
<SemanticTime id="goal1-time">
      <Label> <FreeTerm> Saturday </FreeTerm> </Label>
      <Time>
            <MediaTimePoint> 2000-3-20T20:33:00 </MediaTimePoint>
            <MediaDuration> PT2S </MediaDuration>
      </Time>
</SemanticTime>
<SemanticTime id="Run1-time">
      <Label> <FreeTerm> Saturday </FreeTerm> </Label>
      <Time>
            <MediaTimePoint> 2000-3-20T20:37:00 </MediaTimePoint>
            <MediaDuration> PT3S </MediaDuration>
      </Time>
</SemanticTime>
<SemanticTime id="Run2-time">
      <Label> <FreeTerm> Saturday </FreeTerm> </Label>
      <Time>
            <MediaTimePoint> 2000-3-20T20:37:00 </MediaTimePoint>
            <MediaDuration> PT1S </MediaDuration>
      </Time>
</SemanticTime>
<SemanticTime id="goal2-time">
      <Label> <FreeTerm> Saturday </FreeTerm> </Label>
      <Time>
            <MediaTimePoint> 2000-3-20T20:38:00 </MediaTimePoint>
            <MediaDuration> PT1S </MediaDuration>
```

```
            </Time>
      </SemanticTime>

      <!-- ######################################## -->
      <!—- Semantic relation descriptions          -->
      <!-- ######################################## -->

      <SemanticGraph>

            <!-- ######################################## -->
            <!—- Interview before the game               -->
            <!-- ######################################## -->

            <Edge name="before" source="Interview-ev" target="Game-ev"/>

            <!--  Reporter interviews coach  -->
            <Edge  name="agentOf"  source="Interview-ev"  target="Reporter-
ob"/>
            <Edge  name="patientOf"  source="Interview-ev"  target="Clemente-
ob"/>
            <Edge  name="timeOf"  source="interview-ev"  target="interview-
time"/>

            <!--  Coach talks about game  -->
            <Edge name="agentOf" source="Talk-ev" target="Clemente-ob"/>
            <Edge name="themeOf" source="Talk-ev" target="Game-ev"/>

            <!-- ######################################## -->
            <!—- Info about game                        -->
            <!-- ######################################## -->

            <!--  The game's home team is the Spanish soccer team  -->
            <!--  The game's visiting team is the Swedish soccer team  -->
            <Edge  name="homeTeam"  source="Game-ev"  target="SpanishTeam-
ob"/>
            <Edge name="visitingTeam" source="Game-ev" target="SwedishTeam-
ob"/>

            <!--  Location of game  -->
            <Edge  name="locationOf"  source="Game-ev"  target="Santberna-
ob"/>

            <!-- ######################################## -->
            <!—- Members of soccer teams                 -->
            <!-- ######################################## -->

            <!--  Morientes is a player of the Spanish soccer team  -->
            <!--  Clemente is a member of the Spanish soccer team  -->
            <!--  The Svensoon is a player of the Swedish soccer team  -->
            <!--  Ingesson is a player of the Swedish soccer team  -->
            <Edge name="memberOf" source="Morientes-ob"
                  target="SpanishTeam-ob"/>
            <Edge name="memberOf" source="Clemente-ob" target="SpanishTeam-
ob"/>
            <Edge name="memberOf" source="Svensoon-ob" target="SwedishTeam-
ob"/>
            <Edge name="memberOf" source="Ingensson-ob"
                  target="SwedishTeam-ob"/>

            <!--  The above is not really necessary because the teams are -
->
```

```
            <!--  with PersonGroup DS with already includes this info -->

            <!-- ######################################## -->
            <!—- Events in soccer game                    -->
            <!-- ######################################## -->

                              <!--  Goal 1  -->

            <!--  Location and time of the goal event  -->
            <Edge name="timeOf" source="Goal1-ev" target="goal1-time"/>

            <!--  Morientes kicks ball into goal towards the Goal -->
            <Edge name=“agentOf” source="Kick1-ev" target="Morientes-ob"/>
            <Edge name="patientOf" source="Kick1-ev" target="Ball-ob"/>
            <Edge  name="destinationOf"  source="Kick1-ev"  target=“GoalArea-
loc”/>

            <!--  Goalkeeper makes an error  -->
            <Edge name=“agentOf” source="Error-ev" target="Svensoon-ob"/>

                              <!--  Just running  -->

            <!--  Morientes runs  -->
            <Edge name=“agentOf” source="Run1-ev" target="Morientes-ob"/>
            <Edge name="timeOf" source="run1-ev" target=“Run1-time"/>

            <!--  Ingesson runs  -->
            <Edge name=“agentOf” source="Run2-ev" target="Ingensson-ob"/>
            <Edge name="timeOf" source="Run2-ev" target=“Run2-time"/>

                              <!--  Goal 2  -->

            <!--  Time and location of goal event  -->
            <Edge name="timeOf" source="Goal2-ev" target="goal2-time"/>

            <!--  Morientes kicks the ball toward the goal area  -->
            <Edge name=“agentOf” source="Kick2-ev" target="Morientes-ob"/>
            <Edge name="patientOf" source="Kick2-ev" target="Ball-ob"/>
            <Edge  name="destinationOf"  source="Kick2-ev"  target=“GoalArea-
loc”/>

            <!--  Goal keeper does not catch the boal  -->
            <Edge  name=“agentOf”  source="Not-Catch-ev"  target="Svensoon-
ob"/>
            <Edge name="patientOf" source="Not-Catch-ev" target="Ball-ob"/>

            <!--  Ball enters goal  -->
            <Edge name=“agentOf” source="Enter-ev" target="Ball-ob"/>
            <Edge   name="patientOf"   source="Enter-ev"   target=“GoalArea-
loc”/>

            <!-- ######################################## -->
            <!—- More temporal info about events         -->
            <!-- ######################################## -->

            <Edge name="before" source="Run1-ev" target=“Goal1-ev”/>
            <Edge name="starts" source="Run1-ev" target=“Goal2-ev”/>
            <Edge name="before" source="Run2-ev" target=“Goal2-ev”/>

            <!-- ######################################## -->
            <!—- Result of the game                       -->
```

```
            <!-- ######################################## -->

            <!--  Spanish soccer team wins the game  -->
            <Edge name="agentOf" source="Win-ev" target="SpanishTeam-ob"/>
            <Edge name="resultOf" source="Game-ev" target="Win-ev"/>

      </SemanticGraph>
</Semantic>
```

6.2 Love Scene

See below the description for "A kiss between two young lovers at the same time as the artist was completing his painting on the corner where they first met. The lovers are Mari and Daniel. The artist is Leonardo Persiana". More details are included below.

```
<Semantic id="LoveScene">
      <Label> <FreeTerm> Love scene </FreeTerm> </Label>

<Event id="Event1">
      <Label> <FreeTerm> Kiss </FreeTerm> </Label>
      <Definition>
            <FreeText> A kiss between two joung lovers <FreeText>
      </Definition>
      <MediaOccurrence>
            <MediaLocator>
                  <MediaURL> http://www.seven.com/seven.jpg </MediaURL>
            </MediaLocator>
      <MediaOccurrence>
      <RelationLink name="timeOf" target="Event1-time">
      <RelationLink name="locationOf" target="Event1-loc">
</Event>
<SemanticTime id="Event1-time">
      <Definition>
            <FreeText>
                  At the same time as the artist was
                  completing his painting
            </FreeText>
      </Definition>
      <RelationLink name="equivalent" target="Event2-time">
</SemanticTime>
<LocationObject id="Event1-loc">
      <Label>
            <FreeTerm>
                  On the street corner where the lovers first met
            </FreeTerm>
      </Label>
      <RelationLink name="equivalent" target="Event3-loc">
</LocationObject>

<Event id="Event2">
      <Label> <FreeTerm> Painting </FreeTerm> </Label>
      <Definition>
            <FreeText> The artist is completing his painting </FreeText>
      </Definition>
      <RelationLink name="agentOf" target="PersonObject1"/>
      <RelationLink name="timeOf" target="Event2-time"/>
</Event>
<SemanticTime id="Event2-time">
      <Time>
```

```
            <TimePoint> 2000-8-23T22:00:00 </TimePoint>
      </Time>
</SemanticTime>

<Event id="Event3">
      <Label> <FreeTerm> First meeting </FreeTerm> </Label>
      <Definition>
            <FreeText> The lovers' first meeting </FreeText>
      </Definition>
      <RelationLink name="agentOf" target="PersonObject2"/>
      <RelationLink Relation="accompanierOf" target="PersonObject3"/>
      <RelationLink Relation="locationOf" target="Event3-loc"/>
</Event>
<LocationObject id="Event3-loc">
      <Label> <FreeTerm> Brescia </FreeTerm> </Label>
      <Place>
            <Name xml:lang='en'> Brescia </Name>
            <Country> Italy </Country>
            <Region> Lombardia </Region>
            <PostalAddress>
                  <AddressLine> Via Caduti del Lavoro 114 </AddressLine>
                  <PostingIdentifier> 25100 </PostingIdentifier>
            </PostalAddress>
      </Place>
</LocationObject>

<PersonObject id="PersonObject1">
      <Label>
            <FreeTerm xml:lang="en-us"> The Artist </FreeTerm>
      </Label>
      <Person xsi:type="IndividualType">
            <Name>
                  <GivenName> Leonardo </GivenName>
                  <FamilyName> Persiana </FamilyName>
            </Name>
      </Person>
</PersonObject>
<PersonObject id="PersonObject2">
      <Label>
            <FreeTerm xml:lang="en-us"> Daniel </FreeTerm>
      </Label>
      <Person xsi:type="IndividualType">
            <Name>
                  <GivenName> Daniel </GivenName>
                  <FamilyName> German </FamilyName>
            </Name>
      </Person>
</PersonObject>
<PersonObject id="PersonObject3">
      <Label>
            <FreeTerm xml:lang="en-us"> Maria </FreeTerm>
      </Label>
      <Person xsi:type="IndividualType">
            <Name>
                  <GivenName> Maria </GivenName>
                  <FamilyName> Lucia </FamilyName>
            </Name>
      </Person>
</PersonObject>

</Semantic>
```

6.3 Strength of Relations: Ripe Banana

We wish to describe a ripe banana, using graphical elements, Semantic elements, and illustrating the use of the Properties DS and the SemanticState DS (see diagram in Figure 9). In the diagram, the following abbreviations were made:

- Membership in (is the membership function for) is denoted $\in$.
- Is similar to is denoted $\approx$.
- Membership functions are expressed as SemanticState DS and are abbreviated State.
- Analytical Models, in this case containing Color Histograms are abbreviated Model.

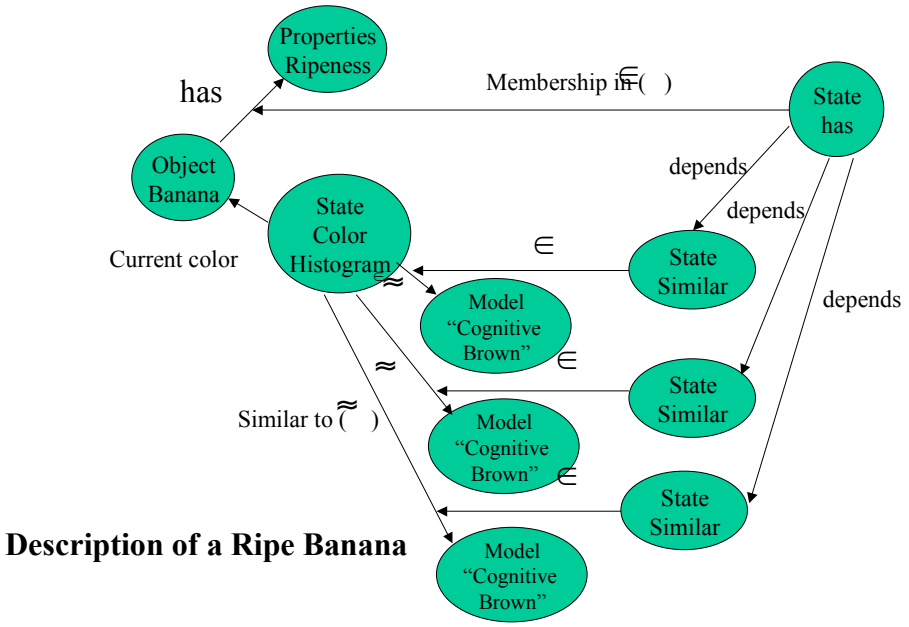

Figure 9: Description of a ripe banana using of membership functions, relations, the Properties DS, and the SemanticState DS

The diagram shows the following things:

1. The Properties, as advertised, is for adjectival qualities. Ripeness is such a quality. There is only one property in this DS, but there could be a list.
2. The Banana is an abstraction or a media abstraction, and "has" the property Ripeness. It also has a SemanticState attached to it, which contains a Color Histogram, and has the relation "current color". In a streaming application, this SemanticState is updated as the color histogram changes.
3. The "has" relationship between the object Banana and the property Ripeness has a SemanticState tracking (giving the parameter value for) the membership of this pair in the relation "has".
4. The three cognitive colors Brown, Yellow, and Green, which are used to describe the membership in Ripeness, are modeled using Analytic Model, they are color histograms of these three colors.
5. The membership parameter in the SemanticState for the "has" relationship is calculated from the membership parameters of the three relationships "is similar to" which point from the SemanticState to each of the Analytic Models. Therefore it has a "depends on" relationship to these three. It varies from 0 when the the Current Color is most similar to the cognitive color Green, to 1 when the Current Color is most similar to the cognitive color Brown.

This is a complex description for a simple object, mostly for use as an illustration. However, it is good to look at what the description can do: It quantifies the high-level property "Ripeness" using low level features, such

that a search for a ripe banana need only specify how ripe the banana should be. It shows the mechanism for building complex membership functions from basic ones, and it is potentially a "self updating" description.

From the diagram, it should be noted:

1. It is possibly clearer to derive a "Membership Function" from SemanticState by extension, the extension giving the formula for calculating the function from the parameters.
2. If a many-to-one relation is allowed between membership functions and relations, then the three membership functions for the "is similar to" relations could be parameters of the membership function for "has". They are different relations however, and this might be confusing, although compact.

```
<xml> Work in progress </xml>
```

7 Annex C: Open Issues in Specification of Semantic DS

This sections contains a list of open issues remaining in the specification of the Semantic DS. These were generated by the participants of this CE and some reviewers.

- Is the Sematnic DS useful to described Audio?
- For the Semantic DS to be useful, computer system must be able to make inferences over MPEG-7 semantic description. It would be interesting to define a mapping from the current semantics to some sort of formal – e.g. formal logic, etc.
- Should we consider introduce variable binding into the formalism?
- Would be worth considering whether we should adopt an existing formalism, like conceptual graphs, as a basis for the Semantic DS.
- Should the Semantic DS be to represent connotations? For example the fact that this video segment symbolizes the freedom of mankind?
- XML type inheritance versus Semantic Type inheritance of objects and events: <Ball> </Ball> or <Object id=”ball”> </Object>
- How would I represent that old chestnut “The cat is on the mat”. Is this a state? An event? Something else? How about “the banana ripened from green to yellow”?
- Currently, media occurrences are embedded inside objects and event. They can be moved outside to semantic entities. There are other cases where it is important to associate a Semantic Description (entity) to another entity. One example is to represent the semantic interpretation of text, a second is to attach semantic to segments. What does it mean to say an object has a “MediaOccurrence” in a video segment. Does Bill Clinton occur in a news segment about him that does not show an image of him? Or must a media occurrence be perceivable?
- The Semantic State DS, Is a state temporally bounded? Or timeless? What does it mean to attach a semantic state to an event? See questions for the sunset example. What is the meaning of the “Attribute” element? It is not described in the semantics. Is this the “Property” element referred to in the semantics? If so, the meaning is still not clear. What does “identifies semantic properties of the entity at any given time” mean? Specifically, what are “semantic properties”? What are “verbal attributes”? What does it mean to attach states to entities other than objects? What is the relation between the Property DS and this SemanticState DS? Shouldn’t the attributes come from a controlled vocabulary? Would it make sense to limit States to apply to Objects only?
- Abstract DS (Concept DS now): Abstraction here seems to mean connotation or symbol. If so, then still want to be able to link this back to the media to say that this. Can any semantic entity (object/event/etc) be represented using this DS? Let’s take the freedom example a bit more. Suppose I have a video showing the fall of the Berlin wall. This could be described (by the newscaster) as “East Germany at long lost has come to know freedom” Is this event abstract? What are the properties of an abstract DS?
- Is the representation of “world time” supported by the Time DS?