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Information technology — UPnP Device Architecture

Part 20-12: Audio video device control protocol —
Level 4 — Content directory service

National foreword

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**Part 20-12:
Audio video device control protocol —
Level 4 — Content directory service**

Technologies de l'information — Architecture de dispositif UPnP —

*Partie 20-12: Protocole de contrôle de dispositif audio-vidéo —
Niveau 4 — Service d'Annuaire de contenu*





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Foreword

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ISO/IEC 29341-20-12 was prepared by UPnP Forum and adopted, under the PAS procedure, by joint technical committee ISO/IEC JTC 1, *Information technology*, in parallel with its approval by national bodies of ISO and IEC.

The list of all currently available parts of ISO/IEC 29341 series, under the general title *Information technology — UPnP Device Architecture*, can be found on the [ISO web site](#).

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Original UPnP Document

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UPnP Document Title	ISO/IEC 29341 Part
UPnP Device Architecture 1.0	ISO/IEC 29341-1:2008
UPnP Device Architecture Version 1.0	ISO/IEC 29341-1:2011
UPnP Device Architecture 1.1	ISO/IEC 29341-1-1:2011
UPnP Device Architecture 2.0	ISO/IEC 29341-1-2
UPnP Basic:1 Device	ISO/IEC 29341-2
UPnP AV Architecture:1	ISO/IEC 29341-3-1:2008
UPnP AV Architecture:1	ISO/IEC 29341-3-1:2011
UPnP AVTransport:1 Service	ISO/IEC 29341-3-10
UPnP ConnectionManager:1 Service	ISO/IEC 29341-3-11
UPnP ContentDirectory:1 Service	ISO/IEC 29341-3-12
UPnP RenderingControl:1 Service	ISO/IEC 29341-3-13
UPnP MediaRenderer:1 Device	ISO/IEC 29341-3-2
UPnP MediaRenderer:2 Device	ISO/IEC 29341-3-2:2011
UPnP MediaServer:1 Device	ISO/IEC 29341-3-3
UPnP AVTransport:2 Service	ISO/IEC 29341-4-10:2008
UPnP AVTransport:2 Service	ISO/IEC 29341-4-10:2011
UPnP ConnectionManager:2 Service	ISO/IEC 29341-4-11:2008
UPnP ConnectionManager:2 Service	ISO/IEC 29341-4-11:2011
UPnP ContentDirectory:2 Service	ISO/IEC 29341-4-12
UPnP RenderingControl:2 Service	ISO/IEC 29341-4-13:2008
UPnP RenderingControl:2 Service	ISO/IEC 29341-4-13:2011
UPnP ScheduledRecording:1	ISO/IEC 29341-4-14
UPnP ScheduledRecording:2	ISO/IEC 29341-4-14:2011
UPnP MediaRenderer:2 Device	ISO/IEC 29341-4-2
UPnP MediaServer:2 Device	ISO/IEC 29341-4-3
UPnP AV Datastructure Template:1	ISO/IEC 29341-4-4:2008
UPnP AV Datastructure Template:1	ISO/IEC 29341-4-4:2011
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UPnP DigitalSecurityCameraMotionImage:1 Service	ISO/IEC 29341-5-10
UPnP DigitalSecurityCameraSettings:1 Service	ISO/IEC 29341-5-11
UPnP DigitalSecurityCameraStillImage:1 Service	ISO/IEC 29341-5-12
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UPnP ControlValve:1 Service	ISO/IEC 29341-6-10
UPnP HVAC_FanOperatingMode:1 Service	ISO/IEC 29341-6-11
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UPnP QoS Architecture:1.0	ISO/IEC 29341-10-1
UPnP QosDevice:1 Service	ISO/IEC 29341-10-10
UPnP QosManager:1 Service	ISO/IEC 29341-10-11
UPnP QosPolicyHolder:1 Service	ISO/IEC 29341-10-12
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UPnP QosDevice:2 Service	ISO/IEC 29341-11-10
UPnP QosManager:2 Service	ISO/IEC 29341-11-11
UPnP QosPolicyHolder:2 Service	ISO/IEC 29341-11-12
UPnP QOS v2 Schema Files	ISO/IEC 29341-11-2
UPnP RemoteUIClientDevice:1 Device	ISO/IEC 29341-12-1
UPnP RemoteUIClient:1 Service	ISO/IEC 29341-12-10
UPnP RemoteUIServer:1 Service	ISO/IEC 29341-12-11
UPnP RemoteUIServerDevice:1 Device	ISO/IEC 29341-12-2
UPnP DeviceSecurity:1 Service	ISO/IEC 29341-13-10
UPnP SecurityConsole:1 Service	ISO/IEC 29341-13-11
UPnP ContentDirectory:3 Service	ISO/IEC 29341-14-12:2011
UPnP MediaServer:3 Device	ISO/IEC 29341-14-3:2011
UPnP ContentSync:1	ISO/IEC 29341-15-10:2011
UPnP Low Power Architecture:1	ISO/IEC 29341-16-1:2011
UPnP LowPowerProxy:1 Service	ISO/IEC 29341-16-10:2011

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UPnP QoSManager:3 Service	ISO/IEC 29341-17-11:2011
UPnP QoSPolicyHolder:3 Service	ISO/IEC 29341-17-12:2011
UPnP QoSDevice:3 Addendum	ISO/IEC 29341-17-13:2011
UPnP RemoteAccessArchitecture:1	ISO/IEC 29341-18-1:2011
UPnP InboundConnectionConfig:1 Service	ISO/IEC 29341-18-10:2011
UPnP RADAConfig:1 Service	ISO/IEC 29341-18-11:2011
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UPnP WANIPv6FirewallControl:1 Service	ISO/IEC 29341-24-11
UPnP WANConnectionDevice:2 Service	ISO/IEC 29341-24-2
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UPnP Calendar:1 Service	ISO/IEC 29341-26-15
UPnP Presense:1 Service	ISO/IEC 29341-26-16
UPnP TelephonyClient:2 Device	ISO/IEC 29341-26-2
UPnP TelephonyServer:2 Device	ISO/IEC 29341-26-3
UPnP Friendly Info Update:1 Service	ISO/IEC 29341-27-1
UPnP MultiScreen MultiScreen Architecture:1	ISO/IEC 29341-28-1
UPnP MultiScreen Application Management:1 Service	ISO/IEC 29341-28-10
UPnP MultiScreen Screen:1 Device	ISO/IEC 29341-28-2
UPnP MultiScreen Application Management:2 Service	ISO/IEC 29341-29-10
UPnP MultiScreen Screen:2 Device	ISO/IEC 29341-29-2
UPnP IoT Management and Control Architecture Overview:1	ISO/IEC 29341-30-1

UPnP DataStore:1 Service	ISO/IEC 29341-30-10
UPnP IoT Management and Control Data Model:1 Service	ISO/IEC 29341-30-11
UPnP IoT Management and Control Transport Generic:1 Service	ISO/IEC 29341-30-12
UPnP IoT Management and Control:1 Device	ISO/IEC 29341-30-2
UPnP Energy Management:1 Service	ISO/IEC 29341-31-1

1 Scope

This document specifies the characteristics of the UPnP networked service named ContentDirectory, version 4. This service definition is compliant with UPnP Device Architecture 1.0 [14].

Many devices within the home network contain various types of content that other devices would like to access (for example, music, videos, still images, etc). As an example, a MediaServer device might contain a significant portion of the homeowner's audio, video, and still-image library. In order for the homeowner to enjoy this content, the homeowner needs to be able to browse the objects stored on the MediaServer, select a specific one, and cause it to be played on an appropriate rendering device (for example, an audio player for music objects, a TV for video content, an Electronic Picture Frame for still-images, etc).

For maximum convenience, it is highly desirable to let the homeowner to initiate these operations from a variety of UI devices. In most cases, these UI devices will either be a UI built into the rendering device, or it will be a stand-alone UI device such as a wireless PDA or tablet. In any case, it is unlikely that the homeowner will interact directly with the device containing the content (that is: the homeowner won't have to walk over to the server device). In order to enable this capability, the server device needs to provide a uniform mechanism for UI devices to browse the content on the server and to obtain detailed information about individual content objects. This is the purpose of the ContentDirectory service.

The ContentDirectory service additionally provides a lookup/storage service that enables clients (for example, UI devices) to locate (and possibly store) individual objects (for example, songs, movies, pictures, etc) that the (server) device is capable of providing. For example, this service can be used to enumerate a list of songs stored on an MP3 player, a list of still-images comprising various slide-shows, a list of movies stored in a DVD-Jukebox, a list of TV shows currently being broadcast (a.k.a an EPG), a list of songs stored in a CD-Jukebox, a list of programs stored on a PVR (Personal Video Recorder) device, etc. Nearly any type of content can be enumerated via this ContentDirectory service. For devices that contain multiple types of content (for example, MP3, MPEG2, JPEG, etc.), a single instance of the ContentDirectory service can be used to enumerate all objects, regardless of their type.

2 Normative references

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

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3 Terms, definitions, symbols and abbreviations

For the purposes of this document, the terms and definitions given in [14] and the following subclauses 3.1 and 3.2 apply.

3.1 Provisioning terms

3.1.1

allowed

A

The definition or behavior is allowed.

3.1.2

conditionally allowed

CA

The definition or behavior depends on a condition. If the specified condition is met, then the definition or behavior is allowed, otherwise it is not allowed.

3.1.3

conditionally required

CR

The definition or behavior depends on a condition. If the specified condition is met, then the definition or behavior is required. Otherwise the definition or behavior is allowed as default unless specifically defined as not allowed.

3.1.4

required

R

The definition or behavior is required.

3.1.5

R/A

Used in a table column heading to indicate that each abbreviated entry in the column declares the provisioning status of the item named in the entry's row.

3.1.6

X

Vendor-defined, non-standard.

3.1.7

-D

Declares that the item referred to is deprecated, when it is appended to any of the other abbreviated provisioning terms.

3.1.8

CSV list (or CSV)

Comma separated value list. List—or one-dimensional array—of values contained in a string and separated by commas

3.2 Symbols

3.2.1

::

Signifies a hierarchical parent-child (parent::child) relationship between the two objects separated by the double colon. This delimiter is used in multiple contexts, for example: Service::Action(), Action()::Argument, parentProperty::childProperty.

4 Notations and Conventions

4.1 Notation

- UPnP interface names defined in the UPnP Device Architecture specification [14] are styled in **green bold underlined** text.

- UPNP interface names defined outside of the UPNP Device Architecture specification [14] are styled in *red italic underlined* text.
- Some additional non-interface names and terms are styled in *italic* text.
- Words that are emphasized are also styled in *italic* text. The difference between italic terms and italics for emphasis will be apparent by context.
- Strings that are to be taken literally are enclosed in “double quotes”.

4.1.1 Data Types

Data type definitions come from three sources:

- All state variable and action argument data types are defined in [14].
- Basic data types for properties are defined in [34].
- Additional data types for properties are defined in the XML schema(s) (see [3]) associated with this service.

For UPNP Device Architecture defined **boolean** data types, it is strongly recommended to use the value “0” for false, and the value “1” for true. However, when used as input arguments, the values “false”, “no”, “true”, “yes” may also be encountered and shall be accepted. Nevertheless, it is strongly recommended that all **boolean** state variables and output arguments be represented as “0” and “1”.

For XML Schema defined Boolean data types, it is strongly recommended to use the value “0” for false, and the value “1” for true. However, when used as input properties, the values “false”, “true” may also be encountered and shall be accepted. Nevertheless, it is strongly recommended that all Boolean properties be represented as “0” and “1”.

4.1.2 Strings Embedded in Other Strings

Some string variables and arguments described in this document contain substrings that shall be independently identifiable and extractable for other processing. This requires the definition of appropriate substring delimiters and an escaping mechanism so that these delimiters can also appear as ordinary characters in the string and/or its independent substrings. This document uses embedded strings in two contexts – Comma Separated Value (CSV) lists (see subclause 4.2.2) and property values in search criteria strings. Escaping conventions use the backslash character, “\” (character code U+005C), as follows:

- a) Backslash (“\”) is represented as “\\” in both contexts.
- b) Comma (“,”) is
 - 1) represented as “\,” in individual substring entries in CSV lists
 - 2) not escaped in search strings
- c) Double quote (“””) is
 - 1) not escaped in CSV lists
 - 2) not escaped in search strings when it appears as the start or end delimiter of a property value
 - 3) represented as “\”” in search strings when it appears as a character that is part of the property value

4.1.3 Extended Backus-Naur Form

Extended Backus-Naur Form is used in this document for a formal syntax description of certain constructs. The usage here is according to the reference [19].

4.1.3.1 Typographic conventions for EBNF

Non-terminal symbols are unquoted sequences of characters from the set of English upper and lower case letters, the digits “0” through “9”, and the hyphen (“-”). Character sequences between 'single quotes' are terminal strings and shall appear literally in valid strings. Character sequences between (*comment delimiters*) are English language definitions or supplementary explanations of their associated symbols. White space in the EBNF is used

to separate elements of the EBNF, not to represent white space in valid strings. White space usage in valid strings is described explicitly in the EBNF. Finally, the EBNF uses the following operators in Table 1:

Table 1 — EBNF Operators

Operator	Semantics
<code>::=</code>	definition – the non-terminal symbol on the left is defined by one or more alternative sequences of terminals and/or non-terminals to its right.
<code> </code>	alternative separator – separates sequences on the right that are independently allowed definitions for the non-terminal on the left.
<code>*</code>	null repetition – means the expression to its left may occur zero or more times.
<code>+</code>	non-null repetition – means the expression to its left shall occur at least once and may occur more times.
<code>[]</code>	optional – the expression between the brackets is allowed.
<code>()</code>	grouping – groups the expressions between the parentheses.
<code>-</code>	character range – represents all characters between the left and right character operands inclusively.

4.2 Derived Data Types

4.2.1 Summary

Subclause 4.2 defines a derived data type that is represented as a string data type with special syntax. This specification uses string data type definitions that originate from two different sources. The UPnP Device Architecture defined [string](#) data type is used to define state variable and action argument [string](#) data types. The XML Schema namespace is used to define property xsd:string data types. The following definition in subclause 4.2.2 applies to both string data types.

4.2.2 CSV Lists

The UPnP AV services use state variables, action arguments and properties that represent lists – or one-dimensional arrays – of values. The UPnP Device Architecture, Version 1.0 [14], does not provide for either an array type or a list type, so a list type is defined here. Lists may either be homogeneous (all values are the same type) or heterogeneous (all values can be of different types). Lists may also consist of repeated occurrences of homogeneous or heterogeneous subsequences, all of which have the same syntax and semantics (same number of values, same value types and in the same order). The data type of a homogeneous list is [string](#) or xsd:string and denoted by CSV (x), where x is the type of the individual values. The data type of a heterogeneous list is also [string](#) or xsd:string and denoted by CSV (x, y, z), where x, y and z are the types of the individual values. If the number of values in the heterogeneous list is too large to show each type individually, that variable type is represented as CSV (heterogeneous), and the variable description includes additional information as to the expected sequence of values appearing in the list and their corresponding types. The data type of a repeated subsequence list is [string](#) or xsd:string and denoted by CSV ({a,b,c},{x, y, z}), where a, b, c, x, y and z are the types of the individual values in the subsequence and the subsequences may be repeated zero or more times.

- A list is represented as a [string](#) type (for state variables and action arguments) or xsd:string type (for properties).
- Commas separate values within a list.
- Integer values are represented in CSVs with the same syntax as the integer data type specified in [14] (that is: allowed leading sign, allowed leading zeroes, numeric US-ASCII)
- Boolean values are represented in state variable and action argument CSVs as either “[0](#)” for false or “[1](#)” for true. These values are a subset of the defined [boolean](#) data type values specified in [14]: [0](#), [false](#), [no](#), [1](#), [true](#), [yes](#).

- Boolean values are represented in property CSVs as either “0” for false or “1” for true. These values are a subset of the defined Boolean data type values specified in [34]: 0, false, 1, true.
- Escaping conventions for the comma and backslash characters are defined in 4.1.2.
- White space before, after, or interior to any numeric data type is not allowed.
- White space before, after, or interior to any other data type is part of the value.

Table 2 — CSV Examples

Type refinement of string	Value	Comments
CSV (<u>string</u>) or CSV (xsd:string)	+artist,-date	List of 2 property sort criteria.
CSV (<u>int</u>) or CSV (xsd:integer)	1,-5,006,0,+7	List of 5 integers.
CSV (<u>boolean</u>) or CSV (xsd:Boolean)	0,1,1,0	List of 4 booleans
CSV (<u>string</u>) or CSV (xsd:string)	Smith\, Fred,Jones\, Davey	List of 2 names, “Smith, Fred” and “Jones, Davey”
CSV (<u>i4</u> , <u>string</u> , <u>ui2</u>) or CSV (xsd:int, xsd:string, xsd:unsignedShort)	-29837, string with leading blanks,0	Note that the second value is “ string with leading blanks”
CSV (<u>i4</u>) or CSV (xsd:int)	3, 4	Illegal CSV. White space is not allowed as part of an integer value.
CSV (<u>string</u>) or CSV (xsd:string)	“ ”	List of 3 empty string values
CSV (heterogeneous)	Alice,Marketing,5,Sue,R&D,21,Dave,Finance,7	List of unspecified number of people and associated attributes. Each person is described by 3 elements: a name <u>string</u> , a department <u>string</u> and years-of-service <u>ui2</u> or a name xsd:string, a department xsd:string and years-of-service xsd:unsignedShort.

4.3 Management of XML Namespaces in Standardized DCPs

UPnP specifications make extensive use of XML namespaces. This enables separate DCPs, and even separate components of an individual DCP, to be designed independently and still avoid name collisions when they share XML documents. Every name in an XML document belongs to exactly one namespace. In documents, XML names appear in one of two forms: qualified or unqualified. An unqualified name (or no-colon-name) contains no colon (“:”) characters. An unqualified name belongs to the document’s default namespace. A qualified name is two no-colon-names separated by one colon character. The no-colon-name before the colon is the qualified name’s namespace prefix, the no-colon-name after the colon is the qualified name’s “local” name (meaning local to the namespace identified by the namespace prefix). Similarly, the unqualified name is a local name in the default namespace.

The formal name of a namespace is a URI. The namespace prefix used in an XML document is *not* the name of the namespace. The namespace name shall be globally unique. It has a single definition that is accessible to anyone who uses the namespace. It has the same meaning anywhere that it is used, both inside and outside XML documents. The namespace prefix, however, in formal XML usage, is defined only in an XML document. It shall be locally unique to the document. Any valid XML no-colon-name may be used. And, in formal XML usage, different XML documents may use different namespace prefixes to refer to the same namespace. The creation and use of the namespace prefix was standardized by the W3C

XML Committee in [32] strictly as a convenient local shorthand replacement for the full URI name of a namespace in individual documents.

All AV object properties are represented in XML by element and attribute names, therefore, all property names belong to an XML namespace.

For the same reason that namespace prefixes are convenient in XML documents, it is convenient in specification text to refer to namespaces using a namespace prefix. Therefore, this specification declares a “standard” prefix for all XML namespaces used herein. In addition, this specification expands the scope where these prefixes have meaning, beyond a single XML document, to all of its text, XML examples, and certain string-valued properties. This expansion of scope *does not* supersede XML rules for usage in documents, it only augments and complements them in important contexts that are out-of-scope for the XML specifications. For example, action arguments which refer to CDS properties, such as the [SearchCriteria](#) argument of the [Search\(\)](#) action or the [Filter](#) argument of the [Browse\(\)](#) action, shall use the predefined namespace prefixes when referring to CDS properties (“upnp:”, “dc:”, etc).

All of the namespaces used in this specification are listed in Table 3 and Table 4. For each such namespace, Table 3 gives a brief description of it, its name (a URI) and its defined “standard” prefix name. Some namespaces included in these tables are not directly used or referenced in this document. They are included for completeness to accommodate those situations where this specification is used in conjunction with other UPnP specifications to construct a complete system of devices and services. For example, since the ScheduledRecording service depends on and refers to the ContentDirectory service, the predefined “srs:” namespace prefix is included. The individual specifications in such collections all use the same standard prefix. The standard prefixes are also used in Table 4 to cross-reference additional namespace information. Table 4 includes each namespace’s valid XML document root element(s) (if any), its schema file name, versioning information (to be discussed in more detail below), and a link to the entry in Clause 2 for its associated schema.

The normative definitions for these namespaces are the documents referenced in Table 3. The schemas are designed to support these definitions for both human understanding and as test tools. However, limitations of the XML Schema language itself make it difficult for the UPnP-defined schemas to accurately represent all details of the namespace definitions. As a result, the schemas will validate many XML documents that are not valid according to the specifications.

The Working Committee expects to continue refining these schemas after specification release to reduce the number of documents that are validated by the schemas while violating the specifications, but the schemas will still be informative, supporting documents. Some schemas might become normative in future versions of the specifications.

Table 3 — Namespace Definitions

Standard Name-space Prefix	Namespace Name	Namespace Description	Normative Definition Document Reference
<i>AV Working Committee defined namespaces</i>			
attrs	urn:schemas-upnp-org:av:AllowedTransformSettings	AllowedTransformSettings and AllowedDefaultTransformSettings state variables for RenderingControl	[21]
av	urn:schemas-upnp-org:av:av	Common data types for use in AV schemas	[3]
avdt	urn:schemas-upnp-org:av:avdt	Datastructure Template	[2]
avs	urn:schemas-upnp-org:av:avs	Common structures for use in AV schemas	[4]
avt-event	urn:schemas-upnp-org:metadata-1-0/AVT/	Evented LastChange state variable for AVTransport	[5]

Standard Name-space Prefix	Namespace Name	Namespace Description	Normative Definition Document Reference
cds-event	urn:schemas-upnp-org:av:cds-event	Evented <u>LastChange</u> state variable for ContentDirectory	[7]
cm-dciu	urn:schemas-upnp-org:av:cm-deviceClockInfoUpdates	Evented <u>DeviceClockInfoUpdates</u> state variable for ConnectionManager	[9]
cm-ftrlst	urn:schemas-upnp-org:av:cm-featureList	<u>FeatureList</u> state variable for ConnectionManager	[9]
didl-lite	urn:schemas-upnp-org:metadata-1-0/DIDL-Lite/	Structure and metadata for ContentDirectory	[7]
dmo	urn:schemas-upnp.org:av:dmo	Evented <u>DeviceMode</u> state variable for ContentDirectory	[7]
dmor	urn:schemas-upnp.org:av:dmor	<u>A_ARG_TYPE_DeviceModeRequest</u> state variable for ContentDirectory	[7]
dmos	urn:schemas-upnp.org:av:dmos	<u>DeviceModeStatus</u> state variable for ContentDirectory	[7]
pi	urn:schemas-upnp.org:av:pi	<u>PermissionsInfo</u> state variable for ContentDirectory	[7]
rds-event	urn:schemas-upnp-org:metadata-1-0/RCS/	Evented <u>LastChange</u> state variable for RenderingControl	[21]
rii	urn:schemas-upnp-org:av:rii	<u>A_ARG_TYPE_RenderingInfoList</u> state variable for ConnectionManager	[9]
rpl	urn:schemas-upnp-org:av:rpl	<u>A_ARG_TYPE_PlaylistInfo</u> state variable for AVTransport	[5]
srs	urn:schemas-upnp-org:av:srs	Metadata and structure for ScheduledRecording	[25]
srs-event	urn:schemas-upnp-org:av:srs-event	Evented <u>LastChange</u> state variable for ScheduledRecording	[25]
trs	urn:schemas-upnp-org:av:TransformSettings	<u>TransformSettings</u> and <u>DefaultTransformSettings</u> state variables for RenderingControl	[21]
upnp	urn:schemas-upnp-org:metadata-1-0/upnp/	Metadata for ContentDirectory	[7]
Externally defined namespaces			
dc	http://purl.org/dc/elements/1.1/	Dublin Core	[13]
xsd	http://www.w3.org/2001/XMLSchema	XML Schema Language 1.0	[33], [34]
xsi	http://www.w3.org/2001/XMLSchema-instance	XML Schema Instance Document schema	[33] 2.6 & 3.2.7
xml	http://www.w3.org/XML/1998/namespace	The "xml:" Namespace	[30]

Table 4 — Schema-related Information

Standard Name-space Prefix	Relative URI and File Name ^a • Form 1, Form 2, Form3	Valid Root Element(s)	Schema Reference
<i>AV Working Committee Defined Namespaces</i>			
atrs	AllowedTransformSetting s-vn-yyyymmdd.xsd AllowedTransformSetting s-vn.xsd AllowedTransformSetting s.xsd	<TransformList>	[1]
av	av-vn-yyyymmdd.xsd av-vn.xsd av.xsd	n/a	[3]
avdt	avdt-vn-yyyymmdd.xsd avdt-vn.xsd avdt.xsd	<AVDT>	[2]
avs	avs-vn-yyyymmdd.xsd avs-vn.xsd avs.xsd	<Capabilities> <Features> <stateVariableValuePairs>	[4]
avt-event	avt-event-vn- yyyymmdd.xsd avt-event-vn.xsd avt-event.xsd	<Event>	[6]
cds-event	cds-event-vn- yyyymmdd.xsd cds-event-vn.xsd cds-event.xsd	<StateEvent>	[8]
cm-dciu	cm- deviceClockInfoUpdates- vn-yyyymmdd.xsd cm- deviceClockInfoUpdates -vn.xsd cm- deviceClockInfoUpdates. xsd	<DeviceClockInfoUpdates>	[10]
cm-ftrlst	cm-featureList-vn- yyyymmdd.xsd cm-featureList-vn.xsd cm-featureList.xsd	<Features>	[11]
didl-lite	didl-lite-vn- yyyymmdd.xsd didl-lite-vn.xsd didl-lite.xsd	<DIDL-Lite>	[15]
dmo	dmo-vn-yyyymmdd.xsd dmo-vn.xsd dmo.xsd	<DeviceMode>	[16]
dmor	dmor-vn-yyyymmdd.xsd dmor-vn.xsd dmor.xsd	<DeviceModeRequest>	[17]
dmos	dmos-vn-yyyymmdd.xsd dmos-vn.xsd dmos.xsd	<DeviceModeStatus>	[18]

Standard Name-space Prefix	Relative URI and File Name ^a • Form 1, Form 2, Form3	Valid Root Element(s)	Schema Reference
pi	pi-vn-yyyymmdd.xsd pi-vn.xsd pi.xsd	<PermissionsInfo>	[20]
rce-event	rce-event-vn-yyyymmdd.xsd rce-event-vn.xsd rce-event.xsd	<Event>	[22]
rii	rii-vn-yyyymmdd.xsd rii-vn.xsd rii.xsd	<rendererInfo>	[23]
rpl	rpl-vn-yyyymmdd.xsd rpl-vn.xsd rpl.xsd	<PlaylistInfo>	[24]
trs	TransformSettings-vn-yyyymmdd.xsd TransformSettings-vn.xsd TransformSettings.xsd	<TransformSettings>	[28]
srs	srs-vn-yyyymmdd.xsd srs-vn.xsd srs.xsd	<srs>	[26]
srs-event	srs-event-vn-yyyymmdd.xsd srs-event-vn.xsd srs-event.xsd	<StateEvent>	[27]
upnp	upnp-vn-yyyymmdd.xsd upnp-vn.xsd upnp.xsd	n/a	[29]
Externally Defined Namespaces			
dc	Absolute URL: http://dublincore.org/schemas/xmls/simpledc20021212.xsd		[12]
xsd	n/a	<schema>	[35]
xsi	n/a		n/a
xml	n/a		[31]
^a Absolute URIs are generated by prefixing the relative URIs with " http://www.upnp.org/schemas/av/ "			

4.3.1 Namespace Prefix Requirements

There are many occurrences in this specification of string data types that contain XML names (property names). These XML names in strings will not be processed under namespace-aware conditions. Therefore, all occurrences in instance documents of XML names in strings shall use the standard namespace prefixes as declared in Table 3. In order to properly process the XML documents described herein, control points and devices shall use namespace-aware XML processors [32] for both reading and writing. As allowed by [32], the namespace prefixes used in an instance document are at the sole discretion of the document creator. Therefore, the declared prefix for a namespace in a document may be different from the standard prefix. All devices shall be able to correctly process any valid XML instance document, even when it uses a non-standard prefix for ordinary XML names. However, it is strongly recommended that all devices use these standard prefixes for all instance documents to avoid confusion on the part of both human and machine readers. These standard prefixes are used in all descriptive text and all XML examples in this and related UPnP specifications. However, each individual specification may assume a default namespace for its descriptive text. In that case, names from that namespace may appear with no prefix.

The assumed default namespace, if any, for each UPnP AV specification is given in Table 5.

Note: all UPnP AV schemas declare attributes to be “unqualified”, so namespace prefixes are never used with AV Working Committee defined attribute names.

Table 5 — Default Namespaces for the AV Specifications

AV Specification Name	Default Namespace Prefix
AVTransport	avt-event
ConnectionManager	n/a
ContentDirectory	didl-lite
MediaRenderer	n/a
MediaServer	n/a
RenderingControl	rct-event
ScheduledRecording	srs

4.3.2 Namespace Names, Namespace Versioning and Schema Versioning

The UPnP AV service specifications define several data structures (such as state variables and action arguments) whose format is an XML instance document that complies with one or more specific XML schemas, which define XML namespaces. Each namespace is uniquely identified by an assigned namespace name. The namespace names that are defined by the AV Working Committee are URNs. See Table 3 for a current list of namespace names. Additionally, each namespace corresponds to an XML schema document that provides a machine-readable representation of the associated namespace to enable automated validation of the XML (state variable or action parameter) instance documents.

Within an XML schema and XML instance document, the name of each corresponding namespace appears as the value of an `xmlns` attribute within the root element. Each `xmlns` attribute also includes a namespace prefix that is associated with that namespace in order to qualify and disambiguate element and attribute names that are defined within different namespaces. The schemas that correspond to the listed namespaces are identified by URI values that are listed in the `schemaLocation` attribute also within the root element (see subclause 4.3.3).

In order to enable both forward and backward compatibility, namespace names are permanently assigned and shall not change even when a new version of a specification changes the definition of a namespace. However, all changes to a namespace definition shall be backward-compatible. In other words, the updated definition of a namespace shall not invalidate any XML documents that comply with an earlier definition of that same namespace. This means, for example, that a namespace shall not be changed so that a new element or attribute becomes required in a conforming instance document. Although namespace names shall not change, namespaces still have version numbers that reflect a specific set of definitional changes. Each time the definition of a namespace is changed, the namespace's version number is incremented by one.

Whenever a new namespace version is created, a new XML schema document (.xsd) is created and published so that the new namespace definition is represented in a machine-readable form. Since a XML schema document is just a representation of a namespace definition, translation errors can occur. Therefore, it is sometime necessary to re-release a published schema in order to correct typos or other namespace representation errors. In order to easily identify the potential multiplicity of schema releases for the same namespace, the URI of each released schema shall conform to the following format (called Form 1):

Form 1: "http://www.upnp.org/schemas/av/" **schema-root-name** "-v" **ver** "-" **yyyymmdd** where

- **schema-root-name** is the name of the root element of the namespace that this schema represents.
- **ver** corresponds to the version number of the namespace that is represented by the schema.

- **yyyymmdd** is the year, month and day (in the Gregorian calendar) that this schema was released.

Table 4 identifies the URI formats for each of the namespaces that are currently defined by the UPnP AV Working Committee.

As an example, the original schema URI for the “rcs-event” namespace (that was released with the original publication of the UPnP AV service specifications in the year 2002) was “<http://www.upnp.org/schemas/av/rcs-event-v1-20020625.xsd>”. When the UPnP AV service specifications were subsequently updated in the year 2006, the URI for the updated version of the “rcs-event” namespace was “<http://www.upnp.org/schemas/av/rcs-event-v2-20060531.xsd>”. However, in 2006, the schema URI for the newly created “srs-event” namespace was “<http://www.upnp.org/schemas/av/srs-event-v1-20060531.xsd>”. Note the version field for the “srs-event” schema is “v1” since it was first version of that namespace whereas the version field for the “rcs-event” schema is “v2” since it was the second version of that namespace.

In addition to the dated schema URIs that are associated with each namespace, each namespace also has a set of undated schema URIs. These undated schema URIs have two distinct formats with slightly different meanings:

Form 2: “<http://www.upnp.org/schemas/av/>” *schema-root-name* “-v” **ver**
where **ver** is described above.

Form 3: “<http://www.upnp.org/schemas/av/>” *schema-root-name*

Form 2 of the undated schema URI is always linked to the most recent release of the schema that represents the version of the namespace indicated by **ver**. For example, the undated URI “.../av/rcs-event-v2.xsd” is linked to the most recent schema release of version 2 of the “rcs-event” namespace. Therefore, on May 31, 2006 (20060531), the undated schema URI was linked to the schema that is otherwise known as “.../av/rcs-event-v2-20060531.xsd”. Furthermore, if the schema for version 2 of the “rcs-event” namespace was ever re-released, for example to fix a typo in the 20060531 schema, then the same undated schema URI (“.../av/rcs-event-v2.xsd”) would automatically be updated to link to the updated version 2 schema for the “rcs-event” namespace.

Form 3 of the undated schema URI is always linked to the most recent release of the schema that represents the highest version of the namespace that has been published. For example, on June 25, 2002 (20020625), the undated schema URI “.../av/rcs-event.xsd” was linked to the schema that is otherwise known as “.../av/rcs-event-v1-20020625.xsd”. However, on May 31, 2006 (20060531), that same undated schema URI was linked to the schema that is otherwise known as “.../av/rcs-event-v2-20060531.xsd”.

When referencing a schema URI within an XML instance document or a referencing XML schema document, the following usage rules apply:

- All instance documents, whether generated by a service or a control point, shall use Form 3.
- All UPnP AV published schemas that reference other UPnP AV schemas shall also use Form 3.

Within an XML instance document, the definition for the `schemaLocation` attribute comes from the XML Schema namespace “<http://www.w3.org/2002/XMLSchema-instance>”. A single occurrence of the attribute can declare the location of one or more schemas. The `schemaLocation` attribute value consists of a whitespace separated list of values that is interpreted as a namespace name followed by its schema location URL. This pair-sequence is repeated as necessary for the schemas that need to be located for this instance document.

In addition to the schema URI naming and usage rules described above, each released schema shall contain a `version` attribute in the `<schema>` root element. Its value shall correspond to the format:

ver “-” **yyyymmdd** where **ver** and **yyyymmdd** are described above.

The `version` attribute provides self-identification of the namespace version and release date of the schema itself. For example, within the original schema released for the “rcs-event” namespace (`.../rcs-event-v2-20020625.xsd`), the `<schema>` root element contains the following attribute: `version="2-20020625"`.

4.3.3 Namespace Usage Examples

The `schemaLocation` attribute for XML instance documents comes from the XML Schema instance namespace “`http://www.w3.org/2002/XMLSchema-instance`”. A single occurrence of the attribute can declare the location of one or more schemas. The `schemaLocation` attribute value consists of a whitespace separated list of values: namespace name followed by its schema location URL. This pair-sequence is repeated as necessary for the schemas that need to be located for this instance document.

Example 1:

Sample *DIDL-Lite XML Instance Document*. Note that the references to the UPnP AV schemas do not contain any version or release date information. In other words, the references follow Form 3 from above. Consequently, this example is valid for all releases of the UPnP AV service specifications.

```
<?xml version="1.0" encoding="UTF-8"?>
<DIDL-Lite
  xmlns:dc="http://purl.org/dc/elements/1.1/"
  xmlns="urn:schemas-upnp-org:metadata-1-0/DIDL-Lite/"
  xmlns:upnp="urn:schemas-upnp-org:metadata-1-0/upnp/"
  xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
  xsi:schemaLocation="
    urn:schemas-upnp-org:metadata-1-0/DIDL-Lite/
      http://www.upnp.org/schemas/av/didl-lite.xsd
    urn:schemas-upnp-org:metadata-1-0/upnp/
      http://www.upnp.org/schemas/av/upnp.xsd">
  <item id="18" parentID="13" restricted="0">
    ...
  </item>
</DIDL-Lite>
```

4.4 Vendor-defined Extensions

Whenever vendors create additional vendor-defined state variables, actions or properties, their assigned names and XML representation shall follow the naming conventions and XML rules as specified below in subclauses 4.4.1 to 4.4.4.

4.4.1 Vendor-defined Action Names

Vendor-defined action names shall begin with “**X**”. Additionally, it should be followed by an ICANN assigned domain name owned by the vendor followed by the underscore character (“_”). It shall then be followed by the vendor-assigned action name. The vendor-assigned action name shall not contain a hyphen character (“-”, 2D Hex in UTF-8) nor a hash character (“#”, 23 Hex in UTF-8). Vendor-assigned action names are case sensitive. The first character of the name shall be a US-ASCII letter (“A”-“Z”, “a”-“z”), US-ASCII digit (“0”-“9”), an underscore (“_”), or a non-experimental Unicode letter or digit greater than U+007F. Succeeding characters shall be a US-ASCII letter (“A”-“Z”, “a”-“z”), US-ASCII digit (“0”-“9”), an underscore (“_”), a period (“.”), a Unicode combiningchar, an extender, or a non-experimental Unicode letter or digit greater than U+007F. The first three letters shall not be “XML” in any combination of case.

4.4.2 Vendor-defined State Variable Names

Vendor-defined state variable names shall begin with “**X**”. Additionally, it should be followed by an ICANN assigned domain name owned by the vendor, followed by the underscore character (“_”). It shall then be followed by the vendor-assigned state variable name. The vendor-assigned state variable name shall not contain a hyphen character (“-”, 2D Hex in UTF-8). Vendor-assigned action names are case sensitive. The first character of the name shall be a US-ASCII letter (“A”-“Z”, “a”-“z”), US-ASCII digit (“0”-“9”), an underscore (“_”), or a

non-experimental Unicode letter or digit greater than U+007F. Succeeding characters shall be a US-ASCII letter ("A"-"Z", "a"-"z"), US-ASCII digit ("0"-"9"), an underscore ("_"), a period ("."), a Unicode combiningchar, an extender, or a non-experimental Unicode letter or digit greater than U+007F. The first three letters shall not be "XML" in any combination of case.

4.4.3 Vendor-defined XML Elements and attributes

UPnP vendors may add non-standard elements and attributes to a UPnP standard XML document, such as a device or service description. Each addition shall be scoped by a vendor-owned XML namespace. Arbitrary XML shall be enclosed in an element that begins with "X," and this element shall be a sub element of a standard complex type. Non-standard attributes may be added to standard elements provided these attributes are scoped by a vendor-owned XML namespace and begin with "X".

4.4.4 Vendor-defined Property Names

UPnP vendors may add non-standard properties to the ContentDirectory service. Each property addition shall be scoped by a vendor-owned namespace. The vendor-assigned property name shall not contain a hyphen character ("-", 2D Hex in UTF-8). Vendor-assigned property names are case sensitive. The first character of the name shall be a US-ASCII letter ("A"-"Z", "a"-"z"), US-ASCII digit ("0"-"9"), an underscore ("_"), or a non-experimental Unicode letter or digit greater than U+007F. Succeeding characters shall be a US-ASCII letter ("A"-"Z", "a"-"z"), US-ASCII digit ("0"-"9"), an underscore ("_"), a period ("."), a Unicode combiningchar, an extender, or a non-experimental Unicode letter or digit greater than U+007F. The first three letters shall not be "XML" in any combination of case.

5 Service Modeling Definitions

5.1 Service Type

The following service type identifies a service that is compliant with this template:

urn:schemas-upnp-org:service:ContentDirectory:4

ContentDirectory service is used herein to refer to this service type.

5.2 Key Concepts

5.2.1 On-line and Off-line Network States

In the context of the ContentDirectory service, a device is considered *attached* to the network (a.k.a. *on-line* or *connected*, or *re-connected*) when the device is physically attached to the network and has sent a UPnP ssdp:alive message that has not yet expired as defined in 1.2.2 of the UPnP Device Architecture specification [14] for details. A device is considered to be *unattached* to the network (a.k.a. *off-line* or *disconnected*) when it sends a UPnP ssdp:byebye message or when all of the device's ssdp:alive messages have expired. See 1.2.2 of the UPnP Device Architecture specification [14] for details.

A UPnP control point is considered *connected* to a network when it is physically attached to that network, is actively monitoring the UPnP multicast discovery address, and is capable of receiving ssdp:alive messages from connected devices as described in 1.2.2 of the UPnP Device Architecture specification [14].

5.2.2 object

A ContentDirectory object is a structured set of metadata properties representing entertainment content that might be playable on a device connected to a network. For example, an object can represent:

- Static content such as a stored song, photo, video, etc.
- Transient content (such as broadcast program) that will be temporarily accessible in real-time (for example, a live broadcast).
- A long-lived access portal for dynamic content such as a "Most recently played" placeholder.

- A collection of other objects (called a “container”).

As illustrated above, an object can represent individual content (for example, a song or photo) or a collection of content (for example, a photo album or the contents of an audio CD). Objects are typically obtained from the ContentDirectory service via a DIDL-Lite compliant XML document usually by way of an action parameter whose data type is [A_ARG_TYPE_Result](#). See subclauses 5.5.8 and 5.5.9 for examples. See subclause 5.3.15 for details.

Each ContentDirectory object includes a set of metadata properties that provide various information about the object and the content that the object represents. Examples include a unique ID, a class, a title, one or more artists, the time created, the access method for the content, etc. See 5.2.20 for details.

For identification purposes, the ContentDirectory service shall assign a unique ID (called an *object ID*) to each object. The object ID is the one and only reliable method for identifying a specific object. Although multiple objects can represent the same piece of content (for example, the same song exposed by both a genre container and an artist container), each object has its own unique object ID. See 5.2.3 for details.

The ContentDirectory service also defines an object class hierarchy that corresponds to the different types of objects that are managed by the ContentDirectory service. The root (base) class of the class hierarchy, from which all other classes are derived, is named [object](#). Although the [object](#) class itself cannot be instantiated, all classes derived from the [object](#) class can be instantiated. See 5.2.6 for details.

5.2.3 Object Identity

Each object that is managed by a ContentDirectory service is assigned a unique ID by the implementation. This object ID, which is exposed via the object's [@id](#) property, provides a unique identity for the object. The [@id](#) property is essential for reliably identifying a specific object among those hosted by a particular ContentDirectory service because no other object metadata (or combinations of metadata) provides a distinct identity for the object. For example, two distinct objects, each with a unique [@id](#) property value, can have identical metadata (except for the [@id](#) property) such as two objects representing the same content. Without the [@id](#) property, there is no way to definitively distinguish between the two objects. Even when there are differences in the metadata of two objects, those differences can be temporary and do not provide a reliable way to distinguish the two objects.

Since the ContentDirectory implementation assigns each object's [@id](#) property value, the implementation fully controls the lifetime of each object; that is: it controls whether or not an object retains its identity. Specifically, when an implementation returns an object with an [@id](#) property value that has been returned in the past, the implementation is indicating that this object is the same object that was returned previously. Even when the object's metadata has changed, an identical [@id](#) property value indicates that this is the same object as before. Similarly, when an implementation assigns a new value to an object's [@id](#) property, the implementation is creating a new object and declaring that this object is different from any other previously known object even if the object's metadata is identical to a previously known object.

If the [@id](#) property values are preserved, control points are able to correlate objects across time, even across periods when the control point or the ContentDirectory service is *off-line* (see 5.2.1). For example, a control point can maintain a *Favorites* or a *Most Recently Used* list of objects so that an end-user can quickly locate specific content. Without persistent [@id](#) property values (that is: with objects that have only a temporary identity), a control point would not be able to deterministically locate the same object that it used earlier.

Additionally, if a ContentDirectory service implementation uses an [@id](#) property value for one object and when that object is deleted reuses that same [@id](#) property value for a new and different object, a control point can mistake the new object for the original, deleted object. This is known as object [@id](#) reuse. Note that if the ContentDirectory service implementation does reuse the [@id](#) property value of a deleted object, it is making the statement that the new object is exactly the same object as was deleted previously (although its metadata might have

changed). A ContentDirectory service implementation shall enforce the above rule for object [@id](#) reuse during periods when the [ServiceResetToken](#) state variable is constant. See 5.3.7 for details.

Preserving the [@id](#) property value across periods when the server is *off-line* is recommended for all objects. For those objects that support tracking changes, through the exposure of the [upnp:objectUpdateID](#) and [upnp:containerUpdateID](#) properties, preservation of the [@id](#) property value across periods when the ContentDirectory service implementation is *off-line* is required. See D.2 for examples of mechanisms to generate persistent and unique [@id](#) property values.

5.2.4 Object Lifetime

The term *object lifetime* refers to the period of time that an object exists. By definition, a ContentDirectory service object exists as long as it is accessible by a control point via the ContentDirectory service [Browse\(\)](#) action. Since an object's identity is defined by the value of the object's [@id](#) property, an object's lifetime is directly related to the period of time that the object's [@id](#) property value can be used to locate the object.

Although the duration of an object's lifetime (short vs. long) can be influenced by many factors, the two most common situations that truncate an object's lifetime (that is: cause the object to cease to exist) are:

- Deleting the object from the ContentDirectory service.
- Changing the value of the object's [@id](#) property thereby creating a brand new object identity.

Some objects tend to be inherently short-lived because they are deleted shortly (for example, within a few hours) after they are created because the object's usefulness fades. Such objects might include EPG objects which represent broadcast programs or objects that are stored on removable media.

Other objects are inherently long-lived, for example, objects that represent files that reside in storage controlled by the ContentDirectory service. As discussed in 5.2.3, preserving the longevity of inherently long-lived objects provide control points with certain advantages. ContentDirectory service implementations are recommended to maintain the lifetime of inherently long-lived objects, for example, by routinely preserving their identity. See D.2 for details.

5.2.5 Object Modification

Except as noted below, an *Object Modification* occurs when the value of one or more of an object's properties is modified, added, or deleted. This includes any vendor-defined properties. Adding or deleting a child object of a container object constitutes an *Object Modification* on the container only when one or more exposed properties of the container (with the exceptions noted below) change as a result of that add or delete (such as the [@childCount](#), [@childContainerCount](#) or [upnp:totalDeletedChildCount](#) properties). However, a change to any property belonging to any of the container's child objects shall not be treated as an *Object Modification* of the container. See 5.2.9 for details.

Exceptions:

The following properties are excluded from the definition of an *Object Modification*:

- [upnp:objectUpdateID](#)
- [upnp:containerUpdateID](#)

Consequently, a modification to any of the above properties shall not be treated as an *Object Modification*. For example, the [SystemUpdateID](#) state variable and all [upnp:containerUpdateID](#) properties (defined below) shall not be incremented when either of these properties are modified.

5.2.6 class

A class is used to assign a type to an object. It also identifies the minimum required set of properties that shall be included in the object's metadata and the allowed properties that may be included. Classes are organized in a hierarchy with certain classes being derived from others as in a typical object-oriented system. At the root of the class hierarchy is the object base class. Examples are object.item.audioItem.musicTrack and object.container.album.musicAlbum. See C.1.1 for a definition of the format of the class specification for an object.

5.2.7 item

An item is a first-level class derived directly from object. An item most often represents a single piece of AV data, such as a CD track, a movie or an audio file. Items may be playable, meaning they have information that can be played on a rendering device. Any object which is derived from the item class is represented in XML using the DIDL-Lite element `<item>...</item>`.

Note: The term item is used in this specification to indicate an object whose class is either item or any of the defined item-derived classes.

5.2.8 container

A container is a first-level class derived directly from object. The term container is used in this specification to indicate an object whose class is either container or any of the defined container-derived classes. A container instance represents a collection of objects. Containers can represent the physical organization of objects (storage containers) or logical collections. Logical collections can have formal definitions of their contents or they can be arbitrary collections. Containers can be either homogeneous, containing objects that are all of the same class, or heterogeneous, containing objects of mixed class. Containers can contain other containers. Any object derived from the container class is represented in XML using the DIDL-Lite element `<container>...</container>`.

Note that a ContentDirectory service implementation is required to maintain a ContainerUpdateIDValue indicator for each of its containers. See 5.2.11 for details.

5.2.9 Container Modification

Since a container (that is: any object whose class is derived from the container class) is derived from the object class, the semantics of an *Object Modification* also apply to all container objects. However, since a container contains other objects (see 5.2.8) the concept of a *Container Modification* is introduced. It is used to indicate that some change has occurred within a container (for example, one or more of the container's properties has changed, this is also defined as an *Object Modification* of that container) or within any of its child item(s) (that is: a child object whose class is not derived from the container class). This includes any vendor-defined properties within the container or any child item. Child container objects (that is: children derived from the container class) do not generate a *Container Modification* for their parent container because they have their own notion of a *Container Modification*. Each change in the ContentDirectory service's metadata results in one and only one *Container Modification* which is associated with one and only one container.

In specific terms, except as noted below, a container experiences a *Container Modification* when any of the following conditions occur:

- The container experiences an *Object Modification*; that is: one or more properties of the container (including any vendor-defined property) are added, removed or changed. See 5.2.5 for details.
- A child object (either a child item or child container - including vendor-defined object classes) is added to or removed from the container.
- A child item (i.e. an object whose class is not derived from the container class) has any of its properties added, removed or changed, except those explicitly listed as exceptions in the *Object Modification* definition in 5.2.5.

Note: The exceptions listed under the definition of object modification also apply to a container modification. Refer to the exceptions listed in 5.2.5.

5.2.10 ContentDirectory Tracking Changes Option

A ContentDirectory service implementation may choose to implement the *Tracking Changes Option*. This means that the ContentDirectory service implementation supports all necessary state variables, properties, and eventing mechanisms to expose to control points the changes to individual objects within the ContentDirectory hierarchy. If the ContentDirectory service implementation supports the *Tracking Changes Option*, there can be objects within the ContentDirectory hierarchy for which the service does not support tracking changes; for example, objects that frequently change, such as EPG data. At any point in time, a ContentDirectory service implementation can support the *Tracking Changes Option* but have no objects for which it is currently tracking changes.

If the ContentDirectory service implementation supports the *Tracking Changes Option*, then it shall:

- Support the LastChange state variable as defined in 5.3.8.
- Implement the Search() action.
- Include the upnp:objectUpdateID and upnp:containerUpdateID properties in the SearchCapabilities state variable.
- Support the following operators for the upnp:objectUpdateID and upnp:containerUpdateID properties: <, <=, >=, >, =, !=, exists.
- Support the = operator for the @id and @parentID properties.
- Support the = and derivedFrom operators for the upnp:class property.

The following metadata properties shall be implemented for all items for which the ContentDirectory service implementation is tracking changes:

- upnp:objectUpdateID
- res@updateCount

The following metadata properties shall be implemented for all containers for which the ContentDirectory service implementation is tracking changes:

- upnp:containerUpdateID
- upnp:objectUpdateID
- @childCount
- upnp:totalDeletedChildCount

If the ContentDirectory service implementation does not implement the *Tracking Changes Option*, then the ContentDirectory service implementation shall not support the LastChange state variable and the following metadata properties shall not be used on any object within the ContentDirectory hierarchy:

- upnp:objectUpdateID
- res@updateCount
- upnp:containerUpdateID
- upnp:totalDeletedChildCount

A control point can determine if the ContentDirectory service implementation supports the *Tracking Changes Option* by checking for the existence of the LastChange state variable in the SCPD.

5.2.11 ContainerUpdateIDValue Indicator

The ContainerUpdateIDValue indicator is an internal, unsigned integer that shall be maintained for each instance of class container and any of its derived classes. In previous

versions of the specification, this was simply known as the ContainerUpdateID. However with this version of the specification it is known as the ContainerUpdateIDValue indicator in order to differentiate it from the exposed allowed upnp:containerUpdateID property, which, if present, carries this same value.

If the ContentDirectory service implementation supports the *Tracking Changes Option*, then the ContainerUpdateIDValue indicator (whether or not it is exposed in a corresponding upnp:containerUpdateID property of the container) shall be the same as the property value defined in B.19.1.

If the ContentDirectory service implementation does not support the *Tracking Changes Option*, then the ContainerUpdateIDValue indicator is incremented each time the container is modified (see 5.2.9 for the precise definition of *Container Modification*). Upon reaching the value of $2^{32}-1$, the next update rolls the value back to 0, and the implementation shall invoke the *Service Reset Procedure* as defined in 5.3.7.1. The initial ContainerUpdateIDValue indicator value for any newly created container is unspecified, but recommended to be 0. Implementers should maintain the same value for each container's ContainerUpdateIDValue indicator through power cycles and any other disappearance/appearance on the network. The ContainerUpdateIDValue indicator is not a formal property of a container object, so a modification to a child container that affects that child's ContainerUpdateIDValue indicator does not propagate upward to the parent container.

5.2.12 ContentDirectory Service Object Organization

From a logical viewpoint, objects are organized in a ContentDirectory service according to a tree hierarchy. This tree hierarchy is called the ContentDirectory service content hierarchy. At the origin (top) of the ContentDirectory service content hierarchy, there is the single root container. This root container contains all other objects—items and containers, in a hierarchical tree fashion—that make up the entire ContentDirectory service content. Containers can contain both sub-containers and items. Items cannot contain other objects. Items are therefore always leaf nodes on the tree. Figure 1 illustrates the concepts. (The figure represents a hypothetical ContentDirectory service content structure.)

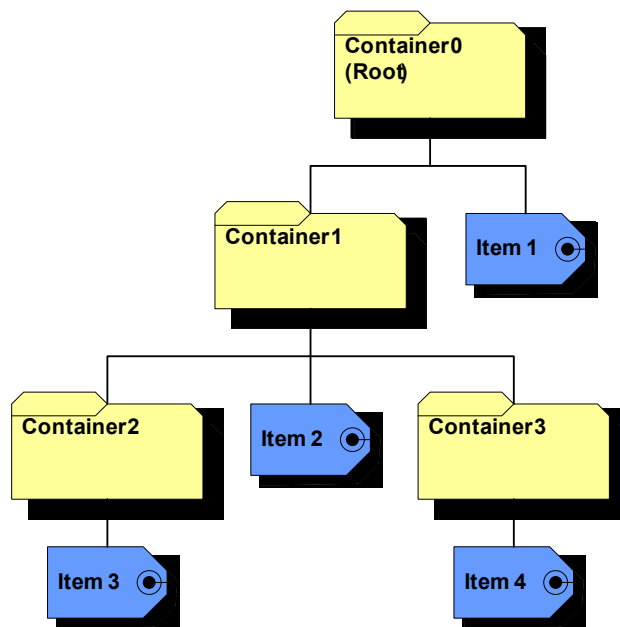


Figure 1 — ContentDirectory Service Object Organization

Container 0 is the root container of the ContentDirectory service tree hierarchy.

5.2.13 Hierarchical location

Within the ContentDirectory service tree hierarchy, an object resides directly below a container if that object's @parentID property value equals the @id property value of that container. That container is called the *parent (container)* of the object (one level up) and the

container is said to have a parent relationship with the object. The object is called a *child (object)* of the container (one level down) and the object is said to have a child relationship with that container.

A child object can be either an item object or a container object. In Figure 1, Item 1 is a child of Container 0 (the Root container). Likewise, Item 3 is a child of Container 2. Any object can only have one parent container, except for the root container, which has none (indicated by setting its [@parentID](#) property value to “-1”). A parent container can have multiple child objects. In Figure 1, Container 1 is the parent of Container 2, Item 2, and Container 3.

An object is called a *descendant object* of a container if it is a child of that container or if it is connected to that container through one or more intermediate child relationships (any level down). A descendant object can be either an item object or a container object. All objects (except the root container) are descendants of the root container. In Figure 1, Item 3 is a descendant of Container 1.

A container is called an *ancestor container* of an object if that container is a parent of that object or if it is connected to the object through one or more intermediate parent relationships (any level up). The root container is an ancestor of all objects within the ContentDirectory service. In Figure 1, Container 1 is an ancestor of Item 4.

See B.1.1 and B.1.2 for additional information.

5.2.14 Subtree

A subtree for a given container is defined as the container itself plus the collection of all objects that have a descendant relationship to that container. That container is called the root container of the subtree. Each container within the ContentDirectory service tree hierarchy is the root container of a single subtree. In Figure 1, Container 1 is the subtree root container of the subtree that consists of Container1, Container 2, Item 2, Container 3, Item 3, and Item 4.

5.2.15 Subtree Updates

In some situations, a ContentDirectory service needs to manipulate (that is: add, modify, or delete) a relatively large number of objects within a single ContentDirectory subtree (that is: all of the objects to be updated are descendants of a single container). Typically, these situations involve an internal operation such as searching a newly found storage medium for new content or updating a large set of EPG objects with fresh data. While performing these types of operations, numerous objects can be created, modified, and/or deleted in a short period of time.

As described in 5.3.8, each object update triggers an event that might need to be processed by a control point. However, the large number of rapidly occurring events can overwhelm the capabilities of some control points. Consequently, the events contained in the [LastChange](#) state variable that correspond to these large subtree updates, can be tagged with the `stUpdate` attribute so that they can be distinguished from other update events which occur far less rapidly and affect far fewer objects (for example, those events triggered by the [CreateObject\(\)](#) or [UpdateObject\(\)](#) actions). The `stUpdate` attribute enables a control point to apply special processing algorithms that are specifically designed to accommodate a large number of object updates.

In addition to the `stUpdate` attribute, the [LastChange](#) state variable also defines a special-purpose event, called `<stDone>`, which is used by the device to indicate that a sub-tree update operation has finished. The `<stDone>` event identifies the container object that represents the root of the updated subtree. This information can be used by a control point to process the subtree updates more efficiently for example, container-by-container rather than object-by-object.

Although the mechanisms above enables a control point to more efficiently handle subtree updates, there is no precise definition of what constitutes a subtree update. Therefore, each ContentDirectory service implementation can designate various update operations as a subtree update as it deems appropriate. A given update operation may be represented as one

or more subtree updates. The following guidelines identify when the subtree update mechanism could be used.

When to use the subtree update mechanism:

- When an entire sub-tree is added to or deleted from the ContentDirectory service.
- When the set of updates underneath a container object has a high “update density”. In other words, when the percentage of descendant objects that are modified vs. the total number of descendant objects within the subtree is relatively high.

When not to use the subtree update mechanism:

- When the set of objects that need to be updated are scattered throughout the ContentDirectory service; that is: there are no high update density subtree roots. If the update density is low, marking every container update as a subtree update could cause the control point to do more work than just processing each object update individually.

When an implementation chooses to use the subtree update mechanism, the following criteria shall be obeyed:

- Each subtree update shall have one and only one container object designated as the root of the subtree. In some extreme cases, the root of the sub-tree update can be the ContentDirectory service root container (*@id*="0").
- All objects represented by an object modification event with the *stUpdate* attribute set to one ("1") shall be a descendant of one and only one designated subtree root. In other words, the root of an active subtree update operation shall not be a descendant of the root of another active subtree update operation.

5.2.16 XML Document

An XML document is a string that represents a valid XML 1.0 document according to a specific schema. Every occurrence of the phrase “*XML Document*” is italicized and preceded by the document’s root element name (also italicized), as listed in column 3, “Valid Root Element(s)” of Table 4.

For example, the phrase *DIDL-Lite XML Document* refers to a valid XML 1.0 document according to the DIDL-Lite schema [15]. Such a document comprises a single `<DIDL-Lite ...>` root element, and it is allowed to be preceded by the XML declaration `<?xml version="1.0" ...?>`.

This string will therefore be of one of the following two forms:

`<DIDL-Lite ...>...</DIDL-Lite>`

or

`<?xml ...?><DIDL-Lite ...>...</DIDL-Lite>`

5.2.17 XML Fragment

An XML fragment is a sequence of XML elements that are valid direct or indirect child elements of the root element according to a specific schema. Every occurrence of the phrase “*XML Fragment*” is italicized and preceded by the document’s root element name (also italicized), as listed in column 3, “Valid Root Element(s)” of Table 4, “ — Schema-related Information”.

The following are examples of *DIDL-Lite XML Fragments*:

`<item id="..." ...>...</item>`

or

`<res protocolInfo="..." ...>...</res>`

or

```
"<dc:title>Sunrise</dc:title>"
```

5.2.18 DIDL-Lite XML Document

Whenever there is a need for action arguments to contain a description of (part of) the ContentDirectory service tree hierarchy (for example, the result of a [Browse\(\)](#) or [Search\(\)](#) action), a valid *DIDL-Lite XML Document* is used. The phrase *DIDL-Lite XML Document* refers to a valid XML 1.0 document according to the DIDL-Lite schema as defined in [15].

Such a document comprises a single `<DIDL-Lite ...>` root element, and it is allowed to be preceded by the XML declaration `<?xml version="1.0" ...?>`.

This string will therefore be one of the following two forms:

```
"<DIDL-Lite ...>...</DIDL-Lite>"
```

or

```
"<?xml ...?><DIDL-Lite ...>...</DIDL-Lite>"
```

The *DIDL-Lite XML Document* presents a flattened view of (part of) the ContentDirectory service tree hierarchy. It is important to make a clear distinction between the ContentDirectory tree hierarchy (a logical concept) and the *DIDL-Lite XML Document* (with its intrinsic document hierarchy), which is a syntax used to express (part of) the ContentDirectory tree hierarchy. Although it is perfectly possible to accurately express hierarchical structure in an XML Document (XML is intrinsically hierarchical), this specification does not use XML hierarchy to express ContentDirectory service tree hierarchy. Instead, information about the hierarchical location of an object within the ContentDirectory service tree hierarchy is maintained by including the object ID of the parent container in which the object resides into the metadata of the object ([@parentID](#) property).

Within the context of the *DIDL-Lite XML Document*, all ContentDirectory service objects are represented as either `<container>` or `<item>` XML elements. They all reside at the same XML hierarchical level. All `<container>` or `<item>` XML elements are sub-elements of the XML root element `<DIDL-Lite>`. No `<container>` element can contain another `<container>` or `<item>` element. In other words, `<container>` and `<item>` elements shall not be embedded in `<container>` elements.

Figure 2 illustrates this flattened view. To the right, the corresponding (incomplete, simplified) *DIDL-Lite XML Document* is also included.

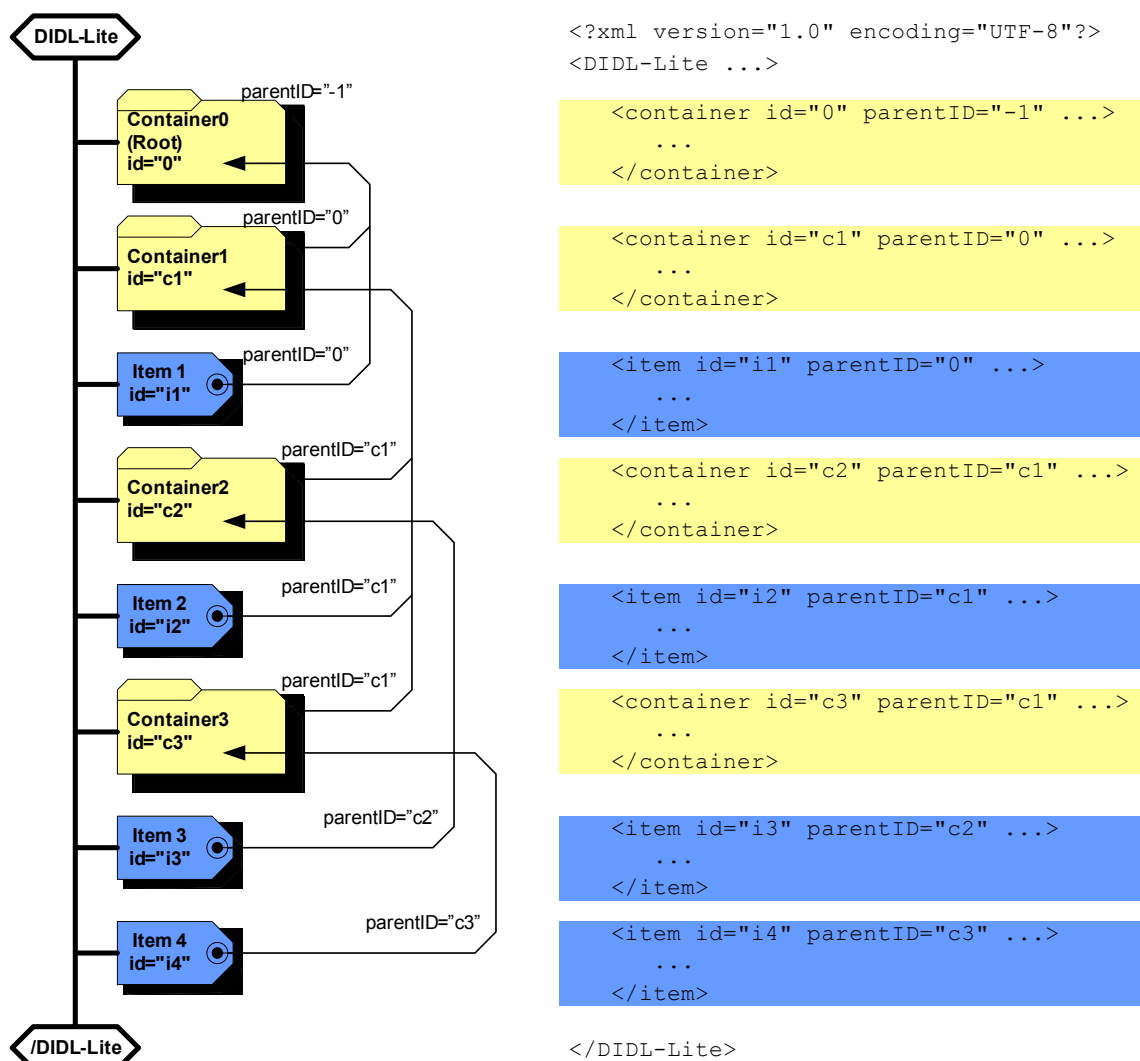


Figure 2 — Flattened DIDL-Lite hierarchical structure

Note: The information about an object in a *DIDL-Lite XML Document* is not necessarily sufficient to determine its hierarchical location in the ContentDirectory tree.

Indeed, to determine the correct hierarchical location, a control point needs to know all of that object's ancestor containers up to the root container. However, in many cases, based on the arguments to the [Browse\(\)](#) or [Search\(\)](#) action, it is possible that the resulting *DIDL-Lite XML Document* does not contain sufficient hierarchical information to reconstruct the exact location within the entire ContentDirectory service tree hierarchy. For example, a [Browse\(\)](#) action on direct children, performed on Container 3 in the example from Figure 1 above will only return the following (incomplete, simplified) *DIDL-Lite XML Document*:

```

<?xml version="1.0" encoding="UTF-8">
<DIDL-Lite ...>
  <item id="i4" parentID="c3" ...>
  </item>
</DIDL-Lite>

```

This *DIDL-Lite XML Document* only indicates that Item 4 resides below Container 3 but it does not convey that in turn, Container 3 resides below Container 1, which in turn resides below the root Container 0.

5.2.19 CDS View

CDS View is an XML representation of ContentDirectory objects that is used as input to an XQuery processor. A *CDS View* contains all descendant objects available underneath a given container in the ContentDirectory service at the time it is processed. The predominant *CDS*