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Title:	**Report of CE on Semantic DS**
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Status:	**Contribution**

1 Introduction

This document reports on the core experiment on the Semantic DS [5]. 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 CE originally started at the Maui meeting in December 1999 [4]. Progress reports of the CE were provided at the Geneva meeting [1], at the Beijing meeting [3], and at the La Baule meeting [2]. In La Baule, some components of the Semantic DS were promoted to the WD - Semantic DS, SemanticBase DS, Object DS, Event DS, AgentObject DS, SemanticPlace DS, SemanticTime DS, MediaOccurrence DS, and semantic relations-, and others were promoted to the XM – SemanticState DS, Concept DS, and AbstractionLevel datatype. The goal of this CE is to continue the refinement and evaluation of the Semantic DS and to continue the evaluation of the use of membership functions to describe relation strength. The AbstractionLevel datatype was promoted to CD before Pisa. At Pisa, the work to update the specification of the the SemanticTime, SemanticPlace, and Event DSs and to explain the methods for abstraction and the use of abstract concepts was started.

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

1. To refine the specification of the Semantic DS by solving open issues identified by reviewers and previous CEs,

2. To recommend the standardization of more semantic relations,

3. To continue the investigation of the use of membership functions to describe the strength of relations,

4. To generate simple and complex semantic descriptions of multimedia material,

5. To continue the implementation of a retrieval and browsing application/s that use/s the generated descriptions and that show/s the functionality of the DSs in the MDS XM, and

6. To recommend changes and additions to the Semantic DS based on the results of the experiment.

The retrieval application that the CE continued the development of the software that had already been integrated into the XM for the Semantic DS.

2 Work Plan

The experiment will start after the Pisa meeting in January 2001 and shall generate a report of the results at the 56th meeting in Singapore, March 2001. The experiment will update the XM software for the Semantic DS.

2.1 Parties

The participants of this Core Experiment are listed in the following table.

Name	Company
Hawley Rising	Sony, USA
Ana Belén Benítez Jiménez	Columbia University, USA
Corinne Jörgensen	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 retrieval and browsing applications 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. Movies and soap operas (fictional content) from MPEG-7 content set.

2. CD 14, CD 18, CD 20, CD 28: Sporting event videos

3. CD 14, CD 15: News videos

4. CD 28: Documentaries

5. Melbourne Photo Database

6. (http://www.cre.canon.co.uk/mpeg7/melbourne_photo_database.htm)

7. Material collected from other sources.

8. Getty Art Institute material if available.

2.4 Output

The output of this core experiment shall be a refined and more complete specification of the Semantic DS (specially for the DS/Ds in the XM), and an application/s that retrieves and browses multimedia material based on semantic descriptions. The retrieval application should demonstrate the functionality of the components of the Semantic DS in a retrieval and browsing scenario. It is the intent of the participants to finish all outstanding DS (in XM), the application scenarios, and the text recommendations in their entirety by the Singapore meeting.

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

- Description of audio data.

- Description of connotations, symbolisms, and interpretations.

- Description of composite agents.

- Descriptions of multimedia content with multiple narrative worlds.

- Definition of a mapping from Semantic DS to some sort of formal – e.g. formal logic, etc.

- Introduction of variable binding into the formalism.

- Adoption of existing formalism, like conceptual graphs, as a basis for the Semantic DS.

- XML type inheritance versus Semantic Type inheritance of objects and events: <Ball> </Ball> or <Object id="ball"> </Object>

- Description of "The cat is on the mat". Is this a state? An event? Something else? How about "the banana ripened from green to yellow"?

- Examine further references and relations, with respect to abstraction.

- Generating very clear concise and complete text within the CD textual specification, especially the parts relevant to abstraction and the abstraction model.

- Generating examples relevant to explaining the model, especially a football scenario which shows "top down" use of abstraction.

- Finish validating and implementing the remaining DS from the XM.

2.5 Measurement

The experiment shall demonstrate the descriptive power of the Semantic DS to express preexisting textual descriptions and to encode new descriptions of multimedia material. The experiment shall try 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 shall also demonstrate 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) Further specify how to use memberships functions and states within the Graph DS to describe changing strength of relations.

3) 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).

4) Recommendations to standardize more relations among semantic entities. More relations identified by the CE on Structured Textual Description [6] will be considered, for example.

5) Selection and description of suitable image, video, and audio material from the MPEG-7 content set.

6) Selection of preexisting textual descriptions for multimedia material.

7) Generation of XML descriptions for the selected content and preexisting descriptions instantiating the Semantic DS. These descriptions should be shared among all the participants.

8) Continue implementation of a retrieval that uses the XML descriptions. The retrieval application can make use of an existing ontology, for example, WordNet.

9) Implementation of a browsing application (maybe in combination with retrieval application) that uses the descriptions of membership functions and states to browse multimedia material.

10) Assess the descriptive power of the Semantic DS with instantiations of the Semantic DS and evaluating the effectiveness of the retrieval and browsing application, in special, the DSs included in the MDS XM.

11) Recommendations to change and extend the Semantic DS based on the results of the experiment.

12) Generate a "football" scenario to explore and report the use of abstractions in Semantic DS.

13) Report of the results of the core experiment.

2.7 Time Table

The Semantic DS core experiment shall be conducted according to the following timetable:

February 5, 2001	February 20, 2001	March 1, 2001
Select multimedia material and preexisting description of multimedia material		
Further specify the use of membership functions to describe strength of relations		
Generate and recommend sections to the text portions of the document		

explaining abstraction.	
Refine specification of Semantic DS Recommend to standardize other semantic relations Generate XML descriptions of multimedia material or encode preexisting descriptions using Semantic DS Finish implementation of retrieval and browsing application Generate textual examples of a football game to demonstrate the abstraction model.	
	Measure the descriptive power of the Semantic DS and components with adequate description and evaluate the effectiveness of the retrieval and browsing applications Report of results of the experiment

2.8 Monitoring

The core experiment work shall be 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 Pisa 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 DS descriptions.

3.1 Specification of the Semantic DS

The specification of the Semantic has been further refined and completed since the Pisa meeting. The proposed changes to the Semantic DS and related Ds/DSs are presented in this section. The updated syntax, semantics, and examples of some components of the Semantic DS are included in Annex A. The proposed changes are mostly based on the examples of the Semantic DS generated during this CE, which are discussed in section 3.2 and included in Annex B, on the development of the retrieval and browsing software for Semantic DS descriptions, which is described in section 3.3, and a deeper analysis and understanding of the semantic description tools.

3.1.1   General Comments

General open issues identified in the current specification of the Semantic DS together with proposals on how to solve them are listed below.

1. *Comment:* The **SemanticPlace DS** can not describe distance or extent (e.g., five kilometers).

    Proposal: Define two new semantic measurement attributes, Position and Extent datatypes, that can be used to describe semantic positions and extents for not only semantic place (SemanticPlace DS) but also semantic time (SemanticTime DS). The specification of the Position and Extent datatypes together with the updates to the SemanticPlace DS and SemanticTime DS are included in Annex A.

2. *Comment:* The **Event DS** contains directly SemanticTime DS but not SemanticPlace DS.

    Proposal: Add SemanticPlace DS to Event DS with occurrence "minOccurs="0 maxOccurs="unbounded". The updated specification of the Event DS is provided in Annex A.

3. *Comment:* A formal abstract agent object can not be described because **AgentObject DS** requires Agent DS and, therefore, a name for the agent object.

    Proposal: Change the occurrence of Agent DS in AgentObject DS from "minOccurs=1" to "minOccurs=0.

4. *Comment:* An **AgentObject DS** description can not reuse an existing Agent DS description of the agent object.

    Proposal: Add AgentRef of type ReferenceType in AgentObject DS.

5. *Comment:* The number of **dependencies** between the descriptions tools that describe the semantic aspects of the content and other MPEG-7 MDS description tools in extremely high, especially because of **MediaOccurrence** in SemanticBase DS that includes DescriptorCollection DS. This issue is extensively described and demonstrated in Annex C.

   Proposal: Replace the DescriptorCollection in MediaOccurence with a spare set of audio and visual descriptors and description schemes. The proposed changes to the specification of the SemanticBase DS are included in Annex A. Another option would be to define a GenericSegment DS that can not be decomposed whose specification is the updated MediaOccurrence.

6. *Comment:* The **SemanticState DS** supports a limited list of value types and does not contain unit information (e.g., pounds) for each attribute value.

   Proposal: There is a need, when defining the state of a semantic entity, to use a combination of basic datatypes and possibly descriptors. This avoids using the basic datatypes for everything, when the descriptors can be controlled (by standardization). To do this, we modify AttributeValuePair in SemanticBase DS with an augmented list of value types as specified in Annex A. Add a Unit element of type TextualString in AttributeValuePair for unit information.

7. *Comment:* The **SemanticState DS** can describe attributes of objects and events such as color and texture using integer and vector values in a similar way to color and texture descriptors. Therefore, there seems to be some overlapping of the functionality of the SemanticState DS and the DescriptorCollection DS in MediaOccurrence.

   Proposal: The list of value types in the SemanticState DS has been augmented with descriptors. See Annex A for the details.

8. *Comment:* Clearer terminology and text is needed to clarify the functionality of **abstractions and concepts**.

   Proposal: The terminology and explanatory text for abstractions and concepts proposed by this CE is provided in Annex D.

9. *Comment:* Mapping of Semantic DSs to a **existing formalism (category graph)** was done in previous meetings; however, it is missing from the current specification of the Semantic DS.

   Proposal: Create an input document to FDIS describing the formal grounding of the MPEG-7 Semantic DSs. These could be an information or normative part of FDIS.

3.1.2 Semantic Relations

Open issues about describing relations among semantic entities identified in the current specification of the Semantic DS together with proposals on how to solve them are listed below.

1. *Comment:* There are not **standard temporal and spatial relations** among semantic times and semantic places, respectively. Therefore, it is not possible to represent the following: "Queens is touching Brooklyn" or "The time of the Ball is after the time of the Wedding".

   Proposal: Add the normative temporal and spatial segment relations to the list of standard relations among semantic times and among semantic places, respectively. Therefore, temporal and spatial relations among events could be described as temporal and spatial relations among the times and places when and where they happen, respectively. In this way, spatial relations could also be described among objects when participating in events. Another possibility is also to add the temporal and spatial segment relations to the list of standard relations among events and among objects, respectively.

2. *Comment:* **Objects** can currently act **as locations** where events take place, e.g., the relations *locationOf, sourceOf, destinationOf,* and *pathOf (*and inverse relations) allow describing an object as being the location, source, destination, or path of an event.

   Proposal: If this is an issue, we should remove the following from the list of relations between objects: locationOf/hasLocationOf, pathOf/hasPathOf, and sourceOf/hasSourceOf.

3. *Comment:* **Temporal and spatial information** is not inherent to **objects**. However, the only way to describe semantic time and place information about objects is for the objects to participate in events for which temporal and spatial information is described. Therefore, it is not possible to describe the following: "Ana is in Singapore today".

Proposal: Add *locationOf/hasLocationOf* and *timeOf/hasTimeOf* as normative relations between semantic places and objects, and between semantic times and objects, respectively. Another option is to make these relations normative between semantic place and semantic entity, and between semantic time and semantic entity, respectively, as shown in Annex A. Consider also allowing *locationOf/hasLocationOf* and *timeOf/hasTimeOf* as normative relations between semantic places and semantic relations, and between semantic times and semantic relations.

4. *Comment:* The **composition of events** can only be described using nested Event DS descriptions; however, there are several compositions relations between objects(e.g., *memberOf* and *componentOf*).

   Proposal: Add *partOf* and *hasPartOf* to the list of standard relations between event or any semantic entities.

5. *Comment:* Objects and narrative worlds could occur in other objects in the same way as objects and narrative worlds can occur in the media. In these cases, a description involves **multiple narrative worlds** such as the example of the music album CD in Annex B. The current Semantic DS lacks relations to directly describe the occurrence of semantic entities in other semantic entities. The example in Annex B informally used *equivalentTo* to describe such relations.

   Proposal: Add *perceptionOf/hasPerceptionOf, symbolOf/hasSymbolOf, and referenceOf/hasReferenceOf* to the list of standard relations between semantic entities. These are the equivalent to standard relations between segments and semantic entities. As an example, a painting depicting a narrative world can be described as an Object DS description for the painting, Semantic DS description for the narrative world, and a *perceptionOf* relationship between the Semantic DS description and the Object DS description.

6. *Comment:* **Non-normative semantic relations** can be described using the Relation DS; however, there is no normative method to indicate that these are semantic relations.

   Proposal: Rename SemanticRelation DS to SemanticRelationBase DS and define SemanticRelation DS as an extension of SemanticRelationBase DS equivalent to the extension of Relation DS.

7. *Comment:* The relation ***supportOf/hasSupportOf*** between segments, objects, and semantic places is non-normative*.*

   Proposal: Add *supports/supportOf* to the list of standard relations between segments, semantic places, and objects.

8. *Comment:* It is not possible to describe the **state of semantic relations** together with semantic time and place information. As an example, consider the following description "The cat is on the map in the mornings". The cat, the map, and mornings can be represented using an Object DS, a SemanticPlace DS, and a SemanticTime DS, respectively.

   Proposal: Consider stateOf/hasStateOf as standard relations between one semantic state and a semantic relation.

3.1.3 Strength of Relations

Open issues about describing the strength of relations identified in the current specification of the Semantic DS together with proposals on how to solve them are listed below.

1. *Comment:* Currently, it is not possible to describe that the property or sets of properties associated with a concept apply to semantic entities such as objects and events. As an example, it is not possible to describe the following: "John is fun", where "John" is represented using a Object DS and "fun" is represented using a Concept DS. Another example is "The banana is ripe", whose description is included in Annex B.

   Proposal: Define ConceptSemanticBaseRelation DS as the standard relations between one concept and one semantic entity. The normative concept – semantic entity relation should include ***propertyOf/hasPropertyOf****.* The specification of the ConceptSemanticBaseRelation DS is provided in Annex A.

2. *Comment:* Description tools and relations between states and semantic entities are missing in order to describe membership functions.

   Proposal: This can be addressed by specifying a SemanticState DS as MembershipFunctionOf in its relation to a SemanticRelation DS. The AttributeValue Pair with attribute "Function" is then used as the

function declaration with no extension. The attributes for the parameters are then given appropriate labels. Recommend that the appropriate SemanticStateRelation Relation be added.

3. *Comment:* Normative semantic **relations between analytical models and semantic entities** are missing in order to describe membership functions.

   Proposal: Add *similarTo* to the list of standard relations between one analytical model and one semantic entity.

3.1.4   Non-Semantic Description Tools

Open issues identified in the current specification of non-semantic description tools together with proposals on how to solve them are listed below.

1. *Comment:* Duration in **Time datatypes** can includes a time zone information "The movie took one hour and twenty minutes, Pacific Daylight Time",

   Proposal: Remove the time zone information of the Duration in Time datatypes*.*

2. *Comment:* The edge in **Graph DS** is less powerful than the unlabeled ReferenceType. Specifically, because it uses ID/IDREF, it is constrained to the current document (XML-Schema-Part 2:Datatypes 3.2.11) whereas ReferenceType is not. The power of any abstraction scheme for descriptions lies in part in being able to store, reference, and reuse such descriptions. Since the only mechanism available for constructing properly documented (i.e. labeled) graphs is local to the current document, this greatly reduces the expressive power of the schemes using Graph, in particular Semantic. Furthermore, there are relations defined for the following situations: 1 SemanticBase-SemanticBase; 2 Object-Object; 3 Object-Event; 4 Event-Event; 5 SemanticPlace-Event; 6 SemanticTime-Event; 7 Segment-SemanticBase; 8 AnalyticModel-SemanticBase; which have the following adjacency matrix (zero indicates no edge):

   ```
   //o , e, sb, c, t, p, s, m, st, r
   {{2 , 3,  1, 1, 1, 1, 7, 8,  0, 0 },  // o
    {3 , 4,  1, 1, 6, 5, 7, 8,  0, 0 },  // e
    {1 , 1,  1, 1, 1, 1, 7, 8,  0, 0 },  // sb
    {1 , 1,  1, 1, 1, 1, 7, 8,  0, 0 },  // c
    {1 , 6,  1, 1, 1, 1, 7, 8,  0, 0 },  // t
    {1 , 5,  1, 1, 1, 1, 7, 7,  0, 0 },  // p
    {7 , 7,  7, 7, 7, 7, 7, 7,  0, 0 },  // s
    {8 , 8,  8, 8, 8, 8, 0, 0,  0, 0 },  // m
    {0 , 0,  0, 0, 0, 0, 0, 0,  0, 0 },  // st
    {0 , 0,  0, 0, 0, 0, 0, 0,  0, 0 }}; // r
   ```

   where o = Object; e = Event; sb = SemanticBase; c = Concept; t = SemanticTime; p = SemanticPlace; s = Segment; m = Model; st = State; r = Relation. As can be seen, most semantic quantities are accessible to each other only through SemanticBase-SemanticBase relations, which are limited to specialization, generalization, similar, opposite, example, and equivalent (roughly but not exactly like the list of labels for TermReferences in ClassificationSchemes).

   Proposal: Allow ReferenceType like references in the Graph DS's edges.

3. *Comment:* **Non-normative segment relations** can be described using the Relation DS; however, there is no normative method to indicate that these are segment relations.

   Proposal: Rename SegmentRelation DS to SegmentRelationBase DS and define SegmentRelation DS as an extension of SegmentRelationBase DS equivalent to the extension of RelationBase DS to define Relation DS, i.e., adding two new attributes "name" and "arity".

4. *Comment:* The relation ***supports/supportOf*** between segments and semantic places is non-normative*.*

   Proposal: Add *supports*/*supportOf* to the list of standard relations between segments and semantic places.

3.2 Example Descriptions of the Semantic DS

Several examples instantiating the Semantic DS and its components were generated by this CE. These can be found in the examples sections of Annex A and in Annex B. Examples descriptions are provided for the updated SemanticPlace DS, SemanticTime DS, two formal abstractions and concrete instances of a soccer game from CD 18 of the MPEG-7 test set, a ripe banana using strength of relations, and a music album CD involving multiple narrative worlds. Existing semantic descriptions of images produced by Getty, LC, and Nara were also mapped to the Semantic DS. Open issues identified in generating these examples were summarized in the previous section together with concrete proposals on how to solve them.

3.3 Demonstrations of the Semantic DS

Two applications demonstrating 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 for MPEG-7 XM Platform (Not updated since La Baule meeting)

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:

- Strings M and Q are of the same length

- String M is longer than string Q

- String Q is longer than string M

- All of the keywords in Q are in M

- 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 Annex B. Only the FreeTerm form of the Label field is supported at the moment.

3.3.2 Browsing Application based on Strength of Relations

The software demonstration has two parts. In the first part, we demonstrate several key features of the Semantic DS abstraction model, the use of membership functions and the use of Concepts and SemanticState. The demonstration implements an object, a banana, and a concept, consisting of one property, "ripe". The relation between these two Semantic entities is "hasPropertyOf". Parametrization of this property for bananas by color is possible, we generate three "cognitive" colors (colors that humans would find to be basic, and that cover a range of measured colors). These colors are labeled "green", "yellow" and "brown". Intuitively, a green banana is the least ripe, a yellow one more ripe, and a brown banana is very ripe (some might say too ripe).

In order to simulate the ripening of a single banana, something that would provide a continuum of states, we took pictures of a total of 17 bananas over four days, to capture them in varying stages of ripening, and various colors. The histograms of the bananas in the three categories were combined, and used for the cognitive color set. The color histograms of images are then compared to these histograms to determine "the ripeness" of the banana. These histograms are contained in a SemanticState DS, since they represent the changing state of the test banana. Finally, the set of bananas are queried to find bananas that are ripe.

In order to demonstrate the abstraction model, the SemanticState is abstracted and we get an abstract parametrization of the relation between an object and a concept. In this case we abstract from a banana ripening to fruit ripening. The new parametrization must then be instantiated, and the new cognitive colors specified, before creating a model of a ripening apple. In order to simulate the ripening of an apple, we took pictures of a total of seven apples, over four days. We show that this leads to a method for browsing apples, derived from that for browsing bananas. We then apply the same reasoning to mangoes. Three pear mangoes were photographed over

the same period. With the apples, we get a browsing method that resembles ripeness. Much of the variation is speciation, however. With the mangoes the task fails. Mango color is only associated with ripeness very early in development.

The demonstration will be provided by the end of the Singapore meeting, and the necessary XM software provided within two weeks thereafter.

4   Conclusions

4.1 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.

- Descriptions of the Semantic DS and its components, which include membership functions, abstract and concrete descriptions, multiple narrative worlds, and mappings of existing semantic descriptions from organizations such as Getty, LC, and NARA.

- Two demonstrations of the usage of semantic descriptions of multimedia content: a retrieval application for the MPEG-7 XM platform and a browsing application.

4.2 Recommendations

The recommendations of this CE are the following:

- Update the specification of the Semantic DS and its components in the MDS CD as proposed by the CE in section 3.1, Annex A, and the abstraction model in Annex D.

- Promote of the SemanticState DS, the Concept DS, the SemanticStateSemanticBaseRelation DS, and the SemanticStateSemanticStateRelation DS from the MDS XM to the MDS FCD.

- Promote membership functions, the ConceptSemanticBaseRelation DS, and the SemanticPlaceObjectRelation DS to the MDS FCD.

- Consider the proposed modifications to non-semantic MDS Ds/DSs for the MDS FCD.

- Put top-down example (football) into MDS FCD.

- Create an input document to FDIS describing the formal grounding of the MPEG-7 Semantic DSs. These could be an information/normative part of FDIS.

5   References

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[5]   MDS Group, "Workplan for CE on Semantic DS", ISO/IEC JTC1/SC29/WG11 MPEG01/N3822, Pisa, Italy, Jan 2001.

[6]   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.

Annex A : Specification of the Semantic DS

1 Semantics of the content

The following are proposed as changes to the semantic entity, attribute, and relation description schemes based on the findings and recommendation of this CE.

1.1 Semantic entities

1.1.1 SemanticBase DS

The SemanticBase DS provides an abstract type from which the specialized semantic entity tools are derived. The SemanticBased DS describes a semantic entity of any type in a narrative world and defines the common properties that apply to the specialized SemanticBase DSs: Semantic DS, Object DS, AgentObject DS, Event DS, SemanticPlaceDS, and SemanticTime DS.

1.1.1.1 SemanticBase DS syntax

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

<complexType name="SemanticBaseType" abstract="true">
   <complexContent>
      <extension base="mpeg7:DSType">
         <sequence>
            <element name="AbstractionLevel" type="mpeg7:AbstractionLevelType"
                  minOccurs="0"/>
            <element name="Label" type="mpeg7:TermType"
                  minOccurs="1" maxOccurs="unbounded"/>
            <element name="Definition" type="mpeg7:TextAnnotationType"
                  minOccurs="0"/>
            <element name="Property" type="mpeg7:TermType"
                  minOccurs="0" maxOccurs="unbounded"/>
            <element name="MediaOccurrence" minOccurs="0" maxOccurs="unbounded">
               <complexType>
                  <sequence>
                     <element name="MediaLocator" type="mpeg7:MediaLocatorType"/>
                     <element name="TemporalMask" type="mpeg7:TemporalMaskType"
                           minOccurs="0"/>
                     <element name="SpatialMask" type="mpeg7:SpatialMaskType"
                           minOccurs="0"/>
                     <element name="SpatioTemporalMask"
                           type="mpeg7:SpatioTemporalMaskType" minOccurs="0"/>
                     <element name="AudioDescriptor" type="mpeg7:AudioDType"
                           minOccurs="0" maxOccurs="unbounded"/>
                     <element name="AudioDescriptionScheme"
                           type="mpeg7:AudioDSType"
                           minOccurs="0" maxOccurs="unbounded"/>
                     <element name="VisualDescriptor" type="mpeg7:VisualDType"
                           minOccurs="0" maxOccurs="unbounded"/>
                     <element name="VisualDescriptionScheme"
                           type="mpeg7:VisualDSType"
                           minOccurs="0" maxOccurs="unbounded"/>
                  </sequence>
                  <attribute name="type" use="default" value="perceivable">
                     <simpleType>
                        <restriction base="string">
```

```
                                <enumeration value="perceivable"/>
                                <enumeration value="reference"/>
                                <enumeration value="symbol"/>
                        </restriction>
                    </simpleType>
                </attribute>
            </complexType>
        </element>
        <element name="Relation" type="mpeg7:RelationBaseType"
                minOccurs="0" maxOccurs="unbounded"/>
        </sequence>
    </extension>
  </complexContent>
</complexType>
```

1.1.1.2   SemanticBase DS semantics

Semantics of the SemanticBaseType:

Name	Definition
SemanticBaseType	Describes a semantic entity.
AbstractionLevel	Indicates the kind of abstraction performed in the description of the semantic entity (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 subclause **Error! Reference source not found.** on AbstractionLevel datatype).
Label	Identifies the type of the semantic entity.
Definition	Defines the semantic entity (optional).
Property	Describes a quality or adjectival property associated with the semantic entity (optional).
MediaOccurrence	Describes an appearance of the semantic entity in the media (optional).
MediaLocator	Locates the media in which the semantic entity appears.
TemporalMask	Describes the temporal intervals of the media in which the semantic entity appears (optional).
SpatialMask	Describes the spatial intervals of the media in which the semantic entity appears (optional).
SpatioTemporalMask	Describes the spatio-temporal intervals of the media in which the semantic entity appears (optional).
AudioDescriptor	Describes a simple audio feature of the audio content at the locations pointed to by the media locator and the masks (optional).
AudioDescriptionScheme	Describes a complex audio feature of the audio content at the locations pointed to by the media locator and the masks (optional).
VisualDescriptor	Describes a simple visual feature of the visual content at the locations pointed to by the media locator and the masks (optional).
VisualDescriptionScheme	Describes a complex visual feature of the visual content at the locations pointed to by the media locator and the masks (optional).

Name	Definition
type	Indicates the type of media occurrence. The types of media occurrences are defined as follows: • *perceivable* - The semantic entity is perceivable in the media. For example, Bill Clinton is perceivable in a picture of him. • *reference* - The semantic entity is a reference in the media. For example, Bill Clinton is a reference in a news reports about him but where he can not be seen or heard. • *symbol* - The semantic entity is symbolized in the media. For example, freedom is a symbol in a picture of the Statue of Liberty. The attribute value is "perceivable" by default.
Relation	Describes a relation between the semantic entity and other content description entities such as still regions, objects, events, and models, among others (optional).

The label element 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 SemanticBase DS descriptions. A SemanticBase DS description can have multiple labels, one for each "index term". The labels can be used to retrieve all the SemanticBase DS descriptions sharing the same label(s).

The MediaOccurrence element describes one appearance of semantic entity in the media with a media locator and optional descriptor values. The purpose of the MediaOccurence 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 of the media, the temporal and spatial localization in the media, and the audio and visual descriptor and description scheme values at that location, is sufficient. If the description requires more information or access to the media, it should use the Segment DS instead.

The AudioDescriptor, AudioDescriptionScheme, VisualDescriptor, and VisualDescriptionScheme elements in the MediaOccurrence element gives features of the audio-visual content where it is pointed to by the MediaLocator and the Mask elements. For instance, if two VisualDescriptor descriptions contain a dominant color and shape descriptor, respectively, the values in the VisualDescriptor elements are the features of the audio-visual content at that point. If the media locator points, for example, to a part of a scene taking place in a red room, one expects the dominant color values to reflect the red color.

1.1.2   SemanticState DS

The SemanticState DS extends from the SemanticBase DS. The SemanticState DS describes and parameterizes semantic properties of a semantic 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 relation graphs.

1.1.2.1   SemanticState DS syntax

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

<complexType name="SemanticStateType">
   <complexContent>
      <extension base="mpeg7:SemanticBaseType">
         <sequence>
            <element name="AttributeValuePair"
                  minOccurs="1" maxOccurs="unbounded">
               <complexType>
                  <complexContent>
```

```
                        <sequence>
                        <element name="Attribute" type="mpeg7:TextualType"/>
                        <element name="Unit" type="mpeg7:TextualType" minOccurs="0"/>
                        <choice minOccurs="1" maxOccurs="unbounded">
                            <element name="BooleanValue" type="boolean"/>
                            <element name="IntegerValue" type="integer"/>
                            <element name="FloatValue" type="float"/>
<!--                        <element name="IntegerVectorValue"
                                    type="mpeg7:IntegerMatrixType/>
                            <element name="FloatVectorValue"
                                    type="mpeg7:FloatMatrixType"/> -->
                            <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"/>
                            <element name="DescriptorValue"
                                    type="mpeg7:DType"/>
                            <!--  Add some other values such as Dtypes?  -->
                        </choice>
                        </sequence>
                    <complexContent>
                </complexType>
            </element>
            <element name="SemanticTime" type="mpeg7:SemanticTimeType"
                    minOccurs="0"/>
            <element name="SemanticPlace" type="mpeg7:SemanticPlaceType"
                    minOccurs="0"/>
        </sequence>
    </extension>
  </complexContent>
</complexType>
```

1.1.2.2 SemanticState DS semantics

Name	Definition
SemanticStateType	Describes the semantic attributes of a semantic entity at a given time or spatial location in the narrative world, or in a given media location.
AttributeValuePair	Describes one pair formed by an attribute and a value being the value a combination of a series of types (e.g. Boolean, integer, real, matrix, string, and controlled text).
Attribute	Indicates the name of the attribute
Unit	Indicates the unit of the attribute value (optional).
BooleanValue	Indicates part of the value of the attribute as a Boolean.
IntegerValue	Indicates part of the value of the attribute as an integer.
FloatValue	Indicates part of the value of the attribute as a float.

Name	Definition
IntegerMatrixValue	Indicates part of the value of the attribute as a matrix of integers.
FloatMatrixValue	Indicates part of the value of the attribute as a matrix of floats.
TextValue	Indicates part of the value of the attribute as a text string.
TextAnnotationValue	Indicates part of the value of the attribute as a text annotation.
ControlledTermValue	Indicates part of the value of the attribute as a controlled term.
DescriptorValue	Describes part of the value of the attribute as a descriptor.
SemanticTime	Describes semantically the time associated with the state (optional).
SemanticPlace	Describes semantically the location associated with the state (optional).

While all semantic entities contain properties, it is sometimes necessary to assign and track parameters associated with these properties. It is also useful to ascribe parameters to relations. The SemanticState DS performs this task. It is a semantic entity, as well, and as such can be abstracted.

As a media abstraction, a SemanticState DS description represents a particular state that could occur in multiple media (for instance, the temperature and humidity, which occur on every channel's weather broadcast). As an abstraction, it represents a portable collection of properties, together with their parameters, that can be attached to similar semantic entities.

1.1.2.3   SemanticState DS examples (informative)

The following example illustrates the use of the SemanticState DS for describing semantic attributes of a sunset. In this example, the event event-sunset represents the sunset and the semantic state sunset-state describes the semantic attributes of the sunset. A graph relates the event sunset-event and the semantic state sunset-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>
   <SemanticBase xsi:type="mpeg7:EventType" id="sunset-event">
      <Label> <FreeTerm> Sunset </FreeTerm> </Label>
      <Definition>
         <FreeText xml:lang="en-us">
            Phenomenon of the sun setting down
         </FreeText>
      </Definition>
   </SemanticBase>
   <SemanticBase xsi:type="mpeg7:SemanticStateType" 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>
      </SemanticBase>
      <Graph>
         <!--  Relate event sunset-event and state sunset-state  -->
         <Relation xsi:type="mpeg7:ObjectEventRelationType" name="stateOf"
                 source="sunset-state" target="sunset-event"/>
      </Graph>
</Semantic>
```

1.1.3   SemanticTime DS

The SemanticTime DS derives from the SemanticBase DS. The SemanticTime DS describes a time in a narrative world. The SemanticTime DS is a specialized SemanticBase DS that encapsulates the Time DS and semantic relative time information within the SemanticBase DS.

1.1.3.1   SemanticTime DS syntax

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

<complexType name="SemanticTimeType">
   <complexContent>
      <extension base="mpeg7:SemanticBaseType">
         <sequence>
            <element name="Time" type="mpeg7:TimeType" minOccurs="0"/>
            <element name="SemanticTimeInterval"
                      minOccurs="0" maxOccurs="unbounded">
               <complexType>
                  <sequence>
                     <element name="TimePoint" type="mpeg7:PositionType"
                              minOccurs="0"/>
                     <element name="Duration" type="mpeg7:ExtentType"
                              minOccurs="0"/>
                  </sequence>
               </complexType>
            </element>
         </sequence>
      </extension>
   </complexContent>
</complexType>
```

1.1.3.2   SemanticTime DS semantics

Semantics of the SemanticTimeType:

Name	Definition
SemanticTimeType	Describes a semantic entity that is a time in a narrative world.
Time	Describes the time point and the duration with numerical attributes (optional).
SemanticTimeInterval	Describes the time point and/or the duration of an interval of the semantic time (optional).

Name	Definition
TimePoint	Semantically describes the time point of the time interval as a string (optional). The Direction element should indicate what direction to measure the time in, for instance, "before" or "after".
Duration	Semantically describes the duration of the time interval as a string (optional).

1.1.3.3 SemanticTime DS examples (informative)

The following example illustrates the use of the Time DS in SemanticTime DS for describing 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 following example illustrates the use of the SemanticTimeInterval element in SemanticTime DS for describing the time "4 weeks".

```
<SemanticTime id="4weeks-time">
    <Label> <FreeTerm> 4 weeks </FreeTerm> </Label>
    <SemanticTimeInterval>
        <Duration measurementType="length" unit="week" value="4"/>
    </SemanticTimeInterval>
</SemanticTime>
```

The following example illustrates the use of the SemanticTimeInterval element in SemanticTime DS for describing the time "last year".

```
<SemanticTime id="lastyear-time">
    <Label> <FreeTerm> Last year </FreeTerm> </Label>
    <SemanticTimeInterval>
        <TimePoint origin="now">
            <Displacement measurementType="length" unit="year" value="1"/>
            <Direction measurementType="direction" unit="direction" value="before"/>
        </TimePoint>
    </SemanticTimeInterval>
</SemanticTime>
```

The following example illustrates the use of the SemanticTimeInterval element in SemanticTime DS for describing the time "the third and fourth day in April".

```
<SemanticTime id="4dayApril-time">
    <Label> <FreeTerm> The third and fourth day in April </FreeTerm> </Label>
    <SemanticTimeInterval>
        <TimePoint origin="April">
            <Displacement measurementType="length" unit="day" value="3"/>
            <Direction measurementType="direction" unit="direction" value="after"/>
```

```
      </TimePoint>
      <Duration measurementType="length" unit="day" value="2"/>
    </SemanticTimeInterval>
</SemanticTime>
```

The following example illustrates the use of the SemanticTimeInterval element in SemanticTime DS for describing the time "Monday through Friday from 9am to 5pm".

```
<SemanticTime id="MonFri_9am_5pm-time">
    <Label> <FreeTerm> Monday through Friday from 9am to 5pm </FreeTerm> </Label>
    <SemanticTimeInterval>
        <TimePoint origin="Monday">
            <Displacement measurementType="length" unit="hour" value="9"/>
            <Direction measurementType="direction" unit="direction" value="after"/>
        </TimePoint>
        <Duration measurementType="length" unit="hour" value="8"/>
    </SemanticTimeInterval>
    <SemanticTimeInterval>
        <TimePoint origin="Monday">
            <Displacement measurementType="length" unit="hour" value="9"/>
            <Direction measurementType="direction" unit="direction" value="after"/>
        </TimePoint>
        <Duration measurementType="length" unit="hour" value="8"/>
    </SemanticTimeInterval>
    <SemanticTimeInterval>
        <TimePoint origin="Tuesday">
            <Displacement measurementType="length" unit="hour" value="9"/>
            <Direction measurementType="direction" unit="direction" value="after"/>
        </TimePoint>
        <Duration measurementType="length" unit="hour" value="8"/>
    </SemanticTimeInterval>
    <SemanticTimeInterval>
        <TimePoint origin="Wednesday">
            <Displacement measurementType="length" unit="hour" value="9"/>
            <Direction measurementType="direction" unit="direction" value="after"/>
        </TimePoint>
        <Duration measurementType="length" unit="hour" value="8"/>
    </SemanticTimeInterval>
    <SemanticTimeInterval>
        <TimePoint origin="Thursday">
            <Displacement measurementType="length" unit="hour" value="9"/>
            <Direction measurementType="direction" unit="direction" value="after"/>
        </TimePoint>
        <Duration measurementType="length" unit="hour" value="8"/>
    </SemanticTimeInterval>
    <SemanticTimeInterval>
        <TimePoint origin="Friday">
            <Displacement measurementType="length" unit="hour" value="9"/>
            <Direction measurementType="direction" unit="direction" value="after"/>
        </TimePoint>
        <Duration measurementType="length" unit="hour" value="8"/>
    </SemanticTimeInterval>
</SemanticTime>
```

The following example illustrates the use of the SemanticTime DS for describing the time "in the year 1899 at the same time when the earthquake happened in San Francisco". In this example, the time "in the year 1899 at the same time when the earthquake happened in San Francisco" and the event "Earthquake in San Francisco in 1899" are described in the SemanticBase DS descriptions with id "sem3-time" and "earthquake-event", respectively. The new semantic time ("sem3-time") can be defined as equivalent to the semantic time description of the event "earthquake-event" –relation *equivalentTo* to semantic time "3m1899-time" (possibility one) - or as being the time when that event happened –relation *timeOf* to the event "earthquake-event" (possibility two)..

```
<Semantic id="semantic1">
    <SemanticBase xsi:type="SemanticTimeType" id="sem3-time">
        <Label> <FreeTerm> Time </FreeTerm> </Label>
        <!—- Possibility one  -->
        <Relation xsi:type="SemanticBaseSemanticBaseRelationType"
                name="equivalentTo" target="3m1899-time"/>
        <!—- Possibility two  -->
        <Relation xsi:type="SemanticTimeSemanticBaseRelationType"
                name="timeOf" target="earthquake-event"/>
    </SemanticBase>
</Semantic>

<Semantic id="semantic2">
    <SemanticBase xsi:type="EventType" id="earthquake-event">
        <Label> <FreeTerm> Earthquake </FreeTerm> </Label>
        <Definition>
            <FreeText> The big earthquake in San Francisco </FreeText>
        </Definition>
        <Relation xsi:type="SemanticTimeSemanticBaseRelationType" name="hasTimeOf"
                target="3m1899-time">
        <Relation xsi:type="SemanticPlaceSemanticBaseRelationType"
name="hasLocationOf"
                target="sanfran-loc"/>
    </SemanticBase>
    <SemanticBase xsi:type="SemanticTimeType" 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>
    </SemanticBase>
    <SemanticBase xsi:type="SemanticPlaceType" id="sanfran-loc">
        <Label> <FreeTerm> San Francisco </FreeTerm> </Label>
    </SemanticBase>
</Semantic>
```

1.1.4   SemanticPlace DS

The SemanticPlace DS extends from the SemanticBase DS. The SemanticPlace DS describes a location in a narrative world. The SemanticPlace DS is a specialized SemanticBase DS that encapsulates the Place DS within the SemanticBase DS.

1.1.4.1   SemanticPlace DS syntax

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

<complexType name="SemanticBaseType">
    <complexContent>
        <extension base="mpeg7:SemanticBaseType">
            <sequence minOccurs="1" maxOccurs="1">
                <element name="Place" type="mpeg7:PlaceType"
                        minOccurs="0" maxOccurs="1"/>
                <element name="SemanticPlaceInterval"
                        minOccurs="0" maxOccurs="unbounded">
                    <complexType>
                        <sequence>
```

```
                        <element name="Location" type="mpeg7:PositionType"
                                minOccurs="0" maxOccurs="1"/>
                        <element name="Extent" type="mpeg7:ExtentType"
                                minOccurs="0" maxOccurs="1"/>
                    </sequence>
                </complexType>
            </element>
        </sequence>
    </extension>
   </complexContent>
</complexType>
```

1.1.4.2   SemanticPlace DS semantics

Semantics of the SemanticPlaceType:

Name	Definition
SemanticPlaceType	Describes a semantic entity that is a location in a narrative world.
Place	Describes the place represented by the semantic entity (optional).
SemanticPlaceInterval	Describes the position and/or the extent of an interval of the semantic place (optional).
Location	Semantically describes the position of the place interval as a string (optional).
Extent	Semantically describes the extent of the place interval related to position, for instance, distance or area (optional).

1.1.4.3   SemanticPlace DS examples (informative)

The following example illustrates the use of the SemanticPlace DS for describing a soccer stadium in Spain.

```
<SemanticPlace id="stadium-location">
    <Label>
        <FreeText> Soccer stadium </FreeText>
    </Label>
    <Place>
        <Name xml:lang="en"> Santiago Bernabeu </Name>
        <Country> es </Country>
        <PostalAddress>
            <AddressLine> Concha Espina s/n., Madrid </AddressLine>
            <PostingIdentifier> E-28036 </PostingIdentifier>
        </PostalAddress>
    </Place>
</SemanticPlace>
```

The following example illustrates the use of the SemanticPlaceInterval element in SemanticPlace DS for describing the location "4 miles".

```
<SemanticPlace id="4miles-place">
    <Label> <FreeTerm> 4 miles </FreeTerm> </Label>
    <SemanticPlaceInterval>
        <Extent measurementType="length" unit=" mile" value="4"/>
    </SemanticPlaceInterval>
</SemanticPlace>
```

The following example illustrates the use of the SemanticPlaceInterval element in SemanticPlace DS for describing the location "Within 4 miles around New York City".

```
<SemanticPlace id="4milesNYC-place">
    <Label> <FreeTerm> Within 4 miles around New York City </FreeTerm> </Label>
    <SemanticPlaceInterval>
        <Location origin="New York City"/>
        <Extent measurementType="area" unit="square miles" value="16*pi"/>
    </SemanticPlaceInterval>
</SemanticPlace>
```

The following example illustrates the use of the SemanticPlaceInterval element in SemanticPlace DS for describing the location "5 kilometers north of York City and 40 kilometers east of Boston".

```
<SemanticPlace id="NYCBoston-place">
    <Label>
        <FreeTerm>
            5 kilometers north of York City and 40 kilometers east of Boston
        </FreeTerm>
    </Label>
    <SemanticPlaceInterval>
        <Location origin="New York City">
            <Displacement measurementType="length" unit="kilometers" value="5"/>
            <Direction measurementType="direction" unit="direction" value="north"/>
        </Location>
    </SemanticPlaceInterval>
    <SemanticPlaceInterval>
        <Location origin="Boston">
            <Displacement measurementType="length" unit="kilometers" value="40"/>
            <Direction measurementType="direction" unit="direction" value="east"/>
        </Location>
    </SemanticPlaceInterval>
</SemanticPlace>
```

The following example illustrates the use of the SemanticPlace DS for describing the location "at the Eiffel Tower in the same spot where Cri and Ale were engaged last year". In this example, the location "at the Eiffel Tower in the same spot where Cri and Ale were engaged last year" and the event "Cri and Ale were engaged last year" are described in the SemanticBase DS descriptions with id "sem2-loc" and "engagement-event", respectively. The new semantic place ("sem2-loc") can be defined as equivalent to the SemanticPlace DS description of the event "engagement-event" – relation *equivalentTo* to semantic place "Eiffel-loc" (possibility one) - or as being the location where that event took placed– relation *locationOf* to the event "engagement-event" (possibility two).

```
<Semantic id="Semantic2">
    <SemanticBase xsi:type="SemanticPlaceType" id="sem2-loc">
        <Label> <FreeTerm> Location </FreeTerm> </Label>
        <!—- Possibility one  -->
        <Relation xsi:type="SemanticBaseSemanticBaseRelationType"
                name="equivalentTo" target="Eiffel-loc"/>
        <!—- Possibility two  -->
        <Relation xsi:type="SemanticPlaceSemanticBaseRelationType"
                name="locationOf" target="engagement-event"/>
    </SemanticBase>
</Semantic>

<Semantic id="Semantic1">
    <SemanticBase xsi:type="EventType" id="engagement-event">
        <Label>
            <FreeTerm> Engagement </FreeTerm>
        </Label>
        <Definition>
            <FreeText>
                Engagement of two lovers, Cri and Ale,
```

```
                    at the Eiffel Tower in Paris
                </FreeText>
            </Definition>
            <Relation xsi:type="SemanticPlaceSemanticBaseRelationType"
name="hasLocationOf"
                    target="Eiffel-loc"/>
            <Relation xsi:type="SemanticTimeSemanticBaseRelationType" name="hasTimeOf"
                    target="lastyear-time"/>
    </SemanticBase>
    <SemanticBase xsi:type="SemanticPlaceType" id="Eiffel-loc">
        <Label> <FreeTerm> Spot at the Eiffel Tower </FreeTerm> </Label>
    </SemanticBase>
    <SemanticBase xsi:type="SemanticPlaceType" id="lastyear-time">
        <Label> <FreeTerm> Last year </FreeTerm> </Label>
        <SemanticTimeInterval>
            <TimePoint origin="now">
                <Displacement measurementType="length" unit="year" value="1"/>
                <Direction measurementType="direction" unit="direction"
                        value="before"/>
            </TimePoint>
        </SemanticTimeInterval>
    </SemanticTime>
</Semantic>
```

1.1.4.4   Event DS

The Event DS extends from the SemanticBase DS. The Event DS describes a perceivable or abstract event in a narrative world. A perceivable event is a dynamic relation involving one or more objects occurring in a region in time and space of a narrative world (e.g., Tom playing the piano). An abstract event is the result of applying abstraction to a perceivable event (e.g., anyone playing the piano). Essentially, this generates a template of the event in question. An event represents a change in the (combined) state for one or more objects.

1.1.4.4.1   Event DS syntax

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

<complexType name="EventType">
    <complexContent>
        <extension base="mpeg7:SemanticBaseType">
            <sequence>
                <element name="Event" type="mpeg7:EventType"
                        minOccurs="0" maxOccurs="unbounded"/>
                <element name="EventRef" type="mpeg7:ReferenceType"
                        minOccurs="0" maxOccurs="unbounded"/>
                <element name="SemanticPlace" type="mpeg7:SemanticPlaceType"
                        minOccurs="0" maxOccurs="unbounded"/>
                <element name="SemanticTime" type="mpeg7:SemanticTimeType"
                        minOccurs="0" maxOccurs="unbounded"/>
            </sequence>
        </extension>
    </complexContent>
</complexType>
```

1.1.4.4.2   Event DS semantics

Semantics of the EventType:

Name	Definition
EventType	Describes a dynamic relation involving one or more objects occurring in a region in time and space of a 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 the SemanticPlace DS in Event DS or a semantic relation *locationOf* to the SemanticPlace DS representing that place. The time when an event happens can be described by the SemanticTime DS in Event DS or a semantic relation *timeOf* to the SemanticTime DS representing that time.
Event	Describes one event resulting from the decomposition of the parent event (optional).The decomposition of an event into sub-events could be a feature/activity decomposition (e.g., paying/shopping), among others.
SemanticPlace	Describes semantically a place where the event occurs, and/or its extent (optional).
SemanticTime	Describes semantically a time when the event occurs, and/or its duration (optional).

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

Events are continuous in the narrative world or semantic time, but not necessarily in the AV content. They are therefore not persistent, unlike objects. As descriptions, however, they have life spans similar to objects, in that one description of a particular event is sufficient (but not necessary) for one instance or multiple instances of AV content.

Events are activities and actions occurring over a duration of time. By connecting objects to events, one describes something that occurs over time, together with the participants. As a media abstraction, an Event DS description represents a specific event that can occur in various media: A wedding can occur in different video segments (from different cameras, etc.). As a formal abstraction, an Event DS description represents a class of specific event, i.e. a generic event.

1.1.4.4.3 Event DS examples (informative)

The following example illustrates the use of the Event DS for describing the event of a goal in a soccer game. In this example, the first Relation DS description describes the goal event as the result of an event representing a play in the soccer game (relation *hasResultOf*); the second Relation DS description describes the goal event as being depicted in a video segment (relation *mediaPerceptionOf*).

```
<Event id="Goal-event">
   <Label>
      <ControlledTerm term="43" scheme="..." schemeLocation="http://www....">
         <Label> Goal </Label>
      </ControlledTerm>
   </Label>
   <Definition>
      <FreeText>
         The act or action of causing a ball or puck to go
         through or into such a goal
      </FreeText>
   </Definition>
   <Relation xsi:type="EventEventRelationType"
           name="resultOf" target="Play-event"/>
   <Relation xsi:type="SegmentSemanticBaseRelationType"
           name="hasMediaPerceptionOf" target="videosegment"/>
</Event>

<Event id="Play-event">
```

```
    <Label>
        <FreeTerm> Soccer play </FreeTerm>
    </Label>
</Event>
```

1.2 Semantic Measurement Attributes

This subclause specifies tools for describing semantic measurement attributes of semantic entity descriptions. The following table summarizes the functionality of each attribute and their application to the different types of semantic entities.

Tool	Functionality	Entities
Extent	This tool describes the extent or size of the entity.	SemanticPlace DS SemanticTime DS
Position	This tool describes the position of the entity.	SemanticPlace DS SemanticTime DS

Table 1: Semantic measurement attributes.

1.2.1   Extent datatype

The Extent datatype describes a size or extent of an entity. The Extent datatype applies to the SemanticPlace DS and the SemanticTime DS.

1.2.1.1   Extent datatype syntax

```
<!-- ############################################# -->
<!-- Definition of Extent datatype                 -->
<!-- ############################################# -->

<complexType name="ExtentType">
    <complexType>
        <attribute name="measurementType" type="string" use="required"/>
        <attribute name="unit" type="string" use="required"/>
        <attribute name="value" type="string" use="required"/>
    </complexType>
</complexType>
```

1.2.1.2   Extent datatype semantics

Semantics of the ExtentType:

Name	Definition
ExtentType	Describes the size or the extent of an entity with respect to a measurement type. The extent is an interval data type.
measurementType	Indicates the type of extent being described. For example, the measurement type could be "length", "weight", or "temperature".
unit	Indicates the unit of the extent for the value attribute.
value	Indicates the value of the extent.

1.2.2 Position datatype

The Position datatype describes the position of an entity.

1.2.2.1 Position datatype syntax

```
<!-- ############################################ -->
<!-- Definition of Position datatype             -->
<!-- ############################################ -->

<complexType name="PositionType">
   <complexType>
      <sequence>
          <element name="Displacement" type="mpeg7:ExtentType" minOccurs="0"/>
          <element name="Direction" type="mpeg7:ExtentType" minOccurs="0"/>
      </sequence>
      <attribute name="origin" type="string" use="required"/>
   </complexType>
</complexType>
```

1.2.2.2 Position datatype semantics

Semantics of the PositionType:

Name	Definition
PositionType	Describes the position of an entity, for example, time point, location, or altitude. The position is a ratio data type.
Displacement	Describes the distance from the origin of the position (optional).
Direction	Describes the direction or the angular displacement from the origin of the position (optional).
origin	Indicates the origin with respect to which the displacement and direction of the position are measured.

1.3 Semantic relations

1.3.1 Semantic entity relations

1.3.1.1 SemanticPlaceSemanticBaseRelation DS

The SemanticPlaceSemanticBaseRelation DS extends from the SemanticBaseRelation DS. The SemanticPlaceSemanticBaseRelation DS describes a relation between one semantic place and one semantic entity corresponding to one of the following relations: *locationOf*, *hasLocationOf*, *sourceOf*, *hasSourceOf*, *destinationOf*, *hasDestinationOf*, *pathOf*, and *hasPathOf*.

1.3.1.1.1 SemanticPlaceSemanticBaseRelation DS syntax

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

<complexType name="SemanticPlaceSemanticBaseRelationType">
   <complexContent>
      <extension base="mpeg7:SemanticBaseRelationType">
```

```
            <attribute name="name" use="required">
                <simpleType>
                    <restriction base="QName">
                        <enumeration value="locationOf"/>
                        <enumeration value="hasLocationOf"/>
                        <enumeration value="sourceOf"/>
                        <enumeration value="hasSourceOf"/>
                        <enumeration value="destinationOf"/>
                        <enumeration value="hasDestinationOf"/>
                        <enumeration value="pathOf"/>
                        <enumeration value="hasPathOf"/>
                    </restriction>
                </simpleType>
            </attribute>
            <attribute name="arity" type="positiveInteger" use="fixed" value="2"/>
        </extension>
    </complexContent>
</complexType>
```

1.3.1.1.2 SemanticPlaceSemanticBaseRelation DS semantics

Semantics of the SemanticPlaceSemanticBaseRelationType:

Name	Definition
SemanticPlaceSemanticBaseRelationType	Describes a relation between one semantic place and one semantic entity. The source attribute, the target attribute, and the Argument elements of the SemanticPlaceSemanticBaseRelation DS must reference a SemanticPlace DS or an SemanticBase DS description or a Node element within a Graph DS description referencing a SemanticPlace DS or an SemanticBase DS description.
name	Identifies the relation. The relations between one semantic place and one semantic entity are defined as follows: • *locationOf* – The relation is the *locationOf* relation. • *hasLocationOf* – The relation is the *hasLocationOf* relation. • *sourceOf* – The relation is the *sourceOf* relation. • *hasSourceOf* – The relation is the *hasSourceOf* relation. • *destinationOf* – The relation is the *destinationOf* relation. • *hasDestinationOf* – The relation is the *hasDestinationOf* relation. • *pathOf* – The relation is the *pathOf* relation. • *hasPathOf* – The relation is the *hasPathOf* relation.
arity	Indicates the number of arguments in the relation. The attribute value is fixed to "2".

For each normative relation between one semantic place and one semantic entity, Table 2 includes the name, the inverse relation, the definition, informative examples, and the descriptions of the examples.

Relation Name	Inverse Relation	Definition	Informative Examples	Example Descriptions
locationOf	hasLocationOf	If semantic place A *locationOf* event B, semantic place A is the place where event B takes place.	In the description, "Marry receives a flower in the street", semantic place "street" is the location of event "receive".	`<SemanticPlaceSemanticBaseRelation name="locationOf" source="street" target="receive"/>`
sourceOf	hasSourceOf	If semantic place A *sourceOf* event B, semantic place A is the starting point for the transfer or motion of event B.	In the example "John moved the box from the floor to table", semantic place "floor" is the source of event "move".	`<SemanticPlaceSemanticBaseRelation name="sourceOf" source="floor" target="move"/>`
destinationOf	hasDestinationOf	If semantic place A *destinationOf* event B, semantic place A is the finishing point for the transfer or motion of event B.	In the description, "Mary moved from California to Toronto", semantic place "Toronto" is the destination of event "move".	`<SemanticPlaceSemanticBaseRelation name="destinationOf" source="Toronto" target="move"/>`
pathOf	hasPathOf	If semantic place A *pathOf* event B, semantic place A is the route along which an entity travels in event B.	In the description "The train traveled along the track", semantic place "track" is the path of event "travel".	`<SemanticPlaceSemanticBaseRelation name="pathOf" source="track" target="travel"/>`

Table 2: Definitions and inverse relations of the normative relations between one semantic place and one <mark>semantic base</mark> with informative examples and descriptions.

1.3.1.2 <mark>SemanticTimeSemanticBase</mark>Relation DS

The SemanticTimeSemanticBaseRelation DS extends from the SemanticBaseRelation DS. The SemanticTimeSemanticBaseRelation DS describes a relation between one semantic time and one <mark>semantic entity</mark> corresponding to one of the following relations: *timeOf* and *hasTimeOf*.

1.3.1.2.1 SemanticTimeSemanticBaseRelation DS syntax

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

<complexType name="SemanticTimeSemanticBaseRelationType">
   <complexContent>
      <extension base="mpeg7:SemanticBaseRelationType">
         <attribute name="name" use="required">
            <simpleType>
               <restriction base="QName">
```

```
                <enumeration value="timeOf"/>
                <enumeration value="hasTimeOf"/>
            </restriction>
        </simpleType>
    </attribute>
    <attribute name="arity" type="positiveInteger" use="fixed" value="2"/>
    </extension>
  </complexContent>
</complexType>
```

1.3.1.2.2 SemanticTimeSemanticBaseRelation DS semantics

Semantics of the SemanticTimeSemanticBaseRelationType:

Name	Definition
SemanticTimeSemanticBaseRelationType	Describes a relation between one semantic time and one semantic entity. The source attribute, the target attribute, and the Argument elements of the SemanticTimeSemanticBaseRelation DS must reference a SemanticTime DS or an SemanticBase DS description or a Node element within a Graph DS description referencing a SemanticTime DS or an SemanticBase DS description.
name	Identifies the relation. The relations between one semantic time and one semantic entity are defined as follows: • *timeOf* – The relation is the *timeOf* relation. • *hasTimeOf* – The relation is the *hasTimeOf* relation.
arity	Indicates the number of arguments in the relation. The attribute value is fixed to "2".

For each normative relation between one semantic time and one semantic entity, Table 3 includes the name, the inverse relation, the definition, informative examples, and the descriptions of the examples.

Relation Name	Inverse Relation	Definition	Informative Examples	Example Descriptions
timeOf	hasTimeOf	If semantic time A *timeOf* event B, semantic time A is the time of event B.	In the description "Mary was born for Christmas", semantic time "Christmas" is the *time of* event "be born".	`<SemanticTimeSemanticBaseRelation name="timeOf" source="Christmas" target="beborn"/>`

Table 3: Definitions and inverse relations of the normative relations between one semantic time and one semantic entity with informative examples and descriptions.

1.3.1.3 ConceptSemanticBaseRelation DS

The ConceptSemanticBaseRelation DS extends from the SemanticBaseRelation DS. The ConceptSemanticBaseRelation DS describes a relation between one concept and one semantic entity corresponding to one of the following relations: *propertyOf* and *hasPropertyOf*.

1.3.1.3.1 ConceptSemanticBaseRelation DS syntax

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

<complexType name="ConceptSemanticBaseRelationType">
    <complexContent>
        <extension base="mpeg7:SemanticBaseRelationType">
            <attribute name="name" use="required">
                <simpleType>
                    <restriction base="QName">
                        <enumeration value="propertyOf"/>
                        <enumeration value="hasPropertyOf"/>
                    </restriction>
                </simpleType>
            </attribute>
            <attribute name="arity" type="positiveInteger" use="fixed" value="2"/>
        </extension>
    </complexContent>
</complexType>
```

1.3.1.3.2 ConceptSemanticBaseRelation DS semantics

Semantics of the ConceptSemanticBaseRelationType:

Name	Definition
ConceptSemanticBaseRelationType	Describes a relation between one concept and one semantic entity. The source attribute, the target attribute, and the Argument elements of the ConceptSemanticBaseRelation DS must reference a Concept DS or an SemanticBase DS description or a Node element within a Graph DS description referencing a Concept DS or a SemanticBase DS description.
name	Identifies the relation. The relations between one concept and one semantic entity are defined as follows: • *propertyOf* – The relation is the *propertyOf* relation. • *hasPropertyOf* – The relation is the *hasPropertyOf* relation.
arity	Indicates the number of arguments in the relation. The attribute value is fixed to "2".

For each normative relation between one concept and one semantic entity, Table 3 includes the name, the inverse relation, the definition, informative examples, and the descriptions of the examples.

Relation Name	Inverse Relation	Definition	Informative Examples	Example Descriptions
propertyOf	hasPropertyOf	If concept A *propertyOf* event B, the properties (one or more) that define concept A are properties of event B.	In the description "John is fun", concept "fun" is the *property of* object "John".	`<ConceptSemanticBaseRelation name="propertyOf" source="fun" target="John"/>`

Annex B : Example Descriptions of the Semantic DS

1   Semantic DS examples (informative)

1.1 Membership Functions: Ripe Banana

The following example illustrates the use of membership functions, SemanticState DSs, Property elements, SemanticRelation DSs, and AnalyticalModel DSs for describing the object ripe banana as shown in Figure 1.

The following abbreviations were made in Figure 1:

- 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.
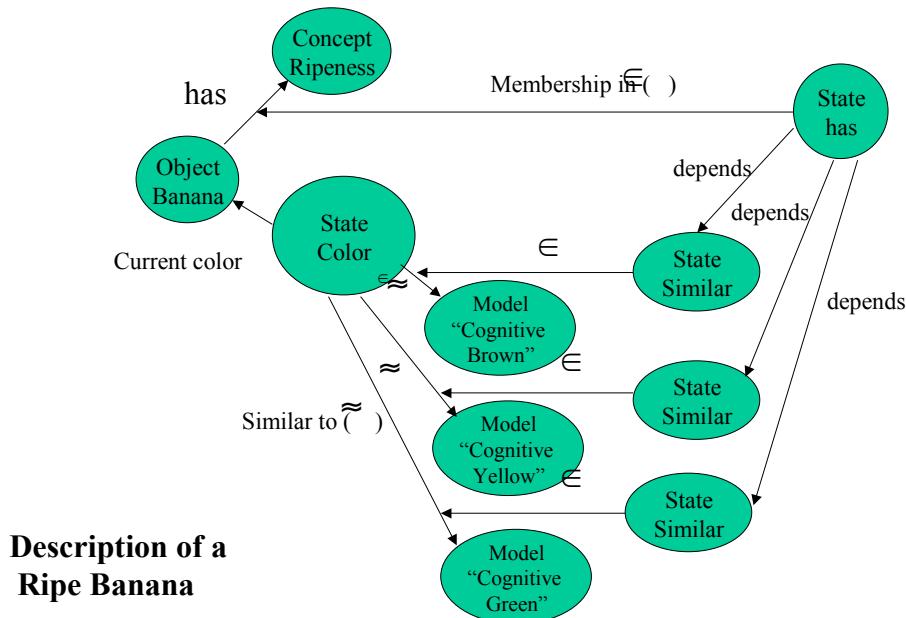
Figure 1: Description of the object ripe banana using membership functions, SemanticState DSs, Property elements, SemanticRelation DSs, and AnalyticalModel DSs.

Figure 1 shows the following:

1. The Property elements are for adjectival qualities and concepts are defined of such properties. Ripeness is such a quality and concept.

2. The Object Banana is an abstraction or a media abstraction, and "has" the property Ripeness. It also has a SemanticState element attached to it, which contains a Color Histogram, and has the relation "current color". In a streaming application, this SemanticState element 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 an AnalyticModel DS, they are color histograms of these three colors.

5. The membership parameter in the SemanticState element for the "has" relationship is calculated from the membership parameters of the three relationships "is similar to" which point from the SemanticState element to each of the AnalyticalModel elements. Therefore it has a "depends on" relationship to these three. It varies from 0 when 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.

```xml
<Mpeg7 xmlns="http://www.mpeg7.org/2001/MPEG-7_Schema" xml:lang="en" type="complete">

    <!--  Semantic entities: objects, states, and concept  -->
    <ContentDescription xsi:type="WorldDescriptionType">
        <Semantics xsi:type="SemanticType" id="RipeBanana-sem">
            <SemanticBase xsi:type="ObjectType" id="banana-obj>
                <Label>
                    <FreeTerm> Banana </FreeTerm>
                </Label>
            </SemanticBase>
            <SemanticBase xsi:type="ConceptType" id="ripe-con">
                <Label>
                    <FreeTerm> Ripeness</FreeTerm>
                </Label>
                <Property> <FreeTerm> Aged </FreeTerm> </Property>
                <Property> <FreeTerm> Matured </FreeTerm> </Property>
                <Property> <FreeTerm> Mellow </FreeTerm> </Property>
                <Property> <FreeTerm> Ripened </FreeTerm> </Property>
            </SemanticBase>
            <SemanticBase xsi:type="SemanticStateType" id="has-sta">
                <Label>
                    <FreeTerm> Has </FreeTerm>
                </Label>
            </SemanticBase>
            <SemanticBase xsi:type="SemanticStateType" id="color-sta">
                <Label>
                    <FreeTerm> Color </FreeTerm>
                </Label>
                <AttributeValuePair>
                    <Attribute> Color </Attribute>
                    <IntegerVectorValue> 1 2 . . . 16 </IntegerVectorValue>
                </AttributeValuePair>
            </SemanticBase>
            <SemanticBase xsi:type="SemanticStateType" id="sim1-sta">
                <Label>
                    <FreeTerm> Similar </FreeTerm>
                </Label>
            </SemanticBase>
            <SemanticBase xsi:type="SemanticStateType" id="sim2-sta">
                <Label>
                    <FreeTerm> Similar </FreeTerm>
                </Label>
            </SemanticBase>
            <SemanticBase xsi:type="SemanticStateType" id="sim3-sta">
                <Label>
                    <FreeTerm> Similar </FreeTerm>
                </Label>
            </SemanticBase>

            <Graph>

                <!--  State of object  -->
```

```xml
                <Relation xsi:type="SemanticStateSemanticBaseRelationType"
                            name="stateOf" source="color-sta" target="banana-obj"/>

                <!--   Property of object  -->
                <Relation xsi:type="ConceptSemanticBaseRelationType" id="has-rel"
                            name="propertyOf" source="ripe-con" target="banana-obj"/>

                <!--   Comparisons between the Sate Color and the analytic models  -->
                <Relation xsi:type="SemanticBaseAnalyticalModelRelationType"
                            name="similarTo" source="color-sta" target="brown-mod"
                            id="sim1-rel"/>
                <Relation xsi:type="SemanticBaseAnalyticalModelRelationType"
                            name="similarTo" source="color-sta" target="yellow-mod"
                            id="sim2-rel"/>
                <Relation xsi:type="SemanticBaseAnalyticalModelRelationType"
                            name="similarTo" source="color-sta" target="yellow-mod"
                            id="sim3-rel"/>

                <!--   Dependencies between State Has and States Similar  -->
                <Relation xsi:type="SemanticStateSemanticStateRelationType"
                            name="dependsOn" source="has-sta" target="sim1-sta"/>
                <Relation xsi:type="SemanticStateSemanticStateRelationType"
                            name="dependsOn" source="has-sta" target="sim2-sta"/>
                <Relation xsi:type="SemanticStateSemanticStateRelationType"
                            name="dependsOn" source="has-sta" target="sim3-sta"/>

                <!--   Membership relationships  -->
                <Relation xsi:type="RelationType"
                            name="membershipIn" source="sim1-sta" target="sim1-rel"/>
                <Relation xsi:type="RelationType"
                            name="membershipIn" source="sim2-sta" target="sim2-rel"/>
                <Relation xsi:type="RelationType"
                            name="membershipIn" source="sim3-sta" target="sim3-rel"/>
                <Relation xsi:type="RelationType"
                            name="membershipIn" source="has-sta" target="has-rel"/>

            </Graph>
        </Semantic>
    </ContentDescription>

    <!--   Anaylitical models of each one of the three cognitive colors:
            brown, yellow, and green  -->
    <ContentDescription xsi:type="ModelDescriptionType">
        <Model xsi:type="CollectionModelType" id="Brown-mod" function="described">
            <Label> Brown </Label>
            <Collection xsi:type="DescriptorCollectionType">
                <Descriptor xsi:type="ScalableColorType"
                            numberOfCoefficients="16" numberOfBitplancesDiscarded="0">
                    <Coefficients dim="16"> 1 2 . . . 16 </Coefficients>
                </Descriptor>
            </Collection>
        </Model>
    </ContentDescription>
    <ContentDescription xsi:type="ModelDescriptionType">
        <Model xsi:type="CollectionModelType" id="Yellow-mod" function="described">
            <Label> Yellow </Label>
            <Collection xsi:type="DescriptorCollectionType">
                <Descriptor xsi:type="ScalableColorType"
                            numberOfCoefficients="16" numberOfBitplancesDiscarded="0">
                    <Coefficients dim="16"> 8 5 . . . 21 </Coefficients>
                </Descriptor>
            </Collection>
        </Model>
    </ContentDescription>
    <ContentDescription xsi:type="ModelDescriptionType">
```

```
        <Model xsi:type="CollectionModelType" id="Green-mod" function="described">
            <Label> Green </Label>
            <Collection xsi:type="DescriptorCollectionType">
                <Descriptor xsi:type="ScalableColorType"
                            numberOfCoefficients="16" numberOfBitplancesDiscarded="0">
                    <Coefficients dim="16"> 4 6 . . . 1 </Coefficients>
                </Descriptor>
            </Collection>
        </Model>
    </ContentDescription>

</Mpeg7>
```

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 this example, it should be noted:

1. It is possibly to derive a "Membership Function" from the SemanticState DS 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.

3. There is a need to standardize several new relations between analytical models and semantic entities.

1.2 Abstraction Levels: Soccer Game (1)

The following example illustrate the use of the SemanticBase DSs and the AbstractionLevel datatype for describing a possible formal abstraction of a soccer game, which is shown in Figure 2. In Figure 2, the circles with grey background represent events, the circles with white background represent objects, the circles with dotted background represent semantic places, the circles with lined background represent semantic times, and the unlabeled arcs represent composition relations.

In this example, a soccer game is represented as an event whose agent, accompanier, instrument, and location are the home team, the visiting team, the ball, and the soccer field, respectively. A soccer game is also represented as an object, equivalent to the soccer game event, which is the patient of an Arbiter event whose agent is a referee team object. A soccer match event is composed of the following events: first period, half-time interval, second period, extra time, penalty period, and time lost. The first period, the second period, and the extra time events are composed of events such as soccer plays, which can be scores, free kicks, faults, off-sides, corner kicks, goal kicks, throw-ins, and penalty kicks. The penalty period event is composed of penalty kick events. The first and the second periods last 45 minutes; whereas the half-time and the extra time are 15 and 30 minutes long, respectively.

The visiting team and the home team are represented as objects specialized from playing team, which is composed of a goalkeeper and 10 more players. A soccer team is described as composed of players, a coach, and some staff, apart from the playing team. The referee team is described as an object composed of three objects: the principal referee and two assistant referees. The soccer stadium is described as an object composed of a soccer field and spectator seats. The soccer field objects is composed of other objects such as the goal, the goal area, the penalty area, and the center circle, among others. The soccer field semantic place is equivalent to the soccer field object.
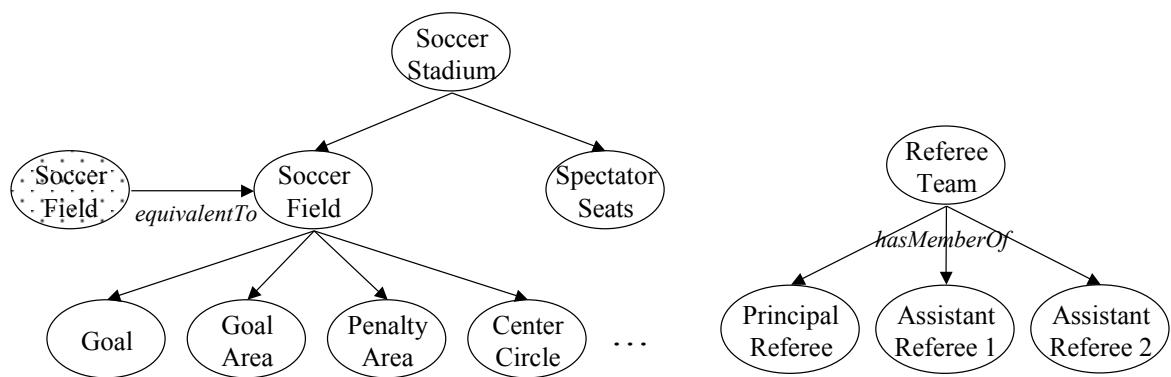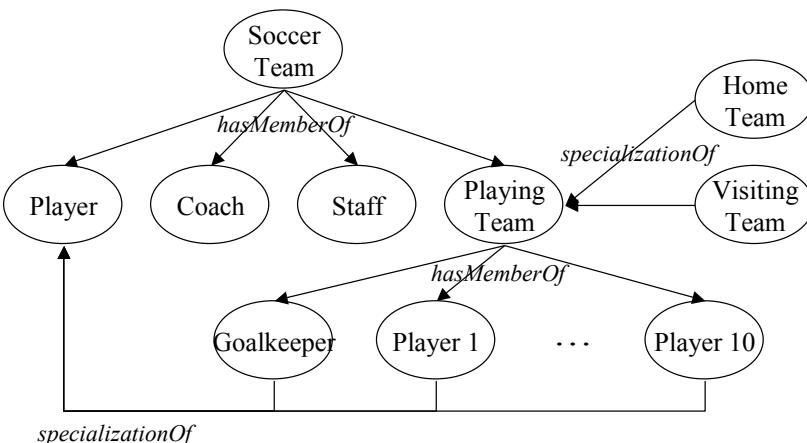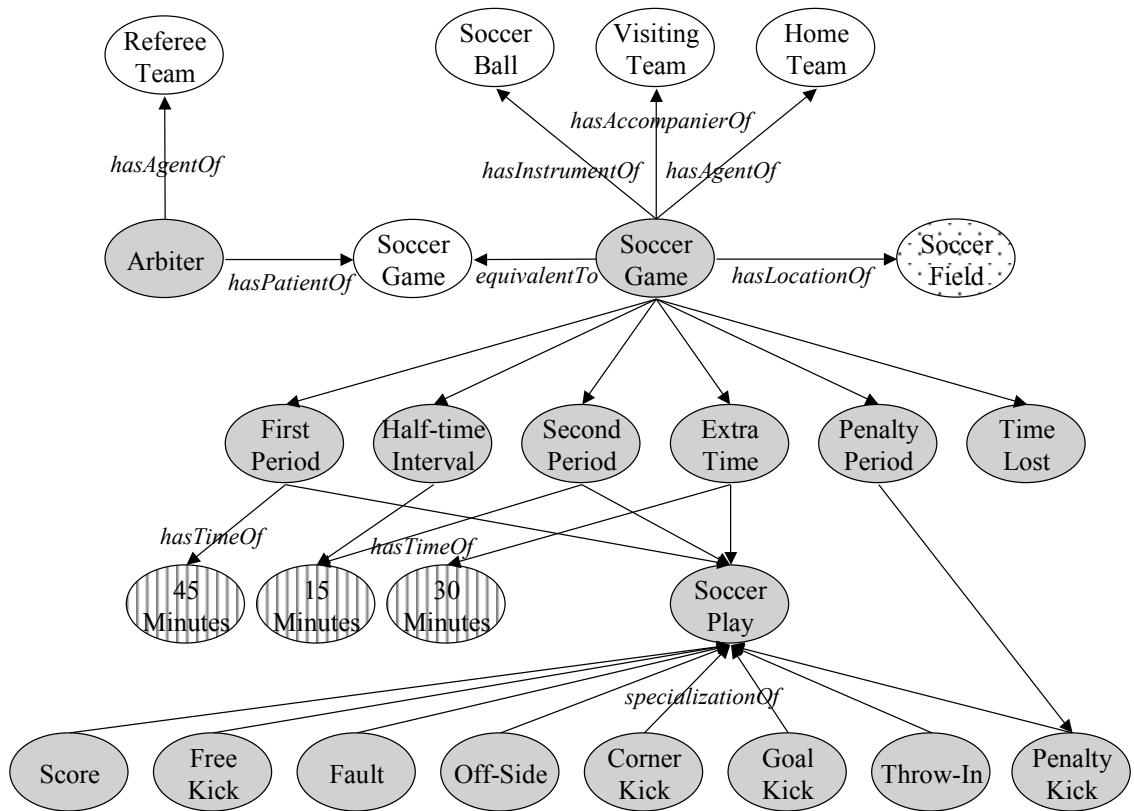
Figure 2: Possible formal abstract description of a soccer game.

```xml
<!--  Formal abstraction: AbstractionLevel = 1 -->
<Semantics xsi:type="SemanticType" id="soccergame-sem">
   <Label> <FreeTerm> Soccer game </FreeTerm> </Label>
   <AbstractionLevel dimension="1"/>
   <!—- Events  -->
   <SemanticBase xsi:type="EventType" id="soccergame-eve">
      <AbstractionLevel dimension="1"/>
      <Label> <FreeTerm> Soccer game </FreeTerm> </Label>
   </SemanticBase>
   <SemanticBase xsi:type="EventType" id="arbiter-eve">
      <AbstractionLevel dimension="1"/>
      <Label> <FreeTerm> Arbiter </FreeTerm> </Label>
   </SemanticBase>
   <SemanticBase xsi:type="EventType" id="1stperiod-eve">
      <AbstractionLevel dimension="1"/>
      <Label> <FreeTerm> First period </FreeTerm> </Label>
   </SemanticBase>
   <SemanticBase xsi:type="EventType" id="halftime-eve">
      <AbstractionLevel dimension="1"/>
      <Label> <FreeTerm> Half time </FreeTerm> </Label>
   </SemanticBase>
   <SemanticBase xsi:type="EventType" id="2ndperiod-eve">
      <AbstractionLevel dimension="1"/>
      <Label> <FreeTerm> Second period </FreeTerm> </Label>
   </SemanticBase>
   <SemanticBase xsi:type="EventType" id="extratime-eve">
      <AbstractionLevel dimension="1"/>
      <Label> <FreeTerm> Extra time </FreeTerm> </Label>
   </SemanticBase>
   <SemanticBase xsi:type="EventType" id="penaltyperiod-eve">
      <AbstractionLevel dimension="1"/>
      <Label> <FreeTerm> Penalty period </FreeTerm> </Label>
   </SemanticBase>
   <SemanticBase xsi:type="EventType" id="timelost-eve">
      <AbstractionLevel dimension="1"/>
      <Label> <FreeTerm> Time lost </FreeTerm> </Label>
   </SemanticBase>
   <SemanticBase xsi:type="EventType" id="soccerplay-eve">
      <AbstractionLevel dimension="1"/>
      <Label> <FreeTerm> Soccer play </FreeTerm> </Label>
   </SemanticBase>
   <SemanticBase xsi:type="EventType" id="score-eve">
      <AbstractionLevel dimension="1"/>
      <Label> <FreeTerm> Score </FreeTerm> </Label>
   </SemanticBase>
   <SemanticBase xsi:type="EventType" id="freekick-eve">
      <AbstractionLevel dimension="1"/>
      <Label> <FreeTerm> Free kick </FreeTerm> </Label>
   </SemanticBase>
   <SemanticBase xsi:type="EventType" id="fault-eve">
      <AbstractionLevel dimension="1"/>
      <Label> <FreeTerm> Fault </FreeTerm> </Label>
   </SemanticBase>
   <SemanticBase xsi:type="EventType" id="offside-eve">
      <AbstractionLevel dimension="1"/>
      <Label> <FreeTerm> Off-side </FreeTerm> </Label>
   </SemanticBase>
   <SemanticBase xsi:type="EventType" id="cornerkick-eve">
      <AbstractionLevel dimension="1"/>
      <Label> <FreeTerm> Corner kick </FreeTerm> </Label>
   </SemanticBase>
   <SemanticBase xsi:type="EventType" id="goalkick-eve">
      <AbstractionLevel dimension="1"/>
      <Label> <FreeTerm> Goal kick </FreeTerm> </Label>
   </SemanticBase>
```

```xml
<SemanticBase xsi:type="EventType" id="throwin-eve">
   <AbstractionLevel dimension="1"/>
   <Label> <FreeTerm> Throw in </FreeTerm> </Label>
</SemanticBase>
<SemanticBase xsi:type="EventType" id="penaltykick-eve">
   <AbstractionLevel dimension="1"/>
   <Label> <FreeTerm> Penalty kick </FreeTerm> </Label>
</SemanticBase>


<!—- Objects -->
<SemanticBase xsi:type="ObjectType" id="soccergame-obj">
   <AbstractionLevel dimension="1"/>
   <Label> <FreeTerm> Soccer game </FreeTerm> </Label>
</SemanticBase>
<SemanticBase xsi:type="ObjectType" id="soccerball-obj">
   <AbstractionLevel dimension="1"/>
   <Label> <FreeTerm> Soccer ball </FreeTerm> </Label>
</SemanticBase>
<SemanticBase xsi:type="ObjectType" id="soccerteam-obj">
   <AbstractionLevel dimension="1"/>
   <Label> <FreeTerm> Soccer team </FreeTerm> </Label>
</SemanticBase>
<SemanticBase xsi:type="ObjectType" id="player-obj">
   <AbstractionLevel dimension="1"/>
   <Label> <FreeTerm> Player </FreeTerm> </Label>
</SemanticBase>
<SemanticBase xsi:type="ObjectType" id="coach-obj">
   <AbstractionLevel dimension="1"/>
   <Label> <FreeTerm> Coach </FreeTerm> </Label>
</SemanticBase>
<SemanticBase xsi:type="ObjectType" id="staff-obj">
   <AbstractionLevel dimension="1"/>
   <Label> <FreeTerm> Staff </FreeTerm> </Label>
</SemanticBase>
<SemanticBase xsi:type="ObjectType" id="playingteam-obj">
   <AbstractionLevel dimension="1"/>
   <Label> <FreeTerm> Playing team </FreeTerm> </Label>
</SemanticBase>
<SemanticBase xsi:type="ObjectType" id="hometeam-obj">
   <AbstractionLevel dimension="1"/>
   <Label> <FreeTerm> Home team </FreeTerm> </Label>
</SemanticBase>
<SemanticBase xsi:type="ObjectType" id="visitingteam-obj">
   <AbstractionLevel dimension="1"/>
   <Label> <FreeTerm> Visiting team </FreeTerm> </Label>
</SemanticBase>
<SemanticBase xsi:type="ObjectType" id="goalkeeper-obj">
   <AbstractionLevel dimension="1"/>
   <Label> <FreeTerm> Goalkeeper </FreeTerm> </Label>
</SemanticBase>
<SemanticBase xsi:type="ObjectType" id="player1-obj">
   <AbstractionLevel dimension="1"/>
   <Label> <FreeTerm> Player 1 </FreeTerm> </Label>
</SemanticBase>
...
<SemanticBase xsi:type="ObjectType" id="player10-obj">
   <AbstractionLevel dimension="1"/>
   <Label> <FreeTerm> Player 10 </FreeTerm> </Label>
</SemanticBase>
<SemanticBase xsi:type="ObjectType" id="refereeteam-obj">
   <AbstractionLevel dimension="1"/>
   <Label> <FreeTerm> Referee team </FreeTerm> </Label>
</SemanticBase>
<SemanticBase xsi:type="ObjectType" id="principalreferee-obj">
   <AbstractionLevel dimension="1"/>
```

```
      <Label> <FreeTerm> Principal referee </FreeTerm> </Label>
   </SemanticBase>
   <SemanticBase xsi:type="ObjectType" id="assistantreferee1-obj">
      <AbstractionLevel dimension="1"/>
      <Label> <FreeTerm> Assistant referee 1 </FreeTerm> </Label>
   </SemanticBase>
   <SemanticBase xsi:type="ObjectType" id="assistantreferee2-obj">
      <AbstractionLevel dimension="1"/>
      <Label> <FreeTerm> Assistant referee 2 </FreeTerm> </Label>
   </SemanticBase>
   <SemanticBase xsi:type="ObjectType" id="soccerstadium-obj">
      <AbstractionLevel dimension="1"/>
      <Label> <FreeTerm> Soccer stadium </FreeTerm> </Label>
   </SemanticBase>
   <SemanticBase xsi:type="ObjectType" id="soccerfield-obj">
      <AbstractionLevel dimension="1"/>
      <Label> <FreeTerm> Soccer field </FreeTerm> </Label>
   </SemanticBase>
   <SemanticBase xsi:type="ObjectType" id="goal-obj">
      <AbstractionLevel dimension="1"/>
      <Label> <FreeTerm> Goal </FreeTerm> </Label>
   </SemanticBase>
   <SemanticBase xsi:type="ObjectType" id="goalarea-obj">
      <AbstractionLevel dimension="1"/>
      <Label> <FreeTerm> Goal area </FreeTerm> </Label>
   </SemanticBase>
   <SemanticBase xsi:type="ObjectType" id="penaltyarea-obj">
      <AbstractionLevel dimension="1"/>
      <Label> <FreeTerm> Penalty area </FreeTerm> </Label>
   </SemanticBase>
   <SemanticBase xsi:type="ObjectType" id="centercircle-obj">
      <AbstractionLevel dimension="1"/>
      <Label> <FreeTerm> Center circle </FreeTerm> </Label>
   </SemanticBase>
   ...
   <SemanticBase xsi:type="ObjectType" id="spectatorseats-obj">
      <AbstractionLevel dimension="1"/>
      <Label> <FreeTerm> Spectator seats </FreeTerm> </Label>
   </SemanticBase>

   <!--  Semantic places  -->
   <SemanticBase xsi:type="ObjectType" id="soccerfield-pla">
      <AbstractionLevel dimension="1"/>
      <Label> <FreeTerm> Soccer field </FreeTerm> </Label>
   </SemanticBase>

   <!--  Semantic times  -->
   <SemanticBase xsi:type="SemanticTimeType" id="45minutes-tim">
      <AbstractionLevel dimension="1"/>
      <Label> <FreeTerm> 45 minutes </FreeTerm> </Label>
      <SemanticTimeInterval>
         <Duration measurementType="length" unit="minutes" value="45"/>
      </SemanticTimeInterval>
   </SemanticBase>
   <SemanticBase xsi:type="SemanticTimeType" id="15minutes-tim">
      <AbstractionLevel dimension="1"/>
      <Label> <FreeTerm> 15 minutes </FreeTerm> </Label>
      <SemanticTimeInterval>
         <Duration measurementType="length" unit="minutes" value="15"/>
      </SemanticTimeInterval>
   </SemanticBase>
   <SemanticBase xsi:type="SemanticTimeType" id="30minutes-tim">
      <AbstractionLevel dimension="1"/>
      <Label> <FreeTerm> 15 minutes </FreeTerm> </Label>
      <SemanticTimeInterval>
```

```
                <Duration measurementType="length" unit="minutes" value="15"/>
        </SemanticTimeInterval>
    </SemanticBase>


    <Graph>
        <!--   Soccer game event relations   -->
        <Relation xsi:type="ObjectEventRelationType"
                  name="hasAgentOf" source="soccergame-eve" target="hometeam-obj"/>
        <Relation xsi:type="ObjectEventRelationType"
                  name="hasAccompaniertOf" source="soccergame-eve"
                  target="visitingteam-obj"/>
        <Relation xsi:type="ObjectEventRelationType"
                  name="hasInstrumentOf" source="soccergame-eve" target="ball-obj"/>
        <Relation xsi:type="ObjectEventRelationType"
                  name="hasLocationOf" source="soccergame-eve"
                  target="soccerfield-pla"/>
        <Relation xsi:type="SemanticBaseSemanticBaseRelationType"
                  name="equivalentTo" source="soccergame-eve"
                  target="soccergame-obj"/>
        <Relation xsi:type="EventEventRelationType"
                  name="hasPartOf" source="soccergame-eve"
                  target="1stperiod-eve"/>
        <Relation xsi:type="EventEventRelationType"
                  name="hasPartOf" source="soccergame-eve"
                  target="halftime-eve"/>
        <Relation xsi:type="EventEventRelationType"
                  name="hasPartOf" source="soccergame-eve"
                  target="2ndperiod-eve"/>
        <Relation xsi:type="EventEventRelationType"
                  name="hasPartOf" source="soccergame-eve"
                  target="extratime-eve"/>
        <Relation xsi:type="EventEventRelationType"
                  name="hasPartOf" source="soccergame-eve"
                  target="penaltyperiod-eve"/>
        <Relation xsi:type="EventEventRelationType"
                  name="hasPartOf" source="soccergame-eve"
                  target="timelost-eve"/>

        <!--   Arbiter event relations   -->
        <Relation xsi:type="ObjectEventRelationType"
                  name="hasAgentOf" source="arbiter-eve" target="refereeteam-obj"/>
        <Relation xsi:type="ObjectEventRelationType"
                  name="hasPatientOf" source="arbiter-eve" target="soccergame-obj"/>

        <!--   Soccer play event relations   -->
        <Relation xsi:type="EventEventRelationType"
                  name="componentOf" source="soccerplay-eve" target="1stperiod-eve"/>
        <Relation xsi:type="EventEventRelationType"
                  name="componentOf" source="soccerplay-eve" target="2ndperiod-eve"/>
        <Relation xsi:type="EventEventRelationType"
                  name="componentOf" source="soccerplay-eve" target="extratime-eve"/>
        <Relation xsi:type="SemanticBaseSemanticBaseRelationType"
                  name="specializationOf" source="score-eve" target="soccerplay-eve"/>
        <Relation xsi:type="SemanticBaseSemanticBaseRelationType"
                  name="specializationOf" source="freekick-eve"
                  target="soccerplay-eve"/>
        <Relation xsi:type="SemanticBaseSemanticBaseRelationType"
                  name="specializationOf" source="fault-eve" target="soccerplay-eve"/>
        <Relation xsi:type="SemanticBaseSemanticBaseRelationType"
                  name="specializationOf" source="offside-eve"
                  target="soccerplay-eve"/>
        <Relation xsi:type="SemanticBaseSemanticBaseRelationType"
                  name="specializationOf" source="cornerkick-eve"
                  target="soccerplay-eve"/>
        <Relation xsi:type="SemanticBaseSemanticBaseRelationType"
```

```
                name="specializationOf" source="goalkick-eve"
                target="soccerplay-eve"/>
        <Relation xsi:type="SemanticBaseSemanticBaseRelationType"
                name="specializationOf" source="goalkick-eve"
                target="soccerplay-eve"/>
        <Relation xsi:type="SemanticBaseSemanticBaseRelationType"
                name="specializationOf" source="throwin-eve"
                target="soccerplay-eve"/>
        <Relation xsi:type="SemanticBaseSemanticBaseRelationType"
                name="specializationOf" source="penaltykick-eve"
                target="soccerplay-eve"/>
        <Relation xsi:type="EventEventRelationType"
                name="hasPartOf" source="penaltyperiod-eve"
                target="penaltykick-eve"/>

        <!--  Semantic times relations  -->
        <Relation xsi:type="SemanticTimeSemanticBaseRelationType"
                name="hasTimeOf" source="1stperiod-eve" target="45minutes-tim"/>
        <Relation xsi:type="SemanticTimeSemanticBaseRelationType"
                name="hasTimeOf" source="2ndperiod-eve" target="45minutes-tim"/>
        <Relation xsi:type="SemanticTimeSemanticBaseRelationType"
                name="hasTimeOf" source="halftime-eve" target="15minutes-tim"/>
        <Relation xsi:type="SemanticTimeSemanticBaseRelationType"
                name="hasTimeOf" source="extratime-eve" target="15minutes-tim"/>

        <!--  Soccer team object relations  -->
        <Relation xsi:type="ObjectObjectRelationType"
                name="hasMemberOf" source="soccerteam-obj" target="player-obj"/>
        <Relation xsi:type="ObjectObjectRelationType"
                name="hasMemberOf" source="soccerteam-obj" target="coach-obj"/>
        <Relation xsi:type="ObjectObjectRelationType"
                name="hasMemberOf" source="soccerteam-obj" target="staff-obj"/>
        <Relation xsi:type="ObjectObjectRelationType"
                name="hasComponentOf" source="soccerteam-obj"
                target="playingteam-obj"/>
        <Relation xsi:type="ObjectObjectRelationType"
                name="hasMemberOf" source="playingteam-obj"
                target="goalkeeper-obj"/>
        <Relation xsi:type="ObjectObjectRelationType"
                name="hasMemberOf" source="playingteam-obj" target="player1-obj"/>
        ...
        <Relation xsi:type="ObjectObjectRelationType"
                name="hasMemberOf" source="playingteam-obj" target="player10-obj"/>
        <Relation xsi:type="SemanticBaseSemanticBaseRelationType"
                name="specializationOf" source="goalkeeper-obj"
                target="player-obj"/>
        <Relation xsi:type="SemanticBaseSemanticBaseRelationType"
                name="specializationOf" source="player1-obj" target="player-obj"/>
        ...
        <Relation xsi:type="SemanticBaseSemanticBaseRelationType"
                name="specializationOf" source="player10-obj" target="player-obj"/>
        <Relation xsi:type="SemanticBaseSemanticBaseRelationType"
                name="specializationOf" source="hometeam-obj"
                target="playingteam-obj"/>
        <Relation xsi:type="SemanticBaseSemanticBaseRelationType"
                name="specializationOf" source="visingteam-obj"
                target="playingteam-obj"/>

        <!-- Soccer stadium object relations  -->
        <Relation xsi:type="ObjectObjectRelationType"
                name="hasComponentOf" source="soccerstadium-obj"
                target="soccerfield-obj"/>
        <Relation xsi:type="ObjectObjectRelationType"
                name="hasComponentOf" source="soccerfield-obj" target="goal-obj"/>
        <Relation xsi:type="ObjectObjectRelationType"
```

```
                name="hasComponentOf" source="soccerfield-obj"
                target="goalarea-obj"/>
     <Relation xsi:type="ObjectObjectRelationType"
                name="hasComponentOf" source="soccerfield-obj"
                target="penaltyarea-obj"/>
     <Relation xsi:type="ObjectObjectRelationType"
                name="hasComponentOf" source="soccerfield-obj"
                target="centercircle-obj"/>
     ...
     <Relation xsi:type="ObjectObjectRelationType"
                name="hasComponentOf" source="soccerstadium-obj"
                target="spectatorseats-obj"/>
     <Relation xsi:type="SemanticBaseSemanticBaseRelationType"
                name="equivalentTo" source="soccerfield-obj"
                target="soccerfield-pla"/>

     <!--  Referee team object relations  -->
     <Relation xsi:type="ObjectObjectRelationType"
                name="hasMemberOf" source="refereeteam-obj"
                target="principalreferee-obj"/>
     <Relation xsi:type="ObjectObjectRelationType"
                name="hasMemberOf" source="refereeteam-obj"
                target="assistantreferee1-obj"/>
     <Relation xsi:type="ObjectObjectRelationType"
                name="hasMemberOf" source="refereeteam-obj"
                target="assistantreferee2-obj"/>
   </Graph>
</Semantic>
```

The following example illustrates the use of Semantic DS for describing a concrete instance of the abstract description of the soccer game above. The semantic base – semantic base relation *exampleOf* relates the abstract semantic entities and their instances. In this example, the soccer game is between the Spanish soccer team (home team) and the Swedish soccer team (visiting team) in the Santiago Bernabeu soccer stadium in Madrid, Spain. The game starts at 8pm on Saturday, March 17, 1995. Morientes, a player of the Spanish soccer team, scores two goals during the first half of the game.

```
<!--  Concrete instance: No AbstractionLevel  -->
<Semantic id="soccergame_ins-sem">
   <Label>
      <FreeTerm> Soccer game between Spanish and Swedish soccer teams </FreeTerm>
   </Label>
   <!--  Events  -->
   <SemanticBase xsi:type="EventType" id="soccergame_ins-eve">
      <Label> <FreeTerm> Soccer game </FreeTerm> </Label>
      <MediaOccurrence>
         <MediaLocator>
            <MediaUri> http://www.mpeg7.org/game.mpg </MediaUri>
         </MediaLocator>
      </MediaOccurrence>
   </SemanticBase>
   <SemanticBase xsi:type="EventType" id="1stperiod-eve">
      <AbstractionLevel dimension="1"/>
      <Label> <FreeTerm> First period </FreeTerm> </Label>
   </SemanticBase>
   <SemanticBase xsi:type="EventType" id="1stperiod_ins-eve">
      <AbstractionLevel dimension="1"/>
      <Label> <FreeTerm> First period </FreeTerm> </Label>
      <MediaOccurrence>
         <MediaLocator>
            <MediaUri> http://www.mpeg7.org/game.mpg </MediaUri>
            <MediaTime>
               <MediaRelTimePoint timeBase="../MediaUri">
                  T0:8:00
```

```xml
                    </MediaRelTimePoint>
                    <MediaDuration> PT48M56S </MediaDuration>
                </MediaTime>
            </MediaLocator>
        </MediaOccurrence>
    </SemanticBase>
    <SemanticBase xsi:type="EventType" id="2ndperiod_ins-eve">
        <AbstractionLevel dimension="1"/>
        <Label> <FreeTerm> Second period </FreeTerm> </Label>
        <MediaOccurrence>
            <MediaLocator>
                <MediaUri> http://www.mpeg7.org/game.mpg </MediaUri>
                <MediaTime>
                    <MediaRelTimePoint timeBase="../MediaUri">
                        T0:71:56
                    </MediaRelTimePoint>
                    <MediaDuration> PT47M6S </MediaDuration>
                </MediaTime>
            </MediaLocator>
        </MediaOccurrence>
    </SemanticBase>
    <SemanticBase xsi:type="EventType" id="score1_ins-eve">
        <AbstractionLevel dimension="1"/>
        <Label> <FreeTerm> Score </FreeTerm> </Label>
        <MediaOccurrence>
            <MediaLocator>
                <MediaUri> http://www.mpeg7.org/game.mpg </MediaUri>
                <MediaTime>
                    <MediaRelTimePoint timeBase="../MediaUri">
                        T0:9:54
                    </MediaRelTimePoint>
                    <MediaDuration> PT2S </MediaDuration>
                </MediaTime>
            </MediaLocator>
        </MediaOccurrence>
    </SemanticBase>
    <SemanticBase xsi:type="EventType" id="score2_ins-eve">
        <AbstractionLevel dimension="1"/>
        <Label> <FreeTerm> Score </FreeTerm> </Label>
        <MediaOccurrence>
            <MediaLocator>
                <MediaUri> http://www.mpeg7.org/game.mpg </MediaUri>
                <MediaTime>
                    <MediaRelTimePoint timeBase="../MediaUri">
                        T0:20:42
                    </MediaRelTimePoint>
                    <MediaDuration> PT5S </MediaDuration>
                </MediaTime>
            </MediaLocator>
        </MediaOccurrence>
    </SemanticBase>

    <!-- Objects -->
    <SemanticBase xsi:type="AgentObjectType" id="spanishteam_ins-obj">
        <Label> <FreeTerm> Spanish soccer team </FreeTerm> </Label>
        <MediaOccurrence>
            <MediaLocator>
                <MediaUri> http://www.mpeg7.org/game.mpg </MediaUri>
            </MediaLocator>
        </MediaOccurrence>
        <Agent xsi:type="PersonGroupType">
            <Name> Spanish soccer team </Name>
            <Member>
                <!-- People in the team -->
                <PersonRef> <IDRef> morientes-per </IDRef> </PersonRef>
```

```
                ...
            </Member>
        </Agent>
    </SemanticBase>
    <SemanticBase xsi:type="AgentObjectType" id="Swedishteam_ins-obj">
        <Label> <FreeTerm> Swedish soccer team </FreeTerm> </Label>
        <MediaOccurrence>
            <MediaLocator>
                <MediaUri> http://www.mpeg7.org/game.mpg </MediaUri>
            </MediaLocator>
        </MediaOccurrence>
        <Agent xsi:type="PersonGroupType">
            <Name> Swedish soccer team </Name>
            <Member>
                <!--  People in the team  -->
                <PersonRef> <IDRef> </IDRef> </PersonRef>
                ...
            </Member>
        </Agent>
    </SemanticBase>
    <SemanticBase xsi:type="AgentObjectType" id="morientes_ins-obj">
        <Label> <FreeTerm> Soccer player </FreeTerm> </Label>
        <MediaOccurrence>
            <MediaLocator>
                <MediaUri> http://www.mpeg7.org/game.mpg </MediaUri>
                <MediaTime>
                    <MediaRelTimePoint timeBase="../MediaUri">
                        T0:9:54
                    </MediaRelTimePoint>
                    <MediaDuration> PT2S </MediaDuration>
                </MediaTime>
            </MediaLocator>
        </MediaOccurrence>
        <MediaOccurrence>
            <MediaLocator>
                <MediaUri> http://www.mpeg7.org/game.mpg </MediaUri>
                <MediaTime>
                    <MediaRelTimePoint timeBase="../MediaUri">
                        T0:20:42
                    </MediaRelTimePoint>
                    <MediaDuration> PT5S </MediaDuration>
                </MediaTime>
            </MediaLocator>
        </MediaOccurrence>
        <Agent xsi:type="PersonType" id="morientes-per">
            <Name>
                <FamilyName>Morientes</FamilyName>
            </Name>
        </Agent>
    </SemanticBase>
    <SemanticBase xsi:type="ObjectType" id="soccerstadium-obj">
        <Label> <FreeTerm> Soccer stadium </FreeTerm> </Label>
        <MediaOccurrence>
            <MediaLocator>
                <MediaUri> http://www.mpeg7.org/game.mpg </MediaUri>
            </MediaLocator>
        </MediaOccurrence>
    </SemanticBase>
    <SemanticBase xsi:type="ObjectType" id="soccerfield-obj">
        <Label> <FreeTerm> Soccer field </FreeTerm> </Label>
        <MediaOccurrence>
            <MediaLocator>
                <MediaUri> http://www.mpeg7.org/game.mpg </MediaUri>
            </MediaLocator>
        </MediaOccurrence>
```

```
    </SemanticBase>

    <!--  Semantic places  -->
    <SemanticBase xsi:type="ObjectType" id="soccerfield_ins-pla">
        <Label> <FreeTerm> Soccer field </FreeTerm> </Label>
    </SemanticBase>
    <SemanticBase xsi:type="ObjectType" id="soccerstadium_ins-pla">
        <Label> <FreeTerm> Soccer stadium </FreeTerm> </Label>
        <Place>
            <Name xml:lang="en"> Santiago Bernabeu </Name>
            <Country> es </Country>
            <PostalAddress>
                <AddressLine> Concha Espina s/n., Madrid </AddressLine>
                <PostingIdentifier> E-28036 </PostingIdentifier>
            </PostalAddress>
        </Place>
    </SemanticBase>

    <!--  Semantic times  -->
    <SemanticBase xsi:type="SemanticTimeType" id="1stperiod_ins-tim">
        <AbstractionLevel dimension="1"/>
        <Label> <FreeTerm> Start time of 1st period </FreeTerm> </Label>
        <SemanticTime>
            <Time>
                <TimePoint> 1995-3-17T20:00:00 </TimePoint>
                <Duration> PT48M56S </Duration>
            </Time>
        </SemanticTime>
    </SemanticBase>
    <SemanticBase xsi:type="SemanticTimeType" id="2ndperiod_ins-tim">
        <AbstractionLevel dimension="1"/>
        <Label> <FreeTerm> Start time of 2nd period </FreeTerm> </Label>
        <SemanticTime>
            <Time>
                <TimePoint> 1995-3-17T21:03:56 </TimePoint>
                <Duration> PT47M6S </Duration>
            </Time>
        </SemanticTime>
    </SemanticBase>

    <Graph>
        <!--  Soccer game event relations  -->
        <Relation xsi:type="ObjectEventRelationType"
                name="hasAgentOf" source="soccergame_ins-eve"
                target="spanishteam_ins-obj"/>
        <Relation xsi:type="ObjectEventRelationType"
                name="hasAgentOf" source="soccergame_ins-eve"
                target="Swedishteam_ins-obj"/>
        <Relation xsi:type="ObjectEventRelationType"
                name="hasLocationOf" source="soccergame_ins-eve"
                target="soccerfield_ins-pla"/>
        <Relation xsi:type="EventEventRelationType"
                name="hasPartOf" source="soccergame_ins-eve"
                target="1stperiod_ins-eve"/>
        <Relation xsi:type="EventEventRelationType"
                name="hasPartOf" source="soccergame_ins-eve"
                target="2ndperiod_ins-eve"/>

        <!--  Score event relations  -->
        <Relation xsi:type="EventEventRelationType"
                name="partOf" source="score1_ins-eve"
                target="1stperiod_ins-eve"/>
        <Relation xsi:type="ObjectEventRelationType"
                name="hasAgentOf" source="score1_ins-eve"
                target="morientes_ins-obj"/>
```

```
        <Relation xsi:type="EventEventRelationType"
                name="partOf" source="score2_ins-eve"
                target="1stperiod_ins-eve"/>
        <Relation xsi:type="ObjectEventRelationType"
                name="hasAgentOf" source="score2_ins-eve"
                target="morientes_ins-obj"/>

    <!-- Semantic times relations -->
        <Relation xsi:type="SemanticTimeSemanticBaseRelationType"
                name="hasTimeOf" source="1stperiod_ins-eve"
                target="1stperiod_ins-tim"/>
        <Relation xsi:type="SemanticTimeSemanticBaseRelationType"
                name="hasTimeOf" source="2ndperiod_ins-eve"
                target="2ndperiod_ins-tim"/>

        <!-- Soccer team object relations -->
        <Relation xsi:type="ObjectObjectRelationType"
                name="hasMemberOf" source="spanishteam_ins-obj"
                target="morientes_ins-obj"/>

        <!-- Soccer stadium object relations -->
        <Relation xsi:type="ObjectObjectRelationType"
                name="hasComponentOf" source="soccerstadium_ins-obj"
                target="soccerfield_ins-obj"/>
        <Relation xsi:type="SemanticBaseSemanticBaseRelationType"
                name="equivalentTo" source="soccerfield_ins-obj"
                target="soccerfield_ins-pla"/>
        <Relation xsi:type="SemanticBaseSemanticBaseRelationType"
                name="equivalentTo" source="soccerstadium_ins-obj"
                target="soccerstadium_ins-pla"/>

        <!-- Instance (example) relations -->
        <Relation xsi:type="SemanticBaseSemanticBaseRelationType"
                name="exampleOf" source="soccergame_ins-eve"
                target="soccergame-eve"/>
        <Relation xsi:type="SemanticBaseSemanticBaseRelationType"
                name="exampleOf" source="score1_ins-eve" target="score-eve"/>
        <Relation xsi:type="SemanticBaseSemanticBaseRelationType"
                name="exampleOf" source="score2_ins-eve" target="score-eve"/>
        <Relation xsi:type="SemanticBaseSemanticBaseRelationType"
                name="exampleOf" source="spanishteam_ins-obj"
                target="hometeam-obj"/>
        <Relation xsi:type="SemanticBaseSemanticBaseRelationType"
                name="exampleOf" source="Swedishteam_ins-obj"
                target="visitingteam-obj"/>
        <Relation xsi:type="SemanticBaseSemanticBaseRelationType"
                name="exampleOf" source="morientes_ins-obj" target="player5-obj"/>
        <Relation xsi:type="SemanticBaseSemanticBaseRelationType"
                name="exampleOf" source="soccerstadium_ins-obj"
                target="soccerstadium-obj"/>
        <Relation xsi:type="SemanticBaseSemanticBaseRelationType"
                name="exampleOf" source="soccerfield_ins-obj"
                target="soccerfield-obj"/>
    </Graph>
</Semantic>
```

From this example, it should be noted:

1. In the current specification of the Semantic DS, objects could act as locations where events take place, e.g., the relations *locationOf* and *pathOf, among others,* allow describing an object being the location or path of an event. In this example, we have chosen not to do that.

2. The relation *exampleOf/hasExampleOf* can be used to describe concrete instances of formal abstractions.

3. The composition of events can only be described using nested Event DS descriptions.

4. A formal abstract agent object can not be described because AgentObject DS requires Agent DS and, therefore, a name for the agent object.

5. An AgentObject DS description can not reuse an existing Agent DS description of the agent object.

1.3 Abstraction Levels: Soccer Game (2)

The following example illustrates the use of Semantic DS, the AbstractionLevel datatype, and the SemanticRelation DSs for describing an possible abstract description of a soccer game and a concrete instance of the abstract description, which are shown in Figure 3. This example is very similar to the one in the previous section. Again, the semantic base – semantic base relation *exampleOf* relates the abstract semantic entities and their instances.
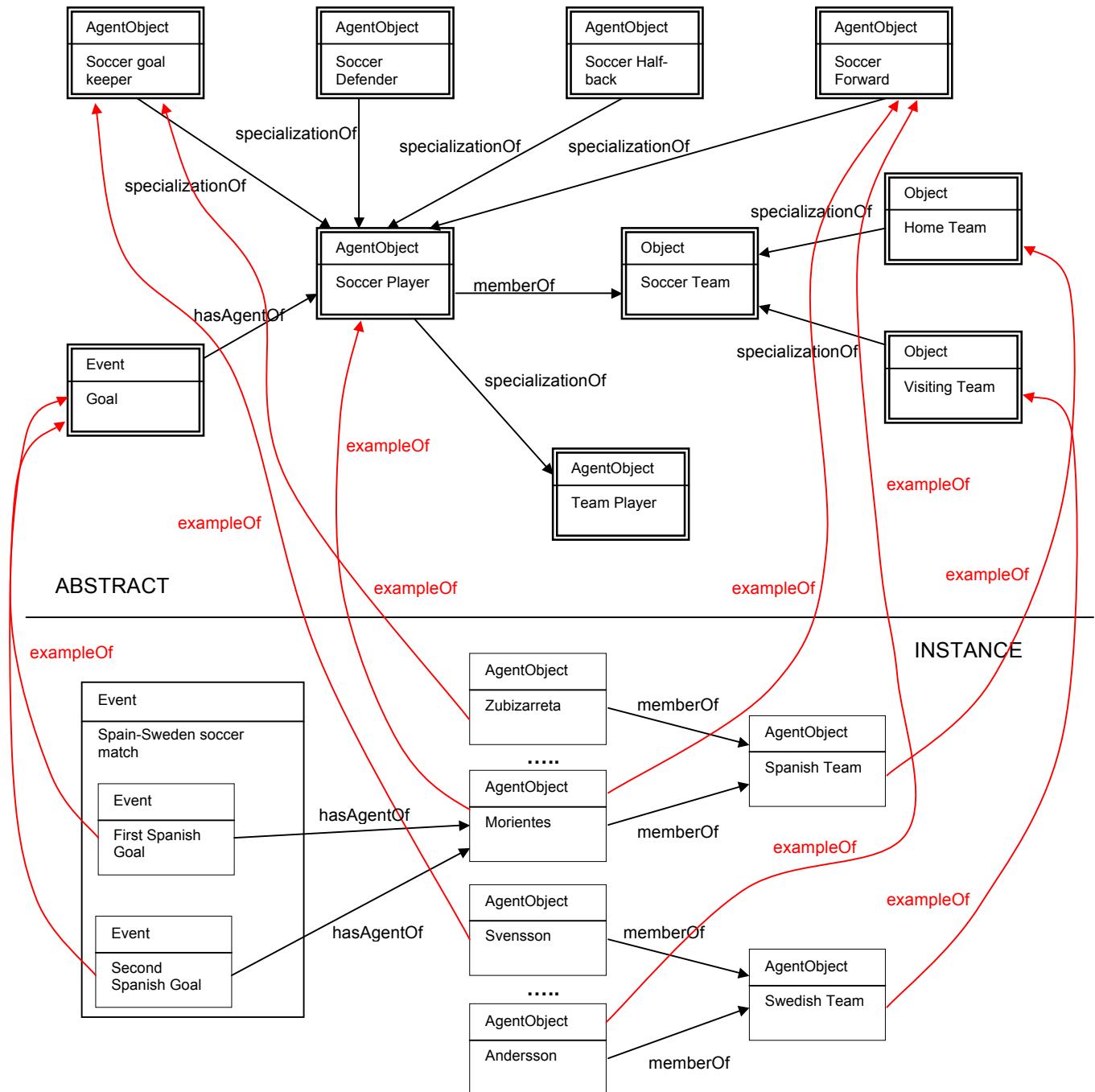
Figure 3: Abstract and concrete description of a soccer game.

```
<!--  Formal abstraction: AbstractionLevel = 1 -->
<Semantic id="SoccerMatchSpain-Sweden">
    <SemanticBase xsi:type="ObjectType" id="SoccerPlayer">
        <AbstractionLevel dimension="1"/>
        <Label> <FreeTerm> Soccer player </Label> </FreeTerm> </Label>
    </SemanticBase>
    <SemanticBase xsi:type="ObjectType" id="SoccerGoalKeeper">
        <AbstractionLevel dimension="1"/>
        <Label> <FreeTerm> Soccer goalkeeper </Label> </FreeTerm> </Label>
    </SemanticBase>
    <SemanticBase xsi:type="ObjectType" id="SoccerDefender">
        <AbstractionLevel dimension="1"/>
        <Label> <FreeTerm> Soccer defender </Label> </FreeTerm> </Label>
    </SemanticBase>
    <SemanticBase xsi:type="AgentObjectType" id="SoccerHalf-Back">
        <AbstractionLevel dimension="1"/>
        <Label> <FreeTerm> Soccer half-back </Label> </FreeTerm> </Label>
    </SemanticBase>
    <SemanticBase xsi:type="ObjectType" id="SoccerForward">
        <Label> <FreeTerm> Soccer forward </Label> </FreeTerm> </Label>
    </SemanticBase>
    <SemanticBase xsi:type="ObjectType" id="TeamPlayer">
        <AbstractionLevel dimension="1"/>
        <Label> <FreeTerm> Player of a team </Label> </FreeTerm> </Label>
    </SemanticBase>
    <SemanticBase xsi:type="EventType" id="Goal">
        <AbstractionLevel dimension="1"/>
        <Label> <FreeTerm> Goal </Label> </FreeTerm> </Label>
    </SemanticBase>
    <SemanticBase xsi:type="ObjectType" id="SoccerTeam">
        <AbstractionLevel dimension="1"/>
        <Label> <FreeTerm> Soccer team </Label> </FreeTerm> </Label>
    </SemanticBase>
    <SemanticBase xsi:type="AgentObjectType" id="HomeTeam">
        <AbstractionLevel dimension="1"/>
        <Label> <FreeTerm> Home team </Label> </FreeTerm> </Label>
    </SemanticBase>
    <SemanticBase xsi:type="AgentObjectType" id="VisitingTeam">
        <AbstractionLevel dimension="1"/>
        <Label> <FreeTerm> Visiting team </Label> </FreeTerm> </Label>
    </SemanticBase>

    <Graph>
        <Node id="nodeA" idref="SoccerPlayer"/>
        <Node id="nodeB" idref="TeamPlayer"/>
        <Node id="nodeC" idref="Goal"/>
        <Node id="nodeD" idref="SoccerTeam"/>
        <Node id="nodeE" idref="SoccerGoalKeeper"/>
        <Node id="nodeF" idref="SoccerFefender"/>
        <Node id="nodeG" idref="SoccerHalf-Back"/>
        <Node id="nodeH" idref="SoccerForward"/>
        <Node id="nodeI" idref="HomeTeam"/>
        <Node id="nodeJ" idref="VisitingTeam"/>

        <Relation xsi:type="SemanticBaseSemanticBaseRelationType"
                  name="specializationOf" source="nodeA" target="nodeB"/>
        <Relation xsi:type="ObjectEventRelationType"
                  name="agentOf" source="nodeA" target="nodeC"/>
        <Relation xsi:type="ObjectObjectRelationType"
                  name="memberOf" source="nodeA" target="nodeD"/>
        <Relation xsi:type="SemanticBaseSemanticBaseRelationType"
                  name="specializationOf" source="nodeE" target="nodeA"/>
        <Relation xsi:type="SemanticBaseSemanticBaseRelationType"
                  name="specializationOf" source="nodeF" target="nodeA"/>
        <Relation xsi:type="SemanticBaseSemanticBaseRelationType"
```

```
                         name="specializationOf" source="nodeG" target="nodeA"/>
        <Relation xsi:type="SemanticBaseSemanticBaseRelationType"
                         name="specializationOf" source="nodeI" target="nodeD"/>
        <Relation xsi:type="SemanticBaseSemanticBaseRelationType"
                         name="specializationOf" source="nodeJ" target="nodeD"/>
    </Graph>
</Semantic>
```

```
<!--  Concrete instance: No AbstractionLevel  -->
<Semantic>
    <SemanticBase xsi:type="AgentObjectType" id="SpanishTeam">
        <Label> <FreeTerm> Spanish team </Label> </FreeTerm> </Label>
        <Relation xsi:type="SemanticBaseSemanticBaseRelationType"
                         name="exampleOf" target="HomeTeam"/>
        <Agent xsi:type="PersonGroupType">
           <Name> Spanish soccer team </Name>
        </Agent>
    </SemanticBase>
    <SemanticBase xsi:type="AgentObjectType" id="SwedishTeam">
        <Label> <FreeTerm> Swedish team </Label> </FreeTerm> </Label>
        <Relation xsi:type="SemanticBaseSemanticBaseRelationType"
                         name="exampleOf" target="VisitingTeam"/>
        <Agent xsi:type="PersonGroupType">
           <Name> Swedish soccer team </Name>
        </Agent>
    </SemanticBase>

    <!-- Spanish team players -->
    <SemanticBase xsi:type="AgentObjectType" id="Zubizarreta">
        <Label> <FreeTerm> Zubizarreta </Label> </FreeTerm> </Label>
        <Relation xsi:type="SemanticBaseSemanticBaseRelationType"
                         name="exampleOf" target="SoccerGoalKeeper"/>
        <Relation xsi:type="ObjectObjectRelationType"
                         name="memberOf" target="SpanishTeam"/>
        <Agent xsi:type="PersonType">
           <Name>
              <GivenName> Antoni </GivenName>
              <FamilyName> Zubizarreta </FamilyName>
           </Name>
        </Agent>
    </SemanticBase>
    <SemanticBase xsi:type="AgentObjectType" id="Morientes">
        <Label> <FreeTerm> Morientes </Label> </FreeTerm> </Label>
        <Relation xsi:type="SemanticBaseSemanticBaseRelationType"
                         name="exampleOf" target="SoccerForward"/>
        <Relation xsi:type="ObjectObjectRelationType"
                         name="memberOf" target="SpanishTeam"/>
        <Agent xsi:type="PersonType">
           <Name>
              <GivenName> Fernando </GivenName>
              <FamilyName> Morientes </FamilyName>
           </Name>
        </Agent>
    </SemanticBase>
    ...

    <!-- Swedish team players-->
    <SemanticBase xsi:type="AgentObjectType" id="Svensson">
        <Label> <FreeTerm> Svensson </Label> </FreeTerm> </Label>
        <Relation xsi:type="SemanticBaseSemanticBaseRelationType"
                         name="exampleOf" target="SoccerGoalKeeper"/>
        <Relation xsi:type="ObjectObjectRelationType"
                         name="memberOf" target="SwedishTeam"/>
```

```xml
            <Agent xsi:type="PersonType">
                <Name>
                    <FamilyName> Svensson </FamilyName>
                </Name>
            </Agent>
    </SemanticBase>
    <SemanticBase xsi:type="AgentObjectType" id="Andersson">
        <Label> <FreeTerm> Andersson </Label> </FreeTerm> </Label>
        <Relation xsi:type="SemanticBaseSemanticBaseRelationType"
                name="exampleOf" target="SoccerForward"/>
        <Relation xsi:type="ObjectObjectRelationType"
                name="memberOf" target="SwedishTeam"/>
        <Agent xsi:type="PersonType">
            <Name>
                <GivenName> Kennet </GivenName>
                <FamilyName> Andersson </FamilyName>
            </Name>
        </Agent>
    </SemanticBase>
    ...

    <SemanticBase xsi:type="EventType" id="Spain-SwedenSoccerMatch">
        <Label> <FreeTerm> Spain-Sweden soccer match </Label> </FreeTerm> </Label>
        <EventRef IDREF="FirstSpanishGoal">
        <EventRef IDREF="SecondSpanishGoal">
        <Relation xsi:type="ObjectEventRelationType"
                name="hasAgentOf" target="SpainishTeam"/>
        <Relation xsi:type="ObjectEventRelationType"
                name="hasAgentOf" target="SwedishTeam"/>
        <SemanticPlace id="SantiagoBarnabeu">
            <Label> <FreeTerm> Santiago Bernabeu </FreeTerm> </Label>
            <Place>
                <Name> Santiago Bernabeu </Name>
                <Country> es </Country>
                <PostalAddress>
                    <AddressLine> Calle Concha, s/n, Madrid</AddressLine>
                    <PostingIdentifier> E-64200 </PostingIdentifier>
                </PostalAddress>
            </Place>
        </SemanticPlace>
        <SemanticTimeType id="TimeOfTheMatch">
            <Label> <FreeTerm> Saturday night 20 march 2000 </FreeTerm> </Label>
            <Time>
                <TimePoint> 2000-3-20T20:30:00 </TimePoint>
                <Duration> PT115M </Duration>
            </Time>
        </SemanticTime>
    </SemanticBase>
    <SemanticBase xsi:type="EventType" id="FirstSpanishGoal">
        <Label> <FreeTerm> First Spanish goal </Label> </FreeTerm> </Label>
        <Relation xsi:type="SemanticBaseSemanticBaseRelationType"
                name="exampleOf" target="Goal"/>
        <Relation xsi:type="ObjectEventRelationType"
                name="hasAgentOf" target="Morientes"/>
        <SemanticTimeType" id="FirstSpanishGoalTime">
            <Label> <FreeTerm> Time of the first Spanish goal </FreeTerm> </Label>
            <SemanticTimeInterval>
                <TimePoint origin="Beginning of match">
                    <Displacement measurementType="length" unit="minute" value="12"/>
                    <Direction measurementType="direction" unit="direction"
                            value="before"/>
                </TimePoint>
            </SemanticTimeInterval>
        </SemanticTime>
    </SemanticBase>
```

```
    <SemanticBase xsi:type="EventType" id="SecondSpanishGoal">
        <Label> <FreeTerm> Second Spanish goal </Label> </FreeTerm> </Label>
        <Relation xsi:type="SemanticBaseSemanticBaseRelationType"
                name="exampleOf" target="Goal"/>
        <Relation xsi:type="ObjectEventRelationType"
                name="hasAgentOf" target="Morientes"/>
        <SemanticTimeType id="SecondSpanishGoalTime">
            <Label> <FreeTerm> Time of the second Spanish goal </FreeTerm> </Label>
            <SemanticTimeInterval>
                <TimePoint origin="Beginning of match">
                    <Displacement measurementType="length" unit="minute" value="33"/>
                    <Direction measurementType="direction" unit="direction"
                            value="before"/>
                </TimePoint>
            </SemanticTimeInterval>
        </SemanticTime>
    </SemanticBase>
</Semantic>
```

From this example, it should be noted:

1. It is possible to create a concrete description of audio-visual content using an formal abstract description as starting point. This way, formal abstraction descriptions are like knowledge models that can be shared among different users and applications in a consistent way.

2. The sharing of formal abstract descriptions allows to extract implicit knowledge using the same or similar inference mechanisms, which would not be available with exclusively concrete descriptions. In this example, inferred knowledge could be scoring players, the role of the scoring players, and the winning team.

1.4 Multiple Narrative Worlds: Music Album CD

The following example illustrate the use of the Semantic DS for describing the music album CD, whose front cover is shown in Figure 4. The description of the music album CD involves multiple narrative worlds corresponding to the album CD, the contents the picture on the album's front cover of the album, the contents of the picture on the disc's front side, and the content of each song. In this example, the album is represented by an object that is composed of a cover, a booklet, and a disc object. The cover object consists in the front and the back cover object. The disc object is composed of the disc's front side and the back side objects; the disc's back side consists of cuts corresponding to songs.

Figure 4: Album CD of the soundtrack of the movie "Romeo + Juliet".

```xml
<!--  Narrative world: Album  -->
<Semantic id="album-sem">
    <Label> <FreeTerm> Album CD </FreeTerm> </Label>
    <SemanticBase xsi:type="ObjectType" id="album-ob">
        <Label> <FreeTerm> Album CD </FreeTerm> </Label>
        <Relation xsi:type="ObjectObjectRelationType"
                  name="hasComponentOf" target="cover-ob"/>
        <Relation xsi:type="ObjectObjectRelationType"
                  name="hasComponentOf" target="booklet-ob"/>
        <Relation xsi:type="ObjectObjectRelationType"
                  name="hasComponentOf" target="disc-ob"/>
    </SemanticBase>
    <SemanticBase xsi:type="ObjectType" id="cover-ob">
        <Label> <FreeTerm> Album cover </FreeTerm> </Label>
        <Relation xsi:type="ObjectObjectRelationType"
                  name="hasComponentOf" target="frontcover-ob"/>
        <Relation xsi:type="ObjectObjectRelationType"
                  name="hasComponentOf" target="backcover-ob"/>
    </SemanticBase>
    <SemanticBase xsi:type="ObjectType" id="frontcover-ob">
        <Label> <FreeTerm> Album cover </FreeTerm> </Label>
        <MediaOccurrence>
            <MediaLocator>
                <MediaUri> http://www.mpeg7.org/frontcover.jpg </MediaUri>
            </MediaLocator>
        </MediaOccurrence>
    </SemanticBase>
    <SemanticBase xsi:type="ObjectType" id="backcover-ob">
        <Label> <FreeTerm> Album cover </FreeTerm> </Label>
        <MediaOccurrence>
            <MediaLocator>
                <MediaUri> http://www.mpeg7.org/backcover.jpg </MediaUri>
            </MediaLocator>
        </MediaOccurrence>
    </SemanticBase>
    <SemanticBase xsi:type="ObjectType" id="booklet-ob">
        <Label> <FreeTerm> Album booklet </FreeTerm> </Label>
        <MediaOccurrence>
            <MediaLocator>
                <MediaUri> http://www.mpeg7.org/booklet.jpg </MediaUri>
            </MediaLocator>
        </MediaOccurrence>
    </SemanticBase>
    <SemanticBase xsi:type="ObjectType" id="disc-ob">
        <Label> <FreeTerm> Disc </FreeTerm> </Label>
        <Relation xsi:type="ObjectObjectRelationType"
                  name="hasComponentOf" target="discbackside-ob"/>
        <Relation xsi:type="ObjectObjectRelationType"
                  name="hasComponentOf" target="discfrontside-ob"/>
    </SemanticBase>
    <SemanticBase xsi:type="ObjectType" id="discfrontside-ob">
        <Label> <FreeTerm> Disc side </FreeTerm> </Label>
        <MediaOccurrence>
            <MediaLocator>
                <MediaUri> http://www.mpeg7.org/discfrontside.jpg </MediaUri>
            </MediaLocator>
        </MediaOccurrence>
        <Relation xsi:type="ObjectObjectRelationType"
                  name="hasComponentOf" target="discbacksidelabel-ob"/>
    </SemanticBase>
    <SemanticBase xsi:type="ObjectType" id="discbackside-ob">
        <Label> <FreeTerm> Disc side </FreeTerm> </Label>
        <MediaOccurrence>
            <MediaLocator>
                <MediaUri> http://www.mpeg7.org/discbackside.jpg </MediaUri>
```

```xml
            </MediaLocator>
        </MediaOccurrence>
        <Relation xsi:type="ObjectObjectRelationType"
                  name="hasComponentOf" target="discbacksidelabel-ob"/>
        <Relation xsi:type="ObjectObjectRelationType"
                  name="hasComponentOf" target="discbacksidecut2-ob"/>
        ...
        <Relation xsi:type="ObjectObjectRelationType"
                  name="hasComponentOf" target="discbacksidecut13-ob"/>
    </SemanticBase>
    <SemanticBase xsi:type="ObjectType" id="discbacksidecut1-ob">
        <Label> <FreeTerm> Cut on disc side </FreeTerm> </Label>
        <MediaOccurrence>
            <MediaLocator>
                <MediaUri> http://www.mpeg7.org/discbackside.jpg </MediaUri>
            </MediaLocator>
            <SpatialMask>
                <RegionLocatorType> ... </RegionLocator>
            </SpatialMask>
        </MediaOccurrence>
    </SemanticBase>
    <SemanticBase xsi:type="ObjectType" id="discbacksidecut2-ob">
        <Label> <FreeTerm> Cut on disc side </FreeTerm> </Label>
        <MediaOccurrence>
            <MediaLocator>
                <MediaUri> http://www.mpeg7.org/discbackside.jpg </MediaUri>
            </MediaLocator>
            <SpatialMask>
                <RegionLocatorType> ... </RegionLocator>
            </SpatialMask>
        </MediaOccurrence>
    </SemanticBase>
    ...
    <SemanticBase xsi:type="ObjectType" id="discbacksidecut13-ob">
        <Label> <FreeTerm> Cut on disc side </FreeTerm> </Label>
        <MediaOccurrence>
            <MediaLocator>
                <MediaUri> http://www.mpeg7.org/discbackside.jpg </MediaUri>
            </MediaLocator>
            <SpatialMask>
                <RegionLocatorType> ... </RegionLocator>
            </SpatialMask>
        </MediaOccurrence>
    </SemanticBase>

    <!--  Narrative world: Front cover (shown in Figure 4)  -->
    <SemanticBase xsi:type="SemanticType" id="frontcover-sem">
        <Label> <FreeTerm> Front Cover </FreeTerm> </Label>
        <!--  This semantic world corresponds to the contents of the front cover  -->
        <Relation xsi:type="SemanticBaseSemanticBaseRelationType"
                  name="equivalentTo" target="frontcover-obj"/>
        <!--  Proposed implementation  -->
        <Relation xsi:type="SemanticBaseSemanticBaseRelationType"
                  name="hasPerceptionOf" target="frontcover-obj"/>
        <SemanticBase xsi:type="AgentObjectType" id="romeo-obj">
            <Label> <FreeTerm> Romeo </FreeTerm> </Label>
            <MediaOccurrence>
                <MediaLocator>
                    <MediaUri> http://www.mpeg7.org/frontcover.jpg </MediaUri>
                </MediaLocator>
                <SpatialMask>
                    <RegionLocatorType> ... </RegionLocator>
                </SpatialMask>
            </MediaOccurrence>
            <Agent xi:type="PersonType">
```

```xml
            <Name>
                <GivenName> Romeo </GivenName>
                <FamilyName> Montague </FamilyName>
            </Name>
        </Agent>
    </SemanticBase>
    <SemanticBase xsi:type="AgentObjectType" id="juliet-obj>
        <Label> <FreeTerm> Juliet </FreeTerm> </Label>
        <MediaOccurrence>
            <MediaLocator>
                <MediaUri> http://www.mpeg7.org/frontcover.jpg </MediaUri>
            </MediaLocator>
            <SpatialMask>
                <RegionLocatorType> ... </RegionLocator>
            </SpatialMask>
        </MediaOccurrence>
        <Agent xi:type="PersonType">
            <Name>
                <GivenName> Juliet </GivenName>
                <FamilyName> Capulet </FamilyName>
            </Name>
        </Agent>
    </SemanticBase>
    <SemanticBase xsi:type="EventType" id="kiss-eve">
        <Label> <FreeTerm> Kiss </FreeTerm> </Label>
        <MediaOccurrence>
            <MediaLocator>
                <MediaUri> http://www.mpeg7.org/frontcover.jpg </MediaUri>
            </MediaLocator>
        </MediaOccurrence>
        <Relation xsi:type="ObjectEventRelationType"
                  name="hasAgentOf" target="romeo-obj"/>
        <Relation xsi:type="ObjectEventRelationType"
                  name="hasAccompanierOf" target="juliet-obj"/>
    </SemanticBase>
    <SemanticBase xsi:type="ConceptType" id="love-con">
        <Label> <FreeTerm> Love </FreeTerm> </Label>
        <Property> <FreeTerm> Devoted </FreeTerm> </Property>
        <Property> <FreeTerm> Attracted </FreeTerm> </Property>
        <Property> <FreeTerm> Enthusiastic </FreeTerm> </Property>
        <Property> <FreeTerm> Admired </FreeTerm> </Property>
        <MediaOccurrence type="symbol">
            <MediaLocator>
                <MediaUri> http://www.mpeg7.org/frontcover.jpg </MediaUri>
            </MediaLocator>
        </MediaOccurrence>
    </SemanticBase>
</SemanticBase>

<!--  Narrative world: Disc's front side   -->
<SemanticBase xsi:type="SemanticType" id="discfrontside-sem">
    ...
    <!--  This semantic world corresponds to the contents of the disc's
          front side  -->
    <Relation xsi:type="SemanticBaseSemanticBaseRelationType"
              name="equivalentTo" target="discfrontside-obj"/>
    <!--  Proposed implementation  -->
    <Relation xsi:type="SemanticBaseSemanticBaseRelationType"
              name="hasPerceptionOf" target="discfrontside-obj"/>
    ...
</SemanticBase>

<!--  Narrative world: Song 1   -->
<SemanticBase xsi:type="SemanticType" id="discbacksidecut1-sem">
    <Label> <FreeTerm> Song </FreeTerm> </Label>
```

```
        <!-- This semantic world corresponds to the contents of cut 1  -->
        <Relation xsi:type="SemanticBaseSemanticBaseRelationType"
                  name="equivalentTo" target="discfrontsidecut1-obj"/>
        <!-- Proposed implementation  -->
        <Relation xsi:type="SemanticBaseSemanticBaseRelationType"
                     name="hasPerceptionOf" target="discfrontsidecut1-obj"/>
        <SemanticBase xsi:type="EventType" id="sacrifice-eve">
           <Label> <FreeTerm> Sacrifice </FreeTerm> </Label>
           <MediaOccurrence type="symbol">
              <MediaLocator>
                 <MediaUri> http://www.mpeg7.org/song1.mp3 </MediaUri>
              </MediaLocator>
           </MediaOccurrence>
           <Relation xsi:type="SemanticBaseSemanticBaseRelationType"
                     name="hasBeneficiaryOf" target="lover-obj"/>
        </SemanticBase>
        <SemanticBase xsi:type="ObjectType" id="lover-obj">
           <Label> <FreeTerm> Lover </FreeTerm> </Label>
           <MediaOccurrence type="symbol">
              <MediaLocator>
                 <MediaUri> http://www.mpeg7.org/song1.mp3 </MediaUri>
              </MediaLocator>
           </MediaOccurrence>
        </SemanticBase>
    </SemanticBase>
    ...
    <!-- Narrative world: Song 13   -->
    <SemanticBase xsi:type="SemanticType" id="discbacksidecut13-sem">
        ...
        <!-- This semantic world corresponds to the contents of cut 13  -->
        <Relation xsi:type="SemanticBaseSemanticBaseRelationType"
                     name="equivalentTo" target="discfrontsidecut13-obj"/>
        <!-- Proposed implementation  -->
        <Relation xsi:type="SemanticBaseSemanticBaseRelationType"
                     name="hasPerceptionOf" target="discfrontsidecut13-obj"/>
        ...
    </SemanticBase>
</Semantic>
```

From this example, it should be noted:

1. Objects and narrative worlds could occur in other objects in the same way as objects and narrative worlds can occur in the media. In these cases, a description involves multiple narrative worlds such the picture of the front cover of an album CD. The current Semantic DS lacks relations to directly describe the occurrence of semantic entities in other semantic entities. In the example, we have *informally* used the relation *equivalentTo* for that purpose.

2. A formal abstract agent object can not be described because AgentObject DS requires Agent DS and, therefore, a name for the agent object.

1.5 Mapping of Existing Semantic Descriptions for Images

1.5.1 Getty Descriptions

1.5.1.1 Maya vessel

The Getty description of the object shown in Figure 5 and the mapping of the description to MPEG-7 are included in this section.
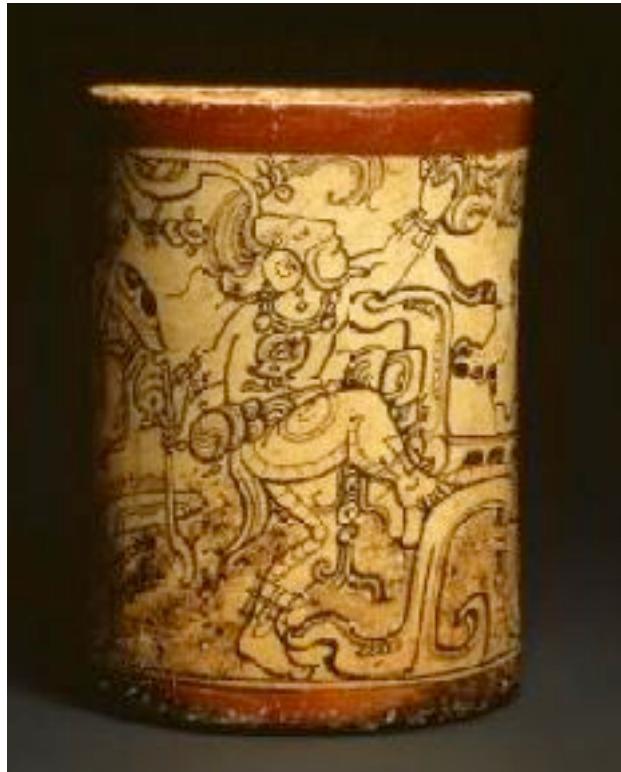
Figure 5: Maya vessel (maya_vessel.gif).

1.5.1.1.1 Getty Description

Image Credits: Vessel with Mythological Scene, 8th century; Maya; Guatemala, Petén Department Ceramic; H. 5 1/2 in. (14 cm); Metropolitan Museum of Art (New York, New York). The Michael C. Rockefeller Memorial Collection, Purchase, Nelson A. Rockefeller Gift, 1968 (1978.412.206). Photo by The Photograph Studio, The Metropolitan Museum of Art, copyright © 2000 The Metropolitan Museum of Art. All rights reserved.

Descriptive Note: Straight-sided ceramic vessels with painted decoration comprising complex scenes were common in eighth-century Maya art. The "codex-style" painting depicts a scene in the realm of the Lords of Death, where a dancing figure holds a long-handled axe and a handstone. On a monster-head altar lies Baby Jaguar, a deity figure, and beside the altar is a dancing, a skeletal death figure. The meaning has been variously interpreted as depicting either sacrifice or celebration.

1.5.1.1.2 MPEG-7 Descriptions

The mapping of the CDWA schema to MPEG-7 description tools is as follows. The values in red in the table do not seem the correct mapping from CDWA to MPEG-7.

MPEG-7	CDWA	Terms (*= CT)
Semantic/SemanticPlace America as *locationOf* Semantic/Event Create	Classification	*Americas
Semantic/Object	Object/Work Type	*vessel
CreationInformation/Creation/Title or Semantic/Object/Label	Title or Names	*Vessel with Mythological Scene
CreationInformation/Creation/Creator Semantic/AgentObject Maya as *agentOf* Semantic/Event Create	Creation-Creator/Role	*Maya
CreationInformation/Creation/Creator Semantic/AgentObject Maya as *agentOf* Semantic/Event Create	creator:	unknown Maya
CreationInformation/Creation/Creator/Creation Coordinates/CreationDate Semantic/AgentObject Maya as *timeOf* Semantic/Event Create	Creation-Date	*8th century
CreationInformation/Creation/Creator/Creation Coordinates/CreationDate	earliest:700	latest: 799

Semantic/AgentObject Maya as *agentOf* Semantic/Event Create		
CreationInformation/Creation/Creator/Creation CoordinatesCreationLocation Semantic/AgentObject Maya as *locationOf* Semantic/Event Create	Creation-Place	Petén Department (Guatemala)
CreationInformation/Classification/Genre or Semantic/AgentObject	Styles/Periods/ Groups	Maya
CreationInformation/Classification/Genre or Semantic/Object	Styles/Periods/ Groups	codex-style painting
CreationInformation/Classification/Genre or Semantic/Object/Property	Styles/Periods/ Groups	Precolumbian
CreationInformation/Classification/Subject or Semantic/Object	Subject Matter	*underworld
CreationInformation/Classification/Subject or Semantic/Object	Subject Matter	skeleton
CreationInformation/Classification/Subject or Semantic/Concept	Subject Matter	death
CreationInformation/Classification/Subject or Semantic/Event	Subject Matter	celebration
CreationInformation/Classification/Subject or Semantic/Event	Subject Matter	sacrifice
CreationInformation/Classification/Subject or Semantic/Object	Subject Matter	altar
CreationInformation/Classification/Subject or Semantic/Event	Subject Matter	ritual
CreationInformation/Classification/Subject or Semantic/Object	Subject Matter	ax
CreationInformation/Classification/Subject or Semantic/AgentObject	Subject Matter	Baby Jaguar
Semantic/SemanticState	Measurements	H. 5 1/2 in. (14 cm)
Semantic/SemanticState	Measurements	height: 14 cm
Semantic/SemanticState	Measurements	width:
CreationInformation/Classification/Genre or Semantic/Object/Property	Materials and Techniques	Ceramic
Semantic/Object/Property	Materials and Techniques	vase painting
Semantic/Object/Property	Materials and Techniques	terracotta
Semantic/Object/SemanticPlace	Current Location-Repository Name	*Metropolitan Museum of Art
Semantic/Object/SemanticPlace	Current Location-Repository Location	New York (New York, USA)
Semantic/Object/SemanticPlace/id ?	Current Location-Repository Numbers	1978.412.206
ContentDescription/Creation/Abstract or Semantic	Descriptive Note	Straight-sided ceramic vessels with painted decoration comprising complex scenes were common in eighth-century Maya art. The "codex-style" painting depicts a scene in the realm of the Lords of Death, where a dancing figure holds a long-handled axe and a handstone. On a monster-head altar lies Baby Jaguar, a deity figure, and beside the altar is a dancing, a skeletal death figure. The meaning has been variously interpreted as depicting either sacrifice or celebration
CreationInformation/Creation/Creator		The Photograph Studio
UsageInformation/Rights		The Metropolitan Museum of Art, copyright © 2000 The Metropolitan Museum of Art. All rights reserved

The following MPEG-7 description only contains the semantic part of the description.

```
<Semantic id="gettymaya-sem">
   <Label> <FreeTerm> Maya vessel from Getty </FreeTerm> </Label>

   <SemanticBase xsi:type="ObjectType" id="vessel-object">
      <Label> <FreeTerm> Vessel </FreeTerm> </Label>
      <Property> <FreeTerm> straight-sided ceramic </FreeTerm> </Property>
```

```xml
    <Property> <FreeTerm> painted decoration </FreeTerm> </Property>
    <Property> <FreeTerm> complex scene </FreeTerm> </Property>
    <Property> <FreeTerm> ceramic </FreeTerm> </Property>
    <Property> <FreeTerm> vase painting </FreeTerm> </Property>
    <Property> <FreeTerm> terracota </FreeTerm> </Property>
    <MediaOccurrence>
        <MediaLocator> <MediaUri> maya_vessel.gif </MediaUri> </MediaLocator>
        <SpatialMask ...> ... </SpatialMask>
    </MediaOccurrence>
    <Relation xsi:type="SemanticPlaceSemanticBaseRelationype" id="moma-rel"
              name="hasLocationOf" target="moma-place"/>
    <Relation xsi:type="SemanticStateSemanticBaseRelationype"
              name="hasStateOf" target="14cm-state"/>
    <Relation xsi:type="ObjectObjectRelationType"
              name="memberOf" target="mayaart-object"/>
    <Relation xsi:type="ObjectObjectRelationType"
              name="hasComponentOf" target="paintings-object"/>
</SemanticBase>

<SemanticBase xsi:type="ObjectType" id="paintings-object">
    <Label> <FreeTerm> Vessel's paintings </FreeTerm> </Label>
    <Property> <FreeTerm> codex-style </FreeTerm> </Property>
    <MediaOccurrence>
        <MediaLocator> <MediaUri> maya_vessel.gif </MediaUri> </MediaLocator>
        <SpatialMask ...> ... </SpatialMask>
    </MediaOccurrence>
</SemanticBase>

<SemanticBase xsi:type="ObjectType" id="mayaart-object">
    <Label> <FreeTerm> Maya Art </FreeTerm> </Label>
</SemanticBase>

<SemanticBase xsi:type="EventType" id="create-event">
    <Label> <FreeTerm> Create </FreeTerm> </Label>
    <Relation xsi:type="SemanticPlaceSemanticBaseRelationType"
              name="hasLocationOf" target="guatemala-place"/>
    <Relation xsi:type="SemanticPlaceSemanticBaseRelationype" id="moma-place"
              name="hasTimeOf" target="8thcentury-time"/>
    <Relation xsi:type="ObjectEventRelationype"
              name="hasPatientOf" target="vessel-object"/>
</SemanticBase>

<SemanticBase xsi:type="SemanticStateType" id="14cm-state">
    <Label> <FreeTerm> Size </FreeTerm> </Label>
    <AttributeValuePair>
        <Attribute> height </Attribute>
        <Unit> cm </Unit>
        <IntegerValue> 14 </IntegerValue>
    </AttributeValuePair>
</SemanticBase>

<SemanticBase xsi:type="SemanticPlaceType" id="guatemala-place">
    <Label> <FreeTerm> Guatemala </FreeTerm> </Label>
    <Place>
        <Name xml:lang="en"> Guatemala </Name>
        <Country> gu </Country>
    </Place>
</SemanticBase>

<SemanticBase xsi:type="SemanticPlaceType" id="moma-place">
    <Label> <FreeTerm> Metropolitan Museum Of Art </FreeTerm> </Label>
    <Place>
        <Name xml:lang="en"> Metropolitan Museum Of Art </Name>
        <Country> us </Country>
        <PostalAddress>
```

```
                    <AddressLine> 52ⁿᵈ St. between 6ᵗʰ & 7ᵗʰ , New York, NY </AddressLine>
                    <PostingIdentifier> U-10024 </PostingIdentifier>
                </PostalAddress>
            </Place>
        </SemanticBase>

        <SemanticBase xsi:type="SemanticTimeType" id="8thcentury-time">
            <Label> <FreeTerm> 8ᵗʰ century </FreeTerm> </Label>
        </SemanticBase>

        <SemanticBase xsi:type="SemanticTimeType" id="present-time">
            <Label> <FreeTerm> Present </FreeTerm> </Label>
            <Relation xsi:type="SemanticTimeSemanticBaseRelationType"
                      name="timeOf" target="moma-rel"/>
        </SemanticBase>

        <SemanticBase xsi:type="SemanticType" id="paintings-sem">
            <Label> <FreeTerm> Vessel's painting </FreeTerm> </Label>
            <Relation xsi:type="SemanticTimeSemanticBaseRelationType"
                      name="hasPerceptionOf" target="paintings-object"/>
            <Relation xsi:type="SemanticPlaceSemanticBaseRelationType"
                      name="hasLocationOf" target="realmoflordsofdeath-place"/>
            <Relation xsi:type="SemanticBaseSemanticBaseRelationType"
                      name="hasSymbolOf" target="sacrifice-event"/>
            <Relation xsi:type="SemanticBaseSemanticBaseRelationType"
                      name="hasSymbolOf" target="celebration-event"/>

            <SemanticBase xsi:type="AgentObjectType" id="lordsofdeath-object">
                <Label> <FreeTerm> Lords of Death </FreeTerm> </Label>
                <Agent xsi:type="GroupType">
                    <Name> Lords of Death </Name>
                </Agent>
            </SemanticBase>

            <SemanticBase xsi:type="SemanticPlaceType" id="realmoflordsofdeath-place">
                <Label> <FreeTerm> Realm of Lords of Death </FreeTerm> </Label>
                <Relation xsi:type="SemanticPlaceSemanticBaseRelationType"
                          name="locationOf" target="lordsofdeath-object"/>
            </SemanticBase>

            <SemanticBase xsi:type="ObjectType" id="figure-object">
                <Label> <FreeTerm> Figure </FreeTerm> </Label>
                <MediaOccurrence>
                    <MediaLocator> <MediaUri> maya_vessel.gif </MediaUri> </MediaLocator>
                    <SpatialMask ...> ... </SpatialMask>
                </MediaOccurrence>
            </SemanticBase>

            <SemanticBase xsi:type="EventType" id="dance1-event">
                <Label> <FreeTerm> Dance </FreeTerm> </Label>
                <Relation xsi:type="ObjectEventRelationType"
                          name="hasAgentOf" target="figure-object"/>
            </SemanticBase>

            <SemanticBase xsi:type="ObjectType" id="axe-object">
                <Label> <FreeTerm> Axe </FreeTerm> </Label>
                <Property> <FreeTerm> long-handled </FreeTerm> </Property>
                <MediaOccurrence>
                    <MediaLocator> <MediaUri> maya_vessel.gif </MediaUri> </MediaLocator>
                    <SpatialMask ...> ... </SpatialMask>
                </MediaOccurrence>
            </SemanticBase>

            <SemanticBase xsi:type="ObjectType" id="handstone-object">
                <Label> <FreeTerm> Handstone </FreeTerm> </Label>
```

```
            <MediaOccurrence>
                <MediaLocator> <MediaUri> maya_vessel.gif </MediaUri> </MediaLocator>
                <SpatialMask ...> ... </SpatialMask>
            </MediaOccurrence>
        </SemanticBase>

        <SemanticBase xsi:type="EventType" id="hold-event">
            <Label> <FreeTerm> Handstone </FreeTerm> </Label>
            <MediaOccurrence>
                <MediaLocator> <MediaUri> maya_vessel.gif </MediaUri> </MediaLocator>
                <SpatialMask ...> ... </SpatialMask>
            </MediaOccurrence>
            <Relation xsi:type="ObjectEventRelationType"
                      name="hasAgentOf" target="figure-object"/>
            <Relation xsi:type="ObjectEventRelationType"
                      name="hasPatientOf" target="axe-object"/>
            <Relation xsi:type="ObjectEventRelationType"
                      name="hasPatientOf" target="handstone-object"/>
        </SemanticBase>

        <SemanticBase xsi:type="ObjectType" id="altar-object">
            <Label> <FreeTerm> Altar </FreeTerm> </Label>
            <Property> <FreeTerm> monster-headed </FreeTerm> </Property>
            <MediaOccurrence>
                <MediaLocator> <MediaUri> maya_vessel.gif </MediaUri> </MediaLocator>
                <SpatialMask ...> ... </SpatialMask>
            </MediaOccurrence>
        </SemanticBase>

        <SemanticBase xsi:type="AgentObjectType" id="babyjaguar-object">
            <Label> <FreeTerm> Baby Jaguar </FreeTerm> </Label>
            <Property> <FreeTerm> monster-headed </FreeTerm> </Property>
            <MediaOccurrence>
                <MediaLocator> <MediaUri> maya_vessel.gif </MediaUri> </MediaLocator>
                <SpatialMask ...> ... </SpatialMask>
            </MediaOccurrence>
            <Agent xsi:type="PersonType">
                <Name>
                    <GivenName> Baby </GivenName>
                    <FamilyName> Jaguar </FamilyName>
                <Name>
            </Agent>
            <Relation xsi:type="SemanticBaseSemanticBaseRelationType"
                      name="exampleOf" target="deity-object"/>
        </SemanticBase>

        <SemanticBase xsi:type="AgentObjectType" id="deity-object">
            <AbstractionLevel dimension="1"/>
            <Label> <FreeTerm> Diety figure </FreeTerm> </Label>
        </SemanticBase>

        <SemanticBase xsi:type="ObjectType" id="deathfigure-object">
            <Label> <FreeTerm> Figure </FreeTerm> </Label>
            <Property> <FreeTerm> Death </FreeTerm> </Property>
            <Property> <FreeTerm> Skeletal </FreeTerm> </Property>
            <MediaOccurrence>
                <MediaLocator> <MediaUri> maya_vessel.gif </MediaUri> </MediaLocator>
                <SpatialMask ...> ... </SpatialMask>
            </MediaOccurrence>
        </SemanticBase>

        <SemanticBase xsi:type="EventType" id="dance-event">
            <Label> <FreeTerm> Dance </FreeTerm> </Label>
            <Relation xsi:type="ObjectEventRelationType"
                      name="hasAgentOf" target="deathfigure-object"/>
```

```
        </SemanticBase>

        <SemanticBase xsi:type="EventType" id="sacrifice-event">
           <Label> <FreeTerm> Sacrifice </FreeTerm> </Label>
        </SemanticBase>

        <SemanticBase xsi:type="EventType" id="celebration-event">
           <Label> <FreeTerm> Celebration </FreeTerm> </Label>
        </SemanticBase>
    </SemanticBase>
</Semantic>
```

1.5.1.2   Watercolor Drawing

The Getty description of the painting shown in Figure 6 and the mapping of the description to MPEG-7 are included in this section.

Figure 6: Watercolor drawing (watercolor_drawing.gif).

1.5.1.2.1   Getty Description

Object/Work –Type   watercolor
Classification –Term   Drawings
Title or Name –Text   Conway Castle, North Wales
Measurements – Dimensions   53.6 x 76.7 cm (21 1/8 x 30 1/8 in.)
Measurements - Dimensions – Type   height
Measurements - Dimensions – Value   53.6
Measurements - Dimensions – Unit   cm
Measurements - Dimensions – Type   width
Measurements - Dimensions – Value   76.7
Measurements - Dimensions – Unit   cm
Materials and Techniques – Description   watercolor and gum arabic with graphite underdrawing
Materials and Techniques - Processes - Imple.   brush
Materials and Techniques - Processes - Imple.   underdrawing
Materials and Techniques - Materials – Name   watercolor
Materials and Techniques - Materials – Name   gum arabic
Materials and Techniques - Materials – Name   graphite
Materials and Techniques - Materials – Name   paper
Creation – Creator   Joseph Mallord William Turner
Creation - Creator – Identity   Turner, Joseph Mallord William (British painter, 1775-1851)
Creation - Creator – Role   artist
Creation – Date   1798

Creation - Date - Earliest Date	1798
Creation - Date - Latest Date	1798
Styles/Periods/Groups/Movements - Indexing Terms	Romanticism
Subject Matter - Description - Indexing Terms	castle
Subject Matter - Description - Indexing Terms	seascape
Subject Matter - Description - Indexing Terms	fishermen
Subject Matter - Description - Indexing Terms	ocean
Subject Matter - Description - Indexing Terms	coast
Subject Matter - Description - Indexing Terms	storm
Subject Matter - Description - Indexing Terms	rocks
Subject Matter - Description - Indexing Terms	Conway Castle (Wales)
Subject Matter - Description - Indexing Terms	struggle
Current Location - Repository Name	J. Paul Getty Museum
Current Location - Geographic Location	Los Angeles (California, USA)
Current Location - Repository Numbers	95.GC.10
Descriptive Note – Text	This is the largest of Turner's four extant watercolors of this

medieval castle on the northern coast of Wales. Turner portrays the landscape and ocean in a dramatic fashion, using angry clouds, sunshine, and roiling waves to animate the scene and emphasize the struggle of the fishermen.

Creator Identification – Name	Turner, Joseph Mallord William
Creator Identification - Variant Names	Joseph Mallord William Turner
Creator Identification - Variant Names	Turner, J. M. W.
Creator Identification - Dates/Locations	1775-1851, active in Great Britain
Creator Identification - Birth Date	1775
Creator Identification - Death Date	1851
Creator Identification - Places of Activity	England (United Kingdom)
Creator Identification - Places of Activity	Great Britain
Creator Identification - Places of Activity	England (United Kingdom)
Creator Identification - Places of Activity	Europe
Creator Identification - Nationality/Citizenship	British
Creator Identification - Life Roles	painter
Creator Identification - Life Roles	Watercolorist

1.5.1.2.2 MPEG-7 Description

The mapping of the CDWA schema to MPEG-7 description tools is included in the previous example. The following MPEG-7 description only contains the semantic part of the description.

```xml
<Semantic id="watercolordrawing-sem">
   <Label> <FreeTerm> Watercolor painting from Getty </FreeTerm> </Label>

   <SemanticBase xsi:type="ObjectType" id="drawing-object">
      <Label> <FreeTerm> Drawing </FreeTerm> </Label>
      <Property> <FreeTerm> Watercolor </FreeTerm> </Property>
      <MediaOccurrence>
         <MediaLocator> <MediaUri>watercolor_drawing.gif</MediaUri> </MediaLocator>
         <SpatialMask ...> ... </SpatialMask>
      </MediaOccurrence>
      <Relation xsi:type="SemanticPlaceSemanticBaseRelationype" id="getty-rel"
               name="hasLocationOf" target="getty-place"/>
      <Relation xsi:type="ObjectObjectRelationype"
               name="memberOf" target="romanticismart-object"/>
      <Relation xsi:type="SemanticStateSemanticBaseRelationype"
               name="hasStateOf" target="size-state"/>
   </SemanticBase>

   <SemanticBase xsi:type="ObjectType" id="romanticismart-object">
      <Label> <FreeTerm> Romanticism art </FreeTerm> </Label>
   </SemanticBase>

   <SemanticBase xsi:type="AgentObjectType" id="turner-person">
      <Label> <FreeTerm> Turner </Label> </FreeTerm> </Label>
      <Agent xsi:type="PersonType">
```

```xml
        <Name>
            <GivenName initial="J. M. W."> Joseph Mallord William </GivenName>
            <FamilyName> Turner </FamilyName>
        </Name>
    </Agent>
</SemanticBase>

<SemanticBase xsi:type="ObjectType" id="brush-object">
    <Label> <FreeTerm> Brush </FreeTerm> </Label>
</SemanticBase>

<SemanticBase xsi:type="EventType" id="paint-event">
    <Label> <FreeTerm> Paint </FreeTerm> </Label>
    <Relation xsi:type="ObjectEventRelationType"
              name="hasAgentOf" target="turner-person"/>
    <Relation xsi:type="ObjectEventRelationType"
              name="hasPatienceOf" target="drawing-object"/>
    <Relation xsi:type="ObjectEventRelationType"
              name="hasInstrumentOf" target="brush-object"/>
    <Relation xsi:type="SemanticTimeSemanticBaseRelationType"
              name="hasTimeOf" target="1798-time"/>
    <Relation xsi:type="SemanticPlaceSemanticBaseRelationType"
              name="hasLocationOf" target="britain-place"/>
</SemanticBase>

<SemanticBase xsi:type="SemanticStateType" id="size-state">
    <Label> <FreeTerm> Size </FreeTerm> </Label>
    <AttributeValuePair>
        <Attribute> height </Attribute>
        <Unit> cm </Unit>
        <IntegerValue> 53.6 </IntegerValue>
    </AttributeValuePair>
    <AttributeValuePair>
        <Attribute> with </Attribute>
        <Unit> cm </Unit>
        <IntegerValue> 76.7 </IntegerValue>
    </AttributeValuePair>
</SemanticBase>

<SemanticBase xsi:type="SemanticPlaceType" id="britain-place">
    <Label> <FreeTerm> Great Britain </FreeTerm> </Label>
</SemanticBase>

<SemanticBase xsi:type="SemanticPlaceType" id="getty-place">
    <Label> <FreeTerm> J. Paul Getty Museum </FreeTerm> </Label>
    <Place>
        <Name xml:lang="en"> J. Paul Getty Museum </Name>
        <Country> us </Country>
        <PostalAddress>
            <AddressLine> Los Angeles, CA </AddressLine>
        </PostalAddress>
    </Place>
</SemanticBase>

<SemanticBase xsi:type="SemanticTimeType" id="1798-time">
    <Label> <FreeTerm> 1798 </FreeTerm> </Label>
</SemanticBase>

<SemanticBase xsi:type="SemanticTimeType" id="present-time">
    <Label> <FreeTerm> Present </FreeTerm> </Label>
    <Relation xsi:type="SemanticTimeSemanticBaseRelationType"
              name="timeOf" target="getty-rel"/>
</SemanticBase>

<SemanticBase xsi:type="SemanticType" id="drawing-sem">
```

```xml
<Label> <FreeTerm> Drawing's content </FreeTerm> </Label>
<Relation xsi:type="SemanticBaseSemanticBaseRelationType"
        name="hasPerceptionOf" target="drawing-object"/>
<Relation xsi:type="SemanticPlaceSemanticBaseRelationType"
        name="hasLocationOf" target="northwales-place"/>
<Relation xsi:type="SemanticBaseSemanticBaseRelationType"
        name="hasSymbolOf" target="struggle-event"/>
<Relation xsi:type="SemanticBaseSemanticBaseRelationType"
        name="hasSymbolOf" target="drama-concept"/>

<SemanticBase xsi:type="ObjectType" id="castle-object">
    <Label> <FreeTerm> Conway Castle </FreeTerm> </Label>
    <MediaOccurrence>
        <MediaLocator>
            <MediaUri>watercolor_drawing.gif</MediaUri>
        </MediaLocator>
        <SpatialMask ...> ... </SpatialMask>
    </MediaOccurrence>
    <Relation xsi:type="SemanticBaseSemanticBaseRelationType"
            name="equivalentTo" target="castle-place"/>
</SemanticBase>

<SemanticBase xsi:type="SemanticPlaceType" id="castle-place">
    <Label> <FreeTerm> Conway Castle </FreeTerm> </Label>
    <Property> <FreeTerm> Medieval </FreeTerm> </Property>
    <Place>
        <Name xml:lang="en"> Conway Castle </Name>
        <Country> uk </Country>
        <PostalAddress>
            <AddressLine> North Wales, United Kingdom </AddressLine>
        </PostalAddress>
    </Place>
</SemanticBase>

<SemanticBase xsi:type="ObjectType" id="rocks-object">
    <Label> <FreeTerm> Rocks </FreeTerm> </Label>
    <MediaOccurrence>
        <MediaLocator>
            <MediaUri>watercolor_drawing.gif</MediaUri>
        </MediaLocator>
        <SpatialMask ...> ... </SpatialMask>
    </MediaOccurrence>
</SemanticBase>

<SemanticBase xsi:type="ObjectType" id="ocean-object">
    <Label> <FreeTerm> Ocean </FreeTerm> </Label>
    <MediaOccurrence>
        <MediaLocator>
            <MediaUri>watercolor_drawing.gif</MediaUri>
        </MediaLocator>
        <SpatialMask ...> ... </SpatialMask>
    </MediaOccurrence>
    <Relation xsi:type="ObjectObjectRelationType"
            name="hasComponentOf" target="waves-object"/>
</SemanticBase>

<SemanticBase xsi:type="ObjectType" id="waves-object">
    <Label> <FreeTerm> Waves </FreeTerm> </Label>
    <Property> <FreeTerm> Roiling </FreeTerm> </Property>
    <MediaOccurrence>
        <MediaLocator>
            <MediaUri>watercolor_drawing.gif</MediaUri>
        </MediaLocator>
        <SpatialMask ...> ... </SpatialMask>
    </MediaOccurrence>
```

```
            </SemanticBase>

            <SemanticBase xsi:type="ObjectType" id="sunshine-object">
                <Label> <FreeTerm> Sunshine </FreeTerm> </Label>
                <MediaOccurrence>
                    <MediaLocator>
                        <MediaUri>watercolor_drawing.gif</MediaUri>
                    </MediaLocator>
                    <SpatialMask ...> ... </SpatialMask>
                </MediaOccurrence>
            </SemanticBase>

            <SemanticBase xsi:type="EventType" id="struggle-event">
                <Label> <FreeTerm> Struggle </FreeTerm> </Label>
                <Relation xsi:type="ObjectEventRelationType"
                        name="hasAgentOf" target="fishermen-person"/>
            </SemanticBase>

            <SemanticBase xsi:type="AgentObjectType" id="fihermen-person">
                <Label> <FreeTerm> Fishermen </FreeTerm> </Label>
            </SemanticBase>

            <SemanticBase xsi:type="ConceptType" id="drama-concept">
                <Label> <FreeTerm> Drama </FreeTerm> </Label>
            </SemanticBase>
        </SemanticBase>
    </Semantic>
```

1.5.2   Library of Congress (LC) Descriptions

1.5.2.1   Baby Shower

The LC description of the photograph shown in Figure 7 and the mapping of the description to MPEG-7 are included in this section.

Figure 7: Bay shower (baby_shower.gif).

1.5.2.1.1   LC Description

Crystal Pettry and Stacy Edmunds assist in a baby shower game which requires the blindfolded participant to scoop cotton balls from a bowl in her lap onto a plate on her head. [Photo]

Photographer   Terry Eiler
People in Photograph Pettry, Crystal; Edmunds, Stacy
Subject(s)   Fall, November, Life Cycle Event, Birth, Baby shower
Event   Baby Shower for Dena Williams' Daughter
Location   Syble's Bed and Barn, Naoma, WV
Created/Published   1997/11
Medium   35 mm Color Slide
Repository   Archive of Folk Culture, American Folklife Center, Library of Congress
Call Number   AFC 1999/008 CRF-TE-C059-11
Digital ID   afccmns tec05911

1.5.2.1.2   MPEG-7 Description

The mapping of the LC schema to MPEG-7 description tools is as follows.

MPEG-7	CDWA	Terms (*= CT)
ContentDescription/Creation/Abstract or Semantic	Description	Crystal Pettry and Stacy Edmunds assist in a baby shower game which requires the blindfolded participant to scoop cotton balls from a bowl in her lap onto a plate on her head.
CreationInformation/Creation/Creator	Photographer	Terry Eiler
Semantic/AgentObject	People	Pettry, Crystal, Edmunds, Stacy
CreationInformation/Creation/Title or Semantic/Event	Event	Baby Shower for Dena Williams' Daughter
CreationInformation/Creation/CreationCoordinates/CreationLocation Semantic/SemanticPlace	Location	Syble's Bed and Barn, Naoma, WV
CreationInformation/Creation/CreationCoordinates/CreationDate Semantic/SemanticTime	Created/Published	1997/11
MediaInformation/MediaProfile/MediaIdentification/ImageDomain	Medium	35 mm Color Slide* (Color photograph*)
MediaInformation/MediaInstance/OfflineLocator	Repository	Archive of Folk Culture, American Folklife Center, Library of Congress
MediaInformation/MediaInstance/InstanceIdentifier	Call Number	AFC 1999/008 CRF-TE-C059-11
MediaInformation/MediaInstance/InstanceIdentifier	Digital ID	afccmns tec05911

The following MPEG-7 description only contains the semantic part of the description.

```
<Semantic id="babyshower-sem">
   <Label> <FreeTerm> Baby shower for Dena Williams' daughter </FreeTerm> </Label>

   <SemanticBase xsi:type="EventType" id="babyshower-event">
      <Label> <FreeTerm> Baby shower </FreeTerm> </Label>
      <MediaOccurrence>
         <MediaLocator> <MediaUri> baby_shower.gif </MediaUri> </MediaLocator>
      </MediaOccurrence>
      <Relation xsi:type="EventEventRelationType"
               name="hasPartOf" target="scoop-event"/>
      <Relation xsi:type="SemanticPlaceSemanticBaseRelationType"
               name="hasLocationOf" target="bedbarn-place"/>
      <Relation xsi:type="SemanticTimeSemanticBaseRelationType"
               name="hasTimeOf" target="1997_11-time"/>
      <Relation xsi:type="ObjectEventRelationType"
               name="hasBeneficaryOf" target="baby-person"/>
      <Relation xsi:type="SemanticBaseSemanticBaseRelationType"
               name="hasSymbolOf" target="lifecycle-event"/>
   </SemanticBase>

   <SemanticBase xsi:type="EventType" id="scoop-event">
      <Label> <FreeTerm> Scoop </FreeTerm> </Label>
      <Relation xsi:type="SemanticBaseSemanticBaseRelationType"
               name="equivalentTo" target="scoop-object"/>
      <Relation xsi:type="ObjectEventRelationType"
               name="hasAgentOf" target="participant-person"/>
      <Relation xsi:type="ObjectEventRelationType"
               name="hasPatientOf" target="cottonballs-object"/>
      <Relation xsi:type="ObjectEventRelationType"
               name="hasSourceOf" target="plate-object"/>
      <Relation xsi:type="ObjectEventRelationType"
               name="hasDestinationOf" target="bowl-object"/>
```

```
        </SemanticBase>

        <SemanticBase xsi:type="ObjectType" id="scoop-object">
            <Label> <FreeTerm> Scoop </FreeTerm> </Label>
        </SemanticBase>

        <SemanticBase xsi:type="EventType" id="assist-event">
            <Label> <FreeTerm> Assit </FreeTerm> </Label>
            <MediaOccurrence>
                <MediaLocator> <MediaUri> baby_shower.gif </MediaUri> </MediaLocator>
            </MediaOccurrence>
            <Relation xsi:type="ObjectEventRelationType"
                        name="hasAgentOf" target="crystal-person"/>
            <Relation xsi:type="ObjectEventRelationType"
                        name="hasAccompanierOf" target="stacy-person"/>
            <Relation xsi:type="ObjectEventRelationType"
                        name="hasBeneficiaryOf" target="scoop-object"/>
        </SemanticBase>

        <SemanticBase xsi:type="AgentObjectType" id="crystal-person">
            <Label> <FreeTerm> Crystal </Label> </FreeTerm> </Label>
            <MediaOccurrence>
                <MediaLocator> <MediaUri> baby_shower.gif </MediaUri> </MediaLocator>
                <SpatialMask ...> ... </SpatialMask>
            </MediaOccurrence>
            <Agent xsi:type="PersonType">
                <Name>
                    <GivenName> Crystal </GivenName>
                    <FamilyName> Pettry </FamilyName>
                </Name>
            </Agent>
        </SemanticBase>

        <SemanticBase xsi:type="AgentObjectType" id="stacy-person">
            <Label> <FreeTerm> Stacy </Label> </FreeTerm> </Label>
            <MediaOccurrence>
                <MediaLocator> <MediaUri> baby_shower.gif </MediaUri> </MediaLocator>
                <SpatialMask ...> ... </SpatialMask>
            </MediaOccurrence>
            <Agent xsi:type="PersonType">
                <Name>
                    <GivenName> Stacy </GivenName>
                    <FamilyName> Edmunds </FamilyName>
                </Name>
            </Agent>
        </SemanticBase>

        <SemanticBase xsi:type="AgentObjectType" id="participant-person">
            <Label> <FreeTerm> Participant </FreeTerm> </Label>
            <Property> <FreeTerm> Blindfolded </FreeTerm> </Property>
            <MediaOccurrence>
                <MediaLocator> <MediaUri> baby_shower.gif </MediaUri> </MediaLocator>
                <SpatialMask ...> ... </SpatialMask>
            </MediaOccurrence>
            <Object id="lap-object">
                <Label> <FreeTerm> Lap </FreeTerm> </Label>
            </Object>
            <Object id="head-object">
                <Label> <FreeTerm> Head </FreeTerm> </Label>
            </Object>
        </SemanticBase>

        <SemanticBase xsi:type="ObjectType" id="cottonballs-object">
            <Label> <FreeTerm> Cotton balls </FreeTerm> </Label>
            <MediaOccurrence>
```

```
            <MediaLocator> <MediaUri> baby_shower.gif </MediaUri> </MediaLocator>
            <SpatialMask ...> ... </SpatialMask>
        </MediaOccurrence>
    </SemanticBase>

    <SemanticBase xsi:type="ObjectType" id="plate-object">
        <Label> <FreeTerm> Plate </FreeTerm> </Label>
        <MediaOccurrence>
            <MediaLocator> <MediaUri> baby_shower.gif </MediaUri> </MediaLocator>
            <SpatialMask ...> ... </SpatialMask>
        </MediaOccurrence>
        <Relation xsi:type="ObjectObjectRelationType"
                  name="hasSupportOf" target="head-object"/>
    </SemanticBase>

    <SemanticBase xsi:type="ObjectType" id="bowl-object">
        <Label> <FreeTerm> Bowl </FreeTerm> </Label>
        <MediaOccurrence>
            <MediaLocator> <MediaUri> baby_shower.gif </MediaUri> </MediaLocator>
            <SpatialMask ...> ... </SpatialMask>
        </MediaOccurrence>
        <Relation xsi:type="ObjectObjectRelationType"
                  name="hasSupportOf" target="lap-object"/>
    </SemanticBase>

    <SemanticBase xsi:type="SemanticPlaceType" id="bedbarn-place">
        <Label> <FreeTerm> Syble's Bed and Barn </FreeTerm> </Label>
        <Place>
            <Name xml:lang="en"> Syble's Bed and Barn </Name>
            <Country> us </Country>
            <PostalAddress>
                <AddressLine> Naoma, WV </AddressLine>
            </PostalAddress>
        </Place>
    </SemanticBase>

    <SemanticBase xsi:type="SemanticTime" id="1997_11-time">
    <Label>
        <FreeTerm> November, 1997 </FreeTerm> </Label>
        <Time>
            <TimePoint> 1997-11 </TimePoint>
        </Time>
    </SemanticBase>

    <SemanticBase xsi:type="EventType" id="lifecycle-event">
        <Label> <FreeTerm> Life cycle </FreeTerm> </Label>
        <MediaOccurrence type="symbol">
            <MediaLocator> <MediaUri> baby_shower.gif </MediaUri> </MediaLocator>
            <SpatialMask ...> ... </SpatialMask>
        </MediaOccurrence>
    </SemanticBase>

</Semantic>
```

1.5.3   National Archives and Records Administration (NARA) Descriptions

1.5.3.1   Beauty Contest

The LC description of the photograph shown in Figure 8 and the mapping of the description to MPEG-7 are included in this section.

Figure 8: Beauty Contest (beauty_contest.gif).

1.5.3.1.1 LC Description

Control Number	NWDNS-412-DA-7601
Media	Photographs
Descr. Level	Item
Record Group	412
Series	DA
Item	7601
Title	TEEN-AGE BEAUTY CONTEST WINNER AND AMISH MOTHER AND CHILD PROVIDE STRIKING CONTRAST ON A STREET IN DOWNTOWN MIDDLEFIELD
Production Date	06/1973
Creating Org.	Environmental Protection Agency.
Variant Control#	127/41/007601
Contributors	Photographer, ALEKSANDROWICZ, FRANK
Medium	Slides
Number	1
Dimensions	2x2
See Also	Series Description
Subject Ref.	Natural resources; Environmental protection; Pollution; Water pollution; Air pollution;

	[Documerica Project]
Geographic Ref.	OHIO--EAST OF CLEVELAND
Access	Unrestricted.
Use Restrictions	None.
Items	1 image(s)
Contact	Still Pictures Branch (NWDNS), National Archives at College Park, 8601 Adelphi Road, College Park, MD 20740-6001 PHONE: 301-713-6625 x234 FAX: 301-713-7436

1.5.3.1.2 MPEG-7 Description

The mapping of the NARA schema to MPEG-7 description tools is as follows.

MPEG-7	CDWA	Terms (*= CT)
MediaInformation/MediaInstance/InstanceIdentifier	Control Number	NWDNS-412-DA-7601
MediaInformation/MediaProfile/MediaIdentification/ImageDomain MediaInformation/MediaProfile/MediaFormat/Medium	Media	Photographs
-	Desc. Level	Item
-	Record Group	412
-	Series	DA
-	Item	7601
CreationInformation/Creation/Title Semantic	Title	TEEN-AGE BEAUTY CONTEST WINNER AND AMISH MOTHER AND CHILD PROVIDE STRIKING CONTRAST ON A STREET IN DOWNTOWN MIDDLEFIELD
CreationInformation/Creation/CreationCoordinates/CreationDates Semantic/SemanticTime	Production date	06/1973
CreationInformation/Creation/Creator	Creating Org.	Environmental Protection Agency
MediaInformation/MediaInstance/InstanceIdentifier	Variant Control#	127/41/007601
CreationInformation/Creation/Creator	Contributors	Photographer, ALEKSANDROWICZ, FRANK
MediaInformation/MediaProfile/MediaIdentification/ImageDomain MediaInformation/MediaProfile/MediaFormat/Medium	Medium	Slides
One MediaInformation/MediaInstance	Number	1
MediaInformation/MediaProfile/MediaFormat/VisualCoding/Frame	Dimensiones	2x2
CreationInformation/RelatedMaterial	See Also	Series Description
CreationInformation/Classification/Subject	Subject Ref.	Natural resources; Environmental protection; Pollution; Water pollution; Air pollution; [Documerica Project]
CreationInformation/Creation/CreationCoordinates/CreationLocation Semantic/SemanticPlace	Geoffraphic Ref.	OHIO--EAST OF CLEVELAND
UsageInformation/Rights	Access	Unrestricted
UsageInformation/Rights	Use Restrictions	None
One MediaInformation/MediaInstance	Items	1 image(s)
MediaInformation/MediaInstance/OfflineLocator	Contact	Still Pictures Branch (NWDNS), National Archives at College Park, 8601 Adelphi Road, College Park, MD 20740-6001 PHONE: 301-713-6625 x234 FAX: 301-713-7436

The following MPEG-7 description only contains the semantic part of the description.

```
<Semantic id="beautycontest-sem">
```

```xml
    <Label> <FreeTerm> Beauty contest in Ohio </FreeTerm> </Label>

    <SemanticBase xsi:type="EventType" id="win-event">
        <Label> <FreeTerm> Win </FreeTerm> </Label>
        <Relation xsi:type="ObjectEventRelationType"
                  name="hasAgentOf" target="teenager-person"/>
        <Relation xsi:type="ObjectEventRelationType"
                  name="hasPatientOf" target="beautycontest-object"/>
        <Relation xsi:type="SemanticPlaceEventRelationType"
                  name="hasLocationOf" target="middlefield-place"/>
        <Relation xsi:type="SemanticTimeEventRelationType"
                  name="hasTimeOf" target="6_1973-time"/>
        <Relation xsi:type="SemanticBaseSemanticBaseRelationType"
                  name="symbolOf" target="contrast-concept"/>
        <MediaOccurrence>
            <MediaLocator> <MediaUri> beauty_contest.gif </MediaUri> </MediaLocator>
        </MediaOccurrence>
    </SemanticBase>

    <SemanticBase xsi:type="ObjectType" id="beautycontest-object">
        <Label> <FreeTerm> Beauty contest </FreeTerm> </Label>
        <Property> <FreeTerm> Teenager </FreeTerm> </Property>
    </SemanticBase>

    <SemanticBase xsi:type="AgentObjectType" id="teenager-person">
        <Label> <FreeTerm> Teenager </FreeTerm> </Label>
        <MediaOccurrence>
            <MediaLocator> <MediaUri> beauty_contest.gif </MediaUri> </MediaLocator>
            <SpatialMask ...> ... </SpatialMask>
        </MediaOccurrence>
    </SemanticBase>

    <SemanticBase xsi:type="AgentObjectType" id="amishfamily-person">
        <Label> <FreeTerm> Family </FreeTerm> </Label>
        <Property> <FreeTerm> Amish </FreeTerm> </Property>
        <MediaOccurrence>
            <MediaLocator> <MediaUri> beauty_contest.gif </MediaUri> </MediaLocator>
            <SpatialMask ...> ... </SpatialMask>
        </MediaOccurrence>
        <Object xsi:type="AgentObjectType">
            <Label> <FreeTerm> Mother </FreeTerm> </Label>
        </Object>
        <Object xsi:type="AgentObjectType">
            <Label> <FreeTerm> Son </FreeTerm> </Label>
        </Object>
    </SemanticBase>

    <SemanticBase xsi:type="SemanticPlaceType" id="middlefield-place">
        <Label> <FreeTerm> Stree in downtown Middlefield </FreeTerm> </Label>
    </SemanticBase>

    <SemanticBase xsi:type="SemanticTime" id="6_1973-time">
    <Label>
        <FreeTerm> June, 1973 </FreeTerm> </Label>
        <Time>
            <TimePoint> 1973-6 </TimePoint>
        </Time>
    </SemanticBase>

    <SemanticBase xsi:type="ConceptType" id="contrast-concept">
        <Label> <FreeTerm> Contrast </FreeTerm> </Label>
    </SemanticBase>

</Semantic>
```

Annex C : Dependencies of Semantic DS

2 Dependencies between the Semantic DS and other MPEG-7 MDS Ds/DSs

If one builds a C++ version of the Semantic DS, then one must declare all of the dependencies, that is, other Ds/DSs which those included in the Semantic DS include or are derived from. This is equivalent, in many respects, to the set of Ds/DSs that a decoder would be responsible for taking action on (although it may choose to skip) and minimally would need to validate if it were to be sure that the incoming stream were normative. It is also important to pay attention to the weight of such Ds/DSs, especially the number of text strings, and the number of unbounded arrays (elements or attributes declared maxOccurs="unbounded"). This task was undertaken as part of developing the retrieval software for the Semantic DS to be integrated into the MPEG-7 XM platform.

This has not ended up being a small task, and the shear number of Ds/DSs and sections of the MDS CD document touched does not seem a good thing. Some of these are to be expected (Basic data types, etc.). Some are not. Here is the list of chapters or sections touched:

- Chapter 3
  - o Descriptors, Description Schemes
- Chapter 4
  - o Integer Datatypes
  - o zeroToOne Datatype
  - o nonNegativeInteger Datatype
- Chapter 5
  - o none
- Chapter 6
  - o References
  - o Time
  - o TimePoint
  - o RelTimePoint
  - o IncrRelTimePoint
  - o Duration
  - o IncrDuration
  - o fractionalTime
  - o fractionalDuration
  - o MediaTime
  - o MediaTimePoint
  - o MediaDuration
  - o MediaIncrDuration
  - o MediaRelTimePoint
  - o MediaIncrRelTimePoint
  - o MediaLocator
  - o VideoSegmentLocator
  - o ImageLocator
  - o AudioSegmentLocator
  - o UniqueID
- Chapter 7
  - o xml:lang
  - o Language
  - o TextualType
  - o TextualAnnotation
  - o FreeTextAnnotation
  - o StructuredAnnotation
  - o KeywordAnnotation
  - o DependencyStructure
  - o ClassificationSchemes
  - o ClassificationSchemeLocator
  - o ClassificationSchemeIdentifier
  - o ControlledTerm
  - o ControlledTermIdentifier

- o Term
  - o TermRelationKind
  - o Agent
  - o Person
  - o PersonGroup
  - o Organization
  - o PersonName
  - o ElectronicAddress
  - o Place
  - o Graph
  - o Relation
  - o RelationProperty
- Chapter 8
  - o MediaInformation
  - o MediaIdentification
  - o MediaProfile
  - o MediaFormat
  - o MediaTranscodingHints
  - o MediaQuality
  - o MediaInstance
- Chapter 9
  - o CreationInformation
  - o Creation
  - o Classification
  - o RelatedMaterial
- Chapter 10
  - o UsageInformation
  - o Rights
  - o Financial
  - o Availability
  - o UsageRecord
- Chapter 11
  - o none
- Chapter 12
  - o [This is the chapter being implemented]
  - o All DSs, all normative Relations, only SemanticBase was counted in figures below.
- Chapter 13
  - o Summarization
  - o Summary
  - o HierarchicalSummary
  - o SummaryThemeList
  - o HighlightSummary
  - o HighlightSegment
  - o SequentialSummary
  - o FrameProperty
  - o SoundProperty
  - o TextProperty
- Chapter 14
  - o Collection
  - o DescriptorCollection
  - o ConceptCollection
  - o MixedCollection

There are Segments and Models that would normally be joined to the Semantic DS by relations, these do not need to be classed, as they are not necessary for a compile. Some operations required extra work, e.g. C++ does not allow one to derive from a class during its definition (which is possibly a good thing).

There is something wrong with this picture, when UsageLabel (a.k.a. AbstractionLevel) or XPath gets debated because the bits may be too expensive, and there are an unbounded number of financial records and other stuff that is potentially in the stream when saying "About an hour and a half". Chapters 8,9,10,13 are involved because of the MediaOccurence, which has a DescriptorCollection in it, which inherits everything needed to designate the availability, transmission, rights, user preferences, and summaries for an entire archive. Oddly MediaOccurence was born because people felt that accessing descriptors through Segment was too heavyweight.

The text reads: "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." Apparently at the expense of possibly having an unbounded number of people laying claim to the intellectual property, and a summary or two.

In this set, there are more than 70 fields designated as "unbounded" (the count undercounts at 63 because records were not recorded until after implementing TextAnnotation and CS). There are 27 TextualTypes, and 48 text strings. It certainly diminishes the horror of allowing "all of XPath".

We would like to make the recommendation in the Semantic DS' CE that the DescriptorCollection be replaced in MediaOccurence, or that its inheritance hierarchy be rewritten to allow a spare set of descriptors. This will largely take care of the major weight in the Semantic DS (except possibly for the AgentObject DS). We suspect that this is not an isolated problem in the MDS document. Other identified problems are a time zone for a duration: "The movie took one hour and twenty minutes, Pacific Daylight Time").

Annex D : Text for Explanatory section on Abstract and Abstraction classes

1   Descriptions in Semantic DS

Description schemes in MPEG-7 generally describe available media. When dealing with the semantics of the content, however, it becomes necessary to draw upon contextual description, as well as other natural descriptive devices, such as abstraction, analogy, and possibly metaphor. This is not because the describer is being poetic; such artifices are part of the way we naturally describe the world. Semantic DS deals with this by using an abstraction model. Instances in the media are objects, events, places, times, and so forth, but in order to structure the description of these, we identify four types of abstract entities. These are Formal Abstractions, Media Abstractions, Concepts, and Properties.

1.1 Formal Abstractions

A Formal Abstraction in Semantic DS describes a pattern in common to a set of entities. The common pattern contains placeholders, or slots to be filled in, representing the essential features common to the set. These placeholders are formally referred to as variables, and the common pattern is called an abstraction.   The description may be formed by gathering a set of examples, determining the necessary slots from these examples, and thus deriving the pattern, or by first creating the common pattern, and then creating the specific examples from the slots. The description is a formal abstraction as long it contains variables, which, when replaced, would create specific examples or instances. Regardless of how a formal abstraction is formed, it takes this form: The entity being described is generic, by means of leaving certain parts of the description as variables. If an instance is generated in which there are no variables, it ceases to be an abstraction; we sometimes refer to such an instance as concrete.

1.2 Media Abstractions

Suppose we have a description, which refers via segments and/or media locators to the data. Such a description is concrete. Suppose we now do nothing to the description, except that we sever all connections to the data it describes. We might do this because we wished to create a remake of a movie, for example. This severed description is less concrete than the original, in that it can now refer to the common description of two or more media presentations. But the description contains no formal variables. This is because we have abstracted the data, but the data is not eligible to become a variable. The data was not part of the description, it was what was being described. Hence the description did not change. In order to handle this case, and to distinguish it from a genuine abstraction, we refer to this as a *media abstraction*.

1.3 Concepts

It is sometimes necessary to refer to abstract entities in a description which are not characterized by replacement of specific entities with variables. That is to say, they were not generated, and could not be generated, by abstraction. For example, "a feeling of satisfaction". In the Semantic DS we refer to such entities as Concepts. They may be described, but only obliquely by listing some of their properties, or describing situations where they occur. They are nonetheless important for description of many semantic entities.

1.4 Properties

When we defined abstractions, we created variables as placeholders for the essential common entities in a description. Descriptions require, as well, that we classify entities by other sets of qualities, some of which may vary over time, others of which may vary within a collection. We refer to these qualities as properties. They need not be physical properties; in the section above, we referred to concepts as being described by a list of properties. We do need a way to distinguish a ripe tomato from a green one, however, and properties are what allow us to do this. (This is semantics, remember, a green tomato refers to its ripeness first, and its color only secondarily). They may loosely be thought of as adjectival entities.