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Information technology — Multimedia framework (MPEG-21) —

Part 7: Digital Item Adaptation

Technologies de l'information — Cadre multimédia (MPEG-21) —

Partie 7: Adaptation d'article numérique

Reference number
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Foreword

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International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 2.

The main task of the joint technical committee is to prepare International Standards. Draft International Standards adopted by the joint technical committee are circulated to national bodies for voting. Publication as an International Standard requires approval by at least 75 % of the national bodies casting a vote.

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ISO/IEC 21000-7 was prepared by Joint Technical Committee ISO/IEC JTC 1, *Information technology*, Subcommittee SC 29, *Coding of audio, picture, multimedia and hypermedia information*.

This second edition cancels and replaces the first edition (ISO/IEC 21000-7:2004), which has been technically revised. It also incorporates the Amendments ISO/IEC 21000-7:2004/Amd.1:2006 and ISO/IEC 21000-7:2004/Amd.2:2007.

ISO/IEC 21000 consists of the following parts, under the general title *Information technology — Multimedia framework (MPEG-21)*:

— *Part 1: Vision, Technologies and Strategy* [Technical Report]

— *Part 2: Digital Item Declaration*

— *Part 3: Digital Item Identification*

— *Part 4: Intellectual Property Management and Protection Components*

— *Part 5: Rights Expression Language*

— *Part 6: Rights Data Dictionary*

— *Part 7: Digital Item Adaptation*

— *Part 8: Reference Software*

— *Part 9: File Format*

— *Part 10: Digital Item Processing*

— *Part 11: Evaluation Tools for Persistent Association Technologies* [Technical Report]

— *Part 12: Test Bed for MPEG-21 Resource Delivery* [Technical Report]

— *Part 14: Conformance Testing*

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— *Part 15: Event Reporting*

— *Part 16: Binary Format*

— *Part 17: Fragment Identification of MPEG Resources*

— *Part 18: Digital Item Streaming*

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Introduction

The multimedia industry is growing at a rapid pace. For this industry, the term 'content' is widely used across different segments and applied in many different ways. For this reason, the term is deliberately avoided within the context of ISO/IEC 21000, where it has been replaced by the defined terms: Digital Item, media resource and resource. Equally important for the specifications of the multimedia framework is the notion of the User. A User of a system includes all members of the value chain (e.g., creator, rights holders, distributors and consumers of Digital Items).

Access devices, with a large set of differing terminal and network capabilities, are making their way into people's lives. Additionally, these access devices are used in different locations and environments; anywhere and at anytime. The Users, however, are currently not given tools to deal efficiently with all the intricacies of this new multimedia usage context.

Solutions with advanced multimedia functionality are becoming increasingly important as individuals are producing more and more digital media, not only for professional use but also for their personal use. All these 'resource providers' have many of the same concerns: management, re-purposing based on consumer and device capabilities, protection of rights, protection from unauthorised access/modification, protection of privacy of providers and consumers, etc. For example, it is becoming increasingly difficult to identify and understand the different intellectual property rights that are associated with the elements of multimedia resources. The boundaries between the delivery of audio (both music and spoken word), accompanying artwork (graphics), text (lyrics), video (visual) and synthetic spaces will become increasingly blurred. New solutions are required to manage the access and delivery process of these different resource types in an integrated and harmonized way, entirely transparent to the many different Users of multimedia services.

The need of these solutions motivates the initiatives of the ISO/IEC 21000 Multimedia Framework, which aims to enable transparent and augmented use of multimedia resources across a wide range of networks and devices.

ISO/IEC 21000-7 specifies tools for the adaptation of Digital Items (as specified in ISO/IEC 21000-2).

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Information technology — Multimedia framework (MPEG-21) —

Part 7:
Digital Item Adaptation

1 Scope

1.1 General

This part of ISO/IEC 21000 specifies the syntax and semantics of tools that may be used to assist the adaptation of Digital Items, i.e., the Digital Item Declaration and resources referenced by the declaration. The tools could be used to satisfy transmission, storage and consumption constraints, as well as Quality of Service management by the various Users. It is important to emphasize that the adaptation engines themselves are non-normative tools of this part of ISO/IEC 21000.

1.2 Organization of the document

This clause describes the various Digital Item Adaptation tools specified in this part of ISO/IEC 21000. Throughout this part of ISO/IEC 21000, each tool is described by the following subclauses:

— Syntax: Normative specification of the syntax of the tool using XML Schema.

— Semantic: Normative specification of the semantics of the tool and its components.

— Informative examples: Optionally, informative examples illustrating use of the tool.

1.3 Overview of Digital Item Adaptation

The goal of the Terminals and Networks element described in ISO/IEC 21000-1 is to achieve interoperable transparent access to (distributed) advanced multimedia content by shielding Users from network and terminal installation, management and implementation issues. To achieve this goal, the adaptation of Digital Items is required. This concept is illustrated in Figure 1. As shown in this conceptual architecture, a Digital Item is subject to a resource adaptation engine, as well as a description adaptation engine, which together produce the adapted Digital Item.

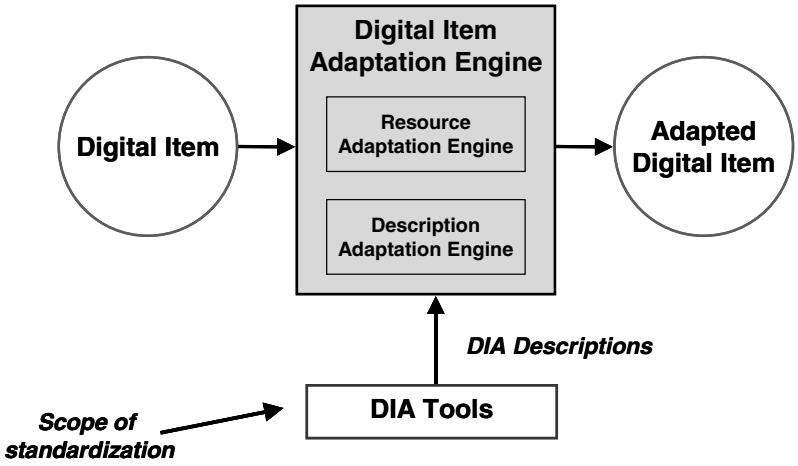

Figure 1 — Illustration of Digital Item Adaptation

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It is important to emphasise that the adaptation engines themselves are non-normative tools of Digital Item Adaptation. However, descriptions and format-independent mechanisms that provide support for Digital Item Adaptation in terms of resource adaptation, description adaptation, and/or Quality of Service management are within the scope of the standardization, and are collectively referred to in Figure 1 as DIA Tools.

1.4 Overview of Digital Item Adaptation tools

The Digital Item Adaptation tools in this part of ISO/IEC 21000 are clustered into eight major categories as illustrated in Figure 2.

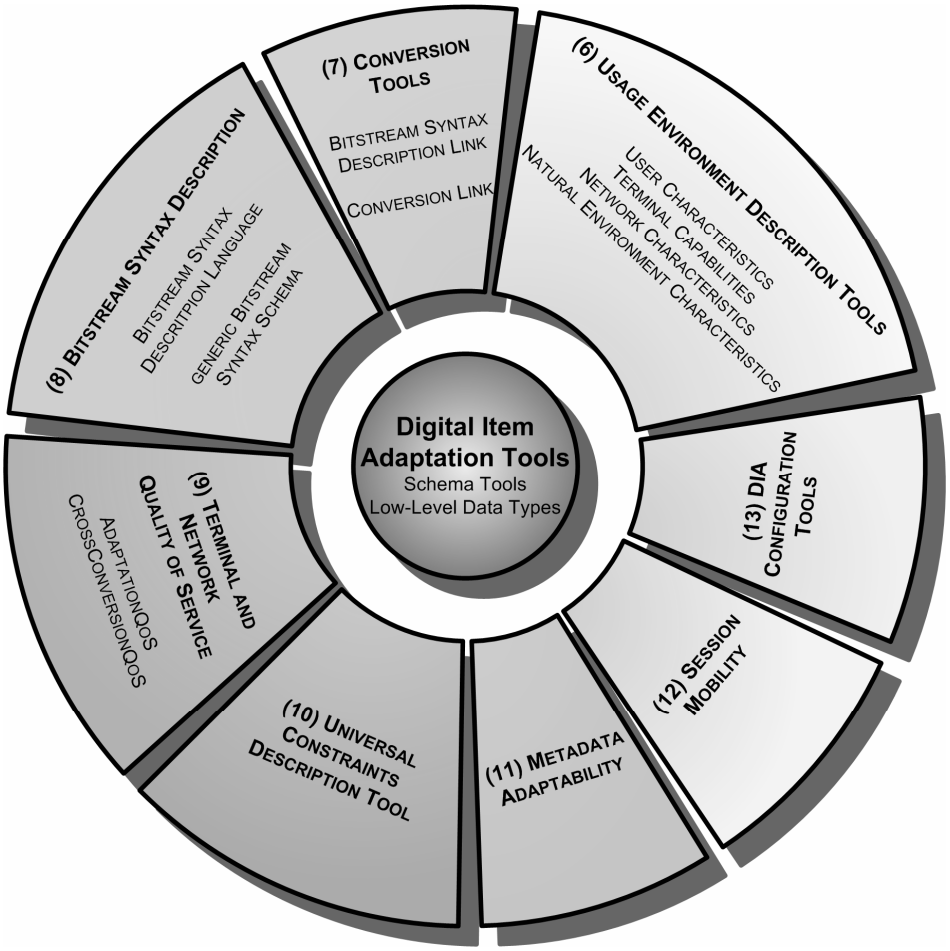

Figure 2 — Overview and organization of Digital Item Adaptation tools

The categories are clustered according to their functionality and use for Digital Item Adaptation around the *Schema Tools* and *Low-Level Data Types*. The schema tools provide uniform root elements for all DIA descriptions as well as some low-level and basic datatypes which can be used by several DIA tools independently. The syntax and semantics of the schema tools and low-level datatypes are specified in clauses 4 and 5, respectively.

— The first major category is the *Usage Environment Description Tools* and includes User characteristics, terminal capabilities, network characteristics and natural environment characteristics. These tools provide descriptive information about the various properties of the usage environment, which originate from Users, to accommodate, for example, the adaptation of Digital Items for transmission, storage and consumption. The syntax and semantics of these tools are specified in clause 6.

— The second category is referred to as *Conversion Tools* and provides the facilities to create a rich variety of adaptation architectures based on tools specified within this part of ISO/IEC 21000, ISO/IEC 21000-2, and ISO/IEC 15398 among others. The syntax and semantics of this tool is specified in clause 7.

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— *Bitstream Syntax Description* tools comprise the third major category of Digital Item Adaptation tools. A BSD describes the syntax – in most cases, the high level structure – of a binary media resource. Using such a description, a Digital Item resource adaptation engine can transform the bitstream and the corresponding description using editing-style operations such as data truncation and simple modifications. Streaming instructions enhance the BSD by defining a set of properties and attributes which describe the fragmentation, timing and random access point indication for the BSD and its described resource. They are used for streamed processing and transport, e.g., in dynamic and distributed adaptation scenarios. These tools are specified in subclause 7.3.

— The fourth category of tools is referred to as *Terminal and Network Quality of Service*. The tools specified in this category describe the relationship between QoS constraints (e.g., on network bandwidth or a terminal's computational capabilities), feasible adaptation operations satisfying these constraints and associated media resource qualities that result from adaptation. This set of tools therefore provides the means to trade-off these parameters with respect to quality so that an adaptation strategy can be formulated and optimal adaptation decisions can be made in constrained environments. The syntax and semantics of these tools are specified in clause 9.

— The *Universal Constraints Description Tools* form the fifth category of tools which enables the possibility to describe limitation and optimisation constraints on adaptations. The syntax and semantics of these tools are specified in subclause 9.10.

— The sixth category is referred to as *Metadata Adaptability*. This tool specifies hint information that can be used to reduce the complexity of adapting the metadata contained in a Digital Item. On the one hand, they are used for filtering and scaling, and on the other hand, for integrating XML instances. The syntax and semantics of this tool are specified in clause 11.

— For *Session Mobility*, the seventh category of tools, the configuration state information that pertains to the consumption of a Digital Item on one device is transferred to a second device. This enables the Digital Item to be consumed on the second device in an adapted way. The syntax and semantics of these tools are specified in clause 12.

— Finally, the eighth category of tools is referred to as *DIA Configuration Tools* and provides information required for the configuration of a Digital Item Adaptation Engine. The syntax and semantics of these description tools are specified in clause 13.

1.5 Relation between Digital Item Adaptation and other parts of ISO/IEC 21000

The Digital Item is the fundamental unit of distribution and transaction in the Multimedia Framework. While the different parts of ISO/IEC 21000 deal with the components and different aspects of Digital Items, together they form a complete integrated interoperable framework. This subclause describes the relationship of this part of ISO/IEC 21000 with the other parts of ISO/IEC 21000 in addressing the specific function of adapting Digital Items.

ISO/IEC 21000-2 enables the declaration of Digital Items. A Digital Item is a packaging of resources, descriptions and rights expression. A Digital Item may contain elements that conform to ISO/IEC 21000-3, ISO/IEC 21000-4, ISO/IEC 21000-5, ISO/IEC 21000-6, and tools that are defined in this part of ISO/IEC 21000.

A Digital Item may be input to a Digital Item Adaptation Engine. The Adaptation Engine can modify the input Digital Item by adapting the resources or metadata within the Digital Item or the declaration of the Digital Item to the usage environment. Additionally, the identifiers and rights expressions pertaining to the adapted Digital Item need not be the same as those pertaining to the input Digital Item.

ISO/IEC 21000-5 and ISO/IEC 21000-6 provide the tools to permit playing, modifying, and adapting by controlling the kinds of things that can be changed. This part of ISO/IEC 21000 provides tools for use with ISO/IEC 21000-5 to provide the means by which the control over the changes that can occur when playing, modifying, or adapting digital items and their component resources can be effected. It is expected that users of this part of ISO/IEC 21000 will register terms describing their specific adaptations with the Registration Authority described in ISO/IEC 21000-6 in order to provide interoperability.

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1.6 Relation between Digital Item Adaptation and ISO/IEC 15938

ISO/IEC 15938 is a standard for multimedia content description. For the most part, the description of multimedia content is used to satisfy a User's request for the resources contained in a particular Digital Item. This search would be carried out by a search engine. However, given the Digital Item of interest, ISO/IEC 15938 descriptions could also be used in the adaptation process. For example, ISO/IEC 15938 offers tools for the summarization of media resources, tools that provide transcoding hints about the media resources, and tools that indicate the available variations of a given media resource. See ISO/IEC 15938 for further information on the syntax and semantics of these tools.

Besides serving as an input to the Digital Item Adaptation Engine, several ISO/IEC 15938 tools are also referenced by the DIA specification. For example, tools that indicate a User's preference have been adopted as part of the DIA usage environment description tools, along with tools that indicate location and time associated with a User. The multimedia description schemes specified by ISO/IEC 15938 can also be used to specify the decoding and encoding formats as part of the terminal capabilities description tool. In this particular case, there exists symmetry between tools that are used to describe media resources and tools that are used to describe the capabilities of a terminal. In this way, the media resources can easily be matched or adapted to satisfy the terminal capabilities.

2 Normative references

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO/IEC 14496-1, *Information technology — Coding of audio-visual objects — Part 1: Systems*

ISO/IEC 14496-2, *Information technology — Coding of audio-visual objects — Part 2: Visual*

ISO/IEC 14496-10, *Information technology — Coding of audio-visual objects — Part 10: Advanced Video Coding*

ISO/IEC 14977:1996, *Information technology — Syntactic metalanguage — Extended BNF*

ISO/IEC 15938-3, *Information technology — Multimedia content description interface — Part 3: Visual*

ISO/IEC 15938-5, *Information technology — Multimedia content description interface — Part 5: Multimedia description schemes*

ISO/IEC 16262, *Information technology — ECMAScript language specification*

ISO/IEC 21000 (all parts), *Information technology — Multimedia framework (MPEG-21)*

ISO/IEC 23001-5, *Information technology — MPEG systems technologies — Part 5: Bitstream Syntax Description language (BSDL)*

Document Object Model (DOM) Level 3 Core Specification, Version 1.0, W3C Recommendation 07 April 2004

IEEE 754-1985, IEEE Standard for Binary Floating-Point Arithmetic

IETF RFC 1034, *Domain Names — Concepts and Facilities*, November 1987

IETF RFC 1738, *Uniform Resource Locators (URL)*, December 1994

IETF RFC 2141, *URN Syntax*, May 1997

IETF RFC 2396, *Uniform Resource Identifiers (URI): Generic Syntax*, August 1998

Namespaces in XML, World Wide Web Consortium, 14 January 1999

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Extensible Markup Language (XML) 1.0 (Second Edition), W3C Recommendation, 6 October 2000

XSL Transformations (XSLT), Version 1.0, W3C Recommendation, 16 November 1999

XML Schema Part 1: Structures, W3C Recommendation, 2 May 2001

XML Schema Part 2: Datatypes, W3C Recommendation, 2 May 2001

XML Information Set, W3C Recommendation 24 October 2001

XML Base, W3C Recommendation 27 June 2001

XML Path Language (XPath), Version 1.0, W3C Recommendation 16 November 1999

XPointer Framework, W3C Recommendation 25 March 2003

XPointer xmlns() Scheme, W3C Recommendation 25 March 2003

XPointer element() Scheme, W3C Recommendation 25 March 2003

3 Terms, definitions, symbols, and abbreviated terms

3.1 Terms and definitions

For the purposes of this document, the following terms and definitions apply:

3.1.1 General terms and definitions

3.1.1.1
description
instantiation of one or more **tools**

3.1.1.2
Digital Item
structured digital object conforming to ISO/IEC 21000-2 that is the fundamental unit of transaction and distribution in the multimedia framework

3.1.1.3
media resource
resource corresponding to audio-visual or multimedia data

3.1.1.4
receiver
side of a multimedia transaction that receives a **resource**

3.1.1.5
resource
component of a **Digital Item** corresponding to a digital asset or other form of intellectual content

3.1.1.6
sender
side of a multimedia transaction that sends a **resource**

3.1.1.7
tool
definition of syntax and corresponding semantics

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3.1.1.8
User
user of a multimedia system, which includes all participants of a value network, e.g., creator, rights holders, distributors and consumers of **Digital Items**

NOTE A **User** may correspond to a single physical person, as well as a group of people, or an organization.

3.1.2 DIA-specific terms and definition

3.1.2.1
adaptation unit
refers to a unit of a logical decomposition of a **bitstream** into segments

3.1.2.2
bitstream
coded **resource** consisting of a structured sequence of binary symbols

3.1.2.3
bitstream syntax
encoding or format of a **bitstream**

3.1.2.4
Bitstream Syntax Description
specification of the high-level structure of a **bitstream** using **Bitstream Syntax Description Language**.

3.1.2.5
Bitstream Syntax Description Language
language specified in this part of ISO/IEC 21000 for defining a **Bitstream Syntax**

3.1.2.6
Bitstream Syntax Schema
XML Schema written in the **Bitstream Syntax Description Language** describing the syntax of a given coding representation format

3.1.2.7
Bitstream Syntax Description transformation
process where a **Bitstream Syntax Description** is modified, producing a new description from which an adapted **bitstream** can be generated. This process may be specified for instance by an XSLT style sheet

3.1.2.8
Digital Item Adaptation
process of manipulation of a **Digital Item** to produce a modified **Digital Item** in order to adapt it to the **usage environment**

3.1.2.9
generic Bitstream Syntax Schema
generic, coding format independent XML Schema for the description of any binary **media resource**

3.1.2.10
resource adaptation
process of manipulation of a **resource** within a **Digital Item** in order to adapt it to the **usage environment**

3.1.2.11
scalable bitstream
bitstream in which data is organized in such a way that, by retrieving the **bitstream**, it is possible to first render a degraded version of the **resource**, and then progressively improve it by loading additional data

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3.1.2.12
usage environment description
refers to metadata that specifies **User** characteristics, terminal capabilities, network characteristics and natural environment characteristics according to ISO/IEC 21000

3.1.3 Conversion and permission-specific terms and definitions

3.1.3.1
conversion
process that changes the characteristics of a **resource**

NOTE In general a conversion performs the act as defined by the ISO/IEC 21000-6 term 'adapt'.

3.1.3.2
conversion act
conversion and its parameters, including the actual name of the parameters. The semantics shall be defined through ISO/IEC 21000-6

3.1.3.3
conversion tool
hardware and/or software module that implements a **conversion act** in order to perform the **conversion** as specified by the ISO/IEC 21000-6 term defining this **conversion**

3.1.4 Dynamic and Distributed Adaptation-specific terms and definitions

3.1.4.1
dynamic adaptation
dynamic adaptation refers to the adaptation of **Digital Item**s according to dynamically changing **usage environment**s

EXAMPLE The available bandwidth may drop during a streaming session and the Digital Item is consequently adapted to this new usage environment.

3.1.4.2
distributed adaptation
distributed adaptation refers to multiple adaptation steps successively performed on different ISO/IEC 21000 **peers**

EXAMPLE A same resource may be successively adapted on a server, network node and/or terminal.

3.1.4.3
process unit
well-formed fragment of a BSD or other XML metadata used for adaptation purposes, that can be consumed as such by the ISO/IEC 21000 **peer**, and to which a time information may be attached, indicating the point in time when it becomes available to the ISO/IEC 21000 **peer** for consumption

NOTE A process unit is a processing-oriented concept rather than a delivery-oriented concept. It does not depend on any encoding method used for delivering it.

3.1.4.4
XML fragmentation
authoring process by which an XML document is split into **process unit**s meaningful for consumption purposes. This process may attach time information to the output **process unit**s indicating the point in time when they become available to the ISO/IEC 21000 **peer** for consumption

3.1.4.5
processing time
point in time when a **process unit** is available to the ISO/IEC 21000 **peer** for consumption

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3.1.4.6
access unit
smallest segment of data that is atomic in time

EXAMPLE ISO/IEC 14496-1 access unit or ISO/IEC 15938-1 access unit (cf. TeM or BiM).

3.1.4.7
encoding
process by which a **process unit** is transformed into another representation for storage and/or delivery purposes

NOTE 1 The output of encoding is a sequence of one or more **access unit**s

NOTE 2 Encoding does not necessarily imply compression (see for example TeM for XML).

3.1.4.8
random access point
indicates whether an **access unit** carries information that can be consumed by a ISO/IEC 21000 **peer** independent from any other **access unit**s

3.2 Symbols and abbreviated terms

For the purposes of this document, the symbols and abbreviated terms given in the following apply:

AU: Access Unit

BSDL: Bitstream Syntax Description Language

BSD: Bitstream Syntax Description

BS Schema: Bitstream Syntax Schema

CS: Classification Scheme

CTS: Composition Time Stamp

DCT: Discrete Cosine Transform

DI: Digital Item

DIA: Digital Item Adaptation

DID: Digital Item Declaration

DII: Digital Item Identification

DTS: Decoding Time Stamp

FGS: Fine Granularity Scalability

IPMP: Intellectual Property Management & Protection

gBSD: generic Bitstream Syntax Description

gBS Schema: generic Bitstream Syntax Schema

RDD: Rights Data Dictionary

REL: Rights Expression Language

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PU: Process Unit

RAP: Random Access Point

PTS: Processing Time Stamp

STX: Streaming Transformations for XML

UCD: Universal Constraint Description

UED: Usage Environment Description

URI: Uniform Resource Identifier

XML: Extensible Markup Language 1.0

XSL: Extensible Stylesheet Language

XSLT: Extensible Stylesheet Language Transformations

3.3 Schema documents

In the main text of this part of ISO/IEC 21000, the syntax of description tools is provided whenever possible as a single schema document.

In some cases though, and in particular for the clauses 4, 6, and 8 the syntax of description tools is provided as a collection of schema snippets imbricated with other text. In order to form a valid schema document, these schema components should be gathered in the same document with the schema wrapper provided at the head of the clause. For better readability, the relevant schema documents are provided in the Annex G, but as non-normative information.

NOTE All ISO/IEC 21000-7 schema documents are publicly available under http://standards.iso.org/ittf/PubliclyAvailableStandards/MPEG-21_schema_files.

In all cases, each schema document has a `version` attribute, the value of which is "ISO/IEC 21000-7". Furthermore, an informative identifier is given as the value of the `id` attribute of the `schema` component. This identifier is non-normative and used as a convention in this specification to reference another schema document. In particular, it is used for the `schemaLocation` attribute of the `include` and `import` schema components.

Several schema documents defined in this part of ISO/IEC 21000 reference description tools defined in ISO/IEC 15938-5. Therefore, it is necessary to import a corresponding schema document that defines the syntax of these tools. In this part of ISO/IEC 21000, the schema document containing referenced ISO/IEC 15938-5 description tools is identified with the id `mpeg7-udp-2004.xsd`.

3.4 Use of prefixes in this specification

For clarity, throughout this part of ISO/IEC 21000, consistent namespace prefixes are used.

"`xsd:`" prefix is not normative. It is a naming convention in this document to refer to an element of the XML Schema namespace (`http://www.w3.org/2001/XMLSchema`). Similarly, "`xsi:`" refers to the `http://www.w3.org/2001/XMLSchema-instance` namespace.

"`xml:`" and "`xmlns:`" are normative prefixes defined in [13]. The prefix "`xml:`" is by definition bound to "`http://www.w3.org/XML/1998/namespace`". The prefix "`xmlns:`" is used only for namespace bindings and is not itself bound to any namespace name.

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All other prefixes used in either the text or examples of this specification are not normative, e.g., "dia:", "bs1:", "bs2:", "sm:", "mpeg7:".

In particular, most of the informative examples in this specification are provided as XML fragments without the normally required XML document declaration and thus miss a correct namespace binding context declaration. In these descriptions fragments, the default namespace is defined as urn:mpeg:mpeg21:2003:01-DIA-NS and the different prefixes are bound to the namespaces as given in the following table.

Table 1 — Mapping of prefixes to namespaces in examples and text

Prefix	Corresponding namespace
None (default namespace)	urn:mpeg:mpeg21:2003:01-DIA-NS
dia	urn:mpeg:mpeg21:2003:01-DIA-NS
mpeg7	urn:mpeg:mpeg7:schema:2001
xsi	http://www.w3.org/2001/XMLSchema-instance
xsd	http://www.w3.org/2001/XMLSchema
bs1	urn:mpeg:mpeg21:2003:01-DIA-BSDL1-NS
bs2	urn:mpeg:mpeg21:2003:01-DIA-BSDL2-NS
did	urn:mpeg:mpeg21:2002:01-DIDL-NS
gbsd	urn:mpeg:mpeg21:2003:01-DIA-gBSD-NS
diac	urn:mpeg:mpeg21:2003:01-DIA-DIAC-NS
sm	urn:mpeg:mpeg21:2003:01-DIA-SM-NS
r	urn:mpeg:mpeg21:2003:01-REL-R-NS
sx	urn:mpeg:mpeg21:2003:01-REL-SX-NS
mx	urn:mpeg:mpeg21:2003:01-REL-MX-NS
msi	urn:mpeg:mpeg21:2003:01-DIA-MSI-NS
si	urn:mpeg:mpeg21:2003:01-DIA-XSI-NS
ps	urn:mpeg:mpeg21:2003:01-DIA-PSS-NS
bs1x	urn:mpeg:mpeg21:2003:01-DIA-BSDL1x-NS
bs2x	urn:mpeg:mpeg21:2003:01-DIA-BSDL2x-NS

Unlike the informative descriptions examples, the normative specification of the syntax of tools in XML Schema follows the namespace binding context defined in the relevant schema declaration such as the one defined in subclause 4.2. The list of non-normative prefixes provided by Table 1 is not relevant to the schema declaration snippets.

This part of ISO/IEC 21000 normatively references description tools in ISO/IEC 15938 using the mpeg7 prefix as given Table 1 with the corresponding namespace as defined in ISO/IEC 15938-5:2003. As amendments of ISO/IEC 15938 become available, users of the standard should update the corresponding mpeg7 namespace. The same remark applies to the namespace defined in ISO/IEC 21000-2 and bound to the "did:" prefix given in Table 1.

3.5 URI fragment identifiers for XML documents

3.5.1 Syntax of URI fragment identifiers

Uniform Resource Identifiers (URIs) are used throughout this specification to identify MPEG-21 descriptions or resources. In some cases, URIs are used to identify a fragment of an XML document. For example, it may be necessary to identify a single element, an attribute or a full XML fragment corresponding to the required description information. A specific syntax is then required for such URI fragment identifier.

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For this, the XPointer framework [14] is the normative format used in this specification for URI fragment identifiers when the URI is used to locate a fragment of an XML document.

When the URI fragment identifier locates a complex content element, i.e., an XML element containing child sub-elements, then the context of use determines whether it points to the single element or the document fragment below this element.

3.5.2 URI fragment identifiers examples

EXAMPLE 1 The following example shows the declaration of an AdaptationQoS description in a document available at the URI http://example.com/ex1.xml. The description itself may be identified by the id of its root element.

```
<DIA xmlns="urn:mpeg:mpeg21:2003:01-DIA-NS">
   <Description xsi:type="AdaptationQoSType" id="myDescrID">
      <Module xsi:type="LookUpTableType">
         <!-- and so on... -->
      </Module>
      <!-- and so on... -->
   </Description>
</DIA>
```

EXAMPLE 2 The following example shows a BSDLink description pointing to the AdaptationQoS description above.

```
<DIA xmlns:dia="urn:mpeg:mpeg21:2003:01-DIA-NS">
   <Description xsi:type="BSDLinkType">
      <SteeringDescriptionRef uri="http://example.com/ex1.xml#myDescrID"/>
         <!-- and so on... -->
   </Description>
</DIA>
```

If the BSDLink and AdaptationQoS descriptions are in the same document, then the URI may be written "#myDescrID".

4 Schema tools

4.1 Introduction

This clause specifies the schema tools that facilitate the creation of descriptions. The following description tools are specified: (1) the base type hierarchy of the description tools defined in this part of ISO/IEC 21000, and (2) the root elements. Base types form the type hierarchy for description tools, while root elements describe the initial wrappers of descriptions. In this clause, we also refer to top-level types, which are types that may follow the root element in a description. The top-level types are defined in the respective clauses in which the related tools to a particular top-level type are defined.

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4.2 Schema wrapper

The syntax of description tools specified in this clause is provided as a collection of schema components, consisting notably in type definitions and element declarations. In order to form a valid schema document, these schema components should be gathered in a same document with the following declaration defining in particular the target namespace and the namespaces prefixes.

```
<?xml version="1.0"?>
<!-- Digital Item Adaptation ISO/IEC 21000-7 Second Edition -->
<!-- Schema for basic schema tools -->
<schema
   version="ISO/IEC 21000-7 2nd"
   id="DIA-2nd.xsd"
   targetNamespace="urn:mpeg:mpeg21:2003:01-DIA-NS"
   xmlns="http://www.w3.org/2001/XMLSchema"
   xmlns:dia="urn:mpeg:mpeg21:2003:01-DIA-NS"
   elementFormDefault="qualified" attributeFormDefault="unqualified">
```

Additionally, the following line should be appended to the resulting schema document in order to obtain a well-formed XML document.

```
</schema>
```

4.3 Base types

4.3.1 Introduction

The following base types are defined in this subclause:

— `DIABaseType`: provides the base abstract type of the type hierarchy. The majority of the tools in this specification are directly defined as an extension of this base type.

— `DIADescriptionType`: extends `DIABaseType` and provides the base abstract type for a subset of types defined in this specification that may follow the `DIA` root element as specified in subclause 4.4. Tools that are defined as an extension of `DIADescriptionType` are referred to as top-level types.

4.3.2 Base types syntax

```
<!-- ################################################   -->
<!--  Definition of DIA Base Types                    -->
<!-- ################################################   -->

<complexType name="DIABaseType" abstract="true">
   <complexContent>
      <restriction base="anyType">
         <attribute name="id" type="ID" use="optional"/>
      </restriction>
   </complexContent>
</complexType>

<complexType name="DIADescriptionType" abstract="true">
   <complexContent>
      <extension base="dia:DIABaseType"/>
   </complexContent>
</complexType>
```


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4.3.3 Base types semantics

Semantics of the `DIABaseType`:

Name	*Definition*
`DIABaseType`	Provides the topmost type of the base type hierarchy. The `DIADescriptionType` extends `DIABaseType`.
`id`	Identifies the `id` of the `DIABaseType`. When used as an `id` for a `DIADescriptionType`, it shall be used to identify the target referenced by the `ReferenceType` tool.

Semantics of the `DIADescriptionType`:

Name	*Definition*
`DIADescriptionType`	`DIADescriptionType` extends `DIABaseType` and provides a base abstract type for a subset of types defined in this specification that may follow the `DIA` root element as specified in subclause 4.4.

4.4 Description metadata

4.4.1 Introduction

The description metadata provides information such as an alias for URIs identifying a classification scheme.

4.4.2 Description metadata syntax

```
<!-- ################################################ -->
<!--  Definition of Description Metadata Type         -->
<!-- ################################################ -->

<complexType name="DescriptionMetadataType">
   <complexContent>
      <extension base="dia:DIABaseType">
         <sequence>
            <element name="ClassificationSchemeAlias" maxOccurs="unbounded">
               <complexType>
                  <complexContent>
                     <extension base="dia:DIABaseType">
                        <attribute name="alias" type="NMTOKEN"
                           use="required"/>
                        <attribute name="href" type="anyURI" use="required"/>
                     </extension>
                  </complexContent>
               </complexType>
            </element>
         </sequence>
      </extension>
   </complexContent>
</complexType>
```

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4.4.3 Description metadata semantics

Semantics of DescriptionMetadataType:

Name	*Definition*
`DescriptionMetadataType`	Tool for describing metadata concerning a DIA description.
`ClassificationSchemeAlias`	Describes an alias for a classification scheme referenced by a URI.
`alias`	Describes the alias assigned to the `ClassificationScheme`. The scope of the alias assigned shall be the entire description regardless of where the `ClassificationSchemeAlias` appears in the description.
`href`	Describes a reference to the classification scheme that is being aliased using a URI. The classification schemes defined in this part of ISO/IEC 21000, whether normative or informative, shall be referenced using the identifying value defined by the uri attribute of the `ClassificationScheme` for that classification scheme.

4.4.4 Classification scheme resolution mechanism

ISO/IEC 15938-5 specifies a descriptor named `mpeg7:ClassificationSchemeAliasType` for assigning an alias to a namespace. Additionally, this part of ISO/IEC 21000 specifies a more compact syntax for the same purpose by making use of the XML namespace binding context. The XML Namespaces recommendation [13] specified how to bind a prefix to a namespace. This namespace binding context is then inherited by the child elements of the element where the namespace is declared. This part of 21000 uses this namespace binding context to resolve the aliases used in classification schemes.

In case of conflicts between the namespace binding context and the binding specified by `mpeg7:ClassificationSchemeAliasType`, the namespace bound by the latter is used.

EXAMPLE 1 When a classification scheme term such as `:myAlias:myCSTerm`, the alias `myAlias` alias is resolved against the namespace binding context, i.e. the XML namespaces declaration.

EXAMPLE 2 Classification Scheme resolution mechanism using the XML namespace declaration. The alias `MV4` is resolved against the namespace binding context, i.e., the XML namespace declaration within the Description element which is inherited by its child elements (`xmlns:MV4="urn:mpeg:mpeg4:video:cs:syntacticalLabels"`).

```
<DIA xmlns="urn:mpeg:mpeg21:2003:01-DIA-NS">
<Description xsi:type="gbsd:gBSDType"
    xmlns:gbsd="urn:mpeg:mpeg21:2003:01-DIA-gBSD-NS"
    bs1:bitstreamURI="akiyo.mpg4"
    xmlns:MV4="urn:mpeg:mpeg4:video:cs:syntacticalLabels">

  <gBSDUnit syntacticalLabel=":MV4:VO" start="0" length="18" />
  <!-- ... and so on ... -->

 </Description>
</ DIA>
```

4.5 Root elements

4.5.1 Introduction

The functionality of a root element is to describe the initial wrapper or root element of descriptions. This subclause specifies two root elements: a `DIA` root element to be used for complete descriptions, and a

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DIADescriptionUnit root element to be used for description units. These two forms of descriptions are defined as follows:

— **Complete Description**: describes the target of the Digital Item Adaptation tools using top-level types, which are a subset of types defined in the specification that follow the root element in descriptions. For example, a self-contained description of a usage environment that includes a description of terminal capabilities and a description of User characteristics is a complete description.

— **Description Unit**: describes an instance of a description. A description unit can be used to represent partial information from a complete description. For example, the description of only the display capabilities.

Either the DIA or DIADescriptionUnit root element shall be used as the topmost element in a description. The use of these root elements must be consistent with the semantics defined below.

4.5.2 Root element syntax

```
<!-- ################################################ -->
<!--  Definition of DIA Root Element                  -->
<!-- ################################################ -->

<element name="DIA">
   <complexType>
      <sequence>
         <element name="DescriptionMetadata" type="dia:DescriptionMetadataType"
             minOccurs="0"/>
          <choice maxOccurs="unbounded">
             <element name="Description" type="dia:DIADescriptionType"/>
             <element name="Reference" type="dia:ReferenceType"/>
          </choice>
      </sequence>
   </complexType>
</element>

<element name="DIADescriptionUnit" type="dia:DIABaseType"/>
```

4.5.3 Root element semantics

Semantics of the DIA root element:

Name	*Definition*
DIA	Serves as the root element for a complete description. DIA shall be used as the topmost element in a complete description.
DescriptionMetadata	Describes the metadata for the descriptions contained within DIA description. The description metadata applies to the elements contained within this description.
Description	Description of the target top-level type according to the specified elements. Only types that are defined as an extension of the DIADescriptionType may follow the DIA root element.
Reference	References an external description of the target top-level type, which is a type that is defined as an extension of the DIADescriptionType.

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Semantics of the `DIADescriptionUnit` root element:

Name	*Definition*
`DIADescriptionUnit`	Serves as the root element for a description unit. `DIADescriptionUnit` shall be used as the topmost element in a description unit.

4.5.4 Root element examples

EXAMPLE 1 The following example shows the use of the `DIA` root element.

```
<DIA>
    <DescriptionMetadata>
        <ClassificationSchemeAlias alias=":ACF:"
            href="urn:mpeg:mpeg7:cs:AudioCodingFormatCS:2001"/>
        <ClassificationSchemeAlias alias=":VCF:"
            href="urn:mpeg:mpeg7:cs:VisualCodingFormatCS:2001"/>
    </DescriptionMetadata>
    <Description xsi:type="UsageEnvironmentType">
        <UsageEnvironmentProperty xsi:type="TerminalsType">
            <Terminal>
                <TerminalCapability xsi:type="DisplaysType">
                    <Display id="d0">
                        <DisplayCapability xsi:type="DisplayCapabilityType">
                            <Mode>
                                <Resolution horizontal="176" vertical="144"/>
                            </Mode>
                        </DisplayCapability>
                    </Display>
                </TerminalCapability>
                <TerminalCapability xsi:type="CodecCapabilitiesType">
                    <Decoding xsi:type="AudioCapabilitiesType">
                        <Format href=":ACF:4.4">
                            <mpeg7:Name xml:lang="en">MP3</mpeg7:Name>
                        </Format>
                        <Format href=":ACF:6">
                            <mpeg7:Name xml:lang="en">AMR</mpeg7:Name>
                        </Format>
                    </Decoding>
                    <Decoding xsi:type="VideoCapabilitiesType">
                        <Format href=":VCF:2001:3.1.2">
                            <mpeg7:Name xml:lang="en">
                                MPEG-4 Visual Simple Profile @ Level 1
                            </mpeg7:Name>
                        </Format>
                    </Decoding>
                </TerminalCapability>
            </Terminal>
        </UsageEnvironmentProperty>
        <UsageEnvironmentProperty xsi:type="NetworksType">
            <Network id="n0">
                <NetworkCharacteristic xsi:type="NetworkCapabilityType"
                    maxCapacity="64000"/>
            </Network>
        </UsageEnvironmentProperty>
    </Description>
</DIA>
```


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EXAMPLE 2 The following example shows the use of the `DIADescriptionUnit` root element.

```
<DIADescriptionUnit xsi:type="DisplayCapabilityType">
    <Mode>
        <Resolution horizontal="176" vertical="144"/>
    </Mode>
</DIADescriptionUnit>
```

4.6 Reference

4.6.1 Introduction

This subclause specifies a tool for referencing.

4.6.2 Reference syntax

```
<!-- ################################################ -->
<!--  Definition of Reference                         -->
<!-- ################################################ -->

<complexType name="ReferenceType">
    <attribute name="uri" type="anyURI" use="required"/>
</complexType>
```

4.6.3 Reference semantics

Semantics of `ReferenceType`:

Name	*Definition*
`ReferenceType`	Tool for providing a means to reference elements whose type is derived from `DIADescriptionType`.
`uri`	Describes a URI.

4.6.4 Reference examples

EXAMPLE 1 The following example shows the use of `Reference` as an external reference, where the descriptions for a `Terminal` capabilities and `Network` characteristics are stored in another location. In this particular example, only the `Network` element is being referenced through its respective `id` attribute.

```
--Example1.xml--
<DIA>
    <Reference uri="Terminal_and_Network1.xml#n0"/>
</DIA>

--Terminal_and_Network1.xml--
<DIA>
    <Description xsi:type="UsageEnvironmentType">
        <UsageEnvironment xsi:type="TerminalsType">
            <Terminal>
                <TerminalCapability xsi:type="DisplaysType">
                    <Display id="d0">
                        <DisplayCapability xsi:type="DisplayCapabilityType">
                            <Mode>
                                <Resolution horizontal="176" vertical="144"/>
                            </Mode>
                        </DisplayCapability>
                    </Display>
                </TerminalCapability>
            </Terminal>
```

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```
        </UsageEnvironmentProperty>
        <UsageEnvironmentProperty xsi:type="NetworksType">
            <Network id="n0">
                <NetworkCharacteristic xsi:type="NetworkCapabilityType"
                    maxCapacity="64000"/>
            </Network>
        </UsageEnvironmentProperty>
    </Description>
</DIA>
```

EXAMPLE 2 When used in the context of a DID, as specified in ISO/IEC 21000-2, it is preferable to use a DID `Reference` element. The following example shows the use of DID `Reference` to achieve similar result as that in the previous example.

```
--Example2.xml--
<DIDL>
    <Item>
        <Descriptor>
            <Reference target="Terminal_and_Network2.xml#n0"/>
        </Descriptor>
    </Item>
</DIDL>

--Terminal_and_Network2.xml--
<DIDL>
    <Item>
        <Descriptor id="n0">
            <Statement>
                <DIADescriptionUnit xsi:type=" NetworkCapabilityType"
                    maxCapacity="64000"/>
            </Statement>
        </Descriptor>
    </Item>
</DIDL>
```

5 Low-level datatypes

5.1 Introduction

This clause specifies a list of low-level datatypes that may be used throughout this part of ISO/IEC 21000.

5.2 Common datatypes

5.2.1 Introduction

This subclause specifies the syntax and semantics of the various datatypes. These datatypes have been designed in such a way that additional datatypes can easily be added in future versions. In this version, four datatypes are included, namely integers, floats, tokens, and booleans. These datatypes can be used as a single value, a vector or a matrix of values.

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5.2.2 Single value datatypes

5.2.2.1 Introduction

This subclause specifies syntax and semantics of single value datatypes.

5.2.2.2 Single value datatypes syntax

```
<?xml version="1.0"?>
<!-- Digital Item Adaptation ISO/IEC 21000-7 Second Edition -->
<!-- Schema for Single Value Data Types -->
<schema
   version="ISO/IEC 21000-7 2nd"
   id="SingleValueDatatypes-2nd.xsd"
   targetNamespace="urn:mpeg:mpeg21:2003:01-DIA-NS"
   xmlns="http://www.w3.org/2001/XMLSchema"
   xmlns:dia="urn:mpeg:mpeg21:2003:01-DIA-NS"
   xmlns:mpeg7="urn:mpeg:mpeg7:schema:2001"
   elementFormDefault="qualified" attributeFormDefault="unqualified">

   <include schemaLocation="DIA-2nd.xsd"/>

   <!-- ################################################ -->
   <!-- Definition of Single Value Data Types            -->
   <!-- ################################################ -->

   <complexType name="ValueDataType" abstract="true">
      <complexContent>
         <extension base="dia:DIABaseType"/>
      </complexContent>
   </complexType>

   <complexType name="IntegerType">
      <complexContent>
         <extension base="dia:ValueDataType">
            <sequence>
               <element name="Value" type="integer"/>
            </sequence>
         </extension>
      </complexContent>
   </complexType>

   <complexType name="FloatType">
      <complexContent>
         <extension base="dia:ValueDataType">
            <sequence>
               <element name="Value" type="float"/>
            </sequence>
         </extension>
      </complexContent>
   </complexType>

   <complexType name="TokenType">
      <complexContent>
         <extension base="dia:ValueDataType">
            <sequence>
               <element name="Value">
                  <simpleType>
                     <restriction base="token">
                        <pattern value="\c+"/>
                     </restriction>
```

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```
                    </simpleType>
                </element>
            </sequence>
        </extension>
    </complexContent>
</complexType>

<complexType name="BooleanType">
    <complexContent>
        <extension base="dia:ValueDataType">
            <sequence>
                <element name="Value" type="boolean"/>
            </sequence>
        </extension>
    </complexContent>
</complexType>

</schema>
```

5.2.2.3 Single value datatypes semantics

Semantics of the `ValueDataType`, `IntegerType`, `FloatType`, `TokenType`, and `BooleanType`:

Name	*Definition*
`ValueDataType`	`ValueDataType` extends `DIABaseType` and provides a base abstract type for a subset of types defined as part of the single value datatypes.
`IntegerType`	Describes a single integer value.
`FloatType`	Describes a single float value.
`TokenType`	Describes a single token value.
`BooleanType`	Describes a single Boolean value.

5.2.3 Vector datatypes

5.2.3.1 Introduction

This subclause specifies syntax and semantics of vector datatypes.

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5.2.3.2 Vector datatypes syntax

```
<?xml version="1.0"?>
<!-- Digital Item Adaptation ISO/IEC 21000-7 Second Edition -->
<!-- Schema for Vector Data Types -->
<schema
   version="ISO/IEC 21000-7 2nd"
   id="VectorDatatypes-2nd.xsd"
   targetNamespace="urn:mpeg:mpeg21:2003:01-DIA-NS"
   xmlns="http://www.w3.org/2001/XMLSchema"
   xmlns:dia="urn:mpeg:mpeg21:2003:01-DIA-NS"
   xmlns:mpeg7="urn:mpeg:mpeg7:schema:2001"
   elementFormDefault="qualified" attributeFormDefault="unqualified">

   <import namespace="urn:mpeg:mpeg7:schema:2001"
      schemaLocation="mpeg7-udp-2004.xsd"/>
   <include schemaLocation="DIA-2nd.xsd"/>

   <!-- ################################################ -->
   <!-- Definition of Vector Data Types                  -->
   <!-- ################################################ -->

   <complexType name="VectorDataType" abstract="true">
      <complexContent>
         <extension base="dia:DIABaseType"/>
      </complexContent>
   </complexType>

   <!-- ################################################ -->
   <!-- Definition of IntegerVectorType                  -->
   <!-- ################################################ -->

   <complexType name="IntegerVectorType">
      <complexContent>
         <extension base="dia:VectorDataType">
            <sequence>
               <element name="Vector" type="mpeg7:integerVector"/>
            </sequence>
         </extension>
      </complexContent>
   </complexType>

   <!-- ################################################ -->
   <!-- Definition of FloatVectorType                    -->
   <!-- ################################################ -->

   <complexType name="FloatVectorType">
      <complexContent>
         <extension base="dia:VectorDataType">
            <sequence>
               <element name="Vector" type="mpeg7:floatVector"/>
            </sequence>
         </extension>
      </complexContent>
   </complexType>

   <!-- ################################################ -->
   <!-- Definition of TokenVectorType                    -->
   <!-- ################################################ -->
```

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```
<complexType name="TokenVectorType">
   <complexContent>
      <extension base="dia:VectorDataType">
         <sequence>
            <element name="Vector">
               <simpleType>
                  <restriction>
                     <simpleType>
                        <list itemType="dia:oneTokenType"/>
                     </simpleType>
                     <minLength value="1"/>
                  </restriction>
               </simpleType>
            </element>
         </sequence>
      </extension>
   </complexContent>
</complexType>
<simpleType name="oneTokenType">
   <restriction base="token">
      <pattern value="\c+"/>
   </restriction>
</simpleType>

<!-- ################################################ -->
<!-- Definition of BooleanVectorType                  -->
<!-- ################################################ -->

<complexType name="BooleanVectorType">
   <complexContent>
      <extension base="dia:VectorDataType">
         <sequence>
            <element name="Vector">
               <simpleType>
                  <list itemType="boolean"/>
               </simpleType>
            </element>
         </sequence>
      </extension>
   </complexContent>
</complexType>

<!-- ################################################ -->
<!-- Definition of ExternalVectorRefType              -->
<!-- ################################################ -->

<complexType name="ExternalVectorRefType" abstract="true">
   <complexContent>
      <extension base="dia:VectorDataType">
         <attribute name="uri" type="anyURI" use="required"/>
      </extension>
   </complexContent>
</complexType>

<!-- ################################################ -->
<!-- Definition of ExternalNMTokenVectorRefType       -->
<!-- ################################################ -->

<complexType name="ExternalNMTokenVectorRefType">
   <complexContent>
      <extension base="dia:ExternalVectorRefType"/>
```


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```
      </complexContent>
   </complexType>

</schema>
```

5.2.3.3 Vector datatypes semantics

Semantics of the `VectorDataType`, `IntegerVectorType`, `FloatVectorType`, `TokenVectorType`, and `BooleanVectorType`:

Name	*Definition*
`VectorDataType`	`VectorDataType` extends `DIABaseType` and provides a base abstract type for a subset of types defined as part of the vector datatypes.
`IntegerVectorType`	Describes a vector of integer values.
`FloatVectorType`	Describes a vector of float values.
`TokenVectorType`	Describes a vector of token values.
`BooleanVectorType`	Describes a vector of Boolean values.

Semantics of the `ExternalVectorRefType`:

`ExternalVectorRefType`	`ExternalVectorRefType` extends `VectorDataType` and provides a base abstract type for referencing external data by use of the XPointer framework.
`Uri`	Describes the URI fragment identifier to be evaluated.

Semantics of the `ExternalNMTokenVectorRefType`:

`ExternalNMTokenVectorRefType`	Describes a vector of `xsd:NMTOKEN` values which must be returned by the URI fragment identifier evaluation.

5.2.4 Matrix datatypes

5.2.4.1 Introduction

This subclause specifies syntax and semantics for matrix datatypes. Additionally, it includes the definition of the `NAType` which allows the inclusion of `NA` values within a matrix.

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5.2.4.2 Matrix datatypes syntax

```
<?xml version="1.0"?>
<!-- Digital Item Adaptation ISO/IEC 21000-7 Second Edition -->
<!-- Schema for Matrix Data Types -->
<schema
   version="ISO/IEC 21000-7 2nd"
   id="MatrixDatatypes-2nd.xsd"
   targetNamespace="urn:mpeg:mpeg21:2003:01-DIA-NS"
   xmlns="http://www.w3.org/2001/XMLSchema"
   xmlns:dia="urn:mpeg:mpeg21:2003:01-DIA-NS"
   xmlns:mpeg7="urn:mpeg:mpeg7:schema:2001"
   elementFormDefault="qualified" attributeFormDefault="unqualified">

   <import namespace="urn:mpeg:mpeg7:schema:2001"
      schemaLocation="mpeg7-udp-2004.xsd"/>
   <include schemaLocation="DIA-2nd.xsd"/>

   <!-- ################################################ -->
   <!-- Definition of Matrix Data Types                  -->
   <!-- ################################################ -->

   <complexType name="MatrixDataType" abstract="true">
      <complexContent>
         <extension base="dia:DIABaseType">
            <attribute ref="mpeg7:dim" use="required"/>
         </extension>
      </complexContent>
   </complexType>

   <simpleType name="NAType">
      <restriction base="token">
         <enumeration value="NA"/>
      </restriction>
   </simpleType>

   <!-- ################################################ -->
   <!-- Definition of IntegerMatrixType                  -->
   <!-- ################################################ -->

   <complexType name="IntegerMatrixType">
      <complexContent>
         <extension base="dia:MatrixDataType">
            <sequence>
               <element name="Matrix" type="dia:NAIntegerMatrixType"/>
            </sequence>
         </extension>
      </complexContent>
   </complexType>

   <simpleType name="NAIntegerMatrixType">
      <list>
         <simpleType>
            <union memberTypes="dia:NAType integer"/>
```


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```
        </simpleType>
    </list>
</simpleType>

<!-- ################################################ -->
<!-- Definition of FloatMatrixType                    -->
<!-- ################################################ -->

<complexType name="FloatMatrixType">
    <complexContent>
        <extension base="dia:MatrixDataType">
            <sequence>
                <element name="Matrix" type="dia:NAFloatMatrixType"/>
            </sequence>
        </extension>
    </complexContent>
</complexType>

<simpleType name="NAFloatMatrixType">
    <list>
        <simpleType>
            <union memberTypes="dia:NAType float"/>
        </simpleType>
    </list>
</simpleType>

<!-- ################################################ -->
<!-- Definition of TokenMatrixType                    -->
<!-- ################################################ -->

<complexType name="TokenMatrixType">
    <complexContent>
        <extension base="dia:MatrixDataType">
            <sequence>
                <element name="Matrix" type="dia:NATokenMatrixType"/>
            </sequence>
        </extension>
    </complexContent>
</complexType>

<simpleType name="NATokenMatrixType">
    <list>
        <simpleType>
            <union memberTypes="dia:NAType dia:aTokenType"/>
        </simpleType>
    </list>
</simpleType>
<simpleType name="aTokenType">
    <restriction base="token">
        <pattern value="\c+"/>
    </restriction>
</simpleType>

<!-- ################################################ -->
<!-- Definition of BooleanMatrixType                  -->
<!-- ################################################ -->

<complexType name="BooleanMatrixType">
    <complexContent>
        <extension base="dia:MatrixDataType">
            <sequence>
                <element name="Matrix" type="dia:NABooleanMatrixType"/>
```

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```
            </sequence>
         </extension>
      </complexContent>
   </complexType>

   <simpleType name="NABooleanMatrixType">
      <list>
         <simpleType>
            <union memberTypes="dia:NAType boolean"/>
         </simpleType>
      </list>
   </simpleType>

</schema>
```

5.2.4.3 Matrix datatypes semantics

Semantics of the `MatrixDataType`, `IntegerMatrixType`, `FloatMatrixType`, `TokenMatrixType`, and `BooleanMatrixType`:

Name	*Definition*
`MatrixDataType`	`MatrixDataType` extends `DIABaseType` and provides a base abstract type for a subset of types defined as part of the matrix datatypes. The reserved word `NA` ("Not Available") can be specified to indicate that a certain value is invalid.
`IntegerMatrixType`	Describes a matrix of integer values.
`FloatMatrixType`	Describes a matrix of float values.
`TokenMatrixType`	Describes a matrix of token values.
`BooleanMatrixType`	Describes a matrix of Boolean values.

5.3 Base stack function

5.3.1 Introduction

This subclause specifies the syntax and semantics of the BaseStackFunction tool which describes a mathematical expression. The expression is represented by serializing it in terms of argument and operator elements. Argument elements are pushed onto a value stack. For operator elements, one or more arguments are popped out of the value stack based on the definition of the operator, the operation is performed, and the result is pushed back onto the value stack.

After all the elements of a serialized stack expression have been processed, only the final value of the expression remains on the value stack. An example of a mathematical expression represented as a stack function is provided in Figure 3. A list of stack function operators are provided in the `StackFunctionOperatorCS` in Annex A.

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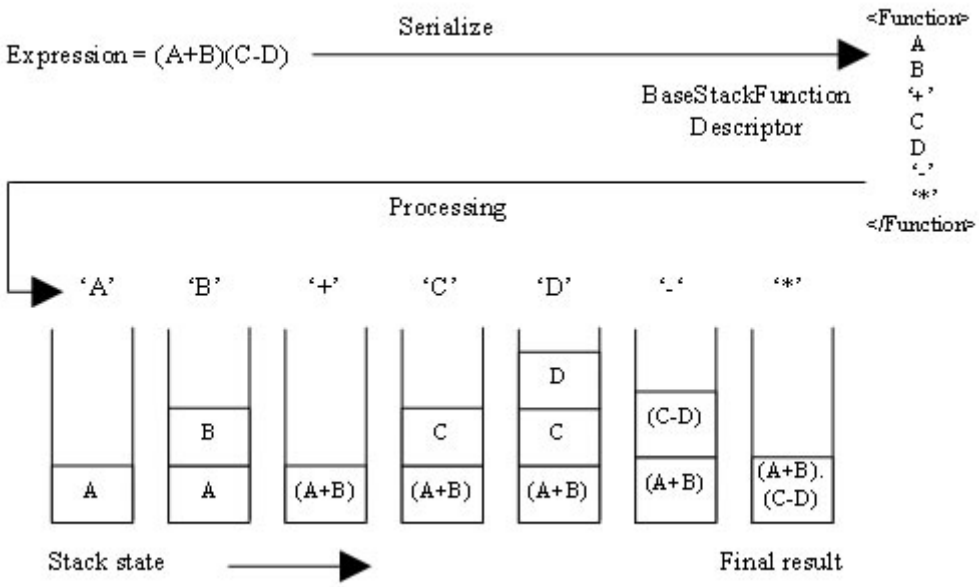

Figure 3 — Base stack function processing

5.3.2 Base stack function syntax

```
<?xml version="1.0"?>
<!-- Digital Item Adaptation ISO/IEC 21000-7 Second Edition -->
<!-- Schema for Stack Function Data Types -->
<schema
   version="ISO/IEC 21000-7 2nd"
   id="BaseStackFunction-2nd.xsd"
   targetNamespace="urn:mpeg:mpeg21:2003:01-DIA-NS"
   xmlns="http://www.w3.org/2001/XMLSchema"
   xmlns:dia="urn:mpeg:mpeg21:2003:01-DIA-NS"
   xmlns:mpeg7="urn:mpeg:mpeg7:schema:2001"
   elementFormDefault="qualified" attributeFormDefault="unqualified">

  <import namespace="urn:mpeg:mpeg7:schema:2001"
      schemaLocation="mpeg7-udp-2004.xsd"/>
  <include schemaLocation="DIA-2nd.xsd"/>

   <!-- ################################################ -->
   <!-- Definition of BaseStackFunctionType              -->
   <!-- ################################################ -->

   <complexType name="BaseStackFunctionType">
      <complexContent>
         <extension base="dia:DIABaseType">
            <choice maxOccurs="unbounded">
               <element name="Argument" type="dia:ArgumentType"/>
               <element name="Operation">
                  <complexType>
                     <attribute name="operator"
                        type="mpeg7:termReferenceType" use="required"/>
                  </complexType>
               </element>
            </choice>
         </extension>
      </complexContent>
   </complexType>
   <!-- ################################################ -->
```

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```
    <!-- Definition of ArgumentType                              -->
    <!-- ################################################### -->

    <complexType name="ArgumentType" abstract="true">
        <complexContent>
            <extension base="dia:DIABaseType"/>
        </complexContent>
    </complexType>

</schema>
```

5.3.3 Base stack function semantics

Semantics of the `BaseStackFunctionType`:

Name	*Definition*
`BaseStackFunctionType`	Tool for describing a mathematical expression. All the child elements of a stack function will be processed sequentially from top to bottom. The child element is pushed to the value stack if it is an `Argument`. If the child element is an `Operation` a corresponding number of values will be popped from the value stack and used as operands with the `operator`. The result value will then be pushed back to the value stack. After all the child elements of a stack expression are processed, only the final value of the stack expression should remain on the value stack.
`Argument`	Describes the input argument.
`Operation`	Describes the operation to be performed.
`operator`	Describes the operation. The CS that must be used for this purpose is the `StackFunctionOperatorCS` defined in Annex A.2.15.

Implementations of the stack function need not implement any operators that are not listed in the CS. Implementations of the stack function should implement all operators in the CS. Stack function writers may utilize any operators that are not listed in the CS, but this will limit interoperability.

Semantics of the `ArgumentType`:

Name	*Definition*
`ArgumentType`	`ArgumentType` extends `DIABaseType` and provides a base abstract type for a subset of types defined as part of subclause 5.4.

5.4 Argument types and extensions

5.4.1 Introduction

This subclause specifies syntax and semantics of possible argument types and its extensions.

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5.4.2 Argument types and extensions syntax

```
<?xml version="1.0"?>
<!-- Digital Item Adaptation ISO/IEC 21000-7 Second Edition -->
<!-- Schema for Stack Function Data Types -->
<schema
   version="ISO/IEC 21000-7 2nd"
   id="ArgumentTypes-2nd.xsd"
   targetNamespace="urn:mpeg:mpeg21:2003:01-DIA-NS"
   xmlns="http://www.w3.org/2001/XMLSchema"
   xmlns:dia="urn:mpeg:mpeg21:2003:01-DIA-NS"
   xmlns:mpeg7="urn:mpeg:mpeg7:schema:2001"
   elementFormDefault="qualified" attributeFormDefault="unqualified">

   <import namespace="urn:mpeg:mpeg7:schema:2001"
      schemaLocation="mpeg7-udp-2004.xsd"/>
   <include schemaLocation="BaseStackFunction-2nd.xsd"/>
   <include schemaLocation="SingleValueDatatypes-2nd.xsd"/>

   <!-- ################################################ -->
   <!-- Definition of VariableRefType                    -->
   <!-- ################################################ -->

   <complexType name="VariableRefType" abstract="true">
      <complexContent>
         <extension base="dia:ArgumentType">
            <attribute name="delay" type="nonNegativeInteger" use="optional"
                  default="0"/>
         </extension>
      </complexContent>
   </complexType>

   <!-- ################################################ -->
   <!-- Definition of SemanticalRefType                  -->
   <!-- ################################################ -->

   <complexType name="SemanticalRefType">
      <complexContent>
         <extension base="dia:VariableRefType">
            <attribute name="semantics" type="mpeg7:termReferenceType"
               use="required"/>
         </extension>
      </complexContent>
   </complexType>

   <!-- ################################################ -->
   <!-- Definition InternalIOPinRefType                  -->
   <!-- ################################################ -->

   <complexType name="InternalIOPinRefType">
      <complexContent>
         <extension base="dia:VariableRefType">
            <attribute name="iOPinRef" type="IDREF" use="required"/>
         </extension>
      </complexContent>
   </complexType>

   <!-- ################################################ -->
   <!-- Definition ExternalIOPinRefType                  -->
   <!-- ################################################ -->
```

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```
<complexType name="ExternalIOPinRefType">
   <complexContent>
      <extension base="dia:VariableRefType">
         <attribute name="iOPinRef" type="anyURI" use="required"/>
      </extension>
   </complexContent>
</complexType>

<!-- ################################################ -->
<!-- Definition of GetValueType                       -->
<!-- ################################################ -->

<complexType name="GetValueType" abstract="true">
   <complexContent>
      <extension base="dia:ArgumentType"/>
   </complexContent>
</complexType>

<!-- ################################################ -->
<!-- Definition of ConstantDataType                   -->
<!-- ################################################ -->

<complexType name="ConstantDataType">
   <complexContent>
      <extension base="dia:GetValueType">
         <sequence>
            <element name="Constant" type="dia:ValueDataType"/>
         </sequence>
      </extension>
   </complexContent>
</complexType>

<!-- ################################################ -->
<!-- Definition of ExternalDataRefType and derived types -->
<!-- ################################################ -->

<complexType name="ExternalDataRefType" abstract="true">
   <complexContent>
      <extension base="dia:GetValueType">
         <attribute name="uri" type="anyURI" use="required"/>
      </extension>
   </complexContent>
</complexType>

<!-- ################################################ -->
<!-- Definition of ExternalIntegerDataRefType -->
<!-- ################################################ -->

<complexType name="ExternalIntegerDataRefType">
   <complexContent>
      <extension base="dia:ExternalDataRefType"/>
   </complexContent>
</complexType>

<!-- ################################################ -->
<!-- Definition of ExternalFloatDataRefType -->
<!-- ################################################ -->

<complexType name="ExternalFloatDataRefType">
   <complexContent>
      <extension base="dia:ExternalDataRefType"/>
   </complexContent>
</complexType>
```

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```
    <!-- ################################################ -->
    <!-- Definition of ExternalNMTokenDataRefType -->
    <!-- ################################################ -->

    <complexType name="ExternalNMTokenDataRefType">
        <complexContent>
            <extension base="dia:ExternalDataRefType"/>
        </complexContent>
    </complexType>

    <!-- ################################################ -->
    <!-- Definition of ExternalBooleanDataRefType -->
    <!-- ################################################ -->

    <complexType name="ExternalBooleanDataRefType">
        <complexContent>
            <extension base="dia:ExternalDataRefType"/>
        </complexContent>
    </complexType>

    <!-- ################################################ -->
    <!-- Definition of SemanticalDataRefType              -->
    <!-- ################################################ -->

    <complexType name="SemanticalDataRefType">
        <complexContent>
            <extension base="dia:GetValueType">
                <attribute name="semantics" type="mpeg7:termReferenceType"
                    use="required"/>
                <attribute name="delay" type="nonNegativeInteger" use="optional"
                    default="0"/>
            </extension>
        </complexContent>
    </complexType>

</schema>
```

5.4.3 Argument types and extensions semantics

Semantics of the `VariableRefType`:

Name	*Definition*
`VariableRefType`	`VariableRefType` extends `ArgumentType` and provides a base abstract type for a subset of types defined as part of this subclause.
`delay`	Describes the delay value as a non-negative integer, in cases where the variable represents information from successive decision making units (frame, GOP, ROI etc.) in a resource, referred to as adaptation units. If delay is greater than zero, then the decision value for the variable delayed by that many adaptation units is used.

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Semantics of the SemanticalRefType:

Name	*Definition*
SemanticalRefType	Describes a variable by semantical reference.
semantics	Describes the semantics of the variable referenced. A CS that may be used for this purpose are the AdaptationQoSCS or MediaInformationCS defined in Annex A.2.2 and A.2.10 respectively. Any CS term that refers to a Digital Item property without specifying whether it refers to the property of the input or output Digital Item is to be interpreted as referring to the property of the output Digital Item.

Semantics of the InternalIOPinRefType:

Name	*Definition*
InternalIOPinRefType	Describes an internal reference to an AdaptationQoS IOPin. Syntax and semantics of the AdaptationQoS IOPin are defined in clause 9.
iOPinRef	Describes the referenced IOPin.

Semantics of the ExternalIOPinRefType:

Name	*Definition*
ExternalIOPinRefType	Describes an external reference to an AdaptationQoS IOPin. Syntax and semantics of the AdaptationQoS IOPin are defined in clause 9.
iOPinRef	Describes the referenced IOPin.

Semantics of the GetValueType:

Name	*Definition*
GetValueType	GetValueType extends ArgumentType and provides a base abstract type for describing a value or a reference to a value.

Semantics of the ConstantDataType:

Name	*Definition*
ConstantDataType	Describes a constant.
Constant	Describes the value of the constant by use of type ValueDataType.

Semantics of the ExternalDataRefType:

Name	*Definition*
ExternalDataRefType	ExternalDataRefType extends GetValueType and provides a base abstract type for referencing external data by use of the XPointer framework.
uri	Describes the URI fragment identifier to be evaluated.

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Semantics of the ExternalIntegerDataRefType:

Name	*Definition*
ExternalIntegerDataRefType	Describes an integer value which must be returned by the URI fragment identifier evaluation.

Semantics of the ExternalFloatDataRefType:

Name	*Definition*
ExternalFloatDataRefType	Describes an float value which must be returned by the URI fragment identifier evaluation.

Semantics of the ExternalNMTokenDataRefType:

Name	*Definition*
ExternalNMTokenDataRefType	Describes an xsd:NMTOKEN value which must be returned by the URI fragment identifier evaluation.

Semantics of the ExternalBooleanDataRefType:

Name	*Definition*
ExternalBooleanDataRefType	Describes an boolean value which must be returned by the URI fragment identifier evaluation.

Semantics of the SemanticalDataRefType:

Name	*Definition*
SemanticalDataRefType	Describes the value as a reference to its semantics.
semantics	Describes the semantics of the value referenced. A CS that may be used for this purpose are the AdaptationQoSCS, MediaInformationCS, or SegmentDecompositionInfoCS defined in Annex A.2.2, A.2.10, and A.2.14 respectively. Any CS term that refers to a Digital Item property without specifying whether it refers to the property of the input or output Digital Item is to be interpreted as referring to the property of the input Digital Item.
delay	Describes the delay value as a non-negative integer, in cases where the semantics represents information from successive decision making units (frame, GOP, ROI etc.) in a resource, referred to as adaptation units. If delay is greater than zero, then the value for the semantics delayed by that many adaptation units is used.

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Any CS term referenced by the semantics attribute which itself refer to CS terms specified in this part of ISO/IEC 21000 or other specifications must return the full URN of this CS term when used in conjunction with the `GetValueType`, i.e., no aliasing is allowed.

EXAMPLE The following example shows the fragment of an AdaptationQoS description containing an `IOPin` with a `GetValue` element.

```
<DIA>
    <DescriptionMetadata>
        <ClassificationSchemeAlias alias=":AQoS:"
            href="urn:mpeg:mpeg21:2003:01-DIA-AdaptationQoSCS:NS"/>
    </DescriptionMetadata>
    <Description xsi:type="AdaptationQoSType">
        <Module xsi:type="LookUpTableType">
            <!-- description of chosen data representation -->
        </Module>
        <!-- other possible AdaptationQoS modules -->
        <IOPin id="VIDEO_DECODING_FORMAT">
            <GetValue xsi:type="SemanticalDataRefType" semantics=":AQoS:6.5.4.6"/>
        </IOPin>
        <!-- other possible IOPins -->
    </Description>
</DIA>
```

The `semantics` attribute refers to a CS term which defines the video decoding format of a terminal. The video decoding format is itself defined by means of a CS term within ISO/IEC 15983-5. In this case, possible returned values must contain the full URN of the video coding format CS term, e.g., `"urn:mpeg:mpeg7:cs:VisualCodingFormatCS:2001:3.3"` (MPEG-4 Visual Advanced Simple Profile), and not something like `":VCF:3.3"` where `":VCF:"` is an alias for `"urn:mpeg:mpeg7:cs:VisualCodingFormatCS:2001"`.

5.5 Conversion descriptions

5.5.1 Introduction

Subclause 5.5 specifies conversion descriptions identifying conversions. Conversion descriptions and parameters can be defined within this part of ISO/IEC 21000 by referencing appropriate ISO/IEC 21000-6 terms which specify the semantics of the conversion as well as its parameters. The conversion description tool as specified within subclause 5.5 provides a basic abstract type for a subset of types that can be used for defining conversions and permissions.

5.5.2 Syntax

```
<?xml version="1.0"?>
<!-- Digital Item Adaptation ISO/IEC 21000-7 Second Edition -->
<!-- Schema for Conversion Descriptions -->
<schema
    version="ISO/IEC 21000-7 2nd"
    id="ConvD-2nd.xsd"
    targetNamespace="urn:mpeg:mpeg21:2003:01-DIA-NS"
    xmlns="http://www.w3.org/2001/XMLSchema"
    xmlns:dia="urn:mpeg:mpeg21:2003:01-DIA-NS"
    elementFormDefault="qualified" attributeFormDefault="unqualified">

    <include schemaLocation="DIA-2nd.xsd"/>

  <!-- ################################################### -->
  <!-- Definition of the BaseParameterType                 -->
  <!-- ################################################### -->
```


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```
  <complexType name="BaseParameterType" abstract="true">
    <complexContent>
      <extension base="dia:DIABaseType">
        <attribute name="name" type="QName" use="required"/>
      </extension>
    </complexContent>
  </complexType>

  <!-- ########################################################## -->
  <!-- Definition of the ConstantType                             -->
  <!-- ########################################################## -->

  <complexType name="ConstantType">
    <complexContent>
      <extension base="dia:BaseParameterType">
        <sequence>
          <element name="Value" type="string"/>
        </sequence>
      </extension>
    </complexContent>
  </complexType>

  <!-- ################################################  -->
  <!--  Definition of ConversionDescriptionBaseType      -->
  <!-- ################################################  -->

  <complexType name="ConversionDescriptionBaseType" abstract="true">
   <complexContent>
    <extension base="dia:DIADescriptionType">
     <sequence>
      <element name="ConversionActUri">
       <complexType>
        <attribute name="uri" type="anyURI" use="required"/>
       </complexType>
      </element>
      <element name="Parameter" type="dia:BaseParameterType"
          minOccurs="0" maxOccurs="unbounded"/>
     </sequence>
    </extension>
   </complexContent>
  </complexType>

</schema>
```

5.5.3 Semantics

Semantics of the `BaseParameterType`:

Name	*Definition*
`BaseParameterType`	`BaseParameterType` extends `DIABaseType` and provides a base abstract type for a subset of types defined as part of the `BSDLinkType`.
`name`	Describes the qualified name of the parameter.

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Semantics of the `ConstantType`:

Name	*Definition*
`ConstantType`	Describes a particular type of parameter with a constant value. The type of the `Value` element is then a string.
`Value`	Describes the value of the parameter.

Semantics of the `IOPinRefType`:

Name	*Definition*
`IOPinRefType`	Describes a particular type of parameter with a variable value, which is the output of the steering description. The type of the `Value` element is then an `anyURI` identifying the relevant `IOPin` of the steering description. NOTE The use of `anyURI` instead of `IDREF` allows referencing an `IOPin` of a steering description provided in another XML document.
`Value`	Describes the value of the parameter.

Semantics of the `ConversionDescriptionBaseType`:

Name	*Definition*
`ConversionDescriptionBaseType`	`ConversionDescriptionBaseType` extends `DIADescriptionType` and provides a base abstract type for a subset of types that can be used as part of the `ConversionCapabilitiesType`, `ConversionLinkType`, `ConversionUriType` and `PermittedDiaChanges` to identify a conversion. A conversion is defined by the conversion act which references a specialized ISO/IEC 21000-6 term and its parameters.
`ConversionActUri`	Describes the conversion act using a reference to a specialized ISO/IEC 21000-6 term.
`uri`	Describes the reference to the specialized ISO/IEC 21000-6 term.
`Parameter`	Describes an input parameter to the conversion tool as defined by the specialized ISO/IEC 21000-6 term.

5.5.4 Example

EXAMPLE See subclause 6.5.29 Example 4, and subclause 14.6 for examples of conversion descriptions.

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6 Usage environment description tools

6.1 Introduction

This clause specifies tools for describing the usage environment. The usage environment includes the description of User characteristics, terminal capabilities, network characteristics and natural environment characteristics. These various properties of the usage environment can be used for Digital Item Adaptation.

To distinguish description tools that are intended to describe multiple entities from those that are intended to describe a single entity, the plural form of that entity is used in the naming of the tool. For instance, the `TerminalsType` as defined in subclause 6.5.2 is a tool that specifies the characteristics of multiple terminals, whereas the characteristics of a single terminal are specified by the `TerminalType` as defined in subclause 6.5.3. Such a design of the schema allows the semantics associated with the respective elements of the tools to be less ambiguous, but still provides sufficient flexibility to describe multiple entities. Readers should take note of this naming convention since it occurs in a number of places throughout this clause.

6.2 Schema wrapper

The syntax of description tools specified in this subclause is provided as a collection of schema components, consisting notably in type definitions and element declarations. In order to form a valid schema document, these schema components should be gathered in a schema document with the following declaration defining in particular the target namespace, the namespaces prefixes and the imported namespaces.

```
<?xml version="1.0"?>
<!-- Digital Item Adaptation ISO/IEC 21000-7 Second Edition -->
<!-- Schema for Usage Environment Description Tools -->
<schema
   version="ISO/IEC 21000-7 2nd"
   id="UED-2nd.xsd"
   targetNamespace="urn:mpeg:mpeg21:2003:01-DIA-NS"
   xmlns="http://www.w3.org/2001/XMLSchema"
   xmlns:dia="urn:mpeg:mpeg21:2003:01-DIA-NS"
   xmlns:mpeg7="urn:mpeg:mpeg7:schema:2001"
   elementFormDefault="qualified" attributeFormDefault="unqualified">

   <import namespace="urn:mpeg:mpeg7:schema:2001"
      schemaLocation="mpeg7-udp-2004.xsd"/>
   <include schemaLocation="DIA-2nd.xsd"/>
   <include schemaLocation="ConvD-2nd.xsd"/>
```

Additionally, the following line should be appended to the resulting schema document in order to obtain a well-formed XML document.

```
</schema>
```

6.3 Usage environment

6.3.1 Introduction

This subclause specifies a container for descriptions of various usage environment properties. The various properties of the usage environment are derived from the abstract `UsageEnvironmentPropertyBaseType`.

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6.3.2 Usage environment syntax

```
<!-- ################################################ -->
<!--  Definition of UsageEnvironment                  -->
<!-- ################################################ -->

<complexType name="UsageEnvironmentType">
   <complexContent>
      <extension base="dia:DIADescriptionType">
         <sequence>
            <element name="UsageEnvironmentProperty"
               type="dia:UsageEnvironmentPropertyBaseType"
               minOccurs="0" maxOccurs="unbounded"/>
         </sequence>
      </extension>
   </complexContent>
</complexType>

<complexType name="UsageEnvironmentPropertyBaseType" abstract="true">
   <complexContent>
      <extension base="dia:DIADescriptionType"/>
   </complexContent>
</complexType>
```

6.3.3 Usage environment semantics

Semantics of the `UsageEnvironmentType`:

Name	*Definition*
`UsageEnvironmentType`	Tool for describing the usage environment.
`UsageEnvironmentProperty`	Describes a property of the usage environment, such as User characteristics, or terminal capabilities, or network characteristics, or natural environment characteristics.

Semantics of the `UsageEnvironmentPropertyBaseType`:

Name	*Definition*
`UsageEnvironmentPropertyBaseType`	`UsageEnvironmentPropertyBaseType` extends `DIADescriptionType` and provides a base abstract type for types that describe different properties of the usage environment.

6.4 User characteristics

6.4.1 Introduction

This subclause specifies tools for describing various characteristics of Users, including general User information, usage preferences and usage history, presentation preferences, accessibility characteristics, mobility characteristics and destination.

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6.4.2 Users

6.4.2.1 Introduction

This subclause specifies the characteristics of multiple Users, where the characteristics of a single User are specified by the `User` element in the `UsersType`.

6.4.2.2 Users syntax

```
<!-- ################################################ -->
<!--  Definition of Users                             -->
<!-- ################################################ -->

<complexType name="UsersType">
   <complexContent>
      <extension base="dia:UsageEnvironmentPropertyBaseType">
         <sequence>
            <element name="User" type="dia:UserType"
               minOccurs="0" maxOccurs="unbounded"/>
         </sequence>
      </extension>
   </complexContent>
</complexType>
```

6.4.2.3 Users semantics

Semantics of the `UsersType`:

Name	*Definition*
`UsersType`	Tool for describing the characteristics of Users.
`User`	Describes a single User in terms of general User information, content preferences, presentation preferences, accessibility characteristics, mobility characteristics and destination.

6.4.3 User

6.4.3.1 Introduction

This subclause specifies the characteristics of a single User. Specific characteristics include general User information, usage preferences and history, presentation preferences, accessibility characteristics, mobility characteristics and destination.

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6.4.3.2 User syntax

```
<!-- ################################################ -->
<!--  Definition of User                              -->
<!-- ################################################ -->

<complexType name="UserType">
   <complexContent>
      <extension base="dia:DIABaseType">
         <sequence>
            <element name="UserCharacteristic"
               type="dia:UserCharacteristicBaseType"
               minOccurs="0" maxOccurs="unbounded"/>
         </sequence>
      </extension>
   </complexContent>
</complexType>

<complexType name="UserCharacteristicBaseType" abstract="true">
   <complexContent>
      <extension base="dia:DIABaseType"/>
   </complexContent>
</complexType>
```

6.4.3.3 User semantics

Semantics of the `UserType`:

Name	*Definition*
`UserType`	Tool for describing characteristics of a single User.
`UserCharacteristic`	Describes a characteristic of the User, which may be related to general User information, content preferences, presentation preferences, accessibility characteristics, mobility characteristics and destination.

Semantics of the `UserCharacteristicBaseType`:

Name	*Definition*
`UserCharacteristicBaseType`	`UserCharacteristicBaseType` extends `DIADescriptionType` and provides a base abstract type for a subset of types defined as part of the `UserType`.

6.4.4 UserInfo

6.4.4.1 Introduction

This subclause specifies general information about Users, such as name and contact information, where a User can be a person, a group of persons, or an organization.

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6.4.4.2 UserInfo syntax

```
<!-- ################################################ -->
<!--  Definition of UserInfo                          -->
<!-- ################################################ -->

<complexType name="UserInfoType">
   <complexContent>
      <extension base="dia:UserCharacteristicBaseType">
         <sequence>
            <element name="UserInfo" type="mpeg7:AgentType" minOccurs="0"/>
         </sequence>
      </extension>
   </complexContent>
</complexType>
```

6.4.4.3 UserInfo semantics

Semantics of the `UserInfoType`:

Name	*Definition*
`UserInfoType`	Tool for describing general information about a User.
`UserInfo`	Describes general characteristics of a User such as name and contact information. A User can be a person, a group of persons, or an organization. The syntax and semantics of `AgentType` is specified in ISO/IEC 15938-5.

6.4.4.4 UserInfo example

EXAMPLE The following example shows the use of `UserInfo` expressing characteristics of a User named John Doe.

```
<DIA>
   <Description xsi:type="UsageEnvironmentType">
      <UsageEnvironmentProperty xsi:type="UsersType">
         <User>
            <UserCharacteristic xsi:type="UserInfoType">
               <UserInfo xsi:type="mpeg7:PersonType">
                  <mpeg7:Name>
                     <mpeg7:GivenName>John</mpeg7:GivenName>
                     <mpeg7:FamilyName>Doe</mpeg7:FamilyName>
                  </mpeg7:Name>
               </UserInfo>
            </UserCharacteristic>
         </User>
      </UsageEnvironmentProperty>
   </Description>
</DIA>
```

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6.4.5 UsagePreferences

6.4.5.1 Introduction

This subclause specifies a tool for describing the usage preferences of a User related to the type and content of Digital Items. The `UsagePreferences` tool is essentially a container of various tools that directly describe the preferences of a User. Specifically, these include tools of preferences related to the creation of Digital Items (e.g., created when, where, by whom), preferences related to the classification of Digital Items (e.g., form, genre, languages), preferences related to the dissemination of Digital Items (e.g., format, location, disseminator), and preferences related to the type and content of summaries of Digital Items (e.g., duration of an audiovisual summary). The syntax and semantics of the `UserPreferencesType` is specified in Part 5 of ISO/IEC 15938.

6.4.5.2 UserPreferences syntax

```
<!-- ################################################ -->
<!--  Definition of UsagePreferences                  -->
<!-- ################################################ -->

<complexType name="UsagePreferencesType">
   <complexContent>
      <extension base="dia:UserCharacteristicBaseType">
         <sequence>
            <element name="UsagePreferences" type="mpeg7:UserPreferencesType"
               minOccurs="0" maxOccurs="unbounded"/>
         </sequence>
      </extension>
   </complexContent>
</complexType>
```

6.4.5.3 UsagePreferences semantics

Semantics of the `UsagePreferencesType`:

Name	*Definition*
`UsagePreferencesType`	Tool for describing the usage preferences of a User related to the type and content of Digital Items.
`UsagePreferences`	Describes usage preferences of a User related to the type and content of Digital Items. The syntax and semantics of `UserPreferencesType` is specified in ISO/IEC 15938-5.

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6.4.5.4 UsagePreferences example

EXAMPLE The below example expresses several preferred genres, namely sports, entertainment, and movies. Such information can be used, for example, by a service provider to personalize the set of Digital Items to be delivered to the User. It can also be used by an agent of the User to automatically filter Digital Items that are broadcast.

```
<DIA>
    <Description xsi:type="UsageEnvironmentType">
        <UsageEnvironmentProperty xsi:type="UsersType">
            <User>
                <UserCharacteristic xsi:type="UsagePreferencesType">
                    <UsagePreferences>
                        <mpeg7:FilteringAndSearchPreferences>
                            <mpeg7:ClassificationPreferences>
                                <mpeg7:Genre>
                                    <mpeg7:Name>Sports</mpeg7:Name>
                                </mpeg7:Genre>
                                <mpeg7:Genre>
                                    <mpeg7:Name>Entertainment</mpeg7:Name>
                                </mpeg7:Genre>
                                <mpeg7:Genre>
                                    <mpeg7:Name>Movies</mpeg7:Name>
                                </mpeg7:Genre>
                            </mpeg7:ClassificationPreferences>
                        </mpeg7:FilteringAndSearchPreferences>
                    </UsagePreferences>
                </UserCharacteristic>
            </User>
        </UsageEnvironmentProperty>
    </Description>
</DIA>
```

6.4.6 UsageHistory

6.4.6.1 Introduction

The `UsageHistory` tool describes the history of actions on Digital Items by a User, e.g., recording a video program or playing back a music piece. As such, it describes the preferences of a User indirectly. These preferences could then be used for the adaptation of Digital Items. The syntax and semantics of the `UsageHistoryType` is specified in Part 5 of ISO/IEC 15938.

6.4.6.2 UsageHistory syntax

```
<!-- ################################################ -->
<!--  Definition of UsageHistory                      -->
<!-- ################################################ -->

<complexType name="UsageHistoryType">
    <complexContent>
        <extension base="dia:UserCharacteristicBaseType">
            <sequence>
                <element name="UsageHistory" type="mpeg7:UsageHistoryType"
                    minOccurs="0" maxOccurs="unbounded"/>
            </sequence>
        </extension>
    </complexContent>
</complexType>
```

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6.4.6.3 UsageHistory semantics

Semantics of the `UsageHistoryType`:

Name	*Definition*
`UsageHistoryType`	Tool for describing the history of actions on Digital Items by a User.
`UsageHistory`	Describes the history of actions on Digital Items by a User. The syntax and semantics of `UsageHistoryType` is specified in ISO/IEC 15938-5.

6.4.6.4 UsageHistory example

EXAMPLE The example below expresses the consumption history of a User during a particular 6 hour time period (called `ObservationPeriod`). In particular, the User has played several items, each identified by a unique identifier. The identifier can be used to identify and/or locate the content descriptions corresponding to each item. The combined information can be used, for example, by a service provider or by a personal agent to infer the preferences of the User, and subsequently provide preferred Digital Items to the User.

```
<DIA>
    <Description xsi:type="UsageEnvironmentType">
        <UsageEnvironmentProperty xsi:type="UsersType">
            <User>
                <UserCharacteristic xsi:type="UsageHistoryType">
                    <UsageHistory>
                        <mpeg7:UserActionHistory>
                            <mpeg7:ObservationPeriod>
                                <mpeg7:TimePoint>
                                    2000-10-09T18:00-08:00
                                </mpeg7:TimePoint>
                                <mpeg7:Duration>PT6H</mpeg7:Duration>
                            </mpeg7:ObservationPeriod>
                            <mpeg7:UserActionList>
                                <mpeg7:ActionType>
                                    <mpeg7:Name>PlayStream</mpeg7:Name>
                                </mpeg7:ActionType>
                                <mpeg7:UserAction>
                                    <mpeg7:ProgramIdentifier>
                                        urn:mymedia:av:02-mnf-109
                                    </mpeg7:ProgramIdentifier>
                                </mpeg7:UserAction>
                                <mpeg7:UserAction>
                                    <mpeg7:ProgramIdentifier>
                                        urn:mymedia:av:14-znn-623
                                    </mpeg7:ProgramIdentifier>
                                </mpeg7:UserAction>
                                <mpeg7:UserAction>
                                    <mpeg7:ProgramIdentifier>
                                        urn:mymedia:av:73-mov-814
                                    </mpeg7:ProgramIdentifier>
                                </mpeg7:UserAction>
                            </mpeg7:UserActionList>
                        </mpeg7:UserActionHistory>
                    </UsageHistory>
                </UserCharacteristic>
            </User>
        </UsageEnvironmentProperty>
    </Description>
</DIA>
```


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6.4.7 AudioPresentationPreferences

6.4.7.1 Introduction

This subclause specifies the preferences of a User regarding the presentation or rendering or audio resources. Specifically, descriptions such as the preferred volume, frequency equalizer settings, and audible frequency ranges are specified. Such attributes may affect the way in which the delivered audio resource is encoded, e.g., allocating more bits to specific components in the given frequency range. Additionally, for limited capability devices that may not have equalization functionality, equalization may be performed prior to transmission given the designated preferences.

6.4.7.2 AudioPresentationPreferences syntax

```
<!-- ################################################ -->
<!--  Definition of AudioPresentationPreferences      -->
<!-- ################################################ -->

<complexType name="AudioPresentationPreferencesType">
   <complexContent>
      <extension base="dia:UserCharacteristicBaseType">
         <sequence>
            <element name="VolumeControl" type="mpeg7:zeroToOneType"
               minOccurs="0"/>
            <element name="FrequencyEqualizer"
               type="dia:FrequencyEqualizerType"
               minOccurs="0"/>
            <element name="AudibleFrequencyRange" minOccurs="0">
               <complexType>
                  <sequence>
                     <element name="StartFrequency" type="float"/>
                     <element name="EndFrequency" type="float"/>
                  </sequence>
               </complexType>
            </element>
            <element name="AudioOutputDevice" minOccurs="0">
               <simpleType>
                  <restriction base="string">
                     <enumeration value="Headphone"/>
                     <enumeration value="Loudspeaker"/>
                  </restriction>
               </simpleType>
            </element>
            <element name="BalancePreference" minOccurs="0">
               <simpleType>
                  <restriction base="float">
                     <minInclusive value="-10"/>
                     <maxInclusive value="10"/>
                  </restriction>
               </simpleType>
            </element>
            <element name="Soundfield" type="dia:SoundfieldType"
                     minOccurs="0"/>
            <element name="SoniferousSpeed" minOccurs="0">
               <simpleType>
                  <restriction base="float">
                     <minExclusive value="0"/>
                  </restriction>
               </simpleType>
            </element>
         </sequence>
      </extension>
```

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```
    </complexContent>
</complexType>

<simpleType name="FrequencyEqualizerType">
    <restriction>
        <simpleType>
            <list itemType="dia:FrequencyEqualizerBaseType"/>
        </simpleType>
        <length value="31"/>
    </restriction>
</simpleType>

<simpleType name="FrequencyEqualizerBaseType">
    <restriction base="float">
        <minInclusive value="-15"/>
        <maxInclusive value="15"/>
    </restriction>
</simpleType>

<complexType name="SoundfieldType">
    <complexContent>
        <extension base="dia:DIABaseType">
            <sequence>
                <element name="ImpulseResponse" type="dia:ImpulseResponseType"
                    minOccurs="0"/>
                <element name="PerceptualParameters"
                    type="dia:PerceptualParametersType" minOccurs="0"/>
            </sequence>
        </extension>
    </complexContent>
</complexType>

<complexType name="ImpulseResponseType">
    <complexContent>
        <extension base="dia:DIABaseType">
            <sequence>
                <element name="SamplingFrequency" type="mpeg7:nonNegativeReal"
                    minOccurs="0"/>
                <element name="BitsPerSample" type="nonNegativeInteger"
                    minOccurs="0"/>
                <element name="NumOfChannels" type="nonNegativeInteger"
                    minOccurs="0"/>
            </sequence>
            <attribute name="href" type="anyURI" use="optional"/>
        </extension>
    </complexContent>
</complexType>

<complexType name="PerceptualParametersType">
    <complexContent>
        <extension base="dia:DIABaseType">
            <sequence>
                <element name="SourcePresence" type="float" minOccurs="0"/>
                <element name="SourceWarmth" type="float" minOccurs="0"/>
                <element name="SourceBrilliance" type="float" minOccurs="0"/>
                <element name="RoomPresence" type="float" minOccurs="0"/>
                <element name="RunningReverberance" type="float" minOccurs="0"/>
                <element name="Envelopment" type="float" minOccurs="0"/>
                <element name="LateReverberance" type="float" minOccurs="0"/>
                <element name="Heavyness" type="float" minOccurs="0"/>
                <element name="Liveness" type="float" minOccurs="0"/>
                <element name="RefDistance" type="float" minOccurs="0"/>
```


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```
            <element name="FreqLow" type="float" minOccurs="0"/>
            <element name="FreqHigh" type="float" minOccurs="0"/>
            <element name="TimeLimit1" type="float" minOccurs="0"/>
            <element name="TimeLimit2" type="float" minOccurs="0"/>
            <element name="TimeLimit3" type="float" minOccurs="0"/>
         </sequence>
      </extension>
   </complexContent>
</complexType>
```

6.4.7.3 AudioPresentationPreferences semantics

Semantics of the `AudioPresentationPreferencesType`:

Name	*Definition*
`AudioPresentationPreferencesType`	Tool for describing the audio presentation preference of a User.
`VolumeControl`	Describes the preference of a User for the volume of audio. The `VolumeControl` is described on a normalized scale from 0.0 to 1.0, where 0.0 is mute and 1.0 is the maximum volume.
`FrequencyEqualizer`	Describes the preference of a User for a specific equalizing scheme in terms of attenuation values.
`AudibleFrequencyRange`	Describes the preference of a User for a specific frequency range.
`StartFrequency`	Describes the start frequency of `AudibleFrequencyRange` in Hz.
`EndFrequency`	Describes the end frequency of `AudibleFrequencyRange` in Hz.
`AudioOutputDevice`	Describes the preference of a User for a particular audio output device, including “headphone” and “loudspeaker”.
`BalancePreference`	Describes the preference of a User for a specific balance range. The left and right level value is given in range from –10 to 10.
`Soundfield`	Describes the preference of a User for a specific soundfield in terms of room impulse response and perceptual parameters.
`SoniferousSpeed`	Describes the preference of a User for the playback speed of audio. It is specified as a ratio, where 1 indicates the original speed; values other than 1 indicate multiplicative time-scaling by the given ratio (i.e., 0.5 specifies twice as fast and 2.0 indicates half the original speed).

Semantics of the `FrequencyEqualizerType`:

Name	*Definition*
`FrequencyEqualizerType`	Tool for describing the preference of a User for a specific equalizing scheme in terms of attenuation values for the ISO 1/3 octave 31 center frequencies (20, 25, 31.5, 40, 50, 63, 80, 100, 125, 160, 200, 250, 315, 400, 500, 630, 800, 1000, 1250, 1600, 2000, 2500, 3150, 4000, 5000, 6300, 8000, 10000, 12500, 16000, 20000). The attenuation or amplification of a center frequency is in the range [–15,15] dB.

Semantics of the `FrequencyEqualizerBaseType`:

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Name	*Definition*
FrequencyEqualizerBaseType	UsageEnvironmentPropertyBaseType extends float to limit the values of a floating-point value in the range [-15,15].

Semantics of the SoundfieldType:

Name	*Definition*
SoundfieldType	Tool for describing the preference of a User for a specific soundfield in terms of room impulse response and perceptual parameters.
ImpulseResponse	Describes the preference of a User for a specific soundfield as an impulse response.
PerceptualParameters	Describes the preference of a User for a specific sound field as perceptual parameters. The parameters are identical to the PerceptualParameters node defined in ISO/IEC 14496-1.

Semantics of the ImpulseResponseType:

Name	*Definition*
ImpulseResponseType	Tool for describing the preference of a User for a specific soundfield as an impulse response.
SamplingFrequency	Describes the preferred sampling frequency in units of Hz.
BitsPerSample	Describes the preferred bits per sample.
NumOfChannels	Describes the preferred number of channels of a room impulse response.
href	Indicates a URI identifying the impulse response of the room.

Semantics of the PerceptualParametersType:

Name	*Definition*
PerceptualParametersType	Tool for describing the preference of a User for a specific sound field as perceptual parameters. The parameters are identical to the PerceptualParameters node defined in ISO/IEC 14496-1.
SourcePresence	Describes the energy of the direct sound and early room effect in dB.
SourceWarmth	Describes the relative early energy at low frequency in dB.
SourceBrilliance	Describes the relative early energy at high frequency in dB.
RoomPresence	Describes the energy of the late room effect in dB.
RunningReverberance	Describes the relative early decay time in milliseconds.
Envelopment	Describes the energy of early room effect relative to direct sound in dB.

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Name	*Definition*
`LateReverberance`	Describes the late decay time in milliseconds.
`Heavyness`	Describes the relative decay time in milliseconds at low frequency.
`Liveness`	Describes the relative decay time in milliseconds at high frequency.
`RefDistance`	Describes the reference distance in meters at which the perceptual parameters are defined.
`FreqLow`	Describes the limit of low frequency in Hz as shown in Figure 4.
`FreqHigh`	Describes the limit of high frequency in Hz as shown in Figure 4.
`TimeLimit1`	Describes the temporal limit 1 (l_1) in milliseconds as shown in Figure 4.
`TimeLimit2`	Describes the temporal limit 2 (l_2) in milliseconds as shown in Figure 4.
`TimeLimit3`	Describes the temporal limit 3 (l_3) in milliseconds as shown in Figure 4.

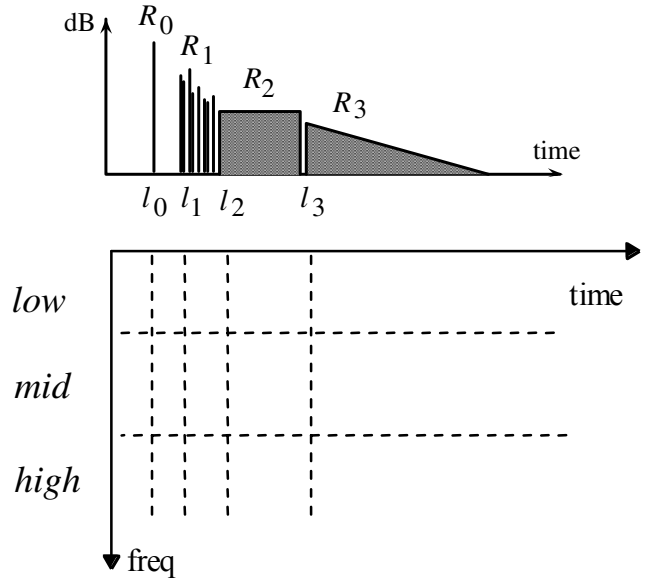

Figure 4 — Generic reverberation response model, where R0 represents the direct sound, R1 the directional early reflections, R2 the diffuse reflections, and R3 the exponentially decaying, diffuse late reverberation.

6.4.7.4 AudioPresentationPreferences example

EXAMPLE The following description elements represent the audio related preferences of the User. They can be used either by the server or the terminal to adapt the presentation to the preferences of the User.

`VolumeControl`**:** In the example below, the User has the preference to hear music very loud. As a result, 0.85 is designated. The adaptation engine may scale the audio signal to match this preference.

`FrequencyEqualizer`**:** This information represents the preference of a User to specific frequencies. This information consists of a set of frequency bands and its associated of attenuation values for the 31 ISO center frequencies. When an audio terminal does not have the capability of an equalizer, the adaptation engine may carry out this function in order to

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deliver the User the expected quality. This information may be used for the audio encoding process on the basis of the human frequency masking phenomena for efficient bit allocation. In the example below, the first and the second value of `Period` specify a frequency range, i.e., the start and the end frequency values of a frequency band and the following frequency the values represent the associated User equalizer preference values. The User preference value can be controlled in range [-15 dB,15 dB] period. The adaptation engine can process an equalizer function on the basis of this information and send the resulting audio signal to the terminal.

`AudibleFrequencyRange`**:** This information represents the preferred audible frequency range in Hz. This description can help an audio resource adaptation engine provide an improved quality of audio by assigning more bits to the components within the specified frequency range when she or he is assigned a fixed network bandwidth. The adaptation engine may send the audio signal only within the described frequency range reducing the network bandwidth or adding additional information of other modality such as text, image, video, etc for the remaining bandwidth. In the example below, the person's preferred an audible frequency range is from 20Hz to 20kHz.

`Soundfield`: The information represents the preference of a User for a specific soundfield. This information consists of the URI and its associated parameters to designate a room impulse response. In addition this information can be described as perceptual parameters to represent the preference to a particular soundfield. When an audio terminal does not have the capability of the soundfield generation; the adaptation engine may carry out this function in order to deliver more realistic sound. As an example, the adaptation engine can process its soundfield function convolving input audio resource with impulse response signal in the remote storage on the basis of this information.

`SoniferousSpeed`**:** It is usually very difficult for User's with an auditory impairment to listen to fast speech. This is true not only for User's with an auditory impairment, but also for User's without an impairment, e.g., a User who is studying a foreign language. Also, in Karaoke, User's may want to sing to a faster than normal rhythm or look like rapper by slight slower rhythm. In TTS (Text-To-Speech), the speed of story telling synthesis is important depending on a User's preference. The `SoniferousSpeed` is specified as a ratio, where 1 indicates the original speed; values other than 1 indicate multiplicative time-scaling by the given ratio (i.e., 0.5 specifies twice as fast and 2.0 indicates half the original speed). In the example below, the soniferous speed preference is indicated as twice as fast.

```
<DIA>
    <Description xsi:type="UsageEnvironmentType">
        <UsageEnvironmentProperty xsi:type="UsersType">
            <User>
                <UserCharacteristic xsi:type="AudioPresentationPreferencesType">
                    <VolumeControl>0.85</VolumeControl>
                    <FrequencyEqualizer>
                        -10 -10 -10 -10 -10 -10 -10 -10 -10
                        -10 -10  0    0   0   0  10  10  10  10
                        -10 -10 -10 -10 -10 -10 -10 -10 -10 -10
                    </FrequencyEqualizer>
                    <AudibleFrequencyRange>
                        <StartFrequency>20</StartFrequency>
                        <EndFrequency>20000</EndFrequency>
                    </AudibleFrequencyRange>
                    <Soundfield>
                        <ImpulseResponse
                            href="http://www.sac.or.kr/concertHall/hallImp.wav">
                            <SamplingFrequency>44100</SamplingFrequency>
                            <BitsPerSample>16</BitsPerSample>
                            <NumOfChannels>1</NumOfChannels>
                        </ImpulseResponse>
                    </Soundfield>
                    <SoniferousSpeed>0.5</SoniferousSpeed>
                </UserCharacteristic>
            </User>
        </UsageEnvironmentProperty>
    </Description>
</DIA>
```


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6.4.8 DisplayPresentationPreferences

6.4.8.1 Introduction

This subclause specifies a tool for describing the preferences of a User regarding the presentation or rendering of images and videos. This tool includes descriptions of preferences related to the color and the conversion of stereoscopic video. The `ColorTemperaturePreference`, the `BrightnessPreference`, the `SaturationPreference` and the `ContrastPreference` describe the preferences of a User regarding the color of the displayed visual contents in terms of color temperature, brightness, saturation and contrast, each of which is a usual color attribute of images. `StereoscopicVideoConversion` describes the preferences of a User related to the conversion of 2D video to 3D stereoscopic video and also the conversion of 3D stereoscopic video to 2D video.

6.4.8.2 DisplayPresentationPreferences syntax

```
<!-- ################################################ -->
<!--  Definition of DisplayPresentationPreferences    -->
<!-- ################################################ -->

<complexType name="DisplayPresentationPreferencesType">
   <complexContent>
      <extension base="dia:UserCharacteristicBaseType">
         <sequence>
            <element name="ColorTemperaturePreference"
               type="dia:ColorPreferenceType" minOccurs="0"/>
            <element name="BrightnessPreference" type="dia:ColorPreferenceType"
               minOccurs="0"/>
            <element name="SaturationPreference" type="dia:ColorPreferenceType"
               minOccurs="0"/>
            <element name="ContrastPreference" type="dia:ColorPreferenceType"
               minOccurs="0"/>
            <element name="StereoscopicVideoConversion"
               type="dia:StereoscopicVideoConversionType" minOccurs="0"/>
         </sequence>
      </extension>
   </complexContent>
</complexType>
```

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6.4.8.3 DisplayPresentationPreferences semantics

Semantics of the `DisplayPresentationPreferencesType`:

Name	*Definition*
`DisplayPresentationPreferencesType`	Tool that describes the display presentation preferences of a User.
`ColorTemperaturePreference`	Describes the color temperature that a User prefers. The color temperature is defined as the correlated color temperature of estimated illumination of the image to be displayed.
`BrightnessPreference`	Describes the brightness that a User prefers. The brightness is defined as an attribute of a visual sensation according to which an area appears to emit more or less light.
`SaturationPreference`	Describes the saturation that a User prefers. The saturation is defined as the colorfulness of an area judged in proportion to its brightness.
`ContrastPreference`	Describes the contrast that a User prefers. The contrast is defined to be the ratio of luminance between the lightest and darkest elements of a scene.
`StereoscopicVideoConversion`	Describes the preferred parameters of a User for stereoscopic video conversion.

6.4.9 ColorPreference

6.4.9.1 Introduction

The `ColorPreferenceType` is a tool that describes preferences related to color attributes. This subclause specifies `ColorPreferenceType`, which is used as a type definition for `ColorTemperaturePreference`, `BrightnessPreference`, `SaturationPreference` and `ContrastPreference`. Each of these elements that reference `ColorPreferenceType` include a pair of color attribute values (`PreferredValue`, `ReferenceValue`) that guide how the color attribute of a displayed image should be controlled so that the perceived color conforms to the preference of a User. The definition of the attribute value depends on the color attribute to which the preference description is related.

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6.4.9.2 ColorPreference syntax

```
<!-- ################################################ -->
<!--  Definition of ColorPreference                   -->
<!-- ################################################ -->

<complexType name="ColorPreferenceType">
   <complexContent>
      <extension base="dia:DIABaseType">
         <sequence>
            <element name="BinNumber" type="mpeg7:unsigned12"/>
            <element name="Value" minOccurs="0" maxOccurs="unbounded">
               <complexType>
                  <sequence>
                     <element name="PreferredValue" type="mpeg7:unsigned12"/>
                     <element name="ReferenceValue" type="mpeg7:unsigned12"/>
                  </sequence>
               </complexType>
            </element>
         </sequence>
      </extension>
   </complexContent>
</complexType>
```

6.4.9.3 ColorPreference semantics

Semantics of the `ColorPreferenceType`:

Name	*Definition*
`ColorPreferenceType`	Tool that describes the color preferences of a User when viewing visual resources. The color preference can be described in terms of color temperature, brightness, saturation and contrast.
`BinNumber`	Describes the quantization level that `PreferredValue` and `ReferenceValue` take.
`Value`	Indicates the minimal unit that describes the color preference of a User. It includes two subelements: `PreferredValue` and `ReferenceValue`. If `PreferredValue` is equal to v1, and `ReferenceValue` is equal to v2, it indicates that the User wants to convert an image of value v2 into an image of value v1 with respect to an attribute of color that ColorPreferenceType description specifies.
`PreferredValue`	Describes the value of a color attribute that a User prefers.
`ReferenceValue`	Describes the value of a color attribute in an image that is used as reference to express the `PreferredValue`. If `ReferenceValue` is equal to zero, it means that `ReferenceValue` is not considered.

Table 2 gives the value definition of `PreferredValue` and `ReferenceValue` for four attributes of color: color temperature, brightness, saturation and contrast of images and videos to be displayed.

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Table 2 — Definition of `PreferredValue` and `ReferenceValue` for each feature.

Attribute Name	Value Type	Value Definition	Value Range, Number of Bins, Quantization Type
Color Temperature	Color Temperature is specified in ISO/IEC 15938-3	Correlated color temperature of estimated illumination of the image to be displayed	The range [1667, 25000] is quantized into 2^8 bins in a non-uniform way as specified in ISO/IEC 15938-3
Brightness	Y-value in the YCbCr* color space	Mean value of Y-values of all pixels in the image to be displayed	The range [0,1] is uniformly quantized. Number of bins $\leq 2^{12}$.
Saturation	S-value in the HSV* color space	Mean value of S-values of all pixels in the image to be displayed	The range [0,1] is uniformly quantized. Number of bins $\leq 2^{12}$.
Contrast	Y-value in the YCbCr* color space	Standard deviation of Y-values of all pixels in the image to be displayed	The range [0,1] is uniformly quantized. Number of bins $\leq 2^{12}$.

* The color spaces YCbCr and HSV are specified in ISO/IEC 15938-3. The standard expressions of Y value and S value are also specified there.

6.4.9.4 ColorPreferences example

EXAMPLE `ColorPreference` allows multiple occurrences of the pair (`PreferredValue`, `ReferenceValue`), so that the pairs can be used to find an optimal mapping of color attributes, for example, through selection among available mapping functions or interpolation by using the pairs as poles. Based on the obtained mapping strategy, an application may convert images so that the resulting images satisfy the User preference for color. The following example shows the use of the `DisplayPresentationPreferences` description tool to express color preference of the User.

```
<DIA>
    <Description xsi:type="UsageEnvironmentType">
        <UsageEnvironmentProperty xsi:type="UsersType">
            <User>
                <UserCharacteristic xsi:type="DisplayPresentationPreferencesType">
                    <ColorTemperaturePreference>
                        <BinNumber>255</BinNumber>
                        <Value>
                            <PreferredValue>110</PreferredValue>
                            <ReferenceValue>127</ReferenceValue>
                        </Value>
                        <Value>
                            <PreferredValue>156</PreferredValue>
                            <ReferenceValue>151</ReferenceValue>
                        </Value>
                        <Value>
                            <PreferredValue>200</PreferredValue>
                            <ReferenceValue>192</ReferenceValue>
                        </Value>
                    </ColorTemperaturePreference>
                    <BrightnessPreference>
                        <BinNumber>255</BinNumber>
                        <Value>
                            <PreferredValue>138</PreferredValue>
                            <ReferenceValue>103</ReferenceValue>
                        </Value>
                        <Value>
                            <PreferredValue>152</PreferredValue>
```


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```
                        <ReferenceValue>150</ReferenceValue>
                    </Value>
                </BrightnessPreference>
                <SaturationPreference>
                    <BinNumber>255</BinNumber>
                    <Value>
                        <PreferredValue>94</PreferredValue>
                        <ReferenceValue>80</ReferenceValue>
                    </Value>
                </SaturationPreference>
                <ContrastPreference>
                    <BinNumber>255</BinNumber>
                    <Value>
                        <PreferredValue>80</PreferredValue>
                        <ReferenceValue>70</ReferenceValue>
                    </Value>
                </ContrastPreference>
            </UserCharacteristic>
        </User>
    </UsageEnvironmentProperty>
</Description>
</DIA>
```

6.4.10 StereoscopicVideoConversion

6.4.10.1 Introduction

This subclause specifies User preferences related to stereoscopic video conversion. Specifically, preferences of a User related to the conversion of 2D video to 3D stereoscopic video and also the conversion of 3D stereoscopic video to 2D video are specified.

6.4.10.2 StereoscopicVideoConversion syntax

```
<!-- ################################################ -->
<!--  Definition of StereoscopicVideoConversion       -->
<!-- ################################################ -->

<complexType name="StereoscopicVideoConversionType">
    <complexContent>
        <extension base="dia:DIABaseType">
            <sequence>
                <element name="From2DTo3DStereoscopic" minOccurs="0">
                    <complexType>
                        <sequence>
                            <element name="ParallaxType">
                                <simpleType>
                                    <restriction base="string">
                                        <enumeration value="Positive"/>
                                        <enumeration value="Negative"/>
                                    </restriction>
                                </simpleType>
                            </element>
                            <element name="DepthRange" type="mpeg7:zeroToOneType"/>
                            <element name="MaxDelayedFrame" type="nonNegativeInteger"
                                minOccurs="0"/>
                        </sequence>
                    </complexType>
                </element>
                <element name="From3DStereoscopicTo2D" minOccurs="0">
```

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```
                <complexType>
                   <sequence>
                      <element name="LeftRightInterVideo">
                         <simpleType>
                            <restriction base="string">
                               <enumeration value="Left"/>
                               <enumeration value="Right"/>
                               <enumeration value="Intermediate"/>
                            </restriction>
                         </simpleType>
                      </element>
                   </sequence>
                </complexType>
             </element>
          </sequence>
       </extension>
    </complexContent>
</complexType>
```

6.4.10.3 StereoscopicVideoConversion semantics

Semantics of the `StereoscopicVideoConversionType`:

Name	*Definition*
`StereoscopicVideoConversionType`	Tool that describes a User's preference for stereoscopic video conversion.
`From2Dto3DStereoscopic`	Describes parameters to perform 2D to 3D stereoscopic video conversion.
`ParallaxType`	Describes the type of parallax including negative and positive parallaxes.
`DepthRange`	Describes the range of 3D depth perceived by the User. The range is the distance between monitor screen and objects in 3D. Its value is varied at [0.0,1.0], where 0.0 and 1.0 indicate the lowest and highest of the depth, respectively.
`MaxDelayedFrame`	Describes the maximum interval of a delayed frame.
`From3DStereoscopicTo2D`	Describes parameters to perform 3D stereoscopic to 2D video conversion.
`LeftRightInterVideo`	Describes the video between the left and right video of the stereoscopic video that is preferred by the User when converting 3D stereoscopic video into 2D video.

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6.4.10.4 StereoscopicVideoConversion example

EXAMPLE The following example shows the use of the `StereoscopicVideoConversionType` description tool.

```
<DIA>
    <Description xsi:type="UsageEnvironmentType">
        <UsageEnvironmentProperty xsi:type="UsersType">
            <User>
                <UserCharacteristic xsi:type="DisplayPresentationPreferencesType">
                    <StereoscopicVideoConversion>
                        <From2DTo3DStereoscopic>
                            <ParallaxType>Positive</ParallaxType>
                            <DepthRange>0.7</DepthRange>
                            <MaxDelayedFrame>3</MaxDelayedFrame>
                        </From2DTo3DStereoscopic>
                        <From3DStereoscopicTo2D>
                            <LeftRightInterVideo>Right</LeftRightInterVideo>
                        </From3DStereoscopicTo2D>
                    </StereoscopicVideoConversion>
                </UserCharacteristic>
            </User>
        </UsageEnvironmentProperty>
    </Description>
</DIA>
```

6.4.11 GraphicsPresentationPreferences

6.4.11.1 Introduction

This subclause specifies presentation preferences related to graphics media. Attributes related to the User's preferred emphasis of geometry, texture and animation are described. In constrained resource environments, a suitable trade-off considering such preferences could be determined considering the available network bandwidth or computational resources.

6.4.11.2 GraphicsPresentationPreferences syntax

```
<!-- ################################################ -->
<!--  Definition of GraphicsPresentationPreferencesType  -->
<!-- ################################################ -->

<complexType name="GraphicsPresentationPreferencesType">
    <complexContent>
        <extension base="dia:UserCharacteristicBaseType">
            <sequence>
                <element name="GeometryEmphasis" type="mpeg7:zeroToOneType"
                    minOccurs="0"/>
                <element name="TextureEmphasis" type="mpeg7:zeroToOneType"
                    minOccurs="0"/>
                <element name="AnimationEmphasis" type="mpeg7:zeroToOneType"
                    minOccurs="0"/>
            </sequence>
        </extension>
    </complexContent>
</complexType>
```

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6.4.11.3 GraphicsPresentationPreferences semantics

Semantics of `GraphicsPresentationPreferencesType`:

Name	*Definition*
`GraphicsPresentationPreferenceType`	Tool for describing the graphics presentation preferences of a User.
`GeometryEmphasis`	Describes the emphasis that a User prefers regarding the degradation of geometry for graphics. This emphasis is described with a float between 0 (maximum degradation preferred) and 1 (no degradation preferred).
`TextureEmphasis`	Describes the emphasis that a User prefers regarding the degradation of the texture for graphics. This emphasis is described with a float between 0 (maximum degradation preferred) and 1 (no degradation preferred).
`AnimationEmphasis`	Describes the emphasis that a User prefers regarding the degradation of the animation for graphics. This emphasis is described with a float between 0 (maximum degradation preferred) and 1 (no degradation preferred).

6.4.11.4 GraphicsPresentationPreferences example

EXAMPLE The example below shows an instance example of the emphasis based graphics preference description. The `GeometryEmphasis`, `AnimationEmphasis` and `TextureEmphasis` can be input by the User using a graphics valuator interface. With this example, the adaptation engine does not degrade the geometry component. For the texture and animation components, the adaptation engine uses its own interpretation for the emphasis values for the adaptation.

```
<DIA>
    <Description xsi:type="UsageEnvironmentType">
        <UsageEnvironmentProperty xsi:type="UsersType">
            <User>
                <UserCharacteristic xsi:type="GraphicsPresentationPreferencesType">
            <GeometryEmphasis>1.0</GeometryEmphasis>
                    <TextureEmphasis>0.5</TextureEmphasis>
                    <AnimationEmphasis>0.5</AnimationEmphasis>
                </UserCharacteristic>
            </User>
        </UsageEnvironmentProperty>
    </Description>
</DIA>
```

6.4.12 ConversionPreference

6.4.12.1 Introduction

In the resource adaptation process, various types of conversions may be carried out when a terminal or network cannot support the consumption or transport of a particular modality or format. For each resource, there may be many conversion possibilities. Given that a User will have preference for certain modalities or formats over others, the role of the `ConversionPreference` tool is to enable Users to specify these preferences to guide the conversion of resources.

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Similarly to `PresentationPriorityPreference`, the User has two ways for identifying resources. The general way is applied to all resources of a certain original modality or format, and the specific way is applied to the specific resources in which the User is interested.

User preference for a conversion is divided into two levels, qualitative and quantitative. First, a User can specify the relative *orders* for possible conversions of each original modality or format. The orders help an adaptation engine find the destination modality or format when the original one needs to be converted under a given constraint. Second, a User can further specify the numeric *weights* for conversions, which can be considered as a User's QoS preferences on the conversion of one modality or format to another.

6.4.12.2 ConversionPreference Syntax

```
<!-- ################################################ -->
<!--    Definition of ConversionPreference            -->
<!-- ################################################ -->

<complexType name="ConversionPreferenceType">
   <complexContent>
      <extension base="dia:UserCharacteristicBaseType">
         <sequence>
            <element name="GeneralResourceConversions"
               type="dia:ResourceConversionType" minOccurs="0"/>
            <element name="SpecificResourceConversions"
               type="dia:SpecificResourceConversionsType" minOccurs="0"/>
         </sequence>
      </extension>
   </complexContent>
</complexType>

<complexType name="ResourceConversionType">
   <complexContent>
      <extension base="dia:DIABaseType">
         <sequence>
            <element name="Conversion" type="dia:ConversionType" minOccurs="0"
               maxOccurs="unbounded"/>
         </sequence>
      </extension>
   </complexContent>
</complexType>

<complexType name="ConversionType">
   <complexContent>
      <extension base="dia:DIABaseType">
         <sequence>
            <element name="From" type="mpeg7:ControlledTermUseType"
               minOccurs="0"/>
            <element name="To" type="mpeg7:ControlledTermUseType"/>
         </sequence>
         <attribute name="order" type="nonNegativeInteger" use="required"/>
         <attribute name="weight" type="mpeg7:nonNegativeReal" use="optional"
            default="1.0"/>
      </extension>
   </complexContent>
</complexType>

<complexType name="SpecificResourceConversionsType">
   <complexContent>
      <extension base="dia:DIABaseType">
         <sequence>
            <element name="Object" minOccurs="0" maxOccurs="unbounded">
```

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```
                <complexType>
                   <complexContent>
                      <extension base="dia:ResourceConversionType">
                         <attribute name="target" type="anyURI"
                            use="required"/>
                      </extension>
                   </complexContent>
                </complexType>
             </element>
          </sequence>
       </extension>
    </complexContent>
</complexType>
```

6.4.12.3 ConversionPreference semantics

Semantics of `ConversionPreferenceType`:

Name	*Definition*
`ConversionPreferenceType`	Tool for describing the conversion choices for different resources.
`GeneralResourceConversions`	Describes the conversion choices for resources in general way. All resources of the same original modality or format bear the same rule to be converted.
`SpecificResourceConversions`	Describes the conversion choices for specific resources known by some priori knowledge, e.g., highlight/summary.

Semantics of `ResourceConversionType`:

Name	*Definition*
`ResourceConversionType`	Tool for describing the conversion choices.
`Conversion`	Describes a conversion.

Semantics of `ConversionType`:

Name	*Definition*
`ConversionType`	Tool for describing the choices for a conversion.
`From`	Describes the original modality or format of a resource. CS's that may be used for this purpose are the `ContentCS`, the `AudioCodingFormatCS` and the `VisualCodingFormatCS` defined in ISO/IEC 15938-5.
`To`	Describes the destination modality or format of a resource. CS's that may be used for this purpose are the `ContentCS`, the `AudioCodingFormatCS` and the `VisualCodingFormatCS` defined in ISO/IEC 15938-5.

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Name	*Definition*
order	Describes the order of the conversion corresponding to the original modality/format indicated by From and the destination modality/format indicated by To. The order represents the qualitative preference of the User on that conversion. Conversion of high order is carried out before conversion of low order. The smaller the value is, the higher the order is, except that when value is 0, the corresponding conversion is forbidden.
weight	Describes the weight of the conversion corresponding to the original modality/format indicated by From and the destination modality/format indicated by To. The weight represents the quantitative preference of the User on that conversion. The weight has the non-negative real type. Its default value is 1.0.

Semantics of SpecificResourceConversionsType:

Name	*Definition*
SpecificResourceConversionsType	Tool for describing the conversion choices for specific resources.
Object	Describes a specific object of a resource that may be converted. The object may be a whole resource (e.g., a video) or a segment of a resource (e.g., a segment of video).
target	Refers to the object of the resource.

6.4.12.4 ConversionPreference examples

EXAMPLE 1 In this first example the User wants to apply generally some conversion rules to video resources, where it is most desired that the videos be retained if possible (i.e., order of video-to-video is 1). However, if videos must be converted, they should be converted to audios first (order of video-to-audio is 2). If the resources again must be converted, it may ultimately be converted to image or text.

```
<DIA>
    <Description xsi:type="UsageEnvironmentType">
        <UsageEnvironmentProperty xsi:type="UsersType">
            <User>
                <UserCharacteristic xsi:type="ConversionPreferenceType">
                    <GeneralResourceConversions>
                        <Conversion order="1" weight="1.0">
                            <From href="urn:mpeg:mpeg7:cs:ContentCS:2001:4.2">
                                <mpeg7:Name>Video</mpeg7:Name>
                            </From>
                            <To href="urn:mpeg:mpeg7:cs:ContentCS:2001:4.2">
                                <mpeg7:Name>Video</mpeg7:Name>
                            </To>
                        </Conversion>
                        <Conversion order="3" weight="1.0">
                            <From href="urn:mpeg:mpeg7:cs:ContentCS:2001:4.2">
                                <mpeg7:Name>Video</mpeg7:Name>
                            </From>
                            <To href="urn:mpeg:mpeg7:cs:ContentCS:2001:4.1">
                                <mpeg7:Name>Image</mpeg7:Name>
                            </To>
                        </Conversion>
                        <Conversion order="2" weight="1.0">
                            <From href="urn:mpeg:mpeg7:cs:ContentCS:2001:4.2">
```

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```
                            <mpeg7:Name>Video</mpeg7:Name>
                        </From>
                        <To href="urn:mpeg:mpeg7:cs:ContentCS:2001:1">
                            <mpeg7:Name>Audio</mpeg7:Name>
                        </To>
                    </Conversion>
                    <Conversion order="4" weight="1.0">
                        <From href="urn:mpeg:mpeg7:cs:ContentCS:2001:4.2">
                            <mpeg7:Name>Video</mpeg7:Name>
                        </From>
                        <To href="urn:mpeg:mpeg7:cs:ContentCS:2001:5">
                            <mpeg7:Name>Text</mpeg7:Name>
                        </To>
                    </Conversion>
                </GeneralResourceConversions>
            </UserCharacteristic>
        </User>
    </UsageEnvironmentProperty>
</Description>
</DIA>
```

EXAMPLE 2 In this second example, the User is interested in a specific resource of video, where `SpecificResourceConversions` is used and the order of video-to-video conversion is given a value of 1. Moreover, in low-constraint conditions, the User prefers to retain the video modality more than usual, so he assigns a value of 1.5 to the weight of video-to-video. In the target address, IT1 is the ID of that video resource in the document named 'DI.xml'.

```
<DIA>
    <Description xsi:type="UsageEnvironmentType">
        <UsageEnvironmentProperty xsi:type="UsersType">
            <User>
                <UserCharacteristic xsi:type="ConversionPreferenceType">
                    <SpecificResourceConversions>
                        <Object target="http://myhost.org/DI.xml#IT1">
                            <Conversion order="1" weight="1.5">
                                <From
                                    href="urn:mpeg:mpeg7:cs:ContentCS:2001:4.2">
                                    <mpeg7:Name>Video</mpeg7:Name>
                                </From>
                                <To
                                    href="urn:mpeg:mpeg7:cs:ContentCS:2001:4.2">
                                    <mpeg7:Name>Video</mpeg7:Name>
                                </To>
                            </Conversion>
                            <Conversion order="2" weight="1.0">
                                <From
                                    href="urn:mpeg:mpeg7:cs:ContentCS:2001:4.2">
                                    <mpeg7:Name>Video</mpeg7:Name>
                                </From>
                                <To
                                    href="urn:mpeg:mpeg7:cs:ContentCS:2001:4.1">
                                    <mpeg7:Name>Image</mpeg7:Name>
                                </To>
                            </Conversion>
                            <Conversion order="3" weight="1.0">
                                <From
                                    href="urn:mpeg:mpeg7:cs:ContentCS:2001:4.2">
                                    <mpeg7:Name>Video</mpeg7:Name>
                                </From>
                                <To
                                    href="urn:mpeg:mpeg7:cs:ContentCS:2001:1">
                                    <mpeg7:Name>Audio</mpeg7:Name>
                                </To>
```


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```
                        </Conversion>
                        <Conversion order="4" weight="1.0">
                            <From
                                href="urn:mpeg:mpeg7:cs:ContentCS:2001:4.2">
                                <mpeg7:Name>Video</mpeg7:Name>
                            </From>
                            <To
                                href="urn:mpeg:mpeg7:cs:ContentCS:2001:5">
                                <mpeg7:Name>Text</mpeg7:Name>
                            </To>
                        </Conversion>
                    </Object>
                </SpecificResourceConversions>
            </UserCharacteristic>
        </User>
    </UsageEnvironmentProperty>
</Description>
</DIA>
```

6.4.13 PresentationPriorityPreference

6.4.13.1 Introduction

`PresentationPriority` is a tool to let the User have choices on the presentation qualities of different resources at the output of the content adaptation process. For this purpose, the User will give different priorities for different resources. Without this tool, the User has to accept any adaptation solution provided by the provider. There are two different ways for identifying the resources. The first is the general way in which the User identifies the resources based on their original modalities and genres. In this case, the User gives the same priority for all resources of certain modality or certain genre. The second is the specific way in which the User identifies some specific resources using some known URI. In this case, the User may have some priori knowledge of the resources, e.g., through a highlight/summary.

An example is when a User accesses a Miss World website and the User is interested in images. For this case, the User gives a high priority for image resources. The result is that images will be adapted with higher quality than usual (i.e., without having the User's priorities). Yet, other resources will be of course degraded because the total bandwidth constraint is likely fixed.

6.4.13.2 PresentationPriorityPreference syntax

```
<!-- ################################################ -->
<!--    Definition of PresentationPriorityPreference     -->
<!-- ################################################ -->

<complexType name="PresentationPriorityPreferenceType">
    <complexContent>
        <extension base="dia:UserCharacteristicBaseType">
            <sequence>
                <element name="GeneralResourcePriorities"
                    type="dia:GeneralResourcePrioritiesType" minOccurs="0"/>
                <element name="SpecificResourcePriorities"
                    type="dia:SpecificResourcePrioritiesType" minOccurs="0"/>
            </sequence>
        </extension>
    </complexContent>
</complexType>

<complexType name="GeneralResourcePrioritiesType">
    <complexContent>
        <extension base="dia:DIABaseType">
            <sequence>
                <element name="ModalityPriorities"
                    type="dia:ModalityPrioritiesType" minOccurs="0"/>
```

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```
            <element name="GenrePriorities" type="dia:GenrePrioritiesType"
               minOccurs="0"/>
         </sequence>
      </extension>
   </complexContent>
</complexType>

<complexType name="SpecificResourcePrioritiesType">
   <complexContent>
      <extension base="dia:DIABaseType">
         <sequence>
            <element name="Object" minOccurs="0" maxOccurs="unbounded">
               <complexType>
                  <attribute name="priorityLevel" type="mpeg7:nonNegativeReal"
                     use="optional" default="1.0"/>
                  <attribute name="target" type="anyURI" use="required"/>
               </complexType>
            </element>
         </sequence>
      </extension>
   </complexContent>
</complexType>

<complexType name="ModalityPrioritiesType">
   <complexContent>
      <extension base="dia:DIABaseType">
         <sequence>
            <element name="Modality" minOccurs="0" maxOccurs="unbounded">
               <complexType>
                  <complexContent>
                     <extension base="mpeg7:ControlledTermUseType">
                        <attribute name="priorityLevel"
                           type="mpeg7:nonNegativeReal" use="optional"
                           default="1.0"/>
                     </extension>
                  </complexContent>
               </complexType>
            </element>
         </sequence>
      </extension>
   </complexContent>
</complexType>

<complexType name="GenrePrioritiesType">
   <complexContent>
      <extension base="dia:DIABaseType">
         <sequence>
            <element name="Genre" minOccurs="0" maxOccurs="unbounded">
               <complexType>
                  <complexContent>
                     <extension base="mpeg7:ControlledTermUseType">
                        <attribute name="priorityLevel"
                           type="mpeg7:nonNegativeReal" use="optional"
                           default="1.0"/>
                     </extension>
                  </complexContent>
               </complexType>
            </element>
         </sequence>
      </extension>
   </complexContent>
</complexType>
```


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6.4.13.3 PresentationPriorityPreference semantics

Semantics of `PresentationPriorityPreferenceType`:

Name	*Definition*
`PresentationPriorityPreferenceType`	Tool for describing the presentation priorities for different resources. This tool allows the User to customize the presentation qualities of different resources.
`GeneralResourcePriorities`	Describes the presentation priorities for resources in a general way. In this case the User has some general knowledge of the content source, e.g., original modalities or genres.
`SpecificResourcePriorities`	Describes the presentation priorities for specific resources known by some priori knowledge, e.g., highlight/summary.

Semantics of `GeneralResourcePrioritiesType`:

Name	*Definition*
`GeneralResourcePrioritiesType`	Tool for describing the presentation priorities for resources in general way, based on their modalities and genres.
`ModalityPriorities`	Describes the presentation priorities for all resources of certain modalities.
`GenrePriorities`	Describes the presentation priorities for all resources of certain genres.

Semantics of `SpecificResourcePrioritiesType`:

Name	*Definition*
`SpecificResourcePrioritiesType`	Tool for describing the presentation priorities for specific resources.
`Object`	Describes a specific object of a resource. The object can be of different layers, e.g., a whole document, a video, a moving region in the video, etc.
`priorityLevel`	Specifies the value of priority for an object of a resource. The priorityLevel is of non-negative real type. The larger the value is, the higher the priority is; when the value is 0, the object is removed. The default value of priorityLevel is 1.0.
`target`	References to a specific object of interest of the resource.

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Semantics of `ModalityPrioritiesType`:

Name	*Definition*
`ModalityPrioritiesType`	Tool for describing the presentation priorities for resources of certain modalities.
`Modality`	Describes a certain modality. A CS that may be used for this purpose is the `ContentCS` defined in ISO/IEC 15938-5.

Semantics of `GenrePrioritiesType`:

Name	*Definition*
`GenrePrioritiesType`	Tool for describing the presentation priorities for resources of certain genres, regardless of their modalities.
`Genre`	Describes a certain genre. A CS that may be used for this purpose is the `GenreCS` defined in ISO/IEC 15938-5.

6.4.13.4 PresentationPriorityPreference examples

EXAMPLE 1 This example shows the presentation priority preference for general resources, where a User wishes to have high quality for video by assigning a priorityLevel of 1.5 to video resources. The User is also interested in Sports and gives priorityLevel of 1.6 to this genre. So, the resources of video modality and Sports genre, especially the Sport videos, should have better qualities after adaptation. Note, that the User already knows the default priorityLevel of resources is 1.0.

```
<DIA>
    <Description xsi:type="UsageEnvironmentType">
        <UsageEnvironmentProperty xsi:type="UsersType">
            <User>
                <UserCharacteristic xsi:type="PresentationPriorityPreferenceType">
                    <GeneralResourcePriorities>
                        <ModalityPriorities>
                            <Modality priorityLevel="1.5"
                                    href="urn:mpeg:mpeg7:cs:ContentCS:2001:4.2">
                                <mpeg7:Name>Video</mpeg7:Name>
                            </Modality>
                        </ModalityPriorities>
                        <GenrePriorities>
                            <Genre priorityLevel="1.6"
                                href="urn:mpeg:mpeg7:cs:GenreCS:2001:1.6">
                                <mpeg7:Name>Sports</mpeg7:Name>
                            </Genre>
                        </GenrePriorities>
                    </GeneralResourcePriorities>
                </UserCharacteristic>
            </User>
        </UsageEnvironmentProperty>
    </Description>
</DIA>
```


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EXAMPLE 2 This example shows the presentation priority preference for some specific resources. In this case the User has already a highlight of the web page, and is interested in item 1 and item 3 of the web page. Then, the User will select these items and give high priorityLevels, 1.6 and 1.5, for item 1 and item 3, respectively. The system may automatically insert the URIs of the specific resources into the description for the User.

```
<DIA>
    <Description xsi:type="UsageEnvironmentType">
        <UsageEnvironmentProperty xsi:type="UsersType">
            <User>
                <UserCharacteristic xsi:type="PresentationPriorityPreferenceType">
                    <SpecificResourcePriorities>
                        <Object priorityLevel="1.6"
                            target="http://myhost.org/DI.xml#IT1"/>
                        <Object priorityLevel="1.5"
                            target="http://myhost.org/DI.xml#IT3"/>
                    </SpecificResourcePriorities>
                </UserCharacteristic>
            </User>
        </UsageEnvironmentProperty>
    </Description>
</DIA>
```

6.4.14 FocusOfAttention

6.4.14.1 Introduction

This subclause specifies the User's preferences related to multimedia segments. Specifically, the focus of attention in a given resource such as audio, visual, audio-visual and/or text contents.

Multimedia resources such as image and video can usually be adapted by a transcoding process accordingly to the network, terminal and/or User characteristics. Normally, transcoding of images or videos is done by varying spatial and/or temporal resolution of the contents regardless of a User's interest in the content. For example, a User may want to watch a particular player, i.e., region of interest (ROI), in the video of a basketball game. This ROI that is designated by the User is referred to as the focus of attention. Given metadata that specifies the focus of attention, adaptation can be better done in a more meaningful way. This description tools considers focus of attention based on specifying an ROI in audio-visual media, as well as focus of attention for text-based media.

With regards to audio-visual media, the User may express an ROI encompassing a semantic object in a video. This ROI can be described using description tools specified in ISO/IEC 15938-5, which can then be transmitted to a server from which the streaming video is originating. The server will parse the ROI description regarding the User's presentation preference on focus of attention in the resources. Then, the server may intelligently interpret the User's preferred focus of attention and perform semantic transcoding on the resource under service. So, essential information on resources such as audio, visual, audio-visual and/or texts can be presented to a particular User's presentation preferences on focus of attention in the resources for personalcasting applications. Since the description of an ROI is made using tools defined elsewhere, e.g., in ISO/IEC 15938-5, the FocusOfAttention tool defined in this specification only needs to reference the ROI description. This relationship is illustrated in Figure 5.

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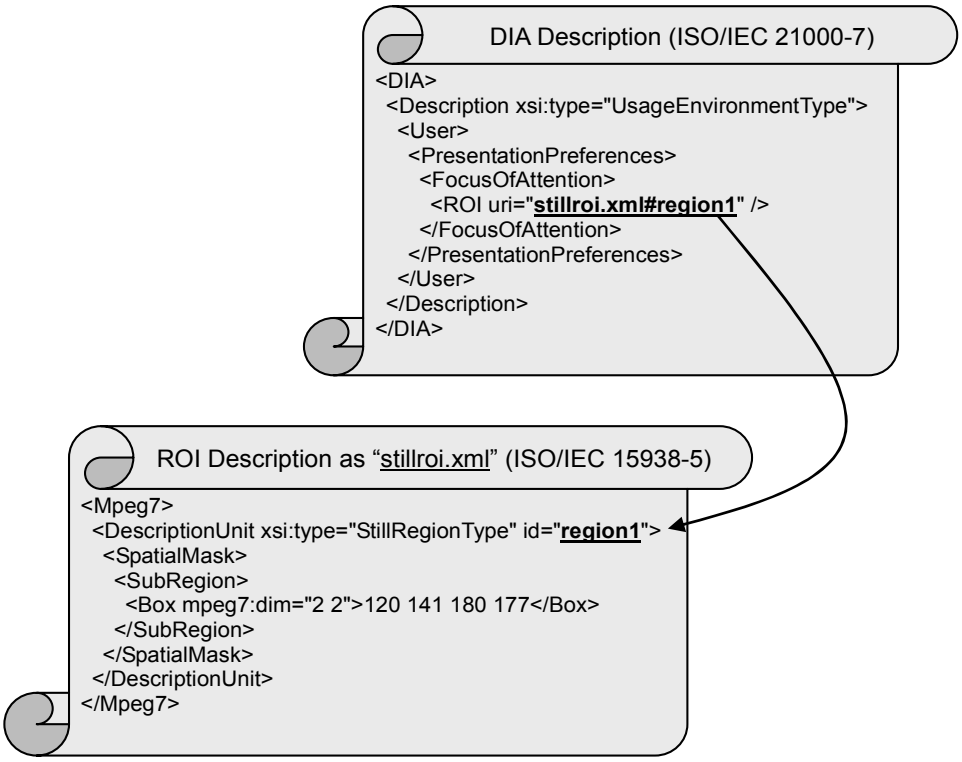

Figure 5 — Illustration of the link between the FocusOfAttention ROI and an external description of the ROI based on ISO/IEC 15938-5 description tools.

With regards to text-based media, the focus of attention is specified in terms of the User's preferred keywords, presentation speed, font types and sizes. As with audio-visual media, text can be summarized, e.g., based on a User's preferred keywords. When a User presents the preferred keyword(s), a server can adapt and deliver more meaningful and effective text information.

6.4.14.2 FocusOfAttention syntax

```
<!-- ################################################ -->
<!-- Definition of FocusOfAttentionType               -->
<!-- ################################################ -->

<complexType name="FocusOfAttentionType">
   <complexContent>
      <extension base="dia:UserCharacteristicBaseType">
         <choice minOccurs="0">
            <element name="ROI" minOccurs="0">
               <complexType>
                  <attribute name="uri" type="anyURI" use="required"/>
                  <attribute name="updateInterval" type="mpeg7:nonNegativeReal"
                     use="optional" default="0"/>
               </complexType>
            </element>
            <element name="TextFocusOfAttention"
               type="dia:TextFocusOfAttentionType" minOccurs="0"/>
            <element name="SceneObjectFocusOfAttention"
               type="mpeg7:MediaLocatorType" minOccurs="0"/>
         </choice>
      </extension>
   </complexContent>
</complexType>
<complexType name="TextFocusOfAttentionType">
```

--`,,```,,,,````-`-`,,`,,`,`,,`---

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```
    <complexContent>
        <extension base="dia:DIABaseType">
            <sequence>
                <element name="Keyword" minOccurs="0" maxOccurs="unbounded">
                    <complexType>
                        <simpleContent>
                            <extension base="mpeg7:TextualType">
                                <attribute name="preferenceValue"
                                    type="mpeg7:preferenceValueType"
                                    use="optional" default="10"/>
                            </extension>
                        </simpleContent>
                    </complexType>
                </element>
                <element name="Font" type="dia:FontType" minOccurs="0"/>
            </sequence>
            <attribute name="textPresentationSpeed" type="mpeg7:nonNegativeReal"
                use="optional"/>
        </extension>
    </complexContent>
</complexType>

<complexType name="FontType">
    <complexContent>
        <extension base="dia:DIABaseType">
            <attribute name="fontColor" type="token" use="optional"/>
            <attribute name="fontSize" type="positiveInteger" use="optional"/>
            <attribute name="fontType" type="token" use="optional"/>
        </extension>
    </complexContent>
</complexType>
```

6.4.14.3 FocusOfAttention semantics

Semantics of the `FocusOfAttentionType`:

Name	*Definition*
`FocusOFAttentionType`	Tool for describing the presentation preference of a User on parts of resources.
`ROI`	Describes a User's interest for an audio-visual segment, including a still region, moving region or video segment. The reference is made to a description of such a segment.
`uri`	Describe the URI in which a description of a the segment exists.
`updateInterval`	Describes a time interval in seconds for a region of interest to be updated. The default value is 0, which corresponds to a still frame or region.
`TextFocusOfAttention`	Designates the User's preferred keywords for which the relevant text is to be presented to a User.
`SceneObjectFocusOfAttention`	Designates an object of interest in a scene consisting of multiple resources (audio, text and/or visual objects). A scene object should uniquely be identified by `MediaLocatorType` which is specified in ISO/IEC 15938-5.

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Semantics of the `TextFocusOfAttentionType`:

Name	*Definition*
`TextFocusOfAttentionType`	Tool for describing the User's preferred keywords for which the relevant text is to be presented to a User.
`Keyword`	Describes a User's preferable words so that a provider (server) of resources in text can adapt the original text resources to appropriate amounts of relevant texts based on the keywords.
`Font`	Described the User's preference of font attributes for text to be presented.
`textPresentationSpeed`	Describes the User's preference for speed on text presentation. The speed of text presentation is defined as the average number of characters in second to be appeared on a display device.

Semantics of the `FontType`:

Name	*Definition*
`FontType`	Tool for describing the size, color and type of font.
`fontColor`	Describes the color of fonts for text.
`fontSize`	Describes the size of fonts for text.
`fontType`	Describes the type of fonts for text.

6.4.14.4 FocusOfAttention examples

EXAMPLE 1 The description example below (stillroi.xml) is based on description tools defined in the ISO/IEC 15938-5 specification and represents a User's ROI. It is expressed by the Box element with the size of (120 141 180 177) in which the first two numbers (120, 141) indicate the x- and y- coordinates for the top left corner point and the last two numbers (180, 177) for the bottom right corner points of a rectangular ROI. This ROI information can then be sent to a server where a transcoder adapts the original image resource according to the ROI. For example, the resolution of the original image can be reduced around the ROI to fit the display size of a User's terminal.

```
<Mpeg7>
    <DescriptionUnit xsi:type="StillRegionType" id="region1">
        <SpatialMask>
            <SubRegion>
                <Box mpeg7:dim="2 2">120 141 180 177</Box>
            </SubRegion>
        </SpatialMask>
    </DescriptionUnit>
</Mpeg7>
```

ROI for still region: In real time or non-real time, a User can designate the ROI of an image frame through a mouse pointer or with an eye-tracking software. By doing so, the description for the corresponding ROI can be generated based on ISO/IEC 15938-5 tools, e.g., StillRegionType as shown in the description example above. The example below presents the information of a User's ROI as part of the presentation preference tool. In this specification, FocusOfAttention references the actual ROI description. In the example below, the ROI refers to region1 in stillroi.xml.

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```
<DIA>
    <Description xsi:type="UsageEnvironmentType">
        <UsageEnvironmentProperty xsi:type="UsersType">
            <User>
                <UserCharacteristic xsi:type="FocusOfAttentionType">
                    <ROI uri="stillroi.xml#region1"/>
                </UserCharacteristic>
            </User>
        </UsageEnvironmentProperty>
    </Description>
</DIA>
```

ROI for moving region: A User can define a moving region in which a semantic object is located in the video content. The ROI for a moving region can be generated through a mouse pointer or with eye-tracking software. By doing so, the description for the corresponding spatio-temporal region can be generated periodically based with a specified time interval. The example below represents a User's ROI, where a still ROI description is generated and updates are made every 0.5 seconds. So, a periodic generation of a still ROI is used to describe a moving ROI description. As with the still ROI case, the actual ROI description is generated based on ISO/IEC 15938-5 tools.

```
<DIA>
    <Description xsi:type="UsageEnvironmentType">
        <UsageEnvironmentProperty xsi:type="UsersType">
            <User>
                <UserCharacteristic xsi:type="FocusOfAttentionType">
                    <ROI uri="stillroi.xml#region1" updateInterval="0.5"/>
                </UserCharacteristic>
            </User>
        </UsageEnvironmentProperty>
    </Description>
</DIA>
```

EXAMPLE 2 The following example illustrates the use of applying focus of attention for text. Mobile terminals usually have a wide range of different display sizes. The amount of text information presented on a screen depends on the font sizes of the text characters at a time instance. The User may want to display as many characters as possible on the screen at one time as long as the displayed characters are readable. Additionally, the font type can be a User preference on display. Also, a User wants to receive text data based on their interested topics or others. The following example shows a User's text presentation preferences with his/her preferred key words, text presentation speed, font size, font color and font type. With this description, a text streaming server is able to provide more focused text information for the User.

```
<DIA>
    <Description xsi:type="UsageEnvironmentType">
        <UsageEnvironmentProperty xsi:type="UsersType">
            <User>
                <UserCharacteristic xsi:type="FocusOfAttentionType">
                    <TextFocusOfAttention textPresentationSpeed="9">
                        <Keyword preferenceValue="50">ronaldo</Keyword>
                        <Keyword preferenceValue="20">kahn</Keyword>
                        <Keyword preferenceValue="20">brazil</Keyword>
                        <Font fontColor="black" fontSize="10" fontType="arial"/>
                    </TextFocusOfAttention>
                </UserCharacteristic>
            </User>
        </UsageEnvironmentProperty>
    </Description>
</DIA>
```

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6.4.15 AuditoryImpairment

6.4.15.1 Introduction

The `AuditoryImpariment` tool is used to describe the characteristics of a particular User's auditory deficiency. The description can be used by the audio resource adaptation engine to optimize the experience of audio contents for the User. The hearing threshold shift of a User is described. The description can be used to compensate the User's auditory impairment such as hearing loss during the adaptation. The tool is meant to be used in case of small hearing loss. For people with more than minimal impairments, gain changes to match the audiogram are normally not sufficient.

6.4.15.2 AuditoryImpairment syntax

```
<!-- ##########################################  -->
<!--  Definition of AuditoryImpairment          -->
<!-- ##########################################  -->

<complexType name="AuditoryImpairmentType">
   <complexContent>
      <extension base="dia:UserCharacteristicBaseType">
         <sequence>
            <element name="RightEar" type="dia:AudiogramType"/>
            <element name="LeftEar" type="dia:AudiogramType"/>
         </sequence>
      </extension>
   </complexContent>
</complexType>

<complexType name="AudiogramType">
   <complexContent>
      <extension base="dia:DIABaseType">
         <sequence>
            <element name="Freq125Hz" type="float" minOccurs="0"/>
            <element name="Freq250Hz" type="float"/>
            <element name="Freq500Hz" type="float"/>
            <element name="Freq1000Hz" type="float"/>
            <element name="Freq1500Hz" type="float" minOccurs="0"/>
            <element name="Freq2000Hz" type="float"/>
            <element name="Freq3000Hz" type="float" minOccurs="0"/>
            <element name="Freq4000Hz" type="float"/>
            <element name="Freq6000Hz" type="float" minOccurs="0"/>
            <element name="Freq8000Hz" type="float"/>
         </sequence>
      </extension>
   </complexContent>
</complexType>
```

6.4.15.3 AuditoryImpairment semantics

Semantics of `AuditoryImpairmentType`:

Name	*Definition*
`AuditoryImpairmentType`	Describes the impairment of a User's auditory system for the left and the right ear.
`RightEar`	Describes the impairment of the right ear.
`LeftEar`	Describes the impairment of the left ear.

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Semantics of `AuditoryImpairmentType`:

Name	*Definition*
`AudiogramType`	Describes the value for the hearing threshold shift measured as dB HL (hearing level in dB) for *N* Hz for one ear.
`FreqNHz`	Describes each element of the Audiogram and represents the threshold shift at the frequencies *N* = 125, 250, 500, 1000, 1500, 2000, 3000, 4000, 6000, 8000 Hz.

6.4.15.4 AuditoryImpairment example

EXAMPLE An example measurement of the audiogram of a User is provided in Figure 6. The description of these measurements can help an audio resource adaptation engine to provide an improved quality of audio by compensating the hearing loss in the left ear.

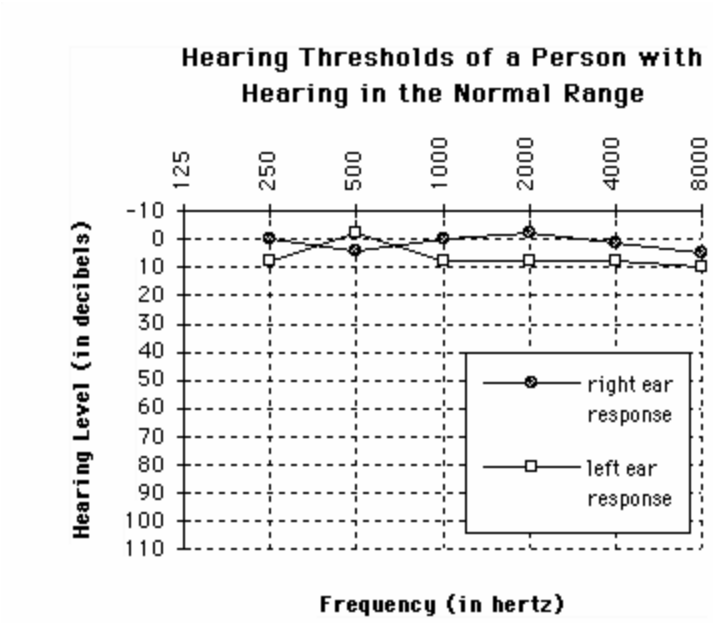

Figure 6 — Audiogram of a measurement of the auditory impairment

The description of the Audiogram in Figure 6 is provided below.

```
<DIA>
    <Description xsi:type="UsageEnvironmentType">
        <UsageEnvironmentProperty xsi:type="UsersType">
            <User>
                <UserCharacteristic xsi:type="AuditoryImpairmentType">
                    <RightEar>
                        <Freq250Hz>0.0</Freq250Hz>
                        <Freq500Hz>5.5</Freq500Hz>
                        <Freq1000Hz>-0.2</Freq1000Hz>
                        <Freq2000Hz>-2.0</Freq2000Hz>
                        <Freq4000Hz>1.5</Freq4000Hz>
                        <Freq8000Hz>5.5</Freq8000Hz>
                    </RightEar>
                    <LeftEar>
```

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```
                        <Freq250Hz>9.0</Freq250Hz>
                        <Freq500Hz>-1.5</Freq500Hz>
                        <Freq1000Hz>9.0</Freq1000Hz>
                        <Freq2000Hz>9.0</Freq2000Hz>
                        <Freq4000Hz>9.0</Freq4000Hz>
                        <Freq8000Hz>10.0</Freq8000Hz>
                    </LeftEar>
                </UserCharacteristic>
            </User>
        </UsageEnvironmentProperty>
    </Description>
</DIA>
```

6.4.16 VisualImpairment

6.4.16.1 Introduction

Visual Impairment covers a wide range of conditions. The various forms of visual impairment include difficulty to read the fine print, low vision that cannot be corrected by standard glasses, total blindness, color vision deficiency, i.e., the inability to recognize certain colors. The low vision conditions, due to their wide variety, are described by the User's symptoms, but the names of conditions are not described.

6.4.16.2 VisualImpairment syntax

```
<!-- ################################### -->
<!--  Definition of VisualImpairment     -->
<!-- ################################### -->

<complexType name="VisualImpairmentType">
    <complexContent>
        <extension base="dia:UserCharacteristicBaseType">
            <sequence>
                <element name="Blindness" minOccurs="0">
                    <complexType>
                        <attribute name="eyeSide" use="required">
                            <simpleType>
                                <restriction base="NMTOKEN">
                                    <enumeration value="both"/>
                                    <enumeration value="left"/>
                                    <enumeration value="right"/>
                                </restriction>
                            </simpleType>
                        </attribute>
                    </complexType>
                </element>
                <element name="LowVisionSymptoms"
                    type="dia:LowVisionImpairmentType" minOccurs="0"/>
                <element name="ColorVisionDeficiency"
                    type="dia:ColorVisionDeficiencyType" minOccurs="0"/>
            </sequence>
            <attribute name="rightSight" type="float" use="optional"/>
            <attribute name="leftSight" type="float" use="optional"/>
        </extension>
    </complexContent>
</complexType>

<complexType name="LowVisionImpairmentType">
    <complexContent>
        <extension base="dia:DIABaseType">
            <sequence>
                <element name="LossOfFineDetail"
                    type="dia:VisualImpairmentDegreeType" minOccurs="0"/>
```

--`,,```,,,,````-`-`,,`,,`,`,,`---

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```
            <element name="LackOfContrast"
               type="dia:VisualImpairmentDegreeType" minOccurs="0"/>
            <element name="LightSensitivity"
               type="dia:VisualImpairmentDegreeType" minOccurs="0"/>
            <element name="NeedOfLight"
               type="dia:VisualImpairmentDegreeType" minOccurs="0"/>
            <element name="CenterVisionLoss"
               type="dia:VisualImpairmentDegreeType" minOccurs="0"/>
            <element name="PeripheralVisionLoss"
               type="dia:VisualImpairmentDegreeType" minOccurs="0"/>
            <element name="Hemianopia" minOccurs="0">
               <complexType>
                  <attribute name="side" use="required">
                     <simpleType>
                        <restriction base="NMTOKEN">
                           <enumeration value="left"/>
                           <enumeration value="right"/>
                        </restriction>
                     </simpleType>
                  </attribute>
               </complexType>
            </element>
         </sequence>
      </extension>
   </complexContent>
</complexType>

<complexType name="VisualImpairmentDegreeType">
   <complexContent>
      <extension base="dia:DIABaseType">
         <choice>
            <element name="NumericDegree" type="mpeg7:zeroToOneType"/>
            <element name="TextualDegree">
               <simpleType>
                  <restriction base="token">
                     <enumeration value="Severe"/>
                     <enumeration value="Medium"/>
                     <enumeration value="Mild"/>
                  </restriction>
               </simpleType>
            </element>
         </choice>
      </extension>
   </complexContent>
</complexType>
```

6.4.16.3 VisualImpairment semantics

Semantics of `VisualImpairmentType`:

Name	*Definition*
`VisualImpairmentType`	Tool that describes the visual impairments of a User.
`Blindness`	Describes the blindness of a User.
`eyeSide`	Describes the side of eye in which blindness is present including left, right, or both (total blindness).
`LowVisionSymptoms`	Describes symptoms due to low vision impairments.

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Name	*Definition*
`ColorVisionDeficiency`	Describe the color vision deficiency of a User.
`rightSight`	Describes the visual acuity degree of right eyesight, which is represented by a decimal notation, such as 1.0 = 20/20 (feet) = 6/6 (meters).
`leftSight`	Describes the visual acuity degree of left eyesight, which is represented by a decimal notation, such as 1.0 = 20/20 (feet) = 6/6 (meters).

Semantics of the `LowVisionImpairmentType`:

Name	*Definition*
`LowVisionImpairmentType`	Tool that describes the types of low vision impairments based on various symptoms.
`LossOfFineDetail`	Describes the loss of fine details in vision of a User when images look blurred and visual acuity is reduced.
`LackOfContrast`	Describes the lack of contrast in vision of a User when both visual acuity and contrast sensitivity decrease.
`LightSensitivity`	Describes a User's extreme light sensitivity (photophobia) in normal condition.
`NeedOfLight`	Describes a User's need of light to see more clearly.
`CenterVisionLoss`	Describes the loss of center vision of a User.
`PeripheralVisionLoss`	Describes the loss of peripheral vision of a User, causing tunnel vision.
`Hemianopia`	Describes the loss in half of the vision field of a User. In hemianopia (also called hemianopsia), the entire half of the vision filed in both eyes are blanked out.
`side`	Specifies which half side (left or right) of the vision field is hemianopia.

Semantics of the `VisualImpairmentDegreeType`:

Name	*Definition*
`VisualImpairmentDegreeType`	Tool that describes the degree for a given type of visual impairment.
`NumericDegree`	Describes the numerical representation for degree of visual impairment. This value can be 0.0 to 1.0.
`TextualDegree`	Describes the textual description for degree of visual impairment. It is defined as three levels; "Severe", "Medium" and "Mild".

6.4.16.4 VisualImpairment example

EXAMPLE The following example shows the use of the `VisualImpairment` description tool.

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```
<DIA>
    <Description xsi:type="UsageEnvironmentType">
        <UsageEnvironmentProperty xsi:type="UsersType">
            <User>
                <UserCharacteristic xsi:type="VisualImpairmentType">
                    <Blindness eyeSide="right"/>
                    <LowVisionSymptoms>
                        <LossOfFineDetail>
                            <TextualDegree>Mild</TextualDegree>
                        </LossOfFineDetail>
                        <LackOfContrast>
                            <TextualDegree>Severe</TextualDegree>
                        </LackOfContrast>
                        <NeedOfLight>
                            <TextualDegree>Mild</TextualDegree>
                        </NeedOfLight>
                        <CenterVisionLoss>
                            <NumericDegree>0.5</NumericDegree>
                        </CenterVisionLoss>
                    </LowVisionSymptoms>
                </UserCharacteristic>
            </User>
        </UsageEnvironmentProperty>
    </Description>
</DIA>
```

6.4.17 ColorVisionDeficiency

6.4.17.1 Introduction

`ColorVisionDeficiency` describes the characteristics of a particular User's color vision deficiency. The description can be used by DIA engine to deliver recognizable color image or video data for a User with color vision deficiency.

6.4.17.2 ColorVisionDeficiency syntax

```
<!-- ########################################  -->
<!--  Definition of ColorVisionDeficiency      -->
<!-- ########################################  -->

<complexType name="ColorVisionDeficiencyType">
    <complexContent>
        <extension base="dia:DIABaseType">
            <sequence>
                <element name="DeficiencyType">
                    <simpleType>
                        <restriction base="token">
                            <enumeration value="Red-Deficiency"/>
                            <enumeration value="Green-Deficiency"/>
                            <enumeration value="Blue-Deficiency"/>
                            <enumeration value="CompleteColorBlindness"/>
                        </restriction>
                    </simpleType>
                </element>
                <element name="DeficiencyDegree"
                    type="dia:VisualImpairmentDegreeType"/>
            </sequence>
        </extension>
    </complexContent>
</complexType>
```

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6.4.17.3 ColorVisionDeficiency semantics

Semantics of the `ColorVisionDeficiencyType`:

Name	*Definition*
`ColorVisionDeficiencyType`	Tools for describing color vision deficiencies of a User.
`DeficiencyType`	Describes a specific *type* of color visual deficiency.
`Red-Deficiency`	Describes a deficiency in the L (long wavelength) cone sensitivity (protan deficiency).
`Green-Deficiency`	Describes a deficiency in the M (medium wavelength) cone sensitivity (deutan deficiency).
`Blue-Deficiency`	Describes a deficiency in the S (short wavelength) cone sensitivity (tritan deficiency).
`CompleteColorBlindness`	Describes a complete color blindness where color vision is essentially absent.
`DeficiencyDegree`	Describes the degree of deficiency to each color. The degree can be represented as numerical and textual type.

When a class of cone pigment genes is absent or the genes are not expressed or not functional, the User is a dichromate and we use the TextualDegree “Severe.” The “Mild” cases refer to anomalous trichromacy, where some trichromatic color vision is present because rearranged gene sequences (chimeric genes) lead to two classes of a remaining red or green cone type in the red-green confusion phenotype. At the time of this writing, the genotype corresponding to the blue-yellow confusion of the tritanomaly phenotype is unknown.

Color blindness can also be acquired though disorders like glaucoma, diabetic retinopathy, and macular degeneration. It is also a symptom of exposure to certain toxic drugs and chemicals.

When the User does not know her/his degree of color vision deficiency in a specific numeric value, i.e., which amino acids have been substituted in the genes, s/he can use a textual representation of “Mild” or “Severe”. A default value of “Mild” in `TextualDegree` is 0.3 in `NumericDegree`.

Table 3 shows that types in medical terms of color vision deficiency are represented by the description of ColorVisionDeficiency (in parenthesis is the phenotype) and also relationship between `TextualDegree` and `NumericDegree`.

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Table 3 — Mapping between medical terms to `ColorVisionDeficiency` descriptions

Medical Terms	`ColorVisionDeficiency`		
	`DeficiencyType`	`DeficiencyDegree`	
		`TextualDegree`	`NumericalDegree`
Protanomaly	Red-Deficiency (some reduction in the discrimination of the reddish and greenish contents of colors, with reddish colors appearing dimmer than normal)	Mild	0.1 – 0.9
Protanopia	Red-Deficiency (severely reduced discrimination of the reddish and greenish contents of colors, with reddish colors appearing dimmer than normal)	Severe	1.0
Deuteranomaly	Green-Deficiency (some reduction in the discrimination of the reddish and greenish contents of colors)	Mild	0.1 – 0.9
Deuteranopia	Green-Deficiency (severely reduced discrimination of the reddish and greenish contents of colors)	Severe	1.0
Tritanomaly	Blue-Deficiency (some reduction in the discrimination of the bluish and yellowish contents of color)	Mild	0.1 – 0.9
Tritanopy	Blue-Deficiency (severely reduced discrimination of the bluish and yellowish contents of colors)	Severe	1.0
Incomplete Achromatopsia	CompleteColorBlindeness (describes a deficiency in both the L cone sensitivity and the M cone sensitivity; no color discrimination, and approximately normal brightnesses of colors)	Mild	0.1 – 0.9
Complete Achromatopsia	CompleteColorBlindness (describes a deficiency in all three of the L cone sensitivity, the M cone sensitivity and the S cone sensitivity; no color discrimination, and brightnesses typical of scotopic vision)	Severe	1.0

6.4.17.4 ColorVisionDeficiency example

EXAMPLE The following example shows an instance of `ColorVisionDeficiency`, in which a description of visual accessibility characteristics of a User who has a certain type and degree of color vision deficiency, e.g., mild red-color deficiency (Protanomaly).

```
<DIA>
    <Description xsi:type="UsageEnvironmentType">
        <UsageEnvironmentProperty xsi:type="UsersType">
            <User>
                <UserCharacteristic xsi:type="VisualImpairmentType">
                    <ColorVisionDeficiency>
                        <DeficiencyType>Red-Deficiency</DeficiencyType>
                        <DeficiencyDegree>
                            <NumericDegree>0.5</NumericDegree>
                        </DeficiencyDegree>
                    </ColorVisionDeficiency>
                </UserCharacteristic>
            </User>
        </UsageEnvironmentProperty>
    </Description>
</DIA>
```

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6.4.18 MobilityCharacteristics

6.4.18.1 Introduction

The mobility characteristics tool aims to provide a concise description of the movement of a User over time. In particular, directivity, location update intervals and erraticity are specified. Directivity is defined to be the amount of angular change in the direction of the movement of a User compared to the previous measurement. The location update interval defines the time interval between two consecutive location updates of a particular User. Updates to the location are received when the User crosses a boundary of a pre-determined area, e.g., circular, elliptic, centered at the coordinate of its last location update. Erraticity defines the degree of randomness in a User's movement. Together, these descriptions can be used to classify Users, e.g., as pedestrians, highway vehicles, etc, in order to provide adaptive location-aware services.

6.4.18.2 MobilityCharacteristics syntax

```
<!-- ################################################ -->
<!--  Definition of MobilityCharacteristics           -->
<!-- ################################################ -->

<complexType name="MobilityCharacteristicsType">
   <complexContent>
      <extension base="dia:UserCharacteristicBaseType">
         <sequence>
            <element name="UpdateInterval" type="dia:UpdateIntervalType"
               minOccurs="0"/>
            <element name="Directivity" type="dia:DirectivityType"
               minOccurs="0"/>
            <element name="Erraticity" type="dia:ErraticityType"
               minOccurs="0"/>
         </sequence>
      </extension>
   </complexContent>
</complexType>

<complexType name="UpdateIntervalType">
   <complexContent>
      <extension base="dia:DIABaseType">
         <sequence>
            <element name="LastUpdatePoint" type="mpeg7:GeographicPointType"
               minOccurs="0"/>
            <element name="LastUpdateBinIndex" type="integer" minOccurs="0"/>
            <element name="LastUpdateTime" type="mpeg7:TimeType"
minOccurs="0"/>
            <element name="Lmax" type="integer" minOccurs="0"/>
            <element name="Values" minOccurs="0">
               <simpleType>
                  <restriction base="mpeg7:probabilityVector">
                     <length value="32"/>
                  </restriction>
               </simpleType>
            </element>
         </sequence>
         <attribute name="xRadius" type="integer" use="optional"/>
         <attribute name="yRadius" type="integer" use="optional"/>
      </extension>
   </complexContent>
</complexType>

<complexType name="DirectivityType">
   <complexContent>
      <extension base="dia:DIABaseType">
```


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```
            <sequence>
               <element name="Mean" type="float" minOccurs="0"/>
               <element name="Variance" type="float" minOccurs="0"/>
               <element name="Values" minOccurs="0">
                  <simpleType>
                     <restriction base="mpeg7:probabilityVector">
                        <length value="16"/>
                     </restriction>
                  </simpleType>
               </element>
            </sequence>
            <attribute name="measuredInterval" type="integer" use="optional"/>
         </extension>
      </complexContent>
   </complexType>

   <complexType name="ErraticityType">
      <complexContent>
         <extension base="dia:DIABaseType">
            <sequence>
               <element name="Values" minOccurs="0">
                  <simpleType>
                     <restriction base="mpeg7:probabilityVector">
                        <length value="128"/>
                     </restriction>
                  </simpleType>
               </element>
            </sequence>
         </extension>
      </complexContent>
   </complexType>
```

6.4.18.3 MobilityCharacteristics semantics

Semantics of the `MobilityCharacteristicsType`:

Name	*Definition*
`MobilityCharactersticsType`	Tool for describing the mobility characteristics of a User.
`UpdateInterval`	Describes information related to a User's location updates.
`Directivity`	Describes the relative angular changes in the direction of a User's movement.
`Erraticity`	Describes the erraticity levels of a User's movement.

Semantics of the `UpdateIntervalType`:

Name	*Definition*
`UpdateIntervalType`	Tool for describing information related to a User's location updates.
`xRadius`	Describes the radius of the location update area on its x-axis in units of meters.
`yRadius`	Describes the radius of the location update area on its y-axis in units of meters.

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Name	*Definition*
`LastUpdatePoint`	Describes the latitude and longitude at the coordinate of the last location update.
`LastUpdateBinIndex`	Describes the bin index corresponding to the time interval between the last two location updates. The value is in the range [1,32].
`LastUpdateTime`	Describes the time of the last location update.
`Lmax`	Describes the maximum location update interval that has been observed in units of seconds.
`Values`	Describes a histogram containing the frequency of location update intervals. The number of bins is fixed to 32. Each bin corresponds to a range of time intervals, where a single time interval is defined as the time difference between two consecutive location updates. The range of each bin is Lmax/32. The values represent the frequency of occurrence for a given range of time intervals, which are normalized by the total number of location updates.

Semantics of the `DirectivityType`:

Name	*Definition*
`DirectivityType`	Tool for describing the relative angular changes in the direction of a User's movement.
`Mean`	Describes the mean of the directivity elements. The range is [0-180] degrees.
`Variance`	Describes the variance of the directivity elements. The range is [0-180] degrees.
`Values`	Describes a histogram containing the frequency of directivity samples. The number of bins is fixed to 16. Each bin corresponds to a fixed range of 11.25 degrees. The values represent the frequency of occurrence of directivity samples in a given range, which are normalized by the total number of directivity samples.
`measuredInterval`	Indicates the time interval of the directivity samples measured in units of seconds. The default value is a 8 seconds.

Semantics of the `ErraticityType`:

Name	*Definition*
ErraticityType	Tool for describing the erraticity levels of a User's movements.
Values	Describes the raw erraticity values for corresponding location update intervals. The length of the vector is 128. Values range in [0,1].

6.4.18.4 MobilityCharacteristics example

EXAMPLE A sample use of `MobilityCharacteristics` to classify Users is described in the following. With the classification of Users, the adaptive selection of resources in a Digital Item may be performed.

Assume that an Application Service Provider (ASP) defines three mobility profiles: highway vehicular, urban vehicular and pedestrian. Furthermore, the histogram of `Directivity` is divided into three regions to represent each of these mobility profiles as shown in Figure 7. The first region is for highway vehicular and corresponds to bin index [1-3], the second

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region is for urban vehicular and corresponds to bin index [4-8], and the third region is for pedestrian and corresponds to bin index [9-16]. This separation is suggested based on the fact that fast moving Users will have mostly smaller directivities. It is expected that each profile will generate some directivity values that may also fall in other regions, but the density of the directivities of a profile still will be the highest in its designated region. Therefore, the ASP may first want to compare the average energy within each mobility profile region, and consider the one with the highest energy as the most likely mobility profile. The output decision may be confirmed, if the $\texttt{Mean} \pm \sqrt{\texttt{Variance}}$ also falls into the selected region. This verification would limit false profile detection.

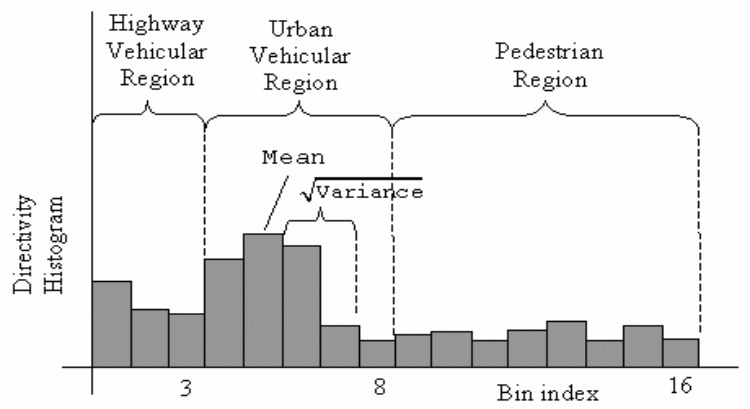

Figure 7 — Illustration of the histogram of Directivity with 16-bin representation and with non-uniform separation of mobility profile regions.

Besides the `Directivity`, the `UpdateInterval` and `Erraticity` fields may also be exploited for profile detection. For instance, the average speed of the User within the last location update interval (LUI) is inferred from the description fields, and the resulting speed may be compared to a set of speed ranges achievable by each mobility profile. Eventually, the profile decision is made. The distance traversed within the last LUI can be derived from the last erraticity value, which is `Values`[127], and `xRadius`. On the other hand, the last LUI is inferred from `Lmax` and `LastUpdateBinIndex`. Hence, the average velocity is the ratio of the distance traversed to the last LUI. The final step is the comparison of the resulting average speed to a set of thresholds preset by the ASP.

Other uses of `MobilityCharacteristics` include media adaptation, e.g., if high mobility is detected, a sending device may reduce the bit-rate, frame-rate or spatial resolution to transmit at lower data rates, thereby allowing space for protective coding against adverse fading effects. Also, the hand-off rate would increase with high mobility having low directivity. Intuitively, each hand-off generates signalling overhead and associated delay, thus affecting the quality of the service being offered to the Users. The second factor results from the fact that some Users (e.g., pedestrians) will have more stringent battery power constraints than others (e.g., vehicular). Therefore, to extend battery lifetime of a User the delivery rate of content may be reduced based on mobility profiles, even if the battery is detected to be full.

Considering other usage environment descriptions, e.g., `UserPreference`, `Destination`, `Time`, `Location`, more sophisticated location-aware services may be offered. For instance, a suitable video program (such as news, weather, outcome of baseball game, etc.) or music contents can be recommended based on a combination of these descriptions. After the recommendation and/or User decision, a suitable communication channel would be automatically selected and a desirable coding format would be determined.

The following example shows a particular instantiation of the `MobilityCharacteristics` description tool.

```
<DIA>
    <Description xsi:type="UsageEnvironmentType">
        <UsageEnvironmentProperty xsi:type="UsersType">
            <User>
                <UserCharacteristic xsi:type="MobilityCharacteristicsType">
                    <UpdateInterval>
                        <LastUpdatePoint latitude="43.3" longitude="101.6"/>
                        <LastUpdateBinIndex>4</LastUpdateBinIndex>
                        <LastUpdateTime>
                            <mpeg7:TimePoint>2002-09-20T15:22+01:00</mpeg7:TimePoint>
                        </LastUpdateTime>
```

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```
                    <Lmax>180</Lmax>
                    <Values>
                        0.4 0.2 0.1 0.1 0.1 0.1 0.0 0.0
                        0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0
                        0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0
                        0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0
                    </Values>
                </UpdateInterval>
                <Directivity>
                    <Mean>35</Mean>
                    <Variance>27</Variance>
                    <Values>
                        0.1 0.2 0.5 0.2 0.0 0.0 0.0 0.0
                        0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0
                    </Values>
                </Directivity>
            </UserCharacteristic>
        </User>
    </UsageEnvironmentProperty>
</Description>
</DIA>
```

6.4.19 Destination

6.4.19.1 Introduction

This subclause specifies a tool for describing the destination of a User. With knowledge of the User's destination, adaptive location-aware services could be provided.

6.4.19.2 Destination syntax

```
<!-- ######################################### -->
<!--  Definition of Destination                -->
<!-- ######################################### -->

<complexType name="DestinationType">
   <complexContent>
      <extension base="dia:UserCharacteristicBaseType">
         <sequence>
            <element name="Time" type="mpeg7:TimeType" minOccurs="0"/>
            <element name="Location" type="mpeg7:PlaceType" minOccurs="0"/>
            <element name="DestinationClass" minOccurs="0">
               <complexType>
                  <choice>
                     <element name="FreeClass" type="mpeg7:TextualType"
                        minOccurs="0" maxOccurs="unbounded"/>
                     <element name="StereotypedClass"
                        type="mpeg7:ControlledTermUseType"/>
                  </choice>
               </complexType>
            </element>
            <element name="DestinationName" type="mpeg7:TextualType"
               minOccurs="0"/>
         </sequence>
      </extension>
   </complexContent>
</complexType>
```


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6.4.19.3 Destination semantics

Semantics of `DestinationType`:

Name	*Definition*
`DestinationType`	Tool for describing the destination related characteristics of a User.
`Time`	Describes arrival time related information regarding the destination of a User.
`Location`	Describes geographical location related information regarding the destination of a User.
`DestinationClass`	Describes semantic or ambiguous classification of the destination of a User.
`FreeClass`	Describes free text annotation of `DestinationClass`.
`StereotypedClass`	Describes stereotyped text annotation of `DestinationClass`. A CS that may be used for this purpose is the `PlaceTypeCS` defined in Annex A.2.11.
`DestinationName`	Describes proper or individual name of the destination of a User.

6.4.19.4 Destination example

EXAMPLE The following example shows the use of the `Destination` description tool.

```
<DIA>
    <Description xsi:type="UsageEnvironmentType">
        <UsageEnvironmentProperty xsi:type="UsersType">
            <User>
                <UserCharacteristic xsi:type="DestinationType">
                    <DestinationClass>
                        <StereotypedClass
                            href="urn:mpeg:mpeg21:2003:01-DIA-PlaceTypeCS-NS:6">
                            <mpeg7:Name xml:lang="en">Hall</mpeg7:Name>
                        </StereotypedClass>
                    </DestinationClass>
                    <DestinationName xml:lang="en">Awaji Yumebutai</DestinationName>
                </UserCharacteristic>
            </User>
        </UsageEnvironmentProperty>
    </Description>
</DIA>
```

6.5 Terminal capabilities

6.5.1 Introduction

The description of a terminal's capabilities is primarily required to satisfy consumption and processing constraints of a particular terminal. Terminal capabilities are defined by a wide variety of attributes. Among them are codec capabilities, which include encoding and decoding capabilities, device properties, which include power, storage and data I/O characteristics, and input-output characteristics, which include display and audio output capabilities.

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6.5.2 Terminals

6.5.2.1 Introduction

This subclause specifies the characteristics of multiple terminals, where the characteristics of a single terminal are specified by the `Terminal` element in the `TerminalsType`.

6.5.2.2 Terminals syntax

```
<!-- ################################################ -->
<!--  Definition of Terminals                         -->
<!-- ################################################ -->

<complexType name="TerminalsType">
   <complexContent>
      <extension base="dia:UsageEnvironmentPropertyBaseType">
         <sequence>
            <element name="Terminal" type="dia:TerminalType"
               minOccurs="0" maxOccurs="unbounded"/>
         </sequence>
      </extension>
   </complexContent>
</complexType>
```

6.5.2.3 Terminals semantics

Semantics of the `TerminalsType`:

Name	*Definition*
`TerminalsType`	Tool for describing the characteristics of terminals.
`Terminal`	Describes a single terminal in terms of coding and decoding capabilities, device properties and input-output capabilities.

6.5.3 Terminal

6.5.3.1 Introduction

This subclause specifies the capabilities and properties of a single terminal. Specific capabilities and properties include coding and decoding capabilities, device properties and input-output capabilities.

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6.5.3.2 Terminal syntax

```
<!-- ################################################ -->
<!--  Definition of Terminal                          -->
<!-- ################################################ -->

<complexType name="TerminalType">
   <complexContent>
      <extension base="dia:DIABaseType">
         <sequence>
            <element name="TerminalCapability"
               type="dia:TerminalCapabilityBaseType"
               minOccurs="0" maxOccurs="unbounded"/>
         </sequence>
      </extension>
   </complexContent>
</complexType>

<complexType name="TerminalCapabilityBaseType" abstract="true">
   <complexContent>
      <extension base="dia:DIABaseType"/>
   </complexContent>
</complexType>
```

6.5.3.3 Terminal semantics

Semantics of the `TerminalCapabilitiesType`:

Name	*Definition*
`TerminalType`	Tool for describing the capabilities of the terminal.
`TerminalCapability`	Describes the capabilities of the terminal in terms of decoding and encoding capabilities, input-output capabilities, and device properties.

Semantics of the `TerminalCapabilityBaseType`:

Name	*Definition*
`TerminalCapabilityBaseType`	`TerminalCapabilityBaseType` extends `DIABaseType` and provides a base abstract type for a subset of types defined as part of the `TerminalType`.

6.5.4 CodecCapabilities

6.5.4.1 Introduction

This subclause specifies decoding and encoding capabilities of a terminal. Specifically, capabilities are defined by the format that a particular terminal is capable of encoding or decoding. Given the variety of different content representation formats that are available today, it is necessary to be aware of the formats that a terminal is capable of. A terminal may be capable of both encoding and decoding and may also be capable of multiple formats.

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6.5.4.2 CodecCapabilities syntax

```
<!-- ################################################ -->
<!--  Definition of CodecCapabilities                 -->
<!-- ################################################ -->

<complexType name="CodecCapabilitiesType">
  <complexContent>
    <extension base="dia:TerminalCapabilityBaseType">
      <sequence>
        <element name="Decoding" type="dia:CodecCapabilityBaseType"
          minOccurs="0" maxOccurs="unbounded"/>
        <element name="Encoding" type="dia:CodecCapabilityBaseType"
          minOccurs="0" maxOccurs="unbounded"/>
        <element name="DecodingEncoding" type="dia:CodecCapabilityBaseType"
          minOccurs="0" maxOccurs="unbounded"/>
      </sequence>
    </extension>
  </complexContent>
</complexType>
```

6.5.4.3 CodecCapabilities semantics

Semantics of the `CodecCapabilitiesType`:

Name	*Definition*
`CodecCapabilitiesType`	Tool for describing the encoding and decoding capabilities of the terminal.
`Decoding`	Describes the decoding capability of the terminal.
`Encoding`	Describes the encoding capability of the terminal.
`DecodingEncoding`	Describes the decoding and encoding capabilities of the terminal.

6.5.5 CodecCapability

6.5.5.1 Introduction

This subclause specifies specific formats that a terminal may be capable of decoding and encoding and associates codec-specific parameters to those formats. The actual codec-parameters are defined in subclause 6.5.6.

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6.5.5.2 CodecCapability syntax

```
<!-- ################################################ -->
<!--  Definition of CodecCapability                   -->
<!-- ################################################ -->

<complexType name="CodecCapabilityBaseType" abstract="true">
   <complexContent>
      <extension base="dia:DIABaseType">
         <sequence minOccurs="0" maxOccurs="unbounded">
            <element name="Format" type="mpeg7:ControlledTermUseType"/>
            <element name="CodecParameter" type="dia:CodecParameterBaseType"
               minOccurs="0" maxOccurs="unbounded"/>
         </sequence>
      </extension>
   </complexContent>
</complexType>

<complexType name="AudioCapabilitiesType">
   <complexContent>
      <extension base="dia:CodecCapabilityBaseType"/>
   </complexContent>
</complexType>

<complexType name="GraphicsCapabilitiesType">
   <complexContent>
      <extension base="dia:CodecCapabilityBaseType"/>
   </complexContent>
</complexType>

<complexType name="ImageCapabilitiesType">
   <complexContent>
      <extension base="dia:CodecCapabilityBaseType"/>
   </complexContent>
</complexType>

<complexType name="SceneGraphCapabilitiesType">
   <complexContent>
      <extension base="dia:CodecCapabilityBaseType"/>
   </complexContent>
</complexType>

<complexType name="TransportCapabilitiesType">
   <complexContent>
      <extension base="dia:CodecCapabilityBaseType"/>
   </complexContent>
</complexType>

<complexType name="VideoCapabilitiesType">
   <complexContent>
      <extension base="dia:CodecCapabilityBaseType"/>
   </complexContent>
</complexType>
```

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6.5.5.3 CodecCapability semantics

Semantics of the `CodecCapabilityType`:

Name	*Definition*
`CodecCapabilityBaseType`	`CodecCapabilityType` extends `DIABaseType` and provides a base abstract type for a subset of types defined as part of the `CodecCapabilitiesType`, which is used to describe both encoding and decoding capabilities.
`Format`	Describes the format that the terminal is capable of encoding or decoding.
`CodecParameter`	Describes codec parameters that are associated with the encoding or decoding of the `Format`.

Semantics of the `AudioCapabilitiesType`:

Name	*Definition*
`AudioCapabilitiesType`	Tool for describing the codec capabilities of the terminal for audio. A classification scheme that may be used to describe the `Format` associated with this type is the `AudioCodingFormatCS` defined in ISO/IEC 15938-5.

Semantics of the `GraphicsCapabilitiesType`:

Name	*Definition*
`GraphicsCapabilitiesType`	Tool for describing the codec capabilities of the terminal for graphics. A classification scheme that may be used to describe the `Format` associated with this type is the `GraphicsCodingFormatCS` defined in Annex A.2.6.

Semantics of the `ImageCapabilitiesType`:

Name	*Definition*
`ImageCapabilitiesType`	Tool for describing the codec capabilities of the terminal for images. A classification scheme that may be used to describe the `Format` associated with this type is the `VisualCodingFormatCS` defined in ISO/IEC 15938-5.

Semantics of the `SceneGraphCapabilitiesType`:

Name	*Definition*
`SceneGraphCapabilitiesType`	Tool for describing the codec capabilities of the terminal for scene graphs. A classification scheme that may be used to describe the `Format` associated with this type is the `SceneCodingFormatCS` defined in Annex A.2.13.

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Semantics of the `TransportFormatsCapabilitiesType`:

Name	*Definition*
`TransportFormatsCapabilitiesType`	Tool for describing the codec capabilities of the terminal for transport formats.

Semantics of the `VideoCapabilitiesType`:

Name	*Definition*
`VideoCapabilitiesType`	Tool for describing the codec capabilities of the terminal for video. A classification scheme that may be used to describe the `Format` associated with this type is the `VisualCodingFormatCS` defined in ISO/IEC 15938-5.

6.5.6 CodecParameter

6.5.6.1 Introduction

This subclause specifies particular codec parameters that are associated with the encoding and decoding of the various codec formats described in subclause 6.5.5. In some instances, it is important to know the limits of specific parameters that affect the operation of the codec. In most coding standards, such limits are often defined. However, it is possible that some devices are designed with further constraints, or that no specification of a particular limit even exists. Therefore, the codec parameters as defined in this subclause would provide a means to describe such limits.

6.5.6.2 CodecParameter syntax

```
<!-- ################################################ -->
<!--  Definition of CodecParameter                    -->
<!-- ################################################ -->

<complexType name="CodecParameterBaseType" abstract="true">
   <complexContent>
      <extension base="dia:DIABaseType"/>
   </complexContent>
</complexType>

<complexType name="CodecParameterBufferSizeType">
   <complexContent>
      <extension base="dia:CodecParameterBaseType">
         <sequence>
            <element name="BufferSize" type="integer" minOccurs="0"/>
         </sequence>
      </extension>
   </complexContent>
</complexType>

<complexType name="CodecParameterBitRateType">
   <complexContent>
      <extension base="dia:CodecParameterBaseType">
         <sequence>
            <element name="BitRate" minOccurs="0">
               <complexType>
                  <attribute name="average" type="nonNegativeInteger"
                     use="optional"/>
                  <attribute name="maximum" type="nonNegativeInteger"
                     use="optional"/>
```

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```
                </complexType>
             </element>
          </sequence>
       </extension>
    </complexContent>
</complexType>

<complexType name="CodecParameterMemoryBandwidthType">
    <complexContent>
       <extension base="dia:CodecParameterBaseType">
          <sequence>
             <element name="MemoryBandwidth" type="integer" minOccurs="0"/>
          </sequence>
       </extension>
    </complexContent>
</complexType>

<complexType name="CodecParameterVertexRateType">
    <complexContent>
       <extension base="dia:CodecParameterBaseType">
          <sequence>
             <element name="VertexRate" type="integer" minOccurs="0"/>
          </sequence>
       </extension>
    </complexContent>
</complexType>

<complexType name="CodecParameterFillRateType">
    <complexContent>
       <extension base="dia:CodecParameterBaseType">
          <sequence>
             <element name="FillRate" type="integer" minOccurs="0"/>
          </sequence>
       </extension>
    </complexContent>
</complexType>
```

6.5.6.3 CodecParameter semantics

Semantics of the `CodecParameterType`:

Name	*Definition*
`CodecParameterBaseType`	`CodecParameterBaseType` extends `DIABaseType` and provides a base abstract type for various types of codec-related parameters.

Semantics of the `CodecParameterBufferSizeType`:

Name	*Definition*
`CodecParameterBufferSizeType`	Tool for describing the buffer size requirements for a codec.
`BufferSize`	Describes the minimum buffer size required by a codec in bits.

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Semantics of the CodecParameterBitRateType:

Name	*Definition*
CodecParameterBitRateType	Tool for describing the bit-rate requirements for the codec.
BitRate	Describes the bit-rate parameters for a codec.
average	Describes the average bit-rate that a decoder is capable of decoding or that an encoder can produce.
maximum	Describes the maximum bit-rate in bits/sec that a decoder is capable of decoding or that an encoder can produce.

Semantics of the CodecParameterMemoryBandwidthType:

Name	*Definition*
CodecParameterMemoryBandwidthType	Tool for describing the memory bandwidth requirements for a codec.
MemoryBandwidth	Describes the maximum memory bandwidth of a codec in units of bits/sec.

Semantics of the CodecParameterVertexRateType:

Name	*Definition*
CodecParameterVertexRateType	Tool for describing the vertex processing rate requirements for a graphics codec.
VertexRate	Describes the maximum vertex processing rate of a graphics codec in units of vertices/sec.

Semantics of the CodecParameterFillRateType:

Name	*Definition*
CodecParameterFillRateType	Tool for describing the fill rate requirements for a graphics codec.
FillRate	Describes the maximum fill rate of a graphics codec in units of pixels/sec. The fill rate is defined as a product of the image resolution, frame rate, and depth complexity.

6.5.7 Displays

6.5.7.1 Introduction

This subclause specifies the capabilities of multiple displays, where the capabilities of a single display are specified by the Display element in the DisplaysType.

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6.5.7.2 Displays syntax

```
<!-- ################################################ -->
<!--  Definition of Displays                          -->
<!-- ################################################ -->

<complexType name="DisplaysType">
   <complexContent>
      <extension base="dia:TerminalCapabilityBaseType">
         <sequence>
            <element name="Display" type="dia:DisplayType"
               minOccurs="0" maxOccurs="unbounded"/>
         </sequence>
      </extension>
   </complexContent>
</complexType>
```

6.5.7.3 Displays semantics

Semantics of the `DisplaysType`:

Name	*Definition*
`DisplaysType`	Tool for describing the capability of displays.
`Display`	Describes the capabilities of a single display.

6.5.8 Display

6.5.8.1 Introduction

This subclause specifies the capabilities and properties of a single display.

6.5.8.2 Display syntax

```
<!-- ################################################ -->
<!--  Definition of Display                           -->
<!-- ################################################ -->

<complexType name="DisplayType">
   <complexContent>
      <extension base="dia:DIABaseType">
         <sequence>
            <element name="DisplayCapability"
               type="dia:DisplayCapabilityBaseType"
               minOccurs="0" maxOccurs="unbounded"/>
         </sequence>
      </extension>
   </complexContent>
</complexType>

<complexType name="DisplayCapabilityBaseType" abstract="true">
   <complexContent>
      <extension base="dia:DIABaseType"/>
   </complexContent>
</complexType>
```


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6.5.8.3 Display semantics

Semantics of the `DisplayType`:

Name	*Definition*
`DisplayType`	Tool for describing the capabilities of the display.
`DisplayCapability`	Describes the capabilities of the display.

Semantics of the `DisplayCapabilityBaseType`:

Name	*Definition*
`DisplayCapabilityBaseType`	`DisplayCapabilityBaseType` extends `DIABaseType` and provides a base abstract type for a subset of types defined as part of the `DisplayType`.

6.5.9 DisplayCapabilities

6.5.9.1 Introduction

This subclause specifies display capabilities of the terminal. Describing the capabilities of a display is obviously very important as certain limitations that impact the visual presentation of information must be taken into consideration, such as the display resolution, color capabilities and/or rendering format.

6.5.9.2 DisplayCapabilities syntax

```
<!-- ################################################ -->
<!--  Definition of DisplayCapability                 -->
<!-- ################################################ -->

<complexType name="DisplayCapabilityType">
   <complexContent>
      <extension base="dia:DisplayCapabilityBaseType">
         <sequence>
            <element name="Mode" minOccurs="0" maxOccurs="unbounded">
               <complexType>
                  <sequence>
                     <element name="Resolution" type="dia:ResolutionType"
                        minOccurs="0" maxOccurs="unbounded"/>
                     <element name="SizeChar" minOccurs="0">
                        <complexType>
                           <attribute name="horizontal" type="integer"
                              use="required"/>
                           <attribute name="vertical" type="integer"
                              use="required"/>
                        </complexType>
                     </element>
                  </sequence>
                  <attribute name="refreshRate" type="float" use="optional"/>
               </complexType>
            </element>
            <element name="ScreenSize" minOccurs="0">
               <complexType>
                  <attribute name="horizontal" type="float" use="required"/>
                  <attribute name="vertical" type="float" use="required"/>
               </complexType>
```

--`,,```,,,,````-`-`,,`,,`,`,,`---

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```
            </element>
            <element name="ColorBitDepth" minOccurs="0">
               <complexType>
                  <attribute name="red" type="integer" use="required"/>
                  <attribute name="green" type="integer" use="required"/>
                  <attribute name="blue" type="integer" use="required"/>
               </complexType>
            </element>
            <element name="ColorPrimaries" minOccurs="0">
               <complexType>
                  <sequence>
                     <element name="ChromaticityRed"
                        type="dia:ChromaticityType"/>
                     <element name="ChromaticityGreen"
                        type="dia:ChromaticityType"/>
                     <element name="ChromaticityBlue"
                        type="dia:ChromaticityType"/>
                     <element name="ChromaticityWhite"
                        type="dia:ChromaticityType" minOccurs="0"/>
                  </sequence>
               </complexType>
            </element>
            <element name="CharacterSetCode" type="mpeg7:characterSetCode"
               minOccurs="0" maxOccurs="unbounded"/>
            <element name="RenderingFormat" type="mpeg7:ControlledTermUseType"
               minOccurs="0" maxOccurs="unbounded"/>
         </sequence>
         <attribute name="stereoscopic" type="boolean" use="optional"/>
         <attribute name="maximumBrightness" type="float" use="optional"/>
         <attribute name="contrastRatio" type="positiveInteger" use="optional"/>
         <attribute name="gamma" type="float" use="optional"/>
         <attribute name="bitsPerPixel" type="integer" use="optional"/>
         <attribute name="colorCapable" type="boolean" use="optional"/>
         <attribute name="sRGB" type="boolean" use="optional"/>
         <attribute name="fieldSequentialColor" type="boolean" use="optional"/>
         <attribute name="backlightLuminance" type="mpeg7:zeroToOneType"
            use="optional"/>
         <attribute name="dotPitch" type="float" use="optional"/>
         <attribute name="activeDisplay" type="boolean" use="optional"/>
      </extension>
   </complexContent>
</complexType>

<complexType name="ResolutionType">
   <complexContent>
      <extension base="dia:DIABaseType">
         <attribute name="horizontal" type="integer" use="required"/>
         <attribute name="vertical" type="integer" use="required"/>
         <attribute name="activeResolution" type="boolean" use="optional"/>
      </extension>
   </complexContent>
</complexType>

<complexType name="ChromaticityType">
   <complexContent>
      <extension base="dia:DIABaseType">
         <attribute name="x" type="mpeg7:zeroToOneType" use="required"/>
         <attribute name="y" type="mpeg7:zeroToOneType" use="required"/>
      </extension>
   </complexContent>
</complexType>
```


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6.5.9.3 DisplayCapability semantics

Semantics of the `DisplayCapabilityType`:

Name	*Definition*
`DisplayCapabilityType`	Tool that describes the display capability of a terminal.
`Mode`	Describes different modes of a display.
`Resolution`	Describes the horizontal and vertical resolution of the display in pixels.
`SizeChar`	Describes the horizontal and vertical size of the display in units of characters.
`refreshRate`	Describes the refresh rate of a display in Hz.
`ScreenSize`	Describes the horizontal and vertical size of the visible display area in units of mm.
`ColorBitDepth`	Describes the number of bits per pixel for each primary color component (red, green and blue) of the display.
`ColorPrimaries`	Describes the color characteristics of the display using the chromaticity values (x, y values) of the three primaries and the white point.
`CharacterSetCode`	Describes the character sets that can be displayed on a terminal. This is achieved with the `mpeg7:characterSetCode` datatype specified in ISO/IEC 15938-5.
`RenderingFormat`	Describes the type of rendering formats the display is capable of. A CS that may be used for this purpose is the `RenderingFormatCS` defined in Annex A.2.12.
`stereoscopic`	Describes whether or not the display device is stereoscopic.
`maximumBrightness`	Describes the maximum luminance of the display in candelas per meter squared (cd/m^2).
`contrastRatio`	Describes the ratio of the maximum luminance and the minimum luminance of the display.
`gamma`	Describes the nonlinearity in the relationship between input signal values and output luminance.
`bitsPerPixel`	Describes the bits-per-pixel, i.e., the color depth, of the display. If `ColorBitDepth` is specified, the value of `bitsPerPixel` is the sum of the individual RGB pixel depths that have been specified.
`colorCapable`	Describes if the display is capable of displaying color or not.
`sRGB`	Describes whether or not the display device supports sRGB color space.
`fieldSequentialColor`	Describes whether or not the color components are displayed in sequential fields.
`backlightLuminance`	Describes the amount of luminance of the display's backlight. Values are in the range of 0.0 to 1.0, where 0.0 indicates no backlight and 1.0 indicates maximum backlight intensity.
`dotPitch`	Describes the dotPitch of the display in units of mm.
`activeDisplay`	Describes if the particular display is active or not for the case when multiple displays of a terminal are specified.

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Semantics of the `ResolutionType`:

Name	*Definition*
`ResolutionType`	Tool that describes the resolution.
`horizontal`	Describes the horizontal resolution.
`vertical`	Describes the vertical resolution.
`activeResolution`	Describes if the particular resolution is active or not for the case when multiple resolutions are specified.

Semantics of the `ChromaticityType`:

Name	*Definition*
`ChromaticityType`	Tool that describes the chromaticity.
`x`	Describes the x-value of chromaticity.
`y`	Describes the y-value of chromaticity.

6.5.10 AudioOutputs

6.5.10.1 Introduction

This subclause specifies the capabilities of multiple audio outputs, where the capabilities of a single audio output are specified by the `AudioOutput` element in the `AudioOutputsType`.

6.5.10.2 AudioOutputs syntax

```
<!-- ################################################ -->
<!--  Definition of AudioOutputs                      -->
<!-- ################################################ -->

<complexType name="AudioOutputsType">
   <complexContent>
      <extension base="dia:TerminalCapabilityBaseType">
         <sequence>
            <element name="AudioOutput" type="dia:AudioOutputType"
               minOccurs="0" maxOccurs="unbounded"/>
         </sequence>
      </extension>
   </complexContent>
</complexType>
```


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6.5.10.3 AudioOutputs semantics

Semantics of the `AudioOutputsType`:

Name	*Definition*
`AudioOutputsType`	Tool for describing the capability of audio outputs.
`AudioOutput`	Describes the capabilities of a single audio output.

6.5.11 AudioOutput

6.5.11.1 Introduction

This subclause specifies the capabilities and properties of a single audio output.

6.5.11.2 AudioOutput syntax

```
<!-- ################################################ -->
<!--  Definition of AudioOutput                       -->
<!-- ################################################ -->

<complexType name="AudioOutputType">
   <complexContent>
      <extension base="dia:DIABaseType">
         <sequence>
            <element name="AudioOutputCapability"
               type="dia:AudioOutputCapabilityBaseType"
               minOccurs="0" maxOccurs="unbounded"/>
         </sequence>
      </extension>
   </complexContent>
</complexType>

<complexType name="AudioOutputCapabilityBaseType" abstract="true">
   <complexContent>
      <extension base="dia:DIABaseType"/>
   </complexContent>
</complexType>
```

6.5.11.3 AudioOutput semantics

Semantics of the `AudioOutputType`:

Name	*Definition*
`AudioOutputType`	Tool for describing the capabilities of the audio output.
`AudioOutputCapability`	Describes the capabilities of the audio output.

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Semantics of the `AudioOutputCapabilityBaseType`:

Name	*Definition*
`AudioOutputCapabilityBaseType`	`AudioOutputCapabilityBaseType` extends `DIABaseType` and provides a base abstract type for a subset of types defined as part of the `AudioOutputType`.

6.5.12 AudioOutputCapabilities

6.5.12.1 Introduction

This subclause specifies audio output capabilities of the terminal. Describing the capabilities of an audio output indicates limitation that impact the auditory presentation of information. This is achieved by specifying the sampling frequency and bits-per-sample, the frequency range of the output, the number of channels supported, as well as power and signal-to-noise ratio.

6.5.12.2 AudioOutputCapabilities syntax

```
<!-- ################################################ -->
<!--  Definition of AudioOutputCapabilities           -->
<!-- ################################################ -->

<complexType name="AudioOutputCapabilitiesType">
   <complexContent>
      <extension base="dia:AudioOutputCapabilityBaseType">
         <sequence>
            <element name="Mode" type="dia:AudioModeType"
               minOccurs="0" maxOccurs="unbounded"/>
         </sequence>
         <attribute name="lowFrequency" type="float" use="optional"/>
         <attribute name="highFrequency" type="float" use="optional"/>
         <attribute name="signalNoiseRatio" type="float" use="optional"/>
         <attribute name="power" type="float" use="optional"/>
         <attribute name="numChannels" type="nonNegativeInteger"
            use="optional"/>
         <attribute name="silenceSuppression" type="boolean" use="optional"/>
      </extension>
   </complexContent>
</complexType>

<complexType name="AudioModeType">
   <complexContent>
      <extension base="dia:DIABaseType">
         <attribute name="samplingFrequency" type="float" use="optional"/>
         <attribute name="bitsPerSample" type="integer" use="optional"/>
      </extension>
   </complexContent>
</complexType>
```


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6.5.12.3 AudioOutputCapabilities semantics

Semantics of the `AudioOutputCapabilitiesType`:

Name	*Definition*
`AudioOutputCapabilitiesType`	Tool that describes the audio output capabilities of a terminal.
`Mode`	Describes the audio output mode of the terminal.
`samplingFrequency`	Describes the sampling frequency in units of Hz.
`bitsPerSample`	Describes the number of bits per sample the output device supports.
`lowFrequency`	Describes the lower value of the frequency range in units of Hz.
`highFrequency`	Describes the upper value of the frequency range in units of Hz.
`signalNoiseRatio`	Describes the signal-to-noise ratio in units of dB.
`power`	Describes the RMS power output in units of Watts.
`numChannels`	Describes the number of output channels the speakers support.
`silenceSuppression`	Describes if silence suppression shall be applied for the audio. NOTE This feature is usually applied to stop the audio transfer through the network during periods when the participants in an audio conference are currently not talking.Furthermore, this feature is applied to decrease the used bandwidth in moments of silence.

Semantics of the `AudioModeType`:

Name	*Definition*
`AudioModeType`	Tool that describes the audio output mode of a terminal.
`samplingFrequency`	Describes the sampling frequency in units of Hz.
`bitsPerSample`	Describes the number of bits per sample the output device supports.

6.5.13 UserInteractionInputs

6.5.13.1 Introduction

This subclause specifies the characteristics of multiple input supports for User interaction on a terminal, where the characteristics of a single input support are specified by the `UserInteractionInput` element in the `UserInteractionInputsType`.

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6.5.13.2 UserInteractionInputs syntax

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

<complexType name="UserInteractionInputsType">
   <complexContent>
      <extension base="dia:TerminalCapabilityBaseType">
         <sequence>
            <element name="UserInteractionInput"
               type="dia:UserInteractionInputType"
               minOccurs="0" maxOccurs="unbounded"/>
         </sequence>
      </extension>
   </complexContent>
</complexType>
```

6.5.13.3 UserInteractionInputs semantics

Semantics of the `UserInteractionInputsType`:

Name	*Definition*
`UserInteractionInputsType`	Tool for describing multiple User interaction input supports of a terminal.
`UserInteractionInput`	Describes a single User interaction input support of a terminal.

6.5.14 UserInteractionInput

6.5.14.1 Introduction

The subclause specifies the various types of User interaction input support that is available on a particular device. With such information available, an adaptation engine could modify the means by which a User would interact with resources contained in a multimedia presentation. Several such instances are elaborated further below.

In one instance, consider an interactive scene that depends on the terminal having a certain number of buttons. In particular, assume two scenes with equivalent purposes are designed. The first depends on the presence of a 3-button mouse, while the second is usable with a 1-button mouse. Given this information, the choice between the delivery of the two scenes can be made.

In a second instance, interaction based on key and string input is considered. Key input is the ability for scene interaction to deal with single keystrokes, thus allowing the author to bind keystrokes to the execution of some commands. String input is the ability for scene interaction to deal with the input of Username, passwords and such multi-keystroke input (with optional editing). If the device is capable of key input, services with simple key bindings can be offered. Otherwise, if a mouse or pen is present, services with menus can be offered. Information pertaining to the key input may allow the adaptation engine to choose between two appropriate scenes along this User interaction dimension. In the same way, further information about the string input capability may allow the adaptation engine to choose between a scene requiring input of strings and an equivalent scene making use of a voice-activated server.

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6.5.14.2 UserInteractionInput syntax

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

<complexType name="UserInteractionInputType">
   <complexContent>
      <extension base="dia:DIABaseType">
         <sequence>
            <element name="UserInteractionInputSupport"
               type="dia:UserInteractionInputSupportBaseType"
               minOccurs="0" maxOccurs="unbounded"/>
         </sequence>
      </extension>
   </complexContent>
</complexType>

<complexType name="UserInteractionInputSupportBaseType" abstract="true">
   <complexContent>
      <extension base="dia:DIABaseType"/>
   </complexContent>
</complexType>
<complexType name="StringInputType">
   <complexContent>
      <extension base="dia:UserInteractionInputSupportBaseType"/>
   </complexContent>
</complexType>

<complexType name="KeyInputType">
   <complexContent>
      <extension base="dia:UserInteractionInputSupportBaseType">
         <sequence>
            <element name="KeyInput" type="mpeg7:ControlledTermUseType"/>
         </sequence>
      </extension>
   </complexContent>
</complexType>

<complexType name="MicrophoneType">
   <complexContent>
      <extension base="dia:UserInteractionInputSupportBaseType"/>
   </complexContent>
</complexType>

<complexType name="MouseType">
   <complexContent>
      <extension base="dia:UserInteractionInputSupportBaseType">
         <sequence>
            <element name="Mouse" type="dia:GenericMouseType"/>
         </sequence>
      </extension>
   </complexContent>
</complexType>

<complexType name="TrackballType">
   <complexContent>
      <extension base="dia:UserInteractionInputSupportBaseType">
         <sequence>
            <element name="Trackball" type="dia:GenericMouseType"/>
         </sequence>
      </extension>
```

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```
    </complexContent>
</complexType>

<complexType name="PenType">
    <complexContent>
        <extension base="dia:UserInteractionInputSupportBaseType">
            <sequence>
                <element name="Pen" type="dia:GenericPenType"/>
            </sequence>
        </extension>
    </complexContent>
</complexType>

<complexType name="TabletType">
    <complexContent>
        <extension base="dia:UserInteractionInputSupportBaseType">
            <sequence>
                <element name="Tablet" type="dia:GenericPenType"/>
            </sequence>
        </extension>
    </complexContent>
</complexType>

<complexType name="GenericMouseType">
    <complexContent>
        <extension base="dia:DIABaseType">
            <attribute name="resolution" type="nonNegativeInteger" use="optional"/>
            <attribute name="buttons" type="nonNegativeInteger" use="required"/>
            <attribute name="scrollWheel" type="boolean" use="optional"/>
        </extension>
    </complexContent>
</complexType>

<complexType name="GenericPenType">
    <complexContent>
        <extension base="dia:DIABaseType">
            <attribute name="resolution" type="nonNegativeInteger" use="optional"/>
        </extension>
    </complexContent>
</complexType>
```

6.5.14.3 UserInteractionInput semantics

Semantics of the `UserInteractionInputType`:

Name	*Definition*
`UserInteractionInputType`	Tool for describing the User interaction input support of the terminal.
`UserInteractionInput`	Describes the User interaction input support of the terminal.

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Semantics of the `UserInteractionInputSupportBaseType`:

Name	*Definition*
`UserInteractionInputSupportBaseType`	`UserInteractionInputSupportBaseType` extends `DIABaseType` and provides a base abstract type for a subset of types defined as part of the `UserInteractionInputType`.

Semantics of the `StringInputType`:

Name	*Definition*
`StringInputType`	Tool for describing the string input capability of the terminal, i.e., the capability to enter words or sentences. The presence of the `StringInputType` indicates that string input is available.

Semantics of the `KeyInputType`:

Name	*Definition*
`KeyInputType`	Tool for describing the key input capabilities of the terminal, i.e., the capability to enter single characters.
`KeyInput`	Describes the type of key input that the terminal supports. A CS that may be used for this purpose is the `KeyInputCS` defined in Annex A.2.7.

Semantics of the `MicrophoneType`:

Name	*Definition*
`MicrophoneType`	Tool for describing the microphone capabilities of the terminal. The presence of the `MicrophoneType` indicates that microphone input is available.

Semantics of the `MouseType`:

Name	*Definition*
`MouseType`	Tool for describing the mouse input capabilities of the terminal, i.e., the capability to enter input through a mouse.
`Mouse`	Describes the capabilities of the mouse input device.

Semantics of the `TrackballType`:

Name	*Definition*
`TrackballType`	Tool for describing the trackball input capabilities of the terminal, i.e., the capability to enter input through a trackball.
`Trackball`	Describes the capabilities of the trackball input device.

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Semantics of the `PenType`:

Name	*Definition*
`PenType`	Tool for describing the pen input capabilities of the terminal, i.e., the capability to enter input through a pen.
`Pen`	Describes the capabilities of the pen input device.

Semantics of the `TabletType`:

Name	*Definition*
`TabletType`	Tool for describing the tablet input capabilities of the terminal, i.e., the capability to enter input through a tablet.
`Tablet`	Describes the capabilities of the tablet input device.

Semantics of the `GenericMouseType`:

Name	*Definition*
`GenericMouseType`	Tool for describing the User interaction input support of the terminal.
`resolution`	Describes the resolution of the mouse in units of pixels.
`buttons`	Describes the number of buttons that the mouse is equipped with.
`scrollWheel`	Indicates whether or not the mouse has a scroll wheel.

Semantics of the `GenericPenType`:

Name	*Definition*
`GenericPenType`	Tool for describing the User interaction input support of the terminal.
`resolution`	Describes the resolution of the pen in units of pixels.

6.5.15 DeviceClass

6.5.15.1 Introduction

This subclause specifies the device class of the terminal. With this tool, it is possible to identify consumer devices such as PC and mobile phones from communication devices such as gateways and routers.

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6.5.15.2 DeviceClass syntax

```
<!-- ################################################ -->
<!--  Definition of DeviceClass                       -->
<!-- ################################################ -->

<complexType name="DeviceClassType">
   <complexContent>
      <extension base="dia:TerminalCapabilityBaseType">
         <sequence>
            <element name="DeviceClass" type="mpeg7:ControlledTermUseType"
               minOccurs="0"/>
         </sequence>
      </extension>
   </complexContent>
</complexType>
```

6.5.15.3 DeviceClass semantics

Semantics of the `DeviceClassType`:

Name	*Definition*
`DeviceClassType`	Tool that describes the device class of a terminal.
`DeviceClass`	Describes the type of terminal. A CS that may be used for this purpose is the `DeviceClassCS` defined in Annex A.2.4.

6.5.16 PowerCharacteristics

6.5.16.1 Introduction

This subclause specifies power characteristics of the terminal. With this tool, it is possible for a sending device to know the average ampere consumption and battery capacity and time that is remaining on a device. Such information may be considered when determining the type of resources to transmit to the device or the parameters of encoded resources. For instance, a device with low battery capacity may not be able to render video at a full frame-rate for the required period of time.

6.5.16.2 PowerCharacteristics syntax

```
<!-- ################################################ -->
<!--  Definition of PowerCharacteristics              -->
<!-- ################################################ -->

<complexType name="PowerCharacteristicsType">
   <complexContent>
      <extension base="dia:TerminalCapabilityBaseType">
         <attribute name="averageAmpereConsumption" type="mpeg7:nonNegativeReal"
            use="optional"/>
         <attribute name="batteryCapacityRemaining" type="mpeg7:nonNegativeReal"
             use="optional"/>
         <attribute name="batteryTimeRemaining" type="integer" use="optional"/>
         <attribute name="runningOnBatteries" type="boolean" use="optional"/>
      </extension>
   </complexContent>
</complexType>
```

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6.5.16.3 PowerCharacteristics semantics

Semantics of the `PowerCharacteristicsType`:

Name	*Definition*
`PowerCharacteristicsType`	Tool that describes the power characteristics of a terminal.
`averageAmpereConsumption`	Describes the average ampere consumption of a terminal in units of Ampere.
`batteryCapacityRemaining`	Describes the remaining capacity of a battery in units of Ampere-Hours.
`batteryTimeRemaining`	Describes the time remaining of a battery in units of seconds.
`runningOnBatteries`	Describes whether the terminal is connected to a power grid or any other external power source or if it is running on its own internal batteries. A value of false indicates that the terminal is connected to an external source of power, while a value of true indicates that it is running on internal batteries.

6.5.17 Storages

6.5.17.1 Introduction

This subclause specifies the characteristics of multiple storage units, where the characteristics of a single storage unit are specified by the `Storage` element in the `StoragesType`.

6.5.17.2 Storages syntax

```
<!-- ################################################ -->
<!--  Definition of Storages                          -->
<!-- ################################################ -->

<complexType name="StoragesType">
   <complexContent>
      <extension base="dia:TerminalCapabilityBaseType">
         <sequence>
            <element name="Storage" type="dia:StorageType"
               minOccurs="0" maxOccurs="unbounded"/>
         </sequence>
      </extension>
   </complexContent>
</complexType>
```

6.5.17.3 Storages semantics

Semantics of the `StoragesType`:

Name	*Definition*
`StoragesType`	Tool for describing the characteristics of storage units.
`Storage`	Describes the characteristics of a single storage unit.

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6.5.18 Storage

6.5.18.1 Introduction

This subclause specifies the characteristics of a single storage unit.

6.5.18.2 Storage syntax

```
<!-- ################################################ -->
<!--  Definition of Storage                           -->
<!-- ################################################ -->

<complexType name="StorageType">
   <complexContent>
      <extension base="dia:DIABaseType">
         <sequence>
            <element name="StorageCharacteristic"
               type="dia:StorageCharacteristicBaseType"
               minOccurs="0" maxOccurs="unbounded"/>
         </sequence>
      </extension>
   </complexContent>
</complexType>

<complexType name="StorageCharacteristicBaseType" abstract="true">
   <complexContent>
      <extension base="dia:DIABaseType"/>
   </complexContent>
</complexType>
```

6.5.18.3 Storage semantics

Semantics of the `StorageType`:

Name	*Definition*
`StorageType`	Tool for describing the characteristics of the storage unit.
`StorageCharacteristic`	Describes the characteristics of the storage unit..

Semantics of the `StorageCharacteristicBaseType`:

Name	*Definition*
`StorageCharacteristicBaseType`	`StorageCharacteristicBaseType` extends `DIABaseType` and provides a base abstract type for a subset of types defined as part of the `StorageType`.

6.5.19 StorageCharacteristics

6.5.19.1 Introduction

This subclause specifies storage characteristics of the terminal, which does include input and output transfer rates, the size of the storage and whether the storage is writeable or not.

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6.5.19.2 StorageCharacteristics syntax

```
<!-- ################################################ -->
<!--  Definition of StorageCharacteristics            -->
<!-- ################################################ -->

<complexType name="StorageCharacteristicsType">
   <complexContent>
      <extension base="dia:StorageCharacteristicBaseType">
         <attribute name="inputTransferRate" type="nonNegativeInteger"
            use="optional"/>
         <attribute name="outputTransferRate" type="nonNegativeInteger"
            use="optional"/>
         <attribute name="size" type="float" use="optional"/>
         <attribute name="writable" type="boolean" use="optional"/>
      </extension>
   </complexContent>
</complexType>
```

6.5.19.3 StorageCharacteristics semantics

Semantics of the `StorageCharacteristicsType`:

Name	*Definition*
`StorageCharacteristicsType`	Tools that describe the storage characteristics of a terminal.
`inputTransferRate`	Describes the input transfer rate the storage device is capable of in units of MBytes/second.
`outputTransferRate`	Describes the output transfer rate the storage device is capable of in units of MBytes/second.
`size`	Describes the size of the storage device in units of Mbytes.
`writable`	Specifies if the storage device can be written to. If true, the storage is writable; if false, the storage is not writable.

6.5.20 DataIOs

6.5.20.1 Introduction

This subclause specifies the characteristics of multiple data IOs, where the characteristics of a single data IO are specified by the `DataIO` element in the `DataIOsType`.

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6.5.20.2 DataIOs syntax

```
<!-- ################################################ -->
<!--  Definition of DataIOs                           -->
<!-- ################################################ -->

<complexType name="DataIOsType">
   <complexContent>
      <extension base="dia:TerminalCapabilityBaseType">
         <sequence>
            <element name="DataIO" type="dia:DataIOType"
               minOccurs="0" maxOccurs="unbounded"/>
         </sequence>
      </extension>
   </complexContent>
</complexType>
```

6.5.20.3 DataIOs semantics

Semantics of the `DataIOsType`:

Name	*Definition*
`DataIOsType`	Tool for describing the characteristics of data IOs.
`DataIO`	Describes the characteristics of a single data IO.

6.5.21 DataIO

6.5.21.1 Introduction

This subclause specifies the characteristics of a single data IO.

6.5.21.2 Data IO syntax

```
<!-- ################################################ -->
<!--  Definition of DataIO                            -->
<!-- ################################################ -->

<complexType name="DataIOType">
   <complexContent>
      <extension base="dia:DIABaseType">
         <sequence>
            <element name="DataIOCharacteristic"
               type="dia:DataIOCharacteristicBaseType"
               minOccurs="0" maxOccurs="unbounded"/>
         </sequence>
      </extension>
   </complexContent>
</complexType>

<complexType name="DataIOCharacteristicBaseType" abstract="true">
   <complexContent>
      <extension base="dia:DIABaseType"/>
   </complexContent>
</complexType>
```

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6.5.21.3 DataIO semantics

Semantics of the `DataIOType`:

Name	*Definition*
`DataIOType`	Tool for describing the characteristics of the data IO.
`DataIOCharacteristic`	Describes the characteristics of the data IO.

Semantics of the `DataIOCharacteristicBaseType`:

Name	*Definition*
`DataIOCharacteristicBaseType`	`DataIOCharacteristicBaseType` extends `DIABaseType` and provides a base abstract type for a subset of types defined as part of the `DataIOType`.

6.5.22 DataIOCharacteristics

6.5.22.1 Introduction

This subclause specifies data input-output characteristics of the terminal. Attributes such as the bus width and transfer speed, as well as the maximum number of devices that are supported by a bus and the number of devices currently on the bus, are specified.

6.5.22.2 DataIOCharacteristics syntax

```
<!-- ################################################ -->
<!--  Definition of DataIOCharacteristics             -->
<!-- ################################################ -->

<complexType name="DataIOCharacteristicsType">
   <complexContent>
      <extension base="dia:DataIOCharacteristicBaseType">
         <attribute name="busWidth" type="nonNegativeInteger" use="optional"/>
         <attribute name="transferSpeed" type="nonNegativeInteger"
            use="optional"/>
         <attribute name="maxDevices" type="nonNegativeInteger" use="optional"/>
         <attribute name="numDevices" type="nonNegativeInteger" use="optional"/>
      </extension>
   </complexContent>
</complexType>
```


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6.5.22.3 DataIOCharacteristics semantics

Semantics of the `DataIOCharacteristicsType`:

Name	*Definition*
`DataIOCharacteristicsType`	Tools that describe the IO characteristics of a terminal.
`busWidth`	Describes the width of the bus in units of bits.
`transferSpeed`	Describes the transfer speed that the bus is capable of in units of MBytes/second.
`maxDevices`	Describes the maximum number devices supported by the bus.
`numDevices`	Describes the number of devices currently on the bus.

6.5.23 Benchmarks

6.5.23.1 Introduction

This subclause specifies the benchmark of multiple devices, where the benchmark of a single device are specified by the `Benchmark` element in the `BenchmarksType`.

6.5.23.2 Benchmarks syntax

```
<!-- ################################################ -->
<!--  Definition of Benchmarks                        -->
<!-- ################################################ -->

<complexType name="BenchmarksType">
   <complexContent>
      <extension base="dia:TerminalCapabilityBaseType">
         <sequence>
            <element name="Benchmark" type="dia:BenchmarkType" minOccurs="0"
                 maxOccurs="unbounded"/>
         </sequence>
      </extension>
   </complexContent>
</complexType>
```

6.5.23.3 Benchmarks semantics

Semantics of the `BenchmarksType`:

Name	*Definition*
`BenchmarksType`	Tool for describing the benchmark of multiple devices.
`Benchmark`	Describes the benchmark of a single device.

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6.5.24 Benchmark

6.5.24.1 Introduction

This subclause specifies the benchmark of a single device.

6.5.24.2 Benchmark syntax

```
<!-- ################################################ -->
<!--  Definition of Benchmark                         -->
<!-- ################################################ -->

<complexType name="BenchmarkType">
   <complexContent>
      <extension base="dia:DIABaseType">
         <sequence>
            <element name="DeviceBenchmark" type="dia:DeviceBenchmarkBaseType"
                minOccurs="0" maxOccurs="unbounded"/>
         </sequence>
      </extension>
   </complexContent>
</complexType>

<!-- ################################################ -->
<!--  Definition of DeviceBenchmarkBaseType           -->
<!-- ################################################ -->

<complexType name="DeviceBenchmarkBaseType" abstract="true">
   <complexContent>
      <extension base="dia:DIABaseType"/>
   </complexContent>
</complexType>
```

6.5.24.3 Benchmark semantics

Semantics of the `BenchmarkType`:

Name	*Definition*
`BenchmarkType`	Tool for describing the benchmark of a single device.
`DeviceBenchmark`	Describes the benchmark of a device.

Semantics of the `DeviceBenchmarkBaseType`:

Name	*Definition*
`DeviceBenchmarkBaseType`	`DeviceBenchmarkBaseType` extends `DIABaseType` and provides a base abstract type for a subset of types defined as part of the `BenchmarkType`.

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6.5.25 CPUBenchmark

6.5.25.1 Introduction

This subclause specifies the benchmark of a device in terms of its CPU performance, which is described as the number of integer or floating-point operations per second. With such a measure, the capability of a device to handle a certain type of media, or a media encoded at a certain quality could be inferred.

6.5.25.2 CPUBenchmark syntax

```
<!-- ################################################ -->
<!--  Definition of CPUBenchmarkType                  -->
<!-- ################################################ -->

<complexType name="CPUBenchmarkType">
   <complexContent>
      <extension base="dia:DeviceBenchmarkBaseType">
         <attribute name="name" type="mpeg7:termReferenceType" use="required"/>
         <attribute name="baseValue" type="float" use="required"/>
      </extension>
   </complexContent>
</complexType>
```

6.5.25.3 CPUBenchmark semantics

Semantics of the `CPUBenchmarkType`:

Name	*Definition*
`CPUBenchmarkType`	Tool for describing the benchmark results of the device in terms of its CPU performance.
`name`	Describes the name of the benchmark used. A CS that may be used for this purpose is the `CPUBenchmarkCS` defined in Annex A.2.4.
`baseValue`	Describes the base value of the benchmark results from a CPU performance test.

6.5.26 ThreeDBenchmark

6.5.26.1 Introduction

This subclause specifies the benchmark of a device in terms of its graphics performance. The graphics performance is described by the mean value of all benchmark results from a 3D graphics performance test. With such a measure, the capability of a device to handle a certain type of graphics media, or a graphics media encoded at a certain quality could be inferred.

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6.5.26.2 ThreeDBenchmark syntax

```
<!-- ################################################ -->
<!--  Definition of ThreeDBenchmarkType                    -->
<!-- ################################################ -->

<complexType name="ThreeDBenchmarkType">
   <complexContent>
      <extension base="dia:DeviceBenchmarkBaseType">
         <attribute name="name" type="mpeg7:termReferenceType" use="required"/>
         <attribute name="meanValue" type="float" use="required"/>
      </extension>
   </complexContent>
</complexType>
```

6.5.26.3 ThreeDBenchmark semantics

Semantics of the `3DBenchmarkType`:

Name	*Definition*
`ThreeDBenchmarkType`	Tool for describing the benchmark results of the device in terms of its graphics performance.
`name`	Describes the name of the benchmark used. A CS that may be used for this purpose is the `ThreeDBenchmarkCS` defined in Annex A.2.1.
`meanValue`	Describes the mean value of all benchmark results from a 3D graphics performance test.

6.5.27 IPMPTools

6.5.27.1 Introduction

This subclause specifies the characteristics of IPMP tools of the terminal to facilitate the adaptation of the protected Digital Items. Specific characteristics include the IPMP_Tool class descriptions included in ISO/IEC 13818 and ISO/IEC 14496, as well as IPMPS_Type descriptions included in ISO/IEC 14496. Generally speaking, IPMP tools are modules that perform one or more IPMP function, such as authentication, decryption, watermarking, etc.

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6.5.27.2 IPMPTools syntax

```
<!-- ################################################ -->
<!--  Definition of IPMPTools                         -->
<!-- ################################################ -->

<complexType name="IPMPToolsType">
   <complexContent>
      <extension base="dia:TerminalCapabilityBaseType">
         <sequence>
            <element name="IPMPTool" minOccurs="0" maxOccurs="unbounded">
               <complexType>
                  <simpleContent>
                     <extension base="base64Binary">
                        <attribute name="ToolCategory" use="required">
                           <simpleType>
                              <restriction base="string">
                                 <enumeration value="MPEG2"/>
                                 <enumeration value="MPEG4"/>
                              </restriction>
                           </simpleType>
                        </attribute>
                     </extension>
                  </simpleContent>
               </complexType>
            </element>
            <element name="IPMPSType" type="hexBinary" minOccurs="0"
               maxOccurs="unbounded"/>
         </sequence>
      </extension>
   </complexContent>
</complexType>
```

6.5.27.3 IPMPTools semantics

Semantics of the `IPMPToolsType`:

Name	*Definition*
`IPMPToolsType`	Tool that describes the IPMP tool characteristics of a terminal.
`IPMPTool`	Describes a base-64 encoded IPMP_Tool class defined in ISO/IEC 14496-1: 2004 describing a logical IPMP tool, which includes IPMP tool identifier, optional parametric description of a tool or alternative tools to the given tool. This class is able to describe either ISO/IEC 13818 or ISO/IEC 14496 IPMP tools.
`ToolCategory`	Describes whether the `IPMPTool` is specified as part of ISO/IEC 13818 as indicated by "MPEG2" or ISO/IEC 14496 as indicated by "MPEG4".
`IPMPSType`	Describes the type of the IPMP system as a hooks compliant terminal specified in ISO/IEC 14496-1: 2004.

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6.5.28 ConversionCapabilities

6.5.28.1 Introduction

This subclause specifies the conversion capabilities of a terminal which express the types of conversions that a terminal is capable of performing.

6.5.28.2 Syntax

```
<!-- ################################################ -->
<!--  Definition of ConversionCapabilitiesType        -->
<!-- ################################################ -->

<complexType name="ConversionCapabilitiesType">
   <complexContent>
      <extension base="dia:TerminalCapabilityBaseType">
         <sequence>
            <element name="ConversionCapability"
               type="dia:ConversionCapabilityType"
               minOccurs="0" maxOccurs="unbounded"/>
         </sequence>
      </extension>
   </complexContent>
</complexType>

<!-- ########################################### -->
<!-- ConversionCapabilityType                    -->
<!-- ########################################### -->

<complexType name="ConversionCapabilityType">
   <complexContent>
      <extension base="dia:ConversionDescriptionBaseType">
         <sequence>
            <any namespace="##other" processContents="lax" minOccurs="0"/>
         </sequence>
      </extension>
   </complexContent>
</complexType>
```

6.5.28.3 Semantics

Semantics of the `ConversionCapabilitiesType`:

Name	*Definition*
`ConversionCapabilitiesType`	Tool for describing the conversions that a terminal is capable of performing. NOTE 1 Each child shall be a conversion capability description that identifies a conversion the terminal is capable of performing.
`ConversionCapability`	Describes a conversion that a terminal is capable of performing.

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Semantics of the `ConversionCapabilityType`:

Name	*Definition*
`ConversionCapabilityType`	Tool for describing a conversion that a terminal is capable of performing.
`any`	Describes a conversion that a terminal is capable of performing using XML. NOTE 2 Provides an extension mechanism which allows the inclusion of conversion descriptions defined within other parts of ISO/IEC 21000 or even other standardization bodies.

6.5.29 RELCapabilities

6.5.29.1 Introduction

This subclause specifies the rights expression languages a terminal supports. A terminal can support none, one, or multiple rights expression languages (RELs). In the case of supporting multiple RELs, the terminal can also specify the preference level for each one of them.

6.5.29.2 RELCapabilities syntax

```
<!-- ################################################ -->
<!--  Definition of RELCapabilities                   -->
<!-- ################################################ -->

<complexType name="RELCapabilitiesType">
   <complexContent>
      <extension base="dia:TerminalCapabilityBaseType">
         <sequence>
            <element name="RightsLanguage" type="dia:RELCapabilityType"
               minOccurs="0" maxOccurs="unbounded"/>
         </sequence>
      </extension>
   </complexContent>
</complexType>
```

6.5.29.3 RELCapabilities semantics

Semantics of the `RELCapabilitiesType`:

Name	*Definition*
`RELCapabilitiesType`	Tool for describing the rights expression language capabilities a terminal supports.
`RightsLanguage`	Describes a rights expression language supported by a terminal.

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6.5.30 RELCapability

6.5.30.1 Introduction

This subclause specifies a rights language that a terminal supports.

6.5.30.2 RELCapability syntax

```
<!-- ################################################ -->
<!--  Definition of RELCapability                     -->
<!-- ################################################ -->

<complexType name="RELCapabilityType">
   <complexContent>
      <extension base="dia:DIABaseType">
         <sequence>
            <element name="Name" type="mpeg7:ControlledTermUseType"/>
         </sequence>
         <attribute name="preferenceLevel" type="positiveInteger"
            use="optional"/>
      </extension>
   </complexContent>
</complexType>
```

6.5.30.3 RELCapability semantics

Semantics of the `RELCapabilityType`:

Name	*Definition*
`RELCapabilityType`	Tool for describing a rights expression language a terminal supports.
`Name`	Describes the name of a rights language. A classification scheme that may be used for this purpose is the `RightsLanguagesCS` defined in Annex A.2.16.
`preferenceLevel`	Describes the preference level of a rights language among the supported ones by a terminal. The value of one indicates the top preference level.

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6.5.31 Terminal capabilities examples

EXAMPLE 1 As a first example, an instantiation of the codec capabilities of the terminal is given below. In this description instance, the terminal is capable of decoding MP3 and AMR audio formats, the JPEG image format, and the MPEG-4 video format (Simple Profile @ Level 1). It is also able to encode audio in an AMR format and encode video in the MPEG-4 format (Simple Profile @ Level 1).

```
<DIA>
    <Description xsi:type="UsageEnvironmentType">
        <UsageEnvironmentProperty xsi:type="TerminalsType">
            <Terminal>
                <TerminalCapability xsi:type="CodecCapabilitiesType">
                    <Decoding xsi:type="AudioCapabilitiesType">
                        <Format
                            href="urn:mpeg:mpeg7:cs:AudioCodingFormatCS:2001:4.4">
                            <mpeg7:Name xml:lang="en">MP3</mpeg7:Name>
                        </Format>
                        <Format href="urn:mpeg:mpeg7:cs:AudioCodingFormatCS:2001:6">
                            <mpeg7:Name xml:lang="en">AMR</mpeg7:Name>
                        </Format>
                    </Decoding>
                    <Decoding xsi:type="ImageCapabilitiesType">
                        <Format href="urn:mpeg:mpeg7:cs:VisualCodingFormatCS:2001:4">
                            <mpeg7:Name xml:lang="en">JPEG</mpeg7:Name>
                        </Format>
                    </Decoding>
                    <Decoding xsi:type="VideoCapabilitiesType">
                        <Format
                            href="urn:mpeg:mpeg7:cs:VisualCodingFormatCS:2001:3.1.2">
                            <mpeg7:Name xml:lang="en">
                                MPEG-4 Visual Simple Profile @ Level 1
                            </mpeg7:Name>
                        </Format>
                    </Decoding>
                    <Encoding xsi:type="AudioCapabilitiesType">
                        <Format href="urn:mpeg:mpeg7:cs:AudioCodingFormatCS:2001:6">
                            <mpeg7:Name xml:lang="en">AMR</mpeg7:Name>
                        </Format>
                    </Encoding>
                    <Encoding xsi:type="VideoCapabilitiesType">
                        <Format
                            href="urn:mpeg:mpeg7:cs:VisualCodingFormatCS:2001:3.1.2">
                            <mpeg7:Name xml:lang="en">
                                MPEG-4 Visual Simple Profile @ Level 1
                            </mpeg7:Name>
                        </Format>
                    </Encoding>
                </TerminalCapability>
            </Terminal>
        </UsageEnvironmentProperty>
    </Description>
</DIA>
```

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EXAMPLE 2 In the second example shown below, several input-output characteristics of a terminal are shown. According to the description, this particular terminal has two displays, a primary display with a resolution of 720x480 and a secondary display with a resolution of 176x144. This description instance also indicates properties of the audio output, as well as the different types of input devices that may be used to interact with the terminal.

```
<DIA>
    <Description xsi:type="UsageEnvironmentType">
        <UsageEnvironmentProperty xsi:type="TerminalsType">
            <Terminal>
                <TerminalCapability xsi:type="DisplaysType">
                    <Display id="primary_display">
                        <DisplayCapability xsi:type="DisplayCapabilityType">
                            <Mode>
                                <Resolution horizontal="720" vertical="480"/>
                            </Mode>
                        </DisplayCapability>
                    </Display>
                    <Display id="secondary_display">
                        <DisplayCapability xsi:type="DisplayCapabilityType">
                            <Mode>
                                <Resolution horizontal="176" vertical="144"/>
                            </Mode>
                        </DisplayCapability>
                    </Display>
                </TerminalCapability>
                <TerminalCapability xsi:type="AudioOutputsType">
                    <AudioOutput xsi:type="AudioOutputType">
                        <AudioOutputCapability xsi:type="AudioOutputCapabilitiesType"
                            lowFrequency="30" highFrequency="8000" numChannels="2"/>
                    </AudioOutput>
                </TerminalCapability>
                <TerminalCapability xsi:type="UserInteractionInputsType">
                    <UserInteractionInput>
                        <UserInteractionInputSupport xsi:type="MicrophoneType"/>
                    </UserInteractionInput>
                    <UserInteractionInput>
                        <UserInteractionInputSupport xsi:type="KeyInputType">
                            <KeyInput
                                href="urn:mpeg:mpeg21:2003:01-DIA-KeyInputCS-NS:1">
                                <mpeg7:Name xml:lang="en">PCKeyboard</mpeg7:Name>
                            </KeyInput>
                        </UserInteractionInputSupport>
                    </UserInteractionInput>
                    <UserInteractionInput>
                        <UserInteractionInputSupport xsi:type="MouseType">
                            <Mouse buttons="2" scrollwheel="true"/>
                        </UserInteractionInputSupport>
                    </UserInteractionInput>
                </TerminalCapability>
            </Terminal>
        </UsageEnvironmentProperty>
    </Description>
</DIA>
```


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EXAMPLE 3 The third example shown below describes various device properties including power, storage, data IO characteristics, benchmark, and IPMPTool characteristics. The description also indicates that the device class is a PC.

```
<DIA>
    <Description xsi:type="UsageEnvironmentType">
        <UsageEnvironmentProperty xsi:type="TerminalsType">
            <Terminal>
                <TerminalCapability xsi:type="PowerCharacteristicsType"
                    batteryTimeRemaining="4200"/>
                <TerminalCapability xsi:type="StoragesType">
                    <Storage xsi:type="StorageType">
                        <StorageCharacteristic xsi:type="StorageCharacteristicsType"
                            inputTransferRate="8" size="1200" writable="true"/>
                    </Storage>
                </TerminalCapability>
                <TerminalCapability xsi:type="DataIOsType">
                    <DataIO xsi:type="DataIOType">
                        <DataIOCharacteristic xsi:type="DataIOCharacteristicsType"
                            busWidth="128"/>
                    </DataIO>
                </TerminalCapability>
                <TerminalCapability xsi:type="DeviceClassType">
                    <DeviceClass
                        href="urn:mpeg:mpeg21:2003:01-DIA-DeviceClassCS-NS:1">
                        <mpeg7:Name xml:lang="en">PC</mpeg7:Name>
                    </DeviceClass>
                </TerminalCapability>
                <TerminalCapability xsi:type="BenchmarksType">
                    <Benchmark>
                        <DeviceBenchmark xsi:type="CPUBenchmarkType"
                        name="urn:mpeg:mpeg21:2003:01-DIA-CPUBenchmarkCS-NS:CINT2000"
                        baseValue="1062.0"/>
                        <DeviceBenchmark xsi:type="CPUBenchmarkType"
                        name="urn:mpeg:mpeg21:2003:01-DIA-CPUBenchmarkCS-NS:CFP2000"
                        baseValue="970.0"/>
                        <DeviceBenchmark xsi:type="ThreeDBenchmarkType"
                        name="urn:mpeg:mpeg21:2003:01-DIA-ThreeDBenchmarkCS-NS:UGS03"
                        meanValue="23.56"/>
                        <DeviceBenchmark xsi:type="ThreeDBenchmarkType"
                        name="urn:mpeg:mpeg21:2003:01-DIA-ThreeDBenchmarkCS-NS:DRV09"
                        meanValue="90.41"/>
                    </Benchmark>
                </TerminalCapability>
                <TerminalCapability xsi:type="IPMPToolsType">
                    <IPMPTool ToolCategory="MPEG4">
                        VndCTFFVZkF5a0F5U1FBWlFRTklCRUFIMEFBQVBvQUFBRDZBQVlRQUVR
                    </IPMPTool>
                    <IPMPSType>0AC1</IPMPSType>
                </TerminalCapability>
            </Terminal>
        </UsageEnvironmentProperty>
    </Description>
</DIA>
```

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EXAMPLE 4 This example describes a terminal capable of dithering and scaling.

```
<DIA>
   <Description xsi:type="TerminalsType">
      <Terminal>
         <TerminalCapability xsi:type="ConversionCapabilitiesType">
            <ConversionCapability>
               <ConversionActUri uri="urn:mpeg:mpeg21:2003:01-RDD-NS:dither"/>
            </ConversionCapability >
            <ConversionCapability>
               <ConversionActUri uri="http://www.adaptationRUs.com/scale"/>
            </ConversionCapability >
         </TerminalCapability>
      </Terminal>
   </Description>
</DIA>
```

EXAMPLE 5 The following example provides an instantiation of the RELCapabilities of the terminal. In this example, the terminal is capable to interpret the following languages in decreased level preference: ISO/IEC 21000-5 Base profile and ISO/IEC 21000-5.

```
<DIA>
  <Description xsi:type="UsageEnvironmentType">
    <UsageEnvironmentProperty xsi:type="TerminalsType">
      <Terminal>
        <TerminalCapability xsi:type="RELCapabilitiesType">
          <RightsLanguage xsi:type="RELCapabilityType" PreferenceLevel="1">
            <Name
               href="urn:mpeg:mpeg21:2003:01-DIA-RightsLanguagesCS-
NS:2003:RELProfile:Base">
              <mpeg7:Name xml:lang="en">MPEG-21 REL Base Profile</mpeg7:Name>
            </Name>
          </RightsLanguage>
          <RightsLanguage xsi:type="RELCapabilityType" PreferenceLevel="2">
            <Name
               href="urn:mpeg:mpeg7:2003:01-DIA-RightsLanguagesCS-NS:2003:REL">
              <mpeg7:Name xml:lang="en">MPEG-21 REL</mpeg7:Name>
            </Name>
          </RightsLanguage>
        </TerminalCapability>
      </Terminal>
    </UsageEnvironmentProperty>
  </Description>
</DIA>
```

6.6 Network characteristics

6.6.1 Introduction

This subclause specifies network characteristics in terms of network capabilities and conditions, including available bandwidth, delay and error characteristics. These descriptions could be used for efficient and robust transmission of resources.

6.6.2 Networks

6.6.2.1 Introduction

This subclause specifies the characteristics of multiple networks, where the characteristics of a single network are specified by the `Network` element in the `NetworksType`.

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6.6.2.2 Networks syntax

```
<!-- ################################################ -->
<!--  Definition of Networks                          -->
<!-- ################################################ -->

<complexType name="NetworksType">
   <complexContent>
      <extension base="dia:UsageEnvironmentPropertyBaseType">
         <sequence>
            <element name="Network" type="dia:NetworkType"
               minOccurs="0" maxOccurs="unbounded"/>
         </sequence>
      </extension>
   </complexContent>
</complexType>
```

6.6.2.3 Networks semantics

Semantics of the `NetworksType`:

Name	*Definition*
`NetworksType`	Tool for describing the characteristics of networks.
`Network`	Describes a single network in terms of its static capabilities and time-varying conditions.

6.6.3 Network

6.6.3.1 Introduction

This subclause specifies the characteristics of a single network. Specific characteristics include static network capabilities, such as the maximum capacity of a channel, as well as time-vary conditions such as the available bandwidth, error characteristics and attributes that describe the delay.

6.6.3.2 Network syntax

```
<!-- ################################################ -->
<!--  Definition of Network                           -->
<!-- ################################################ -->

<complexType name="NetworkType">
   <complexContent>
      <extension base="dia:DIABaseType">
         <sequence>
            <element name="NetworkCharacteristic"
               type="dia:NetworkCharacteristicBaseType"
               minOccurs="0" maxOccurs="unbounded"/>
         </sequence>
      </extension>
   </complexContent>
</complexType>

<complexType name="NetworkCharacteristicBaseType" abstract="true">
   <complexContent>
      <extension base="dia:DIABaseType"/>
   </complexContent>
</complexType>
```

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6.6.3.3 Network semantics

Semantics of the `NetworkType`:

Name	*Definition*
`NetworkType`	Tool for describing characteristics of a single network.
`NetworkCharacteristic`	Describes a characteristic of the network in terms of static capabilities and time-varying conditions.

Semantics of the `NetworkCharacteristicBaseType`:

Name	*Definition*
`NetworkCharacteristicBaseType`	`NetworkCharacteristicBaseType` extends `DIADescriptionType` and provides a base abstract type for a subset of types defined as part of the `NetworkType`.

6.6.4 NetworkCapability

6.6.4.1 Introduction

This subclause specifies the static capabilities of a network, which includes attributes that describe the maximum capacity of a network and the minimum guaranteed bandwidth that a network can provide. Also specified are attributes that indicate if the network can provide in-sequence packet delivery and how the network deals with erroneous packets, i.e., does it forward, correct or discard them.

6.6.4.2 NetworkCapability syntax

```
<!-- ######################################## -->
<!--  Definition of NetworkCapability         -->
<!-- ######################################## -->

<complexType name="NetworkCapabilityType">
   <complexContent>
      <extension base="dia:NetworkCharacteristicBaseType">
         <attribute name="maxCapacity" type="nonNegativeInteger"
            use="optional"/>
         <attribute name="minGuaranteed" type="nonNegativeInteger"
            use="optional"/>
         <attribute name="inSequenceDelivery" type="boolean" use="optional"/>
         <attribute name="errorDelivery" type="boolean" use="optional"/>
         <attribute name="errorCorrection" type="boolean" use="optional"/>
         <attribute name="maxPacketSize" type="positiveInteger" use="optional"/>
      </extension>
   </complexContent>
</complexType>
```


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6.6.4.3 NetworkCapability semantics

Semantics of the `NetworkCapabilityType`:

Name	*Definition*
`NetworkCapabilityType`	Tool for describing the static capabilities of a network.
`maxCapacity`	Describes the maximum bandwidth capacity of a network in bits/sec.
`minGuaranteed`	Describes the minimum guaranteed bandwidth of a network in bits/sec.
`inSequenceDelivery`	Describes the capability of a network to provide in-sequence delivery of data units. If 'true' the network guarantees in-sequence delivery; if 'false' in-sequence delivery is not guaranteed.
`errorDelivery`	Describes whether data units containing errors are delivered or dropped by the network. If 'true' then the erroneous data units are delivered; if 'false' then the erroneous data units are dropped.
`errorCorrection`	Describes whether data units containing errors are corrected or not by the network. If ‘true’ then the erroneous data units are corrected; if ‘false’ then the erroneous data units are not corrected.
`maxPacketSize`	Describes the maximum size of a packet in bit. NOTE This attribute is considered for technologies that support packet transport (e.g. Internet Protocol networks).

6.6.5 NetworkCondition

6.6.5.1 Introduction

This subclause specifies the dynamic conditions of a network including attributes that describe the available bandwidth, error and delay. The error is specified in terms of packet loss rate and bit error rate. Several types of delay are considered, including one-way and two-way packet delay, as well as delay variation. Available bandwidth includes attributes that describe the minimum, maximum, and average available bandwidth of a network. Since these conditions are dynamic, time stamp information is also needed. Consequently, the start time and duration of all measurements pertaining to network conditions are also specified.

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6.6.5.2 NetworkCondition syntax

```
<!-- ########################################  -->
<!--  Definition of NetworkCondition           -->
<!-- ########################################  -->

<complexType name="NetworkConditionType">
   <complexContent>
      <extension base="dia:NetworkCharacteristicBaseType">
         <sequence>
            <element name="AvailableBandwidth" minOccurs="0">
               <complexType>
                  <attribute name="minimum"
                     type="nonNegativeInteger" use="optional"/>
                  <attribute name="maximum"
                     type="nonNegativeInteger" use="optional"/>
                  <attribute name="average"
                     type="nonNegativeInteger" use="optional"/>
               </complexType>
            </element>
            <element name="Delay" minOccurs="0" >
               <complexType>
                  <attribute name="packetTwoWay"
                     type="nonNegativeInteger" use="optional"/>
                  <attribute name="packetOneWay"
                     type="nonNegativeInteger" use="optional"/>
                  <attribute name="delayVariation"
                     type="integer" use="optional"/>
               </complexType>
            </element>
            <element name="Error" minOccurs="0" >
               <complexType>
                  <attribute name="packetLossRate"
                     type="mpeg7:nonNegativeReal" use="optional"/>
                  <attribute name="bitErrorRate"
                     type="nonNegativeInteger" use="optional"/>
               </complexType>
            </element>
         </sequence>
         <attribute name="startTime" type="mpeg7:timePointType" use="optional"/>
         <attribute name="duration" type="mpeg7:durationType" use="optional"/>
      </extension>
   </complexContent>
</complexType>
```

6.6.5.3 NetworkCondition semantics

Semantics of the `NetworkConditionType`:

Name	*Definition*
`NetworkConditionType`	Tool for describing the time-varying conditions of a network.
`AvailableBandwidth`	Describes the available bandwidth of a network.
`minimum`	Describes the minimum available bandwidth in bits per second of the network.
`maximum`	Describes the maximum available bandwidth in bits per second of the network.
`average`	Describes the average available bandwidth in bits per second of the network.

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Name	*Definition*
`Delay`	Describes the delay characteristics of a network.
`packetOneWay`	Describes one-way packet delay of the network in milliseconds.
`packetTwoWay`	Describes round-trip packet delay of the network in milliseconds.
`delayVariation`	Describes the difference between the one-way packet delay of two successive packets. This difference is specified in milliseconds and relates to packets within the same stream and on the same network.
`Error`	Describes the error characteristics of the network.
`packetLossRate`	Describes the packet loss rate on the network. It ranges from 0.0 to 1.0 where 0.0 indicates no loss, and 1.0 indicates 100% loss.
`bitErrorRate`	Describes the bit-error rate on the network. The non-negative integer corresponds to the value n in the expression, 10^{-n}.
`startTime`	Describes the start time of measurement for all attributes of `NetworkConditionType`.
`duration`	Describes the duration of measurement for all attributes of `NetworkConditionType`. Default value is 1 second.

6.6.6 Network characteristics example

EXAMPLE The following example describes a network that is characterized by a maximum capacity of 384 kbps and a minimum guaranteed bandwidth of 32 kbps. Over a `duration` of 330 milliseconds, this description indicates that the maximum bandwidth achieved was 256 kbps and the average over that time was 80 kbps. Other attributes for the delay and error characteristics are described as well.

```
<DIA>
    <Description xsi:type="UsageEnvironmentType">
        <UsageEnvironmentProperty xsi:type="NetworksType">
            <Network>
                <NetworkCharacteristic xsi:type="NetworkCapabilityType"
                    maxCapacity="384000" minGuaranteed="32000"/>
                <NetworkCharacteristic xsi:type="NetworkConditionType"
                    duration="PT330N1000F">
                    <AvailableBandwidth maximum="256000" average="80000"/>
                    <Delay packetTwoWay="330" delayVariation="66"/>
                    <Error packetLossRate="0.05"/>
                </NetworkCharacteristic>
            </Network>
        </UsageEnvironmentProperty>
    </Description>
</DIA>
```

6.7 Natural environment characteristics

6.7.1 Introduction

This subclause specifies tools for describing natural environment characteristics including location and time of usage of a Digital Item, as well as characteristics that pertain to audio-visual aspects. For the visual aspects, illumination characteristics that may affect the perceived display of visual information are specified. For the audio aspects, the description of the noise levels and a noise frequency spectrum are specified.

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6.7.2 NaturalEnvironments

6.7.2.1 Introduction

This subclause specifies the characteristics of multiple natural environments, where the characteristics of a single natural environment are specified by the `NaturalEnvironment` element in the `NaturalEnvironmentsType`.

6.7.2.2 NaturalEnvironments syntax

```
<!-- ################################################ -->
<!--  Definition of NaturalEnvironments               -->
<!-- ################################################ -->

<complexType name="NaturalEnvironmentsType">
   <complexContent>
      <extension base="dia:UsageEnvironmentPropertyBaseType">
         <sequence>
            <element name="NaturalEnvironment"
               type="dia:NaturalEnvironmentType"
               minOccurs="0" maxOccurs="unbounded"/>
         </sequence>
      </extension>
   </complexContent>
</complexType>
```

6.7.2.3 NaturalEnvironment semantics

Semantics of the `NaturalEnvironmentsType`:

Name	*Definition*
`NaturalEnvironmentsType`	Tool for describing the characteristics of natural environments.
`NaturalEnvironment`	Describes a single natural environment in terms of the location and time of usage of a Digital Item, as well as audio-visual characteristics of the natural usage environment.

6.7.3 NaturalEnvironment

6.7.3.1 Introduction

This subclause specifies the characteristics of a single natural environment. Specific characteristics include the location and time of usage of a Digital Item, as well as audio-visual characteristics of the natural usage environment.

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6.7.3.2 NaturalEnvironment syntax

```
<!-- ################################################ -->
<!--  Definition of NaturalEnvironment                -->
<!-- ################################################ -->

<complexType name="NaturalEnvironmentType">
   <complexContent>
      <extension base="dia:DIABaseType">
         <sequence>
            <element name="NaturalEnvironmentCharacteristic"
               type="dia:NaturalEnvironmentCharacteristicBaseType"
               minOccurs="0" maxOccurs="unbounded"/>
         </sequence>
      </extension>
   </complexContent>
</complexType>

<complexType name="NaturalEnvironmentCharacteristicBaseType" abstract="true">
   <complexContent>
      <extension base="dia:DIABaseType"/>
   </complexContent>
</complexType>
```

6.7.3.3 NaturalEnvironment semantics

Semantics of the `NaturalEnvironmentType`:

Name	*Definition*
`NaturalEnvironmentType`	Tool for describing the characteristics of the natural environment of usage of a Digital Item.
`NaturalEnvironmentCharacteristic`	Describes the location and time of usage of a Digital Item, as well as audio-visual characteristics of the natural usage environment.

Semantics of the `NaturalEnvironmentCharacteristicBaseType`:

Name	*Definition*
`NaturalEnvironmentCharacteristicBaseType`	`NaturalEnvironmentCharacteristicBaseType` extends `DIADescriptionType` and provides a base abstract type for a subset of types defined as part of the `NaturalEnvironmentCharacteristicType`.

6.7.4 Location

6.7.4.1 Introduction

This subclause specifies a tool for describing the location of usage of Digital Items by a User based on the `PlaceType` specified in ISO/IEC 15938-5. This tool is able to describe existing, historical, and fictional places, as well as precise geographical location in terms of latitude, longitude, and altitude. Additionally, postal addresses or internal coordinates of the place, e.g., an apartment or room number, the conference room, could be described.

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6.7.4.2 Location syntax

```
<!-- ################################################ -->
<!--  Definition of Location                          -->
<!-- ################################################ -->

<complexType name="LocationType">
   <complexContent>
      <extension base="dia:NaturalEnvironmentCharacteristicBaseType">
         <sequence>
            <element name="Location" type="mpeg7:PlaceType"/>
         </sequence>
      </extension>
   </complexContent>
</complexType>
```

6.7.4.3 Location semantics

Semantics of the `LocationType`:

Name	*Definition*
`LocationType`	Tool for describing the location of the usage of a Digital Item.
`Location`	Describes the location of the usage of a Digital Item. The syntax and semantics of `PlaceType` are specified in ISO/IEC 15938-5.

6.7.4.4 Location example

EXAMPLE The following example shows the use of `Location` to express a precise geographic position somewhere in Japan. Specific coordinates for latitude, longitude and altitude are given.

```
<DIA>
   <Description xsi:type="UsageEnvironmentType">
      <UsageEnvironmentProperty xsi:type="NaturalEnvironmentsType">
         <NaturalEnvironment>
            <NaturalEnvironmentCharacteristic xsi:type="LocationType">
               <Location>
                  <mpeg7:GeographicPosition>
                     <mpeg7:Point longitude="135.75" latitude="35.00"
                        altitude="10.00"/>
                  </mpeg7:GeographicPosition>
                  <mpeg7:Region>jp</mpeg7:Region>
               </Location>
            </NaturalEnvironmentCharacteristic>
         </NaturalEnvironment>
      </UsageEnvironmentProperty>
   </Description>
</DIA>
```

6.7.5 Time

6.7.5.1 Introduction

This subclause specifies a tool for describing the time of usage of Digital Items by a User based on the `TimeType` specified in ISO/IEC 15938-5. This tool can describe dates, time points relative to a time base, and the duration of time.

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6.7.5.2 Time syntax

```
<!-- ################################################ -->
<!--  Definition of Time                              -->
<!-- ################################################ -->

<complexType name="TimeType">
   <complexContent>
      <extension base="dia:NaturalEnvironmentCharacteristicBaseType">
         <sequence>
            <element name="Time" type="mpeg7:TimeType"/>
         </sequence>
      </extension>
   </complexContent>
</complexType>
```

6.7.5.3 Time semantics

Semantics of the `TimeType`:

Name	*Definition*
`TimeType`	Tool for describing the time of the usage of a Digital Item.
`Time`	Describes the time of the usage of a Digital Item. The syntax and semantics of `TimeType` are specified in ISO/IEC 15938-5.

6.7.5.4 Time example

EXAMPLE The following example shows the use of `Time` to define an instant on July 10, 1998, at 15:22, in a time zone that is 1 hour different from UTC (Coordinated Universal Time).

```
<DIA>
   <Description xsi:type="UsageEnvironmentType">
      <UsageEnvironmentProperty xsi:type="NaturalEnvironmentsType">
         <NaturalEnvironment>
            <NaturalEnvironmentCharacteristic xsi:type="TimeType">
               <Time>
                  <mpeg7:TimePoint>1998-07-10T15:22+01:00</mpeg7:TimePoint>
               </Time>
            </NaturalEnvironmentCharacteristic>
         </NaturalEnvironment>
      </UsageEnvironmentProperty>
   </Description>
</DIA>
```

6.7.6 AudioEnvironment

6.7.6.1 Introduction

`AudioEnvironment` describes the natural audio environment of a particular User in terms of the measured noise level and noise frequency spectrum. These descriptions can be used by audio resource adaptation engine to deliver the best experience of audio contents.

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6.7.6.2 AudioEnvironment syntax

```
<!-- ########################################  -->
<!--  Definition of AudioEnvironment           -->
<!-- ########################################  -->

<complexType name="AudioEnvironmentType">
   <complexContent>
      <extension base="dia:NaturalEnvironmentCharacteristicBaseType">
         <sequence>
            <element name="NoiseLevel" type="float" minOccurs="0"/>
            <element name="NoiseFrequencySpectrum" minOccurs="0">
               <simpleType>
                  <restriction base="mpeg7:floatVector">
                     <length value="33"/>
                  </restriction>
               </simpleType>
            </element>
         </sequence>
      </extension>
   </complexContent>
</complexType>
```

6.7.6.3 AudioEnvironment semantics

Semantics of the `AudioEnvironmentType`:

Name	*Definition*
`AudioEnvironmentType`	Tool that describes the natural audio environment of a particular User.
`NoiseLevel`	Describes the noise level as the sound pressure level in dB.
`NoiseFrequencySpectrum`	This information is acquired by processing the noise signal. The noise level is measured as the sound pressure level in dB for 33 frequency bands of 1/3 octave covering all the human audible bandwidth. The followings are the 33 frequency centers of 1/3 octave: 12.5 Hz, 16 Hz, 20 Hz 25 Hz, 31 Hz, 40 Hz 50 Hz, 63 Hz, 80 Hz 100 Hz, 125 Hz, 160 Hz 200 Hz, 250 Hz, 315 Hz 400 Hz, 500 Hz, 630 Hz 800 Hz, 1000 Hz, 1250 Hz 1600 Hz, 2000 Hz, 2500 Hz 3150 Hz, 4000 Hz, 5000 Hz 6300 Hz, 8000 Hz, 10000 Hz 12500 Hz, 16000 Hz, 20000 Hz

6.7.6.4 AudioEnvironment example

EXAMPLE The following example illustrates description elements pertaining to the audio environment.

`NoiseLevel`**:** This information can be acquired by processing noise signal input from a microphone of the User's terminal and represented as sound pressure level in decibel (dB), and can be used by an adaptation engine for automatically adjusting the audio signal level to the terminal. The adaptation engine may reside in the terminal and responds automatically to the changing noise level of the environment. When using mobile phone, it is not easy to adjust the volume setting during conversation. One of the applications is when the noise level is relatively high. In this situation, the

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adaptation engine may increase the signal amplitude so that the intended signal can be audible in such a noisy environment. In the example below, the environmental noise level is 20 dB.

`NoiseFrequencySpectrum`**:** This information is acquired by processing noisy signal input from a microphone of the User's terminal. In the example below, the 30 values represent noise power for 30 1/3-octave frequency band in dB. The adaptation engine can enhance the Users experience by adapting frequency attenuation to the noise characteristics on the basis of this information and send the resulting audio signal to the terminal.

```
<DIA>
    <Description xsi:type="UsageEnvironmentType">
        <UsageEnvironmentProperty xsi:type="NaturalEnvironmentsType">
            <NaturalEnvironment>
                <NaturalEnvironmentCharacteristic xsi:type="AudioEnvironmentType">
                    <NoiseLevel>20</NoiseLevel>
                    <NoiseFrequencySpectrum>
                        40 30 20 10 10 10 10 10 10 10
                        10 40 40 40 30 30 30 20 20 20
                        10 10 10 10 10 10 10 10 10 10
                        10 10 10
                    </NoiseFrequencySpectrum>
                </NaturalEnvironmentCharacteristic>
            </NaturalEnvironment>
        </UsageEnvironmentProperty>
    </Description>
</DIA>
```

6.7.7 IlluminationCharacteristics

6.7.7.1 Introduction

This subclause specifies a tool to describe the overall illumination in the environment where a User's display device is located. The tool includes two elements, each of which describe an attribute of the overall illumination. In particular, `TypeOfIllumination` describes the type of illumination and `Illuminance` describes the illuminance of illumination. These attributes are related to the effect of illumination on the perceived color of a displayed image and can be used to control the color so as to present the original color that is intended.

6.7.7.2 IlluminationCharacteristics syntax

```
<!-- ################################################ -->
<!--   Definition of IlluminationCharacteristics      -->
<!-- ################################################ -->

<complexType name="IlluminationCharacteristicsType">
    <complexContent>
        <extension base="dia:NaturalEnvironmentCharacteristicBaseType">
            <sequence>
                <element name="TypeOfIllumination" minOccurs="0">
                    <complexType>
                        <choice>
                            <element name="ColorTemperature"
                                type="mpeg7:unsigned8"/>
                            <element name="Chromaticity">
                                <complexType>
                                    <sequence>
                                        <element name="x" type="mpeg7:zeroToOneType"/>
                                        <element name="y" type="mpeg7:zeroToOneType"/>
                                    </sequence>
                                </complexType>
                            </element>
                        </choice>
```

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```
                </complexType>
            </element>
            <element name="Illuminance" type="nonNegativeInteger"
                minOccurs="0"/>
        </sequence>
    </extension>
</complexContent>
</complexType>
```

6.7.7.3 IlluminationCharacteristics semantics

Semantics of the `IlluminationCharacteristicsType`:

Name	*Definition*
`IlluminationCharacteristicsType`	Describes the overall illumination characteristics of the natural environment.
`TypeOfIllumination`	Describes the type of overall illumination.
`ColorTemperature`	Indicates the correlated color temperature of the overall illumination. The value expression is obtained through quantizing the range [1667,25000] into 2^8 bins in a non-uniform way as specified in ISO/IEC 15938-3.
`Chromaticity`	Indicates the chromaticity of the overall illumination, where - x: indicates the x coordinate, - y: indicates the y coordinate, of the overall illumination in chromaticity coordinates. The range of each coordinate value is [0,1].
`Illuminance`	Describes the overall illuminance of illumination in units of Lux.

6.7.7.4 IlluminationCharacteristics example

EXAMPLE The overall illumination around a display device affects the perceived color of images on the display device and is a factor causing distortion or variation of perceived color. The information on the type and illuminance of the overall illumination can be used to estimate the effect of illumination on the perceived color. For example, it is possible to estimate the chromatic adaptation of perceived color on chromaticity coordinates. By compensating the estimated distortion, actual distortion caused by the overall illumination can be lessen or removed. The following example indicates that the correlated color temperature of the illumination is 159 and the illuminance is 500 Lux. Note that the expression of correlated color temperature is different from the value in Kelvin unit. It is obtained from a non-uniform quantization of the value in Kelvin unit, as defined in ISO/IEC 15938-3.

```
<DIA>
    <Description xsi:type="UsageEnvironmentType">
        <UsageEnvironmentProperty xsi:type="NaturalEnvironmentsType">
            <NaturalEnvironment>
                <NaturalEnvironmentCharacteristic
                    xsi:type="IlluminationCharacteristicsType">
                    <TypeOfIllumination>
                        <ColorTemperature>159</ColorTemperature>
                    </TypeOfIllumination>
                    <Illuminance>500</Illuminance>
                </NaturalEnvironmentCharacteristic>
            </NaturalEnvironment>
        </UsageEnvironmentProperty>
    </Description>
</DIA>
```


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7 Conversion tools

7.1 Introduction

This clause specifies syntax and semantics of the conversion tools. The conversion tools include the BSDLink and ConversionLink tools. The former provides means for linking a steering description to Bitstream Syntax Descriptions (BSDs) enabling the BSD-based adaptation approach based on the decisions provided by the steering description. The latter is complementary to the BSDLink tool and provides means for linking steering description to general-purpose conversions not covered by the BSDLink tool, e.g., transcoding or summarization.

7.2 Bitstream syntax description link

7.2.1 Introduction

Subclause 7.2 specifies the syntax and semantics of the BSDLink tool. This tool provides the facilities to link so-called steering description tools and BSD tools in a flexible and extensible way. The extensible linking mechanism allows designing a rich variety of adaptation architectures, e.g., steered by resource adaptation tools such as *Terminal and Network Quality of Service*, *Usage Environment Description* tools, ISO/IEC 15398 tools, or steered by the User using the `Choice`/`Selection` mechanism provided by ISO/IEC 21000-2.

The BSDLink tool eases the referencing of information assets which can be used for this kind of Digital Item Adaptation, i.e., references to these assets are stored in the BSDLink. This description contains at least a reference to the Bitstream Syntax Description (BSD, see subclause 7.3) and a reference to the BSD transformation sheet. The BSD transformation sheet could be parameterised according to the desired adaptation. Additionally, the BSDLink may contain a reference to the steering description which governs the whole adaptation process and a reference to the actual resource which is described by the BSD.

A complete walkthrough of an example use case is given in Annex B.

7.2.2 BSDLink syntax

```
<?xml version="1.0"?>
<!-- Digital Item Adaptation ISO/IEC 21000-7 Second Edition -->
<!-- Schema for Bitstream syntax description link -->
<schema
  version="ISO/IEC 21000-7 2nd"
  id="BSDLink-2nd.xsd"
  xmlns="http://www.w3.org/2001/XMLSchema"
  xmlns:dia="urn:mpeg:mpeg21:2003:01-DIA-NS"
  targetNamespace="urn:mpeg:mpeg21:2003:01-DIA-NS"
  elementFormDefault="qualified" attributeFormDefault="unqualified">

  <include schemaLocation="DIA-2nd.xsd"/>
  <include schemaLocation="ConvD-2nd.xsd"/>

  <!-- ########################################################## -->
  <!-- Definition of the BSDLinkType                              -->
  <!-- ########################################################## -->

  <complexType name="BSDLinkType">
    <complexContent>
      <extension base="dia:DIADescriptionType">
        <sequence>
          <element ref="dia:SteeringDescriptionRef" minOccurs="0"/>
          <element name="BSDRef" type="dia:ReferenceType"/>
          <element ref="dia:BitstreamRef" minOccurs="0"/>
          <element name="BSDTransformationRef" maxOccurs="unbounded">
```

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```
          <complexType>
            <complexContent>
              <restriction base="anyType">
                <attribute name="uri" type="anyURI" use="required"/>
                <attribute name="type" type="anyURI" use="optional"/>
              </restriction>
            </complexContent>
          </complexType>
        </element>
        <element name="Parameter" type="dia:BaseParameterType" minOccurs="0"
          maxOccurs="unbounded"/>
      </sequence>
    </extension>
  </complexContent>
</complexType>

<!-- ########################################################## -->
<!-- Definition of the SteeringDescriptionRef                   -->
<!-- ########################################################## -->

<element name="SteeringDescriptionRef" type="dia:ReferenceType"/>

<!-- ########################################################## -->
<!-- Definition of the BitstreamRef                             -->
<!-- ########################################################## -->

<element name="BitstreamRef">
  <complexType>
    <attribute name="uri" type="anyURI" use="required"/>
  </complexType>
</element>

<!-- ########################################################## -->
<!-- Definition of the SteeringDescriptionType                  -->
<!-- ########################################################## -->

<complexType name="SteeringDescriptionType" abstract="true">
  <complexContent>
    <extension base="dia:DIADescriptionType"/>
  </complexContent>
</complexType>

<!-- ########################################################## -->
<!-- Definition of the IOPinRefType                             -->
<!-- ########################################################## -->

<complexType name="IOPinRefType">
  <complexContent>
    <extension base="dia:BaseParameterType">
      <sequence>
        <element name="Value" type="anyURI"/>
      </sequence>
    </extension>
  </complexContent>
</complexType>

<!-- ########################################################## -->
<!-- Definition of the StreamingRefType                         -->
<!-- ########################################################## -->
```

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```
  <complexType name="StreamingRefType">
    <complexContent>
      <extension base="dia:ReferenceType">
        <attribute name="minPUSize" type="positiveInteger"
           use="optional"/>
        <attribute name="avgPUSize" type="positiveInteger"
           use="optional"/>
        <attribute name="maxPUSize" type="positiveInteger"
           use="optional"/>
        <attribute name="minBitstreamPUSize" type="positiveInteger"
           use="optional"/>
        <attribute name="avgBitstreamPUSize" type="positiveInteger"
           use="optional"/>
        <attribute name="maxBitstreamPUSize" type="positiveInteger"
           use="optional"/>
      </extension>
    </complexContent>
  </complexType>

</schema>
```

7.2.3 BSDLink semantics

Semantics of the `BSDLinkType`:

Name	*Definition*
`BSDLinkType`	Tool for describing a link between the parameters provided by a steering description and a (generic) Bitstream Syntax Description. This datatype contains elements to refer to the steering description, the BS Description, the bitstream described by the BS Description, the BSD Transformation and the parameters of the transformation.
`SteeringDescriptionRef`	Describes a reference to the steering description. The target of this reference shall be of `SteeringDescriptionType`.
`BSDRef`	Describes a reference to the (generic) Bitstream Syntax Description. The target of this reference shall be of `bs1:BSDType`.
`BitstreamRef`	Describes a reference to the bitstream described by the target of `BSDRef`. This indication may also be provided by the BSD itself.
`uri`	Describes the URI of the described bitstream.
`BSDTransformationRef`	Describes a reference to a BSD Transformation. The target of this reference shall be a transformation sheet. Multiple references point to different alternative implementations of the same BSD Transformation.
`type`	Describes the namespace of the BSD Transformation.
`Parameter`	Describes an input parameter to the BSD Transformation.

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Semantics of the `SteeringDescriptionType`:

Name	*Definition*
`SteeringDescriptionType`	Tool for describing a steering description which governs the bitstream adaptation based on tools as specified within subclause 7.3. `SteeringDescriptionType` extends `DIADescriptionType` and provides a base abstract type for a subset of types defined as part of the `BSDLinkType`. An example steering description is `AdaptationQoSType` as specified in clause 9.

Semantics of the `StreamingRefType`:

Name	*Definition*
`StreamingRefType`	Describes a reference to the (generic) Bitstream Syntax Description or AdaptationQoS description which can be used by a streaming processor. The target of this reference shall be of `bs1:BSDType` or `dia:AdaptationQoSType`. NOTE 1 In case it is used by the `SteeringDescriptionRef` element the reference shall be of `dia:AdaptationQoSType`. In case it is used by the `BSDRef` element the reference shall be of `bs1:BSDType`.
`minPUSize`	Describes the minimum size of the process unit in bytes.
`avgPUSize`	Describes the average size of the process unit in bytes.
`maxPUSize`	Describes the maximum size of the process unit in bytes.
`minBitstreamPUSize`	Describes the minimum size of the bitstream fragment in bytes which is described by a single process unit. NOTE 2 This attribute shall appear only once, e.g., within a single BSDLink description.
`avgBitstreamPUSize`	Describes the average size of the bitstream fragment in bytes which is described by a single process unit. NOTE 3 This attribute shall appear only once, e.g., within a single BSDLink description.
`maxBitstreamPUSize`	Describes the maximum size of the bitstream fragment in bytes which is described by a single process unit. NOTE 4 This attribute shall appear only once, e.g., within a single BSDLink description.

NOTE 5 The information within the `StreamingRefType` may be used by the buffer of an adaptation engine in a streaming scenario – similar to a decoding buffer of a media resource player – which is related to the processing part of the delivery and not the delivery itself.

7.2.4 BSDLink example

EXAMPLE 1 The following BSDLink example uses the AdaptationQoS tool as a steering description and an XSLT style sheet for transforming the gBS Description. The parameter for the XSLT style sheet are references to `IOPin`s of the

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AdaptationQoS description. This means that the `name` of the `Parameter` appears also in the XSLT style sheet and the `Value` is a reference to an `id` of an `IOPin`. The actual value of the `IOPin` is provided by the adaptation decision-taking engine.

```
<DIA>
    <Description xsi:type="BSDLinkType">
        <SteeringDescriptionRef uri="rubik_lena_AQoS.xml"/>
        <BSDRef uri="rubik lena gBSD.xml"/>
        <BitstreamRef uri="rubik lena gBSD.jp2"/>
        <BSDTransformationRef uri="rubik_lena_transform.xslt"
               type="http://www.w3.org/1999/XSL/Transform"/>
        <Parameter xsi:type="IOPinRefType" name="nLevels">
            <Value>LEVELS</Value>
        </Parameter>
        <Parameter xsi:type="IOPinRefType" name="nBitplanes">
            <Value>BITPLANES</Value>
        </Parameter>
    </Description>
</DIA>
```

EXAMPLE 2 This example demonstrates the usage of the `dia:StreamingRefType` within a BSDLink description for an ISO/IEC 14496-3 bit sliced arithmetic coding (BSAC) bitstream.

```
<DIA>
  <Description xsi:type="BSDLinkType">
    <SteeringDescriptionRef xsi:type="StreamingRefType"
       uri="bsac_AQoS.xml"
       maxPUSize="52"/>
    <BSDRef xsi:type="StreamingRefType"
       uri="bsac_gBSD.xml"
       maxPUSize="132"
       minBitstreamPUSize="98"
       maxBitstreamPUSize="515"
       avgBitstreamPUSize="228"/>
    <BitstreamRef uri="bsac.raw"/>
    <BSDTransformationRef uri="bsac.xslt"
       type="http://www.w3.org/1999/XSL/Transform"/>
    <Parameter xsi:type="IOPinRefType" name="nlayers">
      <Value>LAYERS_OF_SCALABLE_AUDIO</Value>
    </Parameter>
  </Description>
</DIA>
```

7.3 Conversion link

7.3.1 Introduction

Subclause 7.3 specifies the syntax and semantics of the ConversionLink tool. The ConversionLink is similar to BSDLink in the way that this tool provides the facilities to link so-called steering description tools and conversion descriptions in a flexible and extensible way. However, though both tools do target conversions, the BSDLink tool targets basically the adaptation of scalable bitstreams whereas the ConversionLink tool is applicable for any kind of adaptations, e.g., transcoding, transforming, or transmoding.

The ConversionLink tool eases the referencing of information assets which can be used for conversion, i.e., references to these assets are stored in the ConversionLink. This description contains at least a reference to a conversion act which specifies the semantics of a conversion and the semantics of its generic parameters including the actual name of the parameters. Additionally, the ConversionLink tool may contain a reference to a steering description which governs the whole conversion process, a reference to the actual resource subject to the conversion and possibly a description of this resource.

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A conversion decision architecture compatible with Annex B is given in Annex J.

7.3.2 ConversionLink syntax

```
<?xml version="1.0"?>
<!-- Digital Item Adaptation ISO/IEC 21000-7 Second Edition -->
<!-- Schema for Conversion link -->
<schema
   version="ISO/IEC 21000-7:2004 2nd"
   id="ConvL-2nd.xsd"
   targetNamespace="urn:mpeg:mpeg21:2003:01-DIA-NS"
   xmlns="http://www.w3.org/2001/XMLSchema"
   xmlns:dia="urn:mpeg:mpeg21:2003:01-DIA-NS"
   elementFormDefault="qualified" attributeFormDefault="unqualified">

  <include schemaLocation="BSDLink-2nd.xsd"/>
  <include schemaLocation="ConvD-2nd.xsd"/>

  <!-- ########################################################## -->
  <!-- Definition of the ConversionLinkType                       -->
  <!-- ########################################################## -->

  <complexType name="ConversionLinkType">
   <complexContent>
    <extension base="dia:ConversionDescriptionBaseType">
     <sequence>
      <element ref="dia:SteeringDescriptionRef" minOccurs="0"/>
      <element ref="dia:BitstreamRef" minOccurs="0"/>
      <element name="ResourceDescriptionRef" minOccurs="0">
       <complexType>
        <attribute name="uri" type="anyURI" use="required"/>
       </complexType>
      </element>
     </sequence>
    </extension>
   </complexContent>
  </complexType>

  <!-- ########################################## -->
  <!-- ConversionCompositeType                    -->
  <!-- ########################################## -->

  <complexType name="ConversionCompositeType">
    <complexContent>
      <extension base="dia:DIADescriptionType">
        <sequence>
          <element name="ConversionDescription" type="dia:ConversionLinkType"
            minOccurs="2" maxOccurs="unbounded"/>
        </sequence>
      </extension>
    </complexContent>
  </complexType>

</schema>
```


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7.3.3 ConversionLink semantics

Semantics of the `ConversionLinkType`:

Name	Definition
`ConversionLinkType`	Tool for describing suggested conversions as a link between the parameters provided by a steering description and the parameters required for a conversion.
`SteeringDescriptionRef`	Describes a reference to the steering description. The target of this reference shall be of `SteeringDescriptionType`. If this element is not present the conversion should be steered by the ISO/IEC 21000-2 choice/selection mechanism.
`ResourceDescriptionRef`	Describes a reference to a description of the resource subject to the conversion. If this element is present, this description can be used by the resource conversion tools.
`BitstreamRef`	Describes a reference to the bitstream subject to the conversion. NOTE If this element is not present the bitstream should be either provided by the application or the ISO/IEC 21000-2 `Resource` element.

Semantics of `ConversionCompositeType`:

Name	Definition
`ConversionCompositeType`	Tool for describing a conversion as a composite of other conversion links in sequence such that the conversions are given by its child elements and the order is given by the sequence of its child elements.
`ConversionDescription`	Describes a single conversion as part of the composite conversion.

7.3.4 Example

EXAMPLE The following ConversionLink example uses an AdaptationQoS description to provide the scaling factor for the conversion, which is used for spatial scaling of the JPEG image, and the required color components according to the terminal capabilities.

An Adaptation Decision-Taking Engine (ADTE) based on an AdaptationQoS description gets the values of the display resolution and the display color capabilities for the respective I/O pins and then looks up the values of the corresponding `SCALE` and `NR_COLORS` by processing the AdaptationQoS modules. The obtained values of the IOPins `SCALE` and `NR_COLORS` are then used by the ConversionLink to pass parameters to the actual image conversion tool which implements the conversion act URI.

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```
<DIA>
 <Description xsi:type="ConversionLinkType">
  <ConversionActUri uri="urn:mpeg:mpeg21:2003:01-RDD-NS:ImageRescaleGrayScale"/>
  <Parameter xsi:type="IOPinRefType" name="rescale">
   <Value>SCALE</Value>
  </Parameter>
  <Parameter xsi:type="IOPinRefType" name="colors">
   <Value>NR_COLORS</Value>
  </Parameter>
  <SteeringDescriptionRef uri="#akiyo_AQoS"/>
  <BitstreamRef uri="akiyo.jpg"/>
</Description>
</DIA>
```

8 Bitstream Syntax Description

8.1 Introduction

8.1.1 Introduction to BSD-based adaptation

With binary media resources a variety of adapted versions can be retrieved from a single bitstream by performing simple editing-style operations such as data truncation and simple modifications. In order to provide interoperability in Digital Item Adaptation, it is desirable that a processor that is not aware of the specific bitstream coding format can be used for this task. For this, a generic approach is taken by providing a method based on XML for manipulating bitstreams.

A binary media resource consists of a structured sequence of binary symbols, this structure being specific to the coding format. A bitstream is defined as the sequence of binary symbols representing this resource. XML is used to describe the high-level structure of a bitstream; the resulting XML document is called a Bitstream Syntax Description (BS Description, BSD). This description is not meant to replace the original binary format, but acts as an additional layer, similar to metadata. In most cases, it will not describe the bitstream on a bit-per-bit basis, but rather address its high-level structure, e.g., how the bitstream is organized in layers or packets of data. Furthermore, the BS Description is itself scalable, which means it may describe the bitstream at different syntactic layers, e.g., finer or coarser levels of detail, depending on the application. The BS Description itself must also be adaptable in order to properly reflect bitstream adaptations.

With such a description, it is then possible for a resource adaptation engine to transform the BS Description, for example with an XSLT style sheet, and then generate back an adapted bitstream. In this way, Digital Items will be able to exchange Bitstream Syntax Descriptions and related transformations, for example in the form of XSLT style sheets.

8.1.2 Adaptation architecture

Figure 8 depicts the architecture of a resource adaptation step. The architecture comprises the original *Bitstream* and its *Bitstream Syntax Description*, one (or more) *Bitstream Syntax Description Transformation*(s), the resulting *Transformed Bitstream Syntax Description*, the *Adapted Bitstream* and two processors, a BS Description generator and a bitstream generator. The output produced in one adaptation step is an adapted bitstream and possibly an updated BS Description (not appearing on the figure) that correctly references the new bitstream. This output enables the application of multiple successive adaptations. A walkthrough of the process is given below.

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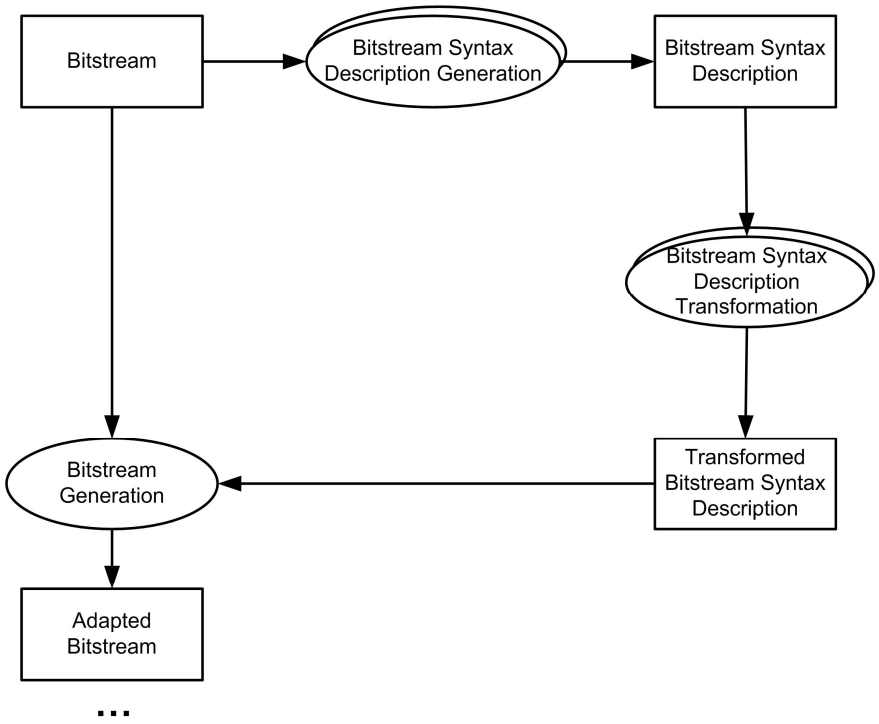

Figure 8 — Adaptation architecture

The BS Description generator parses a bitstream and generates its BS Description. The bitstream and its BS Description are subject to the adaptation. An adaptation engine is assumed to determine the optimal adaptation for the media resource given the constraints as provided by the DIA descriptions. Based on that decision, if the resource is not pre-stored but needs to be derived by adapting an existing resource, then one (or several) BS Description transformation(s) is (are) selected to be applied to the input description. The result of these transformations is a transformed BS Description, which is the base for the generation of the adapted bitstream.

It is pointed out that Figure 8 only provides a high-level view on the bitstream adaptation using tools specified in this clause, which does not restrict the combination of several processing steps illustrated in Figure 8, e.g., for efficiency reasons.

8.1.3 BSDL and gBS Schema

In order to provide full interoperability, it is necessary that a processor that is not aware of the specific coding format can nevertheless be used to produce a BS Description, and/or generate a bitstream from its description. For this purpose, ISO/IEC 21000-7 normatively adopts ISO/IEC 23001-5, i.e., Bitstream Syntax Description Language (BSDL). With this language, it is then possible to design specific Bitstream Syntax Schemas (BS Schemas) describing the syntax of a particular coding format. These schemas can then be used by a generic processor to automatically parse a bitstream and generate its description, and vice-versa.

BSDL provides means for describing a bitstream syntax with a codec specific BS Schema. This requires an adaptation engine to know the specific schema. In some use cases this is not desired, for instance if the adaptation takes place on devices with constrained resources, e.g., in gateways and proxies. In these cases, a codec independent schema is more appropriate. Therefore, a generic Bitstream Syntax Schema (gBS Schema) is specified. The normative gBS Schema introduces means to describe hierarchies of syntactical units and addressing means for efficient bitstream access.

The gBS Description provides an abstract view on the structure of the bitstream that can be used in particular when the availability of a specific BS Schema is not ensured. However, for transformations on gBS Descriptions, coding format specific information has to be included in attributes of the gBS Description. For the BSDL case on the other hand, all coding format specific information can be provided by the BS Schema, which is common to all BS Descriptions following this schema. As a result, smaller descriptions can be

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obtained with BSDL. Furthermore, the flexibility provided by BSDL for designing BS schemas allows including additional application specific information into the BS Description.

Depending on the application requirements one or the other technology may be the most appropriate.

8.1.4 Bitstream Syntax Description transformation

NOTE The BS Description transformation is a non-normative process. A possible way is to apply an XSLT or STX style sheet to the BS Description, as shown in Figure 9. In order to ensure that a bitstream can be re-generated by the bitstream generation process, it is required that the transformed BS Description still conforms to the gBS Schema or the bitstream specific BS Schema.

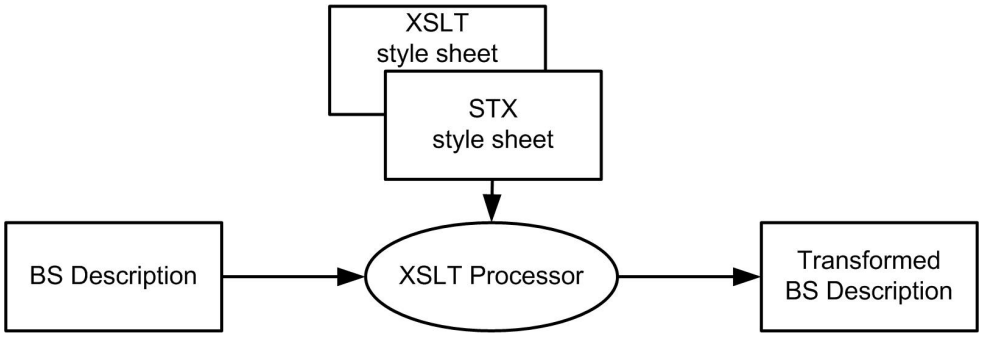

Figure 9 — Architecture of BSD transformation

8.1.5 Multi-step adaptation

For some use cases, a sequence of adaptations is required or desired. Figure 8 shows one adaptation step. In a multi-step adaptation architecture several such transformations are performed on the BS Description before generating the adapted bitstream. This scenario is probable when all adaptation steps are performed in a single device. However, in other use cases the adaptation will take place in multiple steps performed by independent processes, possibly on different devices. Therefore, both the adapted bitstreams and the adapted BS Descriptions will be transmitted.

To enable multi-step adaptations, it is required that at the end of each adaptation step, the output description must correctly describe the output-adapted bitstream. This means that the address information of the syntactical elements must reference the correct parts in the adapted bitstream. This requirement allows the adapted bitstream and its description to be directly input to the next resource adaptation step, which might take place on a different device.

For this, a new description with the updated address information usually needs to be generated, for example during the process which generates the adapted bitstream. This updating mechanism is not normative, but an example process is proposed in the informative Annex D

8.1.6 Organization of this clause

As introduced above, this clause specifies a resource adaptation framework based on a language named BSDL.

BSDL is built by introducing two successive sets of extensions and restrictions over XML Schema. The first set is required for the bitstream generation process and is referred to as BSDL-1. The second set is required for the BS Description generation process and is referred to as BSDL-2. Subclause 8.2 gives an overview of this language and explains the relationship between the different schemas.

Subsequent, subclause 8.3 specifies the technologies required for the bitstream generation process, namely BSDL-1 and the gBS Schema, which uses the *Schema for BSDL-1 extensions*. The bitstream generation process is specified for both technologies as two normative processors, named BSDtoBin and gBSDtoBin respectively.

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Finally, subclause 8.4 specifies BSDL-2, i.e., the set of extensions and restrictions required for the BS Description generation process, which is described by the normative processor BintoBSD. Please note that the generation of a gBS Description (BintogBSD) is not normatively specified within this part of ISO/IEC 21000. It is possible to generate different gBS Descriptions describing the same bitstream for different types of applications, e.g., by introducing different levels of detail or using different marker tokens. Therefore, gBS Descriptions may be constructed using several techniques, for example by transforming existing BS Descriptions or during the encoding process of the bitstream.

Subclauses 8.5 and 8.6 specify media resource and XML streaming instructions required for adapting resources in streaming scenarios, in particular for dynamic and distributed adaptation scenarios. The media resource and XML streaming instructions define a set of properties and attributes which describe the fragmentation, timing, and additional information of a BS or gBS Description and its corresponding bitstream. Furthermore, subclause 8.7 specifies a so-called properties stylesheet enabling to set these properties without modifying the XML document.

8.2 Bitstream Syntax Description Language

8.2.1 Overview

XML Schema and BSDL

The role of XML Schema is to define a set of constraints on XML documents. BSDL is defined on top of XML Schema by adding a new functionality, which is to enable a generic BSDL processor to generate a BS Description for a given bitstream, and to re-generate a bitstream using a corresponding BS Description.

For this, and in a first step, BSDL defines a set of built-in datatypes and attributes in a schema named *Schema for BSDL-1 extensions* having the URN `urn:mpeg:mpeg21:2003:01-DIA-BSDL1-NS` as namespace. BS or gBS Schemas may then import this schema and use these built-in datatypes and attributes, which carry specific semantics in the context of bitstream generation.

In a second step, BSDL introduces a set of new language extensions in the form of attributes and schema components, which carry specific semantics in the context of description generation. These language constructs are added to XML Schema as application-specific annotations, and their syntax is specified in a schema named *Schema for BSDL-2 extensions* having the URN `urn:mpeg:mpeg21:2003:01-DIA-BSDL2-NS` as namespace. Note that since they are language extensions and contrarily to the *Schema for BSDL-1 extensions*, they are ignored in the XML Schema validation process.

Furthermore, BSDL defines a set of restrictions on the use of XML Schema components, which are specified in this subclause, but are not reflected in the schemas introduced above.

In the following, the set of extensions and restrictions required for the bitstream generation process is referred to as BSDL-1, and the set required for the BS Description generation process is referred to as BSDL-2, where BSDL-1 is a subset of BSDL-2.

Note that all the restrictions introduced by BSDL only apply to the elements that take part in the bitstream generation. There is no restriction on attributes since they are ignored by BSDL parsers, nor on potential elements declared in the schema, but not used in the BS Description. For these reasons, some BSDL restrictions can only be checked while generating the bitstream (BSDL-1) or the BS Description (BSDL-2).

Lastly, the BS Schema does not force the conformance of a bitstream to a given format, since this usually implies verifying the value of the parameters, while BSDL is only concerned on how they are binary-encoded. The bitstream conformance is therefore outside the scope of BSDL.

Annotation mechanisms of XML Schema

XML Schema provides two ways of adding application-specific annotations. Firstly, all schema components can contain an `xsd:annotation` component, which itself can contain an `xsd:appinfo` component, intended as a placeholder for application-specific information. Secondly, all XML Schema components allow

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attributes with non-schema namespace, which leaves the possibility to add new attributes to some schema components by qualifying them with a specific namespace.

BSDL-2 uses these features to define two kinds of language extensions to XML Schema:

— *BSDL components* are new schema components similar to XML Schema components. They are added to the schema via `xsd:annotation` and `xsd:appinfo`.

— *BSDL attributes* are new attributes characterising an XML Schema component.

The two types of extensions are qualified with the BSDL-2 namespace. Their syntax is specified in the *Schema for BSDL-2 extensions*. Note that in XML Schema, application-specific information does not intervene in the XML validation, which means an XML Schema validator will not validate the content of the `xsd:appinfo` schema component against its schema. The same applies to attributes with non-schema namespace. It is therefore up to the BSDL parsers to check that the attributes and schema components with BSDL-2 namespace follow the syntax specified in the *Schema for BSDL-2 extensions*.

BSDL parsers

A *BSDL parser* is a generic term encompassing the following two parsers:

— A ***BSDtoBin parser***, which is a generic processor using a BS Schema to parse a possibly transformed BS Description and generate the corresponding bitstream.

— A ***BintoBSD parser***, which is a generic processor using a BS Schema to parse a bitstream and generate the corresponding BS Description.

BSDL-1 extensions may be used by both parsers, while BSDL-2 extensions are used by the BintoBSD parser only.

Extensibility of BSDL

By construction, BSDL inherits from the extension mechanisms of XML Schema.

In the BS Schema, any attribute with a namespace different from XML Schema and BSDL is therefore allowed and ignored. The `xsd:appinfo` component may also contain application-specific information from another namespace. As a general rule, the BSDL parser ignores any schema component or attribute with a namespace different from XML Schema and BSDL.

In the BS Description, the BSDL parser ignores attributes that are not within the BSDL or the XML Schema instance (http://www.w3.org/2001/XMLSchema-instance) namespaces. This leaves the possibility to a schema author to add application-specific information as attributes to the BS Description, which will not interfere with the bitstream generation.

Lastly, BSDL uses an escape mechanism in the form of an attribute named `bs1:ignore` to indicate that a given element and its descendants should be ignored by the BSDtoBin parser. This allows the schema author to add application-specific information to the BS Description as an XML fragment without interfering with the bitstream generation. Otherwise, any element content is interpreted as data to be binary-encoded and appended to the output bitstream.

Optional features

This part of ISO/IEC 21000-7 adopts a set of optional features as specified in Annex A of ISO/IEC 23001-5 which is organized in modules. A conformant BSDtoBin or BintoBSD parser is not required to implement these features. Alternatively, when it implements, it shall conform to their specification as specified in ISO/IEC 23001-5. These features are organized in three modules:

— Use of ISO/IEC 16262 (ECMAScript) for user-defined datatypes.

— Use of ISO/IEC 16262 (ECMAScript) for user-defined XPath functions.

— Support for array of variables.

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8.2.2 Schema hierarchy

BSDL provides a number of built-in datatypes derived from XML Schema, with a specific semantics in the context of generating an adapted bitstream. These datatypes are defined in a schema named *Schema for BSDL-1 extensions*. The target namespace of this schema is defined as the URN `urn:mpeg:mpeg21:2003:01-DIA-BSDL1-NS`.

On top of this, BSDL introduces a number of language constructs defining new types of constraints on XML documents. These constructs are added to the XML Schema language by using annotation mechanisms, and are therefore ignored by XML Schema for the validation, but carry specific semantics in the context of BS Description generation. These language extensions are defined in a schema named *Schema for BSDL-2 extensions*. Its target namespace is defined as the URN `urn:mpeg:mpeg21:2003:01-DIA-BSDL2-NS`.

Applications may define BS Schemas for multimedia coding formats. This specification does not mandate any specific BS Schema. In order to conform with the BSDL specification and thus be used for bitstream and/or BS Description generation, a BS Schema is required to be valid with respect to XML Schema. For this reason, if a BS Schema uses BSDL-1 built-in datatypes, then it is required to import the *Schema for BSDL-1 extensions*. On the other hand, if it uses BSDL-2 extensions, it is not required to import the *Schema for BSDL-2 extensions* since the BSDL-2 language constructs are used in the schema as application-specific annotation and thus ignored by XML Schema.

Furthermore, this specification defines a *gBS Schema*. The target namespace of the gBS Schema is defined as the URN `urn:mpeg:mpeg21:2003:01-DIA-gBSD-NS`. This generic schema uses BSDL built-in datatypes for bitstream generation and therefore imports the *Schema for BSDL-1 extensions*.

The different inclusion mechanisms between the schemas explained above are illustrated in Figure 10. Boxes in grey are normatively specified within this part of ISO/IEC 21000.

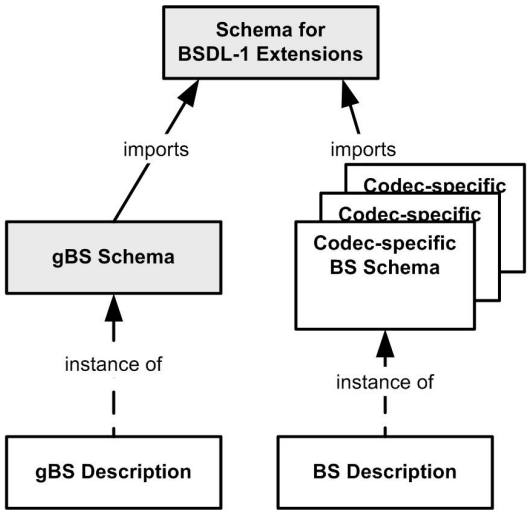

Figure 10 — Schema hierarchy

8.3 Bitstream generation: BSDL-1 and gBS Schema

8.3.1 BSDL-1 and BSDtoBin

Subclause 8.3.1 specifies BSDL-1 and BSDtoBin respectively. Therefore, ISO/IEC 21000-7 normatively adopts the corresponding tools from ISO/IEC 23001-5, especially BSDL-1 and BSDtoBin as specified in clause 5 of ISO/IEC 23001-5.

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8.3.2 generic Bitstream Syntax Schema

8.3.2.1 Introduction

Subclause 8.3.2 specifies the *generic Bitstream Syntax Schema* (gBS Schema) for a flexible binary resource adaptation. The gBS Schema imports the Schema for BSDL-1 extensions defined in subclause 5.1 of ISO/IEC 23001-5 (including the schema document for unsigned integer datatypes) and provides the following functionalities:

— **Codec independence**. The gBS Schema can be used to describe any binary resource in a codec independent manner and no codec specific schema is required to re-generate the bitstream.

— **Semantic marking**. The gBS Schema provides means for semantically meaningful marking of syntactical elements described, by use of the “marker” handle. Such “markers” can be used for semantically meaningful, efficient adaptations of binary media resources.

— **Hierarchical descriptions**. The gBS Schema contains elements for the description of a bitstream in a hierarchical fashion that allows grouping of bitstream elements for efficient, hierarchical adaptations.

8.3.2.2 gBS Schema syntax

```
<?xml version="1.0"?>
<!-- Digital Item Adaptation ISO/IEC 21000-7 Second Edition -->
<!-- generic Bitstream Syntax Schema (gBSSchema) -->
<schema
  version="ISO/IEC 21000-7 2nd"
  id="gBSSchema-2nd.xsd"
  xmlns="http://www.w3.org/2001/XMLSchema"
  xmlns:gbsd="urn:mpeg:mpeg21:2003:01-DIA-gBSD-NS"
  xmlns:bs1="urn:mpeg:mpeg21:2003:01-DIA-BSDL1-NS"
  targetNamespace="urn:mpeg:mpeg21:2003:01-DIA-gBSD-NS"
  elementFormDefault="qualified" attributeFormDefault="unqualified">

  <annotation>
    <documentation>
      Definition of generic Bitstream Syntax Schema (gBSSchema)
    </documentation>
  </annotation>

  <import namespace="urn:mpeg:mpeg21:2003:01-DIA-BSDL1-NS"
          schemaLocation="MPEG-B-BSDL-1.xsd"/>
  <include schemaLocation="MPEG-B-UnsignedIntegers.xsd"/>

  <element name="gBSDUnit" type="gbsd:gBSDUnitType"/>

  <!-- ################################### -->
  <!--          gBSDType definition        -->
  <!-- ################################### -->

  <complexType name="gBSDType">
    <complexContent>
      <extension base="bs1:BSDType">
        <sequence>
          <element ref="gbsd:gBSDUnit" maxOccurs="unbounded"/>
        </sequence>
        <attributeGroup ref="gbsd:addressAttributes"/>
        <anyAttribute namespace="##other" processContents="lax"/>
      </extension>
    </complexContent>
```


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```
  </complexType>

  <!-- ################################### -->
  <!--      Attribute group definition     -->
  <!-- ################################### -->

  <attributeGroup name="addressAttributes">
    <attribute name="addressMode" type="gbsd:addressModeType" use="optional"/>
    <attribute name="addressUnit" type="gbsd:unitsType" use="optional"/>
    <attribute ref="bs1:bitstreamURI" use="optional"/>
  </attributeGroup>

  <!-- ################################### -->
  <!--         gBSDUnit definition         -->
  <!-- ################################### -->

  <complexType name="gBSDUnitType">
    <complexContent>
      <extension base="bs1:bitstreamSegment">
        <choice minOccurs="0" maxOccurs="unbounded">
          <element name="Parameter" type="gbsd:paramType"/>
          <element ref="gbsd:gBSDUnit"/>
        </choice>
        <attribute name="syntacticalLabel" type="gbsd:labelType" use="optional"/>
        <attribute name="marker" type="gbsd:markerType" use="optional"/>
        <attributeGroup ref="gbsd:addressAttributes"/>
        <anyAttribute namespace="##other" processContents="lax"/>
      </extension>
    </complexContent>
  </complexType>

  <!-- Resource address unit definition -->
  <simpleType name="unitsType">
    <restriction base="NMTOKEN">
      <enumeration value="bit"/>
      <enumeration value="byte"/>
    </restriction>
  </simpleType>

  <!-- Address mode definition -->
  <simpleType name="addressModeType">
    <restriction base="NMTOKEN">
      <enumeration value="Absolute"/>
      <enumeration value="Consecutive"/>
      <enumeration value="Offset"/>
    </restriction>
  </simpleType>

  <!-- ******* Marker definition ************ -->
  <simpleType name="markerType">
    <list itemType="NMTOKEN"/>
  </simpleType>

  <!-- ******* Label definition ************ -->
  <simpleType name="labelType">
    <union>
      <simpleType>
        <restriction base="NMTOKEN">
          <whiteSpace value="collapse"/>
          <pattern value=":[^:]+:[^:]+"/>
```

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```
        </restriction>
      </simpleType>
      <simpleType>
        <restriction base="anyURI"/>
      </simpleType>
    </union>
  </simpleType>

  <!-- ################################### -->
  <!--         Parameter definition        -->
  <!-- ################################### -->

  <complexType name="paramType">
    <complexContent>
      <extension base="bs1:bitstreamSegment">
        <sequence>
          <element name="Value" type="anySimpleType"/>
        </sequence>
        <attribute name="name" type="gbsd:labelType" use="optional"/>
        <attribute name="marker" type="gbsd:markerType" use="optional"/>
        <attributeGroup ref="gbsd:addressAttributes"/>
        <anyAttribute namespace="##other" processContents="lax"/>
      </extension>
    </complexContent>
  </complexType>

</schema>
```


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8.3.2.3 gBS Schema semantics

The semantics of the gBS Schema are defined as follows:

Name	*Definition*
`gBSDType`	Tool for describing the structure of a bitstream in a generic, codec independent way.

`addressAttributes`	Describes a set of attributes to specify addressing information. The `addressAttributes` group includes the following attributes:
	— `addressMode`: The specification of the address mode can be instantiated in three different ways and applies to the `start` and `length` attributes: (1) `Absolute`: absolute addressing, by specifying the number of units to be parsed from the beginning of the bitstream; (2) `Consecutive`: relative addressing, by assuming that the start of the specified section consecutively follows the previous section (in this case the `start` attribute does not need to be instantiated); (3) `Offset`: by specifying the offset to the start of the previous section in units.
	For (2) the previous section is defined to be the preceding sibling. If the element is the first child, then it assumes the start value of its parent element. If a `start` attribute is instantiated in an element which is in address mode `Consecutive`, then the value of this attribute gives the offset of this element to the previous element (sibling or parent if it is the first child). If the element is the first element in the gBS Description, then the `start` attribute value is the offset to the beginning of the bitstream. However, if the element is the first element in the gBS Description and the `start` attribute is not present, it assumes the default start value which is 0.
	For (3) the previous section which the offset references is defined to be the parent of this element.
	— `addressUnit`: The address unit specifies the unit for the values of both the start and length attributes. It can be either `bit` or `byte`.
	— `bs1:bitstreamURI`: The URI identifying the bitstream described by this gBS Description, `gBSDUnit`, or `Parameter` element as specified in subclause 8.3.1.

`gBSDUnit`	Describes a segment of the bitstream by extending `bs1:bitstreamSegment` from `urn:mpeg:mpeg21:2003-01-DIA-BSDL1-NS`, which contains `start` and `length` attributes. For the scope of the address attributes, i.e., the attributes possibly used as defined within the `addressAttributes` group, specified within a `gBSDUnit` element following holds: — When specified within a leaf `gBSDUnit` element, i.e., a `gBSDUnit` element without children elements, the scope is simply the element that carries the attributes. — When specified in a `gBSDUnit` element that has children, then the scope is the `gBSDUnit` element itself and all the descendants. The `gBSDUnit` elements do not necessarily correspond to syntactical units of the bitstream. They are placed with respect to the addressing required by the adaptations to be performed on the bitstream.

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Name	*Definition*
`syntacticalLabel`	Describes a syntactic label for a `gBSDUnit` element. This attribute allows a codec aware processor to use the gBS Description for bitstream adaptation. The `syntacticalLabel` attribute is similar to the type `termReferenceType` from `urn:mpeg:mpeg7:schema:2001`. These labels can be bitstream specific such as specifying that a certain segment in an ISO/IEC 14496-2 Visual Elementary Stream is a representation of an I-VOP. To unambiguously specify the labels, the value of this label can refer to a Classification Scheme set up e.g., for specific coding formats, and identified by the `ClassificationSchemeAlias` element, included in the `DescriptionMetadata` element of the `DIA` element.
`Parameter`	Describes a syntactical element of the bitstream by extending `bs1:bitstreamSegment` from `urn:mpeg:mpeg21:2003-01-DIA-BSDL1-NS`, which contains `start` and `length` attributes. The value of the syntactical element in the bitstream is represented by the child element `Value` and might be altered during the adaptation process. For the scope of the address attributes, i.e., the attributes possibly used as defined within the `addressAttributes` group, specified within a `Parameter` element following holds: — The scope is simply the `Parameter` element that carries the attributes.
`Value`	Describes the value of the `Parameter` element. The actual value is given by the content of this element and the datatype is specified in the instantiation by using the `xsi:type` attribute. This datatype can be either one of the XML Schema built-in simple types that are allowed in BSDL (see subclause 5.2 of ISO/IEC 23001-5) or a derived simple type. A library of predefined datatypes is also specified in subclause 5.2 of ISO/IEC 23001-5.
`name`	Describes a syntactical name for the `Parameter` element. The syntax and semantics of the `name` attribute are the same as for the `syntacticalLabel` attribute.
`marker`	Describes a handle to a segment of the bitstream described by a `gBSDUnit` or an element of the bitstream described by a `Parameter` element. The `marker` attribute is an optional attribute that can be assigned to `gBSDUnit` or `Parameter` elements to support efficient bitstream adaptations by providing a handle to segments of the bitstream that should be altered or removed.

The gBS Schema includes the schema document (`id="MPEG-B-UnsignedIntegers.xsd"`) specified in subclause 5.5 of ISO/IEC 23001-5 which defines a list of unsigned integer datatypes. Since this schema document has no defined target namespace, the types inherit the gBS Schema namespace. In a gBS Description, they can be used with a prefix bound to the gBS Schema namespace.

Furthermore, these datatypes inherit specific semantics in the context of bitstream generation, which consists in the binarization scheme specified by BSDL-1.

Lastly, this schema document also represents the normative list of built-in unsigned integer datatypes a gBSDtoBin processor shall implement on top of the XML Schema built-in datatypes listed in Table 2 of ISO/IEC 23001-5 and that may be used for the `gbsd:Value` element in a gBS Description.

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8.3.2.4 Bitstream generation with gBSDtoBin

The gBSDtoBin process (Figure 11) takes as input the original bitstream (Bitstream) and a (Transformed) gBS Description and edits the bitstream according to the Description. The resulting bitstream (Adapted Bitstream) is an adapted version of the original bitstream. The gBS Description must conform to the gBS Schema defined in subclause 8.3.2.2.

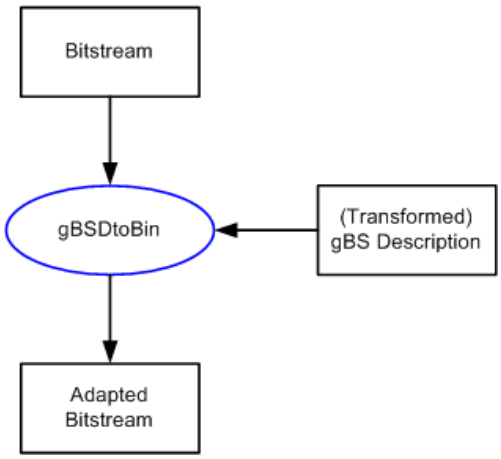

Figure 11 — Architecture of bitstream generation using gBSDtoBin

The gBSDtoBin process is specified as follows:

1) First the gBS Description is parsed as an XML document. A gBS Description comprises one or more `gBSDUnit` elements. The following information can be retrieved from the `Description` element where its type is superseded by `gBSDType` using the `xsi:type` attribute:

   i) `addressUnit` and `addressMode`: The default address unit and address mode used throughout the description.

   ii) `bs1:bitstreamURI`: The `default` URI of the bitstream this gBS Description is describing as specified in subclause 5.3.3 of ISO/IEC 23001-5.

2) gBSDtoBin then sequentially starts to step through the top-level `gBSDUnit` elements. For each `gBSDUnit` element, the gBSDtoBin process shall verify whether this `gBSDUnit` element has `gBSDUnit`, or `Parameter` child elements. If there are such child elements, then gBSDtoBin shall recursively parse these child elements. This depth-first recursion shall continue until an element without `gBSDUnit` or `Parameter` child elements is reached. In the special case when the first `gBSDUnit` element of a gBS Description has address mode `Consecutive` and it carries a start attribute, the value of this attribute provides the offset to the beginning of the bitstream. If the start attribute is absent, it assumes the default value which is 0.

3) When an element without `gBSDUnit` or `Parameter` child elements is encountered, the gBSDtoBin shall proceed as follows, depending on whether this element is a `gBSDUnit` or a `Parameter` element:

   i) `gBSDUnit`: `gBSDUnit` elements describe segments of data of the original bitstream that do not need to be altered. Therefore, gBSDtoBin shall simply locate this segment in the bitstream and append it to the new bitstream. To locate this segment in the bitstream, the addressing scheme of the gBS Schema (subclause 8.3.2.2) must be used. The information needed is: bitstream location as specified by the `bs1:bitstreamURI` attribute, the unit used (`bit` or `byte`) as defined in the `addressUnit` attribute, the addressing mode as defined in the `addressMode` attribute and the start address and the length of the segment (in “units”) as specified by the `start` and `length` attributes. The values of the `bs1:bitstreamURI`, `addressUnit` and

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addressMode attributes are determined by the scope semantics of these attributes as defined in subclause 8.3.2.3. Each of the three address attributes that a gBSDUnit element does not specify itself, inherits its value from the first ancestor of the gBSDUnit element that does specify it, otherwise it assumes the default value specified in the Description element with xsi:type="gBSDType". There are three possible address modes. Depending on the mode, the gBSDtoBin shall proceed as follows in order to locate the position of the gBSDUnit in the original bitstream:

I) Absolute: Both start and length attributes must be specified. The start attribute of gBSDUnit gives the exact (absolute) position in the original bitstream (offset from the beginning of the bitstream) at which the segment begins. The bitstream is assumed to start at 0 units.

II) Consecutive: The length attribute is mandatory whereas the start attribute is optional. If the start attribute is not present, the segment represented by this gBSDUnit starts at the next unit (bit or byte) after the end of the preceding-sibling element or at the same location than its parent element in case the element is the first child. The length of the segment is given by the value of the length attribute. If a start attribute is present, its value (*n*) provides the offset from the preceding-sibling or parent element as follows: the beginning of the data represented by this gBSDUnit element can be located *n* "units" (bit or byte) after the end of the previous preceding-sibling element or after the start of the parent element in case it is the first child element.

III) Offset: Both start and length attributes must be specified. The value of the start attribute is the offset of this gBSDUnit from the absolute start position of its parent gBSDUnit.

ii) Parameter: Parameter elements represent syntactical elements the values of which may have been changed during the description transformation. Therefore, gBSDtoBin needs to correctly encode the value of the Parameter element and append it to the new bitstream. The value of the Parameter element is given by its Value child element and the encoding format shall be determined from the xsi:type attribute specified in the instantiation of the Value element. In the case when the length attribute of the Parameter element is provided and specifies a length (L1) longer than the length (L2) implied by the datatype specified by the xsi:type attribute of the Value element, then the numerical value is encoded using the length specified by the length attribute (L1). In this case, (L1-L2) preceeding zeros are padded to the binary representation of the number. However, the actual value of the number is still restricted by the datatype, i.e., its maximum value cannot exceed the maximum value specified by the corresponding datatype. For gBSDtoBin processes that directly encode the new Parameter value in the original bitstream, it is possible to locate the position of the Parameter in the bitstream following the same process as for the gBSDUnit element, as described above.

8.3.2.5 Examples

EXAMPLE 1 The following example illustrates the usage of the addressMode, addressUnit and bs1:bitstreamURI attributes. These attributes can be defined at the highest level as well as within each gBSDUnit or Parameter element. The scope of these attributes is specified within subclause 8.3.2.3. When used within the dia:Description element with xsi:type="gBSDType" they define the default values, i.e., address mode, address unit, and bitstream URI for the entire gBS Description. The example below shows a gBS Description, which is typically for a Visual Elementary Stream conforming to the ISO/IEC 14496-2 specification. The DescriptionMetadata element defines the classification scheme alias (MV4) as well as its URI, and the default values for addressing are defined within the Description element. Additionally, the example contains several gBSDUnit elements with a syntacticalLabel attribute and corresponding address values. The syntacticalLabel attribute uses the classification scheme alias as defined in the DescriptionMetadata element to reference entries of the corresponding classification scheme. The address mode for the address values – identified by their start and length attributes – is derived from the addressUnit, addressMode, and bs1:bitstreamURI attributes. The bs1:bitstreamURI attribute within the Description element defines the base URI for the entire gBS Description. On the other hand, the bs1:bistreamURI

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of the second gBSDUnit element is relatively resolved against the base URI, i.e., the complete bitstream URI for this gBSDUnit element is http://mediasrv.somewhere.at/Content/akiyoI1.cmp.

```
<DIA>
    <DescriptionMetadata>
        <ClassificationSchemeAlias alias="MV4"
            href="urn:mpeg:mpeg4:video:cs:syntacticalLabels"/>
    </DescriptionMetadata>
    <Description xsi:type="gbsd:gBSDType" addressUnit="byte"
            addressMode="Absolute"
            bs1:bitstreamURI="http://mediasrv.somewhere.at/Content/akiyo.cmp">

        <gbsd:gBSDUnit syntacticalLabel=":MV4:VO" start="0" length="18"/>
        <gbsd:gBSDUnit syntacticalLabel=":MV4:I_VOP" start="18" length="4641"
                       bs1:bitstreamURI="akiyoI1.cmp"/>
        <gbsd:gBSDUnit syntacticalLabel=":MV4:P VOP" start="4659" length="98"/>
        <!-- ... and so on ... -->

    </Description>
</DIA>
```

EXAMPLE 2 The following example illustrates the usage of the gBSDUnit and Parameter elements. The gBSDUnit element describes a section of the bitstream. The example above already demonstrated the use of the syntacticalLabel attribute. Within a gBSDUnit element it is also possible to overwrite the attributes defined within the dia:Description element. The example below shows a fragment of a gBS Description for a JPEG2000 image. It is a more comprehensive example and it additionally shows the usage of the Parameter element.

The gBSDUnit element with the syntacticalLabel attribute ":J2K:SIZ" comprises a gBSDunit child element that overwrites the address mode inherited from the dia:Description element. The information contained in this gBSDunit element (addressMode="Consecutive") applies to itself and all its *child* elements. Alternatively each child element could have an additional addressMode attribute in order to achieve the same result.

The Parameter elements with the name attribute ":J2K:Xsiz" and ":J2K:Ysiz" specify the horizontal and vertical resolution of the image within the corresponding Value elements. These parameters might be updated during the gBS Description transformation process, e.g., during spatial scaling. The gBSDUnit elements with syntacticalLabel attribute ":J2K:Comp_siz" are marked properly in order to enable color reduction, i.e., adaptation from color to greyscale. The marker values (C0, C1, C2) represent the color components in the YUV color space.

The Parameter elements with the syntacticalLabel attributes ":J2K:EPHMarkersUsed", ":J2K:SOPMarkersUsed", and ":J2K:PrecinctsUsed" contain an addressUnit attribute (bit) which overwrites the address unit inherited from the dia:Description element. In addition, these Parameters have datatypes from the UnsignedInteger.xsd schema ("b1"). It should be noted that the Value of the ":J2K:EPHMarkersUsed" parameter element will be encoded on 6 bits (specified by the length attribute) even though the datatype is "b1" which, according to the UnsignedInteger.xsd schema, means that the numerical value of the Parameter element is restricted by the datatype, i.e., it must be between 0 and 1. Preceding, extra bits are zero padded. The Parameter element with the name attribute ":J2K:EPHMarkersUsed" will therefore be encoded as 000001.

```
<dia:DIA>
   <dia:DescriptionMetadata>
      <dia:ClassificationSchemeAlias alias="J2K"
               href="urn:jpeg:jpeg2000:cs:syntacticalLabels"/>
   </dia:DescriptionMetadata>
   <dia:Description xsi:type="gBSDType" addressUnit="byte"
           addressMode="Absolute" bs1:bitstreamURI="content/city.jp2">

      <gBSDUnit syntacticalLabel=":J2K:MainHeader" start="0" length="135">
         <gBSDUnit syntacticalLabel=":J2K:SOC" start="0" length="2"/>
         <gBSDUnit syntacticalLabel=":J2K:SIZ" start="2" length="49">
            <gBSDUnit length="49" addressMode="Consecutive">
               <gBSDUnit length="2"/>
               <Parameter name=":J2K:LMarker" length="2">
                  <Value xsi:type="xsd:unsignedShort">47</Value>
```

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```
               </Parameter>
               <Parameter name=":J2K:Rsiz" length="2">
                  <Value xsi:type="xsd:unsignedShort">0</Value>
               </Parameter>
               <Parameter name=":J2K:Xsiz" length="4">
                  <Value xsi:type="xsd:unsignedInt">768</Value>
               </Parameter>
               <Parameter name=":J2K:Ysiz" length="4">
                  <Value xsi:type="xsd:unsignedInt">512</Value>
               </Parameter>
               <!--... other Parameter elements  ...-->
               <gBSDUnit syntacticalLabel=":J2K:Comp_siz" length="3"
                      marker="C0"/>
               <gBSDUnit syntacticalLabel=":J2K:Comp siz" length="3"
                      marker="C1"/>
               <gBSDUnit syntacticalLabel=":J2K:Comp_siz" length="3"
                      marker="C2"/>
            </gBSDUnit>
         </gBSDUnit>

         <gBSDUnit syntacticalLabel=":J2K:COD" start="51" length="14">
            <gBSDUnit length="14" addressMode="Consecutive">
               <gBSDUnit length="2"/>
               <Parameter name=":J2K:LMarker" length="2">
                  <Value xsi:type="xsd:unsignedShort">12</Value>
               </Parameter>
               <gBSDUnit syntacticalLabel=":J2K:Scod" length="1">
                  <Parameter name=":J2K:EPHMarkersUsed" length="6"
                         addressUnit="bit">
                     <Value xsi:type="b1">0</Value>
                  </Parameter>
                  <Parameter name=":J2K:SOPMarkersUsed" length="1"
                         addressUnit="bit">
                     <Value xsi:type="b1">1</Value>
                  </Parameter>
                  <Parameter name=":J2K:PrecinctsUsed" length="1"
                         addressUnit="bit">
                     <Value xsi:type="b1">0</Value>
                  </Parameter>
               </gBSDUnit>
               <!--... and so on ...-->
            </gBSDUnit>
         </gBSDUnit>
         <!--... and so on ...-->
      </gBSDUnit>

      <gBSDUnit syntacticalLabel=":J2K:Tile" start="135" length="240232">
         <!--... JPEG2000 Tile ...-->
      </gBSDUnit>

      <gBSDUnit syntacticalLabel=":J2K:EOC" start="240367" length="2"/>
   </dia:Description>
</dia:DIA>
```


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Figure 12 illustrates the gBS Description example shown above. It shows the bitstream segments in different colors and the corresponding syntactical labels. The marker values of the three color components are inside the boxes.

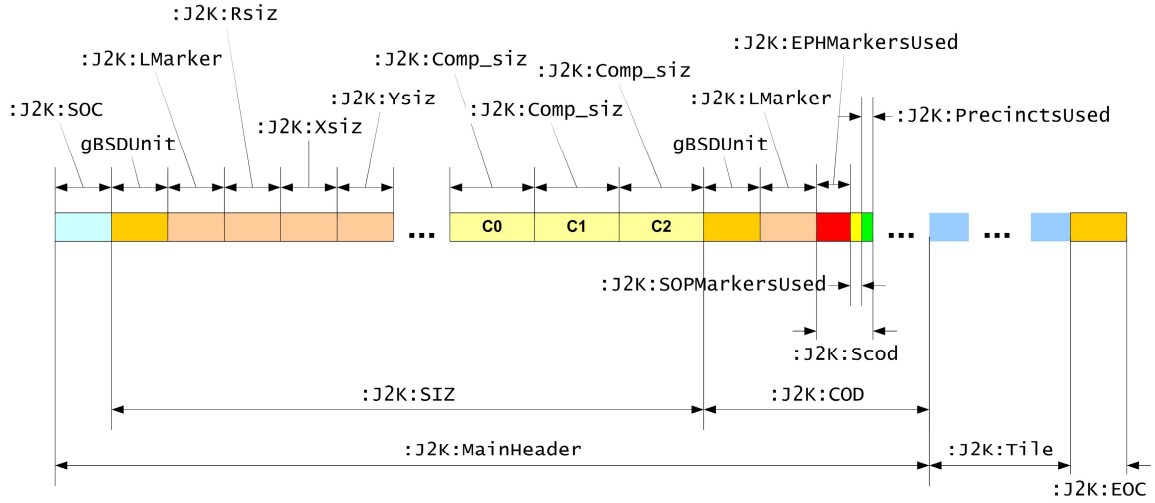

Figure 12 — Example of an original gBS Description for an image

The following adaptations are now performed on the bitstream: reduction of the spatial resolution and reduction of the color components (i.e., from three components to one component, which corresponds to an adaptation to a greyscale image). The resulting bitstream and its syntactical labels are illustrated in Figure 13. Color components (“`:J2K:Comp_siz`”) marked with `C1` and `C2` are removed and the "`:J2K:Xsiz`" and "`:J2K:Ysiz`" parameters are updated to the new resolution. Note that this kind of adaptations requires also some other modifications in the "`:J2K:Tile`" which are not illustrated in the figure.

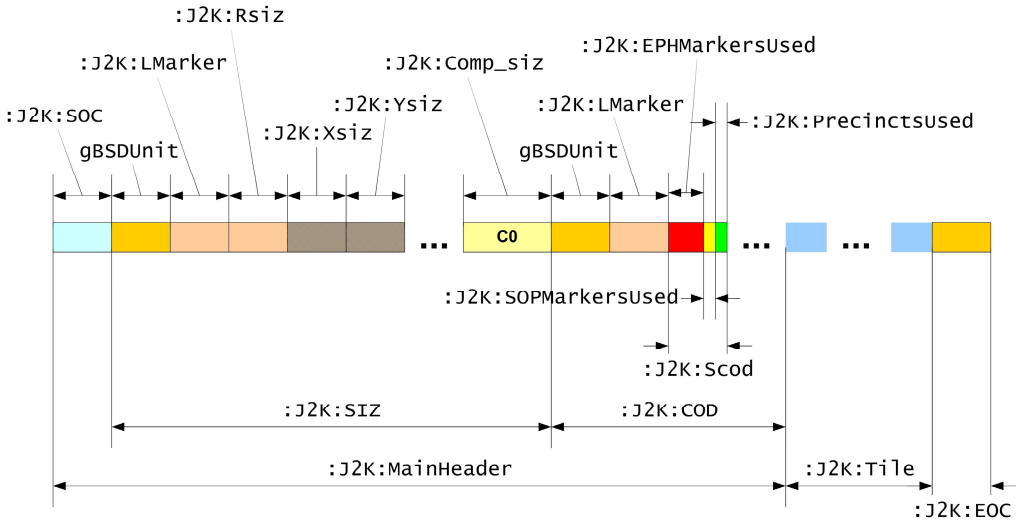

Figure 13 — Example of an adapted/transformed gBS Description for an image

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EXAMPLE 3 The following example illustrates the usage of the `marker` attribute. The `marker` attribute provides means for semantically meaningful marking of syntactical elements. The following example shows a fragment of a gBS Description, which describes the bitstream in a hierarchical fashion. Therefore, an additional `gBSDUnit` element is introduced containing a marker attribute. These additional `gBSDUnit` elements with the `marker` attribute `"violent-5"` and `"violent-3"` enables a description transformation engine to easily identify this element and to perform efficient, hierarchical adaptations (e.g., the removal of the whole `gBSDUnit` element). The value of the `marker` attribute can be derived from an ISO/IEC 15938-5 description of the bitstream by using the `ICRAParentalRatingViolenceCS`.

```
<dia:DIA>
   <dia:DescriptionMetadata>
      <dia:ClassificationSchemeAlias alias="MV4"
               href="urn:mpeg:mpeg4:video:cs:syntacticalLabels"/>
   </dia:DescriptionMetadata>
    <dia:Description xsi:type="gBSDType" addressUnit="byte"
           addressMode="Absolute" bs1:bitstreamURI="Content/starwars.cmp">

        <gBSDUnit syntacticalLabel=":MV4:VO" start="0" length="26"/>
        <gBSDUnit start="26" length="99983" marker="violent-5">
            <gBSDUnit syntacticalLabel=":MV4:I_VOP" start="26" length="2877"/>
            <gBSDUnit syntacticalLabel=":MV4:P_VOP" start="2903" length="64"/>
            <!-- ... and so on ... -->
            <gBSDUnit syntacticalLabel=":MV4:P_VOP" start="98296" length="1713"/>
        </gBSDUnit>
        <gBSDUnit start="100009" length="68022" marker="violent-3">
            <gBSDUnit syntacticalLabel=":MV4:I_VOP" start="100009" length="1825"/>
            <gBSDUnit syntacticalLabel=":MV4:P_VOP" start="101834" length="1780"/>
            <!-- ... and so on ... -->
            <gBSDUnit syntacticalLabel=":MV4:I_VOP" start="166802" length="1229"/>
        </gBSDUnit>
        <!-- ... and so on ... -->
    </dia:Description>
</dia:DIA>
```

Figure 14 illustrates the bitstream and its corresponding `syntacticalLabel` and `marker` attribute values from its `gBSDunit` elements as well as the adapted bitstream and gBS Description when removing `gBSDunit` marked with "`violent-3`".

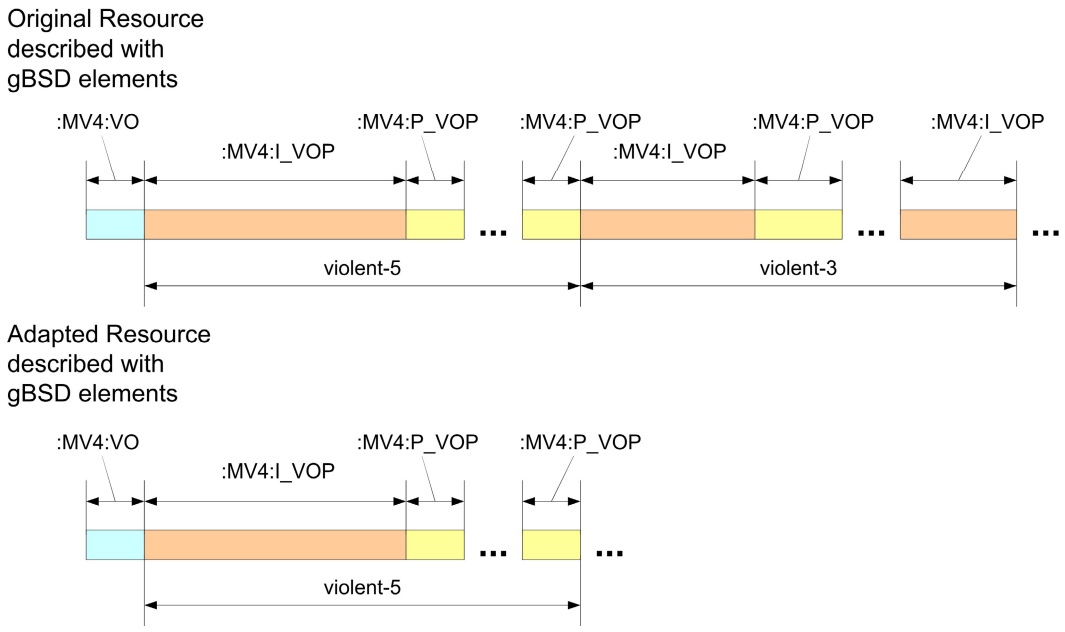

Figure 14 — Example of an original and adapted gBSD for video

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EXAMPLE 4 The following example illustrates the integration of gBS Descriptions into ISO/IEC 21000-2. The gBS Description describes the high-level structure of a resource. A `Component` within ISO/IEC 21000-2 groups a `Resource` with a set of `Descriptor`s containing descriptive information about the `Resource` among others. One of these `Descriptor`s may be a gBS Description as shown in the example below. Note that this not necessarily the only possibility for integrating a gBS Description into ISO/IEC 21000-2.

```
<?xml version="1.0" encoding="UTF-8"?>
<did:DIDL>
    <did:Item>
      <did:Component id="component_id">
         <did:Descriptor id="descriptor id">
            <did:Statement mimeType="text/xml">
               <dia:DIA>
                  <dia:Description xsi:type="gBSDType" addressUnit="byte"
                          addressMode="Absolute">
                     <!-- place gBSDUnit elements here -->
                  </dia:Description>
               </dia:DIA>
            </did:Statement>
         </did:Descriptor>
         <did:Resource ref="URI_to_resource" mimeType="mime_type_of_resource"/>
      </did:Component>
   </did:Item>
</did:DIDL>
```

EXAMPLE 5 The following example illustrates the usage of the `bs1:datatype` attribute. It shows an excerpt of EXAMPLE 2 with the only difference that the datatype is defined by URI referring to the respective datatype as defined within the XML Schema definition. Thus, any datatype can be used as long as it can be referenced by URI, e.g., by using the namespace and XPointer's shorthand pointer.

```
<!--... and so on ...-->
<Parameter name=":J2K:LMarker" length="2">
  <Value bs1:codec="http://www.w3.org/2001/XMLSchema#unsignedShort">47</Value>
</Parameter>
<Parameter name=":J2K:Rsiz" length="2">
  <Value bs1:codec="http://www.w3.org/2001/XMLSchema#unsignedShort">0</Value>
</Parameter>
<Parameter name=":J2K:Xsiz" length="4">
  <Value bs1:codec="http://www.w3.org/2001/XMLSchema#unsignedInt">768</Value>
</Parameter>
<Parameter name=":J2K:Ysiz" length="4">
  <Value bs1:codec="http://www.w3.org/2001/XMLSchema#unsignedInt">512</Value>
</Parameter>
<!--... and so on ...-->
```

8.4 BS Description generation: BSDL-2

Subclause 8.4 specifies BSDL-2 and BintoBSD respectively. Therefore, ISO/IEC 21000-7 normatively adopts the corresponding tools from ISO/IEC 23001-5, especially BSDL-2 and BintoBSD as specified in Clause 6.

8.5 Media resource streaming instructions

8.5.1 Introduction

The media resource streaming instructions specified in this subclause provide the information required for streaming a bitstream described by a BSD and possibly adapted on-the-fly, namely the indication of access units and their associated time information.

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Access units are the fundamental units for transport of media resource streams. They are defined in this specification as the smallest data entity which is atomic in time, *i.e.*, to which a single decoding time can be attached. The media resource streaming instructions allow annotating a BSD in a coding format independent way to indicate the location of the access units in the described bitstream. Additionally, they indicate which access units are random access points, *i.e.*, can be decoded independently from previous access units,

In some cases, an access unit needs to be sub-divided into several parts in order to fit the requirements of the delivery channel. For example, an access unit needs to be fragmented into several Real-time Transport Protocol (RTP) packets when its size exceeds what is allowed by the Maximum Transmission Unit (MTU). For this purpose, some RTP payload formats propose a specific fragmentation based on the semantics of the bitstream. For example, for ISO/IEC 14496-2 visual streams, the RFC 3016 recommends to send a single video packet as a single RTP packet. The media resource streaming instructions provide a way for indicating access unit parts within an access unit in a coding format independent way. In this way, a streaming server that is not aware of the format of the streamed media resource may nevertheless meet the requirements of a specific RTP payload format.

Lastly, media resource streaming instructions provide information about the decoding and composition time stamps (DTS and CTS) of the access units. This information is widely used for streaming media resources such as ISO/IEC 13818 and 14496 visual streams.

For the purpose as mentioned above, this subclause introduces a set of abstract properties and XML attributes used for annotating the BSD.

The properties are abstract in the sense that they do not appear in the XML document, but augment the element information item in the document infoset. They can be specified statically by a set of XML attributes and dynamically by the so-called Properties Style Sheet specified in the subclause 8.7. Additionally, an inheritance mechanism is defined for some of these properties: the value of the property is then inherited by all descendant elements until the property is defined with a different value which then supersedes the inherited value, and is itself inherited by the descendants. Lastly, a default value is specified for each property.

The property of an element information item is specified as follows:

— If a Properties Style Sheet is applied to the document, and if the element matches the pattern of one or more templates, the value indicated by the relevant template applies.

— Otherwise, if the element contains an attribute specifying the property, the attribute value applies.

— Otherwise, if the property is inheritable, its value is inherited from the parent element.

— Otherwise, the property takes the specified default value.

Subclause 8.5.2 specifies a set of properties for annotating a BSD to indicate:

— the access units, access unit parts and random access points of the described media resource bitstream.

— the decoding and composition time stamps (DTS/CTS) of the media resource access units.

Subclause 8.5.3 specifies a set of XML attributes for setting these properties.

NOTE Media resource streaming instructions specified in this subclause can be used to annotate both BS Descriptions and gBS Descriptions. For simplicity, the text uses BSD to refer to either of them.

8.5.2 Properties

The media resource streaming instructions specify two sets of properties for annotating a BSD. The first set indicates the access units in the described bitstream, the random access points, and the subdivision into access unit parts. The second set provides the access unit time stamps.

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A BSD linearly describes a bitstream. Each BSD element therefore corresponds to a point in the described bitstream. The start of an access unit is indicated by an element with an `au` property set to true. This element is named **anchor element**. The extent of the access unit then depends on the value of the `auMode` property of the anchor element. In the sequential mode, the access unit extends until a new element is found with an `au` property set to false or true. In the latter case (i.e., new anchor element), a new access unit immediately follows. If no element is found with an `au` property set to true or false, the access unit extends until the end of the bitstream. In the tree mode, the access unit is the bitstream segment described by the BSD sub-tree below the element flagged with the `au` property set to true.

Access unit parts are defined in a similar way. The start of a new access unit part in an access unit is indicated by an `auPart` property set to true and the extent is specified by the `auMode` property. In the sequential mode, the access unit part extends until a new element has an `auPart` property set to false or true (in the latter case, a new access unit part immediately follows), until the end of the access unit, or until the end of the bitstream. In the tree mode, the access unit part is the bitstream segment corresponding to the sub-tree below the element flagged by the `auPart` property. It is not necessary to indicate the first access unit part since it is supposed to start with the access unit.

Other information about access units is specified by the properties of the anchor element. In particular, the access unit is a random access point if the `rap` property of the anchor element is set to true. The `rap` property is inheritable, and it is therefore possible to factorize the information by setting the `rap` property of the BSD root element to true. The value of the property is then inherited by all descendant elements, including the anchor elements indicating the access units.

The time information of the access unit (CTS and DTS) is also specified by the properties of the anchor element as explained below.

The media resource streaming instructions use an absolute and a relative mode for specifying time information. In absolute mode, the CTS and DTS of an access unit are specified independently from other access units. In relative mode, the CTS and DTS are calculated relatively to the CTS and DTS of the previous access unit. Both modes can be used in a same document. For example, an absolute date can be applied to a given access unit, and the CTS and DTS of the following access units are calculated relatively to this access unit. In both modes, CTS and DTS are specified relatively to a time scale, *i.e.* they are specified as a number of ticks, where the duration of a tick is specified by the time scale which indicates the number if ticks per second. The scale is specified by the `timeScale` property.

In the absolute time mode, two properties `cts` and `dts` define the CTS and DTS of the access unit, expressed as an integer number of ticks. They are not inheritable and may be applied to an anchor element for specifying the CTS and DTS of the corresponding access unit.

In the relative time mode, two properties named `dtsDelta` and `ctsOffset` allow calculating the DTS and CTS of the access unit relatively to the previous access unit. The `dtsDelta` property indicates the time interval in ticks between the current access unit and the next one. The `ctsOffset` property indicates the time interval in ticks between the DTS and the CTS of the current access unit. The DTS of the first access unit is 0 by default.

NOTE Some media resources do not require a CTS information. In this case, the `cts` and `ctsOffset` properties are not used and may be undefined.

The media resource streaming instructions properties are specified in Table 4.

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Table 4 — Table of media resource streaming instructions properties.

Property name	Property value	Is inherited	Default value
auMode	{tree, sequential}	yes	tree
au	{undefined, false, true}	no	undefined
auPart	{undefined, false, true}	no	undefined
rap	{undefined, false, true}	yes	undefined
timeScale	{undefined, an integer value}	yes	undefined
dts	{undefined, an integer value}	no	undefined
cts	{undefined, an integer value}	no	undefined
dtsDelta	{undefined, an integer value}	yes	undefined
ctsOffset	{undefined, an integer value}	yes	undefined

8.5.3 Attributes

8.5.3.1 Introduction

Subclause 8.5.3 specifies a set of XML attributes with normative syntax and semantics associated to the properties defined in subclause 8.5.2. An attribute can be used to set a property for a given element.

NOTE 1 It is reminded that XML does not define any inheritance mechanism for an attribute. In other words, if an attribute is used for a given element, its descendant elements are agnostic about this attribute. Alternatively, the properties introduced in 8.5.1 are inheritable.

NOTE 2 These attributes are not the only means for setting properties, i.e., the property of an element may also be set by a properties stylesheet, inherited from the parent element or get a default value.

8.5.3.2 Syntax

```
<?xml version="1.0"?>
<!-- Digital Item Adaptation ISO/IEC 21000-7 Second Edition -->
<!-- Schema for Media Streaming Instructions -->
<schema
  version="ISO/IEC 21000-7 2nd"
  id="MSI-2nd.xsd"
  xmlns="http://www.w3.org/2001/XMLSchema"
  xmlns:msi="urn:mpeg:mpeg21:2003:01-DIA-MSI-NS"
  targetNamespace="urn:mpeg:mpeg21:2003:01-DIA-MSI-NS"
  elementFormDefault="qualified">

  <annotation>
    <documentation>
      Declaration of attributes used for media resource streaming instructions
    </documentation>
  </annotation>
```

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```
  <!-- The following attribute indicates the access unit mode -->
  <attribute name="auMode" type="msi:auModeType"/>
  <simpleType name="auModeType">
    <restriction base="string">
      <enumeration value="tree"/>
      <enumeration value="sequential"/>
    </restriction>
  </simpleType>

  <!-- The following attribute indicates media resource access units -->
  <attribute name="au" type="boolean"/>

  <!-- The following attribute indicates media resource access unit part -->
  <attribute name="auPart" type="boolean"/>

  <!-- The following attribute indicates Random Access Points -->
  <attribute name="rap" type="boolean"/>

  <!-- The following attributes define the time properties -->
  <attribute name="timeScale" type="unsignedInt"/>

  <attribute name="cts" type="unsignedInt"/>
  <attribute name="dts" type="unsignedInt"/>

  <attribute name="dtsDelta" type="unsignedInt"/>
  <attribute name="ctsOffset" type="int"/>

</schema>
```

8.5.3.3 Semantics

Name	*Definition*
`auMode`	Attribute defining the `auMode` property.
`au`	Attribute defining the `au` property.
`auPart`	Attribute defining the `auPart` property.
`rap`	Attribute defining the `rap` property.
`timeScale`	Attribute defining the `timeScale` property.
`dts`	Attribute defining the `dts` property.
`cts`	Attribute defining the `cts` property.
`dtsDelta`	Attribute defining the `dtsDelta` property.
`ctsOffset`	Attribute defining the `ctsOffset` property.

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8.5.4 Processing

In off-line, BSD-based adaptation scenarios, the normative BSDtoBin and gBSDtoBin processors specified in subclauses 8.3.1.6 and 8.3.2.4 are used to generate an adapted bitstream from the (possibly transformed) BSD. However, in order to stream the generated bitstream, additional information is required to locate the access units and indicate their decoding and composition time stamps. This information can typically be provided by the sample tables of the ISO/IEC 14496-12 file format, but is no longer valid for an adapted bitstream. In particular, the sample offsets in the elementary stream or their DTS/CTS may have changed.

This subclause specifies two normative processors named BSDtoBinAU and gBSDtoBinAU which respectively extend the BSDtoBin and gBSDtoBin processors by providing information about access units in the output bitstream and their associated time stamps. In particular, these processors may be used by a server streaming a media resource adapted on-the-fly based on its BSD.

The behavior of the BSDtoBinAU and gBSDtoBinAU is identical. For conciseness purpose, the description below only mentions BSDtoBinAU.

The input of the BSDtoBinAU processor is the input bitstream and its BSD (gBSD for gBSDtoBinAU), plus media resource streaming instructions. Media resource streaming instructions may be provided as attributes embedded in the BSD and/or as an external Properties Stylesheet, as pictured in Figure 15.

The output of the BSDtoBinAU processor is the output bitstream as produced by BSDtoBin, framed into access units and possibly access unit parts with associated time stamps. Moreover, a new description with the updated address information usually needs to be generated, for example in multi-step/distributed adaptation scenarios. This updating mechanism is not normative, but an example process is proposed in the informative Annex D.

NOTE 1 When using media resource streaming instructions in combination with XML streaming instructions in order to realize a distributed adaptation framework, the input to the BSDtoBinAU processor can consist of BSD PUs instead of a BSD which describes the complete bitstream. The output would then be an updated BSD PU (according to Annex D) which can be encoded and streamed together with the adapted AU. Please refer to Annex M for a detailed description of the combined usage of XML streaming instructions and media resource streaming instructions.

The production of the output bitstream is identical to BSDtoBin. Additionally, the BSDtoBinAU processor defines the following set of properties for each access unit:

— `DTS` and `CTS`: Decoding and composition time stamp of the access unit, expressed as an integer number of ticks.

— `DTS_DELTA`: interval between the current access unit and the next one, expressed as an integer number of ticks.

— `TIME_SCALE`: time scale, i.e. number of ticks per second used for `DTS`, `CTS` and `DTS_DELTA`.

— `RAP`: random access point flag.

NOTE 2 These properties characterize access units and should not be confused with the media resource streaming instructions properties.

NOTE 3 Depending on the media resource streaming instructions provided, some values may remain undefined.

Additionally, the information about access units and their time stamps is calculated from the media resource streaming instructions properties, as specified in the subclause 8.5.2. This information consists in the Decoding and Composition Time Stamps (DTS/CTS), time scale, DTS delta and random access point flag. DTS, CTS and DTS Delta are provided as an integer number of ticks, where the number of ticks per second is provided by the time scale. The DTS delta specifies the interval in ticks between the current and next access unit. In the following, the following notation is used for referring to the information of the nth access unit: `DTS(n)`, `CTS(n)`, `TIME_SCALE(n)`, `DTS_DELTA(n)` and `RAP(n)`.

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A BSD is parsed in a depth-first order. The media resource streaming instructions properties are calculated as specified in the subclause 8.5.2. Anchor elements (i.e., elements with the `au` property set to true) are ordered according to the elements scan order and so are the corresponding access units. An anchor element indicates the start of an access unit, the extent of which is specified by the `auMode` property.

The following pseudo-code specifies how to calculate the properties of each access unit according to the media resource streaming instructions properties.

For each anchor element, the properties of the corresponding access unit are then calculated as follows:

```
 1 if isDefined(dts(n)) {
 2     DTS(n) = dts(n)
 3 } else {
 4  if n = 0 {  // i.e., first access unit
 5    DTS(n) = 0
 6  } else {
 7    DTS(n) = ((DTS(n-1) + DTS_DELTA(n-1))/TIME_SCALE(n-1)) * TIME_SCALE(n)
 8  }
 9 }
10 if isDefined(cts(n)) {
11     CTS(n) = cts(n)
12 } else {
13     CTS(n) = DTS(n) + ctsOffset(n)
14 }
15 TIME_SCALE(n) = timeScale(n)
16 DTS_DELTA(n) = dtsDelta(n)
17 RAP(n) = rap(n)
```

Where `dts(n)`, `cts(n)`, `timeScale(n)`, `dtsDelta(n)`, `ctsOffset(n)`, `rap(n)` represent the media resource streaming instruction properties of the nth anchor element, and `DTS(n)`, `CTS(n)`, `TIME_SCALE(n)`, `DTS_DELTA(n)` and `RAP(n)` represent the properties of the associated n^{th} access unit.

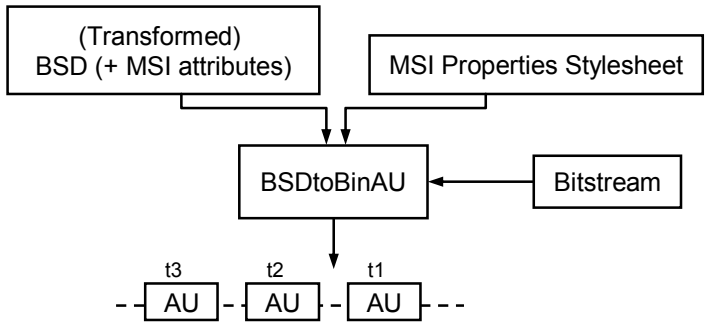

Figure 15 — Processing related to media resource streaming instructions.

8.5.5 Examples

Examples for media resource streaming instructions can be found in Annex L.

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8.6 XML streaming instructions

8.6.1 Introduction

The XML streaming instructions allow firstly to identify process units in an XML document and secondly to assign time information to them.

A process unit is a set of connected XML elements. It is specified by one element named anchor element and by a process unit mode indicating how other connected elements are aggregated to this anchor to compose the process unit. Depending on the mode, the anchor element is not necessarily the root of the process unit. Anchor elements are ordered according to the navigation path of the XML document. Process units may overlap, i.e. some elements (including anchor elements) may belong to several process units. Additionally, the content provider may require that a given process unit be encoded as a random access point, i.e. that the resulting access unit does not require any other access units to be decoded.

Subclause 8.6 specifies a set of properties and XML attributes for:

— Fragmenting an XML document into process units.

— Indicating which process units shall be encoded as random access point.

— Assigning time information (*i.e.*, processing time stamp) to these process units.

Properties are understood and set as in the subclause 8.5.1.

8.6.2 Properties

8.6.2.1 Introduction

Subclause 8.6.2 defines two sets of properties: a first set specifying how an XML document is fragmented into process units and a second set specifying how processing time stamps are assigned to these process units.

8.6.2.2 Properties related to the fragementation

The properties related to the fragmentation are specified as follows:

— `anchorElement` is one of {`undefined`, `false`, `true`}:

  — When set to true, this property indicates an anchor element.

  — This property *is not* inherited and its default value is `undefined`.

A process unit inherits its time properties from the time properties of its anchor element.

— `puMode` is one of {`undefined`, `self`, `ancestors`, `descendants`, `ancestorsDescendants`, `preceding`, `sequential`}:

  — The process unit mode property specifies how elements are aggregated to the anchor element to compose a process unit.

  — The semantics of the values are as follows:

    — `self`: the process unit contains only the anchor element.

    — `ancestors`: the process unit contains the anchor element and its ancestors stack, i.e., its ancestor elements.

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— `descendants`: the process unit contains the anchor element and its descendant elements.

— `ancestorsDescendants`: the process unit contains the anchor element, its ancestor, and descendant elements.

— `preceding`: the process unit contains the anchor element, its descendant and parent elements, and all the preceding-sibling elements of its ancestor elements and their descendants.

— `precedingSiblings`: the process unit contains the anchor element, its descendant and parent elements, and all the preceding-sibling elements (and their descendants) of its ancestor elements.

— `sequential`: the process unit contains the anchor element, its ancestors stack, and all the following elements (i.e., descendants, following siblings, and their ancestors) until a next element is flagged as an anchor element.

— This property *is* inherited and its default value is `undefined`.

EXAMPLE The following figures (Figure 16-Figure 22) show examples of process unit definition following the `puMode` property. The anchor elements are pictured in white.

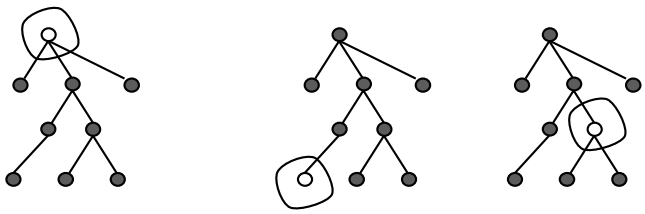

Figure 16 — Examples of process units - `puMode` = `self`

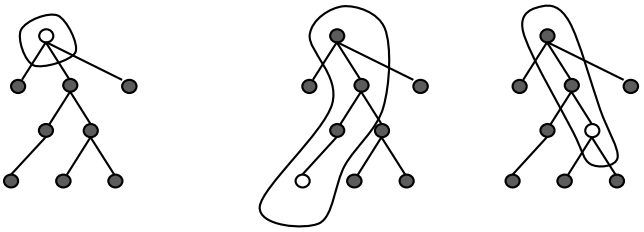

Figure 17 — Examples of process units - `puMode` = `ancestors`

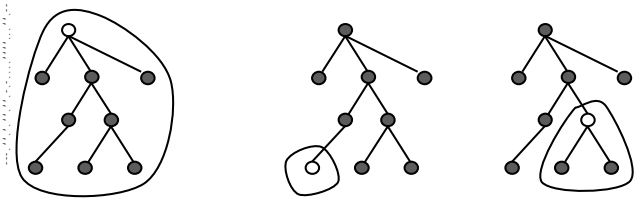

Figure 18 — Examples of process units - `puMode` = `descendants`

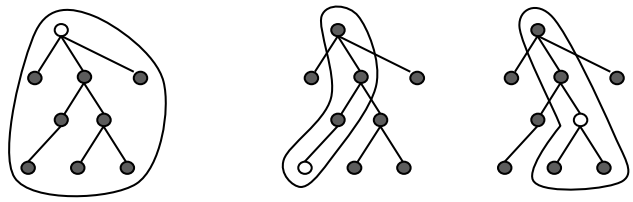

Figure 19 — Examples of process units - `puMode` = `ancestorsDescendants`

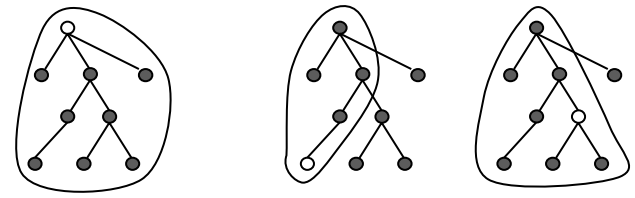

Figure 20 — Examples of process units - `puMode` = `preceding`

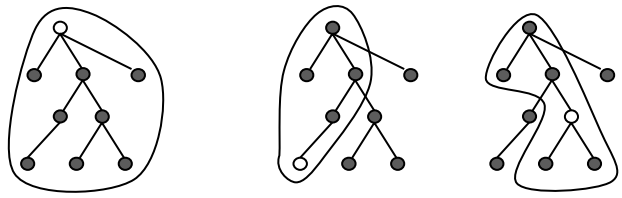

Figure 21 — Examples of process units - `puMode` = `precedingSibling`

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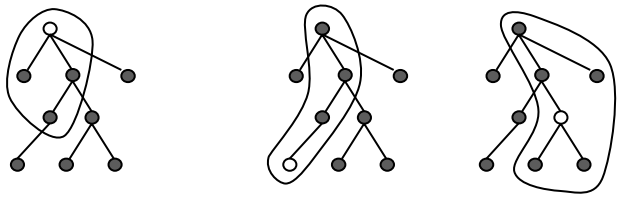

Figure 22 — Examples of process units - `puMode` = `sequential`

— `encodeAsRAP` is one of {`undefined`, `false`, `true`}:

— When set to `true`, this property indicates that the process unit shall be encoded as a random access point.

— This property *is* inherited and its default value is `undefined`.

The fragmentation-related properties are summarized in Table 5.

Table 5 — Table of fragmentation-related properties.

Property name	Property value	Is inherited	Default value
`anchorElement`	{`undefined`, `false`, `true`}	no	`undefined`
`puMode`	{`undefined`, `self`, `ancestors`, `descendants`, `ancestorsDescendants`, `preceding`, `precedingSiblings`, `sequential`}	yes	`undefined`
`encodeAsRap`	{`undefined`, `false`, `true`}	yes	`undefined`

8.6.2.3 Properties related to time information

The processing time stamp of a process unit defines the point in time where it is available to the application for consumption. It is specified by the set of time properties of the PU's anchor element. There are two defined time modes: an **absolute time mode** where the PUs' PTS are specified according to a same time origin and a **relative time mode** where they are defined relatively to the PTS of the previous PU.

The properties related to time information are specified as follows:

— `timeScale` is one of {`undefined`, an integer value}:

— Specifies the time scale, i.e., the number of ticks per second.

— This property *is* inherited and its default value is `undefined`.

— `ptsDelta` is one of {`undefined`, an integer value}:

— The `ptsDelta` property specifies the relative interval in time ticks after the preceding anchor element.

— The default value for the processing time stamp of the first anchor element is 0.

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  - This property *is* inherited and its default value is `undefined`.

— `absTimeScheme` is one of {`undefined`, a string value}:

  - The `absTimeScheme` property specifies the absolute time scheme used.

  - This property *is* inherited and its default value is `undefined`.

EXAMPLE 1 Example time schemes are specified in other standards such as SMPTE or MPEG-7. For example, the value 'mp7t' identifies the MPEG-7 time scheme. See Annex C of ISO/IEC 21000-17:2006 for other examples of time schemes syntax.

— `absTime` is one of {`undefined`, a string value}:

  - The `absTime` property specifies the absolute time of the anchor element. Its syntax and semantics are specified according to the time scheme used (`absTimeScheme` property).

  - This property *is not* inherited and its default value is `undefined`.

EXAMPLE 2 In the MPEG-7 time scheme quoted above, an example absolute time value is 'T17:30:45:2F10'.

— `pts` is one of {`undefined`, an integer value}:

  - The `pts` property specifies the absolute time of the anchor element as the number of ticks since the origin.

  - This property *is not* inherited and its default value is `undefined`.

The time-related properties are summarized in Table 6.

Table 6 — Table of time-related properties.

Property name	Property value	Is inherited	Default value
`timeScale`	{`undefined`, an integer value}	yes	`undefined`
`ptsDelta`	{`undefined`, an integer value}	yes	`undefined`
`absTimeScheme`	{`undefined`, a string value}	yes	`undefined`
`absTime`	{`undefined`, a string value}	no	`undefined`
`pts`	{`undefined`, an integer value}	no	`undefined`

8.6.3 Attributes

8.6.3.1 Introduction

Subclause 8.6.3 specifies a set of XML attributes with normative syntax and semantics associated to the properties defined in subclause 8.6.2. An attribute can be used to set a property for a given element.

NOTE 1 It is reminded that XML does not define any inheritance mechanism for an attribute. In other words, if an attribute is used for a given element, its descendant elements are agnostic about this attribute. Alternatively, the properties introduced in 8.6.1 are inheritable.

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NOTE 2 These attributes are not the only means for setting properties, i.e., the property of an element may also be set by a properties stylesheet, inherited from the parent element or get a default value.

8.6.3.2 Syntax

```
<?xml version="1.0"?>
<!-- Digital Item Adaptation ISO/IEC 21000-7 Second Edition -->
<!-- Schema for XML Streaming Instructions -->
<schema
  version="ISO/IEC 21000-7 2nd"
  id="XSI-2nd.xsd"
  xmlns="http://www.w3.org/2001/XMLSchema"
  xmlns:si="urn:mpeg:mpeg21:2003:01-DIA-XSI-NS"
  targetNamespace="urn:mpeg:mpeg21:2003:01-DIA-XSI-NS"
  elementFormDefault="qualified">

  <annotation>
    <documentation>
      Declaration of attributes used for XML streaming instructions
    </documentation>
  </annotation>

  <!-- The following attribute defines the process units -->
  <attribute name="anchorElement" type="boolean"/>

  <!-- The following attribute indicates that the PU shall be encoded as Random
Access Point -->
  <attribute name="encodeAsRAP" type="boolean"/>

  <attribute name="puMode" type="si:puModeType"/>
  <simpleType name="puModeType">
    <restriction base="string">
      <enumeration value="self"/>
      <enumeration value="ancestors"/>
      <enumeration value="descendants"/>
      <enumeration value="ancestorsDescendants"/>
      <enumeration value="preceding"/>
      <enumeration value="precedingSiblings"/>
      <enumeration value="sequential"/>
    </restriction>
  </simpleType>

  <!-- The following attributes define the time properties -->
  <attribute name="timeScale" type="unsignedInt"/>

  <attribute name="ptsDelta" type="unsignedInt"/>

  <attribute name="absTimeScheme" type="string"/>

  <attribute name="absTime" type="string"/>

  <attribute name="pts" type="nonNegativeInteger"/>

</schema>
```


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8.6.3.3 Semantics

Name	*Definition*
`anchorElement`	Attribute defining the `anchorElement` property.
`puMode`	Attribute defining the `puMode` property.
`encodeAsRap`	Attribute defining the `encodeAsRap` property.
`timeScale`	Attribute defining the `timeScale` property.
`ptsDelta`	Attribute defining the `ptsDelta` property.
`absTimeScheme`	Attribute defining the `absTimeScheme` property.
`absTime`	Attribute defining the `absTime` property.
`pts`	Attribute defining the `pts` property.

8.6.4 Processing

Subclause 8.6.4 specifies a normative processor named *Fragmenter*. This processor uses as input the XML document to be streamed and a set of XML streaming instructions provided either internally (as attributes) and/or externally (with a properties stylesheet). The output of the Fragmenter is a set of timed process units.

It is possible to use XML streaming instructions provided both as internal attributes and with a properties stylesheet. In case of conflicts, the priority rules are detailed subclause 8.7.

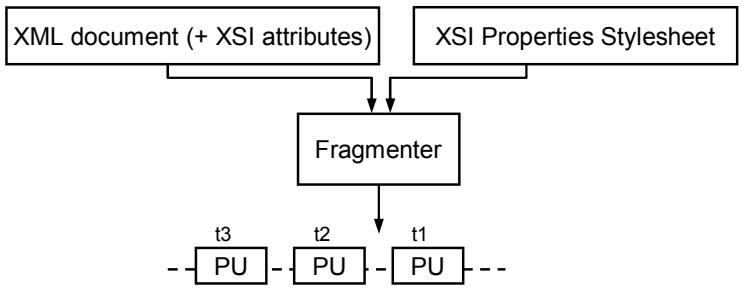

Figure 23 — Normative processing related to XML streaming instructions

The Fragmenter process is specified as follows:

The Fragmenter parses the XML document in a depth-first order. XML streaming instructions properties are computed as explained in subclause 8.5.1. An element with the `pu` property set to true indicates an anchor element and a new process unit. The process unit then comprises connected elements according to the `puMode` property of the anchor element.

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NOTE 1 In the case that an anchorElement attribute is parsed before any puMode attribute, the behaviour of the Fragmenter is undefined.

Additionally, the Fragmenter defines a set of properties for the process unit:

— `ENCODE_AS_RAP`: specifies that the process unit shall be encoded as a random access point

— `PTS`: processing time stamp, expressed as an integer number of ticks.

— `PTS_DELTA`: interval between the current process unit and the next one, expressed as an integer number of ticks.

— `TIME_SCALE`: time scale, i.e. number of ticks per second used for `PTS` and `PTS_DELTA`.

NOTE 2 These properties characterize process units and should not be confused with the XML streaming instructions properties.

The following pseudo-code specifies how to calculate the properties of each process unit according to the XML Streaming Instructions properties.

For each anchor element, the properties of the corresponding process unit are then calculated as follows:

```
if isDefined(absTime(n)) {
  PTS(n) = absTime(n) * timeScale(n)
  // absTime is specified according to the time scheme specified by the value
  // of the absTimeScheme property and converted in seconds.

} else if isDefined(pts(n)) {
  PTS(n) = pts(n)
} else {
  if n = 0 {  // i.e., first process unit
    PTS(n) = 0
  } else {
    PTS(n) = ((PTS(n-1) + PTS_DELTA(n-1))/TIME_SCALE(n-1)) * TIME_SCALE(n)
  }
}
TIME_SCALE(n) = timeScale(n)
PTS_DELTA(n) = ptsDelta(n)
ENCODE_AS_RAP(n) = encodeAsRap(n)
```

Where `absTime(n)`, `pts(n)`, `timeScale(n)`, `ptsDelta(n)` and `encodeAsRap(n)`, represent the XML streaming instruction properties of the nth anchor element, and `PTS(n)`, `TIME_SCALE(n)` and `PTS_DELTA(n)` and `ENCODE_AS_RAP(n)` represent the properties of the associated n^{th} process unit.

NOTE 3 Annex K provides an informative example of how this fragmenter in a chain which transmits process units from one peer to another.

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8.6.5 Examples

EXAMPLE 1 This example shows an example of BSD for an ISO/IEC 14496-2 visual elementary stream.

```
<?xml version="1.0" ?>
<Bitstream xmlns="urn:MPEG4_VES" bs1:bitstreamURI="akiyo.mpg4"
           xmlns:bs1="urn:mpeg:mpeg21:2003:01-DIA-BSDL1-NS"
           xsi:schemaLocation="MPEG4_VES MPEG4_VES.xsd"
           xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
           xmlns:mp4="MPEG4_VES">
    <VOP>
        <vop_start_code>000001B6</vop_start_code>
        <vop_coding_type>0</vop_coding_type>
        <Stuffing>16</Stuffing>
        <Payload>23 4636</Payload>
    </VOP>
    <VOP>
        <vop_start_code>000001B6</vop_start_code>
        <vop_coding_type>1</vop_coding_type>
        <Stuffing>17</Stuffing>
        <Payload>4664 93</Payload>
    </VOP>
    <VOP>
        <vop_start_code>000001B6</vop_start_code>
        <vop_coding_type>2</vop_coding_type>
        <Stuffing>16</Stuffing>
        <Payload>4762 11</Payload>
    </VOP>
  <!-- etc -->
</Bitstream>
```

EXAMPLE 2 This example shows an example of BSD for an ISO/IEC 14496-2 visual elementary stream with XML streaming instructions attributes.

```
<?xml version="1.0" ?>
<Bitstream xmlns="urn:MPEG4_VES" bs1:bitstreamURI="akiyo.mpg4"
           xmlns:bs1="urn:mpeg:mpeg21:2003:01-DIA-BSDL1-NS"
           xmlns:si="urn:mpeg:mpeg21:2003:01-DIA-XSI-NS"
           xsi:schemaLocation="MPEG4_VES MPEG4_VES.xsd"
           xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
           xmlns:mp4="MPEG4_VES"
           si:puMode="ancestorsDescendants"
           si:timescale="15" s:ptsDelta="1">
    <VOP si:anchorElement="true">
        <vop_start_code>000001B6</vop_start_code>
        <vop_coding_type>0</vop_coding_type>
        <Stuffing>16</Stuffing>
        <Payload>23 4636</Payload>
    </VOP>
    <VOP si:anchorElement="true">
        <vop_start_code>000001B6</vop_start_code>
        <vop_coding_type>1</vop_coding_type>
        <Stuffing>17</Stuffing>
        <Payload>4664 93</Payload>
    </VOP>
    <VOP si:anchorElement="true">
        <vop_start_code>000001B6</vop_start_code>
        <vop_coding_type>2</vop_coding_type>
        <Stuffing>16</Stuffing>
        <Payload>4762 11</Payload>
    </VOP>
  <!-- etc -->
</Bitstream>
```

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EXAMPLE 3 This example shows an example of AdaptationQoS with XML streaming instructions attributes.

```
<?xml version="1.0" ?>
<DIA xmlns:si="urn:mpeg:mpeg21:200x:01-SI"
     xmlns="urn:mpeg:mpeg21:2003:01-DIA-NS"
     xmlns:mpeg7="urn:mpeg:mpeg7:schema:2001"
     xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
    <DescriptionMetadata>
        <ClassificationSchemeAlias alias="AQoS" href="urn:mpeg:mpeg21:2003:01-DIA-
AdaptationQoSCS-NS"/>
    </DescriptionMetadata>
    <Description si:timescale="1000" si:ptsDelta="1280" si:puMode="precedingSibling"
xsi:type="AdaptationQoSType">
        <IOPin id="BANDWIDTH">
            <GetValue xsi:type="SemanticalDataRefType" semantics="urn:mpeg:mpeg21:2003:01-
DIA-AdaptationQoSCS-NS:6.6.5.3"/>
        </IOPin>
        <IOPin id="TARGET-BITRATE"/>
        <IOPin id="GOPNR"/>
        <Module xsi:type="LookUpTableSwitchType" switchIOPinRefs="GOPNR">
            <Axis iOPinRef="BANDWIDTH">
                <AxisValues xsi:type="IntegerVectorType">
                    <Vector>25 50 75 100 125 150 175 200 225 250 275 300 325 350 375 400
425 1000</Vector>
                </AxisValues>
            </Axis>
            <ContentSwitch iOPinRef="TARGET-BITRATE">
                <ContentDataSwitch switchValues="1" xmlsi:anchorElement="true">
                    <ContentValues xsi:type="IntegerMatrixType" mpeg7:dim="18">
                        <Matrix>25 50 75 100 125 150 175 200 225 250 275 300 325 350 375 400
425 1000000</Matrix>
                    </ContentValues>
                </ContentDataSwitch>
                <ContentDataSwitch switchValues="2" xmlsi:anchorElement="true">
                    <ContentValues xsi:type="IntegerMatrixType" mpeg7:dim="18">
                        <Matrix>25 50 75 100 125 150 175 200 225 250 275 300 325 350 375 400
425 1000000</Matrix>
                    </ContentValues>
                </ContentDataSwitch>
                <!-- and so on ... -->
            </ContentSwitch>
        </Module>
    </Description>
</DIA>
```

EXAMPLE 4 This example shows the third process unit of EXAMPLE 2 with `puMode = self`.

```
<?xml version="1.0" ?>
<VOP xmlns="urn:MPEG4_VES" si:anchorElement="true"/>
```

EXAMPLE 5 This example shows the third process unit of EXAMPLE 2 with `puMode = ancestors`.

```
<?xml version="1.0" ?>
<Bitstream xmlns="urn:MPEG4_VES" bs1:bitstreamURI="akiyo.mpg4"
           xmlns:bs1="urn:mpeg:mpeg21:2003:01-DIA-BSDL1-NS"
           xmlns:si="urn:mpeg:mpeg21:2003:01-DIA-XSI-NS"
           xsi:schemaLocation="MPEG4_VES MPEG4_VES.xsd"
           xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
           xmlns:mp4="MPEG4_VES"
           si:puMode="ancestorsDescendants"
           si:timescale="15" s:ptsDelta="1">
    <VOP si:anchorElement="true"/>
</Bitstream>
```

EXAMPLE 6 This example shows the third process unit of EXAMPLE 2 with `puMode = descendants`.

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```
<?xml version="1.0" ?>
<VOP xmlns="urn:MPEG4_VES" si:anchorElement="true">
    <vop_start_code>000001B6</vop_start_code>
    <vop_coding_type>2</vop_coding_type>
    <Stuffing>16</Stuffing>
    <Payload>4762 11</Payload>
</VOP>
```

EXAMPLE 7 This example shows the third process unit of EXAMPLE 2 with `puMode = ancestorsDescendants`.

```
<?xml version="1.0" ?>
<Bitstream xmlns="urn:MPEG4_VES" bs1:bitstreamURI="akiyo.mpg4"
           xmlns:bs1="urn:mpeg:mpeg21:2003:01-DIA-BSDL1-NS"
           xmlns:si="urn:mpeg:mpeg21:2003:01-DIA-XSI-NS"
           xsi:schemaLocation="MPEG4_VES MPEG4_VES.xsd"
           xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
           xmlns:mp4="MPEG4_VES"
           si:puMode="ancestorsDescendants"
           si:timescale="15" s:ptsDelta="1">
    <VOP si:anchorElement="true">
        <vop_start_code>000001B6</vop_start_code>
        <vop_coding_type>2</vop_coding_type>
        <Stuffing>16</Stuffing>
        <Payload>4762 11</Payload>
    </VOP>
</Bitstream>
```

EXAMPLE 8 This example shows the third process unit of EXAMPLE 2 with `puMode = preceding`.

```
<?xml version="1.0" ?>
<Bitstream xmlns="urn:MPEG4_VES" bs1:bitstreamURI="akiyo.mpg4"
           xmlns:bs1="urn:mpeg:mpeg21:2003:01-DIA-BSDL1-NS"
           xmlns:si="urn:mpeg:mpeg21:2003:01-DIA-XSI-NS"
           xsi:schemaLocation="MPEG4_VES MPEG4_VES.xsd"
           xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
           xmlns:mp4="MPEG4_VES"
           si:puMode="ancestorsDescendants"
           si:timescale="15" s:ptsDelta="1">
    <VOP si:anchorElement="true">
        <vop_start_code>000001B6</vop_start_code>
        <vop_coding_type>0</vop_coding_type>
        <Stuffing>16</Stuffing>
        <Payload>23 4636</Payload>
    </VOP>
    <VOP si:anchorElement="true">
        <vop_start_code>000001B6</vop_start_code>
        <vop_coding_type>1</vop_coding_type>
        <Stuffing>17</Stuffing>
        <Payload>4664 93</Payload>
    </VOP>
    <VOP si:anchorElement="true">
        <vop_start_code>000001B6</vop_start_code>
        <vop_coding_type>2</vop_coding_type>
        <Stuffing>16</Stuffing>
        <Payload>4762 11</Payload>
    </VOP>
</Bitstream>
```

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EXAMPLE 9 This example shows the second process unit of EXAMPLE 3 with `puMode = precedingSibling`.

```
<?xml version="1.0" ?>
<DIA xmlns:si="urn:mpeg:mpeg21:200x:01-SI"
     xmlns="urn:mpeg:mpeg21:2003:01-DIA-NS"
     xmlns:mpeg7="urn:mpeg:mpeg7:schema:2001"
     xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
    <DescriptionMetadata>
        <ClassificationSchemeAlias alias="AQoS" href="urn:mpeg:mpeg21:2003:01-DIA-
AdaptationQoSCS-NS"/>
    </DescriptionMetadata>
    <Description si:timescale="1000" si:ptsDelta="1280" si:puMode="precedingSibling"
xsi:type="AdaptationQoSType">
        <IOPin id="BANDWIDTH">
            <GetValue xsi:type="SemanticalDataRefType" semantics="urn:mpeg:mpeg21:2003:01-
DIA-AdaptationQoSCS-NS:6.6.5.3"/>
        </IOPin>
        <IOPin id="TARGET-BITRATE"/>
        <IOPin id="GOPNR"/>
        <Module xsi:type="LookUpTableSwitchType" switchIOPinRefs="GOPNR">
            <Axis iOPinRef="BANDWIDTH">
                <AxisValues xsi:type="IntegerVectorType">
                    <Vector>25 50 75 100 125 150 175 200 225 250 275 300 325 350 375 400
425 1000</Vector>
                </AxisValues>
            </Axis>
            <ContentSwitch iOPinRef="TARGET-BITRATE">
                <ContentDataSwitch switchValues="2" xmlsi:anchorElement="true">
                    <ContentValues xsi:type="IntegerMatrixType" mpeg7:dim="18">
                        <Matrix>25 50 75 100 125 150 175 200 225 250 275 300 325 350 375 400
425 1000000</Matrix>
                    </ContentValues>
                </ContentDataSwitch>
            </ContentSwitch>
        </Module>
    </Description>
</DIA>
```

EXAMPLE 10 This example shows the second process unit of EXAMPLE 2 with `puMode = sequential`.

```
<?xml version="1.0" ?>
<Bitstream xmlns="urn:MPEG4_VES" bs1:bitstreamURI="akiyo.mpg4"
           xmlns:bs1="urn:mpeg:mpeg21:2003:01-DIA-BSDL1-NS"
           xmlns:si="urn:mpeg:mpeg21:2003:01-DIA-XSI-NS"
           xsi:schemaLocation="MPEG4_VES MPEG4_VES.xsd"
           xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
           xmlns:mp4="MPEG4_VES"
           si:puMode="ancestorsDescendants"
           si:timescale="15" s:ptsDelta="1">
    <VOP si:anchorElement="true">
        <vop_start_code>000001B6</vop_start_code>
        <vop_coding_type>1</vop_coding_type>
        <Stuffing>17</Stuffing>
        <Payload>4664 93</Payload>
    </VOP>
</Bitstream>
```

8.7 Properties stylesheet

8.7.1 Introduction

Subclause 8.7 specifies a mechanism to dynamically apply media resource or XML streaming instructions to an XML document. This mechanism relies on an external document called properties stylesheet, which allows setting properties to given elements of an XML document without having to modify it.

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Media resource and XML streaming instructions define a set of properties. Properties are to be understood in the meaning of the XML Infoset and characterize an element information item. Both the media resource streaming instructions and XML streaming instructions also specify a set of associated XML attributes which assign the corresponding properties to the element information item. These attributes are meant to be used within the XML document to be streamed. It is therefore required to modify the document. When properties are set according to a regular patter, it is also possible to specify them in an external document, which then avoids modifying the document.

NOTE A properties stylesheet does not specify an XML transformation like XSLT style sheets do. This term must be understood as in cascading style sheets (CSS) which define properties but do not modify the HTML document they are applied to.

8.7.2 Syntax

```
<?xml version="1.0"?>
<!-- Digital Item Adaptation ISO/IEC 21000-7 Second Edition -->
<!-- Schema for Properties Stylesheet -->
<schema
  version="ISO/IEC 21000-7 2nd"
  id="PSS-2nd.xsd"
  xmlns="http://www.w3.org/2001/XMLSchema"
  xmlns:ps="urn:mpeg:mpeg21:2003:01-DIA-PSS-NS"
  targetNamespace="urn:mpeg:mpeg21:2003:01-DIA-PSS-NS">

  <annotation>
    <documentation>
      Declaration of properties stylesheet
    </documentation>
  </annotation>

  <element name="properties">
    <complexType>
      <sequence>
        <element name="template" minOccurs="0" maxOccurs="unbounded">
          <complexType>
            <sequence>
              <element name="property" minOccurs="0" maxOccurs="unbounded">
                <complexType>
                  <attribute name="name" type="QName" use="required"/>
                  <attribute name="namespace" type="anyURI" use="optional"/>
                  <attribute name="value" type="string" use="required"/>
                </complexType>
              </element>
            </sequence>
            <attribute name="match" type="string" use="required"/>
          </complexType>
        </element>
      </sequence>
    </complexType>
  </element>

</schema>
```

8.7.3 Semantics

A properties stylesheet is an ordered sequence of `ps:template` elements. Each `ps:template` element specifies a set of properties defined by the `ps:property` elements to be applied to the elements that match the Lightweight XML Path expression language (LXPath) expression provided by the `match` attribute and

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specified in subclause 8.7.4. Each property is defined by a qualified name and a value. When the name has a prefix, it should be resolved against the namespace binding context of the property element. When it has no prefix, its namespace is the one indicated by the namespace attribute. If this attribute contains an empty string then the property has no namespace. If this attribute is not present, then the default namespace defined for the property element applies. If no such default namespace is defined then the property has no namespace. A `ps:property` element shall not have simultaneously a `namespace` attribute and a prefix.

Conflicts for setting properties may occur in two cases:

— When the property is already set in the original document (either specified by an attribute for the same XML element, or inherited from a parent element).

— When two templates of the properties stylesheet set the same properties for the same XML element.

In this case, the conflict is solved according to the following priority rule:

— A property set by a properties stylesheet overrides the one set by an attribute in the original document.

— In case two templates of the same properties stylesheet set the same properties with different values, the value of the last `ps:template` element in the document overrides the values previously set.

A properties stylesheet itself does not define any processing on the XML document. However, applying a properties stylesheet to an XML document may augment its infoset, but does not modify the document itself.

8.7.4 Lightweight XML Path expression language

8.7.4.1 Introduction

The syntax of Lightweight XML Path expression language (LXPath) is similar to XPath but its semantics differs. An XPath expression is resolved against a context which contains the full XML document. Conversely, the context used in LXPath is the ancestor stack of the context node and its position within sibling elements. Whereas evaluating an XPath expression requires loading the full document in memory, evaluating an LXPath expression only requires a limited context that can be constructed while parsing the XML document with an application programmable interface (API) such as the simple API for XML (SAX).

EXAMPLE In XPath, the expression `/node1/node2` returns a sequence containing all `node2` elements, whose parent element is the document element and is named `node1`. In LXPath, on contrary, the same expression returns a sequence containing a single node from this node-set; the one which is an ancestor of the current node.

Used as a filtering pattern, an LXPath expression is evaluated as a Boolean, i.e., true if the expression returns a non-null node-set, false otherwise.

The advantage of LXPath over XPath is that it can be used in streaming scenarios, especially in live streaming scenarios where the size of the XML document is infinite, which is not possible with XPath. It particularly fits SAX-based architectures.

8.7.4.2 Grammar for LXPath

Table 7 specifies the grammar of LXPath according to ISO/IEC 14977:1996, i.e., Extended Backus-Naur Form (EBNF) notation, with `MatchPattern` as entry point.

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Table 7 — EBNF for LXPath.

```
MatchPattern          ::=   BoolExpr

BoolExpr              ::=   Expression ( "|" Expression)*

Expression            ::=   ( "/" | "//" )? PathStep (( "/" | "//" ) PathStep )*

PathStep              ::=   (QName | WildCard) Predicate*

WildCard              ::=   "*" | ( "*" ":" NCName) | ( NCName ":" "*")

Predicate             ::=   "[" PredicateExpr "]"

PredicateExpr         ::=   OrExpr

OrExpr                ::=   AndExpr ( ("or" | "|") AndExpr )*

AndExpr               ::=   ComparisonExpr ( "and" ComparisonExpr )*

ComparisonExpr        ::=   AdditiveExpr ( GeneralComp AdditiveExpr )?

GeneralComp           ::=   "=" | "!=" | "<" | "<=" | ">" | ">="

AdditiveExpr          ::=   MultiplicativeExpr ( ("+" | "-") MultiplicativeExpr )*

MultiplicativeExpr    ::=   PrimaryExpr ( ("*" | "div" | "idiv" | "mod") PrimaryExpr )*

PrimaryExpr           ::=   AttrExpr | Function | StringLiteral | NumericLiteral

AttrExpr              ::=   "@" NCName

Function              ::=   "position()"

StringLiteral         ::=   "'" Char* "'"

NumericLiteral        ::=   IntegerLiteral | DecimalLiteral

IntegerLiteral        ::=   ("-" | "+")? Digits

DecimalLiteral        ::=   ("-" | "+")? ("." Digits) | (Digits "." [0-9]*)

Digits                ::=   [0-9]+

NCName                ::=   [http://www.w3.org/TR/REC-xml-names/#NT-NCName]

QName                 ::=   [http://www.w3.org/TR/REC-xml-names/#NT-QName]

Char                  ::=   [http://www.w3.org/TR/REC-xml/#NT-Char]
```

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8.7.5 Examples

EXAMPLE 1 Let us consider the following XML document containing arbitrary XML elements which is used for all subsequent examples. For the subsequent examples, this document is referred to as the *original document*. In particular, the result of the fragmenter will be shown.

```
<?xml version="1.0" ?>
<el0 xmlns="urn:myExampleNS">
  <el1>Content of el1</el1>
  <el2 >
    <el21>
      <el211>Content of el211</el211>
    </el21>
    <el22 toto22="toto22">
      <el221/>
      <el222/>
    </el22>
  </el2>
  <el3/>
</el0>
```

EXAMPLE 2 The following XML document shows an example properties stylesheet which is used to assign properties to the original document as shown in the above example.

```
<?xml version="1.0"?>
<properties
    xmlns="urn:mpeg:mpeg21:2003:01-DIA-PSS-NS"
    xmlns:si="urn:mpeg:mpeg21:2003:01-DIA-XSI-NS"
    xmlns:t="urn:myExampleNS"
    xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
    xsi:schemaLocation="urn:mpeg:mpeg21:2003:01-DIA-XSI-NS PSS.xsd">

    <template
      match="/t:el0/t:el1 | /t:el0/t:el2/t:el21/t:el211 | /t:el0/t:el2/t:el22">
        <property name="si:anchorElement" value="true"/>
    </template>

    <template match="t:el22">
        <property name="si:puMode" value="self"/>
    </template>

    <template match="/t:el0">
        <property name="si:puMode" value="descendants"/>
        <property name="si:timeScale" value="22050"/>
        <property name="si:ptsDelta" value="1024"/>
    </template>
</properties>
```

EXAMPLE 3 The following XML document shows the original document with the properties set by attributes instead of using the properties stylesheet.

```
<?xml version="1.0" ?>
<el0 xmlns="urn:myExampleNS" xmlns:si="urn:mpeg:mpeg21:2003:01-DIA-XSI-NS"
  si:puMode="descendants"
  si:timeScale="22050"
  si:ptsDelta="1024">
  <el1 si:anchorElement="true">Content of el1</el1>
  <el2 >
    <el21>
      <el211 si:anchorElement="true">Content of el211</el211>
    </el21>
    <el22 toto22="toto22" si:puMode="self" si:anchorElement="true">
      <el221/>
```


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```
      <el222/>
    </el22>
  </el2>
  <el3/>
</el0>
```

EXAMPLE 4 The following XML document shows an example BSD describing an ISO/IEC 14496-3 BSAC bitstream.

```
<?xml version="1.0" encoding="UTF-8"?>
<BSACBitstream xmlns="urn:mpeg:mpeg4:BSAC"
  xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
  xmlns:bs1="urn:mpeg:mpeg21:2003:01-DIA-BSDL1-NS"
  xmlns:gbsd="urn:mpeg:mpeg21:2003:01-DIA-gBSD-NS"
  xsi:schemaLocation="urn:mpeg:mpeg4:BSAC BSAC.xsd"
  gbsd:addressUnit="bit" gbsd:addressMode="Absolute"
  bs1:bitstreamURI="prom.raw">

  <frame>
    <base>
      <length>618</length>
      <stuff1>11 5</stuff1>
      <topLayer>48</topLayer>
      <stuff2>22 738</stuff2>
    </base>
    <layers>
      <layer>760 48</layer>
      <layer>808 48</layer>
      <!-- and so on... -->
    </layers>
  </frame>

  <frame>
    <base>
      <length>391</length>
      <stuff1>4955 5</stuff1>
      <topLayer>48</topLayer>
      <stuff2>4966 738</stuff2>
    </base>
    <layers>
      <layer>5704 48</layer>
      <layer>5752 48</layer>
      <!-- and so on... -->
    </layers>
  </frame>
  <!-- and so on... -->
</BSACBitstream>
```

EXAMPLE 5 The following XML document shows a properties stylesheet specifying which BSD elements are enriched with which properties from the media resource streaming instructions and its actual values.

```
<?xml version="1.0" encoding="UTF-8"?>
<properties
  xmlns="urn:mpeg:mpeg21:2003:01-DIA-PSS-NS"
  xmlns:msi="urn:mpeg:mpeg21:2003:01-DIA-MSI-NS"
  xmlns:b="urn:mpeg:mpeg4:BSAC"
  xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
  xsi:schemaLocation="urn:mpeg:mpeg21:2003:01-DIA-XSI-NS PSS.xsd">

  <template match="/b:BSACBitstream/b:frame">
    <property name="msi:au" value="true"/>
  </template>

  <template match="/b:BSACBitstream">
    <property name="msi:rap" value="true"/>
```

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```
    <property name="msi:timeScale" value="22050"/>
    <property name="msi:dtsDelta" value="1024"/>
    <property name="msi:ctsOffset" value="0"/>
  </template>
</properties>
```

EXAMPLE 6 The following XML document shows an example of BSD for an ISO/IEC 14496-2 visual elementary stream.

```
<?xml version="1.0" ?>
<Bitstream xmlns="urn:MPEG4_VES" bs1:bitstreamURI="akiyo.mpg4"
           xmlns:bs1="urn:mpeg:mpeg21:2003:01-DIA-BSDL1-NS"
           xsi:schemaLocation="MPEG4_VES MPEG4_VES.xsd"
           xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
           xmlns:mp4="MPEG4_VES">
    <VOP>
        <vop_start_code>000001B6</vop_start_code>
        <vop_coding_type>0</vop_coding_type>
        <Stuffing>16</Stuffing>
        <Payload>23 4636</Payload>
    </VOP>
    <VOP>
        <vop_start_code>000001B6</vop_start_code>
        <vop_coding_type>1</vop_coding_type>
        <Stuffing>17</Stuffing>
        <Payload>4664 93</Payload>
    </VOP>
    <VOP>
        <vop_start_code>000001B6</vop_start_code>
        <vop_coding_type>2</vop_coding_type>
        <Stuffing>16</Stuffing>
        <Payload>4762 11</Payload>
    </VOP>
  <!-- etc -->
</Bitstream>
```

EXAMPLE 7 The following XML document shows an example of a properties stylesheet specifying which BSD elements are enriched with which properties from the XML streaming instructions and its actual values.

```
<?xml version="1.0" encoding="UTF-8"?>
<properties
  xmlns="urn:mpeg:mpeg21:2003:01-DIA-PSS-NS"
  xmlns:m="urn:MPEG4_VES"
  xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance">

  <template match="/m:Bitstream/m:VOP">
    <property name="anchorElement" namespace="urn:mpeg:mpeg21:2003:01-DIA-XSI-NS"
              value="true"/>
  </template>

  <template match="/m:Bitstream">
    <property name="puMode" namespace="urn:mpeg:mpeg21:2003:01-DIA-XSI-NS"
              value="ancestorsDescendants"/>
    <property name="timeScale" namespace="urn:mpeg:mpeg21:2003:01-DIA-XSI-NS"
              value="15"/>
    <property name="ptsDelta" namespace="urn:mpeg:mpeg21:2003:01-DIA-XSI-NS"
              value="1"/>
  </template>
</properties>
```


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9 Terminal and network quality of service

9.1 Introduction

Terminal and network quality of service (QoS) addresses the problem of selecting optimal parameter settings for media resource adaptation to satisfy constraints imposed by terminals and/or networks while maximizing the quality of service. Therefore the `AdaptationQoS` tool specifies the relationship between constraints, feasible adaptation operations satisfying these constraints, and possibly associated utilities (qualities). In this way, terminal and network QoS management is efficiently achieved by adaptation of media resources to imposed constraints.

9.2 Schema wrapper

The syntax of description tools specified in this clause is provided as a collection of schema components, consisting notably in type definitions and element declarations. In order to form a valid schema document, these schema components should be gathered in a same document with the following declaration defining in particular the target namespace, the namespaces prefixes and the imported namespaces.

```
<?xml version="1.0"?>
<!-- Digital Item Adaptation ISO/IEC 21000-7 Second Edition -->
<!-- Schema for terminal and network quality of service tools -->
<schema
   version="ISO/IEC 21000-7 2nd"
   id="AQoS-2nd.xsd"
   targetNamespace="urn:mpeg:mpeg21:2003:01-DIA-NS"
   xmlns="http://www.w3.org/2001/XMLSchema"
   xmlns:dia="urn:mpeg:mpeg21:2003:01-DIA-NS"
   xmlns:mpeg7="urn:mpeg:mpeg7:schema:2001"
   elementFormDefault="qualified" attributeFormDefault="unqualified">

   <import namespace="urn:mpeg:mpeg7:schema:2001"
      schemaLocation="mpeg7-udp-2004.xsd"/>
   <include schemaLocation="DIA-2nd.xsd"/>
   <include schemaLocation="SingleValueDatatypes-2nd.xsd"/>
   <include schemaLocation="VectorDatatypes-2nd.xsd"/>
   <include schemaLocation="MatrixDatatypes-2nd.xsd"/>
   <include schemaLocation="BaseStackFunction-2nd.xsd"/>
   <include schemaLocation="ArgumentTypes-2nd.xsd"/>
```

Additionally, the following line should be appended to the resulting schema document in order to obtain a well-formed XML document.

```
</schema>
```

9.3 AdaptationQoS

9.3.1 Introduction

This subclause specifies syntax and semantics of the `AdaptationQoS` tool. The `AdaptationQoS` tool provides the required information allowing the selection of optimal adaptation parameters.

The tool has been designed in a modular way, i.e., the data and their relationships are structured in modules, which are the basic structural units for grouping the data. These modules can have one of the following representation formats:

— The `UtilityFunction` provides a restricted set of adaptation operation points in a list format to choose from.

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— The `LookUpTable` is a matrix representation format, enabling selection by interpolation of an adaptation operation point and allowing extra info to be represented.

— The `StackFunction` is a functional representation format.

IOPins provide the interface of the modules. Each IOPin is a uniquely identifiable variable globally declared and referenced from within a module. The value of an IOPin may be any value, possibly constrained to a (continuous or discrete) value range specified by the Axis element in the IOPin declaration or to an externally retrieved parameter specified by the `GetValue` element in the IOPin declaration. Two or more modules referencing the same IOPin are linked, meaning that the referenced IOPin's value should be the same for all these modules. Furthermore, an IOPin can also be referenced from outside `AdaptationQoS`, allowing the external retrieval of its attributed value as is the case in, e.g., the BSDLink tool.

Finally, the (continuous or discrete) value range of the IOPins can be further constrained by the Universal Constraints Description tool as specified in subclause 9.10.

9.3.2 AdaptationQoS syntax

```
<!-- ################################################ -->
<!-- Definition of AdaptationQoSType                  -->
<!-- ################################################ -->

<complexType name="AdaptationQoSType">
   <complexContent>
      <extension base="dia:DIADescriptionType">
         <choice>
            <element name="Module" type="dia:BaseModuleType"
               maxOccurs="unbounded"/>
            <element name="IOPin" type="dia:IOPinType" maxOccurs="unbounded"/>
            <element name="Constraints" type="dia:ReferenceType"
               minOccurs="0"/>
         </choice>
      </extension>
   </complexContent>
</complexType>
```

9.3.3 AdaptationQoS semantics

Name	*Definition*
`AdaptationQoSType`	Tool for describing the relationship between constraints, possible adaptations, and qualities in order to support media resource adaptation for terminal and network quality of service.
`Module`	Describes a list of AdaptationQoS modules which can be linked together.
`IOPin`	Describes the globally declared interface of the modules for linking modules and for external referencing.
`Constraints`	Describes a reference to a list of constraints. The target of this reference shall be `UCDType` as specified in subclause 9.10.

9.3.4 AdaptationQoS example

EXAMPLE The following example illustrates the top-level structure of the `AdaptationQoS` description. It contains one or more `AdaptationQoS` modules and one or more `IOPin`s used for internal linking and external referencing. The description generator can choose the most appropriate representation format for a module: `UtilityFunction`, `LookUpTable`, `StackFunction`.

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```
<DIA>
    <DescriptionMetadata>
        <!-- optional description of Classification Scheme aliases -->
    </DescriptionMetadata>
    <Description xsi:type="AdaptationQoSType">
        <Module xsi:type="LookUpTableType">
            <!-- description of chosen data representation -->
        </Module>
        <!-- other possible AdaptationQoS modules -->
        <IOPin id="QUALITY"
            semantics="urn:mpeg:mpeg21:2003:01-DIA-AdaptationQoSCS-NS:3.1"/>
        <!-- other possible IOPins -->
    </Description>
</DIA>
```

9.4 AdaptationQoS modules

9.4.1 Introduction

This subclause describes syntax and semantics of the AdaptationQoS modules tool. The module is the basic structural unit to group data and describe their relationship. The following representation formats can be chosen: `UtilityFunction`, `LookUpTable` and `StackFunction`.

9.4.2 BaseModule syntax

```
<!-- ################################################ -->
<!-- Definition of BaseModuleType                     -->
<!-- ################################################ -->

<complexType name="BaseModuleType" abstract="true">
   <complexContent>
      <extension base="dia:DIABaseType"/>
   </complexContent>
</complexType>
```

9.4.3 BaseModule semantics

Name	*Definition*
`BaseModuleType`	`BaseModuleType` extends `DIABaseType` and provides a base abstract type for all modules of the `AdaptationQoSType`.

9.5 IOPin

9.5.1 Introduction

This subclause specifies syntax and semantics of the `IOPin` tool. IOPins provide the interface for the modules. They act as a uniquely identifiable variable. In essence, they allow the linking of modules and external referencing. Modules are linked when referencing the same globally defined IOPin, meaning that the IOPin's value should be the same in each module. External referencing of IOPins allows the retrieval of their attributed value.

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9.5.2 IOPin syntax

```
<!-- ################################################ -->
<!-- Definition of IOPinType                          -->
<!-- ################################################ -->

<complexType name="IOPinType">
   <sequence>
      <choice>
         <element name="GetValue" type="dia:GetValueType" minOccurs="0"/>
         <element name="GetVector" type="dia:VectorDataType" minOccurs="0"/>
      </choice>
      <element name="Axis" type="dia:AxisBaseType" minOccurs="0"/>
      <element name="Default" type="dia:ValueDataType" minOccurs="0"/>
   </sequence>
   <attribute name="id" type="ID" use="required"/>
   <attribute name="semantics" type="mpeg7:termReferenceType" use="optional"/>
   <attribute name="discrete" type="boolean" use="optional" default="true"/>
</complexType>
```

9.5.3 IOPin semantics

Name	*Definition*
IOPinType	Tool for desribing the globally declared interface of the modules for linking modules and for external referencing.
GetValue	Describes the value to be assigned to the IOPin.
GetVector	Describes the vector of values to be assigned to the IOPin.
Axis	Describes a globally defined LookUpTable axis. It constrains the possible values of the IOPin to a specified (discrete or continuous) value range.
Default	Describes an element conveying the default value of an IOPin that should be conveyed to the resource adaptation engine if a solution is not found.
id	Describes a unique identifier for the IOPin enabling it to be referenced.
semantics	Describes a normative semantic which is used in conjunction with a Classification Scheme. A CS that may be used for this purpose are the AdaptationQoSCS or MediaInformationCS defined in Annex A.2.2 and A.2.10 respectively.
discrete	Describes whether an IOPin is discrete-valued or not, in cases where the Axis element is used. If set to true, the IOPin is discrete-valued, and the vector in the Axis element provides the set of allowable values the IOPin can take. If set to false, the minimum and maximum values of the vector in the Axis element provide the range of allowable values (including minimum and maximum values) of type IntegerVectorType or FloatVectorType the IOPins takes. If the Axis element is of type BooleanVectorType or TokenVectorType, this attribute is always assumed to be true.

NOTE In case the discrete attribute is set to false, the values of the Axis element as a whole can be used as sampling points for interpolation in a Module of type LookUpTableType

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9.6 UtilityFunction

9.6.1 Introduction

This subclause specifies the syntax and semantics of the `UtilityFunction` tool. It describes the relationship between constraints, adaptation operators and utilities in a list format from which an appropriate adaptation parameter setting should be selected.

The `UtilityFunction` describes the distribution of three key factors involved in media resource adaptation – adaptation operation (e.g., frame dropping, spatial size reduction, etc.), constraint (e.g., bandwidth, power, display resolution, etc.), and utility (e.g., objective or subjective quality) and their mapping relations in a list form. The `UtilityFunction` is a kind of conceptual model that extends the conventional rate-distortion (R-D) model, by allowing flexible considerations of diverse types of adaptation operations, constraints, and/or utilities. Therefore, each of these factors involves multiple dimensionalities (space) and the constraint-utility relationship represents analogous but broader concepts than the R-D relationships. As a result, the `UtilityFunction` is able to encompass whole distributions over the three spaces and their mapping relations in a compact form. Moreover, it allows efficient searching and selection in solving the adaptation problems by directly describing the resource-utility relations along with their associated adaptation operations.

The usage of the `UtilityFunction` in terms of syntax and semantics is as follows. The `Constraint` describes a set of sample points of the region of interest in the constraint space, and the `AdaptationOperator` describes one or more permissible adaptation operations meeting constraints corresponding to each constraint point; the `Utility` indicates the value of video utility after the adaptation specified by corresponding `AdaptationOperator` is applied. Note that this tool accommodates the cases where multiple instances of constraint and/or utility are required by allowing multiple occurrences of `Constraint` and `Utility`, respectively. In this manner, the `UtilityFunction` describes feasible adaptation operators and their resulting utilities in a list format using a discrete set of sampled constraint points as indexes.

9.6.2 UtilityFunction syntax

```
<!-- ################################################ -->
<!--  Definition of UtilityFunctionType               -->
<!-- ################################################ -->

<complexType name="UtilityFunctionType">
   <complexContent>
      <extension base="dia:BaseModuleType">
         <sequence>
            <element name="Constraint" type="dia:UFDataType"
                  maxOccurs="unbounded"/>
            <element name="AdaptationOperator" type="dia:UFDataType"
                  maxOccurs="unbounded"/>
            <choice>
               <element name="Utility" type="dia:UFDataType"
                        maxOccurs="unbounded"/>
               <element name="UtilityRank" type="dia:UtilityRankType"/>
            </choice>
         </sequence>
      </extension>
   </complexContent>
</complexType>

<complexType name="UFDataType">
   <complexContent>
      <extension base="dia:DIABaseType">
         <sequence>
            <element name="Values" type="dia:VectorDataType"/>
         </sequence>
         <attribute name="iOPinRef" type="IDREF" use="required"/>
```

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```
      </extension>
   </complexContent>
</complexType>
```

9.6.3 UtilityFunction semantics

Name	*Definition*
`UtilityFunctionType`	Tool for describing the mapping relations among feasible adaptation operation(s), associated qualities and given constraint(s) in a list format, used for sparse, discrete data representation.
`Constraint`	Describes given constraint(s) in a list of sampled points. The values are ordered so that the association of a constraint point, a set of adaptation operators representing an adaptation operation and utility values can be specified. For instance, if there exist multiple adaptation operations satisfying the value of a constraint point, the value should be repeated to become associated with each feasible adaptation operation. Specific semantics are given in the associated `IOPin` specification.
`AdaptationOperator`	Describes a list of adaptation operations, each of which is represented by the set of described adaptation operators. The values are ordered so that the association of a constraint point, an adaptation operation and utility values can be specified. Specific semantics are given in the associated `IOPin` specification.
`Utility`	Describes a list of utility values. The values are ordered so that the association of a constraint point, an adaptation operation and utility value(s) can be specified. Specific semantics are given in the associated `IOPin` specification.
`UtilityRank`	Describes a list of the ranking among the feasible adaptation operations at a given constraint point in terms of quality. It is used to represent a sense of quality in the case that the used adaptation operator gives inconsistent quality values depending on the implementation, instead of representing a numerical value of quality using the `Utility`. The values are ordered so that the association of a constraint point, an adaptation operation and a utility rank can be specified.
`UFDataType`	Tool for specifying the vector of `Values`.
`Values`	Describes a list of values.
`iOPinRef`	Describes a reference to a globally defined `IOPin`.

9.6.4 UtilityRank syntax

```
<!-- ################################################ -->
<!-- Definition of UtilityRankType                    -->
<!-- ################################################ -->

<complexType name="UtilityRankType">
   <simpleContent>
      <extension base="dia:positiveIntegerVector">
         <attribute name="consistencyFlags" type="dia:consistencyFlagsType"
            use="optional"/>
      </extension>
   </simpleContent>
</complexType>
```

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```
<simpleType name="consistencyFlagsType">
   <restriction>
      <simpleType>
         <list itemType="boolean"/>
      </simpleType>
      <minLength value="1"/>
   </restriction>
</simpleType>

<simpleType name="positiveIntegerVector">
   <restriction>
      <simpleType>
         <list itemType="positiveInteger"/>
      </simpleType>
      <minLength value="1"/>
   </restriction>
</simpleType>
```

9.6.5 UtilityRank semantics

Name	*Definition*
`UtilityRankType`	Describes the relative rankings of utility values among different adaptation operators meeting the same constraint point. It can be used to represent a sense of utility in the case where the utility values are inconsistent among different implementations of an adaptation operator, instead of representing a numerical value of quality using the `UtilityValue`.
`consistencyFlags`	Describes if the extracted rank is reliable and consistent. Each attribute corresponds to the rank of the same position in the list of the utility rank.

9.6.6 UtilityFunction example

EXAMPLE 1 The following example illustrates the use of the `AdaptationQoS` description tool using the `UtilityFunction`. The `UtilityFunction` describes a feasible set of adaptation operations satisfying the constraint, each of which is represented by one or more adaptation operators, with associated utilities in a list format using a discrete set of constraint point as indexes. In this example, the combination of adaptation methods of frame dropping and DCT coefficient dropping is used for bitrate adaptation to the given constraint of bandwidth, and a PSNR-measured utility is described. Specific semantics of instantiated adaptation operator, constraint, utility are specified by using IOPins. The values of constraint are ordered so that the association of a constraint point, a set of adaptation operators representing a certain adaptation operation and a corresponding utility value can be specified. If there exist multiple adaptation operations satisfying the same constraint value, the value of that point is repeated to associate each feasible adaptation operation and a corresponding utility. For instance, there exist two adaptation operations satisfying the given bandwidth of 1,200kbps: one is coefficient dropping with the value of (`COEFF_DROPPING=0.21`), the other is combination of frame dropping with the values of (`B_FRAMES=1, P_FRAMES=0`) and coefficient dropping with the value of (`COEFF_DROPPING=0.09`); the two adaptation operations have the PSNR values of 32.48 and 31.40, respectively.

```
<DIA>
   <DescriptionMetadata>
      <ClassificationSchemeAlias alias="AQoS"
           href="urn:mpeg:mpeg21:2003:01-DIA-AdaptationQoSCS-NS"/>
   </DescriptionMetadata>
   <Description xsi:type="AdaptationQoSType">
      <Module xsi:type="UtilityFunctionType">
         <Constraint iOPinRef="BANDWIDTH">
            <Values xsi:type="IntegerVectorType">
               <Vector>1510 1359 1200 1200 1071 1071 1071 941 814 814 814 1296 1000 1000
1000 842 744 909 712 600 396 359 331 293 255 217</Vector>
            </Values>
```

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```
         </Constraint>
         <AdaptationOperator iOPinRef="B_FRAMES">
            <Values xsi:type="IntegerVectorType">
               <Vector>0 0 0 1 0 1 2 0 0 1 2 1 0 1 2 1 1 2 2 2 2 2 2 2 2 2</Vector>
            </Values>
         </AdaptationOperator>
         <AdaptationOperator iOPinRef="P_FRAMES">
            <Values xsi:type="IntegerVectorType">
               <Vector>0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 4 4 4 4 4 4</Vector>
            </Values>
         </AdaptationOperator>
         <AdaptationOperator iOPinRef="COEFF_DROPPING">
            <Values xsi:type="FloatVectorType">
               <Vector>0.0 0.1 0.21 0.09 0.3 0.2 0.0 0.4 0.5 0.44 0.31 0.0 0.35 0.27 0.08
0.4 0.5 0.2 0.4 0.5 0.0 0.1 0.2 0.3 0.4 0.5</Vector>
            </Values>
         </AdaptationOperator>
         <Utility iOPinRef="PSNR">
            <Values xsi:type="FloatVectorType">
               <Vector>34.47 33.56 32.48 31.40 31.58 30.82 28.62 30.27 29.10 28.57 27.53
31.94 30.69 30.15 28.33 29.04 28.11 28.01 27.03 26.49 23.44 23.36 23.29 23.18 23.02
22.87</Vector>
            </Values>
         </Utility>
      </Module>
      <IOPin semantics=":AQoS:1.1.1" id="BANDWIDTH"/>
      <IOPin semantics=":AQoS:2.1" id="PSNR"/>
      <IOPin semantics=":AQoS:3.1.1" id="B_FRAMES"/>
      <IOPin semantics=":AQoS:3.1.2" id="P_FRAMES"/>
      <IOPin semantics=":AQoS:3.1.3" id="COEFF_DROPPING"/>
   </Description>
</DIA>
```

EXAMPLE 2 The following example shows how audio adaptation might work using the UtilityFunction. Suppose that we want to stream a song on the CDMA2000 1x. For a network adaptive streaming MOD service, constraint, a plausible set of audio adaptation operations, and resultant sound quality are described. The constraint is imposed by dynamic changes in available network bandwidth of the CDMA2000 1x. The bandwidth varies from 16 to 86 kbits/sec. The following QoS description illustrates the usage of two audio adaptation operations: Scalable Audio and Channel Dropping. For the bandwidth ranging from 86 down to 44 kbps only Scalable Audio operator is used, so that enhancement layers of the layered bitstream such as MPEG-4 BSAC are truncated. When the available network bandwidth decreases even further, an audio channel is dropped by Channel Dropping adaptation method to satisfy the limited network bandwidth (NUMBER_OF_CHANNELS = 1, CHANNEL_CONFIGURATION = M). The values of audio quality represented by DI (Distortion Index) are specified at each adaptation operation. The different sets of adaptation operations can be chosen in order to maximize DI values.

```
<DIA>
 <DescriptionMetadata>
    <ClassificationSchemeAlias alias="AQoS"
       href="urn:mpeg:mpeg21:2003:01-DIA-AdaptationQoSCS-NS"/>
 </DescriptionMetadata>
 <Description xsi:type="AdaptationQoSType">
   <Module xsi:type="UtilityFunctionType">
     <Constraint iOPinRef="BANDWIDTH">
      <Values xsi:type="IntegerVectorType">
        <Vector>16 18 20 22 24 26 28 30 32 34 36 38 40 42 44 46 48 50 52 54 56 58 60 62 64
66 68 70 72 74 76 78 80 82 84 86</Vector>
      </Values>
     </Constraint>
     <AdaptationOperator iOPinRef="LAYERS_OF_SCALABLE_AUDIO">
      <Values xsi:type="IntegerVectorType">
        <Vector>27 25 23 21 19 17 15 13 11 9 7 5 3 1 21 20 19 18 17 16 15 14 13 12 11 10 9
8 7 6 5 4 3 2 1 0 </Vector>
```

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```
      </Values>
     </AdaptationOperator>
     <AdaptationOperator iOPinRef="NUMBER OF CHANNELS">
      <Values xsi:type="IntegerVectorType">
        <Vector>1 1 1 1 1 1 1 1 1 1 1 1 1 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0</Vector>
      </Values>
     </AdaptationOperator>
     <AdaptationOperator iOPinRef="CHANNEL_CONFIGURATION">
      <Values xsi:type="TokenVectorType">
        <Vector>M M M M M M M M M M M M M LR LR LR LR LR LR LR LR LR LR LR LR LR LR
LR LR LR LR LR LR LR</Vector>
      </Values>
     </AdaptationOperator>
     <Utility iOPinRef="DI">
      <Values xsi:type="FloatVectorType">
        <Vector>-2.77 -2.63 -2.48 -2.41 -2.35 -2.33 -2.33 -2.23 -2.18
         -2.09 -2.02 -1.90 -1.70 -1.64 -2.43 -2.37 -2.37 -2.35 -2.35
         -2.37 -2.35 -2.32 -2.26 -2.22 -2.19 -2.13 -2.05 -2.01 -1.93
         -1.81 -1.74 -1.60 -1.42 -1.36 -1.28 -0.80</Vector>
      </Values>
     </Utility>
   </Module>
   <IOPin semantics=":AQoS:1.1.1" id="BANDWIDTH"/>
   <IOPin semantics=":AQoS:2.4"   id="DI"/>
   <IOPin semantics=":AQoS:3.6.1" id="LAYERS OF SCALABLE AUDIO"/>
   <IOPin semantics=":AQoS:3.7.1" id="NUMBER_OF_CHANNELS"/>
   <IOPin semantics=":AQoS:3.7.2" id="CHANNEL_CONFIGURATION"/>
 </Description>
</DIA>
```

9.7 Look-up table

9.7.1 Introduction

This subclause specifies the syntax and semantics of the `LookUpTable` tool. A `LookUpTable` is a generic matrix representation of data and their relationship, consisting of axes and related content.

The axes should be declared in the same order as the dimension of the matrix in the `Content` element, as specified in ISO/IEC 15938-5. An axis can be globally declared in the referenced IOPin element, constraining the IOPin value to the specified (continuous or discrete) value range. Multiple contents can be specified, each having the same dimensions, relating to the same axes but with different content values and types.

9.7.2 LookUpTable syntax

```
<!-- ################################################ -->
<!-- Definition of LookUpTableType                    -->
<!-- ################################################ -->

<complexType name="LookUpTableType">
   <complexContent>
      <extension base="dia:BaseModuleType">
         <sequence>
            <choice maxOccurs="unbounded">
               <element name="Axis" type="dia:AxisType"/>
               <element name="AxisRef" type="dia:AxisRefType"/>
            </choice>
            <element name="Content" type="dia:ContentType"
               maxOccurs="unbounded"/>
         </sequence>
```

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```
      </extension>
   </complexContent>
</complexType>
```

9.7.3 LookUpTable semantics

Name	*Definition*
`LookUpTableType`	Tool for describing the data in a table format, used for non-sparse, discrete data representation.
`Axis`	Describes an axis of the multidimensional table.
`AxisRef`	Describes a reference to an `IOPin` containing the globally declared `Axis`.
`Content`	Describes the content of the multidimensional table.

9.7.4 Axis syntax

```
<!-- ################################################ -->
<!-- Definition of AxisBaseType                       -->
<!-- ################################################ -->

<complexType name="AxisBaseType">
   <complexContent>
      <extension base="dia:DIABaseType">
         <sequence>
            <element name="AxisValues" type="dia:VectorDataType"/>
         </sequence>
         <attribute name="roundingMethod" type="mpeg7:termReferenceType"
            use="optional"/>
         <attribute name="defaultIndex" type="nonNegativeInteger"
            use="optional"/>
      </extension>
   </complexContent>
</complexType>

<!-- ################################################ -->
<!-- Definition of AxisType                           -->
<!-- ################################################ -->

<complexType name="AxisType">
   <complexContent>
      <extension base="dia:AxisBaseType">
         <attribute name="iOPinRef" type="IDREF" use="required"/>
      </extension>
   </complexContent>
</complexType>

<!-- ################################################ -->
<!-- Definition of AxisRefType                        -->
<!-- ################################################ -->
<complexType name="AxisRefType">
   <complexContent>
      <extension base="dia:DIABaseType">
         <attribute name="iOPinRef" type="IDREF" use="required"/>
      </extension>
   </complexContent>
</complexType>
```


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9.7.5 Axis semantics

Name	*Definition*
`AxisBaseType`	Tool for describing an axis of the multidimensional table.
`AxisValues`	Describes the coordinate values of the axis. Numerical values shall be specified in ascending order.
`roundingMethod`	Describes the rounding method for this axis, used when values do not coincide with the axis values. The CS that must be used for this purpose is the `AqoSRoundingMethodCS` defined in Annex A.2.3. As it is optional, the rounding method (if at all applicable) is supposed to be `urn:mpeg:mpeg21:2003:01-DIA-AQoSRoundingMethodCS-NS:1` (`floor`) whenever the attribute is not specified.
`defaultIndex`	Describes the index of the default value whenever the corresponding input value is unavailable or does not correspond to the list of possible valid values.
`AxisType`	Tool for describing an axis of the multidimensional table. It extends `AxisBaseType` with an `iOPinRef` attribute.
`iOPinRef`	Describes a reference to the `IOPin` containing the `Axis` declaration.
`AxisRefType`	Describes a reference to an `IOPin` containing the `Axis` globally defined.

9.7.6 Content syntax

```
<!-- ################################################ -->
<!-- Definition of ContentBaseType                    -->
<!-- ################################################ -->

<complexType name="ContentBaseType">
   <complexContent>
      <extension base="dia:DIABaseType">
         <sequence>
            <element name="ContentValues" type="dia:MatrixDataType"/>
         </sequence>
         <attribute name="defaultIndex" type="nonNegativeInteger"
            use="optional"/>
         <attribute name="empty" type="boolean" use="optional" default="false"/>
      </extension>
   </complexContent>
</complexType>

<!-- ################################################ -->
<!-- Definition of ContentType                        -->
<!-- ################################################ -->

<complexType name="ContentType">
   <complexContent>
      <extension base="dia:ContentBaseType">
         <attribute name="iOPinRef" type="IDREF" use="required"/>
      </extension>
   </complexContent>
</complexType>
```

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9.7.7 Content semantics

Name	*Definition*
`ContentBaseType`	Tool for describing the content of the multidimensional table.
`ContentValues`	Describes a multidimensional matrix containing the content values.
`defaultIndex`	Describes the index of the default value whenever the corresponding input value is unavailable or does not correspond to the list of possible valid values.
`empty`	Describes if the content is empty or not. If so, it is up to the application to retrieve the required information from the appropriate location. If this attribute is not specified its value is suppose to be `false`.
`ContentType`	Tool for describing the content of the multidimensional table. It extends `ContentBaseType` with an `iOPinRef` attribute.
`iOPinRef`	Describes a reference to a globally defined `IOPin`.

9.7.8 LookUpTable example

EXAMPLE The following example shows the use of `LookUpTable` to describe the relationship between, on the one hand, angle and distance, and, on the other hand, required quality for 3D view-dependent texture decoding. It allows one to encode the data in a matrix-like fashion together with the properties of the data. For each dimension, an axis is described which encloses the properties of data along that dimension, such as the rounding method for data selection.

```
<DIA>
    <DescriptionMetadata>
        <ClassificationSchemeAlias alias="AQoS"
            href="urn:mpeg:mpeg21:2003:01-DIA-AdaptationQoSCS-NS"/>
        <ClassificationSchemeAlias alias="RM"
            href="urn:mpeg:mpeg21:2003:01-DIA-AQoSRoundingMethodCS-NS"/>
    </DescriptionMetadata>
    <Description xsi:type="AdaptationQoSType">
        <Module xsi:type="LookUpTableType">
            <Axis iOPinRef="DISTANCE" roundingMethod=":RM:3">
                <AxisValues xsi:type="FloatVectorType">
                    <Vector>1 5 10 20 30 50 75 100</Vector>
                </AxisValues>
            </Axis>
            <Axis iOPinRef="ANGLE" roundingMethod=":RM:3">
                <AxisValues xsi:type="FloatVectorType">
                    <Vector>0 15 30 45 60 75</Vector>
                </AxisValues>
            </Axis>
            <Content iOPinRef="QUALITY">
                <ContentValues mpeg7:dim="8 6" xsi:type="FloatMatrixType">
                    <Matrix>
                        66.89 43.48 26.72 15.66 13.55 9.73
                        55.47 36.55 21.67 14.01 11.90 8.15
                        26.94 26.60 17.67 15.01 10.81 9.32
                        26.08 25.22 16.97 13.58 10.15 8.56
                        22.06 18.03 15.18 12.01  6.87 5.25
                        18.84 15.62 12.65  7.40  6.83 5.75
                        15.19 11.55  8.44  5.78  5.08 4.20
                        11.78  8.37  7.32  5.14  4.80 3.66
```


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```
                    </Matrix>
                </ContentValues>
            </Content>
        </Module>
        <IOPin id="QUALITY" semantics=":AQoS:2.1"/>
        <IOPin id="ANGLE" semantics=":AQoS:4.1.1"/>
        <IOPin id="DISTANCE" semantics=":AQoS:4.1.2"/>
    </Description>
</DIA>
```

9.8 Stack function

9.8.1 Introduction

This subclause specifies the syntax and semantics of the `StackFunction` tool. It allows to express mathematical relationships between IOPins. This tool allows specification of the value of one IOPin as a function of values of other IOPins, constants, external data, data referenced by semantics, and values of IOPins that are chosen decisions in previous adaptation units. The function is specified using the `BaseStackFunction` tool specified in subclause 5.3, with arguments as specified in subclause 5.4, and operators as specified in the StackFunctionOperator CS (Annex A.2.15).

The chosen `ArgumentType`s used in the function are: `InternalIOPinRefType` or `SemanticalRefType` for specifying other IOPins in the AdaptationQoS as arguments; `ConstantTypes` for specifying constants as arguments; `SemanticalDataRefType` for specifying semantically resolved external data as arguments; `ExternalIntegerDataRefType`, `ExternalFloatDataRefType`, `ExternalNMTokenDataRefType`, or `ExternalBoolDataRefType` for specifying various types of external data as arguments; and `InternalIOPinRefType` or `SemanticalRefType` with delay attribute greater than zero for specifying IOPin values chosen in past adaptation units as arguments

9.8.2 StackFunction syntax

```
<!-- ################################################ -->
<!-- Definition of StackFunctionType                  -->
<!-- ################################################ -->

<complexType name="StackFunctionType">
    <complexContent>
        <extension base="dia:BaseModuleType">
            <sequence>
                <element name="StackFunction" type="dia:BaseStackFunctionType"/>
            </sequence>
            <attribute name="iOPinRef" type="IDREF" use="required"/>
        </extension>
    </complexContent>
</complexType>
```

9.8.3 StackFunction semantics

Name	*Definition*
`StackFunctionType`	Tool for describing the data in a numerical function format using a BaseStackFunction.
`StackFunction`	Describes a mathematical expression using a BaseStackFunction.
`iOPinRef`	Describes the IOPin whose value is returned by the stack function.

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9.8.4 StackFunction example

EXAMPLE The following example demonstrates the use of stack functions along with look up tables in an AdaptationQoS to determine the number of quality layers to include for each frame of a video sequence. The AdaptationQoS description shows data for six frames, each coded with a maximum of four quality layers. For each frame and each number of quality layers included, the codesize (CODESIZE) in bytes and mean-squared-error (MSE) data are provided by means of a look-up-table module. A stack function module computes the Lagrangian cost function (LAGRANGIANCOST) as follows: LAGRANGIANCOST = MSE + LAMBDA.CODESIZE, where LAMBDA is an input IOPin. Another stack function computes the buffer level (BUFFERLEVEL) in a realtime video transmission scenario as follows: BUFFERLEVEL = BUFFERLEVEL(delay=1) + CODESIZE – 4.2667 x TRANSMITRATE, where TRANSMITRATE is another input IOPin, indicating a constant rate in (Kbits/s) at which data is to be transmitted for each frame, and 4.2667 is a constant that indicates the frame interval of 1/30 s times the unit conversion factor of 128 from Kbits to bytes.

```
<DIA>
    <DescriptionMetadata>
        <ClassificationSchemeAlias alias="AQoS"
            href="urn:mpeg:mpeg21:2003:01-DIA-AdaptationQoSCS-NS"/>
        <ClassificationSchemeAlias alias="SFO"
            href="urn:mpeg:mpeg21:2003:01-DIA-StackFunctionOperatorCS-NS"/>
    </DescriptionMetadata>
    <Description xsi:type="AdaptationQoSType">
        <Module xsi:type="LookUpTableType">
            <AxisRef iOPinRef="FRAME"/>
            <AxisRef iOPinRef="LAYERS"/>
            <Content iOPinRef="MSE">
                <ContentValues xsi:type="FloatMatrixType" mpeg7:dim="6 4">
                    <Matrix>
                        10.0 5.3 2.9 1.8
                        12.5 7.3 3.8 2.4
                        15.2 9.7 5.5 2.9
                        11.6 5.9 3.1 1.4
                         9.7 4.9 3.0 1.7
                         8.2 4.7 2.5 1.2
                    </Matrix>
                </ContentValues>
            </Content>
            <Content iOPinRef="CODESIZE">
                <ContentValues xsi:type="IntegerMatrixType" mpeg7:dim="6 4">
                    <Matrix>
                        1005 1607 2996 7209
                        1205 2108 3698 7000
                        1443 2890 5354 9865
                        1392 2481 4295 7491
                         930 1865 3810 6923
                         883 1523 2970 5234
                    </Matrix>
                </ContentValues>
            </Content>
        </Module>
        <Module xsi:type="StackFunctionType" iOPinRef="LAGRANGIANCOST">
            <StackFunction>
                <Argument xsi:type="InternalIOPinRefType" iOPinRef="MSE"/>
                <Argument xsi:type="InternalIOPinRefType" iOPinRef="LAMBDA"/>
                <Argument xsi:type="InternalIOPinRefType" iOPinRef="CODESIZE"/>
                <!-- Multiply -->
                <Operation operator=":SFO:18"/>
                <!-- Add -->
                <Operation operator=":SFO:15"/>
            </StackFunction>
        </Module>
        <Module xsi:type="StackFunctionType" iOPinRef="BUFFERLEVEL">
            <StackFunction>
```


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```
                <Argument xsi:type="InternalIOPinRefType" iOPinRef="BUFFERLEVEL"
                    delay="1"/>
                <Argument xsi:type="InternalIOPinRefType" iOPinRef="CODESIZE"/>
                <!-- Add -->
                <Operation operator=":SFO:15"/>
                <Argument xsi:type="InternalIOPinRefType" iOPinRef="TRANSMITRATE"/>
                <Argument xsi:type="ConstantDataType">
                    <Constant xsi:type="FloatType">
                        <Value>4.2667</Value>
                    </Constant>
                </Argument>
                <!-- Multiply -->
                <Operation operator=":SFO:18"/>
                <!-- Subtract -->
                <Operation operator=":SFO:16"/>
            </StackFunction>
        </Module>
        <IOPin id="FRAME">
            <Axis>
                <AxisValues xsi:type="IntegerVectorType">
                    <Vector>0 1 2 3 4 5</Vector>
                </AxisValues>
            </Axis>
        </IOPin>
        <IOPin id="LAYERS">
            <Axis>
                <AxisValues xsi:type="IntegerVectorType">
                    <Vector>1 2 3 4</Vector>
                </AxisValues>
            </Axis>
            <Default xsi:type="IntegerType">
                <Value>0</Value>
            </Default>
        </IOPin>
        <IOPin id="MSE"/>
        <IOPin id="CODESIZE"/>
        <IOPin id="LAMBDA"/>
        <IOPin id="LAGRANGIANCOST"/>
        <IOPin id="BUFFERLEVEL">
            <Default xsi:type="IntegerType">
                <Value>0</Value>
            </Default>
        </IOPin>
        <IOPin semantics=":AQS:1.1.1" id="TRANSMITRATE"/>
    </Description>
</DIA>
```

9.9 Switch mechanism

9.9.1 Introduction

This subclause specifies the syntax and semantics of the switching modules. The characteristics of a resource typically vary along the different portions constituting it. Therefore a more fine-grained description of these characteristics might be desirable. The switch mechanism allows to select the appropriate description of these characteristics with respect to the considered portion.

The data representation types listed above each have their switching counterparts. As not to duplicate the semantics explained previously, the reader is referred to the previous sections.

9.9.2 BaseSwitchModule syntax

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

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```
<!-- Definition of BaseSwitchModuleType                    -->
<!-- ################################################## -->

<complexType name="BaseSwitchModuleType" abstract="true">
   <complexContent>
      <extension base="dia:BaseModuleType">
         <attribute name="switchIOPinRefs" type="IDREFS" use="required"/>
      </extension>
   </complexContent>
</complexType>
```

9.9.3 BaseSwitchModule semantics

Name	*Definition*
`BaseSwitchModuleType`	`BaseSwitchModuleType` extends `BaseModuleType` and provides a base abstract type for a subset of types as part of the switch mechanism. It allows describing the resource in a more fine-grained way.
`switchIOPinRefs`	Describes the list of `IOPin`s whose values uniquely define a specific section of the resource.

9.9.4 UtilityFunctionSwitch syntax

```
<!-- ################################################--> 
<!-- Definition of UtilityFunctionSwitchType          -->
<!-- ################################################--> 

<complexType name="UtilityFunctionSwitchType">
   <complexContent>
      <extension base="dia:BaseSwitchModuleType">
         <sequence>
            <element name="Switch" type="dia:UFDataSwitchType" minOccurs="1"
               maxOccurs="unbounded"/>
         </sequence>
      </extension>
   </complexContent>
</complexType>

<complexType name="UFDataSwitchType">
   <complexContent>
      <extension base="dia:UtilityFunctionType">
         <attribute name="switchValues" type="NMTOKENS" use="required"/>
      </extension>
   </complexContent>
</complexType>
```


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9.9.5 UtilityFunctionSwitch semantics

Name	*Definition*
`UtilityFunctionSwitchType`	Tool for describing the resource in a more fine-grained way using `Utilityfunction`.
`UFDataSwitchType`	Tool for describing a `UtilityFunction` related to a specific section of the resource.
`switchValues`	Describes the list of `IOPin` values uniquely defining a specific section of the resource.

9.9.6 LookUpTableSwitch syntax

```
<!-- ################################################ -->
<!-- Definition of LookUpTableSwitchType              -->
<!-- ################################################ -->

<complexType name="LookUpTableSwitchType">
   <complexContent>
      <extension base="dia:BaseSwitchModuleType">
         <sequence>
            <choice maxOccurs="unbounded">
               <element name="Axis" type="dia:AxisType"/>
               <element name="AxisRef" type="dia:AxisRefType"/>
            </choice>
            <element name="ContentSwitch" type="dia:ContentSwitchType"
               maxOccurs="unbounded"/>
         </sequence>
      </extension>
   </complexContent>
</complexType>

<complexType name="ContentSwitchType">
   <complexContent>
      <extension base="dia:DIABaseType">
         <sequence>
            <element name="ContentDataSwitch" type="dia:ContentDataSwitchType"
               minOccurs="1" maxOccurs="unbounded"/>
         </sequence>
         <attribute name="iOPinRef" type="IDREF" use="required"/>
      </extension>
   </complexContent>
</complexType>

<complexType name="ContentDataSwitchType">
   <complexContent>
      <extension base="dia:ContentBaseType">
         <attribute name="switchValues" type="NMTOKENS" use="required"/>
      </extension>
   </complexContent>
</complexType>
```

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9.9.7 LookUpTableSwitch semantics

Name	*Definition*
`LookUpTableSwitchType`	Tool for describing the resource in a more fine-grained way using `LookUpTable`.
`ContentSwitchType`	Tool for describing the `Content` values of all sections of the resource.
`ContentDataSwitchType`	Tool for describing the `Content` values associated with a specific section of the resource.
`switchValues`	Describes the list of `IOPin` values uniquely defining a specific section of the resource.

9.9.8 StackFunctionSwitch syntax

```
<!-- ################################################ -->
<!-- Definition of StackFunctionSwitchType            -->
<!-- ################################################ -->

<complexType name="StackFunctionSwitchType">
   <complexContent>
      <extension base="dia:BaseSwitchModuleType">
         <sequence>
            <element name="Switch" type="dia:SFDataSwitchType" minOccurs="1"
               maxOccurs="unbounded"/>
         </sequence>
         <attribute name="iOPinRef" type="IDREF" use="required"/>
      </extension>
   </complexContent>
</complexType>

<complexType name="SFDataSwitchType">
   <complexContent>
      <extension base="dia:BaseStackFunctionType">
         <attribute name="switchValues" type="NMTOKENS" use="required"/>

      </extension>
   </complexContent>
</complexType>
```

9.9.9 StackFunctionSwitch semantics

Name	*Definition*
`StackFunctionSwitchType`	Tool for describing the resource in a more fine-grained way using `StackFunction`**s**.
`SFDataSwitchType`	Tool for describing a `StackFunction` related to a specific section of the resource.
`switchValues`	Describes the list of `IOPin` values uniquely defining a specific section of the resource.

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9.10 CrossConversionQoS

9.10.1 Introduction

Subclause 9.10 specifies syntax and semantics of the CrossConversionQoS tool. A resource may be adapted by different methods, (referred herein as conversion options). Normally, each conversion option is associated with an AdaptationQoS description, so the adaptation engine can find an appropriate conversion level of that conversion option. When there are more than one conversion options available, the CrossConversionQoS tool helps the adaptation engine to select the best conversion option (i.e., with the highest quality) given certain constraints. The quality of a conversion option can be computed from the utilities provided by the AdaptationQoS description of that conversion option, or manually assigned by the provider. Besides elements for quality assessment, CrossConversionQos has a reference to ConversionLink or BSDLink, which provides the details of a conversion option.

9.10.2 CrossConversionQoS syntax

```
<?xml version="1.0"?>
<!-- Digital Item Adaptation ISO/IEC 21000-7 Second Edition -->
<!-- Schema for Cross Conversion QoS -->
<schema
   version="ISO/IEC 21000-7 2nd"
   id="CCQoS-2nd.xsd"
   targetNamespace="urn:mpeg:mpeg21:2003:01-DIA-NS"
   xmlns="http://www.w3.org/2001/XMLSchema"
   xmlns:dia="urn:mpeg:mpeg21:2003:01-DIA-NS"
   xmlns:mpeg7="urn:mpeg:mpeg7:schema:2001"
   elementFormDefault="qualified" attributeFormDefault="unqualified">

   <include schemaLocation="AQoS-2nd.xsd"/>
   <import namespace="urn:mpeg:mpeg7:schema:2001"
      schemaLocation="mpeg7-udp-2004.xsd"/>

  <!-- ################################################ -->
  <!-- Definition of CrossConversionQoSType             -->
  <!-- ################################################ -->

  <complexType name="CrossConversionQoSType">
   <complexContent>
    <extension base="dia:DIADescriptionType">
     <sequence>
      <element name="ConversionOption" type="dia:ConversionOptionType"
          minOccurs="2" maxOccurs="unbounded"/>
     </sequence>
    </extension>
   </complexContent>
  </complexType>

  <!-- ################################################ -->
  <!-- Definition of ConversionOptionType               -->
  <!-- ################################################ -->

  <complexType name="ConversionOptionType">
   <complexContent>
    <extension base="dia:DIABaseType">
     <sequence>
      <element name="Modality" type="mpeg7:ControlledTermUseType"
          minOccurs="0"/>
      <element name="LinkRef" type="dia:ReferenceType"/>
      <element name="QualityFunction">
```

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```
      <complexType>
       <complexContent>
        <extension base="dia:BaseStackFunctionType">
         <attribute name="scale" type="float" use="optional" default="1"/>
        </extension>
       </complexContent>
      </complexType>
     </element>
    </sequence>
   </extension>
  </complexContent>
 </complexType>

</schema>
```

9.10.3 CrossConversionQoS semantics

Semantics of the `CrossConversionQoSType`:

Name	Definition
`CrossConversionQoSType`	Tool for describing different conversion options of a resource and their quality assessments, so as to help the adaptation engine finding the conversion which has the highest quality.
`ConversionOption`	Describes a conversion option.

Semantics of the `ConversionOptionType`:

Name	Definition
`ConversionOptionType`	Describes a conversion option and its associated quality assessment which is obtained from the `QualityFunction`.
`Modality`	Describes the modality or format of the converted Resource. CS's that may be used for this purpose are the `ContentCS`, the `AudioCodingFormatCS` and the `VisualCodingFormatCS` defined in ISO/IEC 15938-5.
`LinkRef`	Describes a reference to a `BSDLink` or `ConversionLink` description.
`QualityFunction`	Describes a function to compute the quality from various utilities. The function, which is of `BaseStackFunctionType`, will return a numerical value. .
`scale`	Describes a multiplicative factor to be applied to the `QualityFunction` result.

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9.10.4 Example

EXAMPLE In this example, we have a video resource which can be adapted by two conversion options, one is video transforming (or scaling) by requantization and the other is video-to-slideshow conversion. Each conversion option is provided with a utility function describing the characteristics like utility, bitrate corresponding to different adaptation levels (operators). CrossConversionQoS is employed to compare this two different conversion options. The slideshow quality is defined by:

$$Slideshow_Q = Slideshow_{PSNR} * 1.9$$

The weighting factor 1.9 is assigned to the value of the `scale` attribute of image modality(i.e. slideshow here). The two utility functions of video and slideshow can be compared on the same scoring scale. When VIDEO_PSNR ≥ SLIDESHOW_PSNR*1.9, video conversion is selected; and when VIDEO_PSNR < SLIDESHOW_PSNR*1.9, slideshow conversion is selected.

```
<DIA>
  <DescriptionMetadata>
    <ClassificationSchemeAlias
      alias="AQoS" href="urn:mpeg:mpeg21:2003:01-DIA-AdaptationQoSCS-NS"/>
    <ClassificationSchemeAlias
      alias="SFO" href="urn:mpeg:mpeg21:2003:01-DIA-StackFunctionOperatorCS-NS"/>
    <ClassificationSchemeAlias
      alias="MEI" href="urn:mpeg:mpeg21:2003:01-DIA-MediaInformationCS-NS"/>
  </DescriptionMetadata>

  <Description xsi:type="CrossConversionQoSType">
    <ConversionOption>
      <Modality href="urn:mpeg:mpeg7:cs:ContentCS:2001:4.2">
        <mpeg7:Name>Video</mpeg7:Name>
      </Modality>
      <LinkRef uri="#Video_ConvLink"/>
      <QualityFunction>
        <Argument xsi:type="InternalIOPinRefType" iOPinRef="VIDEO_PSNR"/>
      </QualityFunction>
    </ConversionOption>
    <ConversionOption>
      <Modality href="urn:mpeg:mpeg7:cs:ContentCS:2001:4.1">
        <mpeg7:Name>Image</mpeg7:Name>
      </Modality>
      <LinkRef uri="#Slideshow_ConvLink"/>
      <QualityFunction scale="1.9">
        <Argument xsi:type="InternalIOPinRefType" iOPinRef="SLIDESHOW_PSNR"/>
      </QualityFunction>
    </ConversionOption>
  </Description>

  <!-- 1st Utility function for video modality with associated UCD and ConversionLink -->
  <Description xsi:type="AdaptationQoSType" id="Video_AQoS">
    <Module xsi:type="UtilityFunctionType">
      <Constraint iOPinRef="VIDEO_BITRATE">
        <Values xsi:type="FloatVectorType">
          <Vector>1073 678 455 196 80 56</Vector>
        </Values>
      </Constraint>
      <AdaptationOperator iOPinRef="VIDEO_QUANT_SCALE">
        <Values xsi:type="FloatVectorType">
          <Vector>2 3 4 8 20 40</Vector>
        </Values>
      </AdaptationOperator>
      <AdaptationOperator iOPinRef="VIDEO_GOP_SIZE">
        <Values xsi:type="FloatVectorType">
          <Vector>12 12 30 50 100 200</Vector>
        </Values>
      </AdaptationOperator>
      <Utility iOPinRef="VIDEO_PSNR">
        <Values xsi:type="FloatVectorType">
```

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```
        <Vector>49.16 45.35 42.88 38.78 34.05 31.78</Vector>
      </Values>
    </Utility>
  </Module>

  <IOPin semantics=":AQoS:1.1.1" id="VIDEO_BITRATE"/>
  <IOPin semantics=":AQoS:2.1" id="VIDEO_PSNR"/>
  <IOPin semantics=":AQoS:1.3.3" id="VIDEO_QUANT_SCALE"/>
  <IOPin id="VIDEO_GOP_SIZE"/>

  <!-- Reference to the UCD for Optimization -->
  <Constraints uri="#Video_UCD"/>
</Description>

<!-- UCD for video transforming adaptation -->
<Description xsi:type="UCDType" id="Video_UCD">
  <AdaptationUnitConstraints>
  <!-- Constraint for video transforming : VIDEO_BITRATE <= Bandwidth UED -->
    <LimitConstraint>
      <Argument xsi:type="InternalIOPinRefType" iOPinRef="VIDEO_BITRATE"/>
      <Argument xsi:type="SemanticalRefType" semantics=":MEI:6"/>
      <Operation operator=":SFO:38"/>
    </LimitConstraint>
  </AdaptationUnitConstraints>
</Description>

<!-- Video transforming adaptation -->
<Description xsi:type="ConversionLinkType" id="Video_ConvLink">
  <ConversionActUri uri="urn:enst:videotransforming123"/>
  <Parameter xsi:type="IOPinRefType" name="qscale">
    <Value>VIDEO_QUANT_SCALE</Value>
  </Parameter>
  <Parameter xsi:type="IOPinRefType" name="gop_size">
    <Value>VIDEO_GOP_SIZE</Value>
  </Parameter>
  <SteeringDescriptionRef uri="#Video_AQoS"/>
  <BitstreamRef uri="mpeg4_video.mp4"/>
</Description>

<!-- 2st utility function for image modality with associated UCD and ConversionLink -->
<Description xsi:type="AdaptationQoSType" id="Slideshow_AQoS">
  <Module xsi:type="UtilityFunctionType">
    <Constraint iOPinRef="SLIDESHOW_BITRATE">
      <Values xsi:type="FloatVectorType">
        <Vector>106 64 32</Vector>
      </Values>
    </Constraint>
    <AdaptationOperator iOPinRef="SLIDESHOW_PERIOD">
      <Values xsi:type="IntegerVectorType">
        <Vector>3 5 10</Vector>
      </Values>
    </AdaptationOperator>
    <Utility iOPinRef="SLIDESHOW_PSNR">
      <Values xsi:type="FloatVectorType">
        <Vector>18.7 17.3 16.8</Vector>
      </Values>
    </Utility>
  </Module>

  <IOPin semantics=":AQoS:1.1.1" id="SLIDESHOW_BITRATE"/>
  <IOPin semantics=":AQoS:2.1" id="SLIDESHOW_PSNR"/>
  <IOPin id="SLIDESHOW_PERIOD"/>

  <!-- Reference to the UCD for Optimization -->
  <Constraints uri="#Slideshow_UCD"/>
</Description>

<!-- UCD for video to Slideshow conversion -->
```

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```
  <Description xsi:type="UCDType" id="Slideshow_UCD">
    <AdaptationUnitConstraints>
    <!-- Constraint for summarization : SLIDESHOW_BITRATE <= Bandwidth UED -->
      <LimitConstraint>
        <Argument xsi:type="InternalIOPinRefType" iOPinRef="SLIDESHOW_BITRATE"/>
        <Argument xsi:type="SemanticalRefType" semantics=":MEI:6"/>
        <Operation operator=":SFO:38"/>
      </LimitConstraint>
    </AdaptationUnitConstraints>
  </Description>

  <!-- Video to Slideshow conversion -->
  <Description xsi:type="ConversionLinkType" id="Slideshow_ConvLink">
    <ConversionActUri uri="urn:enst:videosummarization123"/>
    <Parameter xsi:type="IOPinRefType" name="period">
      <Value>SLIDESHOW_PERIOD</Value>
    </Parameter>
    <SteeringDescriptionRef uri="#Slideshow_AQoS"/>
    <BitstreamRef uri="mpeg4_video.mp4"/>
  </Description>
</DIA>
```

10 Universal constraints description tools

10.1 Introduction

This clause specifies the Universal Constraints Description (UCD) tool for describing constraints for adaptation.

The UCD tool is based on establishing a mathematical abstraction where constraints are specified on variables representing resource and environment characteristics using values obtained either externally by XPath expressions from Usage Environment Descriptions or by a direct specification of numeric constants. When used in conjunction with the AdaptationQoS, these constraints are applied to IOPins in AdaptationQoS. Otherwise, they are applied to resource or environment characteristics indicated by their semantics.

The adaptation constraints can be specified not only on the resource as a whole but also differentiated with respect to individual units of the resource corresponding to logical partitionings such as GOPs, ROIs, Tiles, Frames etc. Such units are referred to as adaptation units.

For each adaptation unit, the description is comprised by a set of limit constraints that specify Boolean expressions which must evaluate to true, along with optional optimization constraints that convey numeric expressions which are to be maximized or minimized within the feasible space of decisions satisfying the limit constraints. Together, the limit and optimisation constraints specify a generic single or multi-objective optimisation problem.

UCD-based decision making

UCD-based decision making is performed on variables with specific semantics that are related to resource or usage environment characteristics. In this context, the set of variables is denoted by vector $\mathbf{I} = \{i_0, i_1, ...\}$. The purpose of the UCD is to specify an optimisation problem involving these variables. First, the case considering only a single adaptation unit in the resource is specified. Subsequently, this specification is extended to the case considering multiple adaptation units.

In the single adaptation unit case, the UCD conveys numeric expressions $O_j(\mathbf{I})$, j=0,1,…,J–1, called optimisation constraints, along with several Boolean expressions $L_k(\mathbf{I})$, k = 0,1,…,K–1, called limit constraints, which are used together to specify the following optimization problem involving **I**:

$$\text{Maximize or Minimize } \{O_j(\mathbf{I})\},\ j=0,1,...,J-1 \quad \text{subject to: } L_k(\mathbf{I}) = \texttt{true},\ k=0,1,\ldots,K-1$$

Let $\mathbf{I}^*$ represent a solution to the above problem that maximizes or minimizes expressions $O_j(\mathbf{I})$ subject to expressions $L_k(\mathbf{I})$ evaluating to `true`. The syntax of the UCD allows any number of optimisation constraints to be specified including none, and based on this three cases must be considered separately. If no

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optimisation constraints are specified (J=0), any solution **I*** in the *feasible solution region*, where the limit constraints evaluate to `true`, is acceptable. If there is a single optimisation constraint (J=1), a single objective optimization problem is defined, where a solution that maximizes or minimizes the only optimization metric within the feasible region is acceptable. This solution is typically unique, but in some cases there can be multiple solutions yielding the same maximum or minimum optimization metric. If there are multiple optimization constraints specified (J>1), a multi-criteria (also known an multi-objective) optimization problem is defined [18]. In this case, any solution **I*** in the Pareto optimal set included in the feasible region is acceptable. In multi-criteria optimization literature, a set of points in the feasible region is said to be Pareto optimal if in moving from any point in the set to another in the feasible region, any improvement in one of the optimization metrics from its current value would cause at least one of the other optimization metrics to deteriorate from its current value. In other words, this is the set of best solutions that could be achieved without disadvantaging at least one metric.

In the multiple adaptation unit case, there is one additional variable, say n, whose axis represents sequentially increasing integer indices for successive adaptation units: 0,1,2,…. Further, all other variables are differentiated by adaptation units, so that the set of variables for the nth adaptation unit is denoted by vector $\mathbf{I}[n] = \{i_0[n], i_1[n], \ldots\}$. The UCD in this case indicates which variable is the adaptation unit variable, and then specifies an optimization problem involving the other variables for each adaptation unit. In particular, it conveys for each adaptation unit n, numeric expressions $O_{n,j}(\mathbf{I}[n], \mathbf{H}[n])$, $j=0,1,\ldots,J_n-1$ called optimisation constraints, along with several Boolean expressions $L_{n,k}(\mathbf{I}[n], \mathbf{H}[n])$, $k=0,1,\ldots,K_n-1$, called limit constraints, which are used together to specify the following optimization problem involving **I**[n]:

Maximize or Minimize $\{O_{n,j}(\mathbf{I}[n], \mathbf{H}[n])\}$, $j=0,1,...,J_n-1$ subject to: $L_{n,k}(\mathbf{I}[n], \mathbf{H}[n])$ = `true`, $k=0,1,\ldots,K_n-1$

Let **I***[n] represent a solution to the above problem for the nth adaptation unit that maximizes or minimizes expressions $O_{n,j}(\mathbf{I}[n], \mathbf{H}[n])$ subject to expressions $L_{n,k}(\mathbf{I}[n], \mathbf{H}[n])$ evaluating to `true`. The vector **H**[n] in the expressions of O_n and $L_{n,k}$ represents the history of all past decisions for adaptation units 0,1,…, n–1. In other words, $\mathbf{H}[n] = \{\mathbf{I}^*[0], \mathbf{I}^*[1],\ldots,\mathbf{I}^*[n-1]\}$. Note that the `delay` attribute of `VariableRefType` used in a stack function to convey limit and optimisation constraints allow dependencies on the past history to be specified.

An adaptation decision-taking engine based on the UCD makes decisions sequentially for the variables **I**[n], for each value along the axis of the adaptation unit variable, i.e., n = 0,1,2,… in order.

Note that in the UCD, the `AdaptationUnitDef` element specifies the variable that is to be used as the adaptation unit, the `LimitConstraint` and `OptimizationConstraint` elements included in `AdaptationUnitConstraints` elements specify the limit and optimisation constraints as described above for each adaptation unit. Apart from the limit and optimization constraints, the UCD allows use of another element `Assign`, which is meant explicitly for making assignments to variables representing usage environment/preference inputs. Even though the same information can also be represented as limit constraints, a different element is used for this purpose because the processing of these assignments can be different, in that they are regarded as variable assignments before the optimisation is performed on the rest of the variables.

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10.2 Universal constraints description syntax

```
<?xml version="1.0"?>
<!-- Digital Item Adaptation ISO/IEC 21000-7 Second Edition -->
<!-- Schema for universal constraints description tools -->
<schema
   version="ISO/IEC 21000-7 2nd"
   id="UCD-2nd.xsd"
   targetNamespace="urn:mpeg:mpeg21:2003:01-DIA-NS"
   xmlns="http://www.w3.org/2001/XMLSchema"
   xmlns:dia="urn:mpeg:mpeg21:2003:01-DIA-NS"
   elementFormDefault="qualified" attributeFormDefault="unqualified">

   <include schemaLocation="DIA-2nd.xsd"/>
   <include schemaLocation="SingleValueDatatypes-2nd.xsd"/>
   <include schemaLocation="BaseStackFunction-2nd.xsd"/>
   <include schemaLocation="ArgumentTypes-2nd.xsd"/>
   <include schemaLocation="AQoS-2nd.xsd"/>

   <!-- ################################################ -->
   <!-- Definition of UCDType                            -->
   <!-- ################################################ -->

   <complexType name="UCDType">
      <complexContent>
         <extension base="dia:DIADescriptionType">
            <sequence>
               <element name="AdaptationUnitDef" type="dia:VariableRefType"
                        minOccurs="0"/>
               <element name="AdaptationUnitConstraints"
                        type="dia:ConstraintsType" maxOccurs="unbounded"/>
            </sequence>
         </extension>
      </complexContent>
   </complexType>

   <!-- ################################################ -->
   <!-- Definition of ConstraintsType                    -->
   <!-- ################################################ -->

   <complexType name="ConstraintsType">
      <complexContent>
         <extension base="dia:DIABaseType">
            <sequence>
               <element name="Assign" type="dia:AssignType"
                      minOccurs="0" maxOccurs="unbounded"/>
               <element name="LimitConstraint" type="dia:LimitConstraintType"
                      minOccurs="0" maxOccurs="unbounded"/>
               <element name="OptimizationConstraint"
                      type="dia:OptimizationConstraintType"
                      minOccurs="0" maxOccurs="unbounded"/>
            </sequence>
         </extension>
      </complexContent>
   </complexType>
```

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```
    <!-- ################################################ -->
    <!-- Definition of AssignType                         -->
    <!-- ################################################ -->

    <complexType name="AssignType">
       <complexContent>
          <extension base="dia:DIABaseType">
             <sequence>
                <element name="VarRef" type="dia:VariableRefType"/>
                <element name="GetValue" type="dia:GetValueType"/>
             </sequence>
          </extension>
       </complexContent>
    </complexType>

    <!-- ################################################ -->
    <!-- Definition of LimitConstraintType                -->
    <!-- ################################################ -->

    <complexType name="LimitConstraintType">
       <complexContent>
          <extension base="dia:BaseStackFunctionType"/>
       </complexContent>
    </complexType>

    <!-- ################################################ -->
    <!-- Definition of OptimizationConstraintType         -->
    <!-- ################################################ -->

    <complexType name="OptimizationConstraintType">
       <complexContent>
          <extension base="dia:BaseStackFunctionType">
             <attribute name="optimize" use="required">
                <simpleType>
                   <restriction base="NMTOKEN">
                      <enumeration value="maximize"/>
                      <enumeration value="minimize"/>
                   </restriction>
                </simpleType>
             </attribute>
          </extension>
       </complexContent>
    </complexType>

</schema>
```

10.3 Universal constraints description semantics

Semantics of the `UCDType`:

Name	*Definition*
`UCDType`	Tool for describing universal constraints.
`AdaptationUnitDef`	Describes the adaptation unit axis. If used in conjunction with the AdaptationQoS, this corresponds to an IOPin whose axis definitions are expected to be present in the AdaptationQoS. Otherwise, it specifies media segment decompositions on which the `AdaptationUnitConstraints` elements apply by semantical reference to segments, such as Frame, GOP, macroblock, etc.

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Name	*Definition*
AdaptationUnitConstraints	Describes constraints for a single adaptation unit (GOP, frames, ROI etc.). There can be an unbounded number of AdaptationUnitConstraints elements, one for each adaptation unit. If the number of such elements is less than the actual number of adaptation units expected based on the AdaptationUnitDef element, then the last AdaptationUnitConstraints element is applied to all remaining adaptation units.

Semantics of the ConstraintsType:

Name	*Definition*
ConstraintsType	Describes constraints for an adaptation unit of a resource.
Assign	Describes input assignments to variables.
LimitConstraint	Describes the limit constraints that must be satisfied. To satisfy a limit constraint, the expression specified in the element must evaluate to true.
OptimizationConstraint	Describes the metric to optimize subject to the constraints described by LimitConstraint elements. If there are no OptimizationConstraint elements, any solution in the feasible region defined by LimitConstraint elements is acceptable. If there is a single OptimizationConstraint element, any solution that optimises the corresponding metric in the feasible region defined by LimitConstraint elements is acceptable. If there are multiple OptimizationConstraint elements, any solution in the Pareto optimal set defined by corresponding metrics in the feasible region defined by LimitConstraint elements is acceptable.

Semantics of the AssignType:

Name	*Definition*
AssignType	Describes an assignment.
VarRef	Describes the target of the assignment.
GetValue	Describes the value to be assigned.

Semantics of the LimitConstraintType:

Name	*Definition*
LimitConstraintType	Describes a constraint by means of a metric represented in stack function form, which must evaluate to Boolean true, for any valid adaptation decision.

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Semantics of the `OptimizationConstraintsType`:

Name	*Definition*
`OptimizationConstraintsType`	Describes a metric to optimize represented in stack function form.
`optimize`	Describes whether the metric is to be maximized or minimized. Possible values are: — `maximize`: maximize the function. — `minimize`: minimize the function.

10.4 Universal constraints description examples

EXAMPLE 1 The following is an example of a UCD generated for adapting a JPEG 2000 image resource, in conjunction with an AdaptationQoS description. The UCD requests an adaptation that returns the largest image that is within a specified codesize upper limit, has a minimum perceptual quality, has width and height not to exceed 75% of the display horizontal and vertical resolutions, and matches the color capability of the terminal. The corresponding IOPins in AdaptationQoS have IDs CODESIZE, PERCEPT_QUALITY, RESOLUTION_X, RESOLUTION_Y, and ISCOLOR. CODESIZE is associated with semantics `urn:mpeg:mpeg21:2003:01-DIA-MediaInformationCS-NS:3`, while RESOLUTION_X and RESOLUTION_Y are associated with semantics `urn:mpeg:mpeg21:2003:01-DIA-MediaInformationCS-NS:17` and `:18` respectively. The entire resource is a single adaptation unit. The Usage Environment Description for a terminal is in my_UED.xml.

```
<DIA>
    <DescriptionMetadata>
        <ClassificationSchemeAlias alias="SFO"
            href="urn:mpeg:mpeg21:2003:01-DIA-StackFunctionOperatorCS-NS"/>
        <ClassificationSchemeAlias alias="AQS"
            href="urn:mpeg:mpeg21:2003:01-DIA-AdaptationQoSCS-NS"/>
        <ClassificationSchemeAlias alias="MEI"
            href="urn:mpeg:mpeg21:2003:01-DIA-MediaInformationCS-NS"/>
    </DescriptionMetadata>
    <Description xsi:type="UCDType">
        <AdaptationUnitConstraints>
            <LimitConstraint>
                <Argument xsi:type="SemanticalRefType" semantics=":MEI:3"/>
                <Argument xsi:type="ConstantDataType">
                    <Constant xsi:type="IntegerType">
                        <Value>30000</Value>
                    </Constant>
                </Argument>
                <Operation operator=":SFO:38"/>
            </LimitConstraint>
            <LimitConstraint>
                <Argument xsi:type="ExternalIOPinRefType"
                    iOPinRef="#PERCEPT_QUALITY"/>
                <Argument xsi:type="ConstantDataType">
                    <Constant xsi:type="FloatType">
                        <Value>1.0</Value>
                    </Constant>
                </Argument>
                <Operation operator=":SFO:39"/>
            </LimitConstraint>
            <LimitConstraint>
                <Argument xsi:type="SemanticalRefType" semantics=":MEI:17"/>
                <Argument xsi:type="ExternalIntegerDataRefType"
uri="my UED.xml#xmlns(dia=urn:mpeg:mpeg21:2003:01-DIA-
NS)xpointer(//dia:DisplayCapability/dia:Resolution/@horizontal)"/>
                <Argument xsi:type="ConstantDataType">
                    <Constant xsi:type="FloatType">
```

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```
                        <Value>0.75</Value>
                    </Constant>
                </Argument>
                <!-- Multiply operation-->
                <Operation operator=":SFO:18"/>
                <!-- Bool IsLessThanOrEqualTo operation-->
                <Operation operator=":SFO:38"/>
            </LimitConstraint>
            <LimitConstraint>
                <Argument xsi:type="SemanticalRefType" semantics=":MEI:18"/>
                <Argument xsi:type="ExternalIntegerDataRefType"
uri="my_UED.xml#xmlns(dia=urn:mpeg:mpeg21:2003:01-DIA-
NS)xpointer(//dia:DisplayCapability/dia:Resolution/@vertical)"/>
                <Argument xsi:type="ConstantDataType">
                    <Constant xsi:type="FloatType">
                        <Value>0.75</Value>
                    </Constant>
                </Argument>
                <!-- Multiply operation-->
                <Operation operator=":SFO:18"/>
                <!-- Bool IsLessThanOrEqualTo operation-->
                <Operation operator=":SFO:38"/>
            </LimitConstraint>
            <LimitConstraint>
                <Argument xsi:type="ExternalIOPinRefType" iOPinRef="#ISCOLOR"/>
                <Argument xsi:type="ExternalBooleanDataRefType"
uri="my_UED.xml#xmlns(dia=urn:mpeg:mpeg21:2003:01-DIA-
NS)xpointer(//dia:DisplayCapability/@colorCapable)"/>
                <!-- Boolean IsEqual operation-->
                <Operation operator=":SFO:11"/>
            </LimitConstraint>
            <OptimizationConstraint optimize="maximize">
                <Argument xsi:type="SemanticalRefType" semantics=":AQS:1.3.5.1"/>
            </OptimizationConstraint>
        </AdaptationUnitConstraints>
    </Description>
</DIA>
```

The corresponding AdaptationQoS description is shown below:

```
<DIA>
    <DescriptionMetadata>
        <ClassificationSchemeAlias alias="SFO"
            href="urn:mpeg:mpeg21:2003:01-DIA-StackFunctionOperatorCS-NS"/>
        <ClassificationSchemeAlias alias="AQS"
            href="urn:mpeg:mpeg21:2003:01-DIA-AdaptationQoSCS-NS"/>
        <ClassificationSchemeAlias alias="MEI"
            href="urn:mpeg:mpeg21:2003:01-DIA-MediaInformationCS-NS"/>
    </DescriptionMetadata>
    <Description xsi:type="AdaptationQoSType" id="river AQoS">
        <Module xsi:type="LookUpTableType">
            <AxisRef iOPinRef="QUALITY"/>
            <Content iOPinRef="PERCEPT QUALITY">
                <ContentValues xsi:type="FloatMatrixType" mpeg7:dim="3">
                    <Matrix>0 1 2</Matrix>
                </ContentValues>
            </Content>
        </Module>
        <Module xsi:type="LookUpTableType">
            <AxisRef iOPinRef="LEVELS"/>
            <Content iOPinRef="DECOMP LEVELS">
                <ContentValues xsi:type="IntegerMatrixType" mpeg7:dim="2">
```

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```
                    <Matrix>0 1</Matrix>
                </ContentValues>
            </Content>
            <Content iOPinRef="RESOLUTION_X">
                <ContentValues xsi:type="IntegerMatrixType" mpeg7:dim="2">
                    <Matrix>384 768</Matrix>
                </ContentValues>
            </Content>
            <Content iOPinRef="RESOLUTION Y">
                <ContentValues xsi:type="IntegerMatrixType" mpeg7:dim="2">
                    <Matrix>256 512</Matrix>
                </ContentValues>
            </Content>
        </Module>
        <Module xsi:type="LookUpTableType">
            <AxisRef iOPinRef="ISCOLOR"/>
            <Content iOPinRef="COMPONENTS">
                <ContentValues xsi:type="IntegerMatrixType" mpeg7:dim="2">
                    <Matrix>1 3</Matrix>
                </ContentValues>
            </Content>
        </Module>
        <Module xsi:type="LookUpTableType">
            <AxisRef iOPinRef="QUALITY"/>
            <AxisRef iOPinRef="LEVELS"/>
            <AxisRef iOPinRef="ISCOLOR"/>
            <Content iOPinRef="CODESIZE">
                <ContentValues xsi:type="IntegerMatrixType" mpeg7:dim="3 2 2">
                    <Matrix>
                        11429 20174 20301 29337 11569 21330
                        27486 37835 14415 28853 33370 48770
                    </Matrix>
                </ContentValues>
            </Content>
        </Module>
        <IOPin id="QUALITY">
            <Axis>
                <AxisValues xsi:type="IntegerVectorType">
                    <Vector>1 2 3</Vector>
                </AxisValues>
            </Axis>
        </IOPin>
        <IOPin id="LEVELS" semantics=":AQS:1.3.5.1">
            <Axis>
                <AxisValues xsi:type="IntegerVectorType">
                    <Vector>1 2</Vector>
                </AxisValues>
            </Axis>
        </IOPin>
        <IOPin id="ISCOLOR">
            <Axis>
                <AxisValues xsi:type="IntegerVectorType">
                    <Vector>0 1</Vector>
                </AxisValues>
            </Axis>
        </IOPin>
        <IOPin id="PERCEPT QUALITY"/>
        <IOPin id="DECOMP LEVELS"/>
        <IOPin id="RESOLUTION X" semantics=":MEI:17"/>
        <IOPin id="RESOLUTION Y" semantics=":MEI:18"/>
        <IOPin id="COMPONENTS"/>
        <IOPin id="CODESIZE" semantics=":MEI:3"/>
    </Description>
</DIA>
```


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EXAMPLE 2 The following is an example of a UCD generated for adapting a MPEG-4 VES video resource by B-VOP dropping. Assume each GOP of the video has VOP pattern IBBPBBPBBPBBPBB, and is organized into four temporal layers: the first comprising only the I-VOPs, the second comprising the P-VOPs, the third comprising the first of every two consecutive B-VOPs and the fourth comprising the second of every two consecutive B-VOPs. Decisions are required to be made on the number of temporal layers to include for each GOP of the video. The GOP comprises the adaptation unit. The UCD requests an adaptation that returns for each GOP the highest framerate within a transmission bit-rate upper limit obtained from a network characteristics description, ensuring that the bit-rate transmitted for each GOP is lower than the available network bandwidth. The GOP segment decomposition is indicated by semantics `urn:mpeg:mpeg21:2003:01-DIA-SegmentDecompositionInfoCS-NS:1`. The semantics `urn:mpeg:mpeg21:2003:01-DIA- MediaInformationCS-NS:7` indicates the bit-rate in bps for each GOP computed over the duration of the GOP (0.5 sec for a 15-VOP GOP), while semantics `urn:mpeg:mpeg21:2003:01-DIA-MediaInformationCS-NS:20` indicates the framerate for each number of temporal layers included. The Usage Environment Description is in my_UED.xml. If this UCD is used in conjunction with an AdaptationQoS to make decisions, the AdaptationQoS will declare and define IOPins associated with each of these semantics to provide the set of possible GOPs, framerates, and the bit-rate for each framerate for each GOP. Note that since there is only a single `AdaptationUnitConstraints` element, it applies to all the adaptation units (GOPs in this case). However, the decisions made are different for each GOP, since it depends on the bit-rate which varies from GOP to GOP.

```
<DIA>
    <DescriptionMetadata>
        <ClassificationSchemeAlias alias="SFO"
            href="urn:mpeg:mpeg21:2003:01-DIA-StackFunctionOperatorlCS-NS"/>
        <ClassificationSchemeAlias alias="AQS"
            href="urn:mpeg:mpeg21:2003:01-DIA-AdaptationQoSCS-NS"/> </DescriptionMetadata>
    <Description xsi:type="UCDType">
        <AdaptationUnitDef xsi:type="SemanticalRefType" semantics=":SED:1"/>
        <AdaptationUnitConstraints>
            <LimitConstraint>
                <Argument xsi:type="SemanticalRefType" semantics=":MEI:7"/>
                <Argument xsi:type="ExternalIntegerDataRefType" uri="my_UED.xml#
xmlns(dia=urn:mpeg:mpeg21:2003:01-DIA-NS)
xpointer(//dia:NetworkCharacteristics/dia:AvailableBandwidth/@average)"/>
                <!-- Bool IsLessThanOrEqualTo operation-->
                <Operation operator=":SFO:38"/>
            </LimitConstraint>
            <OptimizationConstraint optimize="maximize">
                <Argument xsi:type="SemanticalRefType" semantics=":MEI:20"/>
            </OptimizationConstraint>
        </AdaptationUnitConstraints>
    </Description>
</DIA>
```

EXAMPLE 3 The following is an example of a UCD generated for a fully scalable video resource. Each GOP of the video is an adaptation unit, and is coded into several temporal, spatial and quality layers. The UCD requests an adaptation that decides on the optimal number of spatial, temporal and quality layers for the first GOP, but for all subsequent GOPs, the only the optimal number of temporal and quality layers are decided, while the number of spatial layers is required to remain unchanged. For the first GOP, the UCD requires that frame width and height of the adapted video must be less than the display width and height respectively, the bit-rate must be less than the available network bandwidth, and a measure of perceptual distortion that combines temporal and spatial resolutions with quality, is to be minimized. For all subsequent GOPs, the UCD requires that frame width be held the same as the previous GOP's frame width, but the constraints on the bit-rate and the optimization constraint minimizing perceptual distortion remains the same. The GOP segment decomposition is indicated by semantics `urn:mpeg:mpeg21:2003:01-DIA-SegmentDecompositionInfoCS-NS:1`. The semantics `urn:mpeg:mpeg21:2003:01-DIA-MediaInformationCS-NS:7` indicates the bit-rate in bps for each GOP computed over the duration of the GOP, while semantics `urn:mpeg:mpeg21:2003:01-DIA-MediaInformationCS-NS:17` and `:18` indicate the frame width and frame height respectively for each number of temporal layers included. It is assumed that the UCD is to be used in conjunction with an AdaptationQoS, that declare and define IOPins corresponding to GOPs, frame width, frame height and perceptual distortion. The perceptual distortion IOPin has id DISTORTION_TSQ and is referenced directly in the UCD. The Usage Environment Description is in my_UED.xml. Note that since there are two AdaptationUnitConstraints elements, the first applies to the first adaptation unit (GOP), while the second applies to all subsequent adaptation units (GOPs).

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```
<DIA>
    <DescriptionMetadata>
        <ClassificationSchemeAlias alias="SFO"
            href="urn:mpeg:mpeg21:2003:01-DIA-StackFunctionOperatorCS-NS"/>
        <ClassificationSchemeAlias alias="AQS"
            href="urn:mpeg:mpeg21:2003:01-DIA-AdaptationQoSCS-NS"/>
        <ClassificationSchemeAlias alias="MEI"
            href="urn:mpeg:mpeg21:2003:01-DIA-MediaInformationCS-NS"/>
        <ClassificationSchemeAlias alias="SED"
            href="urn:mpeg:mpeg21:2003:01-DIA-SegmentDecompositionInfoCS-NS"/>
    </DescriptionMetadata>
    <Description xsi:type="UCDType">
        <AdaptationUnitDef xsi:type="SemanticalRefType" semantics=":SED:1"/>
        <AdaptationUnitConstraints>
            <LimitConstraint>
                <Argument xsi:type="SemanticalRefType" semantics=":MEI:7"/>
                <Argument xsi:type="ExternalIntegerDataRefType" uri="my UED.xml#
xmlns(dia=urn:mpeg:mpeg21:2003:01-DIA-
NS)xpointer(//dia:NetworkCharacteristics/dia:AvailableBandwidth/@average)"/>
                <!-- Bool IsLessThanOrEqualTo operation-->
                <Operation operator=":SFO:38"/>
            </LimitConstraint>
            <LimitConstraint>
                <Argument xsi:type="SemanticalRefType" semantics=":MEI:17"/>
                <Argument xsi:type="ExternalIntegerDataRefType"
uri="my_UED.xml#xmlns(dia=urn:mpeg:mpeg21:schema:2003)xpointer(//Display/Resolution/@horiz
ontal)"/>
                <!-- Bool IsLessThanOrEqualTo operation-->
                <Operation operator=":SFO:38"/>
            </LimitConstraint>
            <LimitConstraint>
                <Argument xsi:type="SemanticalRefType" semantics=":MEI:18"/>
                <Argument xsi:type="ExternalIntegerDataRefType"
uri="my UED.xml#xmlns(dia=urn:mpeg:mpeg21:schema:2003)xpointer(//Display/Resolution/@verti
cal)"/>
                <!-- Bool IsLessThanOrEqualTo operation-->
                <Operation operator=":SFO:38"/>
            </LimitConstraint>
            <OptimizationConstraint optimize="minimize">
                <Argument xsi:type="ExternalIOPinRefType" iOPinRef="#DISTORTION TSQ"/>
            </OptimizationConstraint>
        </AdaptationUnitConstraints>
        <AdaptationUnitConstraints>
            <LimitConstraint>
                <Argument xsi:type="SemanticalRefType" semantics=":MEI:7"/>
                <Argument xsi:type="ExternalIntegerDataRefType" uri="my UED.xml#
xmlns(dia=urn:mpeg:mpeg21:2003:01-DIA-
NS)xpointer(//dia:NetworkCharacteristics/dia:AvailableBandwidth/@average)"/>
                <!-- Bool IsLessThanOrEqualTo operation-->
                <Operation operator=":SFO:38"/>
            </LimitConstraint>
            <LimitConstraint>
                <Argument xsi:type="SemanticalRefType" semantics=":MEI:17"/>
                <Argument xsi:type="SemanticalRefType" semantics=":MEI:17"
                    delay="1"/>
                <!-- Bool IsEqualTo operation-->
                <Operation operator=":SFO:11"/>
            </LimitConstraint>
            <OptimizationConstraint optimize="minimize">
                <Argument xsi:type="ExternalIOPinRefType"
                    iOPinRef="#DISTORTION TSQ"/>
            </OptimizationConstraint>
        </AdaptationUnitConstraints>
    </Description>
</DIA>
```

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11 Metadata adaptability

11.1 Introduction

This clause specifies a tool for describing adaptation information pertaining to metadata within a Digital Item. This information is a set of syntactical elements with prior knowledge about the metadata that is useful for reducing the complexity of the metadata adaptation process. These elements have been originally designed to enable:

— Filtering and scaling of descriptions (`TotalNumofElements`, `Completeness`, `MaxDepth`, `Value`)

— Integration of descriptions (`AverageValue` and `InvariantProperties`)

Note that a non normative adaptation engine may use such elements jointly to perform the above mentioned processes (scaling or integration), or any other metadata adaptation functionality.

11.2 MetadataAdaptation syntax

```
<?xml version="1.0"?>
<!-- Digital Item Adaptation ISO/IEC 21000-7 Second Edition -->
<!-- Schema for metadata adaptation tools -->
<schema
   version="ISO/IEC 21000-7 2nd"
   id="MetadataAdaptation-2nd.xsd"
   targetNamespace="urn:mpeg:mpeg21:2003:01-DIA-NS"
   xmlns="http://www.w3.org/2001/XMLSchema"
   xmlns:dia="urn:mpeg:mpeg21:2003:01-DIA-NS"
   xmlns:mpeg7="urn:mpeg:mpeg7:schema:2001"
   elementFormDefault="qualified" attributeFormDefault="unqualified">

   <include schemaLocation="DIA-2nd.xsd"/>
   <import namespace="urn:mpeg:mpeg7:schema:2001"
      schemaLocation="mpeg7-udp-2004.xsd"/>

<!--##########################################-->
<!--  Definition of MetadataAdaptationType    -->
<!--##########################################-->
<complexType name="MetadataAdaptationType">
   <complexContent>
      <extension base="dia:DIADescriptionType">
         <sequence>
            <element name="SizeOfMetadata" type="nonNegativeInteger"
               minOccurs="0"/>
            <element name="TotalNumOfElements" type="nonNegativeInteger"
               minOccurs="0"/>
            <sequence>
               <element name="Component" type="dia:ComponentType"
                  minOccurs="0" maxOccurs="unbounded"/>
            </sequence>
         </sequence>
         <attribute name="instanceSchema" type="anyURI" use="required"/>
         <attribute name="instanceLocator" type="anyURI" use="optional"/>
      </extension>
   </complexContent>
</complexType>

<!--##########################################-->
<!--       Definition of ComponentType       -->
<!--##########################################-->
<complexType name="ComponentType">
```

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```
<complexContent>
   <extension base="dia:DIABaseType">
      <sequence>
         <element name="Completeness" type="boolean" minOccurs="0"/>
         <choice minOccurs="0">
            <element name="MaxDepth" type="nonNegativeInteger"
               minOccurs="0"/>
            <element name="Location" type="dia:LocationMethodType"
               maxOccurs="unbounded"/>
         </choice>
         <choice minOccurs="0">
            <element name="Component" type="dia:ComponentType"
               maxOccurs="unbounded"/>
            <sequence>
               <choice>
                  <element name="Value">
                     <complexType>
                        <simpleContent>
                           <extension base="token">
                              <attribute name="type" type="NMTOKEN"
                                 use="required"/>
                           </extension>
                        </simpleContent>
                     </complexType>
                  </element>
                  <sequence>
                     <element name="MinValue" type="float" minOccurs="0"/>
                     <element name="MaxValue" type="float" minOccurs="0"/>
                  </sequence>
               </choice>
            </sequence>
         </choice>
         <choice>
            <element name="AverageValue" minOccurs="0"
               maxOccurs="unbounded">
               <complexType>
                  <complexContent>
                     <extension base="dia:DIABaseType">
                        <sequence>
                           <element name="Location"
                              type="dia:LocationMethodType"
                              maxOccurs="unbounded"/>
                        </sequence>
                        <attribute name="unitOfMeasure" type="NMTOKEN"
                           use="required"/>
                        <attribute name="aValue" type="NMTOKEN"
                           use="required"/>
                     </extension>
                  </complexContent>
               </complexType>
            </element>
            <element name="InvariantProperties" minOccurs="0"
               maxOccurs="unbounded">
               <complexType>
                  <complexContent>
                     <extension base="dia:DIABaseType">
                        <sequence>
                           <element name="Location"
                              type="dia:LocationMethodType"
                              maxOccurs="unbounded"/>
                           <element name="InvariantDimension"
                              maxOccurs="unbounded">
```


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```
                                    <complexType>
                                        <attribute name="dimension"
                                            type="mpeg7:termReferenceType"
                                            use="required"/>
                                        <attribute name="invariantFactor"
                                            type="mpeg7:zeroToOneType"
                                            use="required"/>
                                    </complexType>
                                </element>
                            </sequence>
                        </extension>
                    </complexContent>
                </complexType>
            </element>
        </choice>
    </sequence>
    <attribute name="name" type="QName" use="required"/>
    <attribute name="number" type="nonNegativeInteger" use="optional"/>
  </extension>
 </complexContent>
</complexType>

<!--##########################################-->
<!--       Definition of LocationMethodType   -->
<!--##########################################-->
<complexType name="LocationMethodType">
 <simpleContent>
  <extension base="token">
   <attribute name="type" type="mpeg7:termReferenceType" use="required"/>
  </extension>
 </simpleContent>
</complexType>

</schema>
```

11.3 MetadataAdaptation semantics

Semantics of `MetadataAdaptationType`:

Name	*Definition*
`MetadataAdaptationType`	Tool for describing means for metadata adaptation.
`InstanceSchema`	Describes the schema of the XML instance.
`InstanceLocator`	Describes a link to the described XML instance.
`SizeOfMetadata`	Describes the size of the metadata description in bytes.
`TotalNumOfElements`	Describes the total number of words (i.e., XML elements and values) that are included in a metadata description.
`Component`	Describes a target element in a metadata description.
`Name`	Describes the name of the target element in the metadata description.

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Name	*Definition*
Number	Describes the number of instances of the target element (indicated by Component) that is included in the metadata description. If this number is zero, no instances are present.
Completeness	Describes whether the description is complete. Complete means that the instance of the description tool includes all optional descriptions defined in the schema.
MaxDepth	Describes the maximum number of successively nested target elements in the metadata description.
Location	Describes the means to locate the target element in the metadata description, as well as supplemental information associated with its location.
Value	Describes a discrete set of value(s) that the target element can take.
MinValue	Describes the minimum value that the target element can take for numbers.
MaxValue	Describes the maximum value that the target element can take for numbers.
AverageValue	Describes an average feature (element or attribute) of a set of description tools components (D or DS), associated to Location.
aValue	Describes the average value.
unitOfMeasure	Describes the feature (element or attribute) from which the unit of measure can be derived.
InvariantProperties	Describes the information about invariant properties of a description tool, identified by Location.
InvariantDimension	Describes the information about the dimension for which invariance to cropping for a component (e.g., D or DS instance) applies.
dimension	Describes with respect to which dimension the component is invariant. A CS that may be used for this purpose is the InvariantDimensionCS defined in Annex A.2.7.
invariantFactor	Describes the cropping ratio. A component (e.g., D or DS instance) can be considered invariant if the children segments of the segment (the father segment) it is attached to, have a size which is larger than the size of the father segment multiplied by invariantFactor. 0 means fully invariant, 1 not invariant.

Semantics of LocationMethodType:

Name	*Definition*
LocationMethodType	Tool for describing the means to locate the target element in the metadata description, as well as supplemental information associated with its location.
type	Describes the means to locate the target element in the metadata description. A CS that may be used for this purpose is the LocationTypeCS defined in Annex A.2.9.

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11.4 MetadataAdaptation examples

EXAMPLE 1 This first example includes information about the metadata of a video resource. `SizeOfMetadata` expresses the size of the metadata description and `TotalNumOfElements` expresses the total number of words (i.e., XML elements and values) that are included in the metadata description. These two component will be used to decide whether resizing of the description is required or not. A possible scenario for using such tool is represented by a small terminal that can handle up to 10 KB of metadata or 50 elements. In such a case, the metadata resizing can be performed according to specific hints without a complete analysis of the entire metadata description. Consider below the instance of a description to be scaled:

```
<Mpeg7>
    <Description xsi:type="ContentEntityType">
        <MultimediaContent xsi:type="AudioVisualType">
          <AudioVisual>
           <TemporalDecomposition>
              <AudioVisualSegment id="time1"> ➔ Layer-1
                 <PointOfView viewpoint="TeamB">
                    <Importance>
                       <Value>0.25</Value>
                    </Importance>
                 </PointOfView>
                 ……
              </AudioVisualSegment>
              <AudioVisualSegment> ➔ Layer-1
                 <TemporalDecompsition>
                    <AudioVisualSegment id="time2"> ➔ Layer-2
                       <PointOfView viewpoint="TeamA">
                          <Importance>
                             <Value>0.5</Value>
                          </Importance>
                       </PointOfView>
                       ......
                       <TemporalDecompsotion>
                          <AudioVisualSegment> ➔ Layer-3
                             ....
                             <TemporalDecomposition>
                                <AudioVisualSegment> ➔ Layer-4
                                   .....
                                   <TemporalDecompsition>
                                      <AudioVisualSegment id="time3"> ➔ Layer-5
                                         <MediaSourceDecomposition>
                                            <VideoSegment>
                                               <VisualDescriptor
                                                        xsi:type="MotionActivityType">
                                                  <Intensity>3</Intensity>
                                                  <DominantDirection>1
                                                        </DominantDirection>
                                                  ......
                                               </VisualDescriptor>
                                            </VideoSegment>
                                         </MediaSourceDecomposition>
                                         <TemporalDecompsision>
                                            <AudioVisualSegment> ➔ Layer-6
                                              ......
                                               <TemporalDecompsition>
                                                  <AudioVisualSegment> ➔ Layer-7
                                                     ......
                                                  </AudioVisualSetment>
                                               </TemporalDecomposition>
                                            </AudioVisualSegment>
                                         </TemporalDecomposition>
                                      </AudioVisualSegment>
                                   </TemporalDecomposition>
                                   .....
```

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```
                                </AudioVisualSegment>
                            </TemproalDecompsition>
                        </AudioVisualSegment>
                    </TemproalDecompsition>
                </AudioVisualSegment>
            </TemporalDecompsition>
        </AudioVisualSegment>
    </TemporalDecompsition>
  </AudioVisual>
 </MultimediaContent>
</Description>
</Mpeg7>
```

Now, a possible instantiation of MetadataAdaptation for the scaling functionality is as follows:

```
<DIA>
    <DescriptionMetadata>
        <ClassificationSchemeAlias alias=":LocT:"
            href="urn:mpeg:mpeg21:2003:01-DIA-LocationTypeCS-NS"/>
    </DescriptionMetadata>
    <Description xsi:type="MetadataAdaptationType"
        instanceSchema="urn:mpeg:mpeg7:schema:2001">
        <SizeOfMetadata>12000</SizeOfMetadata>
        <TotalNumOfElements>100</TotalNumOfElements>
        <Component name="VideoSegment">
            <MaxDepth>7</MaxDepth>
            <Component name="MediaTime" number="5">
                <Location type=":locT:3">time1 time2 time3</Location>
            </Component>
            <Component name="MotionActivity" number="4">
                <Completeness>true</Completeness>
                <Location type=":locT:1">5</Location>
            </Component>
            <Component name="ColorLayout" number="5">
                <Completeness>true</Completeness>
                <Location type=":locT:1">3</Location>
            </Component>
            <Component name="MatchingHint" number="0"/>
            <Component name="PointOfView" number="10">
                <Completeness>true</Completeness>
                <Location type=":locT:1">3</Location>
                <Component name="viewpoint">
                    <Value type="listOfString">TeamA TeamB</Value>
                </Component>
                <Component name="Importance">
                    <Value type="listOfFloat">0.0 0.25 0.5 0.75 1.0</Value>
                </Component>
            </Component>
        </Component>
    </Description>
</DIA>
```

The following observation can now be made. The first observation is that the maximum number of successively nested AudioVisualSegment elements is 7. Therefore, in the case that a device can only accept up to 6 layers, we know in advance that 1 layer needs to be scaled. This is not necessarily the final (deepest) layer. The decision to scale a layer may be based on its importance relative to other layers. The second observation is that the MediaTime element appears 5 times in the metadata description and there are three ID's associated with the segments containing this element (time1, time2, time3). Since processing of the metadata description is done sequentially from top-to-bottom, the value of 5 can indicate that no further processing is required after the final (5th) element has been processed. The ID's are used to locate the MediaTime element in the description. The third observation is that the MotionActivity element appears 4 times in the metadata description and these instances have all optional components of the tool instantiated. Furthermore, the description indicates that MotionActivity does not appear after the 5th layer of the parent Component in the description (in this case, AudioVisualSegment). With this information, processing can be saved since one does not have to parse past the 5th layer to reach an element of interest. The fourth observation is that the metadata description does not include a

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MatchingHint element. The fifth observation is that the PointOfView element appears 10 times in the metadata description and these instances have all optional components of the tool instantiated. Furthermore, the viewpoint attribute of this element takes the values “TeamA” or “TeamB”, and the “Importance” attribute of this element takes one of the values in the given list (0.0 0.25 0.5 0.75 1.0).

EXAMPLE 2 In the next example, the MetadataAdaptation tool is used to speed up the integration process of two description instances of a same video programme. The temporal decomposition of the video into scenes with its associated semantics is given by:

```
<Mpeg7>
    <Description xsi:type="ContentEntityType">
        <MultimediaContent xsi:type="VideoType">
            <MediaLocator>
                    <MediaUri>soccer_marathon.mpg</MediaUri>
                </MediaLocator>
                <TemporalDecomposition gap="false" overlap="false">
                    <VideoSegment xsi:type="VideoSegmentType" id="VDS1">
                        <MediaTime>
                            <MediaTimePoint>T00:00:00</MediaTimePoint>
                            <MediaDuration>PT2M20S</MediaDuration>
                        </MediaTime>
                        <TemporalDecomposition gap="false" overlap="false">
                            <VideoSegment id="Scene0">
                                <MediaTime>
                                    <MediaTimePoint>T00:00:00</MediaTimePoint>
                                    <MediaDuration>PT0M13S</MediaDuration>
                                </MediaTime>
                                <Semantic>
                                    <Label>
                                        <Name>soccergame</Name>
                                    </Label>
                                    <SemanticBase xsi:type="EventType">
                                        <Label>
                                            <Name>soccergame</Name>
                                        </Label>
                                    </SemanticBase>
                                </Semantic>
                            </VideoSegment>
                                ..
```

The temporal decomposition of the video into shots is given by:

```
<Mpeg7>
    <Description xsi:type="ContentEntityType">
        <MultimediaContent xsi:type="VideoType">
            <Video id="JornaldanoiteSegment">
                <MediaLocator>
                    <MediaUri>soccer_marathon.mpg</MediaUri>
                </MediaLocator>
                <TemporalDecomposition gap="false" overlap="false">
                    <VideoSegment xsi:type="VideoSegmentType" id="VDS2">
                        <MediaTime>
```

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```
                        <MediaTimePoint>T00:00:00</MediaTimePoint>
                        <MediaDuration>PT2M20S</MediaDuration>
                    </MediaTime>
                    <TemporalDecomposition>
                        <VideoSegment id="Shot 0">
                            <MediaTime>
                                <MediaTimePoint>T00:00:00</MediaTimePoint>
                                <MediaDuration>PT0M5S</MediaDuration>
                            </MediaTime>
                        </VideoSegment>
                        <VideoSegment id="Shot 1">
                            <MediaTime>
                                <MediaTimePoint>T00:00:05</MediaTimePoint>
                                <MediaDuration>PT0M5S</MediaDuration>
                            </MediaTime>
                        </VideoSegment>
                            ..
```

The instantiation of the MetadataAdaptation tool for integrating the above two descriptions is given by:

```
<DIA>
    <DescriptionMetadata>
        <ClassificationSchemeAlias alias=":LocT:"
            href="urn:mpeg:mpeg21:2003:01-DIA-LocationTypeCS-NS"/>
        <ClassificationSchemeAlias alias=":InvDim:"
            href="urn:mpeg:mpeg21:2003:01-DIA-InvariantDimensionCS-NS"/>
    </DescriptionMetadata>
   <Description xsi:type="MetadataAdaptationType"
           instanceSchema="urn:mpeg:mpeg7:schema:2001"
           instanceLocator="VDS1.xml">
     <Component name="VideoSegment">
         <AverageValue aValue="PT1M20S" unitOfMeasure="MediaDuration">
             <Location type=":LocT:2">0</Location>
          </AverageValue>
          <AverageValue aValue="PT0M47S" unitOfMeasure="MediaDuration">
             <Location type=":LocT:2">1</Location>
          </AverageValue>
      </Component>
      <Component name="Semantic">
          <InvariantProperties>
              <Location type=":LocT:3">Semantic0 Semantic2</Location>
              <InvariantDimension dimension=":InvDim:2" invariantFactor="0.3"/>
          </InvariantProperties>
      </Component>
   </Description>
   <Description xsi:type="MetadataAdaptationType"
                instanceSchema="urn:mpeg:mpeg7:schema:2001"
                instanceLocator="VDS2.xml">
      <Component name="VideoSegment">
          <AverageValue aValue="PT1M20S" unitOfMeasure="MediaDuration">
              <Location type=":LocT:2">0</Location>
          </AverageValue>
          <AverageValue aValue="PT0M5S" unitOfMeasure="MediaDuration">
              <Location type=":LocT:2">1</Location>
          </AverageValue>
      </Component>
    </Description>
</DIA>
```

The hints that are used provide an average segment duration and a measure of invariance for the semantics associated to the VideoSegments contained in the description instances. These can be used by a non normative adaptation engine to achieve the integrated description.

More specifically, the above DIA instance gives the following information: (1) VideoSegment VDS1 is a one level decomposition and the average length of segment is 47 sec, (2) in VDS1, the element “Semantic” (Semantic DS) identified

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by “Semantic0” and “Semantic2” can be propagated to all the sub-segments of the segment that contain them provided such child segments have a size larger than 0.3 (`invariantFactor`) times the size of the parent segments, (3) VideoSegment VDS2 is a one-level decomposition with an average length for segment of 5 sec, (4) Using the `AverageValue` hint, a metadata engine is able to automatically conclude that segments associated to the first level of VDS1 are unlikely to have the same granularity of segments at the same level of decomposition in VDS2, and hence they cannot overlap, so that both will be present in the integrated metadata as shown in the instance below.

The information carried by the `InvariantProperties` hint is used to propagate the DS “Semantic” to sub-segments without the need to extract it from the original content.

```
<Mpeg7>
    <Description xsi:type="ContentEntityType">
        <MultimediaContent xsi:type="VideoType">
            <Video id="JornaldanoiteSegment">
                <MediaLocator>
                    <MediaUri>soccer marathon.mpg</MediaUri>
                </MediaLocator>
                <TemporalDecomposition gap="false" overlap="false">
                    <VideoSegment xsi:type="VideoSegmentType">
                        <MediaTime>
                            <MediaTimePoint>T00:00:00</MediaTimePoint>
                            <MediaDuration>PT2M20S</MediaDuration>
                        </MediaTime>
                        <TemporalDecomposition gap="false" overlap="false">
                            <VideoSegment id="Scene 0">
                                <MediaTime>
                                    <MediaTimePoint>T00:00:00</MediaTimePoint>
                                    <MediaDuration>PT0M13S</MediaDuration>
                                </MediaTime>
                                <Semantic>
                                    <Label>
                                        <Name>soccergame</Name>
                                    </Label>
                                    <SemanticBase xsi:type="EventType">
                                        <Label>
                                            <Name>soccergame</Name>
                                        </Label>
                                    </SemanticBase>
                                </Semantic>
                                <TemporalDecomposition gap="false" overlap="false">
                                    <VideoSegment id="Shot 0">
                                        <MediaTime>
                                            <MediaTimePoint>T00:00:00</MediaTimePoint>
                                            <MediaDuration>PT0M5S</MediaDuration>
                                        </MediaTime>
                                        <Semantic>
                                            <Label>
                                                <Name>soccergame</Name>
                                            </Label>
                                            <SemanticBase xsi:type="EventType">
                                                <Label>
                                                    <Name>soccergame</Name>
                                                </Label>
                                            </SemanticBase>
                                        </Semantic>
                                    </VideoSegment>
                                    ...
                                </TemporalDecomposition>
                            </VideoSegment>
                        </TemporalDecomposition>
                    </VideoSegment>
                </TemporalDecomposition>
            </Video>
        </MultimediaContent>
    </Description>
</Mpeg7>
```

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EXAMPLE 3 In the following examples, preferable ways to use the MetadataAdaptation tool in an ISO/IEC 21000-2 description are given. In the first example, both the MetadataAdaptation tool and description instance are contained in the ISO/IEC 21000-2 description.

```
<did:DIDL>
    <did:Item>
        <did:Item>
            <did:Descriptor>
                <did:Statement mimeType="text/xml">
                    <DIA>
                        <DescriptionMetadata>
                            <ClassificationSchemeAlias alias=":LocT:"
                                href="urn:mpeg:mpeg21:2003:01-DIA-LocationTypeCS-NS"/>
                        </DescriptionMetadata>
                        <Description xsi:type="MetadataAdaptationType"
                                  instanceSchema="urn:mpeg:mpeg7:schema:2001">
                            <SizeOfMetadata>12000</SizeOfMetadata>
                            <TotalNumOfElements>100</TotalNumOfElements>
                            <Component name="VideoSegment">
                                <MaxDepth>7</MaxDepth>
                                <Component name="PointOfView" NumOfComponent="10">
                                    <Completeness>true</Completeness>
                                    <Location type=":LocT:1">3</Location>
                                    <Component name="viewpoint">
                                        <Value type="listOfString">TeamA TeamB</Value>
                            </Component>
                                    <Component name="Importance">
                                   <Value type="listOfFloat">0.0 0.25 0.5 0.75 1.0</Value>
                                    </Component>
                                </Component>
                                <!-- ..... -->
                            </Component>
                        </Description>
                    </DIA>
                </did:Statement>
            </did:Descriptor>
        </did:Item>
        <did:Item>
            <did:Descriptor>
                <did:Statement mimeType="text/xml">
                    <Mpeg7>
                        <Description xsi:type="ContentEntityType">
                            <MultimediaContent xsi:type="AudioVisualType">
                                <AudioVisual>
                                    <TemporalDecompsition>
                                        <AudioVisualSegment id="time1">
                                            <PointOfView viewpoint="TeamB">
                                                <Importance>
                                                    <Value>0.25</Value>
                                                </Importance>
                                            </PointOfView>
                                        </AudioVisualSegment>
                                    </TemporalDecompsition>
                                        <!-- .... -->
                                </AudioVisual>
                            </MultimediaContent>
                        </Description>
                    </Mpeg7>
                </did:Statement>
            </did:Descriptor>
        </did:Item>
    </did:Item>
</did:DIDL>
```


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EXAMPLE 4 In another example, the MetadataAdaptation tool is instantiated while the XML description instance is referenced in an external Digital Item.

```
<did:DIDL>
   <did:Item>
      <did:Item>
         <did:Descriptor>
            <did:Statement mimeType="text/xml">
               <DIA>
                    <DescriptionMetadata>
                       <ClassificationSchemeAlias alias=":LocT:"
                              href="urn:mpeg:mpeg21:2003:01-DIA-LocationTypeCS-NS"/>
                    </DescriptionMetadata>
                  <Description xsi:type="MetadataAdaptationType"
                         instanceSchema="urn:mpeg:mpeg7:schema:2001"
                         instanceLocator="mpeg7AVS.xml">
                    <SizeOfMetadata>12000</SizeOfMetadata>
                    <TotalNumOfElements>100</TotalNumOfElements>
                    <Component name="VideoSegment">
                       <Component name="PointOfView" NumOfComponent="10">
                          <Completeness>true</Completeness>
                          <Location type=":LocT:1">3</Location>
                          <Component name="viewpoint">
                             <Value type="listOfString">TeamA TeamB</Value>
                          </Component>
                          <Component name="Importance">
                             <Value type="listOfFloat">
                                    0.0 0.25 0.5 0.75 1.0
                                </Value>
                          </Component>
                       </Component>
                    </Component>
                    <!-- ... -->
                  </Description>
               </DIA>
            </did:Statement>
         </did:Descriptor>
      </did:Item>
      <did:Item>
         <did:Reference target="mpeg7AVS.xml#item id"/>
      </did:Item>
   </did:Item>
</did:DIDL>

<!-- and mpeg7AVS.xml looks like: -->

<did:DIDL>
  <did:Item id="item_id">
    <did:Descriptor>
       <did:Statement mimeType=”text/xml”>
          <!-- MPEG-7AVS data here -->
       </did:Statement>
    </did:Descriptor>
  </did:Item>
</did:DIDL>
```

12 Session mobility tools

12.1 Introduction

This clause specifies a tool to preserve a User's current state of interaction with a Digital Item. Examples of this include providing a mechanism to transfer a User's session between devices and providing a standby feature for a device. The procedure described below specifies a means by which the configuration-state of a

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first Digital Item (referred to as a “content DI”) can be captured to a second Digital Item (referred to as a “context DI”). It is noted that both the content DI and context DI are only used as informative terms and have no normative implications in this part of ISO/IEC 21000.

For session mobility, the context Digital Item captures the configuration-state of the content Digital Item, which is defined by the state of `Selection` elements defined in ISO/IEC 21000-2. The context DI may also capture application-state information, which pertains to information specific to the application currently rendering the Digital Item. Examples of application-state information include the position on the screen in which a video contained in the DI is being rendered, the track currently being rendered in a music album, the view of the Digital Item that the application is presenting to the User.

12.2 Format of a DI for session mobility

In order to preserve a User’s interaction with a content DI, a context DI must contain a minimum set of information to reconstruct the original session. This is achieved by creating a context DI according to the following format:

1) An (initially empty) Digital Item is created using standard DIDL (conformant to ISO/IEC 21000-2). When this is contained in its own DID, this shall be expressed as:

```
<DIDL xmlns="urn:mpeg:mpeg21:2002:01-DIDL-NS">
    <Item>
    </Item>
</DIDL>
```

2) A `Component-Resource` child combination, as a child of the `Item` created in 1), which contains a `DIADescriptionUnit` element of the `SessionMobilityTargetType`, which references the URI for the content DI, is created.

3) For each partially or fully resolved `Choice` element in the content DI there shall be an `Annotation` within the `Item` (from 1)) containing an `Assertion` that captures the current configuration-state of the `Selections` in the `Choice` of the content DI.

NOTE 1 The `Annotation` target attribute will identify an `Item` in the content DI that is an ancestor of the `Choice` to which the `Assertion` applies. In this case the `target` attribute value of the `Annotation` in the context DI will be an external reference to the `Item` in the content DI, where the URI identifies the content DI, and the fragment identifier uses the `id` attribute to identify the `Item`.

NOTE 2 The `target` attribute of the `Assertion` element will identify the `Choice` in the content DI to which the `Assertion` applies. In this case the `target` attribute value of the `Assertion` in the context DI will be an external reference to the `Choice` in the content DI where the URI identifies the content DI, and the fragment identifier uses the `choice_id` attribute to identify the `Choice`. Note that the `Choice` targeted by the `Assertion` must be a descendant of the `Item` targeted by the parent `Annotation`.

NOTE 3 Since the state of each partially or fully resolved `Choice` must be captured in the context DI, only those `Choice` elements for which all `Selections` are in an undecided state are to be omitted.

NOTE 4 The receiving application should intelligently apply the configuration state captured in the context DI taking into consideration such things as its own terminal capabilities.

NOTE 5 Only `Choices` that possess a `choice_id` and have an `Item` ancestor that possesses an `id` are valid for transmission as part of the context DI for session mobility. Hence, authors of Digital Items who wish `Choice` states to be transmittable in session mobility context DIs must ensure that the `Choice` has a `choice_id` and is the descendant of an `Item` with an `id`.

4) A `Descriptor` within the `Item` (from 1)) containing a description of application-specific information as necessary. Application-specific description shall be valid XML qualified using XML namespaces and shall be contained in a `DIADescriptionUnit` element of the `SessionMobilityAppInfoType` .

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12.3 SessionMobility syntax

```
<?xml version="1.0"?>
<!-- Digital Item Adaptation ISO/IEC 21000-7 Second Edition -->
<!-- Schema for Session Mobility Tools -->
<schema
   version="ISO/IEC 21000-7 2nd"
   id="SessionMobility-2nd.xsd"
   targetNamespace="urn:mpeg:mpeg21:2003:01-DIA-SM-NS"
   xmlns="http://www.w3.org/2001/XMLSchema"
   xmlns:sm="urn:mpeg:mpeg21:2003:01-DIA-SM-NS"
   xmlns:dia="urn:mpeg:mpeg21:2003:01-DIA-NS"
   elementFormDefault="qualified" attributeFormDefault="unqualified">

   <import namespace="urn:mpeg:mpeg21:2003:01-DIA-NS" schemaLocation="DIA-
2nd.xsd"/>

<!-- ######################################### -->
<!--  Definition of SessionMobility            -->
<!-- ######################################### -->

   <complexType name="SessionMobilityType">
      <complexContent>
         <extension base="dia:DIADescriptionType">
            <sequence>
               <element name="SessionMobilityTarget"
                  type="sm:SessionMobilityTargetType"/>
               <element name="SessionMobilityAppInfo"
                  type="sm:SessionMobilityAppInfoType"
                  minOccurs="0"/>
               <element name="SessionMobilityItemInfo"
                     type="sm:SessionMobilityItemInfoType"
                     minOccurs="0" maxOccurs="unbounded"/>
            </sequence>
         </extension>
      </complexContent>
   </complexType>

   <complexType name="SessionMobilityTargetType">
      <complexContent>
         <extension base="dia:DIABaseType">
            <attribute name="ref" type="anyURI" use="required"/>
         </extension>
      </complexContent>
   </complexType>

   <complexType name="SessionMobilityAppInfoType">
      <complexContent>
         <extension base="dia:DIABaseType">
            <sequence>
               <element name="ItemInfoList">
                  <complexType>
                     <sequence>
                        <element name="ItemInfo"
                           type="sm:SessionMobilityItemInfoType"
                           minOccurs="0" maxOccurs="unbounded"/>
                     </sequence>
                  </complexType>
               </element>
               <any namespace="##targetNamespace" processContents="strict"
                  minOccurs="0" maxOccurs="unbounded"/>
               <any namespace="##other" processContents="lax" minOccurs="0"
```

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```
                    maxOccurs="unbounded"/>
            </sequence>
        </extension>
    </complexContent>
</complexType>

<complexType name="SessionMobilityItemInfoType">
    <complexContent>
        <extension base="dia:DIABaseType">
            <sequence>
                <any namespace="##targetNamespace" processContents="strict"
                    minOccurs="0" maxOccurs="unbounded"/>
                <any namespace="##other" processContents="lax" minOccurs="0"
                    maxOccurs="unbounded"/>
            </sequence>
            <attribute name="target" type="anyURI" use="required"/>
        </extension>
    </complexContent>
</complexType>

</schema>
```

NOTE The application information may include any data relevant to the application, such as ISO/IEC 15938-5 descriptors, or data utilizing an application-specific schema.

12.4 SessionMobility semantics

Semantics of the `SessionMobilityType`:

Name	*Definition*
`SessionMobilityType`	Tool for capturing application specific state information when preserving the state of a content DI in a session mobility context DI.
`SessionMobilityTarget`	Identifies the target content DI whose state is preserved by the containing context DI.
`SessionMobilityAppInfo`	Describes application-specific state information relevant to the content DI as a whole.
`SessionMobilityItemInfo`	Describes application-specific state information relevant to a particular target Item in the content DI.

NOTE The application-specific state is not defined by the session mobility tool. Application-specific state can be categorized in two broad categories. Firstly, a specific software product (e.g., “ACME Accounting Package”) may use the `SessionMobilityType` tool to preserve any state information specific to that software product. In this case, the developer of the product will typically be responsible for the specification of such state information. Secondly, a generic application domain (e.g., audio-visual media, e-learning, etc) may use the `SessionMobilityType` tool to preserve generic state information applicable to that application domain. In this case, specification of any standard representation of such state information would typically be the responsibility of experts within that application domain.

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Semantics of the SessionMobilityTargetType:

Name	*Definition*
SessionMobilityTargetType	Tool for identifying the target content DI whose state is preserved by the containing context DI.
ref	URI that identifies the target content DI whose state is preserved by the containing context DI.

Semantics of the SessionMobilityAppInfoType:

Name	*Definition*
SessionMobilityAppInfoType	Tool for capturing application specific state information relevant to the content DI as a whole when preserving the state of a content DI in a session mobility context DI.
ItemInfoList	Describes a list of application-specific state information relevant to particular target Items in the content DI.
ItemInfo	Describes application-specific state information relevant to a particular target Item in the content DI.

Semantics of the SessionMobilityItemInfoType:

Name	*Definition*
SessionMobilityItemInfoType	Tool for capturing application-specific state information relevant to a particular target Item in the content DI when preserving the state of a content DI in a session mobility context DI.
target	A URI identifying the target Item element in the content DI to which the preserved application-specific state information applies.

12.5 Reconstructing a session

NOTE A context DI formed according to the normative format defined in subclause 12.2 contains information to reconstruct the User's session. The decoding steps required to do so are described as follows. First, load the content DI based on the reference to the content DI provided in the SessionMobilityTarget of the context DI. Then, for each Assertion in the context DI, identify the Choice in the content DI based on the target attribute of the Assertion, and configure the identified Choice in the content DI according to the Assertion. The Assertion identifies which Selection elements are asserted as being true and/or which Selection elements are being asserted as being false. Selection elements not identified in the Assertion are undecided by definition. The Assertion elements considered in this step are those created in step 3) of subclause 12.2. Such Assertion elements can be identified by the target attribute URI referring to the content DI and with a fragment identifier being the choice_id of the target Choice in the content DI.

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12.6 Session transfer example

EXAMPLE An example of a content Digital Item is shown below. This content DI contains a `Choice` element that requires the configuration state to be preserved.

```
<DIDL>
    <Item id="CONTEXT DEMO">
        <Choice choice_id="EXAMPLE_CHOICE" maxSelections="1">
            <Descriptor>
                <Statement mimeType="text/plain">Terminal Capabilties</Statement>
            </Descriptor>
            <Selection select_id="AUDIO">
                <Descriptor>
                    <Statement mimeType="text/plain">Audio</Statement>
                </Descriptor>
            </Selection>
            <Selection select id="VIDEO">
                <Descriptor>
                    <Statement mimeType="text/plain">Video</Statement>
                </Descriptor>
            </Selection>
        </Choice>
        <Component>
            <Condition require="AUDIO"/>
            <Descriptor>
                <Statement mimeType="text/plain">Audio Clip</Statement>
            </Descriptor>
            <Resource mimeType="audio/mpeg" ref="audio.mp3"/>
        </Component>
        <Component>
            <Condition require="VIDEO"/>
            <Descriptor>
                <Statement mimeType="text/plain">Video Clip</Statement>
            </Descriptor>
            <Resource mimeType="video/mpeg" ref="movie.mpg"/>
        </Component>
    </Item>
</DIDL>
```

Assume that the VIDEO selection has been made. The context DI must capture this selection state information. The corresponding context DI is shown below.

```
<DIDL xmlns="urn:mpeg:mpeg21:2002:01-DIDL-NS">
    <Item>
        <Descriptor>
            <Statement mimeType="text/xml">
                <dia:DIADescriptionUnit
                    xsi:type="sm:SessionMobilityAppInfoType">
                    <sm:ItemInfoList>
                        <sm:ItemInfo
                                target="urn:mpeg:mpeg21:content:smexample#CONTEXT DEMO">
                            <myApp:CurrentPlaybackStatus>
                                PLAYING
                            </myApp:CurrentPlaybackStatus>
                            <myApp:CurrentMediaTime>4.35s</myApp:CurrentMediaTime>
                        </sm:ItemInfo>
                    </sm:ItemInfoList>
                    <mpeg7:UsageHistory id="usage-history-001">
                        <!-- description of UsageHistory -->
                    </mpeg7:UsageHistory>
                </dia:DIADescriptionUnit>
            </Statement>
        </Descriptor>
```


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```
        <Component>
            <Resource mimeType="text/xml">
                <dia:DIADescriptionUnit
                    xsi:type="sm:SessionMobilityTargetType"
                    ref="urn:mpeg:mpeg21:content:smexample"/>
            </Resource>
        </Component>
        <Annotation target="urn:mpeg:mpeg21:content:smexample#CONTEXT DEMO">
            <Assertion
                target="urn:mpeg:mpeg21:content:smexample#EXAMPLE_CHOICE"
                true="VIDEO"/>
        </Annotation>
    </Item>
</DIDL>
```

13 DIA configuration tools

13.1 Introduction

The DIA configuration tools provide the following functionality: identifies the DIA descriptions that are suggested for a specific resource, identifies how `Choice`/`Selection` elements in a DID should be processed, e.g., displayed to Users or configured automatically according to DIA descriptions, and identifies the location of the adaptation, e.g., receiver side, sender side or either side.

13.2 DIAConfiguration syntax

```
<?xml version="1.0"?>
<!-- Digital Item Adaptation ISO/IEC 21000-7 Second Edition -->
<!-- Schema for DIA configuration Tools -->
<schema
    version="ISO/IEC 21000-7-2nd"
    id="DIAConfiguration-2nd.xsd"
    targetNamespace="urn:mpeg:mpeg21:2003:01-DIA-DIAC-NS"
    xmlns="http://www.w3.org/2001/XMLSchema"
    xmlns:diac="urn:mpeg:mpeg21:2003:01-DIA-DIAC-NS"
    xmlns:dia="urn:mpeg:mpeg21:2003:01-DIA-NS"
   xmlns:mpeg7="urn:mpeg:mpeg7:schema:2001"
    elementFormDefault="qualified" attributeFormDefault="unqualified">

    <import namespace="urn:mpeg:mpeg21:2003:01-DIA-NS" schemaLocation="DIA-
2nd.xsd"/>
   <import namespace="urn:mpeg:mpeg7:schema:2001" schemaLocation="mpeg7-udp-
2004.xsd"/>

    <!-- ######################################### -->
    <!--  Definition of SuggestedDIADescriptions   -->
    <!-- ######################################### -->

    <complexType name="SuggestedDIADescriptionsType">
        <complexContent>
            <extension base="dia:DIADescriptionType">
                <sequence>
                    <element name="ReceiverSide" minOccurs="0">
                        <complexType>
                            <sequence>
                                <element name="Target" type="diac:TargetType"
                                    minOccurs="0" maxOccurs="unbounded"/>
                            </sequence>
                        </complexType>
```

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```
                </element>
                <element name="SenderSide" minOccurs="0">
                   <complexType>
                      <sequence>
                         <element name="Target" type="diac:TargetType"
                            minOccurs="0" maxOccurs="unbounded"/>
                      </sequence>
                   </complexType>
                </element>
                <element name="EitherSide" minOccurs="0">
                   <complexType>
                      <sequence>
                         <element name="Target" type="diac:TargetType"
                            minOccurs="0" maxOccurs="unbounded"/>
                      </sequence>
                   </complexType>
                </element>
             </sequence>
          </extension>
       </complexContent>
    </complexType>

    <complexType name="TargetType">
       <complexContent>
          <extension base="dia:DIABaseType">
             <attribute name="targetDescription" type="string" use="required"/>
             <attribute name="semantics" type="mpeg7:termReferenceType"
use="optional"/>
          </extension>
       </complexContent>
    </complexType>

    <!-- ########################################## -->
    <!--  Definition of UserSelection               -->
    <!-- ########################################## -->

    <element name="UserSelection"/>

    <!-- ########################################## -->
    <!--  Definition of BackgroundConfiguration     -->
    <!-- ########################################## -->

    <element name="BackgroundConfiguration"/>

</schema>
```


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13.3 DIAConfiguration semantics

Semantics of the `SuggestedDIADescriptionsType`:

Name	*Definition*
`SuggestedDIADescriptionsType`	Tool for describing the DIA descriptions that are suggested for resource adaptation and DID configuration.
`ReceiverSide`	Indicates receiver descriptions that are suggested for consideration by the receiver of a resource when adapting that resource. The receiver need not utilize those descriptions in the adaptation.
`SenderSide`	Indicates receiver descriptions that are suggested for consideration by the sender of a resource when adapting that resource. The sender need not utilize those descriptions in the adaptation. NOTE The receiver can use this information to save bandwidth by optimizing which of its descriptions it transmits to the sender.
`EitherSide`	Indicates receiver descriptions that are suggested for consideration by either the receiver or the sender of a resource when adapting that resource. The receiver and/or sender need not utilize those descriptions in the adaptation.
`Target`	Describes the suggested DIA descriptions.

Semantics of the `TargetType`:

Name	*Definition*
`TargetType`	Tool for describing DIA descriptions.
`targetDescription`	Describes the DIA descriptions as an XPath expression that points to fragments of a DID or DIA document.
`semantics`	Describes the semantics of the variable referenced. CS's that may be used for this purpose are the `AdaptationQoSCS` or `MediaInformationCS` defined in Annex A.2.2 and A.2.10 respectively. The targetDescription and semantics attributes are exclusive.

EXAMPLE The following XPath expression specifies that the `Format` element of `VideoCapabilitiesType` is suggested and its corresponding value should be retrieved from a DID or DIA document: `//dia:Decoding[@xsi:type=dia:VideoCapabilitiesType]/dia:Format`

NOTE The `dia:` prefix in the above example could either be ignored or used as part of the following expression.

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Semantics of the `UserSelection`:

Name	*Definition*
`UserSelection`	Indicates that the described `Choice` is intended for human user selection. NOTE This description is typically accompanied by other descriptions in the `Choice` and/or the `Selection` that provide information necessary to present the `Choice` to the human for selection.

Semantics of the `BackgroundConfiguration`:

Name	*Definition*
`BackgroundConfiguration`	Indicates that the described `Choice` is intended to be configured in an automated fashion. NOTE This description is typically accompanied by other descriptions in the `Choice` and/or the `Selection` that provide the information necessary to carry out the automated configuration.

14 Change Conditions

14.1 Introduction

ISO/IEC 21000-5 and ISO/IEC 21000-6 provide the tools to permit playing, modifying, and adapting by controlling the kinds of things that can be changed. This part of ISO/IEC 21000 provides tools for use with ISO/IEC 21000-5 to provide the means by which that control over the changes that can occur when playing, modifying, or adapting digital items and their component resources can be effected.

14.2 Additional terms, definitions, symbols, abbreviated terms, namespaces, and conventions for this clause

The terms, definitions, symbols, and abbreviated terms given in clause 3 of ISO/IEC 21000-5 and namespaces and conventions given in clause 4 of ISO/IEC 21000-5 shall additionally apply to this clause.

14.3 Syntax

```
<?xml version="1.0" encoding="UTF-8"?>
<!-- Digital Item Adaptation ISO/IEC 21000-7 Second Edition -->
<!-- Schema for Change Conditions -->
<schema
   version="ISO/IEC 21000-7 2nd"
   id="ChangeCond-2nd.xsd"
   targetNamespace="urn:mpeg:mpeg21:2003:01-DIA-NS"
   xmlns="http://www.w3.org/2001/XMLSchema"
   xmlns:dia="urn:mpeg:mpeg21:2003:01-DIA-NS"
   xmlns:r="urn:mpeg:mpeg21:2003:01-REL-R-NS"
   elementFormDefault="qualified" attributeFormDefault="unqualified">

   <import namespace="urn:mpeg:mpeg21:2003:01-REL-R-NS"
      schemaLocation="rel-r.xsd"/>
   <include schemaLocation="UCD-2nd.xsd"/>
   <include schemaLocation="UED-2nd.xsd"/>
   <include schemaLocation="ConvD-2nd.xsd"/>
```


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```
   <!-- ################################################ -->
   <!--  Definition of PermittedDiaChanges               -->
   <!-- ################################################ -->

   <complexType name="PermittedDiaChanges">
      <complexContent>
         <extension base="r:Condition">
            <sequence>
               <element name="ConversionDescription"
                  type="dia:ConversionDescriptionBaseType"
                  minOccurs="0" maxOccurs="unbounded"/>
            </sequence>
         </extension>
      </complexContent>
   </complexType>

   <!-- ################################################ -->
   <!--  Definition of ChangeConstraint                  -->
   <!-- ################################################ -->

   <complexType name="ChangeConstraint">
      <complexContent>
         <extension base="r:Condition">
            <sequence minOccurs="0">
               <element name="steeringInput" type="r:Resource"
                  minOccurs="0"/>
               <element name="constraint" type="dia:UCDType"/>
            </sequence>
         </extension>
      </complexContent>
   </complexType>

   <!-- ################################################ -->
   <!--  Definition of permittedDiaChanges               -->
   <!-- ################################################ -->

   <element name="permittedDiaChanges" type="dia:PermittedDiaChanges"
      substitutionGroup="r:condition"/>

   <!-- ################################################ -->
   <!--  Definition of changeConstraint                  -->
   <!-- ################################################ -->

   <element name="changeConstraint" type="dia:ChangeConstraint"
      substitutionGroup="r:condition"/>

   <!-- ########################################### -->
   <!-- ConversionUriType                           -->
   <!-- ########################################### -->

   <complexType name="ConversionUriType">
    <complexContent>
     <extension base="dia:ConversionDescriptionBaseType"/>
    </complexContent>
   </complexType>

</schema>
```

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14.4 Authorization Context Properties

Property name	Property value	Statement represented
dia:diaChanges()	*d*	*d* is a `dia:PermittedDiaChanges`, each child of *d* identifies one conversion being used for the formal or format changes (according to the semantics of the Right Member of the authorization request) during the requested performance, and each conversion being used for the formal or format changes (according to the semantics of the Right Member of the authorization request) during the requested performance is identified by some child of *d*. NOTE Some conversion descriptions are given in subclause 5.5.
dia:ucd(*d*)	true	*d* is a `dia:UCDType` and there is at least one possible output of a UCD-based ADTE taking as inputs a null steering description, UCD *d*, and accurate resolvers such that the output result code is success and the values of variables in the output solution (when interpreted according to the semantics ascribed to the variables) accurately describes the changes (according to the semantics of the Right Member of the authorization request) occurring during the requested performance.
dia:ucdt(*t*, *d*)	true	*t* is an `r:Resource` identifying a steering description, *d* is a `dia:UCDType`, and there is at least one possible output of a UCD-based adaptation decision-taking engine taking as inputs steering description *t*, UCD *d*, and accurate resolvers such that the output result code is success and the values of variables in the output solution (when interpreted according to the semantics ascribed to the variables) accurately describes the changes (according to the semantics of the Right Member of the authorization request) occurring during the requested performance.

NOTE Note that authorization context property names do not have any inherent relationship to elements and types defined in the schema. The relation of elements and types defined in the schema to authorization context properties is given in the semantics of those elements and types. For reading convenience names for authorization context properties are chosen to be similar to the elements and types whose semantics reference them.

14.5 Semantics

Semantics of the `PermittedDiaChanges`:

Let *c* be a `dia:PermittedDiaChanges`. Let (*p*, *r*, *t*, *v*, Σ, *L*, *R*) be an authorization request. Let (*g*, *h*, *e*) be an authorization story. Then *c* is Satisfied with respect to (*p*, *r*, *t*, *v*, Σ, *L*, *R*) and (*g*, *h*, *e*) if and only if each child element of Σ.dia:diaChanges() is Equal to at least one of the children of *c*.

Semantics of the `ChangeConstraint`:

Let *c* be an `dia:ChangeConstraint`. Let (*p*, *r*, *t*, *v*, Σ, *L*, *R*) be an authorization request. Let (*g*, *h*, *e*) be an authorization story. Then *c* is Satisfied with respect to (*p*, *r*, *t*, *v*, Σ, *L*, *R*) and (*g*, *h*, *e*) if and only if either *c*/`dia:steeringInput` is absent and Σ.dia:ucd(*c*/`dia:constraint`) is true or *c*/`dia:steeringInput` is present and Σ.dia:ucdt(*c*/`dia:steeringInput`, *c*/`dia:constraint`) is true.

Semantics of the `ConversionUriType`:

Name	Definition
ConversionUriType	Tool for describing a conversion using a URI which references a specialized ISO/IEC 21000-6 term and its parameters.

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14.6 Example

EXAMPLE The following example shows a License to express that Anthony says that a video file can be played by Barney provided that:

- the only formal change Barney makes (if any) is spatial resolution reduction,
- the played aspect ratio is the same as the original file aspect ratio, and
- the played spatial resolution is less than 352x240.

```
<r:license>

   <r:inventory>
      <!-- ... -->
   </r:inventory>

   <r:grant>

      <!-- Barney may play the video ... -->
      <r:keyHolder licensePartIdRef="Barney"/>
      <mx:play/>
      <mx:diReference licensePartIdRef="video"/>

      <!-- ... under these conditions ... -->
      <r:allConditions>

         <!-- He is only permitted to do spatial size reduction.
              He may use Acme's algorithm (not registered in RDD) or
              he may use any algorithm registered in RDD as a SizeChange.
              -->
         <dia:permittedDiaChanges>
            <dia:ConversionDescription xsi:type="dia:ConversionUriType">
               <dia:ConversionActUri uri="urn:acme:spatialSizeReduction"/>
            </dia:ConversionDescription>
            <dia:ConversionDescription xsi:type="dia:ConversionUriType">
               <dia:ConversionActUri uri="urn:mpeg:mpeg21:2003:01-RDD-NS:SizeChange"/>
            </dia:ConversionDescription>
         </dia:permittedDiaChanges>

         <!-- These constraints apply whether or not spatial size is reduced. -->
         <dia:changeConstraint>
            <dia:constraint>
               <dia:AdaptationUnitConstraints>

                  <!-- Width must be less than 352. -->
                  <dia:LimitConstraint>
                     <dia:Argument xsi:type="dia:SemanticalRefType" semantics=
                        "urn:mpeg:mpeg21:2003:01-DIA-MediaInformationCS-NS:17"
                     />
                     <dia:Argument xsi:type="dia:ConstantDataType">
                        <dia:Constant xsi:type="dia:IntegerType">
                           <dia:Value>352</dia:Value>
                        </dia:Constant>
                     </dia:Argument>
                     <dia:Operation operator=
                        "urn:mpeg:mpeg21:2003:01-DIA-StackFunctionOperatorCS-NS:12"/>
                  </dia:LimitConstraint>

                  <!-- Height must be less than 240. -->
                  <dia:LimitConstraint>
                     <dia:Argument xsi:type="dia:SemanticalRefType" semantics=
                        "urn:mpeg:mpeg21:2003:01-DIA-MediaInformationCS-NS:18"
                     />
                     <dia:Argument xsi:type="dia:ConstantDataType">
                        <dia:Constant xsi:type="dia:IntegerType">
```

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```
                        <dia:Value>240</dia:Value>
                     </dia:Constant>
                  </dia:Argument>
                  <dia:Operation operator=
                     "urn:mpeg:mpeg21:2003:01-DIA-StackFunctionOperatorCS-NS:12"/>
               </dia:LimitConstraint>

               <!-- Final aspect ratio must equal input aspect ratio. -->
               <dia:LimitConstraint>
                  <dia:Argument xsi:type="dia:SemanticalRefType" semantics=
                     "urn:mpeg:mpeg21:2003:01-DIA-MediaInformationCS-NS:19"/>
                  <dia:Argument xsi:type="dia:SemanticalDataRefType"
                       semantics=
                     "urn:mpeg:mpeg21:2003:01-DIA-MediaInformationCS-NS:19"/>
                  <dia:Operation operator=
                     "urn:mpeg:mpeg21:2003:01-DIA-StackFunctionOperatorCS-NS:11"/>
               </dia:LimitConstraint>

            </dia:AdaptationUnitConstraints>
         </dia:constraint>
      </dia:changeConstraint>

   </r:allConditions>

</r:grant>

<r:issuer>
   <r:keyHolder licensePartIdRef="Anthony"/>
</r:issuer>

</r:license>
```

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Annex A

(normative)

Classification Schemes

A.1 Introduction

This clause specifies a set of classification schemes that may be used by applications using description tools specified in this part of ISO/IEC 21000. Applications need not use these classification schemes, they can use proprietary or third party ones. However, if they choose to use the classification schemes defined in this clause, no modifications or extensions are allowed to these classification schemes. The classification schemes in this clause are specified using the `ClassificationScheme` defined in ISO/IEC 15938-5. All of the classification schemes defined in this clause are uniquely identified by a URN following the "`urn:mpeg:mpeg21:2003:01-DIA-NameCS-NS`" namespace identifier where `Name` should be replaced with the name of the classification scheme. For example, the URN "`urn:mpeg:mpeg21:2003:01-DIA-PlaceTypeCS-NS`" identifies the classification scheme provided for `PlaceType` values (in its 2003 version).

In some cases there are several classification schemes associated with a single description. In such a case, any one of these classification schemes (as well as classification schemes not defined in this specification) may be used depending on the application domain.

A.2 Classification Schemes

A.2.1 ThreeDBenchmarkCS

```
<ClassificationScheme uri="urn:mpeg:mpeg21:2003:01-DIA-ThreeDBenchmarkCS-NS">
   <Term termID="1">
      <Name xml:lang="en">SPEC VIEWPERF</Name>
      <Definition xml:lang="en">
          ViewPerf (Viewer Performance) benchmark suites specifed by SPEC
          (http://www.spec.org/gpc/opc.static/viewperf71info.html)
      </Definition>
      <Term termID="1.1">
         <Name xml:lang="en">3DSMAX02</Name>
         <Definition xml:lang="en">
             3DSMax 02 Viewset benchmark specified by SPEC.
         </Definition>
      </Term>
      <Term termID="1.2">
         <Name xml:lang="en">LIGHT06</Name>
         <Definition xml:lang="en">
             Lightscape 06 Viewset benchmark specified by SPEC.
         </Definition>
      </Term>
      <Term termID="1.3">
         <Name xml:lang="en">DRV09</Name>
         <Definition xml:lang="en">
             Design Review 09 Viewset benchmark specified by SPEC.
         </Definition>
      </Term>
      <Term termID="1.4">
```

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```
         <Name xml:lang="en">PROE02</Name>
         <Definition xml_lang="en">
              ProEngineer 02 Viewset benchmark specified by SPEC.
         </Definition>
      </Term>
      <Term termID="1.5">
         <Name xml:lang="en">DX02</Name>
         <Definition xml:lang="en">
              Data Explorer 08 Viewset benchmark specified by SPEC.
         </Definition>
      </Term>
      <Term termID="1.6">
         <Name xml:lang="en">UGS03</Name>
         <Definition xml:lang="en">
              Unigraphics 03 Viewset benchmark specified by SPEC.
         </Definition>
      </Term>
   </Term>
</ClassificationScheme>
```

A.2.2 AdaptationQoSCS

```
<?xml version="1.0" encoding="UTF-8"?>
<ClassificationScheme uri="urn:mpeg:mpeg21:2003:01-DIA-AdaptationQoSCS-NS">
   <!-- ############################################################ -->
   <!--                 Terminal and Network QoS terms               -->
   <!-- ############################################################ -->
   <Term termID="1">
      <Name xml:lang="en">Terminal and Network QoS</Name>
      <Definition xml:lang="en">Lists the terms and definitions specifically used
within the Terminal and Network QoS tool as specified in this part of
ISO/IEC 21000.</Definition>
      <Term termID="1.1">
         <Name xml:lang="en">Computation time</Name>
         <Term termID="1.1.1">
            <Name xml:lang="en">Computation time in ms</Name>
            <Definition xml:lang="en">Computation time for decoding and rendering
the resource on a terminal.</Definition>
         </Term>
      </Term>
      <Term termID="1.2">
         <Name xml:lang="en">Utility</Name>
         <Definition xml:lang="en">List of possible utility measurements. The
utility can be measured in an objective or subjective manner.</Definition>
         <Term termID="1.2.1">
            <Name xml:lang="en">PSNR in dB</Name>
            <Definition xml:lang="en">PSNR (Peak Signal to Noise Ratio) is an
objective quality measure that is used to estimate the quality of a reconstructed
image compared with an original image. The PSNR is computed by using the
logarithm of the square of the peak value devided by MSE (mean square
error).</Definition>
         </Term>
         <Term termID="1.2.2">
            <Name xml:lang="en">MOS</Name>
            <Definition xml:lang="en">MOS (Mean Opinion Score) is a subjective
quality measure that may refer to the ITU-R Recommendation BT. 500-10 specifying
the methodlogy.</Definition>
         </Term>
```


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```
         <Term termID="1.2.3">
            <Name xml:lang="en">ODG</Name>
            <Definition xml:lang="en">Objective Difference Grade (ODG) is the
output value of the objective quality measure described in ITU-R Recommendation
BS.1387.The ODG value ranges from -4 to 0, and corresponds to the five-grade
impairment scale (1-5) according to ITU-R BS. 562.</Definition>
         </Term>
         <Term termID="1.2.4">
            <Name xml:lang="en">DI</Name>
            <Definition xml:lang="en">The Distortion Index (DI) has the same
meaning as the ODG. The DI is not limited in range. The DI is better suited to
measure the quality for low and intermediate quality.</Definition>
         </Term>
      </Term>
      <Term termID="1.3">
         <Name xml:lang="en">Adaptation Operation</Name>
         <Definition xml:lang="en">List of possible adaptation
operations.</Definition>
         <Term termID="1.3.1">
            <Name xml:lang="en">Frame dropping and/or DCT coefficient
dropping</Name>
            <Definition xml:lang="en">Describes adaptation operators that adapts
the incoming resource by dropping some parts of the incoming bitstream that
correspond to specific frames and/or DCT coefficients.</Definition>
         <Term termID="1.3.1.1">
            <Name xml:lang="en">B Frame Dropping</Name>
            <Definition xml:lang="en">Describes the number of B-frames to be
dropped between two successive anchor frames in each sub-GOP.</Definition>
         </Term>
         <Term termID="1.3.1.2">
            <Name xml:lang="en">P Frame Dropping</Name>
            <Definition xml:lang="en">Describes the number of P-frames to be
dropped in a GOP.</Definition>
         </Term>
         <Term termID="1.3.1.3">
           <Name xml:lang="en">Coefficient Dropping</Name>
           <Definition xml:lang="en">Describes the ratio of bit rate reduction to
be achieved by DCT coefficient dropping.</Definition>
            </Term>
         </Term>
         <Term termID="1.3.2">
            <Name xml:lang="en">MPEG-4 FGS Adaptation</Name>
            <Definition xml:lang="en">Describes adaptation operators that is
defined in the MPEG-4 FGS  that adapts the incoming ISO/IEC 14496-2 FGS bitstream
by selecting the specified number of bitplanes of FGS-frames and/or FGST-frames
as an enhancement layer.</Definition>
            <Term termID="1.3.2.1">
               <Name xml:lang="en">Bitplanes of FGS</Name>
               <Definition xml:lang="en">Describes the number of bitplanes of the
FGS-frames to be truncated from the enhancement. It is assumed that the least
significant bitplanes are truncated first.</Definition>
            </Term>
            <Term termID="1.3.2.2">
               <Name xml:lang="en">Bitplanes of first FGST</Name>
               <Definition xml:lang="en">Describes the number of bitplanes of the
first FGST-frames between anchor frames to be truncated from the
enhancement.</Definition>
            </Term>
            <Term termID="1.3.2.3">
               <Name xml:lang="en">Bitplanes of second FGST</Name>
```

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```
               <Definition xml:lang="en">Describes the number of bitplanes of the
second FGST-frames between anchor frames to be truncated from the
enhancement.</Definition>
            </Term>
         </Term>
         <Term termID="1.3.3">
            <Name xml:lang="en">Requantization</Name>
            <Definition xml:lang="en">Describes adaptation operators that adapts
the incoming bitstream by requantizing with a different quantization
scale.</Definition>
            <Term termID="1.3.3.1">
               <Name xml:lang="en">Requantization scale</Name>
               <Definition xml:lang="en">
                 Describes the value of the new quantization scale.
             </Definition>
            </Term>
         </Term>
         <Term termID="1.3.4">
            <Name xml:lang="en">Spatial size reduction</Name>
            <Definition xml:lang="en">Describes adaptation operators that adapts
the incoming bitstream by reducing the spatial size (spatial
resolution).</Definition>
            <Term termID="1.3.4.1">
               <Name xml:lang="en">Horizontal Ratio Reduction</Name>
               <Definition xml:lang="en">Describes the value of the horizontal
reduction ratio.</Definition>
            </Term>
            <Term termID="1.3.4.2">
               <Name xml:lang="en">Vertical Ratio Reduction</Name>
               <Definition xml:lang="en">Describes the value of the vertical
reduction ratio.</Definition>
            </Term>
         </Term>
         <Term termID="1.3.5">
            <Name xml:lang="en">Wavelet specific adaptation operations</Name>
            <Definition xml:lang="en">Describes adaptation operators for adapting
a wavelet-coded stream.</Definition>
            <Term termID="1.3.5.1">
               <Name xml:lang="en">Wavelet spatial levels</Name>
               <Definition xml:lang="en">Specifies the number of levels to be
kept.</Definition>
            </Term>
            <Term termID="1.3.5.2">
               <Name xml:lang="en">Wavelet bitplanes</Name>
               <Definition xml:lang="en">Specifies the number of bitplanes to be
kept.</Definition>
            </Term>
         </Term>
         <Term termID="1.3.6">
            <Name xml:lang="en">Scalable Audio</Name>
            <Definition xml:lang="en">Describes an adaptation operator that
adapts the incoming bitstream including ISO/IEC 14496-3 FGS by selecting the
specified number of layers.</Definition>
            <Term termID="1.3.6.1">
               <Name xml:lang="en">Layers Of Scalable Audio</Name>
               <Definition xml:lang="en">Indicates the number of enhancement
layers to be truncated from the full bitstream. It is assumed that the highest
enhancement layer is truncated first.</Definition>
            </Term>
         </Term>
```


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```
         <Term termID="1.3.7">
            <Name xml:lang="en">Channel Dropping</Name>
            <Definition xml:lang="en">Describes an adaptation operator that
adapts the incoming resource by dropping audio output channels.</Definition>
            <Term termID="1.3.7.1">
               <Name xml:lang="en">Number of Channels</Name>
               <Definition xml:lang="en">Indicates the number audio channels to
be dropped.</Definition>
            </Term>
            <Term termID="1.3.7.2">
               <Name xml:lang="en">Channel Configuration</Name>
               <Definition xml:lang="en">Specifies the configuration of audio
output channels given the number of channels to be dropped. </Definition>
            </Term>
         </Term>
         <Term termID="1.3.8">
            <Name xml:lang="en">Spectral Band Reduction</Name>
            <Definition xml:lang="en">Describes an adaptation operator that
adapts the incoming resource by reducing full audio spectral bandwidth down to
the specified frequency cutoff.</Definition>
            <Term termID="1.3.8.1">
               <Name xml:lang="en">Spectral Band Limit</Name>
               <Definition xml:lang="en">Indicates the upper limit of spectral
bandwidth of an audio source in Hz.</Definition>
            </Term>
         </Term>
         <Term termID="1.3.9">
           <Name xml:lang="en">SVC Adaptation</Name>
           <Definition xml:lang="en">Describes adaptation operators that adapt
the incoming SVC bitstream by selecting the specified values of spatial layers,
temporal levels and quality reduction.</Definition>
           <Term termID="1.3.9.1">
             <Name xml:lang="en">Spatial Layers</Name>
             <Definition xml:lang="en">Indicates the number of enhancement layers
for spatial resolution to be truncated from the input bitstream. It is assumed
that the highest enhancement layer is truncated first.</Definition>
           </Term>
           <Term termID="1.3.9.2">
             <Name xml:lang="en">Temporal Levels</Name>
             <Definition xml:lang="en">Indicates the number of enhancement layers
for temporal resolution to be truncated from the input bitstream. It is assumed
that the highest enhancement layer is truncated first.</Definition>
           </Term>
           <Term termID="1.3.9.4">
             <Name xml:lang="en">Quality levels </Name>
             <Definition xml:lang="en">Indicates the number of quality layers
indictaed by the quality_layer parameter to be truncated from the input
bitstream. It is assumed the highest value is truncated first</Definition>
           </Term>
           <Term termID="1.3.9.5">
    <Name xml:lang="en">Priority id</Name>
    <Definition xml:lang="en">Indicates the maximum allowed value for
priority_id. NAL units with a priority_id greater than this value shall be
dropped.</Definition>
           </Term>
         </Term>
      </Term>
      <Term termID="1.4">
         <Name xml:lang="en">Others</Name>
```

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```
         <Definition xml:lang="en">List of not classified Terminal and Network
QoS terms.</Definition>
         <Term termID="1.4.1">
            <Name xml:lang="en">Viewing info</Name>
            <Definition xml:lang="en">Specifies 3D viewing information for view-
dependent adaptation.</Definition>
            <Term termID="1.4.1.1">
               <Name xml:lang="en">Angle in degrees</Name>
            </Term>
            <Term termID="1.4.1.2">
               <Name xml:lang="en">Distance</Name>
            </Term>
         </Term>
         <Term termID="1.4.2">
            <Name xml:lang="en">ROI</Name>
            <Definition xml:lang="en">Specifies the considered ROI for MPEG-4 VTC
view-dependent texture adaptation.</Definition>
         </Term>
      </Term>
   </Term>
   <!-- ############################################################ -->
   <!--               Usage Environment Description terms            -->
   <!-- termID correspond to clause and subclause numbers respectively -->
   <!-- ############################################################ -->
   <Term termID="6">
      <Name xml:lang="en">Usage Environment Description Tools</Name>
      <Definition xml:lang="en">Lists the terms and definitions of the Usage
Environmen Description (UED) tools as defined in this part of
ISO/IEC 21000.</Definition>
      <Term termID="6.4">
         <Name xml:lang="en">User Characteristics</Name>
         <Definition xml:lang="en">Lists the terms and definitions of the User
Characteristics as defined in this part of ISO/IEC 21000.</Definition>
         <Term termID="6.4.4">
           <Name xml:lang="en">UserInfo</Name>
           <Definition xml:lang="en">Describes the UserInfo as defined in this
part of ISO/IEC 21000.</Definition>
         </Term>
         <Term termID="6.4.5">
           <Name xml:lang="en">UsagePreferences</Name>
           <Definition xml:lang="en">Describes the UsagePreferences as defined in
this part of ISO/IEC 21000.</Definition>
         </Term>
         <Term termID="6.4.6">
            <Name xml:lang="en">UsageHistory</Name>
            <Definition xml:lang="en">Describes the UsageHistory as defined in
this part of ISO/IEC 21000.</Definition>
         </Term>
         <Term termID="6.4.7">
            <Name xml:lang="en">AudioPresentationPreferences</Name>
            <Definition xml:lang="en">Lists the terms and definitions of the
AudioPresentationPreferences as defined in this part of
ISO/IEC 21000.</Definition>
            <Term termID="6.4.7.1">
               <Name xml:lang="en">VolumeControl</Name>
               <Definition xml:lang="en">Describes the VolumeControls as defined
in this part of ISO/IEC 21000.</Definition>
            </Term>
            <Term termID="6.4.7.2">
               <Name xml:lang="en">FrequencyEqualizer</Name>
```


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```
               <Definition xml:lang="en">Describes one value of the
FrequencyEqualizer as defined in this part of ISO/IEC 21000.</Definition>
            </Term>
            <Term termID="6.4.7.3">
               <Name xml:lang="en">StartFrequency</Name>
               <Definition xml:lang="en">Describes the StartFrequency as defined
in this part of ISO/IEC 21000.</Definition>
            </Term>
            <Term termID="6.4.7.4">
               <Name xml:lang="en">EndFrequency</Name>
               <Definition xml:lang="en">Describes the EndFrequency as defined in
this part of ISO/IEC 21000.</Definition>
            </Term>
            <Term termID="6.4.7.5">
               <Name xml:lang="en">AudioOutputDevice</Name>
               <Definition xml:lang="en">Describes the AudioOutputDevice as
defined in this part of ISO/IEC 21000.</Definition>
            </Term>
            <Term termID="6.4.7.6">
               <Name xml:lang="en">BalanceReference</Name>
               <Definition xml:lang="en">Describes the BalanceReference as
defined in this part of ISO/IEC 21000.</Definition>
            </Term>
            <Term termID="6.4.7.7">
               <Name xml:lang="en">SamplingFrequency</Name>
               <Definition xml:lang="en">Describes the SamplingFrequency as
defined in this part of ISO/IEC 21000.</Definition>
            </Term>
            <Term termID="6.4.7.8">
               <Name xml:lang="en">BitsPerSample</Name>
               <Definition xml:lang="en">Describes the BitsPerSample as defined
in this part of ISO/IEC 21000.</Definition>
            </Term>
            <Term termID="6.4.7.9">
               <Name xml:lang="en">NumOfChannels</Name>
               <Definition xml:lang="en">Describes the NumOfChannels as defined
in this part of ISO/IEC 21000.</Definition>
            </Term>
            <Term termID="6.4.7.10">
               <Name xml:lang="en">ImpulseResponseURI</Name>
               <Definition xml:lang="en">Describes the URI of the room impulse
response as defined in this part of ISO/IEC 21000.</Definition>
            </Term>
            <Term termID="6.4.7.11">
               <Name xml:lang="en">SourcePresence</Name>
               <Definition xml:lang="en">Describes the SourcePresense as defined
in this part of ISO/IEC 21000.</Definition>
            </Term>
            <Term termID="6.4.7.12">
               <Name xml:lang="en">SourceWarmth</Name>
               <Definition xml:lang="en">Describes the SourceWarmth as defined in
this part of ISO/IEC 21000.</Definition>
            </Term>
            <Term termID="6.4.7.13">
               <Name xml:lang="en">SourceBrilliance</Name>
               <Definition xml:lang="en">Describes the SourceBrilliance as
defined in this part of ISO/IEC 21000.</Definition>
            </Term>
            <Term termID="6.4.7.14">
               <Name xml:lang="en">RoomPresence</Name>
```

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```
               <Definition xml:lang="en">Describes the RoomPresence as defined in
this part of ISO/IEC 21000.</Definition>
            </Term>
            <Term termID="6.4.7.15">
               <Name xml:lang="en">RunningReverberance</Name>
               <Definition xml:lang="en">Describes the RunningReverberance as
defined in this part of ISO/IEC 21000.</Definition>
            </Term>
            <Term termID="6.4.7.16">
               <Name xml:lang="en">Envelopment</Name>
               <Definition xml:lang="en">Describes the Envelopment as defined in
this part of ISO/IEC 21000.</Definition>
            </Term>
            <Term termID="6.4.7.17">
               <Name xml:lang="en">LateReverbarence</Name>
               <Definition xml:lang="en">Describes the LateReverbarence as
defined in this part of ISO/IEC 21000.</Definition>
            </Term>
            <Term termID="6.4.7.18">
               <Name xml:lang="en">Heavyness</Name>
               <Definition xml:lang="en">Describes the Heavyness as defined in
this part of ISO/IEC 21000.</Definition>
            </Term>
            <Term termID="6.4.7.19">
               <Name xml:lang="en">Liveness</Name>
               <Definition xml:lang="en">Describes the Liveness as defined in
this part of ISO/IEC 21000.</Definition>
            </Term>
            <Term termID="6.4.7.20">
               <Name xml:lang="en">RefDistance</Name>
               <Definition xml:lang="en">Describes the RefDistance as defined in
this part of ISO/IEC 21000.</Definition>
            </Term>
            <Term termID="6.4.7.21">
               <Name xml:lang="en">FreqLow</Name>
               <Definition xml:lang="en">Describes the FreqLow as defined in this
part of ISO/IEC 21000.</Definition>
            </Term>
            <Term termID="6.4.7.22">
               <Name xml:lang="en">FreqHigh</Name>
               <Definition xml:lang="en">Describes the FreqHigh as defined in
this part of ISO/IEC 21000.</Definition>
            </Term>
            <Term termID="6.4.7.23">
               <Name xml:lang="en">TimeLimit1</Name>
               <Definition xml:lang="en">Describes the TimeLimit1 as defined in
this part of ISO/IEC 21000.</Definition>
            </Term>
            <Term termID="6.4.7.24">
               <Name xml:lang="en">TimeLimit2</Name>
               <Definition xml:lang="en">Describes the TimeLimit2 as defined in
this part of ISO/IEC 21000.</Definition>
            </Term>
            <Term termID="6.4.7.25">
               <Name xml:lang="en">TimeLimit3</Name>
               <Definition xml:lang="en">Describes the TimeLimit3 as defined in
this part of ISO/IEC 21000.</Definition>
            </Term>
            <Term termID="6.4.7.26">
               <Name xml:lang="en">SoniferousSpeed</Name>
```


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```
               <Definition xml:lang="en">Describes the SoniferousSpeed as defined
in this part of ISO/IEC 21000.</Definition>
            </Term>
         </Term>
         <Term termID="6.4.8">
            <Name xml:lang="en">DisplayPresentationPreferences</Name>
            <Definition xml:lang="en">Lists the terms and definitions of the
DisplayPresentationPreferences as defined in this part of
ISO/IEC 21000.</Definition>
            <Term termID="6.4.8.1">
               <Name xml:lang="en">ColorTemperaturePreference BinNumber</Name>
               <Definition xml:lang="en">Describes the BinNumber of the
ColorTemperaturePreference as defined in this part of ISO/IEC 21000.</Definition>
            </Term>
            <Term termID="6.4.8.2">
               <Name xml:lang="en">ColorTemperaturePreference
PreferredValue</Name>
               <Definition xml:lang="en">Describes the PreferredValue of the
ColorTemperaturePreference as defined in this part of ISO/IEC 21000.</Definition>
            </Term>
            <Term termID="6.4.8.3">
               <Name xml:lang="en">ColorTemperaturePreference
ReferenceValue</Name>
               <Definition xml:lang="en">Describes the ReferenceValue of the
ColorTemperaturePreference as defined in this part of ISO/IEC 21000.</Definition>
            </Term>
            <Term termID="6.4.8.4">
               <Name xml:lang="en">BrightnessPreference BinNumber</Name>
               <Definition xml:lang="en">Describes the BinNumber of the
BrightnessPreference as defined in this part of ISO/IEC 21000.</Definition>
            </Term>
            <Term termID="6.4.8.5">
               <Name xml:lang="en">ColorTemperaturePreference
PreferredValue</Name>
               <Definition xml:lang="en">Describes the PreferredValue of the
BrightnessPreference as defined in this part of ISO/IEC 21000.</Definition>
            </Term>
            <Term termID="6.4.8.6">
               <Name xml:lang="en">ColorTemperaturePreference
ReferenceValue</Name>
               <Definition xml:lang="en">Describes the ReferenceValue of the
BrightnessPreference as defined in this part of ISO/IEC 21000.</Definition>
            </Term>
            <Term termID="6.4.8.7">
               <Name xml:lang="en">ContrastPreference BinNumber</Name>
               <Definition xml:lang="en">Describes the BinNumber of the
ContrastPreferenceas defined in this part of ISO/IEC 21000.</Definition>
            </Term>
            <Term termID="6.4.8.8">
               <Name xml:lang="en">ColorTemperaturePreference
PreferredValue</Name>
               <Definition xml:lang="en">Describes the PreferredValue of the
ContrastPreferenceas defined in this part of ISO/IEC 21000.</Definition>
            </Term>
            <Term termID="6.4.8.9">
               <Name xml:lang="en">ColorTemperaturePreference
ReferenceValue</Name>
               <Definition xml:lang="en">Describes the ReferenceValue of the
ContrastPreferenceas defined in this part of ISO/IEC 21000.</Definition>
            </Term>
```

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```
         </Term>
         <Term termID="6.4.10">
            <Name xml:lang="en">SteroscopicVideoConversion</Name>
            <Definition xml:lang="en">Lists the terms and definitions of the
StereoscopicVideoConversion as defined in this part of
ISO/IEC 21000.</Definition>
            <Term termID="6.4.10.1">
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this part of ISO/IEC 21000.</Definition>
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GraphicsPresentationPreferences as defined in this part of
ISO/IEC 21000.</Definition>
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defined in this part of ISO/IEC 21000.</Definition>
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in this part of ISO/IEC 21000.</Definition>
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GeneralResourceConversions as defined in this part of ISO/IEC 21000.</Definition>
            </Term>
            <Term termID="6.4.12.2">
               <Name xml:lang="en">GeneralResourceConversionsTo</Name>
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GeneralResourceConversions as defined in this part of ISO/IEC 21000.</Definition>
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               <Definition xml:lang="en">Describes the weight of the
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               <Definition xml:lang="en">Describes the To of the
SpecificResourceConversionsFrom as defined in this part of
ISO/IEC 21000.</Definition>
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SpecificResourceConversionsFrom as defined in this part of
ISO/IEC 21000.</Definition>
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part of ISO/IEC 21000.</Definition>
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PresentationPriorityPreference as defined in this part of
ISO/IEC 21000.</Definition>
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this part of ISO/IEC 21000.</Definition>
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Modality as defined in this part of ISO/IEC 21000.</Definition>
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as defined in this part of ISO/IEC 21000.</Definition>
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SpecificResourcePriorities as defined in this part of ISO/IEC 21000.</Definition>
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               <Definition xml:lang="en">Describes the target of the
SpecificResourcePriorities as defined in this part of ISO/IEC 21000.</Definition>
            </Term>
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FocusOfAttention as defined in this part of ISO/IEC 21000.</Definition>
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               <Definition xml:lang="en">Describes the URI of the ROI as defined
in this part of ISO/IEC 21000.</Definition>
            </Term>
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               <Definition xml:lang="en">Describes the updateInterval of the ROI
as defined in this part of ISO/IEC 21000.</Definition>
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part of ISO/IEC 21000.</Definition>
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Keyword as defined in this part of ISO/IEC 21000.</Definition>
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this part of ISO/IEC 21000.</Definition>
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this part of ISO/IEC 21000.</Definition>
            </Term>
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defined in this part of ISO/IEC 21000.</Definition>
            </Term>
            <Term termID="6.4.15.2">
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               <Definition xml:lang="en">Describes the RightEarFreq250Hz as
defined in this part of ISO/IEC 21000.</Definition>
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            <Term termID="6.4.15.3">
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defined in this part of ISO/IEC 21000.</Definition>
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               <Definition xml:lang="en">Describes the RightEarFreq1000Hz as
defined in this part of ISO/IEC 21000.</Definition>
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defined in this part of ISO/IEC 21000.</Definition>
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defined in this part of ISO/IEC 21000.</Definition>
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               <Definition xml:lang="en">Describes the RightEarFreq3000Hz as
defined in this part of ISO/IEC 21000.</Definition>
            </Term>
            <Term termID="6.4.15.8">
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               <Definition xml:lang="en">Describes the RightEarFreq4000Hz as
defined in this part of ISO/IEC 21000.</Definition>
            </Term>
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               <Definition xml:lang="en">Describes the RightEarFreq6000Hz as
defined in this part of ISO/IEC 21000.</Definition>
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               <Definition xml:lang="en">Describes the RightEarFreq8000Hz as
defined in this part of ISO/IEC 21000.</Definition>
            </Term>
            <Term termID="6.4.15.11">
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               <Definition xml:lang="en">Describes the LeftEarFreq125Hz as
defined in this part of ISO/IEC 21000.</Definition>
            </Term>
            <Term termID="6.4.15.12">
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               <Definition xml:lang="en">Describes the LeftEarFreq250Hz as
defined in this part of ISO/IEC 21000.</Definition>
            </Term>
            <Term termID="6.4.15.13">
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               <Definition xml:lang="en">Describes the LeftEarFreq500Hz as
defined in this part of ISO/IEC 21000.</Definition>
            </Term>
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defined in this part of ISO/IEC 21000.</Definition>
            </Term>
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               <Definition xml:lang="en">Describes the LeftEarFreq1500Hz as
defined in this part of ISO/IEC 21000.</Definition>
            </Term>
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               <Definition xml:lang="en">Describes the LeftEarFreq2000Hz as
defined in this part of ISO/IEC 21000.</Definition>
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            <Term termID="6.4.15.17">
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               <Definition xml:lang="en">Describes the LeftEarFreq3000Hz as
defined in this part of ISO/IEC 21000.</Definition>
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               <Definition xml:lang="en">Describes the LeftEarFreq4000Hz as
defined in this part of ISO/IEC 21000.</Definition>
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defined in this part of ISO/IEC 21000.</Definition>
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defined in this part of ISO/IEC 21000.</Definition>
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               <Definition xml:lang="en">Describes the Blindness as defined in
this part of ISO/IEC 21000.</Definition>
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            <Term termID="6.4.16.2">
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               <Name xml:lang="en">LowVisionImpairment LossOfFineDetail
Numeric</Name>
               <Definition xml:lang="en">Describes the NumericDegree of the
LossOfFineDetail of the LowVisionImpairment as defined in this part of
ISO/IEC 21000.</Definition>
            </Term>
            <Term termID="6.4.16.3">
               <Name xml:lang="en">LowVisionImpairment LossOfFineDetail
Textual</Name>
               <Definition xml:lang="en">Describes the TextualDegree of the
LossOfFineDetail of the LowVisionImpairment as defined in this part of
ISO/IEC 21000.</Definition>
            </Term>
            <Term termID="6.4.16.4">
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Numeric</Name>
               <Definition xml:lang="en">Describes the NumericDegree of the
LackOfConstrast of the LowVisionImpairment as defined in this part of
ISO/IEC 21000.</Definition>
            </Term>
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ISO/IEC 21000.</Definition>
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Numeric</Name>
               <Definition xml:lang="en">Describes the NumericDegree of the
LightSensitivity of the LowVisionImpairment as defined in this part of
ISO/IEC 21000.</Definition>
            </Term>
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Textual</Name>
               <Definition xml:lang="en">Describes the TextualDegree of the
LightSensitivity of the LowVisionImpairment as defined in this part of
ISO/IEC 21000.</Definition>
            </Term>
            <Term termID="6.4.16.8">
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               <Definition xml:lang="en">Describes the NumericDegree of the
NeedOfLight of the LowVisionImpairment as defined in this part of
ISO/IEC 21000.</Definition>
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            <Term termID="6.4.16.9">
               <Name xml:lang="en">LowVisionImpairment NeedOfLight Textual</Name>
               <Definition xml:lang="en">Describes the TextualDegree of the
NeedOfLight of the LowVisionImpairment as defined in this part of
ISO/IEC 21000.</Definition>
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Numeric</Name>
               <Definition xml:lang="en">Describes the NumericDegree of the
PeripheralVisionLoss of the LowVisionImpairment as defined in this part of
ISO/IEC 21000.</Definition>
            </Term>
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            <Term termID="6.4.16.11">
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Textual</Name>
               <Definition xml:lang="en">Describes the TextualDegree of the
PeripheralVisionLoss of the LowVisionImpairment as defined in this part of
ISO/IEC 21000.</Definition>
            </Term>
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               <Definition xml:lang="en">Describes the side of Heminaopia as
defined in this part of ISO/IEC 21000.</Definition>
            </Term>
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               <Definition xml:lang="en">Describes the DeficiencyType of the
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            </Term>
            <Term termID="6.4.16.14">
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               <Definition xml:lang="en">Describes the DeficiencyDegree of the
ColorVisionDeficiency as defined in this part of ISO/IEC 21000.</Definition>
            </Term>
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this part of ISO/IEC 21000.</Definition>
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               <Definition xml:lang="en">Describes the leftSide as defined in
this part of ISO/IEC 21000.</Definition>
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MobilityCharacteristics as defined in this part of ISO/IEC 21000.</Definition>
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LastUpdatePoint as defined in this part of ISO/IEC 21000.</Definition>
            </Term>
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               <Definition xml:lang="en">Describes the logitude of the
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            </Term>
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            </Term>
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               <Definition xml:lang="en">Describes the Lmax as defined in this
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            </Term>
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part of ISO/IEC 21000.</Definition>
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part of ISO/IEC 21000.</Definition>
            </Term>
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part of ISO/IEC 21000.</Definition>
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this part of ISO/IEC 21000.</Definition>
            </Term>
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               <Definition xml:lang="en">Describes one value of the Directivity
Values as defined in this part of ISO/IEC 21000.</Definition>
            </Term>
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defined in this part of ISO/IEC 21000.</Definition>
            </Term>
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               <Definition xml:lang="en">Describes one value of the Erraticity
Values as defined in this part of ISO/IEC 21000.</Definition>
            </Term>
         </Term>
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               <Definition xml:lang="en">Describes the Time as defined in this
part of ISO/IEC 21000.</Definition>
            </Term>
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               <Definition xml:lang="en">Describes the Location as defined in
this part of ISO/IEC 21000.</Definition>
            </Term>
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in this part of ISO/IEC 21000.</Definition>
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Decoding CodecCapability as defined in this part of ISO/IEC 21000.</Definition>
            </Term>
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               <Definition xml:lang="en">Describes the GraphicsCodingFormat of
the Decoding CodecCapability as defined in this part of
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defined in this part of ISO/IEC 21000.</Definition>
            </Term>
            <Term termID="6.5.9.5">
               <Name xml:lang="en">refreshRate</Name>
               <Definition xml:lang="en">Describes the refreshRate as defined in
this part of ISO/IEC 21000.</Definition>
            </Term>
            <Term termID="6.5.9.6">
               <Name xml:lang="en">ScreenSize horizontal</Name>
               <Definition xml:lang="en">Describes the horizontal ScreenSize as
defined in this part of ISO/IEC 21000.</Definition>
            </Term>
            <Term termID="6.5.9.7">
               <Name xml:lang="en">ScreenSize vertical</Name>
               <Definition xml:lang="en">Describes the vertical ScreenSize as
defined in this part of ISO/IEC 21000.</Definition>
            </Term>
            <Term termID="6.5.9.8">
               <Name xml:lang="en">ColorBitDepth red</Name>
               <Definition xml:lang="en">Describes the red ColotBitDepth as
defined in this part of ISO/IEC 21000.</Definition>
            </Term>
            <Term termID="6.5.9.9">
               <Name xml:lang="en">ColorBitDepth green</Name>
               <Definition xml:lang="en">Describes the green ColotBitDepth as
defined in this part of ISO/IEC 21000.</Definition>
            </Term>
            <Term termID="6.5.9.10">
               <Name xml:lang="en">ColorBitDepth blue</Name>
               <Definition xml:lang="en">Describes the blue ColotBitDepth as
defined in this part of ISO/IEC 21000.</Definition>
            </Term>
            <Term termID="6.5.9.11">
               <Name xml:lang="en">CromaticityRed x</Name>
               <Definition xml:lang="en">Describes the x CromaticityRed as
defined in this part of ISO/IEC 21000.</Definition>
            </Term>
            <Term termID="6.5.9.12">
               <Name xml:lang="en">CromaticityRed y</Name>
               <Definition xml:lang="en">Describes the y CromaticityRed as
defined in this part of ISO/IEC 21000.</Definition>
            </Term>
            <Term termID="6.5.9.13">
               <Name xml:lang="en">CromaticityGreen x</Name>
               <Definition xml:lang="en">Describes the x CromaticityGreen as
defined in this part of ISO/IEC 21000.</Definition>
            </Term>
            <Term termID="6.5.9.14">
               <Name xml:lang="en">CromaticityGreeb y</Name>
               <Definition xml:lang="en">Describes the y CromaticityGreen as
defined in this part of ISO/IEC 21000.</Definition>
            </Term>
            <Term termID="6.5.9.15">
               <Name xml:lang="en">CromaticityBlue x</Name>
               <Definition xml:lang="en">Describes the x CromaticityBlue as
defined in this part of ISO/IEC 21000.</Definition>
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            </Term>
            <Term termID="6.5.9.16">
               <Name xml:lang="en">CromaticityBlue y</Name>
               <Definition xml:lang="en">Describes the y CromaticityBlue as
defined in this part of ISO/IEC 21000.</Definition>
            </Term>
            <Term termID="6.5.9.17">
               <Name xml:lang="en">CromaticityWhite x</Name>
               <Definition xml:lang="en">Describes the x CromaticityWhite as
defined in this part of ISO/IEC 21000.</Definition>
            </Term>
            <Term termID="6.5.9.18">
               <Name xml:lang="en">CromaticityWhite y</Name>
               <Definition xml:lang="en">Describes the y CromaticityWhite as
defined in this part of ISO/IEC 21000.</Definition>
            </Term>
            <Term termID="6.5.9.19">
               <Name xml:lang="en">CharacterSetCode</Name>
               <Definition xml:lang="en">Describes the CharacterSetCode as
defined in this part of ISO/IEC 21000.</Definition>
            </Term>
            <Term termID="6.5.9.20">
               <Name xml:lang="en">RenderingFormat</Name>
               <Definition xml:lang="en">Describes the RenderingFormat as defined
in this part of ISO/IEC 21000.</Definition>
            </Term>
            <Term termID="6.5.9.21">
               <Name xml:lang="en">stereoscopic</Name>
               <Definition xml:lang="en">Describes the stereoscopic as defined in
this part of ISO/IEC 21000.</Definition>
            </Term>
            <Term termID="6.5.9.22">
               <Name xml:lang="en">maximumBrightness</Name>
               <Definition xml:lang="en">Describes the maximumBrightness as
defined in this part of ISO/IEC 21000.</Definition>
            </Term>
            <Term termID="6.5.9.23">
               <Name xml:lang="en">contrastRatio</Name>
               <Definition xml:lang="en">Describes the contrastRatio as defined
in this part of ISO/IEC 21000.</Definition>
            </Term>
            <Term termID="6.5.9.24">
               <Name xml:lang="en">gamma</Name>
               <Definition xml:lang="en">Describes the gamma as defined in this
part of ISO/IEC 21000.</Definition>
            </Term>
            <Term termID="6.5.9.25">
               <Name xml:lang="en">bitsPerPixel</Name>
               <Definition xml:lang="en">Describes the bitsPerPixel as defined in
this part of ISO/IEC 21000.</Definition>
            </Term>
            <Term termID="6.5.9.26">
               <Name xml:lang="en">colorCapable</Name>
               <Definition xml:lang="en">Describes the colorCapable as defined in
this part of ISO/IEC 21000.</Definition>
            </Term>
            <Term termID="6.5.9.27">
               <Name xml:lang="en">sRGB</Name>
               <Definition xml:lang="en">Describes the sRGB as defined in this
part of ISO/IEC 21000.</Definition>
```


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            </Term>
            <Term termID="6.5.9.28">
               <Name xml:lang="en">fieldSequentialCode</Name>
               <Definition xml:lang="en">Describes the fieldSequentialCode as
defined in this part of ISO/IEC 21000.</Definition>
            </Term>
            <Term termID="6.5.9.29">
               <Name xml:lang="en">backlightLuminance</Name>
               <Definition xml:lang="en">Describes the backlightLuminance as
defined in this part of ISO/IEC 21000.</Definition>
            </Term>
            <Term termID="6.5.9.30">
               <Name xml:lang="en">dotPitch</Name>
               <Definition xml:lang="en">Describes the dotPitch as defined in
this part of ISO/IEC 21000.</Definition>
            </Term>
         </Term>
         <Term termID="6.5.12">
            <Name xml:lang="en">AudioOutputCapabilities</Name>
            <Definition xml:lang="en">Lists the terms and definitions of the
AudioOutputCapabilities as defined in this part of ISO/IEC 21000.</Definition>
            <Term termID="6.5.12.1">
               <Name xml:lang="en">Mode samplingFrequency</Name>
               <Definition xml:lang="en">Describes the samplingFrequency Mode as
defined in this part of ISO/IEC 21000.</Definition>
            </Term>
            <Term termID="6.5.12.2">
               <Name xml:lang="en">Mode bitsPerSample</Name>
               <Definition xml:lang="en">Describes the bitPerSample Mode as
defined in this part of ISO/IEC 21000.</Definition>
            </Term>
            <Term termID="6.5.12.3">
               <Name xml:lang="en">lowFrequency</Name>
               <Definition xml:lang="en">Describes the lowFrequency as defined in
this part of ISO/IEC 21000.</Definition>
            </Term>
            <Term termID="6.5.12.4">
               <Name xml:lang="en">highFrequency</Name>
               <Definition xml:lang="en">Describes the highFrequency as defined
in this part of ISO/IEC 21000.</Definition>
            </Term>
            <Term termID="6.5.12.5">
               <Name xml:lang="en">signalNoiseRatio</Name>
               <Definition xml:lang="en">Describes the signalNoiseRation as
defined in this part of ISO/IEC 21000.</Definition>
            </Term>
            <Term termID="6.5.12.6">
               <Name xml:lang="en">power</Name>
               <Definition xml:lang="en">Describes the power as defined in this
part of ISO/IEC 21000.</Definition>
            </Term>
            <Term termID="6.5.12.7">
               <Name xml:lang="en">NAME</Name>
               <Definition xml:lang="en">Describes the numChannels as defined in
this part of ISO/IEC 21000.</Definition>
            </Term>
         </Term>
         <Term termID="6.5.14">
            <Name xml:lang="en">UserInteractionInput</Name>
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```
            <Definition xml:lang="en">Lists the terms and definitions of the
UserInteractionInput as defined in this part of ISO/IEC 21000.</Definition>
            <Term termID="6.5.14.1">
               <Name xml:lang="en">StringInput</Name>
               <Definition xml:lang="en">Describes the StringInput as defined in
this part of ISO/IEC 21000.</Definition>
            </Term>
            <Term termID="6.5.14.2">
               <Name xml:lang="en">KeyInput</Name>
               <Definition xml:lang="en">Describes the KeyInput as defined in
this part of ISO/IEC 21000.</Definition>
            </Term>
            <Term termID="6.5.14.3">
               <Name xml:lang="en">Microphone</Name>
               <Definition xml:lang="en">Describes the Microphone as defined in
this part of ISO/IEC 21000.</Definition>
            </Term>
            <Term termID="6.5.14.4">
               <Name xml:lang="en">Mouse resolution</Name>
               <Definition xml:lang="en">Describes the resolution of the Mouse as
defined in this part of ISO/IEC 21000.</Definition>
            </Term>
            <Term termID="6.5.14.5">
               <Name xml:lang="en">Mouse buttons</Name>
               <Definition xml:lang="en">Describes the buttons of the Mouse as
defined in this part of ISO/IEC 21000.</Definition>
            </Term>
            <Term termID="6.5.14.6">
               <Name xml:lang="en">Mouse scrollWheel</Name>
               <Definition xml:lang="en">Describes the scrollWheel of the Mouse
as defined in this part of ISO/IEC 21000.</Definition>
            </Term>
            <Term termID="6.5.14.7">
               <Name xml:lang="en">Pen resolution</Name>
               <Definition xml:lang="en">Describes the resolution of the Pen as
defined in this part of ISO/IEC 21000.</Definition>
            </Term>
            <Term termID="6.5.14.8">
               <Name xml:lang="en">Tablet resolution</Name>
               <Definition xml:lang="en">Describes the resolution of the Tablet
as defined in this part of ISO/IEC 21000.</Definition>
            </Term>
            <Term termID="6.5.14.9">
               <Name xml:lang="en">GenericMouse resolution</Name>
               <Definition xml:lang="en">Describes the resolution of the
GenericMouse as defined in this part of ISO/IEC 21000.</Definition>
            </Term>
            <Term termID="6.5.14.10">
               <Name xml:lang="en">GenericMouse buttons</Name>
               <Definition xml:lang="en">Describes the buttons of the
GenericMouse as defined in this part of ISO/IEC 21000.</Definition>
            </Term>
            <Term termID="6.5.14.11">
               <Name xml:lang="en">GenericMouse scrollWheel</Name>
               <Definition xml:lang="en">Describes the scrollWheel of the
GenericMouse as defined in this part of ISO/IEC 21000.</Definition>
            </Term>
            <Term termID="6.5.14.12">
               <Name xml:lang="en">GenericPen resolution</Name>
```


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```
               <Definition xml:lang="en">Describes the resolution of the
GenericPen as defined in this part of ISO/IEC 21000.</Definition>
            </Term>
         </Term>
         <Term termID="6.5.15">
            <Name xml:lang="en">DeviceClass</Name>
            <Definition xml:lang="en">Describes the DeviceClass as defined in
this part of ISO/IEC 21000.</Definition>
         </Term>
         <Term termID="6.5.16">
            <Name xml:lang="en">PowerCharacteristics</Name>
            <Definition xml:lang="en">Lists the terms and definitions of the
PowerCharacteristics as defined in this part of ISO/IEC 21000.</Definition>
            <Term termID="6.5.16.1">
               <Name xml:lang="en">averageAmpereConsumption</Name>
               <Definition xml:lang="en">Describes the averageAmpereConsumption
as defined in this part of ISO/IEC 21000.</Definition>
            </Term>
            <Term termID="6.5.16.2">
               <Name xml:lang="en">batteryCapacityRemainung</Name>
               <Definition xml:lang="en">Describes the batteryCapacityRemaining
as defined in this part of ISO/IEC 21000.</Definition>
            </Term>
            <Term termID="6.5.16.3">
               <Name xml:lang="en">batteryTimeRemaining</Name>
               <Definition xml:lang="en">Describes the batteryTimeReamining as
defined in this part of ISO/IEC 21000.</Definition>
            </Term>
            <Term termID="6.5.16.4">
               <Name xml:lang="en">runningOnBatteries</Name>
               <Definition xml:lang="en">Describes the runningOnBatteries as
defined in this part of ISO/IEC 21000.</Definition>
            </Term>
         </Term>
         <Term termID="6.5.19">
            <Name xml:lang="en">StorageCharacteristics</Name>
            <Definition xml:lang="en">Lists the terms and definitions of the
StorageCharacteristics as defined in this part of ISO/IEC 21000.</Definition>
            <Term termID="6.5.19.1">
               <Name xml:lang="en">inputTransferRate</Name>
               <Definition xml:lang="en">Describes the inputTransferRate as
defined in this part of ISO/IEC 21000.</Definition>
            </Term>
            <Term termID="6.5.19.2">
               <Name xml:lang="en">outputTransferRate</Name>
               <Definition xml:lang="en">Describes the outputTransferRate as
defined in this part of ISO/IEC 21000.</Definition>
            </Term>
            <Term termID="6.5.19.3">
               <Name xml:lang="en">size</Name>
               <Definition xml:lang="en">Describes the size as defined in this
part of ISO/IEC 21000.</Definition>
            </Term>
            <Term termID="6.5.19.4">
               <Name xml:lang="en">writeable</Name>
               <Definition xml:lang="en">Describes the writeable as defined in
this part of ISO/IEC 21000.</Definition>
            </Term>
         </Term>
         <Term termID="6.5.22">
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            <Name xml:lang="en">DataIOCharacteristics</Name>
            <Definition xml:lang="en">Lists the terms and definitions of the
DataIOCharacteristics as defined in this part of ISO/IEC 21000.</Definition>
            <Term termID="6.5.22.1">
               <Name xml:lang="en">busWidth</Name>
               <Definition xml:lang="en">Describes the busWidth as defined in
this part of ISO/IEC 21000.</Definition>
            </Term>
            <Term termID="6.5.22.2">
               <Name xml:lang="en">transferSpeed</Name>
               <Definition xml:lang="en">Describes the transferSpeed as defined
in this part of ISO/IEC 21000.</Definition>
            </Term>
            <Term termID="6.5.22.3">
               <Name xml:lang="en">maxDevices</Name>
               <Definition xml:lang="en">Describes the maxDevices as defined in
this part of ISO/IEC 21000.</Definition>
            </Term>
            <Term termID="6.5.22.4">
               <Name xml:lang="en">numDevices</Name>
               <Definition xml:lang="en">Describes the numDevices as defined in
this part of ISO/IEC 21000.</Definition>
            </Term>
         </Term>
         <Term termID="6.5.25">
            <Name xml:lang="en">CPUBenchmark</Name>
            <Definition xml:lang="en">Lists the terms and definitions of the
CPUBenchmark as defined in this part of ISO/IEC 21000.</Definition>
            <Term termID="6.5.25.1">
               <Name xml:lang="en">name</Name>
               <Definition xml:lang="en">Describes the name as defined in this
part of ISO/IEC 21000.</Definition>
            </Term>
            <Term termID="6.5.25.2">
               <Name xml:lang="en">baseValue</Name>
               <Definition xml:lang="en">Describes the baseValue as defined in
this part of ISO/IEC 21000.</Definition>
            </Term>
         </Term>
         <Term termID="6.5.26">
            <Name xml:lang="en">ThreeDBenchmark</Name>
            <Definition xml:lang="en">Lists the terms and definitions of the
ThreeDBenchmark as defined in this part of ISO/IEC 21000.</Definition>
            <Term termID="6.5.26.1">
               <Name xml:lang="en">name</Name>
               <Definition xml:lang="en">Describes the name as defined in this
part of ISO/IEC 21000.</Definition>
            </Term>
            <Term termID="6.5.26.2">
               <Name xml:lang="en">meanValue</Name>
               <Definition xml:lang="en">Describes the meanValue as defined in
this part of ISO/IEC 21000.</Definition>
            </Term>
         </Term>
         <Term termID="6.5.27">
            <Name xml:lang="en">IPMPTools</Name>
            <Definition xml:lang="en">Lists the terms and definitions of the
IPMPTools as defined in this part of ISO/IEC 21000.</Definition>
            <Term termID="6.5.27.1">
               <Name xml:lang="en">IPMPTool MPEG2</Name>
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```
               <Definition xml:lang="en">Describes the MPEG2 IPMPTool as defined
in this part of ISO/IEC 21000.</Definition>
            </Term>
            <Term termID="6.5.27.2">
               <Name xml:lang="en">IPMPTool MPEG4</Name>
               <Definition xml:lang="en">Describes the MPEG4 IPMPTool as defined
in this part of ISO/IEC 21000.</Definition>
            </Term>
            <Term termID="6.5.27.3">
               <Name xml:lang="en">IPMPSType</Name>
               <Definition xml:lang="en">Describes the IPMPSType as defined in
this part of ISO/IEC 21000.</Definition>
            </Term>
         </Term>
      </Term>
      <Term termID="6.6">
         <Name xml:lang="en">Network Characteristics</Name>
         <Definition xml:lang="en">Lists the terms and defintions of the Network
Characteristics as defined in this part of ISO/IEC 21000.</Definition>
         <Term termID="6.6.4">
            <Name xml:lang="en">NetworkCapability</Name>
            <Definition xml:lang="en">Lists the terms and definitions of the
NetworkCapability as defined in this part of ISO/IEC 21000.</Definition>
            <Term termID="6.6.4.1">
               <Name xml:lang="en">maxCapacity</Name>
               <Definition xml:lang="en">Describes the maxCapacity as defined in
this part of ISO/IEC 21000.</Definition>
            </Term>
            <Term termID="6.6.4.2">
               <Name xml:lang="en">minGuaranteed</Name>
               <Definition xml:lang="en">Describes the minGuaranteed as defined
in this part of ISO/IEC 21000.</Definition>
            </Term>
            <Term termID="6.6.4.3">
               <Name xml:lang="en">inSequenceDelivery</Name>
               <Definition xml:lang="en">Describes the inSequenceDelivery as
defined in this part of ISO/IEC 21000.</Definition>
            </Term>
            <Term termID="6.6.4.4">
               <Name xml:lang="en">errorDelivery</Name>
               <Definition xml:lang="en">Describes the errorDelivery as defined
in this part of ISO/IEC 21000.</Definition>
            </Term>
            <Term termID="6.6.4.5">
               <Name xml:lang="en">errorCorrection</Name>
               <Definition xml:lang="en">Describes the errorCorrection as defined
in this part of ISO/IEC 21000.</Definition>
            </Term>
         </Term>
         <Term termID="6.6.5">
            <Name xml:lang="en">NetworkCondition</Name>
            <Definition xml:lang="en">Lists the terms and definitions of the
NetworkCondition as defined in this part of ISO/IEC 21000.</Definition>
            <Term termID="6.6.5.1">
               <Name xml:lang="en">AvailableBandwidth minimum</Name>
               <Definition xml:lang="en">Describes the minimum AvailableBandwidth
as defined in this part of ISO/IEC 21000.</Definition>
            </Term>
            <Term termID="6.6.5.2">
               <Name xml:lang="en">AvailableBandwidth maximum</Name>
```

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               <Definition xml:lang="en">Describes the maximum AvailableBandwidth
as defined in this part of ISO/IEC 21000.</Definition>
            </Term>
            <Term termID="6.6.5.3">
               <Name xml:lang="en">AvailableBandwidth average</Name>
               <Definition xml:lang="en">Describes the average AvailableBandwidth
as defined in this part of ISO/IEC 21000.</Definition>
            </Term>
            <Term termID="6.6.5.4">
               <Name xml:lang="en">Delay packetTwoWay</Name>
               <Definition xml:lang="en">Describes the packetTwoQay Delay as
defined in this part of ISO/IEC 21000.</Definition>
            </Term>
            <Term termID="6.6.5.5">
               <Name xml:lang="en">Delay packetOneWay</Name>
               <Definition xml:lang="en">Describes the packetOneQay Delay as
defined in this part of ISO/IEC 21000.</Definition>
            </Term>
            <Term termID="6.6.5.6">
               <Name xml:lang="en">delayVariation</Name>
               <Definition xml:lang="en">Describes the delayVariation as defined
in this part of ISO/IEC 21000.</Definition>
            </Term>
            <Term termID="6.6.5.7">
               <Name xml:lang="en">packetLossRate</Name>
               <Definition xml:lang="en">Describes the packetLossRate as defined
in this part of ISO/IEC 21000.</Definition>
            </Term>
            <Term termID="6.6.5.8">
               <Name xml:lang="en">bitErrorRate</Name>
               <Definition xml:lang="en">Describes the bitErrorRate as defined in
this part of ISO/IEC 21000.</Definition>
            </Term>
         </Term>
      </Term>
      <Term termID="6.7">
         <Name xml:lang="en">Natural Environment Characteristics</Name>
         <Definition xml:lang="en">Lists the terms and definitions of the Natural
Environment Characteristics as defined in this part of
ISO/IEC 21000.</Definition>
         <Term termID="6.7.4">
            <Name xml:lang="en">Location</Name>
            <Definition xml:lang="en">Describes the Location as defined in this
part of ISO/IEC 21000.</Definition>
         </Term>
         <Term termID="6.7.5">
            <Name xml:lang="en">Time</Name>
            <Definition xml:lang="en">Describes the Time as defined in this part
of ISO/IEC 21000.</Definition>
         </Term>
         <Term termID="6.7.6">
            <Name xml:lang="en">AudioEnvironment</Name>
            <Definition xml:lang="en">Lists the terms and definitions of the
AudioEnvironment as defined in this part of ISO/IEC 21000.</Definition>
            <Term termID="6.7.6.1">
               <Name xml:lang="en">NoiseLevel</Name>
               <Definition xml:lang="en">Describes the NoiseLevel as defined in
this part of ISO/IEC 21000.</Definition>
            </Term>
            <Term termID="6.7.6.1">
```


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```
               <Name xml:lang="en">NoiseFrequencySpectrum</Name>
               <Definition xml:lang="en">Describes the NoiseFrequencySpectrum as
defined in this part of ISO/IEC 21000.</Definition>
            </Term>
         </Term>
         <Term termID="6.7.7">
            <Name xml:lang="en">IlluminationCharacteristics</Name>
            <Definition xml:lang="en">Lists the terms and definitions of the
IlluminationCharacteristics as defined in this part of
ISO/IEC 21000.</Definition>
            <Term termID="6.7.7.1">
               <Name xml:lang="en">ColorTemperature</Name>
               <Definition xml:lang="en">Describes the ColorTemperature as
defined in this part of ISO/IEC 21000.</Definition>
            </Term>
            <Term termID="6.7.7.2">
               <Name xml:lang="en">Chromaticity x</Name>
               <Definition xml:lang="en">Describes the x Chromaticity as defined
in this part of ISO/IEC 21000.</Definition>
            </Term>
            <Term termID="6.7.7.3">
               <Name xml:lang="en">Chromaticity y</Name>
               <Definition xml:lang="en">Describes the y Chromaticity as defined
in this part of ISO/IEC 21000.</Definition>
            </Term>
            <Term termID="6.7.7.4">
               <Name xml:lang="en">Illuminance</Name>
               <Definition xml:lang="en">Describes the Illuminance as defined in
this part of ISO/IEC 21000.</Definition>
            </Term>
         </Term>
      </Term>
   </Term>
</ClassificationScheme>
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A.2.3 AQoSRoundingMethodCS

```
<ClassificationScheme
   uri="urn:mpeg:mpeg21:2003:01-DIA-AQoSRoundingMethodCS-NS">
   <Term termID="1">
      <Name xml:lang="en">floor</Name>
      <Definition xml:lang="en">
         Round to the nearest smaller integer
      </Definition>
   </Term>
   <Term termID="2">
      <Name xml:lang="en">ceil</Name>
      <Definition xml:lang="en">
         Round to the nearest greater integer
      </Definition>
   </Term>
   <Term termID="3">
      <Name xml:lang="en">linear</Name>
      <Definition xml:lang="en">
         Interpolate linearly
      </Definition>
   </Term>
   <Term termID="4">
      <Name xml:lang="en">nearest</Name>
      <Definition xml:lang="en">
         Round to the nearest integer (either smaller or greater)
      </Definition>
   </Term>
</ClassificationScheme>
```

A.2.4 CPUBenchmarkCS

```
<ClassificationScheme uri="urn:mpeg:mpeg21:2003:01-DIA-CPUBenchmarkCS-NS">
   <Term termID="1">
      <Name xml:lang="en">SPEC CPU95</Name>
      <Definition xml:lang="en">
         CPU95 benchmark suites specifed by SPEC (http://www.spec.org/cpu95/)
      </Definition>
      <Term termID="1.1">
         <Name xml:lang="en">CINT95</Name>
         <Definition xml:lang="en">
             CPU95 integer benchmark specified by SPEC.
         </Definition>
      </Term>
      <Term termID="1.2">
         <Name xml:lang="en">CFP95</Name>
         <Definition xml:lang="en">
             CPU95 floating point benchmark specified by SPEC.
         </Definition>
      </Term>
   </Term>
   <Term termID="2">
      <Name xml:lang="en">SPEC CPU2000</Name>
      <Definition>
         CPU2000 benchmark suites specifed by SPEC (http://www.spec.org/cpu2000/)
      </Definition>
      <Term termID="2.1">
         <Name xml:lang="en">CINT2000</Name>
```


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```
         <Definition xml:lang="en">
              CPU2000 integer benchmark specified by SPEC.
         </Definition>
      </Term>
      <Term termID="2.2">
         <Name xml:lang="en">CFP2000</Name>
         <Definition xml:lang="en">
              CPU2000 floating point benchmark specified by SPEC.
         </Definition>
      </Term>
   </Term>
</ClassificationScheme>
```

A.2.5 DeviceClassCS

```
<ClassificationScheme uri="urn:mpeg:mpeg21:2003:01-DIA-DeviceClassCS-NS" >
   <Term termId="1">
      <Name xml:lang="en">PC</Name>
   </Term>
   <Term termId="2">
      <Name xml:lang="en">PDA</Name>
   </Term>
   <Term termId="3">
      <Name xml:lang="en">Set-Top Box</Name>
   </Term>
   <Term termId="4">
      <Name xml:lang="en">Printer</Name>
   </Term>
   <Term termId="5">
      <Name xml:lang="en">Mobile Phone</Name>
   </Term>
   <Term termId="6">
      <Name xml:lang="en">Digital Still Camera</Name>
   </Term>
   <Term termId="7">
      <Name xml:lang="en">Digital Video Camera</Name>
   </Term>
   <Term termId="8">
      <Name xml:lang="en">Audio Player</Name>
   </Term>
   <Term termId="9">
      <Name xml:lang="en">Television</Name>
   </Term>
   <Term termId="10">
      <Name xml:lang="en">Gateway</Name>
   </Term>
   <Term termId="11">
      <Name xml:lang="en">Router</Name>
   </Term>
</ClassificationScheme>
```

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A.2.6 GraphicsCodingFormatCS

```
<ClassificationScheme
   uri="urn:mpeg:mpeg21:2003:01-DIA-GraphicsCodingFormatCS-NS" >
   <Term termId="1">
      <Name xml:lang="en">MPEG-4 Graphics</Name>
      <Definition xml:lang="en">MPEG-4 Graphics Formats</Definition>
      <Term termId="1.1">
         <Name xml:lang="en">MPEG-4 Graphics Simple 2D Profile</Name>
         <Term termId="1.1.1">
            <Name xml:lang="en">MPEG-4 Graphics Simple 2D Profile
               @ Level 1</Name>
         </Term>
      </Term>
      <Term termId="1.2">
         <Name xml:lang="en">MPEG-4 Graphics Simple 2D Text Profile</Name>
         <Term termId="1.2.1">
            <Name xml:lang="en">MPEG-4 Graphics Simple 2D Text Profile
               @ Level 1</Name>
         </Term>
      </Term>
      <Term termId="1.3">
         <Name xml:lang="en">MPEG-4 Graphics Core 2D Profile</Name>
      <Term termId="1.3.1">
            <Name xml:lang="en">MPEG-4 Graphics Core 2D Profile
               @ Level 1</Name>
         </Term>
         <Term termId="1.3.2">
            <Name xml:lang="en">MPEG-4 Graphics Core 2D Profile
               @ Level 2</Name>
         </Term>
      </Term>
      <Term termId="1.4">
         <Name xml:lang="en">MPEG-4 Graphics Advanced 2D Profile</Name>
         <Term termId="1.4.1">
            <Name xml:lang="en">MPEG-4 Graphics Advanced 2D Profile
               @ Level 1</Name>
         </Term>
         <Term termId="1.4.2">
            <Name xml:lang="en">MPEG-4 Graphics Advanced 2D Profile
               @ Level 2</Name>
         </Term>
      </Term>
   </Term>
   <Term termId="2">
      <Name xml:lang="en">VRML</Name>
      <Definition xml:lang="en">Virtual Reality Modeling Language</Definition>
   </Term>
   <Term termId="3">
      <Name xml:lang="en">H-Anim</Name>
      <Definition xml:lang="en">Humanoid Animation</Definition>
      <Term termId="3.1">
         <Name xml:lang="en">Level of Articulation 0</Name>
      </Term>
      <Term termId="3.2">
         <Name xml:lang="en">Level of Articulation 1</Name>
      </Term>
      <Term termId="3.3">
         <Name xml:lang="en">Level of Articulation 2</Name>
      </Term>
```

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```
      <Term termId="3.4">
         <Name xml:lang="en">Level of Articulation 3</Name>
      </Term>
      <Term termId="3.5">
         <Name xml:lang="en">Custom</Name>
      </Term>
   </Term>
</ClassificationScheme>
```

A.2.7 InvariantDimensionCS

```
<ClassificationScheme uri="urn:mpeg:mpeg21:2003:01-DIA-InvariantDimensionCS-NS" >
   <Term termId="1">
      <Name xml:lang="en">spatial</Name>
         <Definition xml:lang="en">
              Indicates that the instance value is invariant to spatial
              cropping.
      </Definition>
   </Term>
   <Term termId="2">
      <Name xml:lang="en">temporal</Name>
      <Definition xml:lang="en">
              Indicates that the instance value is invariant to temporal
              cropping
      </Definition>
   </Term>
</ClassificationScheme>
```

A.2.8 KeyInputCS

```
<ClassificationScheme uri="urn:mpeg:mpeg21:2003:01-DIA-KeyInputCS-NS" >
   <Term termId="1">
      <Name xml:lang="en">PCKeyBoard</Name>
      <Definition xml:lang=”en”>
         Full-size keyboard with typically 80 to 105 keys
      </Definition>
   </Term>
   <Term termId="2">
      <Name xml:lang="en">MobileKeyboard</Name>
      <Definition xml:lang=”en”>
         Small keyboard with limited number of keys, e.g.,
         0 to 9, *, #, up, down, left, right and enter
      </Definition>
   </Term>
   <Term termId="3">
      <Name xml:lang="en">Custom</Name>
   </Term>
</ClassificationScheme>
```

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A.2.9 LocationTypeCS

```
<ClassificationScheme uri="urn:mpeg:mpeg21:2003:01-DIA-LocationTypeCS-NS">
   <Term termId="1">
      <Name xml:lang="en">maxDepth</Name>
      <Defintion xml:lang="en">
         Location is determined by a maximum depth.
      </Definition>
   </Term>
   <Term termId="2">
      <Name xml:lang="en">depth</Name>
      <Defintion xml:lang="en">
         Location is determined by a  depth.
      </Definition>
   </Term>
   <Term termId="3">
      <Name xml:lang="en">listOfID</Name>
      <Defintion xml:lang="en">
         Location is determined by a list of IDs.
      </Definition>
   </Term>
</ClassificationScheme>
```

A.2.10 MediaInformationCS

```
<ClassificationScheme uri="urn:mpeg:mpeg21:2003:01-DIA-MediaInformationCS">
   <Term termID="1">
      <Name xml:lang="en">content</Name>
      <Definition xml:lang="en">Describes the type of media present (e.g., audio,
         video, text) as specified by the Content element in ISO/IEC 15983-5
         clause 8.2.4</Definition>
   </Term>
   <Term termID="2">
      <Name xml:lang="en">file format</Name>
      <Definition xml:lang="en">Describes the file format as specified within
         ISO/IEC 15983-5 clause 8.2.4</Definition>
   </Term>
   <Term termID="3">
      <Name xml:lang="en">file size</Name>
      <Definition xml:lang="en">Describes file size as specified within ISO/IEC
         15983-5 clause 8.2.4</Definition>
   </Term>
   <Term termID="4">
      <Name xml:lang="en">system</Name>
      <Definition xml:lang="en">Describes the broad media format as specified by
         the System element in ISO/IEC 15983-5 clause 8.2.4</Definition>
   </Term>
   <Term termID="6">
      <Name xml:lang="en">bandwidth</Name>
      <Definition xml:lang="en">Describes the bandwidth as specified within
         ISO/IEC 15983-5 clause 8.2.4</Definition>
   </Term>
   <Term termID="7">
      <Name xml:lang="en">nominal bit rate</Name>
      <Definition xml:lang="en">Describes the nominal bit rate as specified
          within ISO/IEC 15983-5 clause 8.2.4</Definition>
   </Term>
   <Term termID="8">
```


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```
      <Name xml:lang="en">variable bit rate</Name>
      <Definition xml:lang="en">Describes whether the bit rate is variable as
           specified within ISO/IEC 15983-5 clause 8.2.4</Definition>
   </Term>
   <Term termID="9">
      <Name xml:lang="en">average bit rate</Name>
      <Definition xml:lang="en">Describes the average bit rate as specified
           within ISO/IEC 15983-5 clause 8.2.4</Definition>
   </Term>
   <Term termID="10">
      <Name xml:lang="en">minimum bit rate</Name>
      <Definition xml:lang="en">Describes the minimum bit rate as specified
           within ISO/IEC 15983-5 clause 8.2.4</Definition>
   </Term>
   <Term termID="11">
      <Name xml:lang="en">maximum bit rate</Name>
      <Definition xml:lang="en">Describes the maximum bit rate as specified
           within ISO/IEC 15983-5 clause 8.2.4</Definition>
   </Term>
   <Term termID="12">
      <Name xml:lang="en">visual coding format</Name>
      <Definition xml:lang="en">Describes the visual coding format as specified
           within ISO/IEC 15983-5 clause 8.2.4</Definition>
   </Term>
   <Term termID="13">
      <Name xml:lang="en">color domain</Name>
      <Definition xml:lang="en">Describes the color domain as specified within
           ISO/IEC 15983-5 clause 8.2.4</Definition>
   </Term>
   <Term termID="14">
      <Name xml:lang="en">pixel resolution</Name>
      <Definition xml:lang="en">Describes the resolution as specified within
           ISO/IEC 15983-5 clause 8.2.4</Definition>
   </Term>
   <Term termID="15">
      <Name xml:lang="en">pixel aspect ratio</Name>
      <Definition xml:lang="en">Describes the pixel aspect ratio as specified
           within ISO/IEC 15983-5 clause 8.2.4</Definition>
   </Term>
   <Term termID="16">
      <Name xml:lang="en">bits per pixel</Name>
      <Definition xml:lang="en">Describes the bits per pixel as specified within
           ISO/IEC 15983-5 clause 8.2.4</Definition>
   </Term>
   <Term termID="17">
      <Name xml:lang="en">frame width</Name>
      <Definition xml:lang="en">Describes the width of a visual frame as
           specified within ISO/IEC 15983-5 clause 8.2.4</Definition>
   </Term>
   <Term termID="18">
      <Name xml:lang="en">frame height</Name>
      <Definition xml:lang="en">Describes the height of a visual frame as
           specified within ISO/IEC 15983-5 clause 8.2.4</Definition>
   </Term>
   <Term termID="19">
      <Name xml:lang="en">frame aspect ratio</Name>
      <Definition xml:lang="en">Describes the aspect ratio of a visual frame as
           specified within ISO/IEC 15983-5 clause 8.2.4</Definition>
   </Term>
   <Term termID="20">
```

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```
      <Name xml:lang="en">frame rate</Name>
      <Definition xml:lang="en">Describes the frame rate of a visual sequence of
            frames as specified within ISO/IEC 15983-5 clause 8.2.4</Definition>
   </Term>
   <Term termID="21">
      <Name xml:lang="en">frame sampling structure</Name>
      <Definition xml:lang="en">Describes the sampling structure of a visual
            frame (progressive or interlaced) as specified within ISO/IEC 15983-5
            clause 8.2.4</Definition>
   </Term>
   <Term termID="22">
      <Name xml:lang="en">audio coding format</Name>
      <Definition xml:lang="en">Describes the audio coding format as specified
            within ISO/IEC 15983-5 clause 8.2.4</Definition>
   </Term>
   <Term termID="23">
      <Name xml:lang="en">front audio channels</Name>
      <Definition xml:lang="en">Describes the number of front audio channels as
            specified within ISO/IEC 15983-5 clause 8.2.4</Definition>
   </Term>
   <Term termID="24">
      <Name xml:lang="en">side audio channels</Name>
      <Definition xml:lang="en">Describes the number of side audio channels as
specified within ISO/IEC 15983-5 clause 8.2.4</Definition>
   </Term>
   <Term termID="25">
      <Name xml:lang="en">rear audio channels</Name>
      <Definition xml:lang="en">Describes the number of rear audio channels as
            specified within ISO/IEC 15983-5 clause 8.2.4</Definition>
   </Term>
   <Term termID="26">
      <Name xml:lang="en">lfe audio channels</Name>
      <Definition xml:lang="en">Describes the number of low-frequency enhancement
            audio channels as specified within ISO/IEC 15983-5 clause
            8.2.4</Definition>
   </Term>
   <Term termID="27">
      <Name xml:lang="en">audio tracks</Name>
      <Definition xml:lang="en">Describes the number of audio tracks as specified
            within ISO/IEC 15983-5 clause 8.2.4</Definition>
   </Term>
   <Term termid="28">
      <Name xml:lang="en">audio sample rate</Name>
      <Definition xml:lang="en">Describes the audio sample rate as specified
            within ISO/IEC 15983-5 clause 8.2.4</Definition>
   </Term>
   <Term termid="29">
      <Name xml:lang="en">bits per audio sample</Name>
      <Definition xml:lang="en">Describes the bits per audio sample as specified
            within ISO/IEC 15983-5 clause 8.2.4</Definition>
   </Term>
   <Term termid="30">
      <Name xml:lang="en">audio emphasis</Name>
      <Definition xml:lang="en">Describes the audio emphasis as specified within
            ISO/IEC 15983-5 clause 8.2.4</Definition>
   </Term>
   <Term termID="31">
      <Name xml:lang="en">audio presentation format</Name>
      <Definition xml:lang="en">Describes the audio presentation format (as
            specified within ISO/IEC 15983-5 clause 8.2.4</Definition>
```


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```
   </Term>
   <Term termID="32">
      <Name xml:lang="en">scene coding coding format</Name>
      <Definition xml:lang="en">Describes the scene coding format as specified
            within ISO/IEC 15983-5 clause 8.2.4</Definition>
   </Term>
   <Term termID="33">
      <Name xml:lang="en">graphics coding format</Name>
      <Definition xml:lang="en">Describes the graphics coding format as specified
            within ISO/IEC 15983-5 clause 8.2.4</Definition>
   </Term>
   <Term termID="34">
      <Name xml:lang="en">other coding format</Name>
      <Definition xml:lang="en">Describes other coding format as specified within
            ISO/IEC 15983-5 clause 8.2.4</Definition>
   </Term>
</ClassificationScheme>
```

A.2.11 PlaceTypeCS

```
<ClassificationScheme uri="urn:mpeg:mpeg21:2003:01-DIA-PlaceTypeCS-NS">
   <Term termId="1">
      <Name xml:lang="en">My Home</Name>
      <Definition xml:lang=”en”>
         A place where a person lives or a place to go back
      </Definition>
   </Term>
   <Term termId="2">
      <Name xml:lang="en">Transportation Facilities</Name>
      <Definition xml:lang=”en”>
         A place where people access transportation means
      </Definition>
      <Term termId="2.1">
         <Name xml:lang="en">Station</Name>
      </Term>
      <Term termId="2.2">
         <Name xml:lang="en">Stop</Name>
      </Term>
      <Term termId="2.3">
         <Name xml:lang="en">Airport</Name>
      </Term>
      <Term termId="2.4">
         <Name xml:lang="en">Harbor</Name>
      </Term>
   </Term>
   <Term termId="3">
      <Name xml:lang="en">Traffic Facilities</Name>
      <Definition xml:lang=”en”>
         A place where people access by using traffic means
      </Definition>
      <Term termId="3.1">
         <Name xml:lang="en">Entrance</Name>
      </Term>
      <Term termId="3.2">
         <Name xml:lang="en">Parking</Name>
      </Term>
      <Term termId="3.3">
         <Name xml:lang="en">Crossing</Name>
```

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```
      </Term>
      <Term termId="3.4">
         <Name xml:lang="en">Street</Name>
      </Term>
      <Term termId="3.5">
         <Name xml:lang="en">Gas Station</Name>
      </Term>
      <Term termId="3.6">
         <Name xml:lang="en">Highway</Name>
      </Term>
      <Term termId="3.7">
         <Name xml:lang="en">Interchange</Name>
      </Term>
      <Term termId="3.8">
         <Name xml:lang="en">Service Area</Name>
      </Term>
   </Term>
   <Term termId="4">
      <Name xml:lang="en">Work Place</Name>
      <Definition xml:lang=”en”>
         A place where people work
      </Definition>
      <Term termId="4.1">
         <Name xml:lang="en">Office</Name>
      </Term>
      <Term termId="4.2">
         <Name xml:lang="en">Factory</Name>
      </Term>
      <Term termId="4.3">
         <Name xml:lang="en">Studio</Name>
      </Term>
      <Term termId="4.4">
         <Name xml:lang="en">Outdoor</Name>
      </Term>
   </Term>
   <Term termId="5">
      <Name xml:lang="en">School</Name>
      <Definition xml:lang=”en”>
         A place where a person goes to study
      </Definition>
      <Term termId="5.1">
         <Name xml:lang="en">University</Name>
      </Term>
      <Term termId="5.2">
         <Name xml:lang="en">High School</Name>
      </Term>
      <Term termId="5.3">
         <Name xml:lang="en">Kindergarten</Name>
      </Term>
   </Term>
   <Term termId="6">
      <Name xml:lang="en">Hall</Name>
      <Definition xml:lang="en">
         A place or building used for meeting, entertainment, exhibition, etc.
      </Definition>
      <Term termId="6.1">
         <Name xml:lang="en">Museum</Name>
      </Term>
      <Term termId="6.2">
         <Name xml:lang="en">Library</Name>
```


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```
        </Term>
        <Term termId="6.3">
            <Name xml:lang="en">Theater</Name>
        </Term>
    </Term>
    <Term termId="7">
        <Name xml:lang="en">Public Facilities</Name>
        <Definition xml:lang=”en”>
            A place or building for public service
        </Definition>
        <Term termId="7.1">
            <Name xml:lang="en">Bank</Name>
        </Term>
        <Term termId="7.2">
            <Name xml:lang="en">Post Office</Name>
        </Term>
        <Term termId="7.3">
            <Name xml:lang="en">Hospital</Name>
        </Term>
        <Term termId="7.4">
            <Name xml:lang="en">Police</Name>
        </Term>
        <Term termId="7.5">
            <Name xml:lang="en">Public Office</Name>
        </Term>
        <Term termId="7.6">
            <Name xml:lang="en">Fire-Brigade Station</Name>
        </Term>
    </Term>
    <Term termId="8">
        <Name xml:lang="en">Historic Site</Name>
        <Definition xml:lang=”en”>
            A place or building of historic interest and value
        </Definition>
        <Term termId="8.1">
            <Name xml:lang="en">Palace</Name>
        </Term>
        <Term termId="8.2">
            <Name xml:lang="en">Castle</Name>
        </Term>
        <Term termId="8.3">
            <Name xml:lang="en">Church</Name>
        </Term>
        <Term termId="8.4">
            <Name xml:lang="en">Temple</Name>
        </Term>
        <Term termId="8.5">
            <Name xml:lang="en">Shrine</Name>
        </Term>
        <Term termId="8.6">
            <Name xml:lang="en">Graveyard</Name>
        </Term>
    </Term>
    <Term termId="9">
        <Name xml:lang="en">Natural Outdoor Spot</Name>
        <Definition xml:lang="en">
            A spot of natural or outdoor environment
        </Definition>
        <Term termId="9.1">
            <Name xml:lang="en">Mountain</Name>
```

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```
      </Term>
      <Term termId="9.2">
         <Name xml:lang="en">Sea</Name>
      </Term>
      <Term termId="9.3">
         <Name xml:lang="en">Lake</Name>
      </Term>
      <Term termId="9.4">
         <Name xml:lang="en">Pond</Name>
      </Term>
      <Term termId="9.5">
         <Name xml:lang="en">River</Name>
      </Term>
      <Term termId="9.6">
         <Name xml:lang="en">Valley</Name>
      </Term>
      <Term termId="9.7">
         <Name xml:lang="en">Field</Name>
      </Term>
      <Term termId="9.8">
         <Name xml:lang="en">Island</Name>
      </Term>
      <Term termId="9.9">
         <Name xml:lang="en">Sky</Name>
      </Term>
   </Term>
   <Term termId="10">
      <Name xml:lang="en">Hotel</Name>
      <Definition xml:lang=”en”>
         A building or place where people stay, sleep or take a rest
      </Definition>
   </Term>
   <Term termId="11">
      <Name xml:lang="en">Restaurant</Name>
      <Definition xml:lang=”en”>
         A building or place where foods are served and people can eat
      </Definition>
   </Term>
   <Term termId="12">
      <Name xml:lang="en">Shopping Spot</Name>
      <Definition xml:lang=”en”>
         A building or place where people go shopping
      </Definition>
         <Term termId="12.1">
            <Name xml:lang="en">Department Store</Name>
         </Term>
         <Term termId="12.2">
            <Name xml:lang="en">Supermarket</Name>
         </Term>
         <Term termId="12.3">
            <Name xml:lang="en">Shop</Name>
         </Term>
   </Term>
   <Term termId="13">
      <Name xml:lang="en">Leisure Spot</Name>
      <Definition xml:lang=”en”>
         A place where people enjoy leisure
      </Definition>
      <Term termId="13.1">
         <Name xml:lang="en">Park</Name>
```


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```
      </Term>
      <Term termId="13.2">
         <Name xml:lang="en">Garden</Name>
      </Term>
      <Term termId="13.3">
         <Name xml:lang="en">Amusement Park</Name>
      </Term>
      <Term termId="13.4">
         <Name xml:lang="en">Resort</Name>
      </Term>
      <Term termId="13.5">
         <Name xml:lang="en">Hot Spring</Name>
      </Term>
   </Term>
   <Term termId="14">
      <Name xml:lang="en">Sports Spot</Name>
      <Definition xml:lang=”en”>
         A place where people enjoy sports
      </Definition>
      <Term termId="14.1">
         <Name xml:lang="en">Stadium</Name>
      </Term>
      <Term termId="14.2">
         <Name xml:lang="en">Sports Gym</Name>
      </Term>
      <Term termId="14.3">
         <Name xml:lang="en">Tennis Court</Name>
      </Term>
      <Term termId="14.4">
         <Name xml:lang="en">Golf Course</Name>
      </Term>
      <Term termId="14.5">
         <Name xml:lang="en">Swimming Pool</Name>
      </Term>
      <Term termId="14.6">
         <Name xml:lang="en">Skiing Ground</Name>
      </Term>
      <Term termId="14.7">
         <Name xml:lang="en">Skating Rink</Name>
      </Term>
   </Term>
</ClassificationScheme>
```

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A.2.12 RenderingFormatCS

```
<ClassificationScheme
   uri="urn:mpeg:mpeg21:2003:01-DIA-RenderingFormatCS-NS">
   <Term termId="1">
      <Name xml:lang="en">Interlaced</Name>
   </Term>
   <Term termId="2">
      <Name xml:lang="en">Progressive</Name>
   </Term>
   <Term termId="3">
      <Name xml:lang="en">Sync-Double</Name>
   </Term>
   <Term termId="4">
      <Name xml:lang="en">Page-Flipping</Name>
   </Term>
   <Term termId="5">
      <Name xml:lang="en">Anaglyph-Red-Blue</Name>
   </Term>
   <Term termId="6">
      <Name xml:lang="en">Anaglyph-Red-Cyan</Name>
   </Term>
   <Term termId="7">
      <Name xml:lang="en">Anaglyph-Red-Green</Name>
   </Term>
   <Term termId="8">
      <Name xml:lang="en">Anaglyph-Yellow-Blue</Name>
   </Term>
</ClassificationScheme>
```

A.2.13 SceneCodingFormatCS

```
<ClassificationScheme
   uri="urn:mpeg:mpeg21:2003:01-DIA-SceneCodingFormatCS-NS" >
   <Term termId="1">
      <Name xml:lang="en">MPEG-4 Scene Graph</Name>
      <Term termId="1.1">
         <Name xml:lang="en">MPEG-4 Scene Graph Simple 2D Profile</Name>
         <Term termId="1.1.1">
            <Name xml:lang="en">MPEG-4 Scene Graph Simple 2D Profile
               @ Level 1</Name>
         </Term>
         <Term termId="1.1.2">
            <Name xml:lang="en">MPEG-4 Scene Graph Simple 2D Profile
               @ Level 2</Name>
         </Term>
      </Term>
      <Term termId="1.2">
         <Name xml:lang="en">MPEG-4 Scene Graph Audio Profile</Name>
         <Term termId="1.2.1">
            <Name xml:lang="en">MPEG-4 Scene Graph Audio Profile
               @ Level 1</Name>
         </Term>
         <Term termId="1.2.2">
            <Name xml:lang="en">MPEG-4 Scene Graph Audio Profile
               @ Level 2</Name>
         </Term>
         <Term termId="1.2.3">
```

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```
            <Name xml:lang="en">MPEG-4 Scene Graph Audio Profile
                @ Level 3</Name>
        </Term>
        <Term termId="1.2.4">
            <Name xml:lang="en">MPEG-4 Scene Graph Audio Profile
                @ Level 4</Name>
        </Term>
    </Term>
    <Term termId="1.3">
        <Name xml:lang="en">MPEG-4 Scene Graph Audio 3D Profile</Name>
        <Term termId="1.3.1">
            <Name xml:lang="en">MPEG-4 Scene Graph Audio 3D Profile
                @ Level 1</Name>
        </Term>
        <Term termId="1.3.2">
            <Name xml:lang="en">MPEG-4 Scene Graph Audio 3D Profile
                @ Level 2</Name>
        </Term>
        <Term termId="1.3.3">
            <Name xml:lang="en">MPEG-4 Scene Graph Audio 3D Profile
                @ Level 3</Name>
        </Term>
        <Term termId="1.3.4">
            <Name xml:lang="en">MPEG-4 Scene Graph Audio 3D Profile
                @ Level 4</Name>
        </Term>
    </Term>
    <Term termId="1.4">
        <Name xml:lang="en">MPEG-4 Scene Graph Basic 2D Profile</Name>
        <Term termId="1.4.1">
            <Name xml:lang="en">MPEG-4 Scene Graph Basic 2D Profile
                @ Level 1</Name>
        </Term>
    </Term>
    <Term termId="1.5">
        <Name xml:lang="en">MPEG-4 Scene Graph Core 2D Profile</Name>
        <Term termId="1.5.1">
            <Name xml:lang="en">MPEG-4 Scene Graph Core 2D Profile
                @ Level 1</Name>
        </Term>
        <Term termId="1.5.2">
            <Name xml:lang="en">MPEG-4 Scene Graph Core 2D Profile
                @ Level 2</Name>
        </Term>
    </Term>
    <Term termId="1.6">
        <Name xml:lang="en">MPEG-4 Scene Graph Advanced 2D Profile</Name>
        <Term termId="1.6.1">
            <Name xml:lang="en">MPEG-4 Scene Graph Advanced 2D Profile
                @ Level 1</Name>
        </Term>
        <Term termId="1.6.2">
            <Name xml:lang="en">MPEG-4 Scene Graph Advanced 2D Profile
                @ Level 2</Name>
        </Term>
    </Term>
    <Term termId="1.7">
        <Name xml:lang="en">MPEG-4 Scene Graph Main 2D Profile</Name>
        <Term termId="1.7.1">
            <Name xml:lang="en">MPEG-4 Scene Graph Main 2D Profile
```

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```
                @ Level 1</Name>
         </Term>
         <Term termId="1.7.2">
            <Name xml:lang="en">MPEG-4 Scene Graph Main 2D Profile
                @ Level 2</Name>
         </Term>
      </Term>
   </Term>
   <Term termId="2">
      <Name xml:lang="en">VRML</Name>
      <Definition xml:lang="en">Virtual Reality Modeling Language</Definition>
   </Term>
   <Term termId="3">
      <Name xml:lang="en">H-Anim</Name>
      <Definition xml:lang="en">Humanoid Animation</Definition>
      <Term termId="3.1">
         <Name xml:lang="en">Level of Articulation 0</Name>
      </Term>
      <Term termId="3.2">
         <Name xml:lang="en">Level of Articulation 1</Name>
      </Term>
      <Term termId="3.3">
         <Name xml:lang="en">Level of Articulation 2</Name>
      </Term>
      <Term termId="3.4">
         <Name xml:lang="en">Level of Articulation 3</Name>
      </Term>
      <Term termId="3.5">
         <Name xml:lang="en">Custom</Name>
      </Term>
   </Term>
</ClassificationScheme>
```

A.2.14 SegmentDecompositionInfoCS

```
<ClassificationScheme
uri="urn:mpeg:mpeg21: 2003:01-DIA-SegmentDecompositionInfoCS-NS">
   <Term termID="1">
      <Name xml:lang="en">GOP</Name>
      <Definition xml:lang="en">
          Specifies the group of pictures as a unit for video adaptation.
       </Definition>
   </Term>
   <Term termID="2">
      <Name xml:lang="en">VideoFrame</Name>
      <Definition xml:lang="en">
          Specifies the video frame as a unit for video adaptation.
       </Definition>
   </Term>
   <Term termID="3">
      <Name xml:lang="en">VideoField</Name>
      <Definition xml:lang="en">
          Specifies the video field as a unit for video adaptation.
       </Definition>
   </Term>
   <Term termID="4">
      <Name xml:lang="en">Slice</Name>
      <Definition xml:lang="en">
```

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```
            Specifies the slice as a unit for video adaptation.
         </Definition>
      </Term>
      <Term termID="5">
         <Name xml:lang="en">Macroblock</Name>
         <Definition xml:lang="en">
            Specifies the 16x16 macroblock combining all color components as a unit
            for image or video adaptation.
         </Definition>
      </Term>
      <Term termID="6">
         <Name xml:lang="en">Block</Name>
         <Definition xml:lang="en">
            Specifies the 8x8 block for a single component as a unit for image or
            video adaptation.
         </Definition>
      </Term>
      <Term termID="7">
         <Name xml:lang="en">Tile</Name>
         <Definition xml:lang="en">
            Specifies the Tile as a unit for ISO/IEC 15444-1 image adaptation.
         </Definition>
      </Term>
      <Term termID="8">
         <Name xml:lang="en">VideoObjectPlane</Name>
         <Definition xml:lang="en">
            Specifies the ISO/IEC 14496-2 Video Object Plane (VOP) as a unit for
video adaptation.
         </Definition>
      </Term>
      <Term termID="9">
         <Name xml:lang="en">VideoObject</Name>
         <Definition xml:lang="en">
            Specifies the ISO/IEC 14496-2 Video Object (VO) as a unit for video
adaptation.
         </Definition>
      </Term>
      <Term termID="10">
         <Name xml:lang="en">VideoObjectLayer</Name>
         <Definition xml:lang="en">
            Specifies the ISO/IEC 14496-2 Video Object Layer (VOL) as a unit for
video adaptation.
         </Definition>
      </Term>
      <Term termID="11">
         <Name xml:lang="en">AudioFrame</Name>
         <Definition xml:lang="en">
            Specifies the audio/speech frame as a unit for audio/speech adaptation.
         </Definition>
      </Term>
      <Term termID="12">
         <Name xml:lang="en">AudioChannel</Name>
         <Definition xml:lang="en">
            Specifies the audio channel as a unit for audio/speech adaptation.
         </Definition>
      </Term>
      <Term termID="13">
         <Name xml:lang="en">ROI</Name>
         <Definition xml:lang="en">
            Specifies the region of interest as a unit for image adaptation.
```

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```
      </Definition>
   </Term>
   <Term termID="14">
      <Name xml:lang="en">Component</Name>
      <Definition xml:lang="en">
          Specifies a component in a multi-component bit-stream as a unit for
          adaptation
       </Definition>
   </Term>
   <Term termID="15">
      <Name xml:lang="en">Generic2DSpatialUnit</Name>
      <Definition xml:lang="en">
          Specifies a generic 2D spatial unit as a unit for adaptation
       </Definition>
   </Term>
   <Term termID="16">
      <Name xml:lang="en">Generic3DSpatialUnit</Name>
      <Definition xml:lang="en">
          Specifies a generic 3D spatial unit as a unit for adaptation
       </Definition>
   </Term>
   <Term termID="17">
      <Name xml:lang="en">GenericTemporalUnit</Name>
      <Definition xml:lang="en">
          Specifies a generic temporal unit as a unit for adaptation
       </Definition>
   </Term>
   <Term termID="18">
      <Name xml:lang="en">Generic2DSpatioTemporalUnit</Name>
      <Definition xml:lang="en">
          Specifies a generic 3D spatio-temporal unit as a unit for adaptation
       </Definition>
   </Term>
   <Term termID="19">
      <Name xml:lang="en">Generic3DSpatioTemporalUnit</Name>
      <Definition xml:lang="en">
          Specifies a generic 2D spatio-temporal unit as a unit for adaptation
       </Definition>
   </Term>
</ClassificationScheme>
```

A.2.15 StackFunctionOperatorCS

```
<ClassificationScheme
   uri="urn:mpeg:mpeg21:2003:01-DIA-StackFunctionOperatorCS-NS">
   <Header xsi:type="DescriptionMetadataType">
      <Comment>
         <FreeTextAnnotation xml:lang="en">
            List of stack function operators.
         </FreeTextAnnotation>
      </Comment>
   </Header>
   <Term termID="1">
      <Name xml:lang="en">inverse</Name>
      <Definition xml:lang="en">
         Unary operator computing the inverse of the topmost stack element: 1/x
      </Definition>
   </Term>
```


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```
    <Term termID="2">
        <Name xml:lang="en">negative</Name>
        <Definition xml:lang="en">
            Unary operator computing the negative of the topmost stack element: -x
        </Definition>
    </Term>
    <Term termID="3">
        <Name xml:lang="en">magnitude</Name>
        <Definition xml:lang="en">
            Unary operator computing the absolute value of the topmost stack
            element: |x|
        </Definition>
    </Term>
    <Term termID="4">
        <Name xml:lang="en">log</Name>
        <Definition xml:lang="en">
            Unary operator computing the natural logarithm of the topmost stack
            element: logex
        </Definition>
    </Term>
    <Term termID="5">
        <Name xml:lang="en">log10</Name>
        <Definition xml:lang="en">
            Unary operator computing the base 10 logarithm of the topmost stack
            element: log10x
        </Definition>
    </Term>
    <Term termID="6">
        <Name xml:lang="en">exp</Name>
        <Definition xml:lang="en">
            Unary operator computing e raised to the power of the topmost stack
            element: ex
        </Definition>
    </Term>
    <Term termID="7">
        <Name xml:lang="en">power10</Name>
        <Definition xml:lang="en">
            Unary operator computing 10 raised to the power of the topmost stack
            element: 10x
        </Definition>
    </Term>
    <Term termID="8">
        <Name xml:lang="en">sqr</Name>
        <Definition xml:lang="en">
            Unary operator computing square of the topmost stack element: x2
        </Definition>
    </Term>
    <Term termID="9">
        <Name xml:lang="en">sqrt</Name>
        <Definition xml:lang="en">
            Unary operator computing square-root of the topmost stack element: x0.5
        </Definition>
    </Term>
    <Term termID="10">
        <Name xml:lang="en">clampZ</Name>
        <Definition xml:lang="en">
            Unary operator applied to the topmost stack element, clamping negative
            numbers to 0 while passing positive numbers as is: (x<0?0:x)
        </Definition>
    </Term>
```

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```
   <Term termID="11">
      <Name xml:lang="en">boolIsEQ</Name>
      <Definition xml:lang="en">
         Binary operator returning 1 if y - the second topmost stack element is
         equal to x - the topmost stack element, and 0 if not: bool(y==x)
      </Definition>
   </Term>
   <Term termID="12">
      <Name xml:lang="en">boolIsLT</Name>
      <Definition xml:lang="en">
         Binary operator returning 1 if y - the second topmost stack element is
         less than x - the topmost stack element, and 0 if not: bool(y<x)
      </Definition>
   </Term>
   <Term termID="13">
      <Name xml:lang="en">boolIsGT</Name>
      <Definition xml:lang="en">
         Binary operator returning 1 if y - the second topmost stack element is
         greater than x - the topmost stack element, and 0 if not: bool(y>x)
      </Definition>
   </Term>
   <Term termID="14">
      <Name xml:lang="en">boolNOT</Name>
      <Definition xml:lang="en">
         Unary operator returning the Boolean NOT of the topmost stack element:
         NOT(x)
         note: A non-zero operand is regarded as a Boolean 1.
      </Definition>
   </Term>
   <Term termID="15">
      <Name xml:lang="en">add</Name>
      <Definition xml:lang="en">
         Binary operator adding the two topmost stack elements: (x+y)
      </Definition>
   </Term>
   <Term termID="16">
      <Name xml:lang="en">subtract</Name>
      <Definition xml:lang="en">
         Binary operator subtracting x - the topmost stack element, from y –
         the second topmost element: (y-x)
      </Definition>
   </Term>
   <Term termID="17">
      <Name xml:lang="en">absdiff</Name>
      <Definition xml:lang="en">
         Binary operator computing the absolute difference between the
         two topmost stack elements: (|y-x|)
      </Definition>
   </Term>
   <Term termID="18">
      <Name xml:lang="en">multiply</Name>
      <Definition xml:lang="en">
         Binary operator multiplying the two topmost stack elements: (xy)
      </Definition>
   </Term>
   <Term termID="19">
      <Name xml:lang="en">divide</Name>
      <Definition xml:lang="en">
         Binary operator dividing y - the second topmost stack element by
         x - the topmost stack element: (y/x)
```


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```
      </Definition>
   </Term>
   <Term termID="20">
      <Name xml:lang="en">maximum</Name>
      <Definition xml:lang="en">
         Binary operator returning the maximum of the two topmost stack
         elements: max(x,y)
      </Definition>
   </Term>
   <Term termID="21">
      <Name xml:lang="en">minimum</Name>
      <Definition xml:lang="en">
         Binary operator returning the minimum of the two topmost stack
         elements: min(x,y)
      </Definition>
   </Term>
   <Term termID="22">
      <Name xml:lang="en">average</Name>
      <Definition xml:lang="en">
         Binary operator returning the average of the two topmost stack
         elements: (x+y)/2
      </Definition>
   </Term>
   <Term termID="23">
      <Name xml:lang="en">boolOR</Name>
      <Definition xml:lang="en">
         Binary operator returning the Boolean OR of the two topmost stack
         elements: (x OR y)
         Note: Any non-zero operand is regarded as a Boolean 1.
      </Definition>
   </Term>
   <Term termID="24">
      <Name xml:lang="en">boolAND</Name>
      <Definition xml:lang="en">
         Binary operator returning the Boolean AND the two topmost stack
         elements: (x AND y)
         Note: Any non-zero operand is regarded as a Boolean 1.
      </Definition>
   </Term>
   <Term termID="25">
      <Name xml:lang="en">boolXOR</Name>
      <Definition xml:lang="en">
         Binary operator returning the Boolean XOR of the two topmost stack
         elements: (x XOR y)
         Note: Any non-zero operand is regarded as a Boolean 1.
      </Definition>
   </Term>
   <Term termID="26">
      <Name xml:lang="en">floor</Name>
      <Definition xml:lang="en">
         Unary operator computing the floor of the topmost stack element:
         floor(x)
      </Definition>
   </Term>
   <Term termID="27">
      <Name xml:lang="en">ceil</Name>
      <Definition xml:lang="en">
         Unary operator computing the ceiling of the topmost stack element:
         ceil(x)
      </Definition>
```

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```
    </Term>
    <Term termID="28">
        <Name xml:lang="en">round</Name>
        <Definition xml:lang="en">
            Unary operator rounding the topmost stack element to the nearest
            integer: round(x)
        </Definition>
    </Term>
    <Term termID="29">
        <Name xml:lang="en">selector</Name>
        <Definition xml:lang="en">
            Ternary operator, returning y - the second topmost element if x –
            the topmost element is non-zero, and z - the third topmost element,
            otherwise: (x?y:z)
        </Definition>
    </Term>
    <Term termID="30">
        <Name xml:lang="en">tokencmp</Name>
        <Definition xml:lang="en">
            Birnary string operator, returning 0 if the two topmost stack elements
            (both string tokens) are equal, 1 if y - the second topmost stack
            element is later in alphabetical order than x – the topmost stack
            element, and -1 if x is later than y: strcmp(y,x)
        </Definition>
    </Term>
    <Term termID="31">
        <Name xml:lang="en">quotient</Name>
        <Definition xml:lang="en">
            Binary operator computing the integer quotient, when y - the second
            topmost stack element is divided by x - the topmost stack element. The
            quotient is computed such that the remainder always has the same sign
            as x, obtained by taking the floor of the division: floor(y/x)
        </Definition>
    <Term termID="32">
        <Name xml:lang="en">remainder</Name>
        <Definition xml:lang="en">
            Binary operator computing the remainder, when y - the second topmost
            stack element is divided by x - the topmost stack element. The
            remainder always has the same sign as x: y – x.floor(y/x)
        </Definition>
    </Term>
    <Term termID="33">
        <Name xml:lang="en">wavedecompsize</Name>
        <Definition xml:lang="en">
            Binary operator computing the length of the low pass signal after x
            levels of dyadic wavelet decomposition of a length y signal, where x
            and y are the topmost and second topmost stack elements respectively:
            ……    ceil(ceil(y/2)/2 …… x times
        </Definition>
    </Term>
    <Term termID="34">
        <Name xml:lang="en">rightbitshift</Name>
        <Definition xml:lang="en">
            Binary operator computing the result of right bit shift of y – the
            second topmost stack element, by x positions, where x is the topmost
            stack element: …… floor(floor(y/2)/2 …… x times, or y>>x
        </Definition>
    </Term>
    <Term termID="35">
        <Name xml:lang="en">leftbitshift</Name>
```


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```
      <Definition xml:lang="en">
         Binary operator computing the result of left bit shift of y - the
         second topmost stack element, by x positions, where x is the topmost
         stack element: y.(2^x), or y<<x
      </Definition>
   </Term>
   <Term termID="36">
      <Name xml:lang="en">log2</Name>
      <Definition xml:lang="en">
         Unary operator computing the base 2 logarithm of the topmost stack
         element: log2(x)
      </Definition>
   </Term>
   <Term termID="37">
      <Name xml:lang="en">power2</Name>
      <Definition xml:lang="en">
         Unary operator computing 2 raised to the power of the topmost stack
         element: 2^x
      </Definition>
   </Term>
   <Term termID="38">
      <Name xml:lang="en">boolIsLE</Name>
      <Definition xml:lang="en">
         Binary operator returning 1 if y - the second topmost stack element is
         less than or equal to x - the topmost stack element, and 0 if not:
         bool(y<=x)
      </Definition>
   </Term>
   <Term termID="39">
      <Name xml:lang="en">boolIsGE</Name>
      <Definition xml:lang="en">
         Binary operator returning 1 if y - the second topmost stack element is
         greater than or equal to x - the topmost stack element, and 0 if not:
         bool(y>=x)
      </Definition>
   </Term>
</ClassificationScheme>
```

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A.2.16 RightsLanguagesCS

```
<ClassificationScheme
   uri="urn:mpeg:mpeg21:2003:01-DIA-RightsLanguagesCS-NS" >
  <Header xsi:type="DescriptionMetadata">
    <FreeTextAnnotation xml:lang="en">
      List of rights expression languages (RELs).
    </FreeTextAnnotation>
  </Header>
  <Term termId="REL">
    <Name xml:lang="en">MPEG-21 REL</Name>
    <Definition xml:lang="en">
      MPEG-21 Rights Expression Language as defined in ISO/IEC 21000-5.
    </Definition>
    <Term termId="RELProfile:Base">
      <Name xml:lang="en">MPEG-21 REL Base Profile</Name>
      <Definition xml:lang="en">
        MPEG-21 Rights Expression Language Base Profile as defined in
ISO/IEC 21000-5.
      </Definition>
    </Term>
    <Term termId="RELProfile:DAC">
      <Name xml:lang="en">MPEG-21 REL DAC Profile</Name>
      <Definition xml:lang="en">
        MPEG-21 Rights Expression Language Dissemination and Capture
        Profile as defined in ISO/IEC 21000-5.
      </Definition>
    </Term>
  </Term>
</ClassificationScheme>
```


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Annex B

(informative)

Usage of the BSDLink tool

B.1 Introduction

This Annex describes a general architecture for the BSDLink tool as specified in clause 7 to clarify how the tools that are capable to steer the adaptation process, e.g., terminal and network quality of service, usage environment, etc., make use of the BSDLink tool and can be combined and integrated into the DIA framework. For this purpose, in this Annex the AdaptationQoS tool as specified in clause 9 is used as an example for the steering description. Furthermore, the usage as well as the usage environment of the Digital Item is constrained by Universal Constraints Descriptions as specified in subclause 9.10.

In the following an overview of the components used for AdaptationQoS controlled, BSD based adaptations are given and the required processing steps are described.

B.2 Overview of the adaptation architecture

In this subclause the components used in an AdaptationQoS controlled, BSD based adaptation are illustrated and explained. The high-level architecture of a DIA engine is depicted in Figure B.1. The input Digital Item (DI_1) usually comprises the resource (R_1) and associated descriptions (D_1) which are subject to the adaptation process. Other input Digital Items (DI_2) contains the metadata, e.g., ISO/IEC 21000-7 Usage Environment Descriptions (UEDs) or Universal Constraints Descriptions (UCDs), which governs the adaptation process in order to produce the (adapted) output Digital Item (DI_3). The extraction of the desired information from DI_1 and DI_2 could be performed by ISO/IEC 21000-2 reference software (Digital Item Declaration parser). The composing of the adapted Digital Item (DI_3) is similar to the extraction.

The input Digital Items could be also validated using the ISO/IEC 21000 DID reference software prior to the extractions and the adapted output Digital Item could be also validated accordingly.

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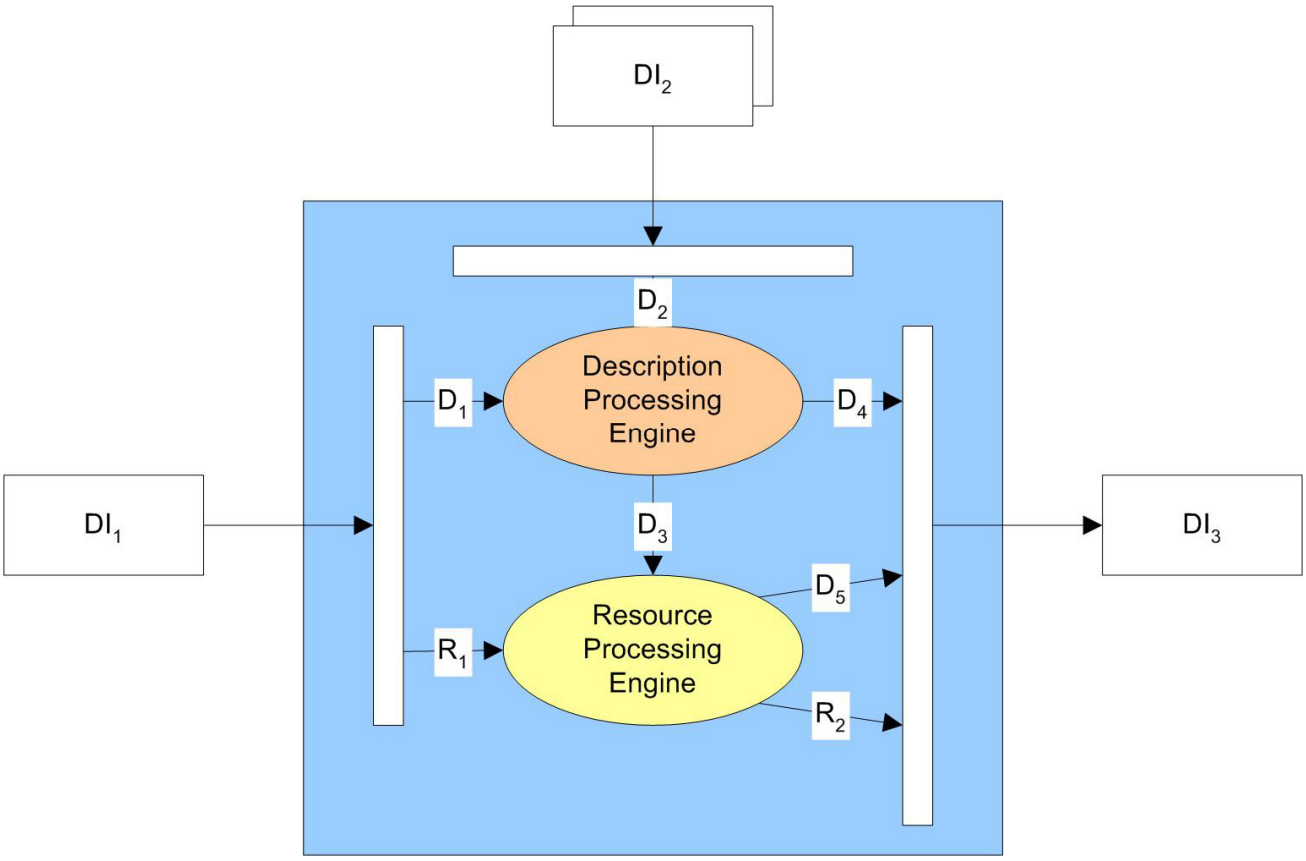

Figure B.1 — High-level architecture of a Digital Item Adaptation engine.

The adaptation engine consists of the Description Processing Engine (DPE) and the Resource Processing Engine (RPE).

The DPE takes as an input the descriptions (D_1) contained within DI_1 and descriptions (D_2) contained within DI_2. The output of the DPE is on the one hand D_3, e.g., a possible transformed description, which governs the actual resource adaptation (input to RPE) and on the other hand D_4 which will become part of the adapted Digital Item (DI_3).

The RPE adapts the resource (R_1) governed by means of the output of the DPE (D_3). The output is the adapted resource (R_2) and possibly an updated (transformed) description (D_5), which reflects the modifications in the resource accordingly.

Finally, the transformed Descriptions (D_3 and D_5) and the resource are composed to the adapted Digital Item (DI_3). The adapted Digital Item could be also validated in the same way as the input Digital Item.

Table B.1 shows example descriptions and resources for the DIA engine as illustrated in Figure B.1.

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Table B.1 — Example descriptions and resources.

Short term	Example instantiation
D_1	BSDLink with an AdaptationQoS description (which may itself reference a Universal Constraints Description (UCD)) as steering description and an XSLT or STX style sheet as BSD Transformation.
D_2	Usage Environment Description (UED) and/or Universal Constraints Description (UCD)
D_3	Transformed (g)BSD
D_4	Transformed BSDLink
R_1	Resource, e.g., JPEG2000 image, MPEG-4 Visual Elementary stream
D_5	Updated, transformed (g)BSD
R_2	Adapted resource, e.g., smaller JPEG2000 image or grayscale JPEG2000 image, or temporal adapted MPEG-4 Visual elementary stream.

In the following a walkthrough of the Digital Item Adaptation engine (Figure B.1) using the Descriptions from Table B.1 is given. In this example, the BSD Transformation is assumed to be an XSLT style sheet but the architecture would be the same for another transformation such as STX.

Figure B.2 illustrates the DPE in more detail.

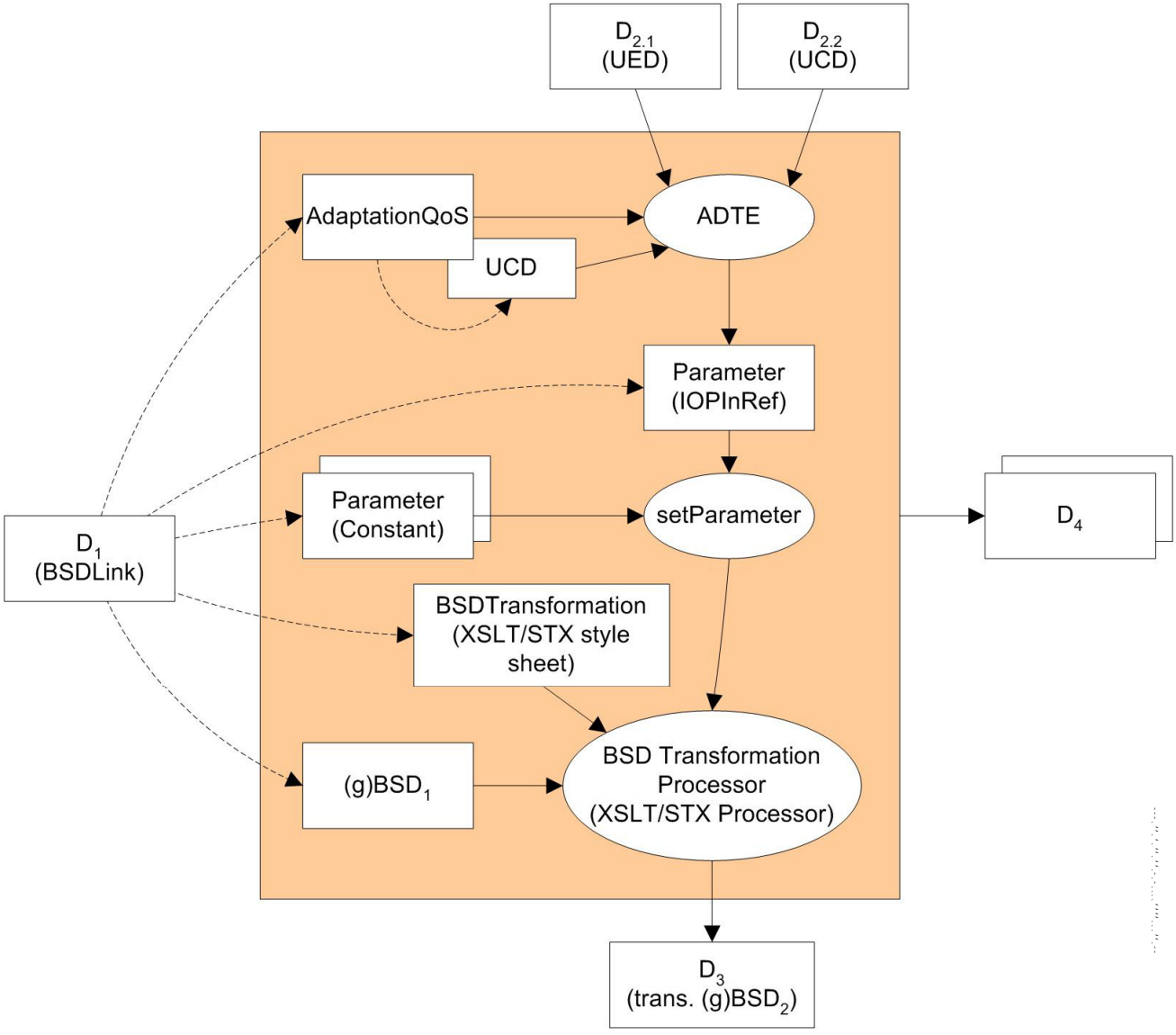

Figure B.2 — Description Processing Engine.

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The processing of D_1 (e.g., BSDLink), $D_{2.1}$ (UED), and $D_{2.2}$ (UCD) is as follows:

1. The steering description, i.e., AdaptationQoS, forms the input for the Adaptation Decision Taking Engine (ADTE) together with the UED. The AdaptationQoS Description as well as the UED may be further restricted by two separate UCDs (cf. Figure E.3).

2. The ADTE retrieves the actual values for the variable parameters (IOPins) defined in the BSDLink description from the UED. Additionally, it resolves the constraints as defined within the UCDs.

3. IOPinRef and constant parameters define the input parameters for the BSD transformation processor, in this example, the XSLT processor.

4. The XSLT processor transforms the (g)BSD using the parameterised XSLT stye sheet and produces the transformed (g)BSD.

5. The ADTE together with the whole DPE might also produce a transformed BSDLink description.

Subsequently, the transformed (g)BSD is forwarded to the RPE, i.e., (g)BSDtoBin, as depicted in Figure B.3. The RPE generates the adapted resource and possibly updates the addressing information according to the adapted resource.

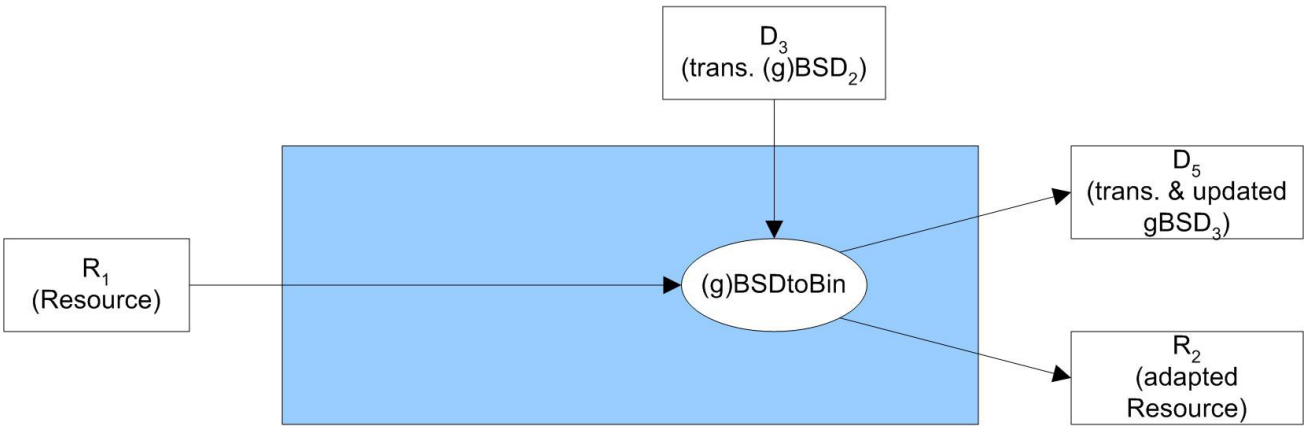

Figure B.3 — Resource Processing Engine.

B.3 Example instances

B.3.1 Introduction

This subclause provides example instances for the descriptions and resources.

The first use case provides the BSDLink for ISO/IEC 15444-1 resources comprising a steering description which is a reference to a AdaptationQoS description. The AdaptationQoS description provides the scaling factor for the BSD transformations (XSLT or STX style sheet) which are used for spatial scaling of the resource. This subclause comprises following DIDs, DIA descriptions, and resources regarding this use case:

- One input DID comprising one Usage Environment Description with the description of the display capabilities and network conditions (B.3.2).

- One input DID comprising the BSDLink description (B.3.3) which itself contains references to following DIA descriptions:

  - AdaptationQoS description as steering description (B.3.4).

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- Alternative AdaptationQoS description as steering description along with provider and consumer side UCD (B.3.5)
- BS Description (B.3.6).
- Two BSD Transformations, i.e., one XSLT style sheet and the equivalent STX version (B.3.7).

- The BS Schema for ISO/IEC 15444-1 resource (B.3.6).
- The equivalent gBS Description to the BS Description (B.3.6).
- The original and adapted ISO/IEC 15444-1 resource (B.3.8).

The second use case provides the BSDLink for ISO/IEC 14496-2 Elementary Streams comprising a steering description which is a reference to a AdaptationQoS description. The AdaptationQoS description provides the frame type which should be removed from the gBSD by means of the BSD transformations (XSLT or STX style sheet). This subclause comprises following DIDs and DIA descriptions regarding this use case:

- One input DID comprising one Usage Environment Description with the description of the decoding capabilities (B.3.2).
- One input DID comprising the BSDLink description (B.3.3) which itself contains references to following DIA descriptions:
  - AdaptationQoS description as steering description (B.3.4).
  - gBS Description (B.3.6).
  - Two BSD Transformations, i.e., one XSLT style sheet and the equivalent STX version (B.3.7).

B.3.2 Usage environment description

The following UED describes one terminal with one active display and its resolution is 176 times 220 pixels. Furthermore its color capability is set to false. Additionally, the network conditions in terms of its available average bandwidth is described, i.e., 200,000 bits/sec.

```
<did:DIDL>
   <did:Item>
      <did:Descriptor>
         <did:Statement mimeType="text/xml">
            <DIA>
               <Description xsi:type="UsageEnvironmentType">
                  <UsageEnvironmentProperty xsi:type="TerminalsType">
                     <Terminal>
                        <TerminalCapability xsi:type="DisplaysType">
                           <Display>
                              <DisplayCapability xsi:type="DisplayCapabilityType"
                                        activeDisplay="true" colorCapable="false">
                                 <Mode>
                                    <Resolution horizontal="176" vertical="220"
                                          activeResolution="true"/>
                                 </Mode>
                              </DisplayCapability>
                           </Display>
                        </TerminalCapability>
                     </Terminal>
                  </UsageEnvironmentProperty>
                  <UsageEnvironmentProperty xsi:type="NetworksType">
                     <Network>
                        <NetworkCharacteristic xsi:type="NetworkConditionType">
                           <AvailableBandwidth average="200000"/>
```

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```
                        </NetworkCharacteristic>
                     </Network>
                  </UsageEnvironmentProperty>
               </Description>
            </DIA>
         </did:Statement>
      </did:Descriptor>
   </did:Item>
</did:DIDL>
```

The following UED describes another terminal with *MPEG-4 Simple Profile* decoding capabilities.

```
<did:DIDL>
   <did:Item>
      <did:Descriptor>
         <did:Statement mimeType="text/xml">
            <DIA>
               <Description xsi:type="UsageEnvironmentType">
                  <UsageEnvironmentProperty xsi:type="TerminalsType">
                      <Terminal>
                         <TerminalCapability xsi:type="CodecCapabilitiesType">
                            <Decoding xsi:type="VideoCapabilitiesType">
                               <Format
                           href="urn:mpeg:mpeg7:cs:VisualCodingFormatCS:2001:3.1">
                                     <mpeg7:Name xml:lang="en">
                                           MPEG-4 Simple Profile
                                        </mpeg7:Name>
                                  </Format>
                            </Decoding>
                         </TerminalCapability>
                     </Terminal>
                  </UsageEnvironmentProperty>
               </Description>
            </DIA>
         </did:Statement>
      </did:Descriptor>
   </did:Item>
</did:DIDL>
```

B.3.3 BSDLink

The following BSDLink implements the first use case as described in Annex B.3.1 (ISO/IEC 15444-1 resources). It contains a reference to a steering descripton, i.e., AdaptationQoS description of this resource, a BSD, XSLT style sheet, STX style sheet and corresponding parameter definitions for scaling the resource with regards to its spatial dimension.

```
<?xml version="1.0" encoding="UTF-8"?>
<did:DIDL>
   <did:Item>
      <!-- Digital Item Adaptation Descripton- BSDLink -->
      <did:Descriptor id="bsdlink">
         <did:Statement mimeType="text/xml">
            <DIA>
               <Description xsi:type="BSDLinkType">
                  <SteeringDescriptionRef uri="AQoS BABY.xml"/>
                  <BSDRef uri="BABY_BSD.xml"/>
                  <BitstreamRef uri="baby.jp2"/>
                  <BSDTransformationRef uri="jp2.xsl"
                              type="http://www.w3.org/1999/XSL/Transform"/>
                  <BSDTransformationRef uri="jp2.stx"
                         type="http://stx.sourceforge.net/2002/ns"/>
                  <Parameter xsi:type="IOPinRefType" name="scale">
```


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```
                    <Value>SCALE</Value>
                 </Parameter>
                 <Parameter xsi:type="ConstantType" name="CsizIn">
                    <Value>NR_COLORS</Value>
                 </Parameter>
              </Description>
           </DIA>
        </did:Statement>
     </did:Descriptor>
  </did:Item>
</did:DIDL>
```

The following BSDLink implements the second use case as described in Annex B.3.1 (ISO/IEC 14496-2 Elementary Streams). It contains a reference to a steering descripton, i.e., AdaptationQoS description of this resource, a gBSD, XSLT style sheet, STX style sheet and a corresponding parameter definition for dropping B-frames.

```
<?xml version="1.0" encoding="UTF-8"?>
<did:DIDL>
   <did:Item>
      <!-- Digital Item Adaptation Descripton- BSDLink -->
      <did:Descriptor id="bsdlink">
         <did:Statement mimeType="text/xml">
            <DIA>
               <Description xsi:type="BSDLinkType">
                  <SteeringDescriptionRef uri="AQoS AKIYO.xml"/>
                  <BSDRef uri="AKIYO_gBSD.xml"/>
                  <BitstreamRef uri="akiyo.cmp"/>
                  <BSDTransformationRef uri="mp4.xsl"
                          type="http://www.w3.org/1999/XSL/Transform"/>
                  <BSDTransformationRef uri="mp4.stx"
                              type="http://stx.sourceforge.net/2002/ns"/>
                  <Parameter xsi:type="IOPinRefType" name="removeBVOPs">
                     <Value>REMOVE_BVOPS</Value>
                  </Parameter>
               </Description>
            </DIA>
         </did:Statement>
      </did:Descriptor>
   </did:Item>
</did:DIDL>
```

B.3.4 Steering description

The following AdaptationQoS description implements the steering description for the first use case as described in Annex B.3.1 (ISO/IEC 15444-1 resources). The input I/O pins are characterised by means of semantical data references to Classification Scheme terms defined within the `AdaptationQoSCS`.

The input I/O pins with the `DISP_WIDTH` and `DISP_HEIGHT` id represent respectively the possible horizontal and vertical display resolution values. The AdaptationQoS module associated with these I/O pins returns the scaling factor applicable to the resource for a given resolution of the display. The scaling factor is provided by the I/O pin with the `SCALE` id.

The input I/O pin with the `COLOR_CAPABLE` id represents the possible display's color capabilities. The AdaptationQoS module associated with this I/O pin returns the required number of color components for the resource with respect to the color capability of the display. The number of color components is provided by the I/O pin with the id `NR_COLORS`.

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```
<?xml version="1.0" encoding="UTF-8"?>
<DIA>
   <DescriptionMetadata>
      <ClassificationSchemeAlias alias="AQoS"
               href="urn:mpeg:mpeg21:2003:01-DIA-AdaptationQoSCS-NS"/>
      <ClassificationSchemeAlias alias="MEI"
               href="urn:mpeg:mpeg21:2003:01-DIA-MediaInformationCS-NS"/>
</DescriptionMetadata>
   <Description xsi:type="AdaptationQoSType">
      <!-- Provides the scale factor with respect to the display resolution -->
      <Module xsi:type="LookUpTableType">
         <Axis iOPinRef="DISP_WIDTH">
            <AxisValues xsi:type="IntegerVectorType">
               <Vector>80 160 320 640</Vector>
            </AxisValues>
         </Axis>
         <Axis iOPinRef="DISP HEIGHT">
            <AxisValues xsi:type="IntegerVectorType">
               <Vector>60 120 240 480</Vector>
            </AxisValues>
         </Axis>
         <Content iOPinRef="SCALE">
            <ContentValues xsi:type="IntegerMatrixType" mpeg7:dim="4 4">
               <Matrix>
                   3 3 3 3
                   3 2 2 2
                   3 2 1 1
                   3 2 1 0
               </Matrix>
            </ContentValues>
         </Content>
      </Module>
      <!-- Provides the number of color components with respect to the
           color capability of the display -->
      <Module xsi:type="LookUpTableType">
         <Axis iOPinRef="COLOR_CAPABLE">
            <AxisValues xsi:type="BooleanVectorType">
               <Vector>false true</Vector>
            </AxisValues>
         </Axis>
         <Content iOPinRef="NR COLORS">
            <ContentValues xsi:type="IntegerMatrixType" mpeg7:dim="2">
               <Matrix>1 3</Matrix>
            </ContentValues>
         </Content>
      </Module>
      <!-- Frame width of the resource -->
      <IOPin id="DISP WIDTH">
         <!-- Horizontal resolution of a display -->
         <GetValue xsi:type="SemanticalDataRefType" semantics=":AQS:6.5.9.1"/>
      </IOPin>
      <!-- Frame height of the resource -->
      <IOPin id="DISP HEIGHT">
         <!-- Vertical resolution of a display -->
         <GetValue xsi:type="SemanticalDataRefType" semantics=":AQS:6.5.9.2"/>
      </IOPin>
      <IOPin id="COLOR CAPABLE">
         <!-- Color capability of a display -->
         <GetValue xsi:type="SemanticalDataRefType" semantics=":AQS:6.5.9.26"/>
      </IOPin>
      <!-- Scale factor for the resource adaptation engine -->
      <IOPin id="SCALE"/>
      <!-- Number of output color components for the
           resource adaptation engine -->
      <IOPin id="NR_COLORS"/>
   </Description>
</DIA>
```


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An Adaptation Decision-Taking Engine based on the above AdaptationQoS description gets the values of display resolution and display color capability in I/O pins DISP_WIDTH, DISP_HEIGHT and COLOR_CAPABLE, and then looks up the values of the corresponding SCALE and NR_COLORS by processing the AdaptationQoS modules. The obtained values of IOPins SCALE and NR_COLORS are then used in the BSDLink to pass parameters to the BSD transformation style sheet.

The following AdaptationQoS description implements the steering description for the second use case as described in Annex B.3.1 (ISO/IEC 14496-2 Elementary Streams). The input I/O pins are characterised by means of semantical data references to Classification Scheme terms defined within the AdaptationQoSCS.

The input I/O pin with the CODING_FORMAT id represents the possible supported video decoding capabilities of the display. The AdaptationQoS module associated with this I/O pin returns a Boolean indicating if B-frames (Visual Object Planes from type 2 according to ISO/IEC 14496-2) of the resource should be dropped or not with respect to the decoding capabilities of the receiving terminal. This information is provided by the I/O pin with the REMOVE_BVOPS id.

```
<?xml version="1.0" encoding="UTF-8"?>
<DIA>
   <DescriptionMetadata>
      <ClassificationSchemeAlias alias="AQoS"
               href="urn:mpeg:mpeg21:2003:01-DIA-AdaptationQoSCS-NS"/>
   </DescriptionMetadata>
   <Description xsi:type="AdaptationQoSType">
      <Module xsi:type="LookUpTableType">
         <Axis iOPinRef="CODING FORMAT">
            <AxisValues xsi:type="NMTokenVectorType">
               <Vector>urn:mpeg:mpeg7:cs:VisualCodingFormatCS:2001:3.1
                        urn:mpeg:mpeg7:cs:VisualCodingFormatCS:2001:3.3</Vector>
            </AxisValues>
         </Axis>
         <Content iOPinRef="REMOVE_BVOPS">
            <ContentValues xsi:type="BooleanMatrixType" mpeg7:dim="2">
               <Matrix>true false</Matrix>
            </ContentValues>
         </Content>
      </Module>
      <IOPin id="CODING_FORMAT">
         <!-- Video Codec (decoding) Capabilities -->
         <GetValue xsi:type="SemanticalDataRefType" semantics=":AQS:10.3"/>
      </IOPin>
      <IOPin id="REMOVE BVOPS"/>
   </Description>
</DIA>
```

An Adaptation Decision-Taking Engine based on the above AdaptationQoS description gets the value of the supported decoding capability in the CODING_FORMAT I/O pin, and then looks up the value of the REMOVE_BVOPS I/O pin by processing the AdaptationQoS module. The REMOVE_BVOPS I/O pin is then used in the BSDLink to pass parameters to the BSD transformation style sheet.

B.3.5 Further constraining the usage and usage environment of a Digital Item

The Universal Constraints Description (UCD) tool provide means for specifying supplementary information to further constrain the *usage* and the *usage environment* of a Digital Item, beyond that is possible by a UED. A link to a provider-side UCD is added to the AdaptationQoS description to constrain the usage of the Digital Item. On the other hand, constraints based on the usage environment of the Digital Item can be specified by an additional consumer-side UCD.

The following AdaptationQoS description implements an alternative steering description for the first use case as described in Annex B.3.1 (ISO/IEC 15444-1 resources), to be processed in conjunction with UCDs. This AdaptationQoS description enables the flexibility of choosing either the scale or the number of color

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components to include, in order to satisfy various provider and consumer side constraints specified using the UCD tool.

The I/O pin with id SCALE provides the possible scalings of the resource, while I/O pins with ids WIDTH and HEIGHT represent respectively the corresponding horizontal and vertical resolution values of the media resource. The I/O pin with id MEDIA_COLOR represents the possible color renderings of the media resource (color or grayscale), while the I/O pin with id NR_COLORS represent the corresponding number of color components to include in the adapted resource. The I/O pin with the id FILE_SIZE represents the file size of the resource for each possible scale and color rendering.

```
<?xml version="1.0" encoding="UTF-8"?>
<DIA>
   <DescriptionMetadata>
      <ClassificationSchemeAlias alias="AQoS"
               href="urn:mpeg:mpeg21:2003:01-DIA-AdaptationQoSCS-NS"/>
      <ClassificationSchemeAlias alias="MEI"
               href="urn:mpeg:mpeg21:2003:01-DIA-MediaInformationCS-NS"/>
</DescriptionMetadata>
   <Description xsi:type="AdaptationQoSType">
      <!-- Provides the scale factor with respect to the
           resolution of the resource -->
      <Module xsi:type="LookUpTableType">
         <AxisRef iOPinRef="SCALE"/>
         <Content iOPinRef="WIDTH">
            <ContentValues xsi:type="IntegerMatrixType" mpeg7:dim="4">
               <Matrix>640 320 160 80</Matrix>
            </ContentValues>
         </Content>
         <Content iOPinRef="HEIGHT">
            <ContentValues xsi:type="IntegerMatrixType" mpeg7:dim="4">
               <Matrix>480 240 120 60</Matrix>
            </ContentValues>
         </Content>
      </Module>
      <!-- Provides the number of color components with respect to the
           media color of the resource -->
      <Module xsi:type="LookUpTableType">
         <AxisRef iOPinRef="MEDIA COLOR"/>
         <Content iOPinRef="NR COLORS">
            <ContentValues xsi:type="IntegerMatrixType" mpeg7:dim="2">
               <Matrix>1 3</Matrix>
            </ContentValues>
         </Content>
      </Module>
      <!-- Provides the scale factor and color components with respect to the
           file size of the resource -->
      <Module xsi:type="LookUpTableType">
         <AxisRef iOPinRef="SCALE"/>
         <AxisRef iOPinRef="MEDIA_COLOR"/>
         <Content iOPinRef="FILE_SIZE">
            <ContentValues xsi:type="IntegerMatrixType" mpeg7:dim="4 2">
               <Matrix>
                      30328 38400 15857 23827
                       7114 14054  3305  7519
               </Matrix>
            </ContentValues>
         </Content>
      </Module>
      <!-- Frame width of the resource -->
      <IOPin id="WIDTH" semantics=":MEI:17"/>
      <!-- Frame height of the resource -->
      <IOPin id="HEIGHT" semantics=":MEI:18"/>
      <!-- Color domain of the resource-->
      <IOPin id="MEDIA_COLOR" semantics=":MEI:13">
         <Axis>
            <AxisValues xsi:type="TokenVectorType">
```

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```
               <Vector>grayscale color</Vector>
            </AxisValues>
         </Axis>
      </IOPin>
      <!-- File size of the resource-->
      <IOPin id="FILE_SIZE" semantics=":MEI:3"/>
      <!-- Scale factor for the resource adaptation engine -->
      <IOPin id="SCALE">
         <Axis>
            <AxisValues xsi:type="IntegerVectorType">
               <Vector>0 1 2 3</Vector>
            </AxisValues>
         </Axis>
      </IOPin>
      <!-- Number of output color components for the
           resource adaptation engine -->
      <IOPin id="NR COLORS"/>
      <Constraints uri="providerUCD.xml#providerUCD"/>
   </Description>
</DIA>
```

The following UCD (providerUCD.xml) is referenced by the `AdaptationQoS` description above via the `Constraints` element. It could be located within the same DID or in a different file or location. The UCD defines following constraints:

- Two limitation constraints which does not allow scaling down the spatial resolution under a given threshold. In this example, the image should not become smaller than 20% of the viewing terminals's resolution.
- An optimization constraint which state that the resource width (and therefore height) should be maximized in case of a possible adaptation.

```
<?xml version="1.0" encoding="UTF-8"?>
<DIA>
   <DescriptionMetadata>
      <ClassificationSchemeAlias alias="AQS"
               href="urn:mpeg:mpeg21:2003:01-DIA-AdaptationQoSCS-NS"/>
      <ClassificationSchemeAlias alias="SFO"
               href="urn:mpeg:mpeg21:2003:01-DIA-StackFunctionOperatorCS-NS"/>
      <ClassificationSchemeAlias alias="MEI"
               href="urn:mpeg:mpeg21:2003:01-DIA-MediaInformationCS-NS"/>
   </DescriptionMetadata>
   <Description xsi:type="UCDType" id="providerUCD">
      <AdaptationUnitConstraints>
         <!-- FrameWidth > 0.20*DisplayWidth  -->
         <LimitConstraint>
            <Argument xsi:type="SemanticalRefType" semantics=":MEI:17"/>
            <Argument xsi:type="SemanticalDataRefType" semantics=":AQS:6.5.9.1"/>
            <Argument xsi:type="ConstantDataType">
               <Constant xsi:type="FloatType">
                  <Value>0.20</Value>
               </Constant>
            </Argument>
            <!-- Multiply operation-->
            <Operation operator=":SFO:18"/>
            <!-- Bool IsGreaterThanOrEqualTo operation-->
            <Operation operator=":SFO:39"/>
         </LimitConstraint>
         <!-- FrameHeight > 0.20*DisplayHeight -->
         <LimitConstraint>
            <Argument xsi:type="SemanticalRefType" semantics=":MEI:18"/>
            <Argument xsi:type="SemanticalDataRefType" semantics=":AQS:6.5.9.2"/>
            <Argument xsi:type="ConstantDataType">
               <Constant xsi:type="FloatType">
                  <Value>0.20</Value>
               </Constant>
            </Argument>
```

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```
            <!-- Multiply operation-->
            <Operation operator=":SFO:18"/>
            <!-- Bool IsGreaterThanOrEqualTo operation-->
            <Operation operator=":SFO:39"/>
         </LimitConstraint>
         <OptimizationConstraint optimize="maximize">
            <Argument xsi:type="SemanticalRefType" semantics=":MEI:17"/>
         </OptimizationConstraint>
      </AdaptationUnitConstraints>
   </Description>
</DIA>
```

The following consumer-side UCD further constrains the UED for the first use case as described in Annex B.3.1, as follows. This UCD references information of the usage environment by extracting data from the UED for the first use case provided in Annex B.3.2.

— Assuming that the viewing application can not exploit the entire display resolution, this UCD constrains the resource resolution to 75% of the display resolution by using two limitation constraints.

— Assuming that the viewing application can not tolerate more than a certain delay for transmission of the resource, a limitation constraint which restricts the file size of the adapted resource by means of the available bandwidth and maximum tolerable transmission delay is provided in this UCD.

— A limitation constraint implementing a logic is provided that allows delivery of a greyscale image although the display is color capable, in order to allow flexibility to satisfy the file size constraints.

```
<did:DIDL>
   <did:Item>
      <did:Descriptor>
         <did:Statement mimeType="text/xml">
            <DIA>
               <DescriptionMetadata>
                  <ClassificationSchemeAlias alias="MediaInfo"
                      href="urn:mpeg:mpeg21:2003:01-DIA-MediaInformationCS-NS"/>
                  <ClassificationSchemeAlias alias="AQoS"
                      href="urn:mpeg:mpeg21:2003:01-DIA-AdaptationQoSCS-NS"/>
                  <ClassificationSchemeAlias alias="SFO"
                      href="urn:mpeg:mpeg21:2003:01-DIA-StackFunctionOperatorCS-NS"/>
               </DescriptionMetadata>
               <Description xsi:type="UCDType" id="consumerUCD">
                  <AdaptationUnitConstraints>
                     <!-- FrameWidth <= 0.75*DisplayWidth  -->
                     <LimitConstraint>
                        <Argument xsi:type="SemanticalRefType"
                              semantics=":MEI:17"/>
                        <Argument xsi:type="ExternalIntegerDataRefType"
uri="my UED.xml#xmlns(dia=urn:mpeg:mpeg21:2003:01-DIA-
NS)xpointer(//dia:DisplayCapability/dia:Resolution/@horizontal)"/>
                        <Argument xsi:type="ConstantDataType">
                           <Constant xsi:type="FloatType">
                              <Value>0.75</Value>
                           </Constant>
                        </Argument>
                        <!-- Multiply operation-->
                        <Operation operator=":SFO:18"/>
                        <!-- Bool IsLessThanOrEqualTo operation-->
                        <Operation operator=":SFO:38"/>
                     </LimitConstraint>
                     <!-- FrameHeight <= 0.75*DisplayHeight -->
                     <LimitConstraint>
                        <Argument xsi:type="SemanticalRefType"
                              semantics=":MEI:18"/>
                        <Argument xsi:type="ExternalIntegerDataRefType"
uri="my_UED.xml#xmlns(dia=urn:mpeg:mpeg21:2003:01-DIA-
NS)xpointer(//dia:DisplayCapability/dia:Resolution/@vertical)"/>
```


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```
                        <Argument xsi:type="ConstantDataType">
                           <Constant xsi:type="FloatType">
                              <Value>0.75</Value>
                           </Constant>
                        </Argument>
                        <!-- Multiply operation-->
                        <Operation operator=":SFO:18"/>
                        <!-- Bool IsLessThanOrEqualTo operation-->
                        <Operation operator=":SFO:38"/>
                     </LimitConstraint>
                     <!-- FileSize <= 0.125*AvailableAverageBandwidth*Tx_delay
                          where Tx_delay is the maximum transmission
                          delay allowed-->
                     <LimitConstraint>
                        <Argument xsi:type="SemanticalRefType"
                             semantics=":MEI:3"/>
                        <Argument xsi:type="ExternalIntegerDataRefType"
uri="my UED.xml#xmlns(dia=urn:mpeg:mpeg21:2003:01-DIA-
NS)xpointer(//dia:NetworkCharacteristic/dia:AvailableBandwidth/@average)"/>
                        <Argument xsi:type="ConstantDataType">
                           <Constant xsi:type="FloatType">
                              <Value>0.125</Value>
                           </Constant>
                        </Argument>
                        <!-- Multiply operation-->
                        <Operation operator=":SFO:18"/>
                        <!-- Tolerable delay for transmission in seconds -->
                        <Argument xsi:type="ConstantDataType">
                           <Constant xsi:type="FloatType">
                              <Value>1.0</Value>
                           </Constant>
                        </Argument>
                        <!-- Multiply operation-->
                        <Operation operator=":SFO:18"/>
                        <!-- Bool IsLessThanOrEqualTo operation-->
                        <Operation operator=":SFO:38"/>
                     </LimitConstraint>
                     <!-- Implement a logic so that if display is color capabale
                          both grayscale and color content is allowed. If display
                          is grayscale only grayscale content is allowed. -->
                     <LimitConstraint>
                        <Argument xsi:type="SemanticalRefType"
                             semantics=":MEI:13"/>
                        <Argument xsi:type="ConstantDataType">
                           <Constant xsi:type="TokenType">
                              <Value>grayscale</Value>
                           </Constant>
                        </Argument>
                        <!-- Tokencmp operation-->
                        <Operation operator=":SFO:30"/>
                        <!-- Bool NOT operation-->
                        <Operation operator=":SFO:14"/>
                        <Argument xsi:type="ExternalBooleanDataRefType"
uri="my_UED.xml#xmlns(dia=urn:mpeg:mpeg21:2003:01-DIA-
NS)xpointer(//dia:DisplayCapability/@colorCapable)"/>
                        <!-- Bool OR operation-->
                        <Operation operator=":SFO:23"/>
                     </LimitConstraint>
                  </AdaptationUnitConstraints>
               </Description>
            </DIA>
         </did:Statement>
      </did:Descriptor>
   </did:Item>
</did:DIDL>
```

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An Adaptation Decision-Taking Engine based on the above AdaptationQoS and UCD descriptions search the space of all scales and color renderings of the resource to find the pair that satisfies all the constraints and optimises the optimisation metric provided in UCDprovider.xml. The corresponding values of IOPins `SCALE` and `NR_COLORS` are then used in the BSDLink to pass parameters to the BSD transformation style sheets.

B.3.6 Bitstream Syntax Description

The following BSD describes the structure of the “Baby” ISO/IEC 15444-1 resource. The corresponding BS Schema can be found subsequently.

```
<?xml version="1.0"?>
<dia:DIA xmlns="JP2" xmlns:jp2="JP2">
   <dia:Description xsi:type="JP2 BSDescriptionType">
      <Codestream bs1:bitstreamURI="baby2.jp2">
         <MainHeader>
            <SOC>
               <Marker>FF4F</Marker>
            </SOC>
            <SIZ>
               <Marker>FF51</Marker>
               <LMarker>47</LMarker>
               <Rsiz>0</Rsiz>
               <Xsiz>640</Xsiz>
               <Ysiz>480</Ysiz>
               <XOsiz>0</XOsiz>
               <YOsiz>0</YOsiz>
               <XTsiz>640</XTsiz>
               <YTsiz>480</YTsiz>
               <XTOsiz>0</XTOsiz>
               <YTOsiz>0</YTOsiz>
               <Csiz>3</Csiz>
               <Comp siz>
                  <sign>0</sign>
                  <bitDepth>7</bitDepth>
                  <XRsiz>1</XRsiz>
                  <YRsiz>1</YRsiz>
               </Comp siz>
               <Comp siz>
                  <sign>0</sign>
                  <bitDepth>7</bitDepth>
                  <XRsiz>1</XRsiz>
                  <YRsiz>1</YRsiz>
               </Comp siz>
               <Comp_siz>
                  <sign>0</sign>
                  <bitDepth>7</bitDepth>
                  <XRsiz>1</XRsiz>
                  <YRsiz>1</YRsiz>
               </Comp_siz>
            </SIZ>
            <COD>
               <Marker>FF52</Marker>
               <LMarker>12</LMarker>
               <Scod>
                  <EPHMarkersUsed>0</EPHMarkersUsed>
                  <SOPMarkersUsed>1</SOPMarkersUsed>
                  <PrecinctsUsed>0</PrecinctsUsed>
               </Scod>
               <SGcod>
                  <progType>1</progType>
                  <numLayers>1</numLayers>
                  <mct>1</mct>
               </SGcod>
               <SPcod>
                  <nDecompLevels>3</nDecompLevels>
                  <codeBlockWidth>4</codeBlockWidth>
```

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```
                  <codeBlockHeight>4</codeBlockHeight>
                  <codeBlockStyle>
                     <optSegMarkers>0</optSegMarkers>
                     <optErTerm>0</optErTerm>
                     <optVertStrCausal>0</optVertStrCausal>
                     <optRegTerm>0</optRegTerm>
                     <optResetMQ>0</optResetMQ>
                     <optByPass>0</optByPass>
                  </codeBlockStyle>
                  <Transformation>0</Transformation>
               </SPcod>
            </COD>
            <QCD>
               <Marker>FF5C</Marker>
               <LMarker>23</LMarker>
               <Sqcd>
                  <guardBits>2</guardBits>
                  <quantStyle>2</quantStyle>
               </Sqcd>
               <Spqcd 2>
                  <exponent>11</exponent>
                  <mantissa>1845</mantissa>
               </Spqcd 2>
               <Spqcd 2>
                  <exponent>11</exponent>
                  <mantissa>1868</mantissa>
               </Spqcd 2>
               <Spqcd 2>
                  <exponent>11</exponent>
                  <mantissa>1868</mantissa>
               </Spqcd_2>
               <Spqcd 2>
                  <exponent>11</exponent>
                  <mantissa>1892</mantissa>
               </Spqcd_2>
               <Spqcd_2>
                  <exponent>9</exponent>
                  <mantissa>3</mantissa>
               </Spqcd 2>
               <Spqcd_2>
                  <exponent>9</exponent>
                  <mantissa>3</mantissa>
               </Spqcd 2>
               <Spqcd 2>
                  <exponent>9</exponent>
                  <mantissa>69</mantissa>
               </Spqcd 2>
               <Spqcd 2>
                  <exponent>9</exponent>
                  <mantissa>2002</mantissa>
               </Spqcd 2>
               <Spqcd 2>
                  <exponent>9</exponent>
                  <mantissa>2002</mantissa>
               </Spqcd_2>
               <Spqcd 2>
                  <exponent>9</exponent>
                  <mantissa>1889</mantissa>
               </Spqcd_2>
            </QCD>
            <COM>
               <Marker>FF64</Marker>
               <LMarker>31</LMarker>
               <Rcom>1</Rcom>
               <Ccom xsi:type="StringComment">CREATOR: JJ2000 version 4.1</Ccom>
            </COM>
         </MainHeader>
         <Tile>
```

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```
            <TileHeader>
               <SOT>
                  <Marker>FF90</Marker>
                  <LMarker>10</LMarker>
                  <Isot>0</Isot>
                  <Psot>38275</Psot>
                  <TPsot>0</TPsot>
                  <TNsot>1</TNsot>
               </SOT>
               <SOD>
                  <Marker>FF93</Marker>
               </SOD>
            </TileHeader>
            <Bitstream>
               <Packet>
                  <SOP>
                     <Marker>FF91</Marker>
                     <LMarker>4</LMarker>
                     <Nsop>0</Nsop>
                  </SOP>
                  <PacketData>143 3184</PacketData>
               </Packet>
               <Packet>
                  <SOP>
                     <Marker>FF91</Marker>
                     <LMarker>4</LMarker>
                     <Nsop>1</Nsop>
                  </SOP>
                  <PacketData>3333 1990</PacketData>
               </Packet>
               <Packet>
                  <SOP>
                     <Marker>FF91</Marker>
                     <LMarker>4</LMarker>
                     <Nsop>2</Nsop>
                  </SOP>
                  <PacketData>5329 2206</PacketData>
               </Packet>
               <Packet>
                  <SOP>
                     <Marker>FF91</Marker>
                     <LMarker>4</LMarker>
                     <Nsop>3</Nsop>
                  </SOP>
                  <PacketData>7541 3797</PacketData>
               </Packet>
               <Packet>
                  <SOP>
                     <Marker>FF91</Marker>
                     <LMarker>4</LMarker>
                     <Nsop>4</Nsop>
                  </SOP>
                  <PacketData>11344 1035</PacketData>
               </Packet>
               <Packet>
                  <SOP>
                     <Marker>FF91</Marker>
                     <LMarker>4</LMarker>
                     <Nsop>5</Nsop>
                  </SOP>
                  <PacketData>12385 1679</PacketData>
               </Packet>
               <Packet>
                  <SOP>
                     <Marker>FF91</Marker>
                     <LMarker>4</LMarker>
                     <Nsop>6</Nsop>
                  </SOP>
```


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```
                <PacketData>14070 8731</PacketData>
             </Packet>
             <Packet>
                <SOP>
                   <Marker>FF91</Marker>
                   <LMarker>4</LMarker>
                   <Nsop>7</Nsop>
                </SOP>
                <PacketData>22807 405</PacketData>
             </Packet>
             <Packet>
                <SOP>
                   <Marker>FF91</Marker>
                   <LMarker>4</LMarker>
                   <Nsop>8</Nsop>
                </SOP>
                <PacketData>23218 613</PacketData>
             </Packet>
             <Packet>
                <SOP>
                   <Marker>FF91</Marker>
                   <LMarker>4</LMarker>
                   <Nsop>9</Nsop>
                </SOP>
                <PacketData>23837 14459</PacketData>
             </Packet>
             <Packet>
                <SOP>
                   <Marker>FF91</Marker>
                   <LMarker>4</LMarker>
                   <Nsop>10</Nsop>
                </SOP>
                <PacketData>38302 10</PacketData>
             </Packet>
             <Packet>
                <SOP>
                   <Marker>FF91</Marker>
                   <LMarker>4</LMarker>
                   <Nsop>11</Nsop>
                </SOP>
                <PacketData>38318 80</PacketData>
             </Packet>
          </Bitstream>
       </Tile>
       <EOC>
          <Marker>FFD9</Marker>
       </EOC>
    </Codestream>
 </dia:Description>
</dia:DIA>
```

The following BS Schema is used for generating the BSD as shown above by using the BintoBSD processor.

```
<?xml version="1.0" encoding="UTF-8"?>
<!-- Schema of a bitsream compliant to :
    JPEG 2000 Part I Final Draft International Standard
    ISO/IEC JTC1/SC29 WG1, JPEG 2000
-->
<xsd:schema targetNamespace="JP2"
    xmlns:bs2="urn:mpeg:mpeg21:2003:01-DIA-BSDL2-NS"
    xmlns:bs1="urn:mpeg:mpeg21:2003:01-DIA-BSDL1-NS"
    xmlns:xsd="http://www.w3.org/2001/XMLSchema" xmlns:jp2="JP2"
    elementFormDefault="qualified" bs2:rootElement="jp2:Codestream">

   <xsd:import namespace="urn:mpeg:mpeg21:2003:01-DIA-BSDL1-NS"
           schemaLocation="BSDL-1.xsd"/>
```

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```
<!--
     Note #1: The following schema has no target namespace and thus inherits
 the JP2 namespace from the current schema.
     Note #2: Unlike gBSDtoBin, the BSDtoBin parser is not required to
     implement the UnsignedIntegers.xsd schema document.
     It is therefore processed here as any user-defined schema.
     -->
<xsd:include schemaLocation="UnsignedIntegers.xsd"/>
<!-- ############ Description wrapper for inclusion into DIA ############ -->
<xsd:complexType name="JP2_BSDescriptionType">
   <xsd:complexContent>
      <xsd:extension base="bs1:BSDType">
         <xsd:sequence>
            <xsd:element ref="jp2:Codestream"/>
         </xsd:sequence>
      </xsd:extension>
   </xsd:complexContent>
</xsd:complexType>
<!-- ############## Codestream element Declaration ################ -->
<xsd:element name="Codestream" type="jp2:CodestreamType"/>
<!-- ################## Codestream complex type ################## -->
<xsd:complexType name="CodestreamType">
   <xsd:sequence>
      <xsd:element name="MainHeader" type="jp2:MainHeaderType"/>
      <xsd:element name="Tile" type="jp2:TileType"/>
      <xsd:element ref="jp2:EOC"/>
   </xsd:sequence>
   <xsd:attribute ref="bs1:bitstreamURI"/>
</xsd:complexType>
<!-- ################## MainHeader complex type ################## -->
<xsd:complexType name="MainHeaderType">
   <xsd:sequence>
      <xsd:element ref="jp2:SOC"/>
      <xsd:element ref="jp2:SIZ"/>
      <xsd:choice maxOccurs="unbounded">
         <xsd:element ref="jp2:COD"/>
         <xsd:element ref="jp2:QCD"/>
         <xsd:element ref="jp2:COC"/>
         <xsd:element ref="jp2:QCC"/>
         <xsd:element ref="jp2:RGN"/>
         <xsd:element ref="jp2:POC"/>
         <xsd:element ref="jp2:PPM"/>
         <xsd:element ref="jp2:TLM"/>
         <xsd:element ref="jp2:PLM"/>
         <xsd:element ref="jp2:CRG"/>
         <xsd:element ref="jp2:COM"/>
      </xsd:choice>
   </xsd:sequence>
</xsd:complexType>
<!-- ################## Tile complex type ################## -->
<xsd:complexType name="TileType">
   <xsd:sequence>
      <xsd:element name="TileHeader" type="jp2:TileHeaderType"/>
      <xsd:element name="Bitstream" type="jp2:BitstreamType"/>
   </xsd:sequence>
</xsd:complexType>
<!-- ################## TileHeader complex type ################## -->
<xsd:complexType name="TileHeaderType">
   <xsd:sequence>
      <xsd:element ref="jp2:SOT"/>
      <xsd:choice minOccurs="0" maxOccurs="unbounded">
         <xsd:element ref="jp2:COD"/>
         <xsd:element ref="jp2:COC"/>
         <xsd:element ref="jp2:QCD"/>
         <xsd:element ref="jp2:QCC"/>
         <xsd:element ref="jp2:RGN"/>
         <xsd:element ref="jp2:POC"/>
```


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```
            <xsd:element ref="jp2:PPT"/>
            <xsd:element ref="jp2:PLT"/>
            <xsd:element ref="jp2:COM"/>
         </xsd:choice>
         <xsd:element ref="jp2:SOD"/>
      </xsd:sequence>
   </xsd:complexType>
   <!-- ################## Bitstream complex type ################## -->
   <xsd:complexType name="BitstreamType">
      <xsd:sequence>
         <xsd:element name="Packet" maxOccurs="unbounded" bs2:ifNext="FF91">
            <xsd:complexType>
               <xsd:sequence>
                  <xsd:element ref="jp2:SOP" minOccurs="0"/>
                  <xsd:element name="PacketData" type="jp2:PacketDataType"/>
               </xsd:sequence>
            </xsd:complexType>
         </xsd:element>
      </xsd:sequence>
   </xsd:complexType>
   <!-- ######################################################## -->
   <!-- ##                  Marker Segments                   ## -->
   <!-- ######################################################## -->
   <!-- ################## SOC marker segment ################## -->
   <xsd:element name="SOC" bs2:ifNext="FF4F">
      <xsd:complexType>
         <xsd:sequence>
            <xsd:element name="Marker" type="jp2:MarkerType" fixed="FF4F"/>
         </xsd:sequence>
      </xsd:complexType>
   </xsd:element>
   <!-- ################## SIZ marker segment ################## -->
   <xsd:element name="SIZ" bs2:ifNext="FF51">
      <xsd:complexType>
         <xsd:complexContent>
            <xsd:extension base="jp2:AbMarkerSegmentType">
               <xsd:sequence>
                  <xsd:element name="Rsiz" type="xsd:unsignedShort"/>
                  <xsd:element name="Xsiz" type="xsd:unsignedInt"/>
                  <xsd:element name="Ysiz" type="xsd:unsignedInt"/>
                  <xsd:element name="XOsiz" type="xsd:unsignedInt"/>
                  <xsd:element name="YOsiz" type="xsd:unsignedInt"/>
                  <xsd:element name="XTsiz" type="xsd:unsignedInt"/>
                  <xsd:element name="YTsiz" type="xsd:unsignedInt"/>
                  <xsd:element name="XTOsiz" type="xsd:unsignedInt"/>
                  <xsd:element name="YTOsiz" type="xsd:unsignedInt"/>
                  <xsd:element name="Csiz" type="xsd:unsignedShort"/>
                  <xsd:element name="Comp siz" maxOccurs="unbounded"
                               bs2:nOccurs="jp2:Csiz">
                     <xsd:complexType>
                        <xsd:sequence>
                           <xsd:element name="sign" type="jp2:b1"/>
                           <xsd:element name="bitDepth" type="jp2:b7"/>
                           <xsd:element name="XRsiz" type="xsd:unsignedByte"/>
                           <xsd:element name="YRsiz" type="xsd:unsignedByte"/>
                        </xsd:sequence>
                        <xsd:attribute name="id" type="xsd:ID"/>
                     </xsd:complexType>
                  </xsd:element>
               </xsd:sequence>
            </xsd:extension>
         </xsd:complexContent>
      </xsd:complexType>
   </xsd:element>
   <!-- ################## COD marker segment ################## -->
   <xsd:element name="COD" bs2:ifNext="FF52">
      <xsd:complexType>
         <xsd:complexContent>
```

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```
            <xsd:extension base="jp2:AbMarkerSegmentType">
               <xsd:sequence>
                  <xsd:element name="Scod">
                     <xsd:complexType>
                        <xsd:sequence>
                           <xsd:element name="EPHMarkersUsed" type="jp2:b6"/>
                           <xsd:element name="SOPMarkersUsed" type="jp2:b1"/>
                           <xsd:element name="PrecinctsUsed" type="jp2:b1"/>
                        </xsd:sequence>
                     </xsd:complexType>
                  </xsd:element>
                  <xsd:element name="SGcod">
                     <xsd:complexType>
                        <xsd:sequence>
                           <xsd:element name="progType" type="xsd:unsignedByte"/>
                           <xsd:element name="numLayers" type="xsd:unsignedShort"/>
                           <xsd:element name="mct" type="xsd:unsignedByte"/>
                        </xsd:sequence>
                     </xsd:complexType>
                  </xsd:element>
                  <xsd:element name="SPcod">
                     <xsd:complexType>
                        <xsd:sequence>
                           <xsd:element name="nDecompLevels" type="xsd:unsignedByte"/>
                           <xsd:element name="codeBlockWidth" type="jp2:b8"/>
                           <xsd:element name="codeBlockHeight" type="jp2:b8"/>
                           <xsd:element name="codeBlockStyle">
                              <xsd:complexType>
                                 <xsd:sequence>
                                    <xsd:element name="optSegMarkers" type="jp2:b3"/>
                                    <xsd:element name="optErTerm" type="jp2:b1"/>
                                    <xsd:element name="optVertStrCausal" type="jp2:b1"/>
                                    <xsd:element name="optRegTerm" type="jp2:b1"/>
                                    <xsd:element name="optResetMQ" type="jp2:b1"/>
                                    <xsd:element name="optByPass" type="jp2:b1"/>
                                 </xsd:sequence>
                              </xsd:complexType>
                           </xsd:element>
                           <xsd:element name="Transformation" type="xsd:unsignedByte"/>
                           <xsd:element name="PrecinctSize" minOccurs="0"
                                        maxOccurs="unbounded"
                                        bs2:if="//jp2:COD/jp2:Scod/jp2:PrecinctsUsed=1"
                                        bs2:nOccurs="jp2:nDecompLevels+1">
                              <xsd:complexType>
                                 <xsd:sequence>
                                    <xsd:element name="PPy" type="jp2:b4"/>
                                    <xsd:element name="PPx" type="jp2:b4"/>
                                 </xsd:sequence>
                              </xsd:complexType>
                           </xsd:element>
                        </xsd:sequence>
                     </xsd:complexType>
                  </xsd:element>
               </xsd:sequence>
            </xsd:extension>
         </xsd:complexContent>
      </xsd:complexType>
   </xsd:element>
   <!-- ################## QCD marker segment ################## -->
   <xsd:element name="QCD" bs2:ifNext="FF5C">
      <xsd:complexType>
         <xsd:complexContent>
            <xsd:extension base="jp2:AbMarkerSegmentType">
               <xsd:sequence>
                  <xsd:element name="Sqcd">
                     <xsd:complexType>
                        <xsd:sequence>
                           <xsd:element name="guardBits" type="jp2:b3"/>
```

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```
                        <xsd:element name="quantStyle" type="jp2:b5"/>
                     </xsd:sequence>
                  </xsd:complexType>
               </xsd:element>
               <xsd:choice>
                  <xsd:element name="Spqcd_0" minOccurs="0" maxOccurs="unbounded"
                            bs2:if="jp2:Sqcd/jp2:quantStyle=0"
                            bs2:nOccurs="(//jp2:COD/jp2:SPcod/jp2:nDecompLevels)*3+1">
                     <xsd:complexType>
                        <xsd:sequence>
                           <xsd:element name="exponent" type="jp2:b5"/>
                           <xsd:element name="stuffing" type="jp2:b3"/>
                        </xsd:sequence>
                     </xsd:complexType>
                  </xsd:element>
                  <xsd:element name="Spqcd_1" minOccurs="0"
                              bs2:if="jp2:Sqcd/jp2:quantStyle=1" bs2:nOccurs="1">
                     <xsd:complexType>
                        <xsd:sequence>
                           <xsd:element name="exponent" type="jp2:b5"/>
                           <xsd:element name="mantissa" type="jp2:b11"/>
                        </xsd:sequence>
                     </xsd:complexType>
                  </xsd:element>
                  <xsd:element name="Spqcd_2" minOccurs="0" maxOccurs="unbounded"
                            bs2:if="jp2:Sqcd/jp2:quantStyle=2"
                            bs2:nOccurs="(//jp2:COD/jp2:SPcod/jp2:nDecompLevels)*3+1">
                     <xsd:complexType>
                        <xsd:sequence>
                           <xsd:element name="exponent" type="jp2:b5"/>
                           <xsd:element name="mantissa" type="jp2:b11"/>
                        </xsd:sequence>
                     </xsd:complexType>
                  </xsd:element>
               </xsd:choice>
            </xsd:sequence>
         </xsd:extension>
      </xsd:complexContent>
   </xsd:complexType>
</xsd:element>
<!-- ################## SOT marker segment ################## -->
<xsd:element name="SOT" bs2:ifNext="FF90">
   <xsd:complexType>
      <xsd:complexContent>
         <xsd:extension base="jp2:AbMarkerSegmentType">
            <xsd:sequence>
               <xsd:element name="Isot" type="xsd:unsignedShort"/>
               <xsd:element name="Psot" type="xsd:unsignedInt"/>
               <xsd:element name="TPsot" type="xsd:unsignedByte"/>
               <xsd:element name="TNsot" type="xsd:unsignedByte"/>
            </xsd:sequence>
         </xsd:extension>
      </xsd:complexContent>
   </xsd:complexType>
</xsd:element>
<!-- ################## SOD marker segment ################## -->
<xsd:element name="SOD" bs2:ifNext="FF93">
   <xsd:complexType>
      <xsd:sequence>
         <xsd:element name="Marker" type="jp2:MarkerType" fixed="FF93"/>
      </xsd:sequence>
   </xsd:complexType>
</xsd:element>
<!-- ################## SOP complex type ################## -->
<xsd:element name="SOP" bs2:ifNext="FF91">
   <xsd:complexType>
      <xsd:complexContent>
         <xsd:extension base="jp2:AbMarkerSegmentType">
```

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```
            <xsd:sequence>
               <xsd:element name="Nsop" type="xsd:unsignedShort"/>
            </xsd:sequence>
         </xsd:extension>
      </xsd:complexContent>
   </xsd:complexType>
</xsd:element>
<!-- ################## EOC complex type ################## -->
<xsd:element name="EOC" bs2:ifNext="FFD9">
   <xsd:complexType>
      <xsd:sequence>
         <xsd:element name="Marker" type="jp2:MarkerType" fixed="FFD9"/>
      </xsd:sequence>
   </xsd:complexType>
</xsd:element>
<!-- ################## COM complex type ################## -->
<xsd:element name="COM" bs2:ifNext="FF64">
   <xsd:complexType>
      <xsd:complexContent>
         <xsd:extension base="jp2:AbMarkerSegmentType">
            <xsd:sequence>
               <xsd:element name="Rcom" type="xsd:short"/>
               <xsd:element name="Ccom" type="jp2:BinaryOrStringType"/>
            </xsd:sequence>
         </xsd:extension>
      </xsd:complexContent>
   </xsd:complexType>
</xsd:element>
<!-- ######################################################## -->
<!-- ##          Non implemented Marker Segments           ## -->
<!-- ######################################################## -->
<!-- For the following markers, different parameters are not read
     individually because they are not needed in the application.
     Instead, the marker segment content is read as a whole using
     the length information given after the marker -->
<xsd:element name="COC" type="jp2:MarkerSegmentType" bs2:ifNext="FF53"/>
<xsd:element name="QCC" type="jp2:MarkerSegmentType" bs2:ifNext="FF5D"/>
<xsd:element name="RGN" type="jp2:MarkerSegmentType" bs2:ifNext="FF5E"/>
<xsd:element name="POC" type="jp2:MarkerSegmentType" bs2:ifNext="FF5F"/>
<xsd:element name="PPT" type="jp2:MarkerSegmentType" bs2:ifNext="FF61"/>
<xsd:element name="PLT" type="jp2:MarkerSegmentType" bs2:ifNext="FF58"/>
<xsd:element name="PPM" type="jp2:MarkerSegmentType" bs2:ifNext="FF60"/>
<xsd:element name="TLM" type="jp2:MarkerSegmentType" bs2:ifNext="FF55"/>
<xsd:element name="PLM" type="jp2:MarkerSegmentType" bs2:ifNext="FF57"/>
<xsd:element name="CRG" type="jp2:MarkerSegmentType" bs2:ifNext="FF63"/>
<!-- ################## Marker segment complex type ################## -->
<xsd:complexType name="AbMarkerSegmentType" abstract="true">
   <xsd:sequence>
      <xsd:element name="Marker" type="jp2:MarkerType"/>
      <xsd:element name="LMarker" type="jp2:LMarkerType"/>
   </xsd:sequence>
</xsd:complexType>
<xsd:complexType name="MarkerSegmentType">
   <xsd:complexContent>
      <xsd:extension base="jp2:AbMarkerSegmentType">
         <xsd:sequence>
            <xsd:element name="MarkerData" type="jp2:MarkerDataType"/>
         </xsd:sequence>
      </xsd:extension>
   </xsd:complexContent>
</xsd:complexType>
<!-- ################## Simple Types Definition ################## -->
<!-- ################## MarkerType ################## -->
<xsd:simpleType name="MarkerType" id="MarkerTypeID">
   <xsd:restriction base="xsd:hexBinary">
      <xsd:length value="2"/>
   </xsd:restriction>
</xsd:simpleType>
```


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```
   <!-- ################## LMarkerType ################## -->
   <xsd:simpleType name="LMarkerType">
      <xsd:restriction base="xsd:unsignedShort"/>
   </xsd:simpleType>
   <!-- ################## MarkerDataType ################## -->
   <xsd:simpleType name="MarkerDataType">
      <xsd:restriction base="bs1:byteRange">
         <xsd:annotation>
            <xsd:appinfo>
               <bs2:length value="../jp2:LMarker - 2"/>
            </xsd:appinfo>
         </xsd:annotation>
      </xsd:restriction>
   </xsd:simpleType>
   <!-- ################## BinaryOrStringType ################## -->
   <xsd:simpleType name="BinaryOrStringType">
      <xsd:union memberTypes="jp2:BinaryComment jp2:StringComment">
         <xsd:annotation>
            <xsd:appinfo>
               <bs2:ifUnion value="../jp2:Rcom = 0"/>
               <bs2:ifUnion value="../jp2:Rcom = 1"/>
            </xsd:appinfo>
         </xsd:annotation>
      </xsd:union>
   </xsd:simpleType>
   <xsd:simpleType name="BinaryComment">
      <xsd:restriction base="bs1:byteRange">
         <xsd:annotation>
            <xsd:appinfo>
               <bs2:length value="../jp2:LMarker - 4"/>
            </xsd:appinfo>
         </xsd:annotation>
      </xsd:restriction>
   </xsd:simpleType>
   <xsd:simpleType name="StringComment">
      <xsd:restriction base="xsd:normalizedString">
         <xsd:annotation>
            <xsd:appinfo>
               <bs2:length value="../jp2:LMarker - 4"/>
            </xsd:appinfo>
         </xsd:annotation>
      </xsd:restriction>
   </xsd:simpleType>
   <!-- ################## MarkerDataType ################## -->
   <xsd:simpleType name="PacketDataType">
      <xsd:restriction base="bs1:byteRange">
         <xsd:annotation>
            <xsd:appinfo>
               <bs2:startCode value="FF91"/>
               <bs2:startCode value="FFD9"/>
            </xsd:appinfo>
         </xsd:annotation>
      </xsd:restriction>
   </xsd:simpleType>
</xsd:schema>
```

The following gBSD is the equivalent to the BSD from above which has been generated by applying an appropriate XSLT style sheet to the BSD. It introduces several markers which facilitates the transformation, e.g., Cx markers represent one color component within the YUC color space or Rx markers represent the resolution layer.

```
<?xml version="1.0" encoding="UTF-8"?>
<dia:DIA>
   <dia:DescriptionMetadata>
```

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```
      <dia:ClassificationSchemeAlias alias="J2K"
            href="urn:jpeg:jpeg2000:cs:syntacticalLabels"/>
   </dia:DescriptionMetadata>
   <dia:Description xsi:type="gBSDType" addressUnit="byte" addressMode="Absolute"
         bs1:bitstreamURI="baby2.jp2">
      <gBSDUnit syntacticalLabel=":J2K:MainHeader" start="0" length="123">
         <gBSDUnit syntacticalLabel=":J2K:SOC" start="0" length="2"/>
         <gBSDUnit syntacticalLabel=":J2K:SIZ" start="2" length="49">
            <gBSDUnit addressMode="Consecutive" length="49">
               <gBSDUnit length="2"/>
               <Parameter name=":J2K:LMarker" length="2">
                  <Value xsi:type="xsd:unsignedShort">47</Value>
               </Parameter>
               <Parameter name=":J2K:Rsiz" length="2">
                  <Value xsi:type="xsd:unsignedShort">0</Value>
               </Parameter>
               <Parameter name=":J2K:Xsiz" length="4">
                  <Value xsi:type="xsd:unsignedInt">640</Value>
               </Parameter>
               <Parameter name=":J2K:Ysiz" length="4">
                  <Value xsi:type="xsd:unsignedInt">480</Value>
               </Parameter>
               <Parameter name=":J2K:XOsiz" length="4">
                  <Value xsi:type="xsd:unsignedInt">0</Value>
               </Parameter>
               <Parameter name=":J2K:YOsiz" length="4">
                  <Value xsi:type="xsd:unsignedInt">0</Value>
               </Parameter>
               <Parameter name=":J2K:XTsiz" length="4">
                  <Value xsi:type="xsd:unsignedInt">640</Value>
               </Parameter>
               <Parameter name=":J2K:YTsiz" length="4">
                  <Value xsi:type="xsd:unsignedInt">480</Value>
               </Parameter>
               <Parameter name=":J2K:XTOsiz" length="4">
                  <Value xsi:type="xsd:unsignedInt">0</Value>
               </Parameter>
               <Parameter name=":J2K:YTOsiz" length="4">
                  <Value xsi:type="xsd:unsignedInt">0</Value>
               </Parameter>
               <Parameter name=":J2K:Csiz" length="2">
                  <Value xsi:type="xsd:unsignedShort">3</Value>
               </Parameter>
               <gBSDUnit syntacticalLabel=":J2K:Comp siz" length="3"
                      marker="C0"/>
               <gBSDUnit syntacticalLabel=":J2K:Comp siz" length="3"
                      marker="C1"/>
               <gBSDUnit syntacticalLabel=":J2K:Comp siz" length="3"
                      marker="C2"/>
            </gBSDUnit>
         </gBSDUnit>
         <gBSDUnit syntacticalLabel=":J2K:COD" start="51" length="14">
            <gBSDUnit addressMode="Consecutive" length="14">
               <gBSDUnit length="2"/>
               <Parameter name=":J2K:LMarker" length="2">
                  <Value xsi:type="xsd:unsignedShort">12</Value>
               </Parameter>
               <gBSDUnit syntacticalLabel=":J2K:Scod" length="1">
                  <Parameter name=":J2K:EPHMarkersUsed" length="6"
                         addressUnit="bit">
                     <Value xsi:type="b1">0</Value>
                  </Parameter>
                  <Parameter name=":J2K:SOPMarkersUsed" length="1"
                         addressUnit="bit">
                     <Value xsi:type="b1">1</Value>
                  </Parameter>
                  <Parameter name=":J2K:PrecinctsUsed" length="1"
                         addressUnit="bit">
```


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```
                  <Value xsi:type="b1">0</Value>
               </Parameter>
            </gBSDUnit>
            <gBSDUnit syntacticalLabel=":J2K:SGcod" length="4">
               <Parameter name=":J2K:progType" length="1">
                  <Value xsi:type="xsd:unsignedByte">1</Value>
               </Parameter>
               <Parameter name=":J2K:numLayers" length="2">
                  <Value xsi:type="xsd:unsignedShort">1</Value>
               </Parameter>
               <Parameter name=":J2K:mct" length="1">
                  <Value xsi:type="xsd:unsignedByte">1</Value>
               </Parameter>
            </gBSDUnit>
            <gBSDUnit syntacticalLabel=":J2K:SPcod" length="5">
               <Parameter name=":J2K:nDecompLevels" length="1">
                  <Value xsi:type="xsd:unsignedByte">3</Value>
               </Parameter>
               <gBSDUnit length="4"/>
            </gBSDUnit>
         </gBSDUnit>
      </gBSDUnit>
      <gBSDUnit syntacticalLabel=":J2K:QCD" start="65" length="25">
         <gBSDUnit addressMode="Consecutive" length="25">
            <gBSDUnit length="2"/>
            <Parameter name=":J2K:LMarker" length="2">
               <Value xsi:type="xsd:unsignedShort">23</Value>
            </Parameter>
            <gBSDUnit syntacticalLabel=":J2K:Sqcd" length="1">
               <Parameter name=":J2K:guardBits" length="3" addressUnit="bit">
                  <Value xsi:type="b3">2</Value>
               </Parameter>
               <Parameter name=":J2K:quantStyle" length="5" addressUnit="bit">
                  <Value xsi:type="b5">2</Value>
               </Parameter>
            </gBSDUnit>
            <gBSDUnit syntacticalLabel=":J2K:Spqcd 2" length="2" marker="R0"/>
            <gBSDUnit syntacticalLabel=":J2K:Spqcd 2" length="2" marker="R1"/>
            <gBSDUnit syntacticalLabel=":J2K:Spqcd 2" length="2" marker="R1"/>
            <gBSDUnit syntacticalLabel=":J2K:Spqcd_2" length="2" marker="R1"/>
            <gBSDUnit syntacticalLabel=":J2K:Spqcd 2" length="2" marker="R2"/>
            <gBSDUnit syntacticalLabel=":J2K:Spqcd 2" length="2" marker="R2"/>
            <gBSDUnit syntacticalLabel=":J2K:Spqcd 2" length="2" marker="R2"/>
            <gBSDUnit syntacticalLabel=":J2K:Spqcd 2" length="2" marker="R3"/>
            <gBSDUnit syntacticalLabel=":J2K:Spqcd_2" length="2" marker="R3"/>
            <gBSDUnit syntacticalLabel=":J2K:Spqcd 2" length="2" marker="R3"/>
         </gBSDUnit>
      </gBSDUnit>
      <gBSDUnit syntacticalLabel=":J2K:COM" start="90" length="33"/>
   </gBSDUnit>
   <gBSDUnit syntacticalLabel=":J2K:Tile" start="123" length="38275">
      <gBSDUnit syntacticalLabel=":J2K:TileHeader" length="14"
            addressMode="Consecutive">
         <gBSDUnit syntacticalLabel=":J2K:SOT" length="12">
            <gBSDUnit length="2"/>
            <Parameter name=":J2K:LMarker" length="2">
               <Value xsi:type="xsd:unsignedShort">10</Value>
            </Parameter>
            <Parameter name=":J2K:Isot" length="2">
               <Value xsi:type="xsd:unsignedShort">0</Value>
            </Parameter>
            <Parameter name=":J2K:Psot" length="4">
               <Value xsi:type="xsd:unsignedInt">38275</Value>
            </Parameter>
            <Parameter name=":J2K:TPsot" length="1">
               <Value xsi:type="xsd:unsignedByte">0</Value>
            </Parameter>
            <Parameter name=":J2K:TNsot" length="1">
```

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```
            <Value xsi:type="xsd:unsignedByte">1</Value>
         </Parameter>
      </gBSDUnit>
      <gBSDUnit syntacticalLabel=":J2K:SOD" start="135" length="2"
         addressMode="Absolute"/>
   </gBSDUnit>
   <gBSDUnit syntacticalLabel=":J2K:Packet" start="137" length="3190"
         marker="R0 L0 C0 P0">
      <gBSDUnit addressMode="Consecutive" length="3190">
         <gBSDUnit length="4"/>
         <Parameter name=":J2K:Nsop" length="2">
            <Value xsi:type="xsd:unsignedShort">0</Value>
         </Parameter>
         <gBSDUnit length="3184"/>
      </gBSDUnit>
   </gBSDUnit>
   <gBSDUnit syntacticalLabel=":J2K:Packet" start="3327" length="1996"
         marker="R0 L0 C1 P0">
      <gBSDUnit addressMode="Consecutive" length="1996">
         <gBSDUnit length="4"/>
         <Parameter name=":J2K:Nsop" length="2">
            <Value xsi:type="xsd:unsignedShort">1</Value>
         </Parameter>
         <gBSDUnit length="1990"/>
      </gBSDUnit>
   </gBSDUnit>
   <gBSDUnit syntacticalLabel=":J2K:Packet" start="5323" length="2212"
         marker="R0 L0 C2 P0">
      <gBSDUnit addressMode="Consecutive" length="2212">
         <gBSDUnit length="4"/>
         <Parameter name=":J2K:Nsop" length="2">
            <Value xsi:type="xsd:unsignedShort">2</Value>
         </Parameter>
         <gBSDUnit length="2206"/>
      </gBSDUnit>
   </gBSDUnit>
   <gBSDUnit syntacticalLabel=":J2K:Packet" start="7535" length="3803"
         marker="R1 L0 C0 P0">
      <gBSDUnit addressMode="Consecutive" length="3803">
         <gBSDUnit length="4"/>
         <Parameter name=":J2K:Nsop" length="2">
            <Value xsi:type="xsd:unsignedShort">3</Value>
         </Parameter>
         <gBSDUnit length="3797"/>
      </gBSDUnit>
   </gBSDUnit>
   <gBSDUnit syntacticalLabel=":J2K:Packet" start="11338" length="1041"
         marker="R1 L0 C1 P0">
      <gBSDUnit addressMode="Consecutive" length="1041">
         <gBSDUnit length="4"/>
         <Parameter name=":J2K:Nsop" length="2">
            <Value xsi:type="xsd:unsignedShort">4</Value>
         </Parameter>
         <gBSDUnit length="1035"/>
      </gBSDUnit>
   </gBSDUnit>
   <gBSDUnit syntacticalLabel=":J2K:Packet" start="12379" length="1685"
         marker="R1 L0 C2 P0">
      <gBSDUnit addressMode="Consecutive" length="1685">
         <gBSDUnit length="4"/>
         <Parameter name=":J2K:Nsop" length="2">
            <Value xsi:type="xsd:unsignedShort">5</Value>
         </Parameter>
         <gBSDUnit length="1679"/>
      </gBSDUnit>
   </gBSDUnit>
   <gBSDUnit syntacticalLabel=":J2K:Packet" start="14064" length="8737"
         marker="R2 L0 C0 P0">
```


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```
            <gBSDUnit addressMode="Consecutive" length="8737">
               <gBSDUnit length="4"/>
               <Parameter name=":J2K:Nsop" length="2">
                  <Value xsi:type="xsd:unsignedShort">6</Value>
               </Parameter>
               <gBSDUnit length="8731"/>
            </gBSDUnit>
         </gBSDUnit>
         <gBSDUnit syntacticalLabel=":J2K:Packet" start="22801" length="411"
               marker="R2 L0 C1 P0">
            <gBSDUnit addressMode="Consecutive" length="411">
               <gBSDUnit length="4"/>
               <Parameter name=":J2K:Nsop" length="2">
                  <Value xsi:type="xsd:unsignedShort">7</Value>
               </Parameter>
               <gBSDUnit length="405"/>
            </gBSDUnit>
         </gBSDUnit>
         <gBSDUnit syntacticalLabel=":J2K:Packet" start="23212" length="619"
               marker="R2 L0 C2 P0">
            <gBSDUnit addressMode="Consecutive" length="619">
               <gBSDUnit length="4"/>
               <Parameter name=":J2K:Nsop" length="2">
                  <Value xsi:type="xsd:unsignedShort">8</Value>
               </Parameter>
               <gBSDUnit length="613"/>
            </gBSDUnit>
         </gBSDUnit>
         <gBSDUnit syntacticalLabel=":J2K:Packet" start="23831" length="14465"
               marker="R3 L0 C0 P0">
            <gBSDUnit addressMode="Consecutive" length="14465">
               <gBSDUnit length="4"/>
               <Parameter name=":J2K:Nsop" length="2">
                  <Value xsi:type="xsd:unsignedShort">9</Value>
               </Parameter>
               <gBSDUnit length="14459"/>
            </gBSDUnit>
         </gBSDUnit>
         <gBSDUnit syntacticalLabel=":J2K:Packet" start="38296" length="16"
               marker="R3 L0 C1 P0">
            <gBSDUnit addressMode="Consecutive" length="16">
               <gBSDUnit length="4"/>
               <Parameter name=":J2K:Nsop" length="2">
                  <Value xsi:type="xsd:unsignedShort">10</Value>
               </Parameter>
               <gBSDUnit length="10"/>
            </gBSDUnit>
         </gBSDUnit>
         <gBSDUnit syntacticalLabel=":J2K:Packet" start="38312" length="86"
               marker="R3 L0 C2 P0">
            <gBSDUnit addressMode="Consecutive" length="86">
               <gBSDUnit length="4"/>
               <Parameter name=":J2K:Nsop" length="2">
                  <Value xsi:type="xsd:unsignedShort">11</Value>
               </Parameter>
               <gBSDUnit length="80"/>
            </gBSDUnit>
         </gBSDUnit>
      </gBSDUnit>
      <gBSDUnit syntacticalLabel=":J2K:EOC" start="38398" length="2"/>
   </dia:Description>
</dia:DIA>
```

The following gBSD describes the structure of the Akiyo ISO/IEC 14496-2 ES on a frame level only. Please note that this gBSD only decribes a small part of the resource, i.e., only a few frames. However, the description of the complete Akiyo ISO/IEC 14496-2 ES looks similar to the fragment shown below.

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```
<?xml version="1.0" encoding="UTF-8"?>
<dia:DIA>
   <dia:DescriptionMetadata>
      <dia:ClassificationSchemeAlias alias="MV4"
               href="urn:mpeg:mpeg4:video:cs:syntacticalLabels"/>
   </dia:DescriptionMetadata>
   <dia:Description xsi:type="gBSDType" addressUnit="byte" addressMode="Absolute"
           bs1:bitstreamURI="content/akiyo.cmp">
      <gBSDUnit syntacticalLabel=":M4V:VO" start="0" length="4"/>
      <gBSDUnit syntacticalLabel=":M4V:VOL" start="4" length="14"/>
      <gBSDUnit syntacticalLabel=":M4V:I_VOP" start="18" length="4641"/>
      <gBSDUnit syntacticalLabel=":M4V:P_VOP" start="4659" length="98"/>
      <gBSDUnit syntacticalLabel=":M4V:B VOP" start="4757" length="16"/>
      <gBSDUnit syntacticalLabel=":M4V:B VOP" start="4773" length="23"/>
      <gBSDUnit syntacticalLabel=":M4V:P VOP" start="4796" length="178"/>
      <gBSDUnit syntacticalLabel=":M4V:B_VOP" start="4974" length="53"/>
      <gBSDUnit syntacticalLabel=":M4V:B VOP" start="5027" length="39"/>
      <gBSDUnit syntacticalLabel=":M4V:P VOP" start="5066" length="235"/>
      <gBSDUnit syntacticalLabel=":M4V:B VOP" start="5301" length="66"/>
      <gBSDUnit syntacticalLabel=":M4V:B VOP" start="5367" length="65"/>
      <gBSDUnit syntacticalLabel=":M4V:P_VOP" start="5432" length="274"/>
      <gBSDUnit syntacticalLabel=":M4V:B VOP" start="5706" length="74"/>
      <gBSDUnit syntacticalLabel=":M4V:B VOP" start="5780" length="68"/>
      <gBSDUnit syntacticalLabel=":M4V:I VOP" start="5848" length="4670"/>
      <!--... and so on ...-->
   </dia:Description>
</dia:DIA>
```

B.3.7 BSD transformation

The following XSLT style sheet provides the functionality of reducing the number of color components, the number of resolution layers, or the number of quality layers depending on the input parameters `CsizIn`, `numLayersIn`, or `scale`. The input parameter type determines the type of transformation as describes before.

Please note that this XSLT style sheet does not perform the adaptation on the actual resource but transforms its BSD which can be used for achieving the same result by generating the resource based on this transformed BSD. This XSLT style sheet is restricted to be used with BSDs only.

```
<?xml version="1.0"?>
<!--
    Style sheet for removing:
    - quality layers and/or
    - color component and/or
    - resolution
    This style sheet assumes that no precincts are used.
    Progression orders implemented: progType = 0, 1 and 4.
-->
<stylesheet
    xmlns:j="JP2" xmlns="http://www.w3.org/1999/XSL/Transform" version="1.0">

    <output method="xml" indent="yes"/>

    <!-- Input parameters ************************************************* -->
    <!--  Number of output components -->
    <param name="CsizIn">-1</param>
    <!--  Number of output SNR quality layers -->
    <param name="numLayersIn">-1</param>
    <!-- Scale ("0"=no scaling, "1"=divide image size by 2, "2"=by 4 ...) -->
    <param name="scale">0</param>

    <!-- Parameters fetched from description ****************************** -->
    <variable name="Csiz" select="//j:SIZ/j:Csiz"/>
    <variable name="Xsiz" select="//j:SIZ/j:Xsiz"/>
```


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```
    <variable name="Ysiz" select="//j:SIZ/j:Ysiz"/>
    <variable name="numLayers" select="//j:COD/j:SGcod/j:numLayers"/>
    <variable name="nDecompLevels" select="//j:COD/j:SPcod/j:nDecompLevels"/>
    <variable name="progType" select="//j:COD/j:SGcod/j:progType"/>

    <!-- Variables ******************************************************** -->
    <variable name="scaleFactor">
        <call-template name="power">
            <with-param name="in" select="$scale"/>
        </call-template>
    </variable>

    <!-- Output parameters ************************************************ -->
    <variable name="CsizOut">
        <choose>
            <when test="$CsizIn=-1">
                <value-of select="$Csiz"/>
            </when>
            <otherwise>
                <!-- Check input value -->
                <if test="(($CsizIn > $Csiz) or ($CsizIn &lt; 1))">
                    <message terminate="yes">Incorrect value for CsizIn</message>
                </if>
                <value-of select="$CsizIn"/>
            </otherwise>
        </choose>
    </variable>

    <variable name="numLayersOut">
        <choose>
            <when test="$numLayersIn=-1">
                <value-of select="$numLayers"/>
            </when>
            <otherwise>
                <!-- Check input value -->
                <if test="(($numLayersIn > $numLayers) or ($numLayersIn &lt; 1))">
                    <message terminate="yes">
                        Incorrect value for numLayersIn</message>
                </if>
                <value-of select="$numLayersIn"/>
            </otherwise>
        </choose>
    </variable>

    <variable name="nDecompLevelsOut">
        <choose>
            <when test="$scale=0">
                <value-of select="$nDecompLevels"/>
            </when>
            <otherwise>
                <!-- Check input value -->
                <if test="(($scale > $nDecompLevels) or ($scale &lt; 0))">
                    <message terminate="yes">Incorrect value for scale</message>
                </if>
                <value-of select="$nDecompLevels - $scale"/>
            </otherwise>
        </choose>
    </variable>

    <variable name="nSOPOut">
        <value-of select= "($nDecompLevelsOut + 1) * $numLayersOut * $CsizOut"/>
    </variable>

    <!-- Variables describing the packets nesting -->
    <!-- Dimension #0 -->
    <variable name="dimIn0">
        <choose>
            <when test="$progType=0"><value-of select="$Csiz"/></when>
```

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```
            <when test="$progType=1"><value-of select="$Csiz"/></when>
            <when test="$progType=4"><value-of select="$numLayers"/></when>
        </choose>
    </variable>
    <variable name="dimOut0">
        <choose>
            <when test="$progType=0"><value-of select="$CsizOut"/></when>
            <when test="$progType=1"><value-of select="$CsizOut"/></when>
            <when test="$progType=4"><value-of select="$numLayersOut"/></when>
        </choose>
    </variable>

    <!-- Dimension #1 -->
    <variable name="dimIn1">
        <choose>
            <when test="$progType=0"><value-of select="$nDecompLevels+1"/></when>
            <when test="$progType=1"><value-of select="$numLayers"/></when>
            <when test="$progType=4"><value-of select="$nDecompLevels+1"/></when>
        </choose>
    </variable>
    <variable name="dimOut1">
        <choose>
            <when test="$progType=0">
                <value-of select="$nDecompLevelsOut+1"/></when>
            <when test="$progType=1"><value-of select="$numLayersOut"/></when>
            <when test="$progType=4">
                <value-of select="$nDecompLevelsOut+1"/></when>
        </choose>
    </variable>

    <!-- Dimension #2 -->
    <variable name="dimIn2">
        <choose>
            <when test="$progType=0"><value-of select="$numLayers"/></when>
            <when test="$progType=1"><value-of select="$nDecompLevels+1"/></when>
            <when test="$progType=4"><value-of select="$Csiz"/></when>
        </choose>
    </variable>
    <variable name="dimOut2">
        <choose>
            <when test="$progType=0"><value-of select="$numLayersOut"/></when>
            <when test="$progType=1">
                <value-of select="$nDecompLevelsOut+1"/></when>
            <when test="$progType=4"><value-of select="$CsizOut"/></when>
        </choose>
    </variable>

    <variable name="dimIn01" select="$dimIn0 * $dimIn1"/>
    <variable name="dimOut01" select="$dimOut0 * $dimOut1"/>

    <!-- ************************************************************** -->
    <!-- ***                        Named Templates                   ** -->
    <!-- ************************************************************** -->

    <!-- Simulate power function  -->
    <template name="power">
        <param name="in"/>
        <choose>
            <when test="$in = 0">1</when>
            <when test="$in = 1">2</when>
            <when test="$in = 2">4</when>
            <when test="$in = 3">8</when>
            <when test="$in = 4">16</when>
            <when test="$in = 5">32</when>
            <when test="$in = 6">64</when>
            <otherwise>
                <message terminate="yes">
                    Error: scaling not supported:<value-of select="$in"/>
```


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```
            </message>
        </otherwise>
    </choose>
</template>

<!-- Get new index -->
<template name="getNewIndex">
    <param name="n"/>
    <variable name="x0" select="$n mod $dimIn0"/>
    <variable name="x1" select="floor($n div $dimIn0) mod $dimIn1"/>
    <variable name="x2" select="floor($n div $dimIn01) mod $dimIn2"/>
    <choose>
        <when test="($x0 &gt;= $dimOut0) or
                    ($x1 &gt;= $dimOut1) or
                    ($x2 &gt;= $dimOut2) ">
            <value-of select="-1"/>
        </when>
        <otherwise>
            <value-of select="$x0 + $x1 * $dimOut0 + $x2 * $dimOut01 "/>
        </otherwise>
    </choose>
</template>

<!-- Named template for Nsop -->
<template name="packetTmpl" match="j:Packet">
    <param name="nsop"/>
    <copy>
        <element name="SOP" namespace="JP2">
            <element name="Marker" namespace="JP2">
                <value-of select="j:SOP/j:Marker"/>
            </element>
            <element name="LMarker" namespace="JP2">
                <value-of select="j:SOP/j:LMarker"/>
            </element>
            <element name="Nsop" namespace="JP2">
                <value-of select="$nsop"/>
            </element>
        </element>
        <element name="PacketData" namespace="JP2">
            <value-of select="j:PacketData"/>
        </element>
    </copy>
</template>

<!-- ********************************************************************** -->
<!-- ***                          Templates                             ** -->
<!-- ********************************************************************** -->

<!-- Match all: default template ************************************** -->
<template match="@*|node()">
    <copy>
        <apply-templates select="@*|node()"/>
    </copy>
</template>

<!-- SIZ marker segment *********************************************** -->
<!-- Match SIZ/LMarker -->
<template match="j:SIZ/j:LMarker" >
    <copy>
        <value-of select="38 + 3 * $CsizOut"/>
    </copy>
    </template>

<!-- Xsiz XTsiz -->
<template match="j:Xsiz/text() | j:XTsiz/text()">
    <value-of select="ceiling($Xsiz div $scaleFactor)"/>
</template>
```

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```
    <!-- Ysiz YTsiz -->
    <template match="j:Ysiz/text() | j:YTsiz/text()">
        <value-of select="ceiling($Ysiz div $scaleFactor)"/>
    </template>

    <!-- Csiz -->
    <template match="j:Csiz">
        <copy>
            <value-of select="$CsizOut"/>
        </copy>
    </template>

    <!-- Match SIZ/Comp siz -->
    <!-- Do not copy Comp siz with position greater than CsizOut -->
    <template match="j:SIZ/j:Comp siz[position() &gt; $CsizOut]" />

    <!-- COD marker segment ********************************************** -->
    <!-- numLayers -->
    <template match="j:numLayers">
        <copy>
            <value-of select="$numLayersOut"/>
        </copy>
    </template>

    <!-- mct -->
    <template match="j:mct">
        <!-- Set mct value to 0 if colors are removed -->
        <copy>
            <choose>
                <when test="$CsizOut=1">0</when>
                <otherwise><apply-templates/></otherwise>
            </choose>
        </copy>
    </template>

    <!-- nDecompLevels -->
    <template match="j:nDecompLevels">
        <copy>
            <value-of select="$nDecompLevelsOut"/>
        </copy>
    </template>

    <!-- QCD ************************************************************ -->
    <!-- Variable quantization style -->
    <variable name="quantStyle">
        <value-of select="//j:Sqcd/j:quantStyle"/>
    </variable>

    <!-- Match QCD/LMarker -->
    <template match="j:QCD/j:LMarker" >
        <copy>
            <choose>
            <when test="$quantStyle = 0">
                <value-of select="4 + 3 * $nDecompLevelsOut"/>
            </when>
            <when test="$quantStyle = 1">
                5
            </when>
            <when test="$quantStyle = 2">
                <value-of select="5 + 6 * $nDecompLevelsOut"/>
            </when>
            <otherwise>
                <message terminate="yes">
                    Error: incorrect value for QCD/Sqcd/quantStyle:
                  <value-of select="$quantStyle"/>
                </message>
            </otherwise>
            </choose>
```


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```
        </copy>
    </template>

    <!-- Variable : number of output SPqcd -->
    <variable name="nSPqcdOut">
        <choose>
            <when test="$quantStyle = 1">1</when>
            <otherwise><value-of select="1 + 3 * $nDecompLevelsOut"/></otherwise>
        </choose>
    </variable>

    <!-- Match QCD/Spqcd_0 and QCD/Spqcd_2 -->
    <!-- Do not copy Spqcd * with position greater than nSPqcdOut -->
    <template match="j:QCD/j:Spqcd 2[position() &gt; $nSPqcdOut] |
                     j:QCD/j:Spqcd 0[position() &gt; $nSPqcdOut]" />

    <!-- Match Bitstream ************************************************** -->
    <template match="j:Bitstream">
        <!-- Output number of packets -->
        <variable name="nSOPOut"
            select= "($nDecompLevelsOut + 1) * $numLayersOut * $CsizOut"/>
        <copy>
            <apply-templates/>
        </copy>
    </template>

    <!-- Match Packet ***************************************************** -->
    <template match="j:Packet">
        <variable name="index" select="j:SOP/j:Nsop"/>
        <variable name="newIndex">
            <call-template name="getNewIndex">
                <with-param name="n" select="$index"/>
            </call-template>
        </variable>
        <if test="$newIndex != -1">
            <call-template name="packetTmpl">
                <with-param name="nsop" select="$newIndex"/>
            </call-template>
        </if>
    </template>

</stylesheet>
```

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The following STX style sheet provides the same functionality as the XSLT style sheet describe above.

```
<?xml version="1.0"?>
<!--
    Style sheet for removing:
    - quality layers and/or
    - color component and/or
    - resolution
    This style sheet assumes that no precincts are used.
    Progression orders implemented: progType = 0, 1 and 4.
-->
<transform xmlns="http://stx.sourceforge.net/2002/ns" version="1.0" xmlns:j="JP2" pass-
through="all" strip-space="yes">
   <!-- Input parameters ************************************************** -->
   <!-- Scale ("0"=no scaling, "1"=divide image size by 2, "2"=by 4 ...) -->
   <param name="scale" select="0"/>
   <!-- Number of output components -->
   <param name="CsizIn" select="-1"/>
   <!-- Number of output SNR quality layers -->
   <param name="numLayersIn" select="-1"/>
   <!-- Global variables ************************************************** -->
   <variable name="CsizOut"/>
   <variable name="numLayersOut"/>
   <variable name="nDecompLevelsOut"/>
   <!-- The following parameters need to be fetched in the main header -->
   <variable name="Csiz"/>
   <variable name="Xsiz"/>
   <variable name="Ysiz"/>
   <variable name="progType"/>
   <variable name="numLayers"/>
   <variable name="nDecompLevels"/>
   <variable name="quantStyle"/>
   <!-- Procedures ******************************************************** -->
   <procedure name="power" visibility="global">
      <param name="in"/>
      <choose>
         <when test="$in = 0">1</when>
         <when test="$in = 1">2</when>
         <when test="$in = 2">4</when>
         <when test="$in = 3">8</when>
         <when test="$in = 4">16</when>
         <when test="$in = 5">32</when>
         <when test="$in = 6">64</when>
         <otherwise>
            <message>Error: scaling not supported:<value-of select="$in"/>
            </message>
         </otherwise>
      </choose>
   </procedure>
   <!-- Process Main Header *********************************************** -->
   <group name="MainHeaderGrp">
      <buffer name="bufferMainHeader"/>
      <template match="j:MainHeader" visibility="global">
         <copy attributes="@*">
            <!-- We need to look ahead for parameters -->
            <result-buffer name="bufferMainHeader">
               <process-children group="getParametersGrp"/>
            </result-buffer>
            <!-- Assign other variables -->
            <assign name="CsizOut">
               <if test="$CsizIn=-1">
                  <value-of select="$Csiz"/>
               </if>
               <else>
                  <!-- Check input value -->
                  <if test="(($CsizIn > $Csiz) or ($CsizIn &lt; 1))">
                     <message>Incorrect value for CsizIn</message>
```


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```
                </if>
                <value-of select="$CsizIn"/>
             </else>
          </assign>
          <assign name="numLayersOut">
             <if test="$numLayersIn=-1">
                <value-of select="$numLayers"/>
             </if>
             <else>
                <!-- Check input value -->
                <if test="(($numLayersIn > $numLayers) or
                            ($numLayersIn &lt; 1))">
                   <message>Incorrect value for numLayersIn</message>
                </if>
                <value-of select="$numLayersIn"/>
             </else>
          </assign>
          <assign name="nDecompLevelsOut">
             <if test="$scale=0">
                <value-of select="$nDecompLevels"/>
             </if>
             <else>
                <!-- Check input value -->
                <if test="(($scale > $nDecompLevels) or ($scale &lt; 0))">
                   <message>Incorrect value for scale</message>
                </if>
                <value-of select="$nDecompLevels - $scale"/>
             </else>
          </assign>
          <!-- Now process buffer -->
          <process-buffer name="bufferMainHeader"/>
       </copy>
    </template>
 </group>
 <!-- Get some MainHeader parameters ************************************ -->
 <group name="getParametersGrp">
    <template match="node()">
       <copy attributes="@*">
          <process-children/>
       </copy>
    </template>
    <!-- Get Csiz -->
    <template match="j:Csiz/text()">
       <assign name="Csiz" select="."/>
       <copy/>
    </template>
    <!-- Get Xsiz -->
    <template match="j:Xsiz/text()">
       <assign name="Xsiz" select="."/>
       <copy/>
    </template>
    <!-- Get Ysiz -->
    <template match="j:Ysiz/text()">
       <assign name="Ysiz" select="."/>
       <copy/>
    </template>
    <!-- Get progType -->
    <template match="j:progType/text()">
       <assign name="progType" select="."/>
       <copy/>
    </template>
    <!-- Get numLayers -->
    <template match="j:numLayers/text()">
       <assign name="numLayers" select="."/>
       <copy/>
    </template>
    <!-- Get nDecompLevels -->
    <template match="j:nDecompLevels/text()">
```

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```
         <assign name="nDecompLevels" select="."/>
         <copy/>
      </template>
      <!-- Get quantStyle -->
      <template match="j:quantStyle/text()">
         <assign name="quantStyle" select="."/>
         <copy/>
      </template>
   </group>
   <!-- Process SIZ marker segment ************************************** -->
   <group name="SIZ">
      <variable name="scaleFactor"/>
      <variable name="XsizOut"/>
      <variable name="YsizOut"/>
      <!-- SIZ -->
      <template match="j:SIZ" visibility="global">
         <assign name="scaleFactor">
            <call-procedure name="power">
               <with-param name="in" select="$scale"/>
            </call-procedure>
         </assign>
         <assign name="XsizOut">
            <value-of select="$Xsiz"/>
         </assign>
         <assign name="YsizOut">
            <value-of select="$Ysiz"/>
         </assign>
         <copy attributes="@*">
            <process-children/>
         </copy>
      </template>
      <!-- LMarker -->
      <template match="j:LMarker/text()">
         <value-of select="38 + 3 * $CsizOut"/>
      </template>
      <!-- Csiz -->
      <template match="j:Csiz/text()">
         <value-of select="$CsizOut"/>
      </template>
      <!-- Xsiz XTsiz -->
      <template match="j:Xsiz/text() | j:XTsiz/text()">
         <value-of select="ceiling($XsizOut div $scaleFactor)"/>
      </template>
      <!-- Ysiz YTsiz -->
      <template match="j:Ysiz/text() | j:YTsiz/text()">
         <value-of select="ceiling($YsizOut div $scaleFactor)"/>
      </template>
      <!-- Comp siz -->
      <template match="j:Comp_siz[position()>$CsizOut]"/>
   </group>
   <!-- Process COD marker segment ************************************** -->
   <group name="COD">
      <!-- COD -->
      <template match="j:COD" visibility="global">
         <copy attributes="@*">
            <process-children/>
         </copy>
      </template>
      <!-- numLayers -->
      <template match="j:numLayers/text()">
         <value-of select="$numLayersOut"/>
      </template>
      <!-- mct -->
      <template match="j:mct/text()">
         <if test="$CsizOut=1">
            <text>0</text>
         </if>
         <else>
```


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```
            <copy/>
         </else>
      </template>
      <!-- nDecompLevels -->
      <template match="j:nDecompLevels/text()">
         <value-of select="$nDecompLevelsOut"/>
      </template>
   </group>
   <!-- QCD marker segment ********************************************** -->
   <group name="QCD">
      <variable name="nSPqcdOut"/>
      <template match="j:QCD" visibility="global">
         <!-- Now that quantSyle is known, calculate nSPqcdOut -->
         <assign name="nSPqcdOut">
            <choose>
               <when test="$quantStyle = 1">1</when>
               <otherwise>
                  <value-of select="1 + 3 * $nDecompLevelsOut"/>
               </otherwise>
            </choose>
         </assign>
         <copy attributes="@*">
            <process-children/>
         </copy>
      </template>
      <template match="j:LMarker/text()">
         <choose>
            <when test="$quantStyle = 0">
               <value-of select="4 + 3 * $nDecompLevelsOut"/>
            </when>
            <when test="$quantStyle = 1">
                  5
               </when>
            <when test="$quantStyle = 2">
               <value-of select="5 + 6 * $nDecompLevelsOut"/>
            </when>
            <otherwise>
               <message>
                      Error: incorrect value for QCD/Sqcd/quantStyle:
                      <value-of select="$quantStyle"/>
               </message>
            </otherwise>
         </choose>
      </template>
      <template match="j:Spqcd_0[position()>$nSPqcdOut] |
                       j:Spqcd 2[position()>$nSPqcdOut]"/>
   </group>
   <!-- Bitstream ******************************************************** -->
   <group name="BitstreamGrp">
      <variable name="newNsop" select="0"/>
      <variable name="col" select="0"/>
      <variable name="res" select="0"/>
      <variable name="lay" select="0"/>
      <variable name="nDecompLevelsOutp1"/>
      <variable name="nDecompLevelsp1"/>
      <template match="j:Bitstream" visibility="global">
         <!-- Variables assigning -->
         <assign name="nDecompLevelsOutp1" select="$nDecompLevelsOut + 1"/>
         <assign name="nDecompLevelsp1" select="$nDecompLevels + 1"/>
         <copy attributes="@*">
            <process-children group="PacketsNoPrecinctsGrp"/>
         </copy>
         <message>Output nr of packets: <value-of select="$newNsop "/>
         </message>
      </template>
      <!-- Packets no precincts ****************************************** -->
      <group name="PacketsNoPrecinctsGrp">
         <template match="j:Packet">
```

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```
            <if test="($col &lt; $CsizOut) and
                      ($res &lt; $nDecompLevelsOutp1) and
                      ($lay &lt; $numLayersOut)">
               <copy attributes="@*">
                  <process-children/>
               </copy>
               <assign name="newNsop" select="$newNsop + 1"/>
            </if>
            <!-- Increment counters -->
            <if test="$progType=0">
               <assign name="col" select="$col + 1"/>
               <if test="$col &gt;= $Csiz">
                  <assign name="col" select="0"/>
                  <assign name="res" select="$res + 1"/>
               </if>
               <if test="$res &gt;= $nDecompLevelsp1">
                  <assign name="res" select="0"/>
                  <assign name="lay" select="$lay + 1"/>
               </if>
            </if>
            <if test="$progType=1">
               <assign name="col" select="$col + 1"/>
               <if test="$col &gt;= $Csiz">
                  <assign name="col" select="0"/>
                  <assign name="lay" select="$lay + 1"/>
               </if>
               <if test="$lay &gt;= $numLayers">
                  <assign name="lay" select="0"/>
                  <assign name="res" select="$res + 1"/>
               </if>
            </if>
            <if test="$progType=4">
               <assign name="lay" select="$lay + 1"/>
               <if test="$lay &gt;= $numLayers">
                  <assign name="lay" select="0"/>
                  <assign name="res" select="$res + 1"/>
               </if>
               <if test="$res &gt;= $nDecompLevelsp1">
                  <assign name="res" select="0"/>
                  <assign name="col" select="$col + 1"/>
               </if>
            </if>
         </template>
         <template match="j:Nsop/text()">
            <value-of select="$newNsop"/>
         </template>
      </group>
   </group>
</transform>
```

The following XSLT style sheet provides the functionality of B-frame dropping depending on the input parameter `removeBVOPs`.

Please note that this XSLT style sheet does not perform the adaptation on the actual resource but transforms its BSD which can be used for achieving the same result by generating the resource based on this transformed BSD. This XSLT style sheet is restricted to be used with gBSDs only.

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```
<?xml version="1.0" encoding="UTF-8"?>
<xsl:stylesheet
    xmlns="urn:mpeg:mpeg21:2003:01-DIA-gBSD-NS"
    xmlns:gbsd="urn:mpeg:mpeg21:2003:01-DIA-gBSD-NS"
    xmlns:dia="urn:mpeg:mpeg21:2003:01-DIA-NS"
    xmlns:xsl="http://www.w3.org/1999/XSL/Transform" version="1.0">

    <xsl:output method="xml" version="1.0" encoding="UTF-8" indent="yes"/>

    <xsl:param name="removeBVOPs" select="'true'"/>

    <!-- Match all: default template -->
    <xsl:template name="tplAll" match="@*|node()">
        <xsl:copy>
            <xsl:apply-templates select="@*|node()"/>
        </xsl:copy>
    </xsl:template>
    <!-- Match gBSDUnit: removes B VOPs -->
    <xsl:template name="tplB VOP" match="gbsd:gBSDUnit[@syntacticalLabel]">
        <xsl:choose>
            <xsl:when test="$removeBVOPs and @syntacticalLabel=':M4V:B_VOP'">
                <!-- Do nothing -->
            </xsl:when>
            <xsl:otherwise>
                <xsl:copy>
                    <xsl:apply-templates select="node()|@*"/>
                </xsl:copy>
            </xsl:otherwise>
        </xsl:choose>
    </xsl:template>
</xsl:stylesheet>
```

The following STX style sheet provides the same functionality as the XSLT style sheet describe above.

```
<?xml version="1.0"?>
<stx:transform
    xmlns:="urn:mpeg:mpeg21:2003:01-DIA-gBSD-NS"
    xmlns:dia="urn:mpeg:mpeg21:2003:01-DIA-NS"
    xmlns:gbsd="urn:mpeg:mpeg21:2003:01-DIA-gBSD-NS"
    xmlns:stx="http://stx.sourceforge.net/2002/ns"
    pass-through="all" strip-space="yes" version="1.0">

   <stx:param name="frameType" select="'true'"/>
   <!-- Variables declaration -->
   <stx:variable name="type"/>
   <!-- Buffer declaration -->
   <stx:buffer name="bufferVOP"/>
   <stx:template match="dia:DIA">
      <stx:result-buffer name="bufferVOP" clear="yes">
         <stx:process-children/>
      </stx:result-buffer>
      <stx:if test="$removeBVOPs and $type != ':MV4:B VOP'">
         <stx:copy>
            <stx:process-buffer name="bufferVOP"/>
         </stx:copy>
      </stx:if>
   </stx:template>
   <stx:template match="gbsd:gBSDUnit[@syntacticalLabel]">
      <stx:assign name="type" select="."/>
      <stx:copy/>
   </stx:template>
</stx:transform>
```

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B.3.8 Resources

Figure B.4 shows the original ISO/IEC 15444-1 resource with a resolution of 640×480 pixels whereas Figure B.5 shows the adapted version (80×60 pixels) according to the UED (≤ 176×220 pixels) taking into account UCDs from the consumer side (≤ 132×165 pixels) as well as from the provider side (≥ 35×44 pixels) and the possibilities provided by the AdaptationQoS (= 80×60 pixels) description.



Figure B.4 — Original ISO/IEC 15444-1 resource.



Figure B.5 — Adapted ISO/IEC 15444-1 resource.

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Annex C

(informative)

Usage of DIA Configuration

C.1 Introduction

In this Annex, three examples that illustrate the use of the DIA Configuration tool are provided. These examples also demonstrate a suggested use of this tool with other ISO/IEC 21000 components.

C.2 Example 1

The first use case scenario shows how the DIA Configuration tool, together with the usage environment descriptions, can be used to facilitate dynamic resource adaptation and updating in a media streaming environment.

Figure C.1 illustrates the steps involved in the media streaming adaptation and updating process in an end-to-end approach within the ISO/IEC 21000 framework.

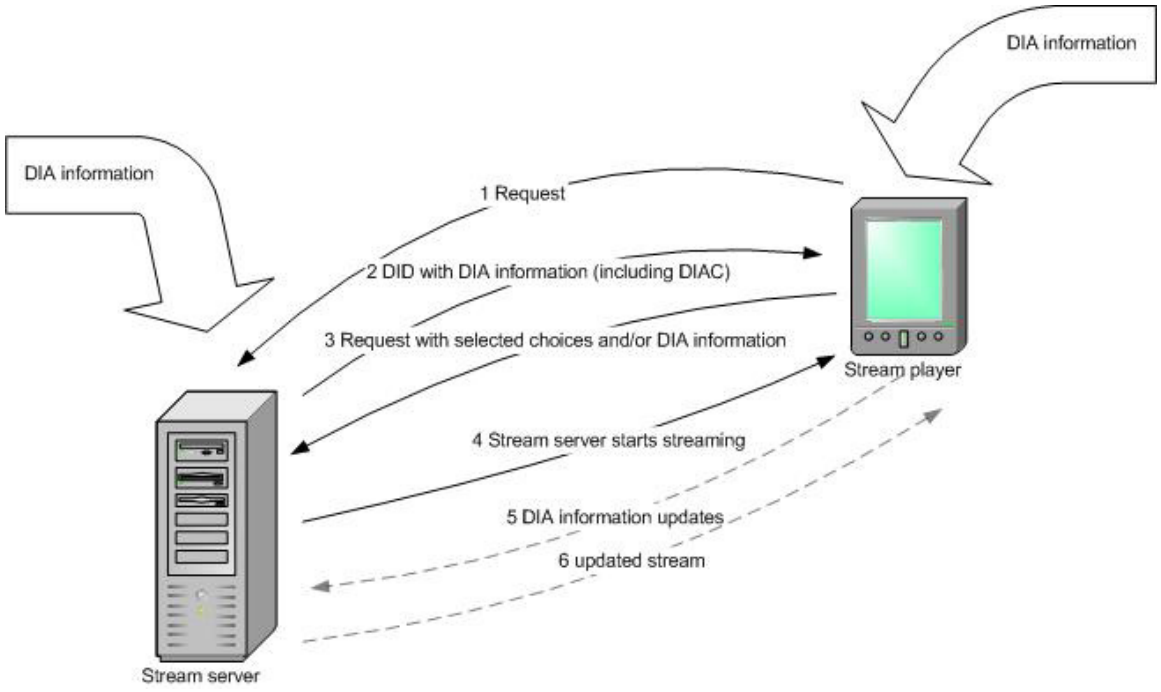

Figure C.1 — Architecture for the media streaming process.

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The sample terminal description used in this example is given below.

```
<DIA>
    <Description xsi:type="UsageEnvironmentType">
        <UsageEnvironmentProperty xsi:type="TerminalsType">
            <Terminal>
                <TerminalCapability xsi:type="CodecCapabilitiesType">
                    <Decoding xsi:type="VideoCapabilitiesType">
                        <Format href="urn:mpeg:mpeg7:cs:VisualFileFormatCS:2001:7">
                            <mpeg7:Name xml:lang="en">avi</mpeg7:Name>
                        </Format>
                    </Decoding>
                </TerminalCapability>
                <TerminalCapability xsi:type="DisplaysType">
                    <Display>
                        <DisplayCapability xsi:type="DisplayCapabilityType"
                            colorCapable="true">
                            <Mode>
                                <Resolution horizontal="176" vertical="144"/>
                            </Mode>
                            <CharacterSetCode>US-ASCII</CharacterSetCode>
                        </DisplayCapability>
                    </Display>
                </TerminalCapability>
            </Terminal>
        </UsageEnvironmentProperty>
    </Description>
</DIA>
```

The sample DID used in this example is given below. The suggested DIA descriptions from the receiver side include `Format` of the `VideoCapabilitiesType`. On the sender side, `Resolution` and `colorCapable` from the `DisplayCapabilitiesType` could be used for adaptation and are suggested to be sent. For either side, if the receiver supports adaptation based on `CharacterSetCode`, it can choose to perform such an adaptation; otherwise, it can choose to send the descriptions to the sender where the adaptation may occur. The `UserSelection` tag that appears as a `Descriptor` of the `Choice` pertaining to video quality indicates that the video quality is selected by the User, while the `BackgroundConfiguration` tag that appears as a `Descriptor` of the `Choice` pertaining to the supported format is configured by the terminal automatically.

```
<DIDL>
    <Item id="foreman Reply">
        <Descriptor>
            <Statement mimeType="text/plain">
                <dia:DIA>
                    <dia:Description xsi:type="diac:SuggestedDIADescriptionsType">
                        <diac:ReceiverSide>
                            <diac:Target xsi:type="diac:TargetType"
targetDescription="//dia:Decoding[@xsi:type=dia:VideoCapabilitiesType]/dia:Format"/>
                        </diac:ReceiverSide>
                        <diac:SenderSide>
                            <diac:Target xsi:type="diac:TargetType"
targetDescription="//dia:Display[@xsi:type=dia:DisplayCapabilitiesType]/dia:Resolution"/>
                            <diac:Target xsi:type="diac:TargetType"
targetDescription="//dia:Display[@xsi:type=dia:DisplayCapabilitiesType]/dia:@colorCapable"
/>
                        </diac:SenderSide>
                        <diac:EitherSide>
                            <diac:Target xsi:type="diac:TargetType"
targetDescription="//dia:Display[@xsi:type=dia:DisplayCapabilitiesType]/dia:CharacterSetCo
de"/>
                        </diac:EitherSide>
                    </dia:Description>
                </dia:DIA>
            </Statement>
        </Descriptor>
        <Choice choice id="SupportedFormat" maxSelections="1" minSelections="1">
            <Descriptor>
                <Statement>
```


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```
                    <diac:BackgroundConfiguration/>
                </Statement>
            </Descriptor>
            <Selection select id="SupportedFormat avi">
                <Descriptor>
                    <Statement mimeType="text/plain">avi</Statement>
                </Descriptor>
                <Descriptor>
                    <Statement mimeType="text/xml">
                        <dia:DIADescriptionUnit xsi:type="dia:VideoCapabilitiesType">
                            <dia:Format href="urn:mpeg:mpeg7:cs:FileFormatCS:2001:7">
                                <mpeg7:Name xml:lang="en">avi</mpeg7:Name>
                            </dia:Format>
                        </dia:DIADescriptionUnit>
                    </Statement>
                </Descriptor>
            </Selection>
            <Selection select id="SupportedFormat mpeg">
                <Descriptor>
                    <Statement mimeType="text/plain">mpeg</Statement>
                </Descriptor>
                <Descriptor>
                    <Statement mimeType="text/xml">
                        <dia:DIADescriptionUnit xsi:type="dia:VideoCapabilitiesType">
                            <dia:Format href="urn:mpeg:mpeg7:cs:FileFormatCS:2001:3">
                                <mpeg7:Name xml:lang="en">mpeg</mpeg7:Name>
                            </dia:Format>
                        </dia:DIADescriptionUnit>
                    </Statement>
                </Descriptor>
            </Selection>
        </Choice>
        <Choice choice id="VideoQuality" maxSelections="1" minSelections="1">
            <Descriptor>
                <Statement>
                    <diac:UserSelection/>
                </Statement>
            </Descriptor>
            <Selection select id="VideoQuality Low">
                <Descriptor>
                    <Statement mimeType="text/plain">Low</Statement>
                </Descriptor>
            </Selection>
            <Selection select id="VideoQuality High">
                <Descriptor>
                    <Statement mimeType="text/plain">High</Statement>
                </Descriptor>
            </Selection>
        </Choice>
        <Component>
            <Condition require="SupportedFormat avi VideoQuality Low"/>
            <Resource mimeType="video/streaming" ref="foreman low.avi"/>
        </Component>
        <Component>
            <Condition require="SupportedFormat mpeg VideoQuality Low"/>
            <Resource mimeType="video/streaming" ref="foreman low.mpeg"/>
        </Component>
        <Component>
            <Condition require="SupportedFormat avi VideoQuality High"/>
            <Resource mimeType="video/streaming" ref="foreman_high.avi"/>
        </Component>
        <Component>
            <Condition require="SupportedFormat mpeg VideoQuality High"/>
            <Resource mimeType="video/streaming" ref="foreman high.mpeg"/>
        </Component>
    </Item>
</DIDL>
```

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The six steps involved in the adaptation process are as follows:

1) Stream player requests DID with DIA information (e.g., DID file of a movie): stream player sends a request to the stream server for a Digital Item. If a similar request was issued in the past, its data might be stored in the local cache. This might enable the stream player's request to be fulfilled without sending the request to the stream server and thus the device can jump straight to step 3.

2) Stream server sends the requested DID back to the stream player. The stream player performs some DID configuration and adaptation based on DIA information stored on the device and included in the DID. DIAC information is included as part of the content DI to provide the stream player with instructions on how to perform the adaptation and how `Choice`/`Selection` should be configured.

3) The stream player requests a resource from the stream server after performing appropriate DIA adaptation and DID configuration. This involves the transfer of DIA information to the stream server as part of the resource request. The mechanism used for transferring the request is out of DIA scope.

4) The stream server determines the appropriate resource adaptation based on DIA information transferred from the stream player and/or stored on the stream server. The stream server begins streaming the adapted resource to the stream player.

   As an example, the stream server receives both the request for the selected resource and the capability descriptions (`Resolution` ands `colorCapable`). Then, it configures that resource for the resolution and color of the receiver and starts streaming the movie.

   Note that the requested resource may not actually match the resolution of the display. Therefore, the stream server device needs to transcode the resource to the appropriate resolution.

   Note that it is possible that when the stream server performs the resource adaptation, it will need to take into consideration its own capability descriptions. For example, it may use information about its CPU processing power and current available bandwidth to determine the resource's configuration. Here, we have simplified the scenario by excluding the stream server's DIA capability descriptions since their processing is similar to the descriptions on the consumer side.

5) The stream player transfers updated DIA information to the stream server.

6) The stream server determines the appropriate resource adaptation based on the updated DIA information. The currently media streaming is then modified accordingly.

C.3 Example 2

The second example extends from the first example and shows how `DIAConfiguration` could be used when an intermediate node such as a proxy is added into the adaptation process. Figure C.2 illustrates this scenario.

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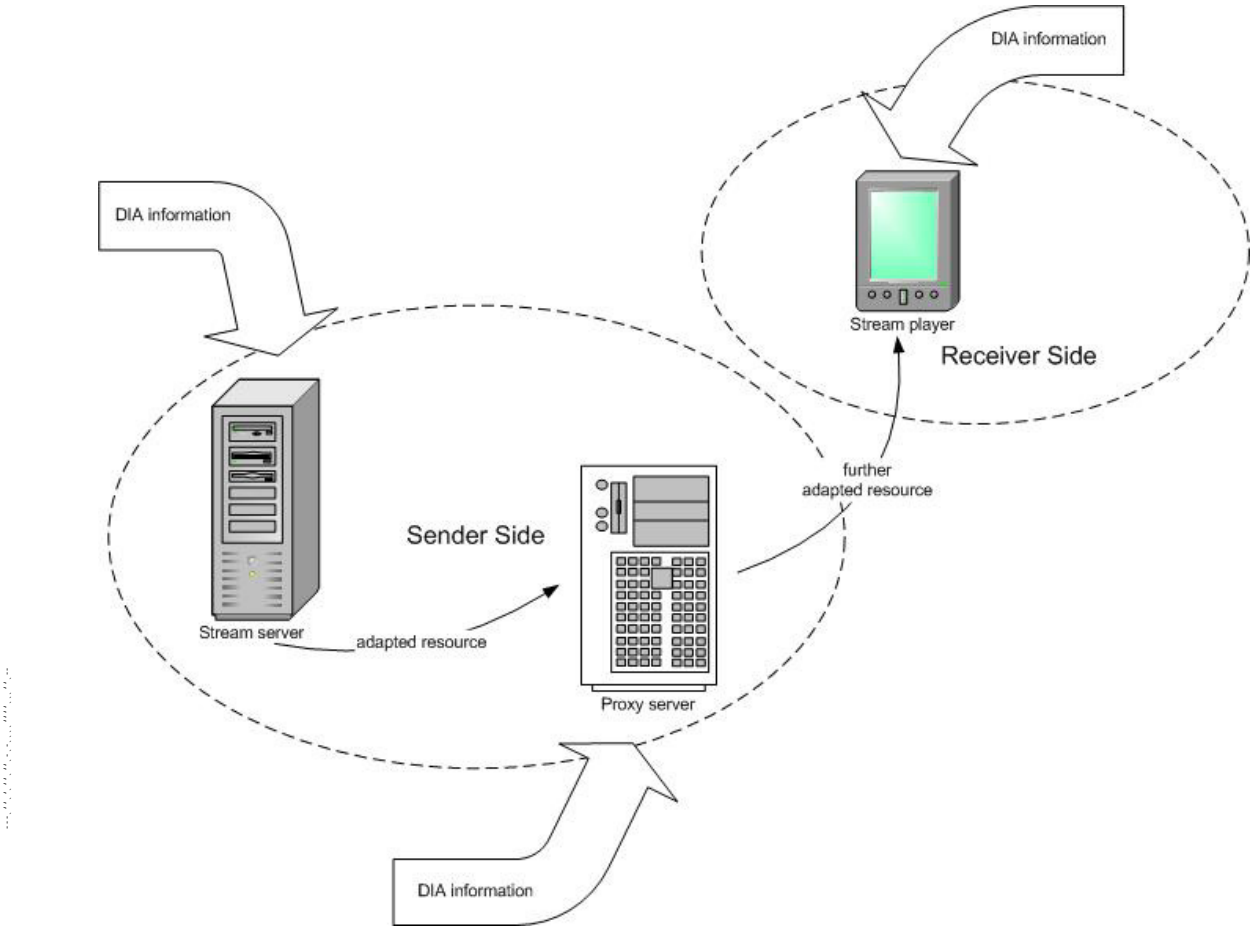

Figure C.2 — Illustration of multiple sender-side adaptations.

In this use case, the sender side is now expanded to include both the stream server and proxy server. The adaptation processes on the sender side are then divided among the stream server and proxy server. For example, the stream server performs colour selection according to the `colorCapable` attribute, then the selected media stream is passed onto the proxy server for resource transcoding. The stream server and proxy server knows that those DIA information are suggested and needs to be adapted on the sender side according to the information in the `SourceSide` element, and then the adaptation task is divided among them according to their capabilities and availabilities. It should be noted that the mechanism for adaptation task allocation on the sender side is not within the scope of standardization.

C.4 Example 3

The third example also extends from the first example and shows how `DIAConfiguration` could be used when the resource is adapted and consumed by two devices in turn such as a laptop and a PDA. Figure C.3 illustrates this scenario.

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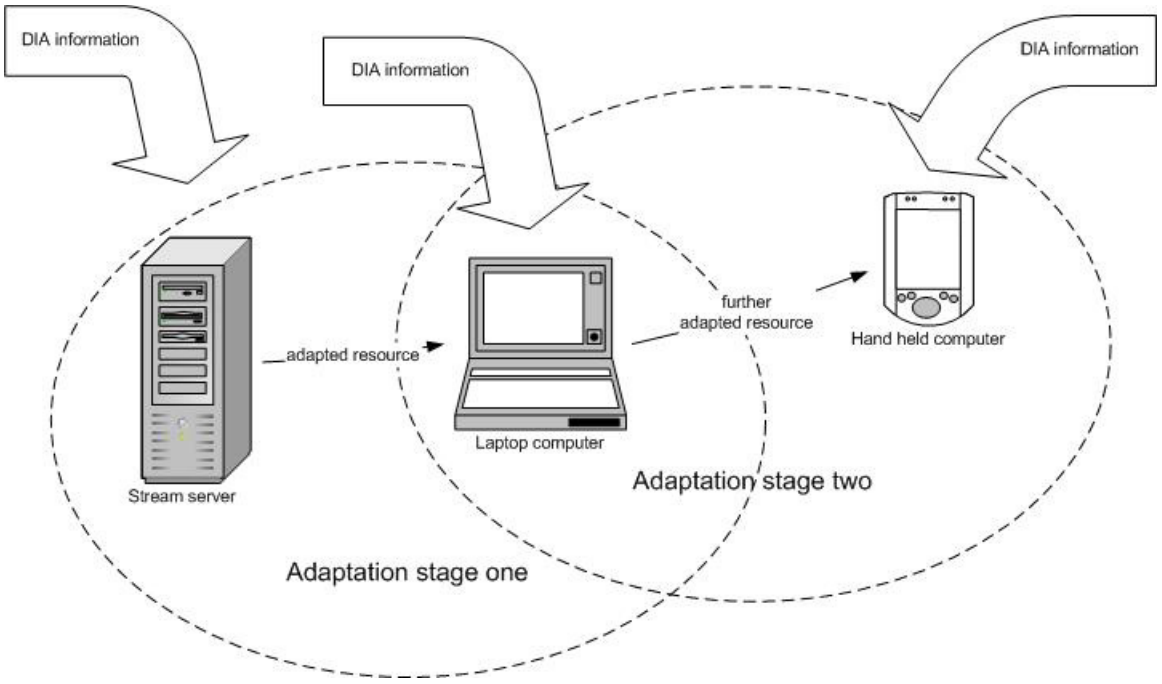

Figure C.3 — Example of a multiple-step adaptation process.

In this use case, the resource is adapted and consumed by the laptop, and then the laptop performs further adaptation before sending it to the PDA for consumption. This process is considered in two stages:

1) The laptop and the stream server perform the adaptation according to the end-to-end approach described in the first example for the adaptation process.

2) Now the second adaptation process is performed by switching the laptop from being the receiver side device to the sender side device. Now as the resource has already been adapted for the Laptop, it checks whether the resource needs to be readapted for the PDA device. It determines which Usage Environment Descriptions are suggested for the adaptation on its side by checking the information in the `SourceSide` element of the CDI, while as the PDA device checks the `ReceiverSide` element for its adaptation. It is noted that the mechanism for switching from a sender side device to receiver side device and vice versa is not within the scope of standardization.

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Annex D

(informative)

Address corrections in (g)BS Descriptions for multi-step adaptations

When an adapted bitstream is generated, then the address information in the transformed BS Description, that was used to generate the bitstream, may become incorrect. This means that the address information in the BS Description needs to be adjusted to correctly point to the new bitstream. The attributes of a gBS Description that might need to be adjusted are:

— `bs1:bitstreamURI`: location of the new bitstream.

— `start`: the start address of `gBSDUnit` and `Parameter` elements might have changed because of element removals or modifications. In the case of `Consecutive` addressing, the value of the start element – if present – should be set to 0.

— `length`: the value of the `length` attribute of an intermediate `gBSDUnit` element might have changed because of element removals or modifications in its child elements.

— `addressUnit`: in some cases it is required to change the `addressUnit` due to element removals.

EXAMPLE In some cases the gBSDtoBin process may create a bitstream in which subsequent `gBSDUnit` elements are not byte-aligned. For example, if two subsequent `gBSDUnit` elements `elemA` and `elemB` (initially aligned to byte boundaries and with `addressUnit="byte"`) are adapted in a way that some bits are removed from `elemA`, then `elemB` will not be byte-aligned. This requires a modification of the `addressUnit` attribute of subsequent `gBSDUnit` elements (i.e., in this case `elemB`) from `byte` to `bit`. Note that in such cases, the `start` and `length` attributes need to be updated also.

Since this problem occurs only when the (adapted) bitstream is generated, the correction of the address references can be incorporated into the bitstream generation process described in subclause 8.3.2.4. More specifically, the following additional functionalities are needed:

— While stepping through the gBS Description elements, the processor should keep track of the current position in the new bitstream.

— If an element has a `start` attribute, the processor should update this `start` attribute with the current position in the new bitstream.

The output of this process should be the adapted bitstream (as with the gBSDtoBin process) and an updated gBS Description that correctly references the adapted bitstream.

A possible architecture is shown in Figure D.1 for gBSDtoBin.

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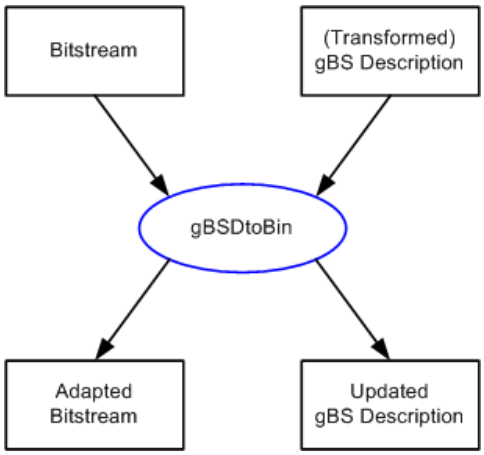

Figure D.1 — Architecture of gBS Description generation with address corrections.

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Annex E

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UCD-based adaptation decision making engine

E.1 Introduction

The Universal Constraint Description (UCD) can travel both upstream from the consumer to an adaptation engine, and downstream in conjunction with AdaptationQoS or other steering descriptions sent from the content provider. In the former case, the UCD supplements the information in the Usage Environment Descriptions. In the latter case, the UCD allows content providers to specify provider side constraints that must be satisfied for any adaptation of a resource.

E.2 ADTE architectures

Based on how the UCD tool is used, different adaptation architectures are possible. Figure E.1 illustrates the push mode architecture where the UCD, typically referenced in the AdaptationQoS, flows downstream from the DI provider to an adaptation engine while the UED flows upstream from the DI consumer. The UCD, UED, and possibly an AdaptationQoS or other steering description, will be an input to a UCD-based Adaptation Decision-Taking Engine (ADTE).

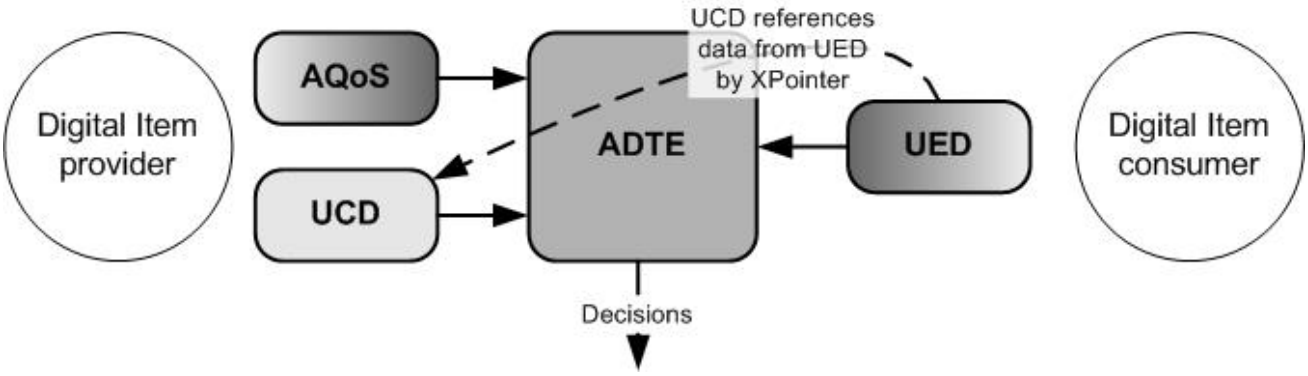

Figure E.1 — Push mode adaptation architecture with the UCD tool.

In the pull mode architecture as depicted in Figure E.2, the UCD is issued by the DI consumer rather than by the DI provider. The UCD may still reference to data contained in the UED but may also originate from a different location within the DI consumer's usage environment.

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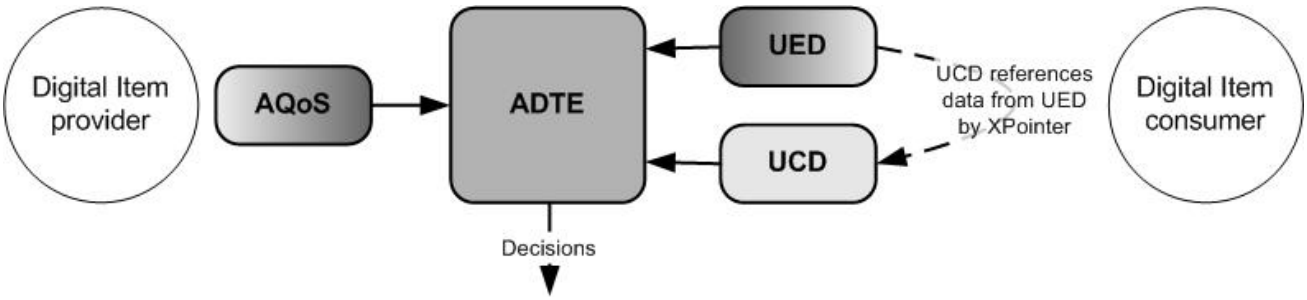

Figure E.2 — Pull mode adaptation architecture with the UCD tool.

In the hybrid mode as shown in Figure E.3 the UCD, typically included in the AdaptationQoS, may go downstream from the DI provider, and also come upstream from the DI consumer, and both are jointly used by the ADTE to provide decisions.

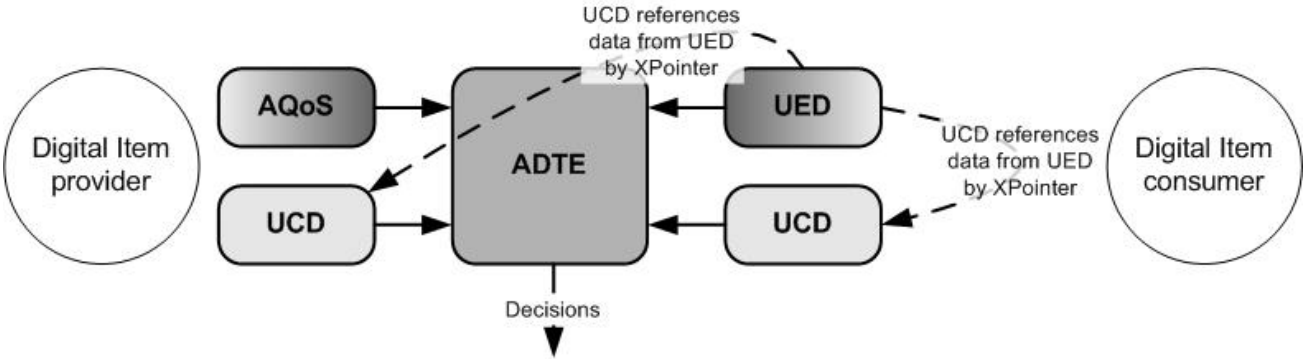

Figure E.3 — Hybrid mode adaptation architecture with the UCD tool

In addition to the above modes of operation, the UCD can also be originated from a REL-RDD grant.

Note that in all the figures above, the AQoS (AdaptationQoS) box refers to any other steering descriptions as well, and can be even dropped if the ADTE is format-specific.

E.3 UCD based ADTE processing model

In order to ensure predictable behavior of a UCD-based Adaptation Decision-Taking Engine (ADTE), in this subclause, the processing model for such a processor is specified. Figure E.4 shows the schematic of an abstract UCD-based ADTE.

The inputs to the UCD-based ADTE are:

- An AdaptationQoS description or other steering description.
- A list of UCDs from various sources (internal in AdaptationQoS description, external from a DI consumer, or external from a REL-RDD grant).
- A URI resolver that has access to UEDs and other external documents to resolve URIs that are referenced in arguments of type ExternalDataRefType.
- A classification scheme term resolver to resolve semantics specified in arguments of type SemanticalDataRefType.

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The outputs of the ADTE are:

- A result code indicating one of the following:
  - Success: Solution was found
  - PartSuccess: Solution could not be found for at least one of the UCDs based on its optimization constraints, but a solution that satisfied all the limit constraints was successfully substituted. Or, a solution could not be found for at least one of the limit constraints, but a specified default solution was successfully substituted.
  - Failure: Solution was not found
- The Solution specified as values of variables for each adpatation unit.

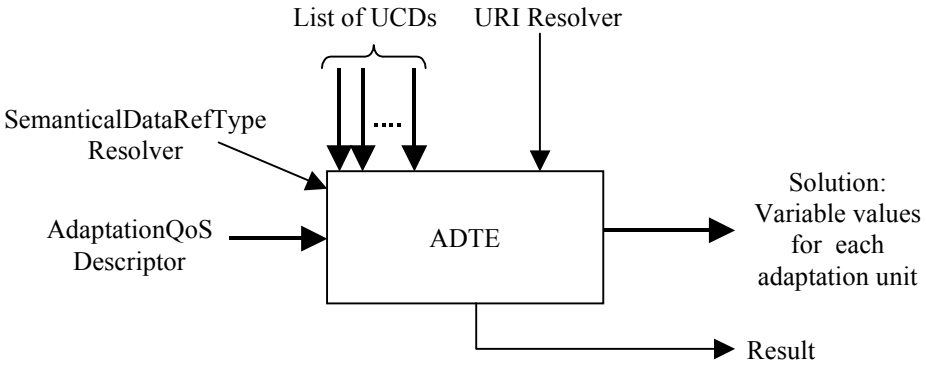

Figure E.4 — Decision making architecture in the UCD-based ADTE.

The processing model of the ADTE based on the above input-output characteristics is specified below. Note that while an implementation of an engine does not need to follow this model exactly, the final result must be consistent with the interpretation of the UCD and the AdaptationQoS descriptions as specified in this model. Note that variables below refer to input or output media characteristics or usage environment inputs or preferences. If an AdaptationQoS description is used, these would typically map to IOPins.

Step 1: Consistency check for adaptation unit definitions:

```
Step 1A: Check to see if all AdaptationUnitDef elements in all UCDs are
      consistent, i.e., refer to the same variable or none.
Step 1B: If not consistent, flag Result=Failure and go to Step 3.
```

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Step 2: Process adaptation units sequentially:

```
Step 2A: Assign Result=Success
Step 2B: Assign auIndex = 0
Step 2C: While auIndex < TotalAdaptationUnits {
      Step 2Ca: Obtain initial viable solution space (A) by analysis of
            AdaptationQoS, other steering description information or knowledge
            embedded in the engine
      Step 2Cb: Restrict solution space A so that the value of the assigned
            variable in the solution matches the value given by each Assign
            element for the current adaptation unit in each input UCD. The
            restricted solution space is B, where B is a subset of A. If unable
            to perform this step, go to Step 2Ck.
      Step 2Cc: If B is null, indicating conflicting assignments, go to Step
            2Ck.
      Step 2Cd: Further restrict solution space so that the evaluation of the
            stack function in each LimitConstraint element corresponding to the
            current adaptation unit for each input UCD, returns true when all
            arguments are replaced by the respective values from the
            SemanticalDataRefType Resolver, the URI Resolver, or the solution.
            The restricted solution space is denoted C, where C is a subset of B.
            If unable to perform this step, go to Step 2Ck.
      Step 2Ce: If C is null, indicating unsatisfied limit constraints, go to
            Step 2Ck.
      Step 2Cf: Find optimal set S of solutions in the restricted solution space
            C that maximizes or minimizes the numeric evaluation of the stack
            functions for the OptimizationConstraint elements corresponding to
            the current adaptation unit, in each UCD. If unable to perform this
            step for at least one UCD, go to step 2Cj.
            Note: if a UCD contains no OptimizationConstraint elements, set S =
            C; if a UCD contains exactly one OptimizationConstraint element, the
            set S is the set of solutions included in C where the same maximum or
            minimum for the evaluation of the stack function in the
            OptimizationConstraint element is satisfied; if a UCD contains
            multiple OptimizationConstraint elements, the set S is the Pareto
            optimal set included in C, corresponding to the multiple stack
            functions in the multiple OptimizationConstraint elements.
      Step 2Cg: Find intersection S* of the sets S of solutions for all UCDs.
      Step 2Ch: If S* is null, denoting conflicting solutions, go to Step 2Cj.
      Step 2Ci: Record any one solution in S* as optimum and go to Step 2Cl.
      Step 2Cj: Assign Result=PartSuccess and record any one solution in
            solution space C. Then go to Step 2Cl.
      Step 2Ck: Assign Result=PartSuccess and attempt to record a solution with
            default values for variables (for AdaptationQoS, this is specified in
            the Default sub-element in the IOPin element). If there are variables
            with no defaults available, assign Result=Failure, and go to Step 3.
      Step 2Cl: auIndex = auIndex+1;
}
```

Step 3: Report:

```
Step 3A:  Output Result
Step 3B:  If (Result != Failure) output Solution for all adaptationUnits.
```

Since an UCD-based ADTE is essentially semantics independent, it is not its job to understand external relations on outputs based on their semantics. If it is desired for the outputs of the ADTE to be consistent with these external relations, they should be expressed as additional UCD limitation constraints. For example, Aspect_ratio = image_width/image_height is an external relation known from the semantics of the three properties, but cannot be processed by a UCD based decision-making engine unless this relation is explicitly provided by means of a limititation constraint.

--`,,```,,,,````-`-`,,`,,`,`,,`---

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Annex F

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Annex G
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Schema

G.1 Introduction

In the main text of this specification, the syntax of description tools is provided whenever possible as a single schema document, containing in particular the namespaces declarations, include and import statements.

In some cases though, and in particular for the clauses 4, 6 and 8, the syntax of description tools is imprecated with the semantics definition and examples. For better readability and informatively, the syntax is also provided for the relevant clauses in this Annex as a single schema document.

NOTE All ISO/IEC 21000-7 schema documents are publicly available under http://standards.iso.org/ittf/PubliclyAvailableStandards/MPEG-21_schema_files.

G.2 Schema definition for schema tools (clause 4)

```
<?xml version="1.0"?>
<!-- Digital Item Adaptation ISO/IEC 21000-7 Second Edition -->
<!-- Schema for basic schema tools -->
<schema
   version="ISO/IEC 21000-7 2nd"
   id="DIA-2nd.xsd"
   targetNamespace="urn:mpeg:mpeg21:2003:01-DIA-NS"
   xmlns="http://www.w3.org/2001/XMLSchema"
   xmlns:dia="urn:mpeg:mpeg21:2003:01-DIA-NS"
   elementFormDefault="qualified" attributeFormDefault="unqualified">

   <!-- ################################################ -->
   <!--  Definition of DIA Base Types                    -->
   <!-- ################################################ -->

   <complexType name="DIABaseType" abstract="true">
      <complexContent>
         <restriction base="anyType">
            <attribute name="id" type="ID" use="optional"/>
         </restriction>
      </complexContent>
   </complexType>

   <complexType name="DIADescriptionType" abstract="true">
      <complexContent>
         <extension base="dia:DIABaseType"/>
      </complexContent>
   </complexType>

   <!-- ################################################ -->
   <!--  Definition of Description Metadata Type         -->
   <!-- ################################################ -->
   <complexType name="DescriptionMetadataType">
      <complexContent>
         <extension base="dia:DIABaseType">
```


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```
            <sequence>
               <element name="ClassificationSchemeAlias" maxOccurs="unbounded">
                  <complexType>
                     <complexContent>
                        <extension base="dia:DIABaseType">
                           <attribute name="alias" type="NMTOKEN"
use="required"/>
                           <attribute name="href" type="anyURI"
use="required"/>
                        </extension>
                     </complexContent>
                  </complexType>
               </element>
            </sequence>
         </extension>
      </complexContent>
   </complexType>

   <!-- ################################################ -->
   <!--  Definition of DIA Root Element                  -->
   <!-- ################################################ -->

   <element name="DIA">
      <complexType>
         <sequence>
            <element name="DescriptionMetadata"
type="dia:DescriptionMetadataType"
               minOccurs="0"/>
            <choice maxOccurs="unbounded">
               <element name="Description" type="dia:DIADescriptionType"/>
               <element name="Reference" type="dia:ReferenceType"/>
            </choice>
         </sequence>
      </complexType>
   </element>

   <element name="DIADescriptionUnit" type="dia:DIABaseType"/>

   <!-- ################################################ -->
   <!--  Definition of Reference                         -->
   <!-- ################################################ -->

   <complexType name="ReferenceType">
      <attribute name="uri" type="anyURI" use="required"/>
   </complexType>

</schema>
```

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G.3 Schema definition for usage environment descriptions tools (clause 6)

```
<?xml version="1.0"?>
<!-- Digital Item Adaptation ISO/IEC 21000-7 Second Edition -->
<!-- Schema for Usage Environment Description Tools -->
<schema targetNamespace="urn:mpeg:mpeg21:2003:01-DIA-NS"
xmlns:mpeg7="urn:mpeg:mpeg7:schema:2001" xmlns:dia="urn:mpeg:mpeg21:2003:01-DIA-
NS" xmlns="http://www.w3.org/2001/XMLSchema" elementFormDefault="qualified"
attributeFormDefault="unqualified" version="ISO/IEC 21000-7 2nd" id="UED-
2nd.xsd">
   <import namespace="urn:mpeg:mpeg7:schema:2001" schemaLocation="mpeg7-udp-
2004.xsd"/>
   <include schemaLocation="DIA-2nd.xsd"/>
   <include schemaLocation="ConvD-2nd.xsd"/>
   <!-- ################################################ -->
   <!--  Definition of UsageEnvironment      -->
   <!-- ################################################ -->
   <complexType name="UsageEnvironmentType">
      <complexContent>
         <extension base="dia:DIADescriptionType">
            <sequence>
               <element name="UsageEnvironmentProperty"
type="dia:UsageEnvironmentPropertyBaseType" minOccurs="0" maxOccurs="unbounded"/>
            </sequence>
         </extension>
      </complexContent>
   </complexType>
   <complexType name="UsageEnvironmentPropertyBaseType" abstract="true">
      <complexContent>
         <extension base="dia:DIADescriptionType"/>
      </complexContent>
   </complexType>
   <!-- ################################################ -->
   <!--  Definition of Users          -->
   <!-- ################################################ -->
   <complexType name="UsersType">
      <complexContent>
         <extension base="dia:UsageEnvironmentPropertyBaseType">
            <sequence>
               <element name="User" type="dia:UserType" minOccurs="0"
maxOccurs="unbounded"/>
            </sequence>
         </extension>
      </complexContent>
   </complexType>
   <!-- ################################################ -->
   <!--  Definition of User       -->
   <!-- ################################################ -->
   <complexType name="UserType">
      <complexContent>
         <extension base="dia:DIABaseType">
            <sequence>
               <element name="UserCharacteristic"
type="dia:UserCharacteristicBaseType" minOccurs="0" maxOccurs="unbounded"/>
            </sequence>
         </extension>
      </complexContent>
   </complexType>
   <complexType name="UserCharacteristicBaseType" abstract="true">
      <complexContent>
         <extension base="dia:DIABaseType"/>
```


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```
      </complexContent>
   </complexType>
   <!-- ################################################ -->
   <!--  Definition of UserInfo          -->
   <!-- ################################################ -->
   <complexType name="UserInfoType">
      <complexContent>
         <extension base="dia:UserCharacteristicBaseType">
            <sequence>
               <element name="UserInfo" type="mpeg7:AgentType" minOccurs="0"/>
            </sequence>
         </extension>
      </complexContent>
   </complexType>
   <!-- ################################################ -->
   <!--  Definition of UsagePreferences      -->
   <!-- ################################################ -->
   <complexType name="UsagePreferencesType">
      <complexContent>
         <extension base="dia:UserCharacteristicBaseType">
            <sequence>
               <element name="UsagePreferences"
type="mpeg7:UserPreferencesType" minOccurs="0" maxOccurs="unbounded"/>
            </sequence>
         </extension>
      </complexContent>
   </complexType>
   <!-- ################################################ -->
   <!--  Definition of UsageHistory        -->
   <!-- ################################################ -->
   <complexType name="UsageHistoryType">
      <complexContent>
         <extension base="dia:UserCharacteristicBaseType">
            <sequence>
               <element name="UsageHistory" type="mpeg7:UsageHistoryType"
minOccurs="0" maxOccurs="unbounded"/>
            </sequence>
         </extension>
      </complexContent>
   </complexType>
   <!-- ################################################ -->
   <!--  Definition of AudioPresentationPreferences      -->
   <!-- ################################################ -->
   <complexType name="AudioPresentationPreferencesType">
      <complexContent>
         <extension base="dia:UserCharacteristicBaseType">
            <sequence>
               <element name="VolumeControl" type="mpeg7:zeroToOneType"
minOccurs="0"/>
               <element name="FrequencyEqualizer"
type="dia:FrequencyEqualizerType" minOccurs="0"/>
               <element name="AudibleFrequencyRange" minOccurs="0">
                  <complexType>
                     <sequence>
                        <element name="StartFrequency" type="float"/>
                        <element name="EndFrequency" type="float"/>
                     </sequence>
                  </complexType>
               </element>
               <element name="AudioOutputDevice" minOccurs="0">
                  <simpleType>
                     <restriction base="string">
```

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```
                        <enumeration value="Headphone"/>
                        <enumeration value="Loudspeaker"/>
                     </restriction>
                  </simpleType>
               </element>
               <element name="BalancePreference" minOccurs="0">
                  <simpleType>
                     <restriction base="float">
                        <minInclusive value="-10"/>
                        <maxInclusive value="10"/>
                     </restriction>
                  </simpleType>
               </element>
               <element name="Soundfield" type="dia:SoundfieldType"
minOccurs="0"/>
               <element name="SoniferousSpeed" minOccurs="0">
                  <simpleType>
                     <restriction base="float">
                        <minExclusive value="0"/>
                     </restriction>
                  </simpleType>
               </element>
            </sequence>
         </extension>
      </complexContent>
   </complexType>
   <simpleType name="FrequencyEqualizerType">
      <restriction>
         <simpleType>
            <list itemType="dia:FrequencyEqualizerBaseType"/>
         </simpleType>
         <length value="31"/>
      </restriction>
   </simpleType>
   <simpleType name="FrequencyEqualizerBaseType">
      <restriction base="float">
         <minInclusive value="-15"/>
         <maxInclusive value="15"/>
      </restriction>
   </simpleType>
   <complexType name="SoundfieldType">
      <complexContent>
         <extension base="dia:DIABaseType">
            <sequence>
               <element name="ImpulseResponse" type="dia:ImpulseResponseType"
minOccurs="0"/>
               <element name="PerceptualParameters"
type="dia:PerceptualParametersType" minOccurs="0"/>
            </sequence>
         </extension>
      </complexContent>
   </complexType>
   <complexType name="ImpulseResponseType">
      <complexContent>
         <extension base="dia:DIABaseType">
            <sequence>
               <element name="SamplingFrequency" type="mpeg7:nonNegativeReal"
minOccurs="0"/>
               <element name="BitsPerSample" type="nonNegativeInteger"
minOccurs="0"/>
               <element name="NumOfChannels" type="nonNegativeInteger"
minOccurs="0"/>
```


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```
            </sequence>
            <attribute name="href" type="anyURI" use="optional"/>
         </extension>
      </complexContent>
   </complexType>
   <complexType name="PerceptualParametersType">
      <complexContent>
         <extension base="dia:DIABaseType">
            <sequence>
               <element name="SourcePresence" type="float" minOccurs="0"/>
               <element name="SourceWarmth" type="float" minOccurs="0"/>
               <element name="SourceBrilliance" type="float" minOccurs="0"/>
               <element name="RoomPresence" type="float" minOccurs="0"/>
               <element name="RunningReverberance" type="float" minOccurs="0"/>
               <element name="Envelopment" type="float" minOccurs="0"/>
               <element name="LateReverberance" type="float" minOccurs="0"/>
               <element name="Heavyness" type="float" minOccurs="0"/>
               <element name="Liveness" type="float" minOccurs="0"/>
               <element name="RefDistance" type="float" minOccurs="0"/>
               <element name="FreqLow" type="float" minOccurs="0"/>
               <element name="FreqHigh" type="float" minOccurs="0"/>
               <element name="TimeLimit1" type="float" minOccurs="0"/>
               <element name="TimeLimit2" type="float" minOccurs="0"/>
               <element name="TimeLimit3" type="float" minOccurs="0"/>
            </sequence>
         </extension>
      </complexContent>
   </complexType>
   <!-- ################################################ -->
   <!--  Definition of DisplayPresentationPreferences    -->
   <!-- ################################################ -->
   <complexType name="DisplayPresentationPreferencesType">
      <complexContent>
         <extension base="dia:UserCharacteristicBaseType">
            <sequence>
               <element name="ColorTemperaturePreference"
type="dia:ColorPreferenceType" minOccurs="0"/>
               <element name="BrightnessPreference"
type="dia:ColorPreferenceType" minOccurs="0"/>
               <element name="SaturationPreference"
type="dia:ColorPreferenceType" minOccurs="0"/>
               <element name="ContrastPreference"
type="dia:ColorPreferenceType" minOccurs="0"/>
               <element name="StereoscopicVideoConversion"
type="dia:StereoscopicVideoConversionType" minOccurs="0"/>
            </sequence>
         </extension>
      </complexContent>
   </complexType>
   <!-- ################################################ -->
   <!--  Definition of ColorPreference       -->
   <!-- ################################################ -->
   <complexType name="ColorPreferenceType">
      <complexContent>
         <extension base="dia:DIABaseType">
            <sequence>
               <element name="BinNumber" type="mpeg7:unsigned12"/>
               <element name="Value" minOccurs="0" maxOccurs="unbounded">
                  <complexType>
                     <sequence>
                        <element name="PreferredValue"
type="mpeg7:unsigned12"/>
```

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```
                        <element name="ReferenceValue"
type="mpeg7:unsigned12"/>
                     </sequence>
                  </complexType>
               </element>
            </sequence>
         </extension>
      </complexContent>
   </complexType>
   <!-- ################################################ -->
   <!--  Definition of StereoscopicVideoConversion    -->
   <!-- ################################################ -->
   <complexType name="StereoscopicVideoConversionType">
      <complexContent>
         <extension base="dia:DIABaseType">
            <sequence>
               <element name="From2DTo3DStereoscopic" minOccurs="0">
                  <complexType>
                     <sequence>
                        <element name="ParallaxType">
                           <simpleType>
                              <restriction base="string">
                                 <enumeration value="Positive"/>
                                 <enumeration value="Negative"/>
                              </restriction>
                           </simpleType>
                        </element>
                        <element name="DepthRange"
type="mpeg7:zeroToOneType"/>
                        <element name="MaxDelayedFrame"
type="nonNegativeInteger" minOccurs="0"/>
                     </sequence>
                  </complexType>
               </element>
               <element name="From3DStereoscopicTo2D" minOccurs="0">
                  <complexType>
                     <sequence>
                        <element name="LeftRightInterVideo">
                           <simpleType>
                              <restriction base="string">
                                 <enumeration value="Left"/>
                                 <enumeration value="Right"/>
                                 <enumeration value="Intermediate"/>
                              </restriction>
                           </simpleType>
                        </element>
                     </sequence>
                  </complexType>
               </element>
            </sequence>
         </extension>
      </complexContent>
   </complexType>
   <!-- ################################################ -->
   <!--  Definition of GraphicsPresentationPreferencesType  -->
   <!-- ################################################ -->
   <complexType name="GraphicsPresentationPreferencesType">
      <complexContent>
         <extension base="dia:UserCharacteristicBaseType">
            <sequence>
               <element name="GeometryEmphasis" type="mpeg7:zeroToOneType"
minOccurs="0"/>
```


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```
                <element name="TextureEmphasis" type="mpeg7:zeroToOneType"
minOccurs="0"/>
                <element name="AnimationEmphasis" type="mpeg7:zeroToOneType"
minOccurs="0"/>
             </sequence>
          </extension>
       </complexContent>
    </complexType>
    <!-- ################################################ -->
    <!--    Definition of ConversionPreference     -->
    <!-- ################################################ -->
    <complexType name="ConversionPreferenceType">
       <complexContent>
          <extension base="dia:UserCharacteristicBaseType">
             <sequence>
                <element name="GeneralResourceConversions"
type="dia:ResourceConversionType" minOccurs="0"/>
                <element name="SpecificResourceConversions"
type="dia:SpecificResourceConversionsType" minOccurs="0"/>
             </sequence>
          </extension>
       </complexContent>
    </complexType>
    <complexType name="ResourceConversionType">
       <complexContent>
          <extension base="dia:DIABaseType">
             <sequence>
                <element name="Conversion" type="dia:ConversionType"
minOccurs="0" maxOccurs="unbounded"/>
             </sequence>
          </extension>
       </complexContent>
    </complexType>
    <complexType name="ConversionType">
       <complexContent>
          <extension base="dia:DIABaseType">
             <sequence>
                <element name="From" type="mpeg7:ControlledTermUseType"
minOccurs="0"/>
                <element name="To" type="mpeg7:ControlledTermUseType"/>
             </sequence>
             <attribute name="order" type="nonNegativeInteger" use="required"/>
             <attribute name="weight" type="mpeg7:nonNegativeReal"
use="optional" default="1.0"/>
          </extension>
       </complexContent>
    </complexType>
    <complexType name="SpecificResourceConversionsType">
       <complexContent>
          <extension base="dia:DIABaseType">
             <sequence>
                <element name="Object" minOccurs="0" maxOccurs="unbounded">
                   <complexType>
                      <complexContent>
                         <extension base="dia:ResourceConversionType">
                            <attribute name="target" type="anyURI"
use="required"/>
                         </extension>
                      </complexContent>
                   </complexType>
                </element>
             </sequence>
```

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```
         </extension>
      </complexContent>
   </complexType>
   <!-- ################################################ -->
   <!--    Definition of PresentationPriorityPreference  -->
   <!-- ################################################ -->
   <complexType name="PresentationPriorityPreferenceType">
      <complexContent>
         <extension base="dia:UserCharacteristicBaseType">
            <sequence>
               <element name="GeneralResourcePriorities"
type="dia:GeneralResourcePrioritiesType" minOccurs="0"/>
               <element name="SpecificResourcePriorities"
type="dia:SpecificResourcePrioritiesType" minOccurs="0"/>
            </sequence>
         </extension>
      </complexContent>
   </complexType>
   <complexType name="GeneralResourcePrioritiesType">
      <complexContent>
         <extension base="dia:DIABaseType">
            <sequence>
               <element name="ModalityPriorities"
type="dia:ModalityPrioritiesType" minOccurs="0"/>
               <element name="GenrePriorities" type="dia:GenrePrioritiesType"
minOccurs="0"/>
            </sequence>
         </extension>
      </complexContent>
   </complexType>
   <complexType name="SpecificResourcePrioritiesType">
      <complexContent>
         <extension base="dia:DIABaseType">
            <sequence>
               <element name="Object" minOccurs="0" maxOccurs="unbounded">
                  <complexType>
                     <attribute name="priorityLevel"
type="mpeg7:nonNegativeReal" use="optional" default="1.0"/>
                     <attribute name="target" type="anyURI" use="required"/>
                  </complexType>
               </element>
            </sequence>
         </extension>
      </complexContent>
   </complexType>
   <complexType name="ModalityPrioritiesType">
      <complexContent>
         <extension base="dia:DIABaseType">
            <sequence>
               <element name="Modality" minOccurs="0" maxOccurs="unbounded">
                  <complexType>
                     <complexContent>
                        <extension base="mpeg7:ControlledTermUseType">
                           <attribute name="priorityLevel"
type="mpeg7:nonNegativeReal" use="optional" default="1.0"/>
                        </extension>
                     </complexContent>
                  </complexType>
               </element>
            </sequence>
         </extension>
      </complexContent>
```


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```
    </complexType>
    <complexType name="GenrePrioritiesType">
        <complexContent>
            <extension base="dia:DIABaseType">
                <sequence>
                    <element name="Genre" minOccurs="0" maxOccurs="unbounded">
                        <complexType>
                            <complexContent>
                                <extension base="mpeg7:ControlledTermUseType">
                                    <attribute name="priorityLevel"
type="mpeg7:nonNegativeReal" use="optional" default="1.0"/>
                                </extension>
                            </complexContent>
                        </complexType>
                    </element>
                </sequence>
            </extension>
        </complexContent>
    </complexType>
    <!-- ################################################ -->
    <!-- Definition of FocusOfAttentionType        -->
    <!-- ################################################ -->
    <complexType name="FocusOfAttentionType">
        <complexContent>
            <extension base="dia:UserCharacteristicBaseType">
                <choice minOccurs="0">
                    <element name="ROI" minOccurs="0">
                        <complexType>
                            <attribute name="uri" type="anyURI" use="required"/>
                            <attribute name="updateInterval"
type="mpeg7:nonNegativeReal" use="optional" default="0"/>
                        </complexType>
                    </element>
                    <element name="TextFocusOfAttention"
type="dia:TextFocusOfAttentionType" minOccurs="0"/>
                    <element name="SceneObjectFocusOfAttention"
type="mpeg7:MediaLocatorType" minOccurs="0"/>
                </choice>
            </extension>
        </complexContent>
    </complexType>
    <complexType name="TextFocusOfAttentionType">
        <complexContent>
            <extension base="dia:DIABaseType">
                <sequence>
                    <element name="Keyword" minOccurs="0" maxOccurs="unbounded">
                        <complexType>
                            <simpleContent>
                                <extension base="mpeg7:TextualType">
                                    <attribute name="preferenceValue"
type="mpeg7:preferenceValueType" use="optional" default="10"/>
                                </extension>
                            </simpleContent>
                        </complexType>
                    </element>
                    <element name="Font" type="dia:FontType" minOccurs="0"/>
                </sequence>
                <attribute name="textPresentationSpeed"
type="mpeg7:nonNegativeReal" use="optional"/>
            </extension>
        </complexContent>
    </complexType>
```

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```
    <complexType name="FontType">
       <complexContent>
          <extension base="dia:DIABaseType">
             <attribute name="fontColor" type="token" use="optional"/>
             <attribute name="fontSize" type="positiveInteger" use="optional"/>
             <attribute name="fontType" type="token" use="optional"/>
          </extension>
       </complexContent>
    </complexType>
    <!-- ########################################  -->
    <!--  Definition of AuditoryImpairment          -->
    <!-- ########################################  -->
    <complexType name="AuditoryImpairmentType">
       <complexContent>
          <extension base="dia:UserCharacteristicBaseType">
             <sequence>
                <element name="RightEar" type="dia:AudiogramType"/>
                <element name="LeftEar" type="dia:AudiogramType"/>
             </sequence>
          </extension>
       </complexContent>
    </complexType>
    <complexType name="AudiogramType">
       <complexContent>
          <extension base="dia:DIABaseType">
             <sequence>
                <element name="Freq125Hz" type="float" minOccurs="0"/>
                <element name="Freq250Hz" type="float"/>
                <element name="Freq500Hz" type="float"/>
                <element name="Freq1000Hz" type="float"/>
                <element name="Freq1500Hz" type="float" minOccurs="0"/>
                <element name="Freq2000Hz" type="float"/>
                <element name="Freq3000Hz" type="float" minOccurs="0"/>
                <element name="Freq4000Hz" type="float"/>
                <element name="Freq6000Hz" type="float" minOccurs="0"/>
                <element name="Freq8000Hz" type="float"/>
             </sequence>
          </extension>
       </complexContent>
    </complexType>
    <!-- ################################## -->
    <!--  Definition of VisualImpairment    -->
    <!-- ################################## -->
    <complexType name="VisualImpairmentType">
       <complexContent>
          <extension base="dia:UserCharacteristicBaseType">
             <sequence>
                <element name="Blindness" minOccurs="0">
                   <complexType>
                      <attribute name="eyeSide" use="required">
                         <simpleType>
                            <restriction base="NMTOKEN">
                               <enumeration value="both"/>
                               <enumeration value="left"/>
                               <enumeration value="right"/>
                            </restriction>
                         </simpleType>
                      </attribute>
                   </complexType>
                </element>
                <element name="LowVisionSymptoms"
type="dia:LowVisionImpairmentType" minOccurs="0"/>
```


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```
                <element name="ColorVisionDeficiency"
type="dia:ColorVisionDeficiencyType" minOccurs="0"/>
            </sequence>
            <attribute name="rightSight" type="float" use="optional"/>
            <attribute name="leftSight" type="float" use="optional"/>
         </extension>
      </complexContent>
   </complexType>
   <complexType name="LowVisionImpairmentType">
      <complexContent>
         <extension base="dia:DIABaseType">
            <sequence>
               <element name="LossOfFineDetail"
type="dia:VisualImpairmentDegreeType" minOccurs="0"/>
               <element name="LackOfContrast"
type="dia:VisualImpairmentDegreeType" minOccurs="0"/>
               <element name="LightSensitivity"
type="dia:VisualImpairmentDegreeType" minOccurs="0"/>
               <element name="NeedOfLight"
type="dia:VisualImpairmentDegreeType" minOccurs="0"/>
               <element name="CenterVisionLoss"
type="dia:VisualImpairmentDegreeType" minOccurs="0"/>
               <element name="PeripheralVisionLoss"
type="dia:VisualImpairmentDegreeType" minOccurs="0"/>
               <element name="Hemianopia" minOccurs="0">
                  <complexType>
                     <attribute name="side" use="required">
                        <simpleType>
                           <restriction base="NMTOKEN">
                              <enumeration value="left"/>
                              <enumeration value="right"/>
                           </restriction>
                        </simpleType>
                     </attribute>
                  </complexType>
               </element>
            </sequence>
         </extension>
      </complexContent>
   </complexType>
   <complexType name="VisualImpairmentDegreeType">
      <complexContent>
         <extension base="dia:DIABaseType">
            <choice>
               <element name="NumericDegree" type="mpeg7:zeroToOneType"/>
               <element name="TextualDegree">
                  <simpleType>
                     <restriction base="token">
                        <enumeration value="Severe"/>
                        <enumeration value="Medium"/>
                        <enumeration value="Mild"/>
                     </restriction>
                  </simpleType>
               </element>
            </choice>
         </extension>
      </complexContent>
   </complexType>
   <!-- ########################################  -->
   <!--  Definition of ColorVisionDeficiency      -->
   <!-- ########################################  -->
   <complexType name="ColorVisionDeficiencyType">
```

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```
      <complexContent>
         <extension base="dia:DIABaseType">
            <sequence>
               <element name="DeficiencyType">
                  <simpleType>
                     <restriction base="token">
                        <enumeration value="Red-Deficiency"/>
                        <enumeration value="Green-Deficiency"/>
                        <enumeration value="Blue-Deficiency"/>
                        <enumeration value="CompleteColorBlindness"/>
                     </restriction>
                  </simpleType>
               </element>
               <element name="DeficiencyDegree"
type="dia:VisualImpairmentDegreeType"/>
            </sequence>
         </extension>
      </complexContent>
   </complexType>
   <!-- ################################################ -->
   <!--  Definition of MobilityCharacteristics    -->
   <!-- ################################################ -->
   <complexType name="MobilityCharacteristicsType">
      <complexContent>
         <extension base="dia:UserCharacteristicBaseType">
            <sequence>
               <element name="UpdateInterval" type="dia:UpdateIntervalType"
minOccurs="0"/>
               <element name="Directivity" type="dia:DirectivityType"
minOccurs="0"/>
               <element name="Erraticity" type="dia:ErraticityType"
minOccurs="0"/>
            </sequence>
         </extension>
      </complexContent>
   </complexType>
   <complexType name="UpdateIntervalType">
      <complexContent>
         <extension base="dia:DIABaseType">
            <sequence>
               <element name="LastUpdatePoint" type="mpeg7:GeographicPointType"
minOccurs="0"/>
               <element name="LastUpdateBinIndex" type="integer"
minOccurs="0"/>
               <element name="LastUpdateTime" type="mpeg7:TimeType"
minOccurs="0"/>
               <element name="Lmax" type="integer" minOccurs="0"/>
               <element name="Values" minOccurs="0">
                  <simpleType>
                     <restriction base="mpeg7:probabilityVector">
                        <length value="32"/>
                     </restriction>
                  </simpleType>
               </element>
            </sequence>
            <attribute name="xRadius" type="integer" use="optional"/>
            <attribute name="yRadius" type="integer" use="optional"/>
         </extension>
      </complexContent>
   </complexType>
   <complexType name="DirectivityType">
      <complexContent>
```


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```
         <extension base="dia:DIABaseType">
            <sequence>
               <element name="Mean" type="float" minOccurs="0"/>
               <element name="Variance" type="float" minOccurs="0"/>
               <element name="Values" minOccurs="0">
                  <simpleType>
                     <restriction base="mpeg7:probabilityVector">
                        <length value="16"/>
                     </restriction>
                  </simpleType>
               </element>
            </sequence>
            <attribute name="measuredInterval" type="integer" use="optional"/>
         </extension>
      </complexContent>
   </complexType>
   <complexType name="ErraticityType">
      <complexContent>
         <extension base="dia:DIABaseType">
            <sequence>
               <element name="Values" minOccurs="0">
                  <simpleType>
                     <restriction base="mpeg7:probabilityVector">
                        <length value="128"/>
                     </restriction>
                  </simpleType>
               </element>
            </sequence>
         </extension>
      </complexContent>
   </complexType>
   <!-- ######################################### -->
   <!--  Definition of Destination      -->
   <!-- ######################################### -->
   <complexType name="DestinationType">
      <complexContent>
         <extension base="dia:UserCharacteristicBaseType">
            <sequence>
               <element name="Time" type="mpeg7:TimeType" minOccurs="0"/>
               <element name="Location" type="mpeg7:PlaceType" minOccurs="0"/>
               <element name="DestinationClass" minOccurs="0">
                  <complexType>
                     <choice>
                        <element name="FreeClass" type="mpeg7:TextualType"
minOccurs="0" maxOccurs="unbounded"/>
                        <element name="StereotypedClass"
type="mpeg7:ControlledTermUseType"/>
                     </choice>
                  </complexType>
               </element>
               <element name="DestinationName" type="mpeg7:TextualType"
minOccurs="0"/>
            </sequence>
         </extension>
      </complexContent>
   </complexType>
   <!-- ################################################ -->
   <!--  Definition of Terminals         -->
   <!-- ################################################ -->
   <complexType name="TerminalsType">
      <complexContent>
         <extension base="dia:UsageEnvironmentPropertyBaseType">
```

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```
            <sequence>
               <element name="Terminal" type="dia:TerminalType" minOccurs="0"
maxOccurs="unbounded"/>
            </sequence>
         </extension>
      </complexContent>
   </complexType>
   <!-- ################################################ -->
   <!--  Definition of Terminal                          -->
   <!-- ################################################ -->
   <complexType name="TerminalType">
      <complexContent>
         <extension base="dia:DIABaseType">
            <sequence>
               <element name="TerminalCapability"
type="dia:TerminalCapabilityBaseType" minOccurs="0" maxOccurs="unbounded"/>
            </sequence>
         </extension>
      </complexContent>
   </complexType>
   <complexType name="TerminalCapabilityBaseType" abstract="true">
      <complexContent>
         <extension base="dia:DIABaseType"/>
      </complexContent>
   </complexType>
   <!-- ################################################ -->
   <!--  Definition of CodecCapabilities                 -->
   <!-- ################################################ -->
   <complexType name="CodecCapabilitiesType">
      <complexContent>
         <extension base="dia:TerminalCapabilityBaseType">
            <sequence>
               <element name="Decoding" type="dia:CodecCapabilityBaseType"
minOccurs="0" maxOccurs="unbounded"/>
               <element name="Encoding" type="dia:CodecCapabilityBaseType"
minOccurs="0" maxOccurs="unbounded"/>
               <element name="DecodingEncoding"
type="dia:CodecCapabilityBaseType" minOccurs="0" maxOccurs="unbounded"/>
            </sequence>
         </extension>
      </complexContent>
   </complexType>
   <!-- ################################################ -->
   <!--  Definition of CodecCapability                   -->
   <!-- ################################################ -->
   <complexType name="CodecCapabilityBaseType" abstract="true">
      <complexContent>
         <extension base="dia:DIABaseType">
            <sequence minOccurs="0" maxOccurs="unbounded">
               <element name="Format" type="mpeg7:ControlledTermUseType"/>
               <element name="CodecParameter" type="dia:CodecParameterBaseType"
minOccurs="0" maxOccurs="unbounded"/>
            </sequence>
         </extension>
      </complexContent>
   </complexType>
   <complexType name="AudioCapabilitiesType">
      <complexContent>
         <extension base="dia:CodecCapabilityBaseType"/>
      </complexContent>
   </complexType>
   <complexType name="GraphicsCapabilitiesType">
```


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```
      <complexContent>
         <extension base="dia:CodecCapabilityBaseType"/>
      </complexContent>
   </complexType>
   <complexType name="ImageCapabilitiesType">
      <complexContent>
         <extension base="dia:CodecCapabilityBaseType"/>
      </complexContent>
   </complexType>
   <complexType name="SceneGraphCapabilitiesType">
      <complexContent>
         <extension base="dia:CodecCapabilityBaseType"/>
      </complexContent>
   </complexType>
   <complexType name="TransportCapabilitiesType">
      <complexContent>
         <extension base="dia:CodecCapabilityBaseType"/>
      </complexContent>
   </complexType>
   <complexType name="VideoCapabilitiesType">
      <complexContent>
         <extension base="dia:CodecCapabilityBaseType"/>
      </complexContent>
   </complexType>
   <!-- ################################################ -->
   <!--  Definition of CodecParameter                    -->
   <!-- ################################################ -->
   <complexType name="CodecParameterBaseType" abstract="true">
      <complexContent>
         <extension base="dia:DIABaseType"/>
      </complexContent>
   </complexType>
   <complexType name="CodecParameterBufferSizeType">
      <complexContent>
         <extension base="dia:CodecParameterBaseType">
            <sequence>
               <element name="BufferSize" type="integer" minOccurs="0"/>
            </sequence>
         </extension>
      </complexContent>
   </complexType>
   <complexType name="CodecParameterBitRateType">
      <complexContent>
         <extension base="dia:CodecParameterBaseType">
            <sequence>
               <element name="BitRate" minOccurs="0">
                  <complexType>
                     <attribute name="average" type="nonNegativeInteger"
use="optional"/>
                     <attribute name="maximum" type="nonNegativeInteger"
use="optional"/>
                  </complexType>
               </element>
            </sequence>
         </extension>
      </complexContent>
   </complexType>
   <complexType name="CodecParameterMemoryBandwidthType">
      <complexContent>
         <extension base="dia:CodecParameterBaseType">
            <sequence>
               <element name="MemoryBandwidth" type="integer" minOccurs="0"/>
```

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```
            </sequence>
         </extension>
      </complexContent>
   </complexType>
   <complexType name="CodecParameterVertexRateType">
      <complexContent>
         <extension base="dia:CodecParameterBaseType">
            <sequence>
               <element name="VertexRate" type="integer" minOccurs="0"/>
            </sequence>
         </extension>
      </complexContent>
   </complexType>
   <complexType name="CodecParameterFillRateType">
      <complexContent>
         <extension base="dia:CodecParameterBaseType">
            <sequence>
               <element name="FillRate" type="integer" minOccurs="0"/>
            </sequence>
         </extension>
      </complexContent>
   </complexType>
   <!-- ################################################ -->
   <!--  Definition of Displays         -->
   <!-- ################################################ -->
   <complexType name="DisplaysType">
      <complexContent>
         <extension base="dia:TerminalCapabilityBaseType">
            <sequence>
               <element name="Display" type="dia:DisplayType" minOccurs="0"
maxOccurs="unbounded"/>
            </sequence>
         </extension>
      </complexContent>
   </complexType>
   <!-- ################################################ -->
   <!--  Definition of Display          -->
   <!-- ################################################ -->
   <complexType name="DisplayType">
      <complexContent>
         <extension base="dia:DIABaseType">
            <sequence>
               <element name="DisplayCapability"
type="dia:DisplayCapabilityBaseType" minOccurs="0" maxOccurs="unbounded"/>
            </sequence>
         </extension>
      </complexContent>
   </complexType>
   <complexType name="DisplayCapabilityBaseType" abstract="true">
      <complexContent>
         <extension base="dia:DIABaseType"/>
      </complexContent>
   </complexType>
   <!-- ################################################ -->
   <!--  Definition of DisplayCapability        -->
   <!-- ################################################ -->
   <complexType name="DisplayCapabilityType">
      <complexContent>
         <extension base="dia:DisplayCapabilityBaseType">
            <sequence>
               <element name="Mode" minOccurs="0" maxOccurs="unbounded">
                  <complexType>
```


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```
                        <sequence>
                           <element name="Resolution" type="dia:ResolutionType"
minOccurs="0" maxOccurs="unbounded"/>
                           <element name="SizeChar" minOccurs="0">
                              <complexType>
                                 <attribute name="horizontal" type="integer"
use="required"/>
                                 <attribute name="vertical" type="integer"
use="required"/>
                              </complexType>
                           </element>
                        </sequence>
                        <attribute name="refreshRate" type="float"
use="optional"/>
                     </complexType>
                  </element>
                  <element name="ScreenSize" minOccurs="0">
                     <complexType>
                        <attribute name="horizontal" type="float"
use="required"/>
                        <attribute name="vertical" type="float" use="required"/>
                     </complexType>
                  </element>
                  <element name="ColorBitDepth" minOccurs="0">
                     <complexType>
                        <attribute name="red" type="integer" use="required"/>
                        <attribute name="green" type="integer" use="required"/>
                        <attribute name="blue" type="integer" use="required"/>
                     </complexType>
                  </element>
                  <element name="ColorPrimaries" minOccurs="0">
                     <complexType>
                        <sequence>
                           <element name="ChromaticityRed"
type="dia:ChromaticityType"/>
                           <element name="ChromaticityGreen"
type="dia:ChromaticityType"/>
                           <element name="ChromaticityBlue"
type="dia:ChromaticityType"/>
                           <element name="ChromaticityWhite"
type="dia:ChromaticityType" minOccurs="0"/>
                        </sequence>
                     </complexType>
                  </element>
                  <element name="CharacterSetCode" type="mpeg7:characterSetCode"
minOccurs="0" maxOccurs="unbounded"/>
                  <element name="RenderingFormat"
type="mpeg7:ControlledTermUseType" minOccurs="0" maxOccurs="unbounded"/>
               </sequence>
               <attribute name="stereoscopic" type="boolean" use="optional"/>
               <attribute name="maximumBrightness" type="float" use="optional"/>
               <attribute name="contrastRatio" type="positiveInteger"
use="optional"/>
               <attribute name="gamma" type="float" use="optional"/>
               <attribute name="bitsPerPixel" type="integer" use="optional"/>
               <attribute name="colorCapable" type="boolean" use="optional"/>
               <attribute name="sRGB" type="boolean" use="optional"/>
               <attribute name="fieldSequentialColor" type="boolean"
use="optional"/>
               <attribute name="backlightLuminance" type="mpeg7:zeroToOneType"
use="optional"/>
               <attribute name="dotPitch" type="float" use="optional"/>
```

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```
            <attribute name="activeDisplay" type="boolean" use="optional"/>
         </extension>
      </complexContent>
   </complexType>
   <complexType name="ResolutionType">
      <complexContent>
         <extension base="dia:DIABaseType">
            <attribute name="horizontal" type="integer" use="required"/>
            <attribute name="vertical" type="integer" use="required"/>
            <attribute name="activeResolution" type="boolean" use="optional"/>
         </extension>
      </complexContent>
   </complexType>
   <complexType name="ChromaticityType">
      <complexContent>
         <extension base="dia:DIABaseType">
            <attribute name="x" type="mpeg7:zeroToOneType" use="required"/>
            <attribute name="y" type="mpeg7:zeroToOneType" use="required"/>
         </extension>
      </complexContent>
   </complexType>
   <!-- ################################################ -->
   <!--  Definition of AudioOutputs        -->
   <!-- ################################################ -->
   <complexType name="AudioOutputsType">
      <complexContent>
         <extension base="dia:TerminalCapabilityBaseType">
            <sequence>
               <element name="AudioOutput" type="dia:AudioOutputType"
minOccurs="0" maxOccurs="unbounded"/>
            </sequence>
         </extension>
      </complexContent>
   </complexType>
   <!-- ################################################ -->
   <!--  Definition of AudioOutput          -->
   <!-- ################################################ -->
   <complexType name="AudioOutputType">
      <complexContent>
         <extension base="dia:DIABaseType">
            <sequence>
               <element name="AudioOutputCapability"
type="dia:AudioOutputCapabilityBaseType" minOccurs="0" maxOccurs="unbounded"/>
            </sequence>
         </extension>
      </complexContent>
   </complexType>
   <complexType name="AudioOutputCapabilityBaseType" abstract="true">
      <complexContent>
         <extension base="dia:DIABaseType"/>
      </complexContent>
   </complexType>
   <!-- ################################################ -->
   <!--  Definition of AudioOutputCapabilities    -->
   <!-- ################################################ -->
   <complexType name="AudioOutputCapabilitiesType">
      <complexContent>
         <extension base="dia:AudioOutputCapabilityBaseType">
            <sequence>
               <element name="Mode" type="dia:AudioModeType" minOccurs="0"
maxOccurs="unbounded"/>
            </sequence>
```


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```
            <attribute name="lowFrequency" type="float" use="optional"/>
            <attribute name="highFrequency" type="float" use="optional"/>
            <attribute name="signalNoiseRatio" type="float" use="optional"/>
            <attribute name="power" type="float" use="optional"/>
            <attribute name="numChannels" type="nonNegativeInteger"
use="optional"/>
            <attribute name="silenceSuppression" type="boolean"
use="optional"/>
         </extension>
      </complexContent>
   </complexType>
   <complexType name="AudioModeType">
      <complexContent>
         <extension base="dia:DIABaseType">
            <attribute name="samplingFrequency" type="float" use="optional"/>
            <attribute name="bitsPerSample" type="integer" use="optional"/>
         </extension>
      </complexContent>
   </complexType>
   <!-- ################################################ -->
   <!--  UserInteractionInputs          -->
   <!-- ################################################ -->
   <complexType name="UserInteractionInputsType">
      <complexContent>
         <extension base="dia:TerminalCapabilityBaseType">
            <sequence>
               <element name="UserInteractionInput"
type="dia:UserInteractionInputType" minOccurs="0" maxOccurs="unbounded"/>
            </sequence>
         </extension>
      </complexContent>
   </complexType>
   <!-- ################################################ -->
   <!--  UserInteractionInputType          -->
   <!-- ################################################ -->
   <complexType name="UserInteractionInputType">
      <complexContent>
         <extension base="dia:DIABaseType">
            <sequence>
               <element name="UserInteractionInputSupport"
type="dia:UserInteractionInputSupportBaseType" minOccurs="0"
maxOccurs="unbounded"/>
            </sequence>
         </extension>
      </complexContent>
   </complexType>
   <complexType name="UserInteractionInputSupportBaseType" abstract="true">
      <complexContent>
         <extension base="dia:DIABaseType"/>
      </complexContent>
   </complexType>
   <complexType name="StringInputType">
      <complexContent>
         <extension base="dia:UserInteractionInputSupportBaseType"/>
      </complexContent>
   </complexType>
   <complexType name="KeyInputType">
      <complexContent>
         <extension base="dia:UserInteractionInputSupportBaseType">
            <sequence>
               <element name="KeyInput" type="mpeg7:ControlledTermUseType"/>
            </sequence>
```

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```
            </extension>
        </complexContent>
    </complexType>
    <complexType name="MicrophoneType">
        <complexContent>
            <extension base="dia:UserInteractionInputSupportBaseType"/>
        </complexContent>
    </complexType>
    <complexType name="MouseType">
        <complexContent>
            <extension base="dia:UserInteractionInputSupportBaseType">
                <sequence>
                    <element name="Mouse" type="dia:GenericMouseType"/>
                </sequence>
            </extension>
        </complexContent>
    </complexType>
    <complexType name="TrackballType">
        <complexContent>
            <extension base="dia:UserInteractionInputSupportBaseType">
                <sequence>
                    <element name="Trackball" type="dia:GenericMouseType"/>
                </sequence>
            </extension>
        </complexContent>
    </complexType>
    <complexType name="PenType">
        <complexContent>
            <extension base="dia:UserInteractionInputSupportBaseType">
                <sequence>
                    <element name="Pen" type="dia:GenericPenType"/>
                </sequence>
            </extension>
        </complexContent>
    </complexType>
    <complexType name="TabletType">
        <complexContent>
            <extension base="dia:UserInteractionInputSupportBaseType">
                <sequence>
                    <element name="Tablet" type="dia:GenericPenType"/>
                </sequence>
            </extension>
        </complexContent>
    </complexType>
    <complexType name="GenericMouseType">
        <complexContent>
            <extension base="dia:DIABaseType">
                <attribute name="resolution" type="nonNegativeInteger"
use="optional"/>
                <attribute name="buttons" type="nonNegativeInteger"
use="required"/>
                <attribute name="scrollwheel" type="boolean" use="optional"/>
            </extension>
        </complexContent>
    </complexType>
    <complexType name="GenericPenType">
        <complexContent>
            <extension base="dia:DIABaseType">
                <attribute name="resolution" type="nonNegativeInteger"
use="optional"/>
            </extension>
        </complexContent>
```


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```
    </complexType>
    <!-- ################################################ -->
    <!--  Definition of DeviceClass                       -->
    <!-- ################################################ -->
    <complexType name="DeviceClassType">
       <complexContent>
          <extension base="dia:TerminalCapabilityBaseType">
             <sequence>
                <element name="DeviceClass" type="mpeg7:ControlledTermUseType"
minOccurs="0"/>
             </sequence>
          </extension>
       </complexContent>
    </complexType>
    <!-- ################################################ -->
    <!--  Definition of PowerCharacteristics              -->
    <!-- ################################################ -->
    <complexType name="PowerCharacteristicsType">
       <complexContent>
          <extension base="dia:TerminalCapabilityBaseType">
             <attribute name="averageAmpereConsumption"
type="mpeg7:nonNegativeReal" use="optional"/>
             <attribute name="batteryCapacityRemaining"
type="mpeg7:nonNegativeReal" use="optional"/>
             <attribute name="batteryTimeRemaining" type="integer"
use="optional"/>
             <attribute name="runningOnBatteries" type="boolean"
use="optional"/>
          </extension>
       </complexContent>
    </complexType>
    <!-- ################################################ -->
    <!--  Definition of Storages                          -->
    <!-- ################################################ -->
    <complexType name="StoragesType">
       <complexContent>
          <extension base="dia:TerminalCapabilityBaseType">
             <sequence>
                <element name="Storage" type="dia:StorageType" minOccurs="0"
maxOccurs="unbounded"/>
             </sequence>
          </extension>
       </complexContent>
    </complexType>
    <!-- ################################################ -->
    <!--  Definition of Storage                           -->
    <!-- ################################################ -->
    <complexType name="StorageType">
       <complexContent>
          <extension base="dia:DIABaseType">
             <sequence>
                <element name="StorageCharacteristic"
type="dia:StorageCharacteristicBaseType" minOccurs="0" maxOccurs="unbounded"/>
             </sequence>
          </extension>
       </complexContent>
    </complexType>
    <complexType name="StorageCharacteristicBaseType" abstract="true">
       <complexContent>
          <extension base="dia:DIABaseType"/>
       </complexContent>
    </complexType>
```

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```
    <!-- ################################################ -->
    <!--  Definition of StorageCharacteristics    -->
    <!-- ################################################ -->
    <complexType name="StorageCharacteristicsType">
       <complexContent>
          <extension base="dia:StorageCharacteristicBaseType">
             <attribute name="inputTransferRate" type="nonNegativeInteger"
use="optional"/>
             <attribute name="outputTransferRate" type="nonNegativeInteger"
use="optional"/>
             <attribute name="size" type="float" use="optional"/>
             <attribute name="writable" type="boolean" use="optional"/>
          </extension>
       </complexContent>
    </complexType>
    <!-- ################################################ -->
    <!--  Definition of DataIOs          -->
    <!-- ################################################ -->
    <complexType name="DataIOsType">
       <complexContent>
          <extension base="dia:TerminalCapabilityBaseType">
             <sequence>
                <element name="DataIO" type="dia:DataIOType" minOccurs="0"
maxOccurs="unbounded"/>
             </sequence>
          </extension>
       </complexContent>
    </complexType>
    <!-- ################################################ -->
    <!--  Definition of DataIO         -->
    <!-- ################################################ -->
    <complexType name="DataIOType">
       <complexContent>
          <extension base="dia:DIABaseType">
             <sequence>
                <element name="DataIOCharacteristic"
type="dia:DataIOCharacteristicBaseType" minOccurs="0" maxOccurs="unbounded"/>
             </sequence>
          </extension>
       </complexContent>
    </complexType>
    <complexType name="DataIOCharacteristicBaseType" abstract="true">
       <complexContent>
          <extension base="dia:DIABaseType"/>
       </complexContent>
    </complexType>
    <!-- ################################################ -->
    <!--  Definition of DataIOCharacteristics     -->
    <!-- ################################################ -->
    <complexType name="DataIOCharacteristicsType">
       <complexContent>
          <extension base="dia:DataIOCharacteristicBaseType">
             <attribute name="busWidth" type="nonNegativeInteger"
use="optional"/>
             <attribute name="transferSpeed" type="nonNegativeInteger"
use="optional"/>
             <attribute name="maxDevices" type="nonNegativeInteger"
use="optional"/>
             <attribute name="numDevices" type="nonNegativeInteger"
use="optional"/>
          </extension>
       </complexContent>
```


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```
    </complexType>
    <!-- ################################################ -->
    <!--  Definition of Benchmarks                        -->
    <!-- ################################################ -->
    <complexType name="BenchmarksType">
       <complexContent>
          <extension base="dia:TerminalCapabilityBaseType">
             <sequence>
                <element name="Benchmark" type="dia:BenchmarkType" minOccurs="0"
maxOccurs="unbounded"/>
             </sequence>
          </extension>
       </complexContent>
    </complexType>
    <!-- ################################################ -->
    <!--  Definition of Benchmark                         -->
    <!-- ################################################ -->
    <complexType name="BenchmarkType">
       <complexContent>
          <extension base="dia:DIABaseType">
             <sequence>
                <element name="DeviceBenchmark"
type="dia:DeviceBenchmarkBaseType" minOccurs="0" maxOccurs="unbounded"/>
             </sequence>
          </extension>
       </complexContent>
    </complexType>
    <!-- ################################################ -->
    <!--  Definition of DeviceBenchmarkBaseType           -->
    <!-- ################################################ -->
    <complexType name="DeviceBenchmarkBaseType" abstract="true">
       <complexContent>
          <extension base="dia:DIABaseType"/>
       </complexContent>
    </complexType>
    <!-- ################################################ -->
    <!--  Definition of CPUBenchmarkType                  -->
    <!-- ################################################ -->
    <complexType name="CPUBenchmarkType">
       <complexContent>
          <extension base="dia:DeviceBenchmarkBaseType">
             <attribute name="name" type="mpeg7:termReferenceType"
use="required"/>
             <attribute name="baseValue" type="float" use="required"/>
          </extension>
       </complexContent>
    </complexType>
    <!-- ################################################ -->
    <!--  Definition of ThreeDBenchmarkType               -->
    <!-- ################################################ -->
    <complexType name="ThreeDBenchmarkType">
       <complexContent>
          <extension base="dia:DeviceBenchmarkBaseType">
             <attribute name="name" type="mpeg7:termReferenceType"
use="required"/>
             <attribute name="meanValue" type="float" use="required"/>
          </extension>
       </complexContent>
    </complexType>
    <!-- ################################################ -->
    <!--  Definition of IPMPTools                         -->
    <!-- ################################################ -->
```

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```
    <complexType name="IPMPToolsType">
       <complexContent>
          <extension base="dia:TerminalCapabilityBaseType">
             <sequence>
                <element name="IPMPTool" minOccurs="0" maxOccurs="unbounded">
                   <complexType>
                      <simpleContent>
                         <extension base="base64Binary">
                            <attribute name="ToolCategory" use="required">
                               <simpleType>
                                  <restriction base="string">
                                     <enumeration value="MPEG2"/>
                                     <enumeration value="MPEG4"/>
                                  </restriction>
                               </simpleType>
                            </attribute>
                         </extension>
                      </simpleContent>
                   </complexType>
                </element>
                <element name="IPMPSType" type="hexBinary" minOccurs="0"
maxOccurs="unbounded"/>
             </sequence>
          </extension>
       </complexContent>
    </complexType>
    <!-- ################################################ -->
    <!--  Definition of ConversionCapabilitiesType       -->
    <!-- ################################################ -->
    <complexType name="ConversionCapabilitiesType">
       <complexContent>
          <extension base="dia:TerminalCapabilityBaseType">
             <sequence>
                <element name="ConversionCapability"
                   type="dia:ConversionCapabilityType"
                   minOccurs="0" maxOccurs="unbounded"/>
             </sequence>
          </extension>
       </complexContent>
    </complexType>
    <!-- ########################################### -->
    <!-- ConversionCapabilityType                    -->
    <!-- ########################################### -->
    <complexType name="ConversionCapabilityType">
       <complexContent>
          <extension base="dia:ConversionDescriptionBaseType">
             <sequence>
                <any namespace="##other" processContents="lax" minOccurs="0"/>
             </sequence>
          </extension>
       </complexContent>
    </complexType>
    <!-- ################################################ -->
    <!--  Definition of RELCapabilities                  -->
    <!-- ################################################ -->
    <complexType name="RELCapabilitiesType">
       <complexContent>
          <extension base="dia:TerminalCapabilityBaseType">
             <sequence>
                <element name="RightsLanguage" type="dia:RELCapabilityType"
    minOccurs="0" maxOccurs="unbounded"/>
```


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```
            </sequence>
         </extension>
      </complexContent>
   </complexType>
   <!-- ################################################ -->
   <!--  Definition of RELCapability                     -->
   <!-- ################################################ -->
   <complexType name="RELCapabilityType">
      <complexContent>
         <extension base="dia:DIABaseType">
            <sequence>
               <element name="Name" type="mpeg7:ControlledTermUseType"/>
            </sequence>
            <attribute name="preferenceLevel" type="positiveInteger"
use="optional"/>
         </extension>
      </complexContent>
   </complexType>
   <!-- ################################################ -->
   <!--  Definition of Networks         -->
   <!-- ################################################ -->
   <complexType name="NetworksType">
      <complexContent>
         <extension base="dia:UsageEnvironmentPropertyBaseType">
            <sequence>
               <element name="Network" type="dia:NetworkType" minOccurs="0"
maxOccurs="unbounded"/>
            </sequence>
         </extension>
      </complexContent>
   </complexType>
   <!-- ################################################ -->
   <!--  Definition of Network          -->
   <!-- ################################################ -->
   <complexType name="NetworkType">
      <complexContent>
         <extension base="dia:DIABaseType">
            <sequence>
               <element name="NetworkCharacteristic"
type="dia:NetworkCharacteristicBaseType" minOccurs="0" maxOccurs="unbounded"/>
            </sequence>
         </extension>
      </complexContent>
   </complexType>
   <complexType name="NetworkCharacteristicBaseType" abstract="true">
      <complexContent>
         <extension base="dia:DIABaseType"/>
      </complexContent>
   </complexType>
   <!-- ######################################  -->
   <!--  Definition of NetworkCapability      -->
   <!-- ######################################  -->
   <complexType name="NetworkCapabilityType">
      <complexContent>
         <extension base="dia:NetworkCharacteristicBaseType">
            <attribute name="maxCapacity" type="nonNegativeInteger"
use="optional"/>
            <attribute name="minGuaranteed" type="nonNegativeInteger"
use="optional"/>
            <attribute name="inSequenceDelivery" type="boolean"
use="optional"/>
            <attribute name="errorDelivery" type="boolean" use="optional"/>
```

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```
            <attribute name="errorCorrection" type="boolean" use="optional"/>
            <attribute name="maxPacketSize" type="positiveInteger"
use="optional"/>
         </extension>
      </complexContent>
   </complexType>
   <!-- ########################################  -->
   <!--  Definition of NetworkCondition     -->
   <!-- ########################################  -->
   <complexType name="NetworkConditionType">
      <complexContent>
         <extension base="dia:NetworkCharacteristicBaseType">
            <sequence>
               <element name="AvailableBandwidth" minOccurs="0">
                  <complexType>
                     <attribute name="minimum" type="nonNegativeInteger"
use="optional"/>
                     <attribute name="maximum" type="nonNegativeInteger"
use="optional"/>
                     <attribute name="average" type="nonNegativeInteger"
use="optional"/>
                  </complexType>
               </element>
               <element name="Delay" minOccurs="0">
                  <complexType>
                     <attribute name="packetTwoWay" type="nonNegativeInteger"
use="optional"/>
                     <attribute name="packetOneWay" type="nonNegativeInteger"
use="optional"/>
                     <attribute name="delayVariation" type="integer"
use="optional"/>
                  </complexType>
               </element>
               <element name="Error" minOccurs="0">
                  <complexType>
                     <attribute name="packetLossRate"
type="mpeg7:nonNegativeReal" use="optional"/>
                     <attribute name="bitErrorRate" type="nonNegativeInteger"
use="optional"/>
                  </complexType>
               </element>
            </sequence>
            <attribute name="startTime" type="mpeg7:timePointType"
use="optional"/>
            <attribute name="duration" type="mpeg7:durationType"
use="optional"/>
         </extension>
      </complexContent>
   </complexType>
   <!-- ################################################-->
   <!--  Definition of NaturalEnvironments     -->
   <!-- ################################################-->
   <complexType name="NaturalEnvironmentsType">
      <complexContent>
         <extension base="dia:UsageEnvironmentPropertyBaseType">
            <sequence>
               <element name="NaturalEnvironment"
type="dia:NaturalEnvironmentType" minOccurs="0" maxOccurs="unbounded"/>
            </sequence>
         </extension>
      </complexContent>
   </complexType>
```


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```
    <!-- ################################################ -->
    <!--  Definition of NaturalEnvironment      -->
    <!-- ################################################ -->
    <complexType name="NaturalEnvironmentType">
       <complexContent>
          <extension base="dia:DIABaseType">
             <sequence>
                <element name="NaturalEnvironmentCharacteristic"
type="dia:NaturalEnvironmentCharacteristicBaseType" minOccurs="0"
maxOccurs="unbounded"/>
             </sequence>
          </extension>
       </complexContent>
    </complexType>
    <complexType name="NaturalEnvironmentCharacteristicBaseType" abstract="true">
       <complexContent>
          <extension base="dia:DIABaseType"/>
       </complexContent>
    </complexType>
    <!-- ################################################ -->
    <!--  Definition of Location         -->
    <!-- ################################################ -->
    <complexType name="LocationType">
       <complexContent>
          <extension base="dia:NaturalEnvironmentCharacteristicBaseType">
             <sequence>
                <element name="Location" type="mpeg7:PlaceType"/>
             </sequence>
          </extension>
       </complexContent>
    </complexType>
    <!-- ################################################ -->
    <!--  Definition of Time           -->
    <!-- ################################################ -->
    <complexType name="TimeType">
       <complexContent>
          <extension base="dia:NaturalEnvironmentCharacteristicBaseType">
             <sequence>
                <element name="Time" type="mpeg7:TimeType"/>
             </sequence>
          </extension>
       </complexContent>
    </complexType>
    <!-- ########################################  -->
    <!--  Definition of AudioEnvironment        -->
    <!-- ########################################  -->
    <complexType name="AudioEnvironmentType">
       <complexContent>
          <extension base="dia:NaturalEnvironmentCharacteristicBaseType">
             <sequence>
                <element name="NoiseLevel" type="float" minOccurs="0"/>
                <element name="NoiseFrequencySpectrum" minOccurs="0">
                   <simpleType>
                      <restriction base="mpeg7:floatVector">
                         <length value="33"/>
                      </restriction>
                   </simpleType>
                </element>
             </sequence>
          </extension>
       </complexContent>
    </complexType>
```

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```
    <!-- ################################################ -->
    <!--   Definition of IlluminationCharacteristics      -->
    <!-- ################################################ -->
    <complexType name="IlluminationCharacteristicsType">
       <complexContent>
          <extension base="dia:NaturalEnvironmentCharacteristicBaseType">
             <sequence>
                <element name="TypeOfIllumination" minOccurs="0">
                   <complexType>
                      <choice>
                         <element name="ColorTemperature"
type="mpeg7:unsigned8"/>
                         <element name="Chromaticity">
                            <complexType>
                               <sequence>
                                  <element name="x"
type="mpeg7:zeroToOneType"/>
                                  <element name="y"
type="mpeg7:zeroToOneType"/>
                               </sequence>
                            </complexType>
                         </element>
                      </choice>
                   </complexType>
                </element>
                <element name="Illuminance" type="nonNegativeInteger"
minOccurs="0"/>
             </sequence>
          </extension>
       </complexContent>
    </complexType>
</schema>
```


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G.4 Schema definition for Terminal and network quality of service tools (clause 8)

```
<?xml version="1.0"?>
<!-- Digital Item Adaptation ISO/IEC 21000-7 Second Edition -->
<!-- Schema for terminal and network quality of service tools -->
<schema
   version="ISO/IEC 21000-7 2nd"
   id="AQoS-2nd.xsd"
   targetNamespace="urn:mpeg:mpeg21:2003:01-DIA-NS"
   xmlns="http://www.w3.org/2001/XMLSchema"
   xmlns:dia="urn:mpeg:mpeg21:2003:01-DIA-NS"
   xmlns:mpeg7="urn:mpeg:mpeg7:schema:2001"
   elementFormDefault="qualified" attributeFormDefault="unqualified">

   <import namespace="urn:mpeg:mpeg7:schema:2001"
      schemaLocation="mpeg7-udp-2004.xsd"/>
   <include schemaLocation="DIA-2nd.xsd"/>
   <include schemaLocation="SingleValueDatatypes-2nd.xsd"/>
   <include schemaLocation="VectorDatatypes-2nd.xsd"/>
   <include schemaLocation="MatrixDatatypes-2nd.xsd"/>
   <include schemaLocation="BaseStackFunction-2nd.xsd"/>
   <include schemaLocation="ArgumentTypes-2nd.xsd"/>
   <include schemaLocation="UCD-2nd.xsd"/>

   <!-- ################################################ -->
   <!-- Definition of AdaptationQoSType                  -->
   <!-- ################################################ -->
   <complexType name="AdaptationQoSType">
      <complexContent>
         <extension base="dia:DIADescriptionType">
            <sequence>
               <element name="Module" type="dia:BaseModuleType"
maxOccurs="unbounded"/>
               <element name="IOPin" type="dia:IOPinType"
maxOccurs="unbounded"/>
               <element name="Constraints" type="dia:ReferenceType"
minOccurs="0"/>
            </sequence>
         </extension>
      </complexContent>
   </complexType>
   <!-- ################################################ -->
   <!-- Definition of BaseModuleType                     -->
   <!-- ################################################ -->
   <complexType name="BaseModuleType" abstract="true">
      <complexContent>
         <extension base="dia:DIABaseType"/>
      </complexContent>
   </complexType>
   <!-- ################################################ -->
   <!-- Definition of IOPinType                          -->
   <!-- ################################################ -->
   <complexType name="IOPinType">
      <sequence>
         <element name="GetValue" type="dia:GetValueType" minOccurs="0"/>
         <element name="Axis" type="dia:AxisBaseType" minOccurs="0"/>
         <element name="Default" type="dia:ValueDataType" minOccurs="0"/>
      </sequence>
      <attribute name="id" type="ID" use="required"/>
      <attribute name="semantics" type="mpeg7:termReferenceType"
use="optional"/>
   </complexType>
```

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```
    <!-- ################################################ -->
    <!--  Definition of UtilityFunctionType               -->
    <!-- ################################################ -->
    <complexType name="UtilityFunctionType">
       <complexContent>
          <extension base="dia:BaseModuleType">
             <sequence>
                <element name="Constraint" type="dia:UFDataType"
maxOccurs="unbounded"/>
                <element name="AdaptationOperator" type="dia:UFDataType"
maxOccurs="unbounded"/>
                <choice>
                   <element name="Utility" type="dia:UFDataType"
maxOccurs="unbounded"/>
                   <element name="UtilityRank" type="dia:UtilityRankType"/>
                </choice>
             </sequence>
          </extension>
       </complexContent>
    </complexType>
    <complexType name="UFDataType">
       <complexContent>
          <extension base="dia:DIABaseType">
             <sequence>
                <element name="Values" type="dia:VectorDataType"/>
             </sequence>
             <attribute name="iOPinRef" type="IDREF" use="required"/>
          </extension>
       </complexContent>
    </complexType>
    <!-- ################################################ -->
    <!-- Definition of UtilityRankType                    -->
    <!-- ################################################ -->
    <complexType name="UtilityRankType">
       <simpleContent>
          <extension base="dia:positiveIntegerVector">
             <attribute name="consistencyFlags" type="dia:consistencyFlagsType"
use="optional"/>
          </extension>
       </simpleContent>
    </complexType>
    <simpleType name="consistencyFlagsType">
       <restriction>
          <simpleType>
             <list itemType="boolean"/>
          </simpleType>
          <minLength value="1"/>
       </restriction>
    </simpleType>
    <simpleType name="positiveIntegerVector">
       <restriction>
          <simpleType>
             <list itemType="positiveInteger"/>
          </simpleType>
          <minLength value="1"/>
       </restriction>
    </simpleType>
    <!-- ################################################ -->
    <!-- Definition of LookUpTableType                    -->
    <!-- ################################################ -->
```

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```
    <complexType name="LookUpTableType">
       <complexContent>
          <extension base="dia:BaseModuleType">
             <sequence>
                <choice maxOccurs="unbounded">
                   <element name="Axis" type="dia:AxisType"/>
                   <element name="AxisRef" type="dia:AxisRefType"/>
                </choice>
                <element name="Content" type="dia:ContentType"
maxOccurs="unbounded"/>
             </sequence>
          </extension>
       </complexContent>
    </complexType>
    <!-- ################################################ -->
    <!-- Definition of AxisBaseType                       -->
    <!-- ################################################ -->
    <complexType name="AxisBaseType">
       <complexContent>
          <extension base="dia:DIABaseType">
             <sequence>
                <element name="AxisValues" type="dia:VectorDataType"/>
             </sequence>
             <attribute name="roundingMethod" type="mpeg7:termReferenceType"
use="optional"/>
             <attribute name="defaultIndex" type="nonNegativeInteger"
use="optional"/>
          </extension>
       </complexContent>
    </complexType>
    <!-- ################################################ -->
    <!-- Definition of AxisType                           -->
    <!-- ################################################ -->
    <complexType name="AxisType">
       <complexContent>
          <extension base="dia:AxisBaseType">
             <attribute name="iOPinRef" type="IDREF" use="required"/>
          </extension>
       </complexContent>
    </complexType>
    <!-- ################################################ -->
    <!-- Definition of AxisRefType                        -->
    <!-- ################################################ -->
    <complexType name="AxisRefType">
       <complexContent>
          <extension base="dia:DIABaseType">
             <attribute name="iOPinRef" type="IDREF" use="required"/>
          </extension>
       </complexContent>
    </complexType>
    <!-- ################################################ -->
    <!-- Definition of ContentBaseType                    -->
    <!-- ################################################ -->
    <complexType name="ContentBaseType">
       <complexContent>
          <extension base="dia:DIABaseType">
             <sequence>
                <element name="ContentValues" type="dia:MatrixDataType"/>
             </sequence>
             <attribute name="defaultIndex" type="nonNegativeInteger"
use="optional"/>
```

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```
            <attribute name="empty" type="boolean" use="optional"
default="false"/>
         </extension>
      </complexContent>
   </complexType>
   <!-- ################################################## -->
   <!-- Definition of ContentType                          -->
   <!-- ################################################## -->
   <complexType name="ContentType">
      <complexContent>
         <extension base="dia:ContentBaseType">
            <attribute name="iOPinRef" type="IDREF" use="required"/>
         </extension>
      </complexContent>
   </complexType>
   <!-- ################################################## -->
   <!-- Definition of StackFunctionType                    -->
   <!-- ################################################## -->
   <complexType name="StackFunctionType">
      <complexContent>
         <extension base="dia:BaseModuleType">
            <sequence>
               <element name="StackFunction" type="dia:BaseStackFunctionType"/>
            </sequence>
            <attribute name="iOPinRef" type="IDREF" use="required"/>
         </extension>
      </complexContent>
   </complexType>
   <!-- ################################################## -->
   <!-- Definition of BaseSwitchModuleType                 -->
   <!-- ################################################## -->
   <complexType name="BaseSwitchModuleType" abstract="true">
      <complexContent>
         <extension base="dia:BaseModuleType">
            <attribute name="switchIOPinRefs" type="IDREFS" use="required"/>
         </extension>
      </complexContent>
   </complexType>
   <!-- ################################################--> 
   <!-- Definition of UtilityFunctionSwitchType         -->
   <!-- ################################################--> 
   <complexType name="UtilityFunctionSwitchType">
      <complexContent>
         <extension base="dia:BaseSwitchModuleType">
            <sequence>
               <element name="Switch" type="dia:UFDataSwitchType" minOccurs="2"
maxOccurs="unbounded"/>
            </sequence>
         </extension>
      </complexContent>
   </complexType>
   <complexType name="UFDataSwitchType">
      <complexContent>
         <extension base="dia:UtilityFunctionType">
            <attribute name="switchValues" type="NMTOKENS" use="required"/>
         </extension>
      </complexContent>
   </complexType>
```


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```
    <!-- ################################################ -->
    <!-- Definition of LookUpTableSwitchType              -->
    <!-- ################################################ -->
    <complexType name="LookUpTableSwitchType">
       <complexContent>
          <extension base="dia:BaseSwitchModuleType">
             <sequence>
                <choice maxOccurs="unbounded">
                   <element name="Axis" type="dia:AxisType"/>
                   <element name="AxisRef" type="dia:AxisRefType"/>
                </choice>
                <element name="ContentSwitch" type="dia:ContentSwitchType"
maxOccurs="unbounded"/>
             </sequence>
          </extension>
       </complexContent>
    </complexType>
    <complexType name="ContentSwitchType">
       <complexContent>
          <extension base="dia:DIABaseType">
             <sequence>
                <element name="ContentDataSwitch"
type="dia:ContentDataSwitchType" minOccurs="2" maxOccurs="unbounded"/>
             </sequence>
             <attribute name="iOPinRef" type="IDREF" use="required"/>
          </extension>
       </complexContent>
    </complexType>
    <complexType name="ContentDataSwitchType">
       <complexContent>
          <extension base="dia:ContentBaseType">
             <attribute name="switchValues" type="NMTOKENS" use="required"/>
          </extension>
       </complexContent>
    </complexType>
    <!-- ################################################ -->
    <!-- Definition of StackFunctionSwitchType            -->
    <!-- ################################################ -->
    <complexType name="StackFunctionSwitchType">
       <complexContent>
          <extension base="dia:BaseSwitchModuleType">
             <sequence>
                <element name="Switch" type="dia:SFDataSwitchType" minOccurs="2"
maxOccurs="unbounded"/>
             </sequence>
             <attribute name="iOPinRef" type="IDREF" use="required"/>
          </extension>
       </complexContent>
    </complexType>
    <complexType name="SFDataSwitchType">
       <complexContent>
          <extension base="dia:BaseStackFunctionType">
             <attribute name="switchValues" type="NMTOKENS" use="required"/>
          </extension>
       </complexContent>
    </complexType>
</schema>
```

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Annex H

(informative)

Conversion Description Examples

H.1 Introduction

This Annex describes how a conversion description for the cropping of a rectangular bitmap image can be created in an interoperable way (leveraging ISO/IEC 21000-6) and used within the conversion description framework. These steps are followed:

1) Elaborate the semantics of cropping a rectangular bitmap image.

2) Identify existing RDD terms related to those semantics.

3) Specialize existing RDD terms to arrive at a CropRectangularBitmapImage term.

4) Write the syntax and semantics for any relevant parameters needed to describe the conversion.

5) Write the conversion description.

6) Use the conversion description in the conversion description framework.

It is important to note that these steps only describe how to use a conversion *description* within the conversion description framework. They do not go beyond that and describe how to use a *conversion*. The methods of using a conversion go beyond the scope of this Annex and beyond the scope of this Part of ISO/IEC 21000.

In order to perform a conversion, a party might be required to have authorization from some other party. This authorization can be conveyed to that first party by that other party using a description of that conversion in a rights expression (see ISO/IEC 21000-5) according to the conversion description framework (see specifically clause 14).

H.2 Elaborate the semantics of cropping a rectangular bitmap image

Cropping refers to spatial cropping. The following statements provide more details about what is meant by cropping a rectangular bitmap image:

— Temporal cropping is not considered.

— Bitmap images consist of a two-dimensional array of pixel values. Therefore, decoding a bitmap into pixel values and re-encoding those pixel values into a bitmap is lossless.

— No pixel value is affected by its adjacent pixel values, and removing any pixel has no effect on the remaining pixels.

— Pixels are arranged in a rectangular grid (a grid with right angles), so any two pixel locations (or a pixel location and a width and height) are sufficient to describe a rectangular block of pixels that clearly include or exclude pixels from the original image (no pixel is half included and half excluded from the cropped region).

— The following mathematical description provide more details about what is meant by cropping a rectangular bitmap image:

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- Let x_in be the number of pixels along the x axis of the input resource.
- Let y_in be the number of pixels along the y axis of the input resource.
- Let x_out be the number of pixels along the x axis of the output resource.
- Let y_out be the number of pixels along the y axis of the output resource.
- Let pixels_in[x][y] be a zero-based array representation of the pixels in the input resource.
- Let pixels_out[x][y] be a zero-based array representation of the pixels in the output resource.
- Let x_offset be some integer representing the x coordinate in the input resource of the upper-left corner of the output resource.
- Let y_offset be some integer representing the y coordinate in the input resource of the lower-right corner of the output resource.
- Then the following constraints must hold:
  - 0 <= x_offset < x_in
  - 0 <= y_offset < y_in
  - 0 < x_out <= x_in
  - 0 < y_out <= y_in
  - x_offset + x_out <= x_in
  - y_offset + y_out <= y_in
  - for each x where 0 <= x < x_out, for each y where 0 <= y < y_out, pixels_out[x][y] = pixels_in[x+x_offset][y+y_offset]

H.3 Identify existing RDD terms related to those semantics

The concept of a rectangular bitmap image relates to the existing RDD term Resource.

The concepts of x, y, x_in, y_in, x_out, y_out, x_offset, and y_offset relate to the existing RDD term Quantity.

The concept of number of pixels relates to the existing RDD term UnitOfMeasure.

The concept of numerical pixel value (pixels_in[x][y] and pixels_out[x][y]) relates to the existing RDD term Quantity.

The concept of [x] and [y] coordinates indicating a location in a bitmap relates to the existing RDD term Place.

The concept of cropping relates to the existing RDD term Diminish, defined in the RDD as:

> "To Derive a new Resource which is smaller than its Source."

In the RDD Standard the (multiple) inheritance hierarchy for the Act "Diminish" is:

Act
- Do
--- Make
----- Adapt
------- **Diminish**
--- InteractWith
----- Change

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------- ChangeTransiently
--------- Adapt
---------- **Diminish**

Its related family of Terms (eg Diminisher, Diminution, SourceOfDiminution, TimeOfDiminishing etc) all follow parallel hierarchies.

The scope of Diminish is defined in RDD and REL as follows:

> "With *Diminish*, two distinct Resources will exist at the end of the process, one of which [SourceOfDiminution] is the original Resource in unchanged form, and one of which [Diminution] is newly made, whose content is Adapted from the original Resource, and a Measure of which is smaller than that of the original while no Measures of it are larger. Changes can include the removal of elements of the original Resource. Changes can be made temporarily to the original Resource in the course of the Diminish process, but such changes are not saved in the original Resource at the end of the process."

Using the representation syntax[1] of the RDD standard, the elements of a ContextView for a DiminishingEvent are as follows:

#1[DiminishingEvent] icoAgent #2.n[Diminisher][occ:1-n]
#1[DiminishingEvent] icoResource #3.n[Diminution][occ:1-n]
#1[DiminishingEvent] icoResource #4.n[SourceOfDiminution][occ:1-n]
#1[DiminishingEvent] icoTime #5.n[TimeOfDiminishing][occ:1-n]
#1[DiminishingEvent] icoPlace #6.n[PlaceOfDiminishing][occ:1-n]
#1[DiminishingEvent] icoPlace #7.n[PlaceOfDiminishingFrom][occ:1-n]
#7.n IsPartOf #6.n
#7.n IsPlaceOf #4.n
#1[DiminishingEvent] icoPlace #8.n[PlaceOfDiminishingTo][occ:1-n]
#8.n IsPartOf #6.n
#8.n IsEquivalentTo #7.n [ver:Possible]
#8.n IsPlaceOf #3.n

For ease of reading this can be serialized to these simpler, nested RDD triples:

#1 IsA DiminishingEvent
#1 icoAgent #2.n [occ:1-n]
    #2.n IsA Diminisher
#1 icoResource #3.n [occ:1-n]
    #3.n IsA Diminution
#1 icoResource #4.n [occ:1-n]
    #4.n IsA SourceOfDiminution
#1 icoTime #5.n [occ:1-n]
    #5.n IsA TimeOfDiminishing
#1 icoPlace #6.n [occ:1-n]
    #6.n IsA PlaceOfDiminishing
#1 icoPlace #7.n [occ:1-n]
    #7.n IsA PlaceOfDiminishingFrom
    #7.n IsPartOf #6.n
    #7.n IsPlaceOf #4.n

[1] The element #n represents a value of an instance of the bracketed class in each case (for example, #1[DiminishingEvent] represents an instance of a DiminishingEvent). The form #n.n represents each instance of the bracketed class in the Context, though that has no impact in this example. The abbreviation "ico" stands for "IsContextOf".

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#1 icoPlace #8.n [occ:1-n]
#8.n IsA PlaceOfDiminishingTo
#8.n IsPartOf #6.n
#8.n IsEquivalentTo #7.n [ver:Possible]
#8.n IsPlaceOf #3.n

H.4 Specialize existing RDD terms to arrive at a CropRectangularBitmapImage term

The process of specialization is to add the necessary additional constraints to elements of the ContextView.

The requirements add no specialized constraints on the Agent, Time or Place, so all specialization is confined to the attributes of the Resources: the input (SourceOfDiminution) and the (Diminution). The triples to be specialized are therefore:

#1 icoResource #3.n [occ:1-n]
#3.n IsA Diminution
#1 icoResource #4.n [occ:1-n]
#4.n IsA SourceOfDiminution

This Act relates to a single input and a single output:

#1 icoResource **#3** [occ:**1**]
#3 IsA Diminution
#1 icoResource **#4** [occ:**1**]
#4 IsA SourceOfDiminution

Each resource is a BitmapImage (BitmapImage needs to be defined as an RDD Term):

#1 icoResource #3 [occ:1]
#3 IsA Diminution
#3 IsA BitmapImage
#1 icoResource #4 [occ:1]
#4 IsA SourceOfDiminution
#4 IsA BitmapImage

Each resource is Rectangular (Rectangular must be defined as an RDD Term). This might be shown thus:

#1 icoResource #3 [occ:1]
#3 IsA Diminution
#3 IsA BitmapImage
#3 Is Rectangular
#1 icoResource #4 [occ:1]
#4 IsA SourceOfDiminution
#4 IsA BitmapImage
#4 Is Rectangular

or as this is a common resource type a new subtype of BitmapImage might be defined according to the following heirarchy:

Resource
- **BitmapImage**
--- **RectangularBitmapImage**

and used thus:

#1 icoResource #3 [occ:1]
#3 IsA Diminution
#3 IsA **Rectangular**BitmapImage

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#1 icoResource #4 [occ:1]
#4 IsA SourceOfDiminution
#4 IsA **Rectangular**BitmapImage

BitmapHeight, BitmapWidth, and NumberOfPixels would need to be defined as RDD Terms. Such definition might result in the following heirarchy:

Quantity
- **Distance**
--- **Height**
----- **BitmapHeight**
--- **Width**
----- **BitmapWidth**

UnitOfMeasure
- **Count**
--- **NumberOfPixels**

Each image has a vertical and horizontal axis measured in NumberOfPixels:

#1 icoResource #3 [occ:1]
#3 IsA Diminution
#3 IsA RectangularBitmapImage
#3 HasQuantity #9
#9 IsA BitmapHeight
#9 HasUnitOfMeasure NumberOfPixels
#3 HasQuantity #10
#10 IsA BitmapWidth
#10 HasUnitOfMeasure NumberOfPixels
#1 icoResource #4 [occ:1]
#4 IsA SourceOfDiminution
#4 IsA RectangularBitmapImage
#4 HasQuantity #11
#11 IsA BitmapHeight
#11 HasUnitOfMeasure NumberOfPixels
#4 HasQuantity #12
#12 IsA BitmapWidth
#12 HasUnitOfMeasure NumberOfPixels

The “HasQuantity” may instead be specialized itself to “HasBitmapHeight” and “HasBitmapWidth”, but the elements still require definition.

Some mathematical functions are now needed. RDD should Adopt its semantics for mathematical functions from elsewhere (eg MML), but for illustration some of these might be expressed along these lines.

First, the comparison of the Heights and Widths of the inputs and outputs:

#1 icoResource #3 [occ:1]
#3 IsA Diminution
#3 IsA RectangularBitmapImage
#3 HasQuantity #9
#9 IsA BitmapHeight
#9 HasUnitOfMeasure NumberOfPixels
#9 IsLessThanOrEqualTo #11
#3 HasQuantity #10
#10 IsA BitmapWidth
#10 HasUnitOfMeasure NumberOfPixels
#10 IsLessThanOrEqualTo #12

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#1 icoResource #4 [occ:1]
#4 IsA SourceOfDiminution
#4 IsA RectangularBitmapImage
#4 HasQuantity #11
#11 IsA BitmapHeight
#11 HasUnitOfMeasure NumberOfPixels
#4 HasQuantity #12
#12 IsA BitmapWidth
#12 HasUnitOfMeasure NumberOfPixels

CropWidthOffset and CropHeightOffset need to be defined as RDD Terms. Such definition might result in the following heirarchy:

Quantity
- Distance
--- Height
----- BitmapHeight
----- **CropHeightOffset**
--- Width
----- BitmapWidth
----- **CropWidthOffset**

The positioning of the output image in relation to the source is described by the relationship of the output co-ordinates to that of the source:

#1 icoResource #3 [occ:1]
#3 IsA Diminution
#3 IsA RectangularBitmapImage
#3 HasQuantity #9
#9 IsA BitmapHeight
#9 HasUnitOfMeasure NumberOfPixels
#9 IsLessThanOrEqualTo #11
#3 HasQuantity #10
#10 IsA BitmapWidth
#10 HasUnitOfMeasure NumberOfPixels
#10 IsLessThanOrEqualTo #12
#3 HasQuantity #13
#13 IsA CropHeightOffset
#13 HasUnitOfMeasure NumberOfPixels
#13 IsGreaterThanOrEqualTo "0"
#13 IsLessThan #11
#3 HasQuantity #14
#14 IsA CropWidthOffset
#14 HasUnitOfMeasure NumberOfPixels
#14 IsGreaterThanOrEqualTo "0"
#14 IsLessThan #12
#1 icoResource #4 [occ:1]
#4 IsA SourceOfDiminution
#4 IsA RectangularBitmapImage
#4 HasQuantity #11
#11 IsA BitmapHeight
#11 HasUnitOfMeasure NumberOfPixels

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#4 HasQuantity #12
#12 IsA BitmapWidth
#12 HasUnitOfMeasure NumberOfPixels

NumericalPixelValue, PixelXCoordinate, PixelYCoordinate, and PixelPlanarCoordinateLocation would need to be defined as RDD Terms. Such definition might result in the following heirarchy:

Place
- **PixelPlanarCoordinateLocation**

Quantity
- Distance
--- Height
----- BitmapHeight
----- CropHeightOffset
----- **PixelYCoordinate**
--- Width
----- BitmapWidth
----- CropWidthOffset
----- **PixelXCoordinate**
- **ColorQuantity**
--- **NumericalPixelValue**

In order to express the relation between the source and destination pixel locations and crop offset, a further mathematical function to represent a sum (suggested here as **IsSumOf**) and RDD notation to represent a list (suggested here as **{#1, #2}**) of values to sum is needed.

Finally, it needs to be declared that the numerical pixel value of each pixel in the output is numerically equal to the corresponding numerical pixel value in the input:

#1 icoResource #3 [occ:1]
#3 IsA Diminution
#3 IsA RectangularBitmapImage
#3 HasQuantity #9
#9 IsA BitmapHeight
#9 HasUnitOfMeasure NumberOfPixels
#9 IsLessThanOrEqualTo #11
#3 HasQuantity #10
#10 IsA BitmapWidth
#10 HasUnitOfMeasure NumberOfPixels
#10 IsLessThanOrEqualTo #12
#3 HasQuantity #13
#13 IsA CropHeightOffset
#13 HasUnitOfMeasure NumberOfPixels
#13 IsGreaterThanOrEqualTo “0”
#13 IsLessThan #11
#3 HasQuantity #14
#14 IsA CropWidthOffset
#14 HasUnitOfMeasure NumberOfPixels
#14 IsGreaterThanOrEqualTo “0”
#14 IsLessThan #12
#3 HasPart #15.n [occ:1-n]
#15.n IsA Pixel
#15.n HasNumericalPixelValue #17.n
#15.n HasPlace #18.n

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#18.n IsA PlanarCoordinateLocation
#18.n HasYCoordinate #19.n
#18.n HasXCoordinate #20.n

#1 icoResource #4 [occ:1]
#4 IsA SourceOfDiminution
#4 IsA RectangularBitmapImage
#4 HasQuantity #11
#11 IsA BitmapHeight
#11 HasUnitOfMeasure NumberOfPixels
#4 HasQuantity #12
#12 IsA BitmapWidth
#12 HasUnitOfMeasure NumberOfPixels
#4 HasPart #16.n [occ:1-n]
#16.n IsA Pixel
#16.n HasNumericalPixelValue #17.n
#16.n HasPlace #21.n
#21.n IsA PlanarCoordinateLocation
#21.n HasYCoordinate #22.n
#22.n IsSumOf {#13, #19.n}
#21.n HasXCoordinate #23.n
#23.n IsSumOf {#14, #20.n}

So, the ContextView for CropRectangularBitmapImage might be a specialization of a DiminishingEvent looking like this:

#1 IsA DiminishingEvent
#1 icoAgent #2.n [occ:1-n]
#2.n IsA Diminisher
#1 icoResource #3 [occ:1]
#3 IsA Diminution
#3 IsA RectangularBitmapImage
#3 HasQuantity #9
#9 IsA BitmapHeight
#9 HasUnitOfMeasure NumberOfPixels
#9 IsLessThanOrEqualTo #11
#3 HasQuantity #10
#10 IsA BitmapWidth
#10 HasUnitOfMeasure NumberOfPixels
#10 IsLessThanOrEqualTo #12
#3 HasQuantity #13
#13 IsA CropHeightOffset
#13 HasUnitOfMeasure NumberOfPixels
#13 IsGreaterThanOrEqualTo “0”
#13 IsLessThan #11
#3 HasQuantity #14
#14 IsA CropWidthOffset
#14 HasUnitOfMeasure NumberOfPixels
#14 IsGreaterThanOrEqualTo “0”
#14 IsLessThan #12

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#3 HasPart #15.n [occ:1-n]
#15.n IsA Pixel
#15.n HasNumericalPixelValue #17.n
#15.n HasPlace #18.n
#18.n IsA PlanarCoordinateLocation
#18.n HasYCoordinate #19.n
#18.n HasXCoordinate #20.n
#1 icoResource #4 [occ:1]
#4 IsA SourceOfDiminution
#4 IsA RectangularBitmapImage
#4 HasQuantity #11
#11 IsA BitmapHeight
#11 HasUnitOfMeasure NumberOfPixels
#4 HasQuantity #12
#12 IsA BitmapWidth
#12 HasUnitOfMeasure NumberOfPixels
#4 HasPart #16.n [occ:1-n]
#16.n IsA Pixel
#16.n HasNumericalPixelValue #17.n
#16.n HasPlace #21.n
#21.n IsA PlanarCoordinateLocation
#21.n HasYCoordinate #22.n
#22.n IsSumOf {#13, #19.n}
#21.n HasXCoordinate #23.n
#23.n IsSumOf {#14, #20.n}
#1 icoTime #5.n [occ:1-n]
#5.n IsA TimeOfDiminishing
#1 icoPlace #6.n [occ:1-n]
#6.n IsA PlaceOfDiminishing
#1 icoPlace #7.n [occ:1-n]
#7.n IsPartOf #6.n
#7.n IsPlaceOf #4.n
#7.n IsA PlaceOfDiminishingFrom
#1 icoPlace #8.n [occ:1-n]
#8.n IsA PlaceOfDiminishingTo
#8.n IsPartOf #6.n
#8.n IsEquivalentTo #7.n [ver:Possible]
#8.n IsPlaceOf #3.n

The above definition of CropRectangularBitmapImage might result in a heirarchy like this:

Act
- Do
--- Make
----- Adapt
------- Diminish
--- InteractWith
----- Change
------- ChangeTransiently
--------- Adapt
---------- Diminish

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---------- **DiminishBitmapImage**
---------- **CropBitmapImage**
---------- **CropRectangularBitmapImage**

Finally a point about multiple inheritance: the above tree of ActTypes is only one of many routes by which CropRectangularBitmapImage may be specialized, as RDD has to be a “lattice” rather than a “tree”. Here is another route following from Adapt rather than Diminish:

Act
- Do
--- Make
----- Adapt
--- InteractWith
----- Change
------- ChangeTransiently
--------- Adapt
---------- **AdaptBitmapImage**
---------- **AdaptRectangularBitmapImage**
---------- CropRectangularBitmapImage

H.5 Write the conversion description

The following example describes a cropping of a rectangular bitmap image that results in a 40-by-40 rectangular bitmap image matching the upper left corner of the original image.

```
<DIA>
   <Description xsi:type="ConversionUriType">
      <ConversionActUri uri=
         "urn:mpeg:mpeg21:2003:01-RDD-NS:CropRectangularBitmapImage"/>
      <Parameter xsi:type="ConstantType" name="DiminutionBitmapHeight">
         <Value>40</Value>
      </Parameter>
      <Parameter xsi:type="ConstantType" name="DiminutionBitmapWidth">
         <Value>40</Value>
      </Parameter>
      <Parameter xsi:type="ConstantType" name="DiminutionCropHeightOffset">
         <Value>0</Value>
      </Parameter>
      <Parameter xsi:type="ConstantType" name="DiminutionCropWidthOffset">
         <Value>0</Value>
      </Parameter>
   </Description>
</DIA>
```

H.6 Use the conversion description in the conversion description framework

The conversion description can then be used inside a `dia:ConversionCapabilitiesType`, a `dia:ConversionLinkType`, a `dia:ConversionUriType`, or a `dia:PermittedDiaChanges`.

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Annex I

(informative)

OWL-S Conversion Description Example

I.1 Introduction

OWL-based Web Service Ontology (OWL-S) [19] provides a computer-interpretable description of services, and the means by which they can be accessed. The structuring of the OWL-S description is motivated by the need to provide three essential types of knowledge about a service (shown in Figure I.1), each characterized by the question it answers:

— What does the service require from the user(s) or other agents as well as what does it provide for them? The answer to this question is given in the service profile. Thus, the class *Service* presents a *ServiceProfile*.

— How does it work? The answer to this question is given in the service model. Thus, the class *Service* is described by a *ServiceModel*.

— How is it used? The answer to this question is given in the service grounding. Thus, the class *Service* supports a *ServiceGrounding*.

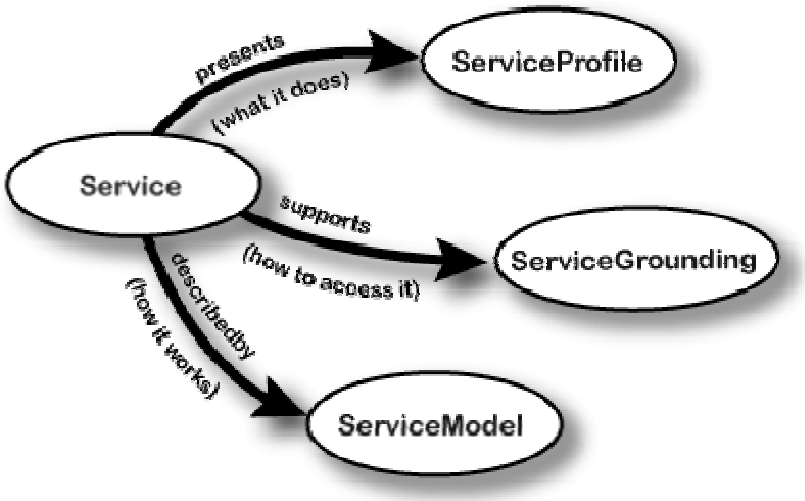

Figure I.1 — OWL-S overview [19].

I.2 Service profile

The service profile of a service provides a concise description of the service to a registry, but once the service has been selected the service profile is useless; rather, the client will use the service model to control the interaction with the service. Although the service profile and the service model play different roles during the transaction between Web services, they are two different representations of the same service. Therefore, it is natural to expect that the inputs, outputs, preconditions, and effects (IOPEs) of the service profile are reflected in the service model and vice versa.

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An essential component of the service profile is the specification of what functionality the service provides and the specification of the conditions that must be satisfied for a successful result. Additionally, the service profile specifies what conditions result from the service, including the expected and unexpected results of the service activity. The OWL-S service profile represents two aspects of the functionality of the service: the information transformation (represented by inputs and outputs) and the state change produced by the execution of the service (represented by preconditions and effects). For example, a spatial scaling service for images may require the original image as input as well as the desired width and height of the image after scaling. The effect of applying the service is a spatially scaled image.

The service profile ontology does not provide a schema to describe IOPE instances. However, such a schema exists in the service model ontology, as discussed in the next section. Ideally, the IOPEs published by the service profile are a subset of those published by the service model. Therefore, the service model part of a description will create all the IOPE instances and the service profile instance can simply point to these instances.

I.3 Service model

A service model can be seen as a more fine grained description of a service which tells the user how to interact with the service. For example, a video-to-slide show service may consist of certain operations such as identifying proper images, transcoding the format, etc.

OWL-S supports three types of processes:

— Atomic processes are directly invocable. Atomic processes have no subprocesses and execute in a one step.

— Simple processes provide an abstraction mechanism to provide multiple views of the same process. Simple processes are not invocable.

— Composite processes are decomposable into other (non-composite or composite) processes.

A process can have any number of inputs (including zero), representing the information that is, under some conditions, required for the execution of the process. It can have any number of outputs, i.e., the information that the process provides. There can be any number of preconditions, which must all hold in order for the process to be invoked. Finally, the process can have any number of effects.

Inputs and outputs are described by the parameter class which carries the syntactical information about parameters: name (ID) and data type. A process cannot be invoked unless its preconditions are true. If it is invoked, it has various effects. Furthermore, preconditions and effects are represented as logical formulae.

I.4 Service grounding

I.4.1 Introduction

A service grounding (or just grounding) specifies the details of how an agent can access a service. Typically, grounding will specify a communication protocol, message formats, and other service-specific details such as port numbers used in contacting the service. Generally speaking, the service profile provides the information needed for an agent to discover a service whereas the service model and service grounding objects associated with a service provide enough information for an agent to make use of a service.

I.4.2 Web services description language

A WSDL document defines services as collections of network endpoints, or ports. In WSDL, the abstract definition of endpoints and messages is separated from their concrete network deployment or data format bindings. This allows the reuse of abstract definitions: messages, which are abstract descriptions of the data being exchanged, and port types which are abstract collections of operations. The concrete protocol and data

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format specifications for a particular port type constitute a reusable binding. A port is defined by associating a network address with a reusable binding, and a collection of ports define a service. Hence, a WSDL document uses the following elements in the definition of network services:

- Types: a container for data type definitions using some type system (such as XSD).
- Message: an abstract, typed definition of the data being communicated. Operation: an abstract description of an action supported by the service.
- Port Type: an abstract set of operations supported by one or more endpoints.
- Binding: a concrete protocol and data format specification for a particular port type.
- Port: a single endpoint defined as a combination of a binding and a network address.
- Service: a collection of related endpoints.

I.5 Example

I.5.1 Introduction

The following example provides the service profile, the service model, the service grounding, and the Web services description language description of the image cropping example as defined in Annex H.

I.5.2 Service profile

```
<?xml version="1.0" encoding="UTF-8"?>
<!DOCTYPE uridef [
  <!ENTITY xsd "http://www.w3.org/2001/XMLSchema">
  <!ENTITY rdf "http://www.w3.org/1999/02/22-rdf-syntax-ns">
  <!ENTITY rdfs "http://www.w3.org/2000/01/rdf-schema">
  <!ENTITY owl "http://www.w3.org/2002/07/owl">
  <!ENTITY profile "http://www.daml.org/services/owl-s/1.1/Profile.owl">
  <!ENTITY process "http://www.daml.org/services/owl-s/1.1/Process.owl">
  <!ENTITY hierarchy "urn:mpeg:mpeg21:2003:01-RDD-NS">
  <!ENTITY crop_process
    "http://www.itec.uni-klu.ac.at/~klaus/sws/stdcrop/CropProcess.owl">
  <!ENTITY DEFAULT
    "http://www.itec.uni-klu.ac.at/~klaus/sws/stdcrop/CropProfile.owl">
]>
<rdf:RDF
  xmlns:rdf="&rdf;#" xmlns:rdfs="&rdfs;#" xmlns:owl="&owl;#"
  xmlns:process="&process;#" xmlns:profile="&profile;#"
  xmlns:hierarchy="&hierarchy;#" xmlns:crop_process="&crop_process;#"
  xmlns="&DEFAULT;#">

  <owl:Ontology rdf:about="">
    <owl:versionInfo>
           $Id: CropSemProfile.owl,v 1.2 2004/10/20 klaus Exp $
    </owl:versionInfo>
    <rdfs:comment>
           OWL-S profile for an image cropper
    </rdfs:comment>
    <owl:imports rdf:resource="&profile;"/>
    <owl:imports rdf:resource="&process;"/>
    <owl:imports rdf:resource="&crop_process;"/>
  </owl:Ontology>

  <!-- Reference to the RDD term for the image crop conversion -->
  <hierarchy:CropRectangularBitmapImage rdf:ID="CropImage">
    <!-- reference to the process model specification -->
```

--`,,```,,,,````-`-`,,`,,`,`,,`---

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```
    <profile:has_process rdf:resource="&crop_process;#CropImage"/>
    <profile:serviceName>
    CropImage
    </profile:serviceName>
    <profile:textDescription>
    This conversion operation...
    </profile:textDescription>
    <profile:contactInformation>
    <!-- contact information described by, e.g., MPEG-7 -->
    </profile:contactInformation>
    <profile:hasInput rdf:resource="&crop_process;#roi-imageIn"/>
    <profile:hasInput rdf:resource="&crop_process;#roi-width"/>
    <profile:hasInput rdf:resource="&crop_process;#roi-height"/>
    <profile:hasInput rdf:resource="&crop_process;#roi-x"/>
    <profile:hasInput rdf:resource="&crop_process;#roi-y"/>
    <profile:hasOutput rdf:resource="&crop_process;#imageOut"/>
    <profile:hasEffect rdf:resource="&crop_process;#eff_resolution"/>
  </hierarchy:CropRectangularBitmapImage>

</rdf:RDF>
```

I.5.3 Service model

```
<?xml version="1.0" encoding="ISO-8859-1"?>
<!DOCTYPE uridef [
  <!ENTITY rdf "http://www.w3.org/1999/02/22-rdf-syntax-ns">
  <!ENTITY rdfs "http://www.w3.org/2000/01/rdf-schema">
  <!ENTITY owl "http://www.w3.org/2002/07/owl">
  <!ENTITY xsd "http://www.w3.org/2001/XMLSchema">
  <!ENTITY process "http://www.daml.org/services/owl-s/1.1/Process.owl">
  <!ENTITY swrlx "http://www.csl.sri.com/users/denker/owl/swrl.owl">
  <!ENTITY owlx "http://www.w3.org/2003/05/owl-xml">
  <!ENTITY expr
    "http://www.daml.org/services/owl-s/1.1/generic/Expression.owl">
  <!ENTITY DEFAULT
    "http://www.itec.uni-klu.ac.at/~klaus/sws/stdcrop/CropProcess.owl">
]>
<rdf:RDF
  xmlns:rdf="&rdf;#" xmlns:rdfs="&rdfs;#" xmlns:owl="&owl;#"
  xmlns:xsd="&xsd;" xmlns:process="&process;#" xmlns:swrlx="&swrlx;#"
  xmlns:owlx="&owlx;#" xmlns:expr="&expr;#">

  <owl:Ontology rdf:about="">
    <owl:versionInfo>
    $Id: Crop Image V 1.2
    </owl:versionInfo>
    <rdfs:comment>
    Semantic description of a crop operation
    </rdfs:comment>
    <owl:imports rdf:resource="&rdf;"/>
    <owl:imports rdf:resource="&rdfs;"/>
    <owl:imports rdf:resource="&owl;"/>
    <owl:imports rdf:resource="&process;"/>
  </owl:Ontology>

  <!--Process-->
  <process:AtomicProcess rdf:ID="CropImage">
    <rdfs:label> The CropImage process </rdfs:label>

    <!-- The parameters of the process -->
    <process:hasInput>
      <process:Input rdf:ID="imageIn">
        <process:parameterType rdf:datatype="&xsd;#anyURI">
          <!-- JPEG image -->
          urn:mpeg:mpeg7:cs:FileFormatCS:2001:1
```

--`,,```,,,,````-`-`,,`,,`,`,,`---

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```
        </process:parameterType>
      </process:Input>
    </process:hasInput>

    <process:hasInput>
      <process:Input rdf:ID="roi-width">
        <process:parameterType rdf:datatype="&xsd;#anyURI">
          <!-- newly introduced VisualCS - region of interest:width -->
          urn:mpeg7:cs:VisualCS:2002:3.1
        </process:parameterType>
      </process:Input>
    </process:hasInput>

    <process:hasInput>
      <process:Input rdf:ID="roi-height">
        <process:parameterType rdf:datatype="&xsd;#anyURI">
          <!-- newly introduced VisualCS - region of interest:height -->
          urn:mpeg7:cs:VisualCS:2002:3.2
        </process:parameterType>
      </process:Input>
    </process:hasInput>

    <process:hasInput>
      <process:Input rdf:ID="roi-x">
        <process:parameterType rdf:datatype="&xsd;#anyURI">
          <!-- newly introduced VisualCS - region of interest:x -->
          urn:mpeg7:cs:VisualCS:2002:3.3
        </process:parameterType>
      </process:Input>
    </process:hasInput>

    <process:hasInput>
      <process:Input rdf:ID="roi-y">
        <process:parameterType rdf:datatype="&xsd;#anyURI">
          <!-- newly introduced VisualCS - region of interest:y -->
          urn:mpeg7:cs:VisualCS:2002:3.4
        </process:parameterType>
      </process:Input>
    </process:hasInput>

    <process:hasOutput>
      <process:Output rdf:ID="imageOut">
        <process:parameterType rdf:datatype="&xsd;#anyURI">
          <!-- JPEG image -->
          urn:mpeg:mpeg7:cs:FileFormatCS:2001:1
        </process:parameterType>
      </process:Output>
    </process:hasOutput>

    <process:hasResult>
      <process:Result rdf:ID="eff_resolution">
        <rdfs:comment>
       Effects are changed MPEG-7 descriptors and
            met MPEG-21 terminal constraints
        </rdfs:comment>

        <process:hasEffect>
          <expr:SWRL-Expression>
            <expr:expressionBody rdf:parseType="Literal">
              <swrlx:AtomList>
                <rdf:first>
                  <swrlx:classAtom>
                    <!-- MPEG-7 width -->
                    <owlx:Class owlx:name="urn:mpeg:mpeg21:01-DIA-MediaInformationCS-
NS:81"/>
                    <owlx:Individual owlx:name="#roi-width"/>
                  </swrlx:classAtom>
                </rdf:first>
```


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```
                <rdf:rest>
                  <swrlx:AtomList>
                    <rdf:first>
                      <swrlx:classAtom>
                        <!-- MPEG-7 height -->
                        <owlx:Class owlx:name="urn:mpeg:mpeg21:01-DIA-MediaInformationCS-
NS:82"/>
                        <owlx:Individual owlx:name="#roi-heigth"/>
                      </swrlx:classAtom>
                    </rdf:first>
                    <rdf:rest>
                      <swrlx:AtomList>
                        <rdf:first>
                          <swrlx:classAtom>
                            <!-- MPEG-21 horizontal -->
                            <owlx:Class owlx:name="urn:mpeg:mpeg21:2003:01-DIA-
AdaptationQoSCS-NS:6.5.9.1"/>
                            <owlx:Individual owlx:name="#roi-width"/>
                          </swrlx:classAtom>
                        </rdf:first>
                        <rdf:rest>
                          <swrlx:AtomList>
                            <rdf:first>
                              <swrlx:classAtom>
                                <!-- MPEG-21 vertical -->
                                <owlx:Class owlx:name="urn:mpeg:mpeg21:2003:01-DIA-
AdaptationQoSCS-NS:6.5.9.2"/>
                                <owlx:Individual owlx:name="#roi-height"/>
                              </swrlx:classAtom>
                            </rdf:first>
                            <rdf:rest rdf:resource="&rdf;#nil"/>
                          </swrlx:AtomList>
                        </rdf:rest>
                      </swrlx:AtomList>
                    </rdf:rest>
                  </swrlx:AtomList>
                </rdf:rest>
              </swrlx:AtomList>
            </expr:expressionBody>
          </expr:SWRL-Expression>
        </process:hasEffect>

      </process:Result>
    </process:hasResult>

  </process:AtomicProcess>
</rdf:RDF>
```

I.5.4 Service grounding

```
<?xml version="1.0" encoding="ISO-8859-1"?>
<!DOCTYPE uridef [
  <!ENTITY rdf "http://www.w3.org/1999/02/22-rdf-syntax-ns">
  <!ENTITY rdfs "http://www.w3.org/2000/01/rdf-schema">
  <!ENTITY owl "http://www.w3.org/2002/07/owl">
  <!ENTITY xsd "http://www.w3.org/2001/XMLSchema">
  <!ENTITY service "http://www.daml.org/services/owl-s/1.1/Service.owl">
  <!ENTITY process "http://www.daml.org/services/owl-s/1.1/Process.owl">
  <!ENTITY grounding
    "http://www.daml.org/services/owl-s/1.1/Grounding.owl">
  <!ENTITY cropper_process
    "http://www.itec.uni-klu.ac.at/~klaus/sws/stdcrop/CropProcess.owl">
  <!ENTITY cropper_wsdl
    "http://www.itec.uni-klu.ac.at/~klaus/sws/stdcrop/CropGrounding.wsdl">
  <!ENTITY DEFAULT
```

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```
    "http://www.itec.uni-klu.ac.at/~klaus/sws/stdcrop/CropGrounding.owl">
]>
<rdf:RDF
  xmlns:rdf="&rdf;#" xmlns:rdfs="&rdfs;#" xmlns:owl="&owl;#"
  xmlns:xsd="&xsd;#" xmlns:service="&service;#"
  xmlns:grounding="&grounding;#" xmlns="&DEFAULT;#" xml:base="&DEFAULT;">

  <owl:Ontology rdf:about="">
    <owl:versionInfo>
    $Id: CropGrounding.owl,v 1.0 2005/01/07 klaus Exp $
    </owl:versionInfo>
    <owl:imports rdf:resource="&service;"/>
    <owl:imports rdf:resource="&process;"/>
    <owl:imports rdf:resource="&grounding;"/>
    <owl:imports rdf:resource="&cropper_process;"/>
  </owl:Ontology>

  <!-- Grounding Instance for the Service -->
  <grounding:WsdlGrounding rdf:ID="CropperServiceGrounding">
    <rdfs:comment>
    This service employs one atomic process for the cropper.
    </rdfs:comment>
    <grounding:hasAtomicProcessGrounding rdf:resource="#CropperGrounding"/>
  </grounding:WsdlGrounding>

  <!-- Grounding for Atomic Process CropImage -->
  <grounding:WsdlAtomicProcessGrounding rdf:ID="CropperGrounding">
    <grounding:owlsProcess rdf:resource="&cropper_process;#CropImage"/>

    <grounding:wsdlOperation>
      <grounding:WsdlOperationRef>
        <grounding:portType rdf:datatype="&xsd;#anyURI">
        &cropper_wsdl;#Cropper_port
        </grounding:portType>
        <grounding:operation rdf:datatype="&xsd;#anyURI">
        &cropper_wsdl;#Crop_operation
        </grounding:operation>
      </grounding:WsdlOperationRef>
    </grounding:wsdlOperation>

    <!-- grounding for input message -->
    <grounding:wsdlInputMessage rdf:datatype="&xsd;#anyURI">
    &cropper_wsdl;#Crop_Input
    </grounding:wsdlInputMessage>

    <!-- map OWL-S imageIn to WSDL imageIn -->
    <grounding:wsdlInput>
      <grounding:WsdlInputMessageMap>
        <grounding:owlsParameter rdf:resource="&cropper_process;#imageIn"/>
        <grounding:wsdlMessagePart rdf:datatype="&xsd;#anyURI">
        &cropper_wsdl;#imageIn
        </grounding:wsdlMessagePart>
      </grounding:WsdlInputMessageMap>
    </grounding:wsdlInput>

    <!-- map OWL-S roi-width to WSDL roiWidth -->
    <grounding:wsdlInput>
      <grounding:WsdlInputMessageMap>
        <grounding:owlsParameter
        rdf:resource="&cropper_process;roi-width"/>
        <grounding:wsdlMessagePart rdf:datatype="&xsd;#anyURI">
        &cropper_wsdl;#roiWidth
        </grounding:wsdlMessagePart>
      </grounding:WsdlInputMessageMap>
    </grounding:wsdlInput>

    <!-- map OWL-S roi-height to WSDL roiHeight -->
    <grounding:wsdlInput>
```


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```
      <grounding:WsdlInputMessageMap>
        <grounding:owlsParameter
       rdf:resource="&cropper_process;roi-heigth"/>
        <grounding:wsdlMessagePart rdf:datatype="&xsd;#anyURI">
       &cropper_wsdl;#roiHeigth
        </grounding:wsdlMessagePart>
      </grounding:WsdlInputMessageMap>
    </grounding:wsdlInput>

    <!-- map OWL-S roi-x to WSDL roiX -->
    <grounding:wsdlInput>
      <grounding:WsdlInputMessageMap>
        <grounding:owlsParameter rdf:resource="&cropper_process;roi-x"/>
        <grounding:wsdlMessagePart rdf:datatype="&xsd;#anyURI">
       &cropper_wsdl;#roiX
        </grounding:wsdlMessagePart>
      </grounding:WsdlInputMessageMap>
    </grounding:wsdlInput>

    <!-- map OWL-S roi-y to WSDL roiY -->
    <grounding:wsdlInput>
      <grounding:WsdlInputMessageMap>
        <grounding:owlsParameter rdf:resource="&cropper_process;roi-y"/>
        <grounding:wsdlMessagePart rdf:datatype="&xsd;#anyURI">
       &cropper_wsdl;#roiY
        </grounding:wsdlMessagePart>
      </grounding:WsdlInputMessageMap>
    </grounding:wsdlInput>

    <!-- grounding for output message -->
    <grounding:wsdlOutputMessage rdf:datatype="&xsd;#anyURI">
    &cropper_wsdl;#cropOutput
    </grounding:wsdlOutputMessage>

    <!-- map OWL-S imageOut to WSDL cropReturn -->
    <grounding:wsdlOutput>
      <grounding:WsdlOutputMessageMap>
        <grounding:owlsParameter
       rdf:resource="&cropper_process;#imageOut"/>
        <grounding:wsdlMessagePart rdf:datatype="&xsd;#anyURI">
       &cropper_wsdl;#cropReturn
        </grounding:wsdlMessagePart>
      </grounding:WsdlOutputMessageMap>
    </grounding:wsdlOutput>

    <grounding:wsdlReference rdf:datatype="&xsd;#anyURI">
    http://www.w3.org/TR/2001/NOTE-wsdl-20010315
    </grounding:wsdlReference>

    <grounding:otherReference rdf:datatype="&xsd;#anyURI">
    http://schemas.xmlsoap.org/wsdl/java/
    </grounding:otherReference>

    <grounding:wsdlDocument rdf:datatype="&xsd;#anyURI">
    &cropper_wsdl;
    </grounding:wsdlDocument>

  </grounding:WsdlAtomicProcessGrounding>
</rdf:RDF>
```

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I.5.5 Web service description language

```
<?xml version="1.0"?>
<definitions
  xmlns:Cropper="http://www.itec.uni-klu.ac.at/~klaus/sws/stdcrop/CropProcess.wsdl"
  xmlns:java="http://schemas.xmlsoap.org/wsdl/java/"
  xmlns:format="http://schemas.xmlsoap.org/wsdl/formatbinding/"
  xmlns="http://schemas.xmlsoap.org/wsdl/"
  targetNamespace="http://www.itec.uni-klu.ac.at/~klaus/sws/stdcrop/CropGrounding.wsdl"
  name="ImageCropper_WSDL">

  <!-- message declarations -->
  <message name="cropInput">
    <part name="imageIn" type="inputstream"/>
    <part name="roiWidth" type="xsd:int"/>
    <part name="roiHeight" type="xsd:int"/>
    <part name="roiX" type="xsd:int"/>
    <part name="roiY" type="xsd:int"/>
  </message>
  <message name="cropOutput">
    <part name="cropReturn" type="outputstream"/>
  </message>

  <!-- port type declarations -->
  <portType name="Cropper_port">
    <operation name="crop_operation">
      <input name="cropInput" message="cropInput"/>
      <output name="cropOutput" message="cropOutput"/>
    </operation>
  </portType>

  <!-- binding declarations -->
  <binding name="JavaBinding" type="Cropper">
    <java:binding/>  <!-- indicates that the binding is a Java binding.-->
    <format:typeMapping encoding="Java" style="Java">
      <format:typeMap typeName="inputstream"
       formatType="java.io.InputStream"/>
      <format:typeMap typeName="outputstream"
       formatType="java.io.OutputStream"/>
    </format:typeMapping>
    <operation name="crop_operation">
      <java:operation name="crop_operation"
       parameterOrder="imageIn roiWidth roiHeight roiX roiY"/>
      <input name="cropInput"/>
      <output name="cropOutput"/>
    </operation>
  </binding>

  <!-- service declaration -->
  <service name="CropImageService">
    <port name="JavaPort" binding="JavaBinding">
      <java:address className="itec.adapt.Cropper"/>
    </port>
  </service>

</definitions>
```


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I.5.6 Usage of OWL-S descriptions within ISO/IEC 21000-7 conversion capabilities

```
<?xml version="1.0" encoding="UTF-8"?>
<!DOCTYPE uridef [
  <!ENTITY xsd "http://www.w3.org/2001/XMLSchema">
  <!ENTITY rdf "http://www.w3.org/1999/02/22-rdf-syntax-ns">
  <!ENTITY rdfs "http://www.w3.org/2000/01/rdf-schema">
  <!ENTITY owl "http://www.w3.org/2002/07/owl">
  <!ENTITY profile "http://www.daml.org/services/owl-s/1.1B/Profile.owl">
  <!ENTITY process "http://www.daml.org/services/owl-s/1.1B/Process.owl">
  <!ENTITY hierarchy "urn:mpeg:mpeg21:2003:01-RDD-NS">
  <!ENTITY crop_process "http://www.itec.uni-
klu.ac.at/~klaus/sws/cropper/CropProcess.owl">
  <!ENTITY DEFAULT "http://www.itec.uni-klu.ac.at/~klaus/sws/cropper/CropProfile.owl">
]>
<DIA xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance" xmlns="urn:mpeg:mpeg21:2003:01-
DIA-NS" xmlns:dia="urn:mpeg:mpeg21:2003:01-DIA-NS" xmlns:r="urn:mpeg:mpeg21:2003:01-REL-R-
NS" xmlns:sx="urn:mpeg:mpeg21:2003:01-REL-SX-NS"
xsi:schemaLocation="urn:mpeg:mpeg21:2003:01-DIA-NS ConvCapab.xsd">
  <Description xsi:type="TerminalsType">
    <Terminal>
      <TerminalCapability xsi:type="ConversionCapabilitiesType">
        <ConversionCapability>
          <ConversionActUri uri="urn:mpeg:mpeg21:2003:01-RDD-
NS:CropRectangularBitmapImage"/>
          <rdf:RDF xmlns:rdf="&rdf;#" xmlns:rdfs="&rdfs;#" xmlns:owl="&owl;#"
xmlns:process="&process;#" xmlns:profile="&profile;#" xmlns:hierarchy="&hierarchy;#"
xmlns:crop_process="&crop_process;#" xmlns="&DEFAULT;#">
            <owl:Ontology rdf:about="">
              <owl:versionInfo>$Id: RescaleProfile.owl,v 1.23 2004/10/03 klaus Exp
$</owl:versionInfo>
              <rdfs:comment>OWL-S profile for an image scaler</rdfs:comment>
              <owl:imports rdf:resource="&profile;"/>
              <owl:imports rdf:resource="&process;"/>
              <owl:imports rdf:resource="&crop_process;"/>
            </owl:Ontology>
            <!-- Reference to the RDD term for the image crop conversion -->
            <hierarchy:CropRectangularBitmapImage rdf:ID="CropImage">
              <!-- reference to the process model specification -->
              <profile:has_process rdf:resource="&crop_process;#CropImage"/>
              <profile:serviceName>CropImage</profile:serviceName>
              <profile:textDescription>This conversion
operation...</profile:textDescription>
              <profile:contactInformation>contact info</profile:contactInformation>
              <!-- Descriptions of IO -->
              <profile:hasInput rdf:resource="&crop_process;#crop_in0_imageIn"/>
              <profile:hasInput rdf:resource="&crop_process;#crop_in1_roiURL"/>
              <profile:hasOutput rdf:resource="&crop_process;#crop_return_imageOut"/>
            </hierarchy:CropRectangularBitmapImage>
          </rdf:RDF>
        </ConversionCapability>
      </TerminalCapability>
    </Terminal>
  </Description>
</DIA>
```

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Annex J

(informative)

Usage of ConversionLink and CrossConversionQoS tools

J.1 Introduction

This Annex describes a architecture for the ConversionLink and CrossConversionQoS tools as specified in clause 7 to clarify how the tools that are capable to steer the adaptation process, e.g., terminal and network quality of service, usage environment, etc., make use of the ConversionLink and CrossConversionQoS tool and can be combined and integrated into the DIA framework. This architecture is compatible with the general architecture for the BSDLink tool described in Annex B and illustrates how single and multiple conversion suggestions can be handled to provide an optimized conversion decision-taking.

J.2 Single conversion adaptation architecture

Figure J.1 illustrates how AdaptationQoS, UCD, UED, MPEG-7 description and ConversionLink can fit together in a conversion scenario. AdaptationQoS, UCD and UED are used as input by the Adaptation Decision-Taking Engine (ADTE) to optimize the conversion decision. In the single-conversion use case, the decision process consists in optimizing conversion parameter values. The mapping between ADTE optimized IOPins and conversion tool parameters is achieved using ConversionLink `Parameter` syntax.

The conversion is then completely determined using ConversionLink references. The selected conversion tool will apply referenced IOPin values as conversion parameter values to the targeted bitstream. An optional MPEG-7 resource description can also be used by the conversion tool to enhance the conversion using resource semantics (however, if the conversion tool cannot handle any MPEG-7 description, this information can be ignored).

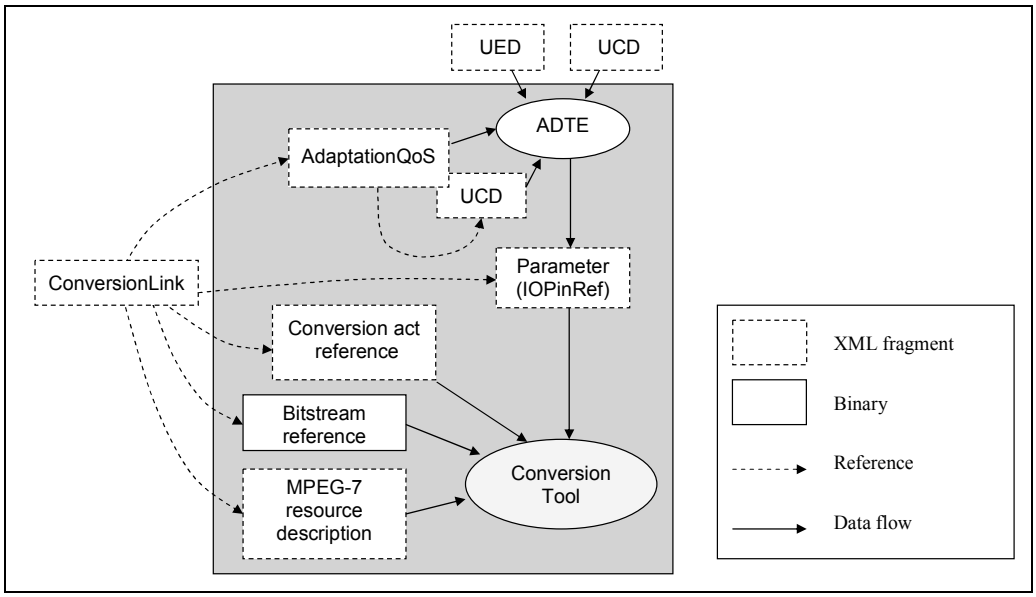

Figure J.1 — AdaptationQoS-based conversion adaptation architecture.

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J.3 Multiple conversion adaptation architecture

Figure J.2 shows a Digital Item Adaptation architecture example that can handle several conversion options, described in the ConversionLink and BSDLink elements, for a single resource. In case of multiple possible conversions, CrossConversionQoS can make use of IOPins defined in AdaptationQoS referenced by ConversionLink or BSDLink to suggest conversion decision boundaries based on UED or other conversion alternative IOPins.

The Cross-conversion Decision-Taking Engine (CDTE) processes a CrossConversionQoS. It then instantiates an AdaptationQoS Decision-Taking Engine (ADTE) and resource adapter couple for each Conversion Option, based on the information provided in the LinkRef element, i.e. the referenced ConversionLink or BSDLink. Each ADTE then investigates if it can perform a conversion that satisfies the given context constraints (specified in a UED and/or UCD). Finally, the CDTE investigates all valid options provided by each ADTE and selects the one that maximizes a quality metric defined in the CrossConversionQoS descriptor. More details for this processing can be found in Annex J.4.

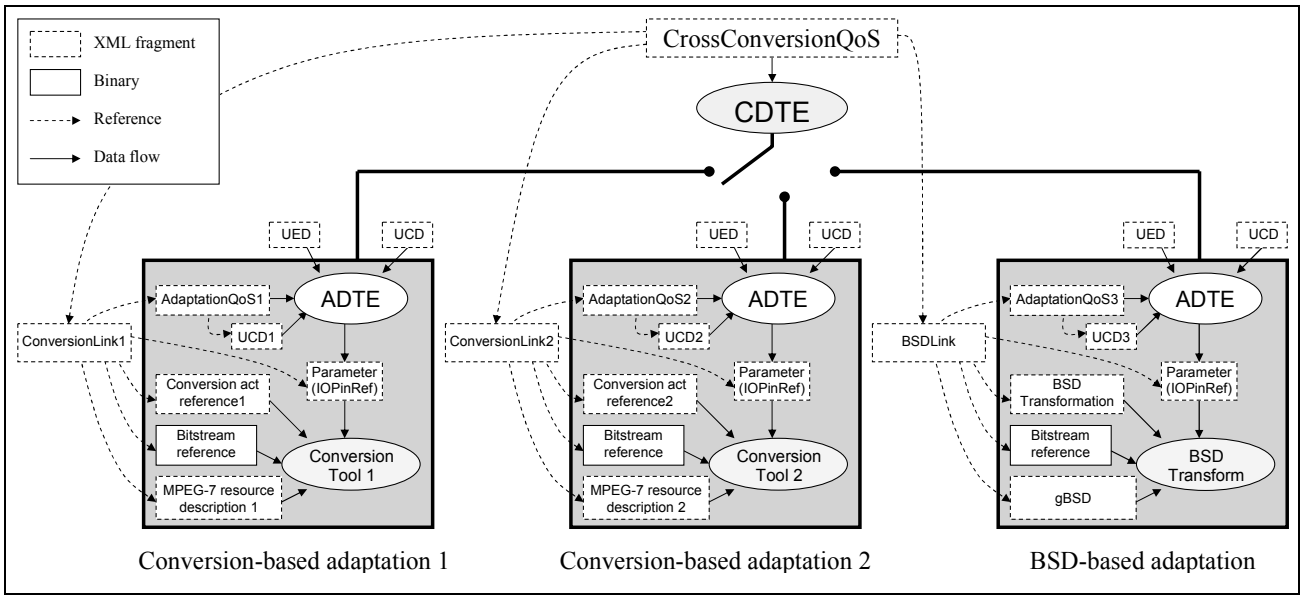

Figure J.2 — Multiple adaptation and conversions for a single resource.

J.4 Multiple conversions processing walkthrough

An adaptation strategy that includes gBSD-based adaptations and conversions could be described in the following processing steps:

a) Parse CrossConversionQoS descriptor (entry-point for the Cross-conversion Decision-Taking Engine).

b) Parse each ConversionLink/BSDLink descriptor referenced in CrossConversionQoS.

c) For each ConversionLink/BSDLink parse the corresponding AQoS.

d) For each AQoS parse the corresponding UCD.

e) Each AdaptationQoS Decision-Taking Engine processes each AQoS descriptor together with its UCD and provides a list of valid adaptation options.

f) For each conversion type and each valid adaptation option, the CDTE calculates the overall conversion quality by resolving the associated QualityFunction and multipliying it with the ‘scale’ value.

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g) Choose the conversion option that maximizes the conversion quality.

h) Process the associated ConversionLink or BSDLink descriptor to perform the actual conversion of the bitstream referenced in the BitstreamRef element with the optimal selected adaptation parameters:

   1) LinkRef targets a BSDLink: the DIA standard clearly specifies that a BSDL/gBSD resource converter should be used.

   2) LinkRef targets a ConversionLink: the semantics of the conversion act are retrieved and the conversion parameters are matched. Once the conversion is clearly identified, the corresponding conversion tool is selected.

   3) LinkRef targets a ConversionLink where ConversionActUri specifies an empty uri: this means that no conversion should be applied and the resource referenced by the BitstreamRef element of ConversionLink should be selected without further adapting/converting it.

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Annex K
(informative)

XML streaming instructions' relation to encoding

The solution proposed in Section 8.6 is independent from the encoding method used. For example, the following methods can be used:

— Plain text encoding, i.e. the process unit (PU) is sent in plain text format.

— TeM

— BiM

In all cases, the output of the encoding step is an elementary stream consisting of a sequence of access units.

The following XML document shows an example of an elementary stream (ES) where plain-encoding is used for the PUs. The ES is the concatenation of the PUs. Note that this stream is not an XML document (since several elements are declared at the root), but a concatenation of XML documents.

```
<!-- access unit #1 -->
<el0 xmlns="urn:myExampleNS">
    <el1/>
</el0>
<!-- access unit #2 -->
<el0 xmlns="urn:myExampleNS">
  <el2>
    <el21>
      <el211/>
    </el21>
  </el2>
</el0>
<!-- access unit #3 -->
<el0 xmlns="urn:myExampleNS">
  <el2>
    <el22>
      <el221/>
      <el222/>
    </el22>
  </el2>
</el0>
```

The following XML document shows an example of an elementary stream where TeM encoding is used for the PUs.

```
<mpeg7s:DecoderInit systemsProfileLevelIndication="0"
                    xmlns:mpeg7s="urn:mpeg:mpeg7:systems:2003">
  <mpeg7s:SchemaReference name="urn:mpeg:mpeg7:systems:2001"/>
  <mpeg7s:InitialDescription>
    <mpeg7s:FragmentUpdateUnit>
      <mpeg7s:FUCommand>addNode</mpeg7s:FUCommand>
      <mpeg7s:FUContext>/</mpeg7s:FUContext>
      <mpeg7s:FUPayload>
        <el0 xmlns="urn:myExampleNS"/>
      </mpeg7s:FUPayload>
    </mpeg7s:FragmentUpdateUnit>
  </mpeg7s:InitialDescription>
</mpeg7s:DecoderInit>
```

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```
<!-- access unit #1 -->
<mpeg7s:AccessUnit xmlns:mpeg7s="urn:mpeg:mpeg7:systems:2003">
  <mpeg7s:FragmentUpdateUnit>
    <mpeg7s:FUCommand>addNode</mpeg7s:FUCommand>
    <mpeg7s:FUContext>/el0/</mpeg7s:FUContext>
    <mpeg7s:FUPayload>
        <el1/>
    </mpeg7s:FUPayload>
  </mpeg7s:FragmentUpdateUnit>
</mpeg7s:AccessUnit>
<!-- access unit #2 -->
<mpeg7s:AccessUnit xmlns:mpeg7s="urn:mpeg:mpeg7:systems:2003">
  <mpeg7s:FragmentUpdateUnit>
    <mpeg7s:FUCommand>replaceNode</mpeg7s:FUCommand>
    <mpeg7s:FUContext>/el0/el1</mpeg7s:FUContext>
    <mpeg7s:FUPayload>
        <el2>
            <el21>
                <el211/>
            </el21>
        </el2>
    </mpeg7s:FUPayload>
  </mpeg7s:FragmentUpdateUnit>
</mpeg7s:AccessUnit>
<!-- access unit #3 -->
<mpeg7s:AccessUnit xmlns:mpeg7s="urn:mpeg:mpeg7:systems:2003">
  <mpeg7s:FragmentUpdateUnit>
    <mpeg7s:FUCommand>replaceNode</mpeg7s:FUCommand>
    <mpeg7s:FUContext>/el0/el2/el21</mpeg7s:FUContext>
    <mpeg7s:FUPayload>
        <el22>
            <el221/>
            <el222/>
        </el22>
    </mpeg7s:FUPayload>
  </mpeg7s:FragmentUpdateUnit>
</mpeg7s:AccessUnit>
```

The elementary stream can then be streamed to the network (on-line encoding) or stored on a server (off-line encoding).

In **on-line** mode, PUs are encoded into access units (AUs) which are directly sent to the network. Note that the AUs may be packetized (e.g. into RTP packets) according to the transport layer requirements. The time information provided by the XML streaming instructions is used for the delivery time stamp (e.g. RTP time stamp).

In **off-line** mode, the AUs are concatenated in an elementary stream and stored, e.g., in the mdat box of the ISO/IEC 14496-12. Then the time information provided by the XML streaming instructions can be stored in the sample table boxes of the file format. Alternatively, if the encoded elementary stream is stored as a stand-alone file, time information can be stored as a NHNT file.

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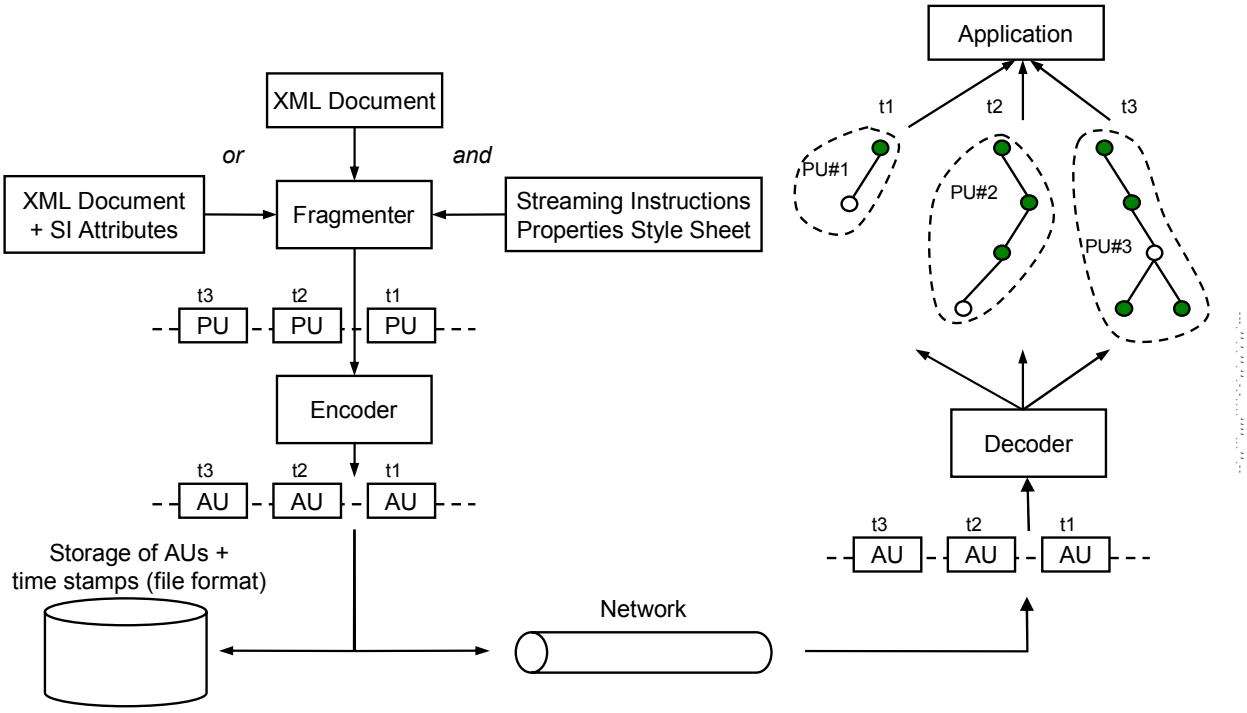

Figure K.1 — Usage of XML streaming instructions in a streaming scenario.

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Annex L
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Examples of media resource streaming instructions

Table L.1 shows the timing information for the described bitstream based on the example of subclause 8.15 of ISO/IEC 14496-12:2005 which is the basis for all subsequent examples.

Table L.1 — Timing information for an ISO/IEC 14496-2 visual elementary stream.

	I	P	B	B	P	B	B
dtsDelta	10	10	10	10	10	10	10
ctsOffset	10	30	0	0	30	0	0
DTS	0	10	20	30	40	50	60
CTS	10	40	20	30	70	50	60

EXAMPLE 1 Example of a BSD describing an ISO/IEC 14496-2 visual elementary stream with media resource streaming instructions in absolute time mode. The frame rate is 15 frames per second.

```
<?xml version="1.0" ?>
<Bitstream xmlns="urn:MPEG4_VES"
    bs1:bitstreamURI="akiyo.mpg4"
    xmlns:bs1="urn:mpeg:mpeg21:2003:01-DIA-BSDL1-NS"
    xsi:schemaLocation="urn:MPEG4_VES MPEG4_VES2.xsd"
    xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
    xmlns:msi="urn:mpeg:mpeg21:2003:01-DIA-MSI-NS"
    xmlns:mp4="urn:MPEG4_VES"
    msi:timeScale="150">

  <I_VOP msi:au="true" msi:dts="0" msi:cts="10" msi:rap="true">
    <vop_start_code>000001B6</vop_start_code>
    <vop_coding_type>0</vop_coding_type>
    <Stuffing>16</Stuffing>
    <Payload>23 4636</Payload>
  </I_VOP>
  <P_VOP msi:au="true" msi:dts="10" msi:cts="40">
    <vop_start_code>000001B6</vop_start_code>
    <vop_coding_type>1</vop_coding_type>
    <Stuffing>17</Stuffing>
    <Payload>4664 93</Payload>
  </P_VOP>
  <B_VOP msi:au="true" msi:dts="20" msi:cts="20">
    <!-- and so on... -->
  </B_VOP>
  <B_VOP msi:au="true" msi:dts="30" msi:cts="30">
    <!-- and so on... -->
  </B_VOP>
  <P_VOP msi:au="true" msi:dts="40" msi:cts="70">
    <!-- and so on... -->
  </P_VOP>
  <B_VOP msi:au="true" msi:dts="50" msi:cts="50">
    <!-- and so on... -->
  </B_VOP>
```


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```
  <B_VOP msi:au="true" msi:dts="60" msi:cts="60">
    <!-- and so on... -->
  </B_VOP>
</Bitstream>
```

EXAMPLE 2 Example of a BSD describing an ISO/IEC 14496-2 visual elementary stream with media resource streaming instructions in relative time mode.

```
<?xml version="1.0" ?>
<Bitstream xmlns="urn:MPEG4_VES"
    bs1:bitstreamURI="akiyo.mpg4"
    xmlns:bs1="urn:mpeg:mpeg21:2003:01-DIA-BSDL1-NS"
    xsi:schemaLocation="urn:MPEG4_VES MPEG4_VES2.xsd"
    xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
    xmlns:msi="urn:mpeg:mpeg21:2003:01-DIA-MSI-NS"
    xmlns:mp4="urn:MPEG4_VES"
    msi:timeScale="150"
    msi:dtsDelta="10">

  <I_VOP msi:au="true" msi:ctsOffset="10" msi:rap="true">
    <vop_start_code>000001B6</vop_start_code>
    <vop_coding_type>0</vop_coding_type>
    <Stuffing>16</Stuffing>
    <Payload>23 4636</Payload>
  </I_VOP>
  <P_VOP msi:au="true" msi:ctsOffset="30" >
    <vop_start_code>000001B6</vop_start_code>
    <vop_coding_type>1</vop_coding_type>
    <Stuffing>17</Stuffing>
    <Payload>4664 93</Payload>
  </P_VOP>
  <B_VOP msi:au="true" msi:ctsOffset="0">
    <!-- and so on... -->
  </B_VOP>
  <B_VOP msi:au="true" msi:ctsOffset="0">
    <!-- and so on... -->
  </B_VOP>
  <P_VOP msi:au="true" msi:ctsOffset="30">
    <!-- and so on... -->
  </P_VOP>
  <B_VOP msi:au="true" msi:ctsOffset="0">
    <!-- and so on... -->
  </B_VOP>
  <B_VOP msi:au="true" msi:ctsOffset="0">
    <!-- and so on... -->
  </B_VOP>
</Bitstream>
```

EXAMPLE 3 Example of gBSD describing an ISO/IEC 14496-2 visual elementary stream with media resource streaming instructions in absolute time mode.

```
<?xml version="1.0" encoding="UTF-8" ?>
<gBSDUnit xmlns="urn:mpeg:mpeg21:2003:01-DIA-gBSD-NS"
    xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
    xmlns:xsd="http://www.w3.org/2001/XMLSchema"
    xmlns:bs1="urn:mpeg:mpeg21:2003:01-DIA-BSDL1-NS"
    xmlns:msi="urn:mpeg:mpeg21:2003:01-DIA-MSI-NS"
    xsi:type="gBSDUnitType"
    xsi:schemaLocation="
      urn:mpeg:mpeg21:2003:01-DIA-gBSD-NS gBSSchema-AMD2.xsd
      urn:mpeg:mpeg21:2003:01-DIA-MSI-NS MSI.xsd"
    addressUnit="byte" addressMode="Absolute"
    bs1:bitstreamURI="akiyo.mpg4"
    syntacticalLabel="Bitstream"
```

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```
    msi:timeScale="150">

  <gBSDUnit syntacticalLabel="I_VOP" msi:au="true" msi:dts="0" msi:cts="10"
                                     msi:rap="true">
    <Parameter name="vop_start_code">
      <Value xsi:type="xsd:hexBinary">000001B6</Value>
    </Parameter>
    <Parameter name="vop_coding_type">
      <Value xsi:type="b2">0</Value>
    </Parameter>
    <Parameter name="Stuffing">
      <Value xsi:type="b6">16</Value>
    </Parameter>
    <gBSDUnit start="23" length="4636"/>
  </gBSDUnit>
  <gBSDUnit syntacticalLabel="P_VOP" msi:au="true" msi:dts="10" msi:cts="40">
    <Parameter name="vop_start_code">
      <Value xsi:type="xsd:hexBinary">000001B6</Value>
    </Parameter>
    <Parameter name="vop_coding_type">
      <Value xsi:type="b2">1</Value>
    </Parameter>
    <Parameter name="Stuffing">
      <Value xsi:type="b6">17</Value>
    </Parameter>
    <gBSDUnit start="4664" length="93"/>
  </gBSDUnit>
  <gBSDUnit syntacticalLabel="B_VOP" msi:au="true" msi:dts="20" msi:cts="20">
    <!-- and so on... -->
  </gBSDUnit>
  <gBSDUnit syntacticalLabel="B_VOP" msi:au="true" msi:dts="30" msi:cts="30">
    <!-- and so on... -->
  </gBSDUnit>
  <gBSDUnit syntacticalLabel="P_VOP" msi:au="true" msi:dts="40" msi:cts="70">
    <!-- and so on... -->
  </gBSDUnit>
  <gBSDUnit syntacticalLabel="B_VOP" msi:au="true" msi:dts="50" msi:cts="50">
    <!-- and so on... -->
  </gBSDUnit>
  <gBSDUnit syntacticalLabel="B_VOP" msi:au="true" msi:dts="60" msi:cts="60">
    <!-- and so on... -->
  </gBSDUnit>
</gBSDUnit>
```

EXAMPLE 4 Example of a gBSD describing an ISO/IEC 14496-2 visual elementary stream with media resource streaming instructions in relative time mode.

```
<?xml version="1.0" encoding="UTF-8" ?>
<gBSDUnit xmlns="urn:mpeg:mpeg21:2003:01-DIA-gBSD-NS"
  xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
  xmlns:xsd="http://www.w3.org/2001/XMLSchema"
  xmlns:bs1="urn:mpeg:mpeg21:2003:01-DIA-BSDL1-NS"
  xmlns:msi="urn:mpeg:mpeg21:2003:01-DIA-MSI-NS"
  xsi:type="gBSDUnitType"
  xsi:schemaLocation="
    urn:mpeg:mpeg21:2003:01-DIA-gBSD-NS gBSSchema-AMD2.xsd
    urn:mpeg:mpeg21:2003:01-DIA-MSI-NS MSI.xsd"
  addressUnit="byte" addressMode="Absolute"
  bs1:bitstreamURI="akiyo.mpg4"
  syntacticalLabel="Bitstream"
  msi:timeScale="150"
  msi:dtsDelta="10">

  <gBSDUnit syntacticalLabel="I_VOP" msi:au="true" msi:rap="true"
                                        msi:ctsOffset="10">
    <Parameter name="vop_start_code">
```


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```
      <Value xsi:type="xsd:hexBinary">000001B6</Value>
    </Parameter>
    <Parameter name="vop_coding_type">
      <Value xsi:type="b2">0</Value>
    </Parameter>
    <Parameter name="Stuffing">
      <Value xsi:type="b6">16</Value>
    </Parameter>
    <gBSDUnit start="23" length="4636"/>
  </gBSDUnit>
  <gBSDUnit syntacticalLabel="P_VOP" msi:au="true" msi:ctsOffset="30">
    <Parameter name="vop_start_code">
      <Value xsi:type="xsd:hexBinary">000001B6</Value>
    </Parameter>
    <Parameter name="vop_coding_type">
      <Value xsi:type="b2">1</Value>
    </Parameter>
    <Parameter name="Stuffing">
      <Value xsi:type="b6">17</Value>
    </Parameter>
    <gBSDUnit start="4664" length="93"/>
  </gBSDUnit>
  <gBSDUnit syntacticalLabel="B_VOP" msi:au="true" msi:ctsOffset="0">
    <!-- and so on... -->
  </gBSDUnit>
  <gBSDUnit syntacticalLabel="B_VOP" msi:au="true" msi:ctsOffset="0">
    <!-- and so on... -->
  </gBSDUnit>
  <gBSDUnit syntacticalLabel="P_VOP" msi:au="true" msi:ctsOffset="30">
    <!-- and so on... -->
  </gBSDUnit>
  <gBSDUnit syntacticalLabel="B_VOP" msi:au="true" msi:ctsOffset="0">
    <!-- and so on... -->
  </gBSDUnit>
  <gBSDUnit syntacticalLabel="B_VOP" msi:au="true" msi:ctsOffset="0">
    <!-- and so on... -->
  </gBSDUnit>
</gBSDUnit>
```

EXAMPLE 5 Example of a gBSD with media resource streaming instructions describing an ISO/IEC 14496-3 bit sliced arithmetic coding (BSAC) bitstream.

```
<?xml version="1.0" encoding="UTF-8"?>

<gBSDUnit xmlns="urn:mpeg:mpeg21:2003:01-DIA-gBSD-NS"
  xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
  xmlns:xsd="http://www.w3.org/2001/XMLSchema"
  xmlns:bs1="urn:mpeg:mpeg21:2003:01-DIA-BSDL1-NS"
  xmlns:msi="urn:mpeg:mpeg21:2003:01-DIA-MSI-NS"
  xsi:type="gBSDUnitType"
  xsi:schemaLocation="
    urn:mpeg:mpeg21:2003:01-DIA-gBSD-NS gBSSchema-AMD2.xsd
    urn:mpeg:mpeg21:2003:01-DIA-MSI-NS MSI.xsd"
  addressUnit="bit" addressMode="Absolute"
  bs1:bitstreamURI="prom.raw"
  syntacticalLabel="BSACBitstream"
  msi:rap="true"
  msi:timeScale="22050"
  msi:dtsDelta="1024"
  msi:ctsOffset="0">

  <gBSDUnit    addressMode="Absolute" start="0" length="4944"
               syntacticalLabel=":MA4:BSAC:BSAC_frame_element"
               msi:au="true">
    <gBSDUnit syntacticalLabel=":MA4:BSAC:BSAC_base_element"
              start="0" length="760">
```

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```
      <Parameter name=":MA4:BSAC:BSAC_base_element:framelength"
                 start="0" length="11">
        <Value xsi:type="b11">618</Value>
      </Parameter>
      <gBSDUnit syntacticalLabel="dummy1" start="11" length="5"/>
      <Parameter start="16" length="6"
                 name=":MA4:BSAC:BSAC_base_element:toplayer">
        <Value xsi:type="b6">48</Value>
      </Parameter>
      <gBSDUnit syntacticalLabel="dummy2" start="22" length="738"/>
    </gBSDUnit>
    <gBSDUnit syntacticalLabel=":MA4:BSAC:BSAC_layer_element"
              start="760" length="4184" marker="bitrate">
      <gBSDUnit start="760" length="48" marker="el1"/>
      <gBSDUnit start="808" length="48" marker="el2"/>
      <!-- and so on... -->
    </gBSDUnit>
  </gBSDUnit>
  <gBSDUnit syntacticalLabel=":MA4:BSAC:BSAC_frame_element"
            start="4944" length="3128" msi:au="true">
    <!-- and so on... -->
  </gBSDUnit>
</gBSDUnit>
```

EXAMPLE 6 Example of a BSD with media resource streaming instructions describing an ISO/IEC 14496-3 BSAC bitstream.

```
<?xml version="1.0" encoding="UTF-8"?>
<BSACBitstream xmlns="urn:mpeg:mpeg4:BSAC"
  xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
  xmlns:bs1="urn:mpeg:mpeg21:2003:01-DIA-BSDL1-NS"
  xmlns:msi="urn:mpeg:mpeg21:2003:01-DIA-MSI-NS"
  xsi:schemaLocation="urn:mpeg:mpeg4:BSAC BSAC.xsd"
  bs1:addressUnit="bit"
  bs1:bitstreamURI="prom.raw"
  msi:timeScale="22050"  msi:dtsDelta="1024" msi:ctsOffset="0">

  <frame msi:au="true">
    <base>
      <length>618</length>
      <stuff1>11 5</stuff1>
      <topLayer>48</topLayer>
      <stuff2>22 738</stuff2>
    </base>
    <layers>
      <layer>760 48</layer>
      <layer>808 48</layer>
      <!-- and so on... -->
    </layers>
  </frame>

  <frame msi:au="true">
    <base>
      <length>391</length>
      <stuff1>4955 5</stuff1>
      <topLayer>48</topLayer>
      <stuff2>4966 738</stuff2>
    </base>
    <layers>
      <layer>5704 48</layer>
      <layer>5752 48</layer>
      <!-- and so on... -->
    </layers>
  </frame>
</BSACBitstream>
```


--`,,```,,,,````-`-`,,`,,`,`,,`---
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EXAMPLE 7 Example of gBSD describing an ISO/IEC 14496-2 visual elementary stream with media resource streaming instructions in absolute time mode signaling the splitting of AUs into AU parts because of the MTU.

```
<?xml version="1.0" encoding="UTF-8" ?>
<gBSDUnit xmlns="urn:mpeg:mpeg21:2003:01-DIA-gBSD-NS"
    xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
    xmlns:xsd="http://www.w3.org/2001/XMLSchema"
    xmlns:bs1="urn:mpeg:mpeg21:2003:01-DIA-BSDL1-NS"
    xmlns:msi="urn:mpeg:mpeg21:2003:01-DIA-MSI-NS"
    xsi:type="gBSDUnitType"
    xsi:schemaLocation="
      urn:mpeg:mpeg21:2003:01-DIA-gBSD-NS gBSSchema-AMD2.xsd
      urn:mpeg:mpeg21:2003:01-DIA-MSI-NS MSI.xsd"
    addressUnit="byte" addressMode="Absolute"
    bs1:bitstreamURI="akiyo.mpg4"
    syntacticalLabel="Bitstream"
    msi:timeScale="150">

  <gBSDUnit syntacticalLabel="I_VOP" msi:au="true" msi:dts="0" msi:cts="10"
                                     msi:rap="true">
    <Parameter name="vop_start_code">
      <Value xsi:type="xsd:hexBinary">000001B6</Value>
    </Parameter>
    <Parameter name="vop_coding_type">
      <Value xsi:type="b2">0</Value>
    </Parameter>
    <Parameter name="Stuffing">
      <Value xsi:type="b6">16</Value>
    </Parameter>
    <gBSDUnit start="23" length="4636"/>
  </gBSDUnit>
  <gBSDUnit syntacticalLabel="P_VOP" msi:au="true" msi:dts="10" msi:cts="40">
    <Parameter name="vop_start_code">
      <Value xsi:type="xsd:hexBinary">000001B6</Value>
    </Parameter>
    <Parameter name="vop_coding_type">
      <Value xsi:type="b2">1</Value>
    </Parameter>
    <Parameter name="Stuffing">
      <Value xsi:type="b6">17</Value>
    </Parameter>
    <gBSDUnit start="4664" length="93"/>
  </gBSDUnit>
  <gBSDUnit syntacticalLabel="B_VOP" msi:au="true" msi:dts="20" msi:cts="20">
    <gBSDUnit msi:auPart="true" start="4757" length="100"/>
    <gBSDUnit msi:auPart="true" start="4857" length="100"/>
    <gBSDUnit msi:auPart="true" start="4957" length="100"/>
    <gBSDUnit msi:auPart="true" start="5057" length="33"/>
  </gBSDUnit>
  <gBSDUnit syntacticalLabel="B_VOP" msi:au="true" msi:dts="30" msi:cts="30">
    <gBSDUnit msi:auPart="true" start="5090" length="100"/>
    <gBSDUnit msi:auPart="true" start="5190" length="100"/>
    <gBSDUnit msi:auPart="true" start="5290" length="100"/>
    <gBSDUnit msi:auPart="true" start="5298" length="8"/>
  </gBSDUnit>
  <!-- and so on... -->
</gBSDUnit>
```

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Annex M
(informative)

Combined usage of media resource streaming instructions and XML streaming instructions

M.1 Introduction

This Annex describes how the media resource streaming instructions and the XML streaming instructions can be used together in a distributed adaptation framework.

M.2 System View

Figure M.1 depicts how the streaming instructions are integrated with the BS Description-based adaptation approach in an adaptation server in order to enable dynamic and distributed adaptation.

NOTE Media resource streaming instructions specified in this subclause can be used to annotate both BS Descriptions and gBS Descriptions. For simplicity, the text uses BSD to refer to either of them.

The BSD is provided, together with the XML streaming instructions, to the XML fragmenter. The XML fragmenter then computes the next PU from the BSD and assigns a time stamp to it, as described in subclause 8.6. This PU is then transformed, e.g., using an XSLT, in the same way as an entire BSD would be transformed (as described in subclause 8.1.4). The transformed PU is forwarded to the BSDtoBinAU processor, which also has the appropriate media AU and its time stamp available, thanks to the media resource streaming instructions. In the next step the media AU is adapted in order to correspond to the transformed PU which represents the result of the adaptation decision.

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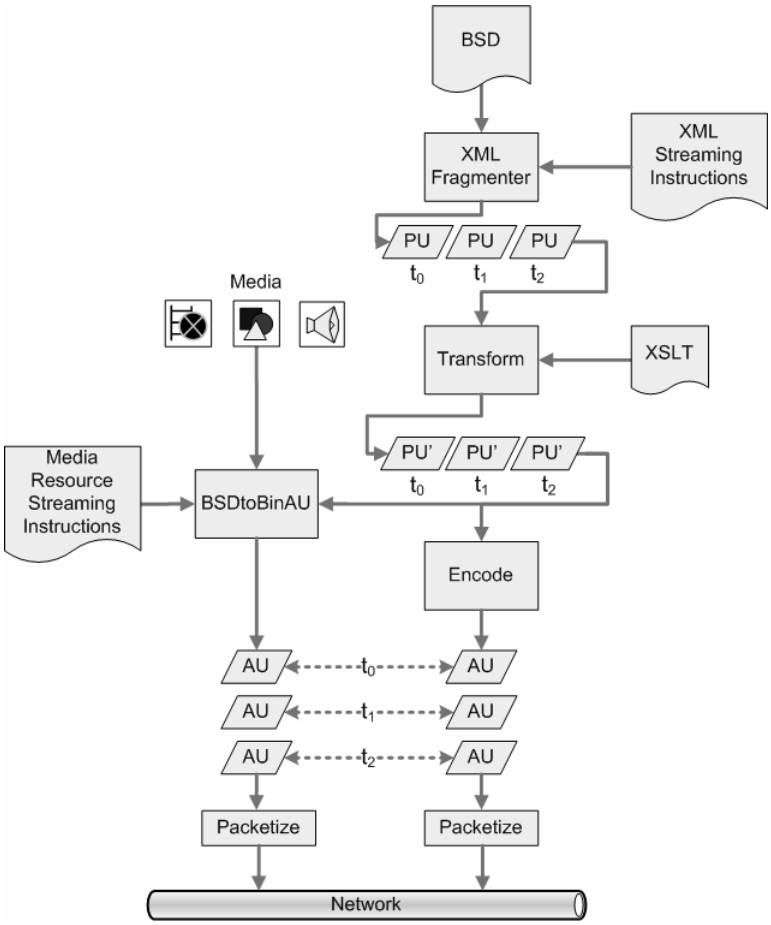

Figure M.1 — Usage of streaming instructions on an adaptation server in a distributed adaptation framework.

The transformed PUs which are still represented in the text domain are then encoded into AUs using a proper encoding mechanism, e.g., ISO/IEC 15938-1 access unit (cf. TeM or BiM), for transport purposes.

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