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1. INTRODUCTION

Between the MPEG meetings in Seoul and Vancouver, discussions led the DDL development group to the decision to use XML Schema language as the basis for the DDL. However certain reservations were raised at the Vancouver MPEG meeting concerning this approach [1]. Some of the major concerns are:

- The dependency on the output and time schedule of W3C XML Schema working group;
- Limited access to internal documents associated with XML Schema development;
- The copyright of the XML Schema specification belongs to W3C. This may make extensions specifically for MPEG-7 requirements problematic.

As a result of these concerns, further discussions at Vancouver led to the decision to develop our own language in parallel with the XML Schema development . This work involves:

- Developing a grammar based on the improved version of P547 [2] but with modifications to ensure simple mapping to XML Schema;
- Specifying validation mechanisms which must be provided by the parser;
- Developing a parser which validates this DDL.

2. CHANGES REFLECTING XML SCHEMA CHANGES

The latest versions of XML Schema:Structures and XML Schema:Datypes [3,4] incorporate a number of changes to the XML Schema grammar which we have incorporated into the MPEG-7 DDL grammar below. These include:

- Replaced `<schema name = ''>` with `<schema targetNS=''>` in preamble
- Replaced *attrDecl* with *attribute*
- Replaced *datatypeRef* with *type=''*
- Replaced *sequence* with *seq*
- Replaced *minOccur*, *maxOccur* etc with *minOccurs*, *maxOccurs*
- Replaced *required='true|false'* with *minOccurs*, *maxOccurs*

In addition, named model groups have been added to enable the construction of ‘abstract’ DSs i.e. Description Schemes which are used for describing and reusing DS structures but which cannot be instantiated and thus cannot appear in an MPEG-7 description.

DescType and DescTypeRef have been replaced with DType and DTypeRef to reflect the MPEG-7 terminology which uses the term D to represent a Descriptor.

3. DDL OVERVIEW

This language has been designed with four major objectives in mind:

- To satisfy the MPEG-7 DDL requirements;
- To use XML syntax and the MPEG-7 terminology of Description Schemes (DSs) and Descriptors (Ds);
- To be independent of the XML Schema language but to map easily to XML Schema constructs [3], [4];
- Simplicity. To provide only the basic functionality which can easily be extended as required in the future and which will satisfy the basic requirements until the situation wrt XML Schema language is clarified.

4. DDL STRUCTURES

The main features provided within this language are:

- The Schema – the wrapper around the definitions and declarations;
- DType definitions - complete set of constraints on the content and attributes of DSs;
- DS refinement – provides a mechanism for the inheritance of DS content and their refinement;
- DType - Descriptor Type Definitions and DType refinement;
- Attribute Declaration and Attribute Group Definition;
- Data typing mechanisms.

Schema Wrapper – Preamble

The preamble consists of :

- the current schema identity i.e. the URI by which the current schema is to be identified e.g.
targetNS='http://www.mpeg7.org/GenericDS.ddl'
- a schema version specification e.g. *version='1.0'*
- a reference (uri) to the MPEG7 DDL schema to be used for validation e.g.
xmlns='http://www.mpeg7.org/mpeg7.dtd'
- References to other imported schemas and abbreviations for referring to definitions in these external schemas e.g. 'dstc:someattr'.

```
<?xml version='1.0'?>
<schema targetNS='http://www.mpeg7.org/GenericDS.ddl'
        version='1.0'
        xmlns='http://www.mpeg7.org/mpeg7.dtd'
        xmlns:dstc='http://www.dstc.com/dstc_schema.ddl'>
.....
.....
</schema>
```

4.2 Description Scheme Declarations - DStype

DStype declarations enable the specification of constraints on Description Schemes which can include the association of other DSs, Ds, attributes and their datatypes. *DStypeRef* enables reference to declarations of DStypes.

```
<DStype name='SegmentDS'>
  <attribute name='id' type='ID' />
  <attribute name='href' type='uri' />
  <DStypeRef name='TimeDS' minOccurs='1' maxOccurs='1' />
  <DStypeRef name='SegmentLevelDS' minOccurs='0' maxOccurs='1' />
  <DStypeRef name='MediaInfoDS' minOccurs='0' maxOccurs='1' />
  <DStypeRef name='MetaInfoDS' minOccurs='0' maxOccurs='1' />
  <DStypeRef name='FreeDecompositionDS' minOccurs='0' maxOccurs='*' />
  <DStypeRef name='NormalDecompositionDS' minOccurs='0' maxOccurs='*' />
</DStype>
```

Within DS declarations, it is also possible to specify further constraints on the content of DSs through:

- DS compositors
 - *seq* – ordered list of DS elements;
 - *choice* – set of alternative DS elements;
 - *all* – set of all DS elements in any order;
- Cardinality
 - *minOccurs*, *maxOccurs* - min and max Occurrence are defined by integers.
 - *minOccursPar*, *maxOccursPar* - min and max Occurrence are defined by the value of a named element

```
<DStype name='myDStype3'>
  <choice minOccurs='3' maxOccurs='9'>
    <DStypeRef name='myDStype1' />
    <DStypeRef name='myDStype2' />
  </choice>
</DStype>
```

```
<DStype name='myDStype4'>
  <attribute name='size' type='integer' />
  <seq minOccurs='0' maxOccursPar='size'>
    <DStypeRef name='myDStype1' />
  </seq>
</DStype>
```

4.3 DS Refinement - subDSOf

The *subDSOf* element indicates the subset/superset relation between DSs. Content structure is inherited from DSs to subDSs. Refinement is possible through the addition of new DSs/Ds/attributes to extend subDSs.

subDSOf is transitive, so that if DS A is a sub-DS of some broader DS B, and B is a sub-DS of C, then A is also implicitly a sub-DS of C. Consequently, resources that are instances of DS A will also be instances of C, since A is a sub-set of both B and C. A DS can never be declared to be a sub-DS of itself, nor of any of its own sub-DSs. To simplify the validation, we propose that inheritance be restricted to single inheritance only i.e. each DS can have a maximum of one superDS (unless the superDS is a subDS of another superDS).

The issue of multiple inheritance needs to be resolved. Currently it is not supported because of problems associated with element name duplication and recursion, but if the DS group decides that multiple inheritance is very important, then this could be reconsidered.

Unlike archetypes in the XML Schema language, we assume all DSs are refinable. There is no *model* attribute which defines archetypes to be *open*, *closed* or *refinable*.

```
<DSType name='VisualSegmentDS' />
  <subDSOf name='SegmentDS' />
  <DSTypeRef name='EditingEffectDS' minOccurs='0' maxOccurs='2' />
  <DSTypeRef name='CameraMotionDS' minOccurs='0' />
  <DSTypeRef name='KeyFrameDS' minOccurs='0' maxOccurs='*' />
  <DSTypeRef name='MosaicDS' minOccurs='0' maxOccurs='*' />
</DSType>
```

Wrt inheritance of actual data values, it is assumed that a child/subDS node inherits the values of its father/superDS node which it is a part of, unless a new descriptor explicitly specifies a different value. For example, the media information of a given segment is inherited by all its descendant (Visual) segments, except if one of them has a different media information. In this case, new values for the MediaInfoDS, which override the parent's values, will be specified.

4.4 Descriptor Type Declarations - DType

DType declarations enable the specification of constraints on *DTypeRef* enables reference to declarations of *DType*. Contrary to the original definition of descriptors as leaf nodes, recent discussions have led to the agreement that descriptors can be either simple data types or compositions of attributes and other Descriptors. However it is NOT possible for a D to contain a DS. Hence within D declarations, it is possible to specify further constraints on the content of Ds through:

- D compositors
 - *seq* – ordered list of D elements;
 - *choice* – set of alternative D elements;
 - *all* – set of all D elements in any order;
- Cardinality
 - *minOccurs*, *maxOccurs* - min and max Occurrence are defined by integers.
 - *minOccursPar*, *maxOccursPar* - min and max Occurrence are defined by the value of a named element

```
<DType name='Title' type='string' />

<DType name='ModelDescriptor'>
  <attribute name='Type' type='modelTypes' />
  <choice minOccurs='1' maxOccurs='1'>
    <DTypeRef name='TranslationModelD' />
    <DTypeRef name='RotationScaleModelD' />
    <DTypeRef name='AffineModelD' />
    <DTypeRef name='PlanarPerspectiveModelD' />
    <DTypeRef name='ParabolicModels' />
  </choice>
</DType>

<DType name='Dominant_Color_D' />
  <attribute name='DominantColorsNumber' type='integer' />
  <attribute name='ConfidenceMeasure' type='integer' />
```

```

    <seq minOccurs='0' maxOccursPar='DominantColorsNumber'>
      <DTypeRef name='DominantColorValues' />
    </seq>
  </DType>

```

Possible constraints on simple, atomic Descriptors include:

- data typing;
- cardinality (*minOccurs*, *maxOccurs*);
- value constraint - fixed/default .

```

<DType name='minAge' type='integer' default='18' minOccurs='1' />

```

Further examples of the DDL encoding of Descriptor specifications are contained in Appendix B.

4.5 Descriptor Refinement - subDOf

The *subDOf* element indicates the subset/superset relation between Descriptors. Content structure is inherited from superDescriptors to subDescriptors. Refinement is possible through the addition of new Ds and/or attributes.

Subclassing of descriptors has been added to handle the procedural type and parameterized structures required by some descriptors. In many descriptors, the structure is dependent on the values of certain attributes within the container Descriptor. For example, consider the Bounding Box Descriptor which contains a boolean attribute *Is3D*. If *Is3D* is true then the Bounding Box is 3-dimensional and there exists an additional attribute, *BoxDepth*.

```

<DType name='BoundingBoxD'>
  <attribute name='BoxHeight' type='real' />
  <attribute name='BoxWidth' type='real' />
  <attribute name='Is3D' type='boolean' />
</DType>

<DType name='3DboundingBoxD'>
  <subDOf name='BoundingBoxD' />
  <attribute name='BoxDepth' type='real' />
</DType>

```

4.6 Attribute Declaration

Attribute declarations enable the following constraints to be associated with an attribute name:

- data typing
- cardinality (*minOccurs*, *maxOccurs*)
- value constraint - fixed/default

```

<attribute name='myAttribute' type='integer' default='42' minOccurs='1' />

```

4.7 Attribute Group Definition

Attribute Group definitions provide a mechanism by which you can name a group of attributes for incorporation within DS definitions:

```

<attrGroup name='id_href_Group'
  <attribute name='id' type='id' minOccurs='1' maxOccurs='1' />
  <attribute name='href' type='uri' minOccurs='1' maxOccurs='1' />

```

```

</attrGroup>

<DSType name='myDSType' >
  <attrGroupRef name='id_href_Group' />
  <DSTypeRef name=... />
</DSType>

```

4.8 Named Model Groups

These provide a mechanism by which you can name a group of DSs and or Ds for incorporation within other DSs or Ds. Model group names cannot appear in description instantiations and thus represent a way to implement 'abstract' DSs.

```

<modelGroup name='myModelGroup' >
  <choice>
    <DSTypeRef name='MyDS1' />
    <DSTypeRef name='MyDS2' />
  </choice>
</modelGroup>

<DSType name='AnotherDS' >
  <modelGroupRef name='myModelGroup' >
  <attribute ..... />
</DSType>

```

6. DATATYPES

We recommend the use of the XML Schema data types as proposed in the most recent Data types document released on September 27, 1999 [4]. The only recommended addition is to add a built-in generated datatype, *mimetype*, which is an enumerated type based on the IANA list of Internet media types [5].

The changes to Datatyping in the most recent version of XML Schema:Datatypes include:

- *dateTime* in built-in datatypes has been replaced by *timeInstant*, *timeDuration* and *recurringInstant*
- *timePeriod* removed from built-in generated datatypes

6.1 Built-in Primitive Datatypes

The following built-in primitive data types are provided within XML Schema: Datatypes:

- NMTOKEN, NMTOKENS
- string
- boolean
- real
- timeInstant [ISO 8601]
- timeDuration [ISO 8601]
- recurringInstant
- binary
- uri
- language [RFC 1766]

6.2 Built-in Generated Datatypes

The following built-in datatypes which have been generated from the primitive data types are also provided:

- Name - NCName, ID, IDREF, IDREFS, ENTITY, ENTITIES, NOTATION (facet = enumeration)
- decimal (facets = precision, scale, maxIncl, maxExcl, minIncl, minExcl)
- integer, non-negative-integer, positive-integer, non-positive-integer, negative-integer
- date
- time
- mimeType [RFC2045, RFC2046]

Defining Customized Datatypes

A certain number of facets are provided by which one can constrain the content of a particular data type or generate one's own customized data types:

- **length, maxLength** - apply to *string* datatype to constrain length or maximum length;

```
<datatype name='myString'>
  <basetype name='string' />
  <maxLength>24</maxLength>
</datatype>
```

- **lexicalRepresentation** e.g. dateTime [ISO8601];

```
<datatype name='myDate'>
  <basetype name='date' />
  <lexicalRepresentation>
    <lexical>CCYY-DD</lexical>
    <lexical>CCYY-MM-DD</lexical>
  </lexicalRepresentation>
</datatype>
```

- **enumeration**;

```
<datatype name='modelTypes'>
  <basetype name='string' />
  <enumeration>
    <literal>Analytic</literal>
    <literal>Synthetic</literal>
    <literal>Correspondence</literal>
  </enumeration>
</datatype>
```

- **minInclusive, minExclusive** (lower bound), **maxInclusive, maxExclusive** (upper bound).

```
<datatype name='heightInInches'>
  <basetype name='real' />
  <minInclusive>0.0</minInclusive>
  <maxInclusive>120.0</maxInclusive>
</datatype>
```

- Numeric facets

- **precision** - the total number of decimal digits.
- **scale** - the number of decimal digits after the decimal point.

```
<datatype name='mysizedatatype'>
  <basetype name='decimal' />
  <precision>8</precision>
```

```
<scale>2</scale>
</datatype>

<attribute name='size' type='mysizedatatype' />
```

7. COMPARISON WITH XML SCHEMA

This proposal defines a new grammar for defining MPEG-7 Description Schemes and Descriptors. It uses XML syntax and MPEG-7 terminology, is simpler than XML Schema language but maps easily to it.

Some of the key differences between this DDL and XML Schema are:

- Element type declarations are replaced by DSTypes and DTypes;
- Element type references are replaced by DSTypeRef and DTypeRef;
- Archetypes and archetype refinement are replaced with subDSOf and subDOF.

For the sake of simplicity, this language proposal does not include the following XML Schema features:

- Entities;
- Notations;
- Internal, external parsed entities;
- Schema import, export, inclusion (whole/part)

6. OPEN ISSUES

In this proposal, I have not attempted to resolve the following DDL open issues which remain outstanding:

- Constraints on links;
- Links to procedural code;
- Binary encoding of descriptions;

However in this proposal I have suggested approaches to handle the issues of:

- Data inheritance;
- Parameterized descriptor structures.

If following further discussions and feedback, a grammar is agreed upon based on this proposal, then the next steps are:

1. To write the XML DTD which corresponds to this grammar;
2. Define the validations which a parser must perform;
3. Write the parser.

REFERENCES

- [1] MPEG-7 Description Definition Language Document V 1.0, N2862, Vancouver July 1999
- [2] Hunter J., DSTC , "A Revised Proposal for an MPEG-7 DDL", M4518, MPEG Seoul, 1999
- [3] XML Schema Part 1: Structures, W3C Working Draft, 27 September 1999
<http://www.w3.org/1999/05/06-xmlschema-1/>
- [4] XML Schema Part 2: Datatypes, W3C Working Draft, 27 September 1999
<http://www.w3.org/1999/05/06-xmlschema-2/>

- [5] IANA Media Types [RFC2045,RFC2046]
<http://www.isi.edu/in-notes/iana/assignments/media-types/media-types>
- [6] Generic Audio Visual Description Scheme for MPEG-7 (V0.4), ISO/IEC JTC1/SC29/WG11 M4677, Vancouver, July 1999.
- [7] MPEG-7 Visual part of eXperimentation Model Version 2.0, ISO/IEC JTC1/SC29/WG11 N2822, Vancouver, July 1999.

ANNEX A – DS REPRESENTATIONS IN THE PROPOSED GRAMMAR

Below is a representation of the Generic AV DS V0.3 [6] using the proposed grammar.

```
<?xml version='1.0'?>
<!DOCTYPE schema PUBLIC "-//W3C//DTD XML Schema Version 1.0//EN"
        SYSTEM 'http://www.mpeg7.org/mpeg7-ddl.dtd' >
<schema targetNS='http://www.mpeg7.org/GenericAVDS.xsd'
        version='1.0'
        xmlns='http://www.w3.org/mpeg7-ddl.xsd'>
<include schemaName='http://www.w3.org/TR/xmlschema-2/datatypes.xsd'/>

<!-- ##### -->
<!-- Definition of 'AudioVisualDS' -->
<!-- ##### -->

<attrGroup name='id_href'>
    <attribute name='id' type = 'ID' minOccurs='1'/>
    <attribute name='href' type='uri' minOccurs='1'/>
</attrGroup>

<DSType name='AudioVisualDS'>
    <attrGroupRef name='id_href'/>
    <DSTypeRef name='SyntacticDS' minOccurs='0' maxOccurs='1'/>
    <DSTypeRef name='SyntacticSemanticLinkDS' minOccurs='0' maxOccurs='1'/>
    <DSTypeRef name='SemanticDS' minOccurs='0' maxOccurs='1'/>
    <DSTypeRef name='MediaInfoDS' minOccurs='0' maxOccurs='1'/>
    <DSTypeRef name='MetaInfoDS' minOccurs='0' maxOccurs='1'/>
    <DSTypeRef name='VisualizationDS' minOccurs='0' maxOccurs='1'/>
    <DSTypeRef name='ModelDS' minOccurs='0' maxOccurs='1'/>
</DSType>

<!-- ##### -->
<!-- Definition of 'SyntacticDS' -->
<!-- ##### -->

<DSType name='SyntacticDS'>
    <attrGroupRef name='id_href'/>
    <DSTypeRef name='SegmentDS' minOccurs='0' maxOccurs='*'/>
    <DSTypeRef name='RegionDS' minOccurs='0' maxOccurs='*'/>
    <DSTypeRef name='SegmentRegionRelationDS' minOccurs='0' maxOccurs='*'/>
</DSType>

<!-- ##### -->
<!-- Definition of 'SegmentDS' -->
<!-- ##### -->

<DSType name='SegmentDS'>
    <attrGroupRef name='id_href'/>
    <DSTypeRef name='TimeDS' minOccurs='1' maxOccurs='1'/>
    <DSTypeRef name='SegmentLevelDS' minOccurs='0' maxOccurs='1'/>
    <DSTypeRef name='MediaInfoDS' minOccurs='0' maxOccurs='1'/>
    <DSTypeRef name='MetaInfoDS' minOccurs='0' maxOccurs='1'/>
    <DSTypeRef name='FreeDecompositionDS' minOccurs='0' maxOccurs='*'/>
    <DSTypeRef name='NormalDecompositionDS' minOccurs='0' maxOccurs='*'/>
</DSType>

<!-- ##### -->
<!-- Definition of 'AudioSegmentDS' -->
<!-- ##### -->
```

```

<DSType name='AudioSegmentDS'>
  <subDSOf name='SegmentDS' />
</DSType>

<!-- ##### -->
<!-- Definition of 'VisualSegmentDS' -->
<!-- ##### -->

<DSType name='VisualSegmentDS'>
  <subDSOf name='SegmentDS' />
  <DSTypeRef name='EditingEffectDS' minOccurs='0' maxOccurs='2' />
  <DSTypeRef name='KeyFrameDS' minOccurs='0' maxOccurs='*' />
  <DSTypeRef name='MosaicDS' minOccurs='0' maxOccurs='*' />
  <DSTypeRef name='CameraMotionDS' minOccurs='0' />
</DSType>

<!-- ##### -->
<!-- Definition of 'FreeDecompositionDS' -->
<!-- ##### -->

<DSType name='FreeDecompositionDS'>
  <subDSOf name='SegmentDS' />
</DSType>

<DSType name='ProgramDS'>
  <subDSOf name='FreeDecompositionDS' />
</DSType>

<!-- ##### -->
<!-- Definition of 'NormalDecompositionDS' -->
<!-- ##### -->

<DSType name='NormalDecompositionDS'>
  <subDSOf name='SegmentDS' />
</DSType>

<DSType name='SceneDS'>
  <subDSOf name='NormalDecompositionDS' />
</DSType>

<!-- ##### -->
<!-- Definition of 'RegionDS' -->
<!-- ##### -->

<DSType name='RegionDS'>
  <attrGroupRef name='id_href' />
  <DSTypeRef name='RegionDS' minOccurs='0' maxOccurs='*' />
  <DSTypeRef name='TimeDS' minOccurs='1' maxOccurs='1' />
  <DSTypeRef name='2DGeomtryDS' minOccurs='0' maxOccurs='1' />
  <DSTypeRef name='ColorDS' minOccurs='0' maxOccurs='1' />
  <DSTypeRef name='TextureDS' minOccurs='0' maxOccurs='1' />
  <DSTypeRef name='MotionDS' minOccurs='0' maxOccurs='1' />
  <DSTypeRef name='DeformationDS' minOccurs='0' maxOccurs='1' />
  <DSTypeRef name='MediaInfoDS' minOccurs='0' maxOccurs='1' />
  <DSTypeRef name='MetaInfoDS' minOccurs='0' maxOccurs='1' />
</DSType>

<!-- ##### -->
<!-- Definition of 'SegmentRegionRelationGraphDS' -->
<!-- ##### -->

```

```

<DSType name='SegmentRegionRelationGraphDS'>
  <attrGroupRef name='id_href' />
  <DSTypeRef name='EntityRelationDS' minOccurs='1' maxOccurs='*' />
</DSType>

<DSType name='EntityRelationDS'>
  <attrGroupRef name='id_href' />
  <DSTypeRef name='RelationDS' minOccurs='1' maxOccurs='1' />
  <DTypeRef name='SegmentRef' minOccurs='0' maxOccurs='*' />
  <DTypeRef name='RegionRef' minOccurs='0' maxOccurs='*' />
  <DSTypeRef name='EntityRelationDS' minOccurs='0' maxOccurs='*' />
</DSType>

<DSType name='RelationDS'>
  <attrGroupRef name='id_href' />
  <DTypeRef name='RelationType' minOccurs='1' maxOccurs='1' />
  <DTypeRef name='RelationName' minOccurs='1' maxOccurs='1' />
</DSType>

<DType name='RelationType' type='relationTypes' />

<datatype name='relationTypes'>
  <basetype name='string'>
    <enumeration>
      <literal>Temp.Dir</literal>
      <literal>Temp.Top</literal>
      <literal>Spat.Dir</literal>
      <literal>Spat.Top</literal>
      <literal>Semantic</literal>
      <literal>Audio</literal>
    </enumeration>
  </basetype>
</datatype>

<DType name='RelationName' type='ID' />

<DType name='SegmentRef' type='ID' />

<DType name='RegionRef' type='ID' />

<!-- ##### -->
<!-- Definition of 'SemanticDS' -->
<!-- ##### -->

<DSType name='SemanticDS'>
  <attrGroupRef name='id_href' />
  <DSTypeRef name='EventDS' minOccurs='0' maxOccurs='*' />
  <DSTypeRef name='ObjectDS' minOccurs='0' maxOccurs='*' />
  <DSTypeRef name='EventObjectRelationGraphDS'
    minOccurs='0' maxOccurs='*' />
</DSType>

<!-- ##### -->
<!-- Definition of 'EventDS' -->
<!-- ##### -->

<DSType name='EventDS'>
  <attrGroupRef name='id_href' />
  <DTypeRef name='EventType' minOccurs='1' maxOccurs='1' />
  <DSTypeRef name='AnnotationDS' minOccurs='0' maxOccurs='1' />
  <DSTypeRef name='EventDS' minOccurs='0' maxOccurs='*' />
</DSType>

```

```

<DType name='EventType' type='string' />

<DSType name='AnnotationDS'>
  <attrGroupRef name='id_href' />
  <DTypeRef name='Annotation' minOccurs='0' maxOccurs='1' />
  <DTypeRef name='Who' minOccurs='0' maxOccurs='1' />
  <DTypeRef name='What' minOccurs='0' maxOccurs='1' />
  <DTypeRef name='Where' minOccurs='0' maxOccurs='1' />
  <DTypeRef name='When' minOccurs='0' maxOccurs='1' />
  <DTypeRef name='Why' minOccurs='0' maxOccurs='1' />
</DSType>

<DType name='Annotation' type='string' />
<DType name='Who' type='string' />
<DType name='What' type='string' />
<DType name='Where' type='string' />
<DType name='When' type='string' />
<DType name='Why' type='string' />

<!-- ##### -->
<!-- Definition of 'ObjectDS' -->
<!-- ##### -->

<DSType name='ObjectDS'>
  <attrGroupRef name='id_href' />
  <DTypeRef name='ObjectType' />
  <DSTypeRef name='ObjectBehaviorDS'
              minOccurs='0' maxOccurs='*' />
  <DSTypeRef name='AnnotationDS' minOccurs='0' maxOccurs='1' />
  <DSTypeRef name='ObjectDS' minOccurs='0' maxOccurs='*' />
</DSType>

<DType name='ObjectType' type='string' />

<!-- ##### -->
<!-- Definition of 'EventObjectRelationGraphDS' -->
<!-- ##### -->

<DSType name='EventObjectRelationGraphDS'>
  <attrGroupRef name='id_href' />
  <DSTypeRef name='EntityRelationDS' minOccurs='1' maxOccurs='*' />
</DSType>

<DSType name='EntityRelationDS'>
  <attrGroupRef name='id_href' />
  <DSTypeRef name='RelationDS' minOccurs='1' maxOccurs='1' />
  <DTypeRef name='EventRef' minOccurs='0' maxOccurs='*' />
  <DTypeRef name='ObjectRef' minOccurs='0' maxOccurs='*' />
  <DSTypeRef name='EntityRelationDS'
              minOccurs='0' maxOccurs='*' />
</DSType>

<DType name='EventRef' type='ID' />
<DType name='ObjectRef' type='ID' />

<!-- ##### -->
<!-- Definition of 'SyntacticSemanticLinkDS' -->
<!-- ##### -->

```

```

<DSType name='SyntacticSemanticLinkDS'>
  <attrGroupRef name='id_href' />
  <DSTypeRef name='LinkDS' minOccurs='0' maxOccurs='*' />
</DSType>

<DSType name='LinkDS'>
  <attrGroupRef name='id_href' />
  <attribute name='type' type='LinkTypes' />
  <DTypeRef name='LinkSource' minOccurs='1' maxOccurs='1' />
  <DTypeRef name='LinkTargets' minOccurs='1' maxOccurs='*' />
</DSType>

<DType name='LinkSource' type='ID' />

<DType name='LinkTargets' type='ID' />

<!-- ##### -->
<!-- Definition of 'VisualizationDS' -->
<!-- ##### -->

<DSType name = 'VisualizationDS'>
  <attrGroupRef name='id_href' />
  <DSTypeRef name='ViewDS' minOccurs='0' maxOccurs='*' />
</DSType>

<DSType name='ViewDS'>
  <attrGroupRef name='id_href' />
  <DTypeRef name='ViewType'>
  <choice minOccurs='1'>
    <DSTypeRef name='HierarchicalViewDS' />
    <DSTypeRef name='SequentialViewDS' />
    <DSTypeRef name='AlternativeViewDS' />
  </choice>
</DSType>

<DType name='ViewType' type='string' />

<DSType name='HierarchicalViewDS'>
  <subDSOf name='ViewDS' />
  <DSTypeRef name='HierarchicalLevelDS' minOccurs='1' maxOccurs='1' />
  <DTypeRef name='HierarchyType' minOccurs='1' maxOccurs='1' />
</DSType>

<DType name='HierarchyType' type='hierarchyTypes' />

<datatype name='hierarchyTypes'>
  <basetype name='string'>
    <enumeration>
      <literal>simple</literal>
      <literal>pyramid</literal>
    </enumeration>
  </datatype>

<DSType name='HierarchicalLevelDS'>
  <DSTypeRef name='HierarchicalLevelDS' minOccurs='0' maxOccurs='*' />
  <choice>
    <DSTypeRef name='HighlightLevelDS' />
    <DSTypeRef name='MultiresLevelDS' />
  </choice>
</DSType>

<DSType name='HighlightLevelDS'>

```

```

    <subDSOf name='HierarchicalLevelDS' />
    <DSTypeRef name='SegmentLocatorDS' minOccurs='1' maxOccurs='*' />
</DSType>

<DSType name='MultiresLevelDS'>
  <subDSOf name='HierarchicalLevelDS' />
  <DSTypeRef name='ImageLocatorDS' minOccurs='1' maxOccurs='*' />
  <seq minOccurs='0' maxOccurs='*'>
    <DSTypeRef name='SpaceFreqParameters' />
  </seq>
</DSType>

<DType name='SpaceFreqParameters' type='real' />

<DSType name='SequentialViewDS'>
  <subDSOf name='ViewDS' />
  <DSTypeRef name='ImageLocatorDS' minOccurs='1' maxOccurs='*' />
  <DSTypeRef name='FramepropertyDS' minOccurs='0' maxOccurs='*' />
</DSType>

<DSType name='FramePropertyDS'>
  <DSTypeRef name='TimeDS' minOccurs='1' maxOccurs='1' />
  <DType name='FrameChangeRate' type='integer' minOccurs='1' />
</DSType>

<DSType name='AlternativeViewDS'>
  <DSTypeRef name='ViewDS' minOccurs='1' maxOccurs='*' />
</DSType>

<DSType name='MediaLocatorDS'>
  <attribute name='MediaLocatorType' type='string' />
</DSType>

<DSType name='SegmentLocatorDS'>
  <subDSOf name='MediaLocatorDS' />
  <DSTypeRef name='TimeDS' minOccurs='0' maxOccurs='1' />
  <DType name='VideoURL' type='uri' minOccurs='1' />
</DSType>

<DSType name='ImageLocatorDS'>
  <subDSOf name='MediaLocatorDS' />
  <DSTypeRef name='TimeDS' />
  <DType name='ImageURL' type='uri' minOccurs='1' />
</DSType>

<DSType name='MetaInfoDS'>
  <all>
    <DType name='Title' type='string' />
    <DType name='Creator' type='string' />
    <DType name='Description' type='string' />
    <DType name='Subject' type='string' />
  ...
  </all>
</DSType>

<DSType name='MediaInfoDS'>
  <all>
    <DType name='Format' type='string' />
    <DType name='FileSize' type='string' />
    <DType name='FileLocation' type='string' />
    <DType name='VideoSystem' type='string' />

```

```
... </all>
</DSType>
</schema>
```

ANNEX B – DESCRIPTOR REPRESENTATIONS USING THE PROPOSED MPEG-7 DDL

The following representations are of descriptors outlined in document N2822, MPEG-7 Visual part of eXperimentation Model Version 2.0 [7].

```
<!-- ##### -->
<!-- Definition of 'GridLayout' -->
<!-- ##### -->

<DType name='GridLayout' />
  <attribute name='PartNumberH' type='integer' minOccurs='1' />
  <attribute name='PartNumberV' type='integer' minOccurs='1' />
</DType>

<!-- ##### -->
<!-- Definition of 'Histogram_Descriptor' -->
<!-- ##### -->

<DType name='Histogram' />
  <attribute name='histogram_norm_factor' type='integer' />
  <attribute name='number_histogram_bins' type='integer' />
  <seq minOccurs='0' maxOccursPar='number_histogram_bins'>
    <DType name='histogram_value' type='integer' />
  </seq>
</DType>

<!-- ##### -->
<!-- Definition of 'Color_Space_Descriptor' -->
<!-- ##### -->

<DType name='Color_Space_D' />
  <attribute name='color_space_type' type='color_space_types' />
</DType>

<datatype name='color_space_types'>
  <basetype name='string' />
  <enumeration>
    <literal>rgb</literal>
    <literal>yrcrb</literal>
    <literal>hsv</literal>
    <literal>linear_matrix</literal>
  </enumeration>
</datatype>

<DType name='linear_matrix_D'>
  <subDOf name='Color_Space_D' />
  <DType name='color_trans_mat' />
    <seq minOccurs='3' maxOccurs='3'>
      <seq minOccurs='3' maxOccurs='3'>
        <DType name='color_trans_mat_value' type='integer' />
      </seq>
    </seq>
  </DType>
</DType>

<!-- ##### -->
<!-- Definition of 'Dominant_Color_Descriptor' -->
<!-- ##### -->

<DType name='Dominant_Color_D' />
```

```

        <attribute name='DominantColorsNumber' type='integer' />
        <attribute name='ConfidenceMeasure' type='integer' />
        <seq minOccurs='0' maxOccursPar='DominantColorsNumber'>
            <DTypeRef name='DominantColorValues' />
        </seq>
    </DType>

<DType name='DominantColorValues'>
    <attribute name='Percentage' type='integer' />
    <seq minOccurs='0' maxOccursPar='ColorSpaceDimension'>
        <DType name='ColorValue' type='integer' />
    </seq>
</DType>

<!-- ##### -->
<!-- Definition of 'BoundingBoxDescriptor' -->
<!-- ##### -->

<DType name='BoundingBoxD'>
    <attribute name='LengthUnits' type='unitTypes' />
    <attribute name='BoxHeight' type='real' />
    <attribute name='BoxWidth' type='real' />
    <attribute name='FractionalOccupancy' type='real' />
    <attribute name='Is3D' type='boolean' />
    <attribute name='HasCompositionInfo' type='boolean' />
</DType>

<DType name='3DBoundingBoxD'>
    <subDOf name='BoundingBoxD' />
    <attribute name='BoxDepth' type='real' />
</DType>

<DType name='BoundBoxwithCompInfo'>
    <subDOf name='BoundingBoxD' />
    <attribute name='BoxCentreH' type='real' />
    <attribute name='BoxCentreW' type='real' />
    <attribute name='omega' type='real' />
</DType>

<DType name='3DBoundBoxwithCompInfo'>
    <subDOf name='BoundBoxwithCompInfo' />
    <attribute name='BoxDepth' type='real' />
    <attribute name='BoxCentred' type='real' />
    <attribute name='theta' type='real' />
</DType>

<!-- ##### -->
<!-- Definition of 'CameraMotionDescriptor' -->
<!-- ##### -->

<DType name='CameraMotionD'>
    <attribute name='NumSegmentDescription' type='integer' />
    <attribute name='DescriptionMode' type='boolean' />
    <seq minOccurs='0' maxOccursPar='NumSegmentDescription'>
        <DTypeRef name='SegmentedCameraMotionD' />
    </seq>
</DType>

<DType name='SegmentedCameraMotionD'>
    <DType name='start_time' type='time' />
    <DType name='duration' type='timeDuration' />

```

```

    <DTypeRef name='presence' />
    <DTypeRef name='speeds' />
    <DType name='FOE_FOC_HorizontalPosition' type='real' />
    <DType name='FOE_FOC_VerticalPosition' type='real' />
</DType>

<DType name='speeds'>
  <attribute name='TRACK_LEFT' type='real' />
  <attribute name='TRACK_RIGHT' type='real' />
  <attribute name='BOOM_DOWN' type='real' />
  <attribute name='BOOM_UP' type='real' />
  <attribute name='DOLLY_FORWARD' type='real' />
  <attribute name='DOLLY_BACKWARD' type='real' />
  <attribute name='PAN_LEFT' type='real' />
  <attribute name='PAN_RIGHT' type='real' />
  <attribute name='TILT_UP' type='real' />
  <attribute name='TILT_DOWN' type='real' />
  <attribute name='ROLL_CLOCKWISE' type='real' />
  <attribute name='ROLL_ANTICLOCKWISE' type='real' />
  <attribute name='ZOOM_IN' type='real' />
  <attribute name='ZOOM_OUT' type='real' />
</DType>

<DType name='presence'>
  <subDO of name='speeds' />
  <attribute name='fixed' type='real' />
</DType>

```